



2015

# OPTICS + PHOTONICS.

The latest research in optical engineering and applications,  
nanotechnology, sustainable energy, organic photonics,  
and astronomical instrumentation

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ADVANCE  
TECHNICAL  
PROGRAM

THIS PROGRAM IS CURRENT AS OF  
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Conferences & Courses  
9–13 August 2015

San Diego Convention Center  
San Diego, California, USA

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Exhibition  
11–13 August 2015



# SPIE. OPTICS + PHOTONICS

San Diego Convention Center  
San Diego, California, USA

**CONFERENCES  
AND COURSES:**  
9-13 AUGUST 2015

**EXHIBITION**  
11-13 AUGUST 2015

Hear the latest research on optical engineering and applications, sustainable energy, nanotechnology, organic photonics, and astronomical instrumentation.

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## ATTEND SPIE OPTICS + PHOTONICS

The largest international, multidisciplinary optical science and technology meeting in North America.

**4,500 Attendees**

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**3,350 Papers**

Hear presentations on the latest research.

**38 Courses  
& Workshops**

You can't afford to stop learning.

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## 180-Company Exhibition

See optical devices, components, materials, and technologies.

## **SPIE.** OPTICS+ PHOTONICS NANOSCIENCE+ ENGINEERING

Metamaterials, plasmonics, CNTs, graphene, thin films, spintronics, nanoengineering, optical trapping, nanophotonic materials, nanomedicine, Low-D and 2D materials

## **SPIE.** OPTICS+ PHOTONICS OPTICS+PHOTONICS FOR SUSTAINABLE ENERGY

Thin films, concentrators, reliability, next generation cell technologies

## **SPIE.** OPTICS+ PHOTONICS ORGANIC PHOTONICS+ ELECTRONICS

OLEDs, OTFTs, OPVs, liquid crystals, organic materials, organic semiconductors, printed memory and circuits

## **SPIE.** OPTICS+ PHOTONICS OPTICAL ENGINEERING+ APPLICATIONS

Optical manufacturing design, metrology, x-ray, SSL, remote sensing, atmospheric and space optical systems, astronomical instrumentation, photonic devices, signal and image processing

### CHECK THE WEB FOR UPDATES AND INFORMATION

- Paper listings, session times, participants, and locations
- Special events
- Exhibiting companies and activities on the show floor
- Courses and workshops
- Hotel, travel, and parking information

Reserve Hotel Rooms by: **14 July 2015**

Registration Rates Increase after: **24 July 2015**

**REGISTER TODAY**

[www.spie.org/op15program](http://www.spie.org/op15program)

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SPIE would like to express its deepest appreciation to the symposium chairs, conference chairs, program committees, session chairs, and authors who have so generously given their time and advice to make this symposium possible.

The symposium, like our other conferences and activities, would not be possible without the dedicated contribution of our participants and members. This program is based on commitments received up to the time of publication and is subject to change without notice.

# EVENTS SCHEDULE

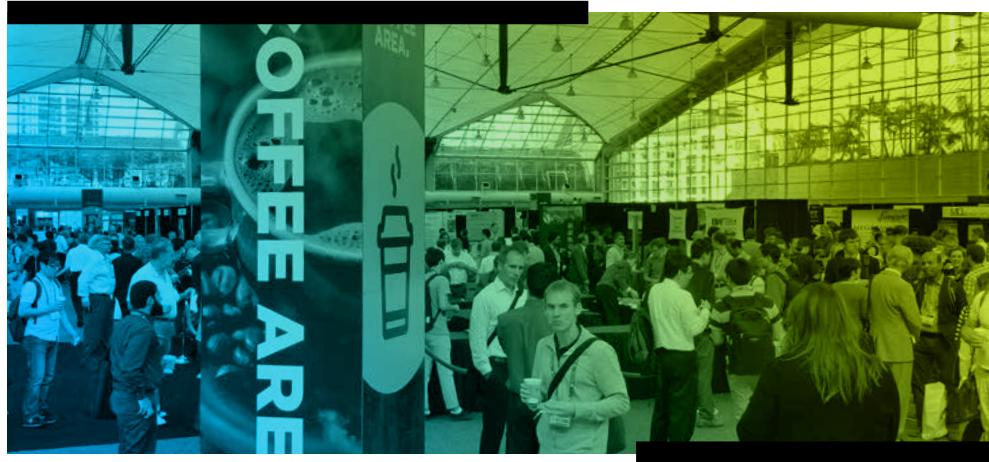
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**See Course Daily Schedule, pages 211-215.**

# SOCIAL, TECHNICAL, AND NETWORKING EVENTS.

- TECHNICAL
- INDUSTRY
- MEMBERSHIP
- SOCIAL NETWORKING
- STUDENT
- PROFESSIONAL DEVELOPMENT



## Technical Events

### POSTER SESSION: Organic, Sustainable Energy, and Optical Engineering + Applications

Monday 10 August 2015 · 5:30 PM - 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the collection of posters within the topics of Optics + Photonics for Sustainable Energy, Organic Photonics + Electronics, and Optical Engineering + Applications. Enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, visit <http://spie.org/x30293.xml> for set-up instructions.

### Illumination Technical Event

Monday 10 August 2015 · 8:00 PM - 10:00 PM

Chair: **Jake Jacobsen**, Synopsys, Inc. (United States)

Please join us for an evening of stimulating discussion. Since we last discussed this topic five years ago, solar energy production in the US has seen substantial growth. What is the state of solar technology and what is coming down the road? Join us for an evening of discussion of the current state of solar energy production and a look into the future. At the end of the planned event, time permitting, any member of the audience may present information within the broad field of illumination. Light refreshments will be served.

*Light refreshments sponsored by:*

The Optical Solutions Group at **SYNOPSYS®**

### The Nature of Light: What are Photons? Technical Event

Tuesday 11 August 2015 · 7:30 PM - 10:00 PM

Session Chair: **Chandrasekhar Roychoudhuri**, Univ. of Connecticut (USA) and Femto Macro Continuum (USA)

Join us for a special technical event featuring Prof. Marlan Scully's Keynote Talk. Prof. Scully holds joint appointments with Texas A&M Univ. (USA), Princeton Univ. (USA), and Baylor Univ. (USA). He is an eminent scientist and a very well-known author in the field of Quantum Optics. Prof. Scully's pioneering work includes the first quantum theory of the laser with Nobel laureate, Lamb; the first demonstrations of lasing without inversion; the first demonstration of ultraslow light in hot gases, and the use of quantum coherence to detect anthrax in real time. Furthermore, Marlan Scully's work on quantum coherence and correlation effects has shed new light on the foundations of quantum mechanics, e.g., the quantum eraser. Because of his involvement in cattle ranching and research in beef cattle production, Prof. Marlan Scully is also known as the "quantum cowboy." Prof. Scully will shed more light on the continuing debate over wave-particle duality of light waves and "indivisible quanta," which started in late 1600 with Newton (corpuscular) and Huygens (secondary wavelets). See SPIE abstract 9570-101 for more details. Prof. Scully's one-hour talk will begin at 8:00 pm following an informal brief reception at 7:30 pm. Discussions and networking, after his talk, will continue until 10:00 pm. Light snacks and beverages will be provided.

# TECHNICAL EVENTS continued

## From Cosmic Birth to Living Earths: The Future of UVOIR Space Astronomy

Tuesday 11 August 2015 · 8:00 PM - 10:00 PM

**Chairs:** Phil Stahl and Heidi Hammel

The Association of Universities for Research in Astronomy (AURA) has commissioned a report entitled "From Cosmic Birth to Living Earths: The Future of UVOIR Space Astronomy." The committee, co-chaired by Profs. Julianne Dalcanton and Sara Seager, has been charged with studying future space-based options for UV and optical astronomy that significantly advance our understanding of the origin and evolution of the cosmos and the life within it. Specifically, the committee is tasked with constructing a coherent and well-justified path leading to a next-generation UVOIR mission with the highest possible scientific impact in the era immediately following JWST. The committee will present its main findings at this public splinter session. Presentations will include summaries of the top science cases for the next major UV-optical observatory, the technology developments that will need to be achieved in the current decade to enable its construction, and the path forward that will lead to a viable flight proposal for consideration by the NRC in their 2020 Astronomy and Astrophysics Decadal Review.

## Life in the Cosmos Panel

Tuesday 11 August 2015 · 8:00 PM - 10:00 PM

**Moderator:** Richard B. Hoover, Athens State Univ. (USA) and Buckingham Ctr. for Astrobiology (United Kingdom)

**Panelists:** Steven A. Benner, The Foundation For Applied Molecular Evolution (USA); Michael H. Engel, The Univ. of Oklahoma (USA); George E. Fox, Univ. of Houston (USA); Gilbert V. Levin, Arizona State Univ. (USA); Joseph Seckbach, The Hebrew Univ. of Jerusalem (Israel); Luis Villarreal, Univ. Calif. Irvine (USA); Jamie Wallis, Buckingham Ctr. for Astrobiology (United Kingdom); N. Chandra Wickramasinghe, Buckingham Ctr. for Astrobiology (United Kingdom)

Does life exist only on Earth, or is it a cosmic imperative and widely distributed throughout the Cosmos? This is the fundamental question of Astrobiology. It is now well established that life exists on Earth wherever liquid water, biogenic elements and a source of energy co-exist. A recent study of red dwarf stars carried out at the European Southern Observatory has revealed that tens of billions of rocky, Earth-sized planets with the potential for liquid water probably exist in the Milky Way galaxy alone. Astrobiologists, biochemists, microbiologists, and paleontologists continue to investigate the origin of pre-biotic and chiral biomolecules and life and the distribution of water and life on Earth and in the Cosmos. The 2015 SPIE Life in the Cosmos Panel will review recent discoveries in Astronomy, Microbiology, and Astrobiology and discuss their implications with members of the audience.

## Workshop on X-Ray Optics

Tuesday 11 August 2015 · 8:00 PM - 10:00 PM

**Chair:** Ali M. Khounsary, X-ray Optics, Inc. (USA) and Illinois Institute of Technology (USA)

The X-Ray Optics Working Group provides an informal setting for the interested engineers and scientists to meet and discuss issues related to the design, analysis, cooling, fabrication, and metrology of x-ray optics. Topics for discussion can be e-mailed to the organizer, Dr. Ali Khounsary (amk@iit.edu), prior to the meeting.

## Lens Design Technical Event

Tuesday 11 August 2015 · 8:00 PM - 10:00 PM

**Session Chair:** Rich Pfisterer, Photon Engineering, LLC (USA)

### "Let's Give 'Em Something to Talk About!"

Lens designers! Join us for our annual gathering to meet and discuss...lens design! Let's talk about what we're designing, how we're going about doing it (what materials, software, techniques, etc.), and which problems we're encountering. We'll also explore current technical and commercial trends in the marketplace. This year's invited speaker will be Dr. Michael Chrisp from MIT Lincoln Laboratory, speaking on the use of NURBS surfaces in freeform optics design. Don't know what NURBS are? Then come to the meeting and see the advantage these spline-based surfaces have for freeform optics. Michael will discuss his success with optimizing these surfaces and the resulting designs.

Cosponsored by:  Photon ENGINEERING Illuminating Ideas

Light refreshments sponsored by:

The Optical Solutions Group at  SYNOPSYS®

## Penetrating Radiation Technical Event

Tuesday 11 August 2015 · 8:00 PM - 10:00 PM

**Chair:** James E. Baciak, Univ. of Florida (USA)

This event brings together technologists and scientists with interests in neutron, x- and gamma-ray detection, spectroscopy, and imaging for all applications. This year's speaker is soon to be announced.

## Optomechanical/Instrument Technical Group Event

Tuesday 11 August 2015 · 8:00 PM - 10:00 PM

**Session Chair:** Alson E. Hatheway, Alson E. Hatheway Inc. (USA)

This is the annual meeting of the premier group of optomechanical engineers that design and analyze the world's optical instruments and systems. This gathering is open to all technical attendees of SPIE Optics + Photonics. Anyone who wishes to put an item on the agenda should contact the Chair, Al Hatheway, at aeh@aehinc.com. The featured speaker is Jacob Egan of Northrop Grumman Electronic Systems. His talk will be "Opto-Mechanical Ground Testing of Space-Based Optical Systems." Following the featured speaker, the floor will be open for other agenda items and a workshop session on Problems and Solutions. Come prepared to present some challenges to the Group.

## POSTER SESSION: Nanotechnology and Optical Engineering + Applications

Wednesday 12 August 2015 · 5:30 PM - 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the collection of posters within the topics of Nanoscience + Engineering; X-Ray, Gamma-Ray, and Particle Technologies; Signal, Image, and Data Processing; Remote Sensing; and Atmospheric and Space Optical Systems. Enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, visit <http://spie.org/x30293.xml> for set-up instructions.

# INDUSTRY EVENTS

Information, insight, and connections  
to help you succeed.



## PANELS **Interactive discussions**

- Getting Hired Panel
- Women in the Optics and Photonics Workplace
- Charting a Course in the Photonics Industry

## WORKSHOPS AND SEMINARS

### **Learn essential skills for business**

- Funding your Photonics Venture
- 2015 Updates to the US Munitions List That Will Impact ITAR
- Patent Filing Considerations and Portfolio Evaluation for Photonic Engineers and Managers
- ITAR and Other International Trade Regulations
- Software Workshop: What is the Best Software for Advancing Optical Design?
- Prototypes to Products: What is the Best Path?

## SPECIAL PRESENTATIONS

### **Networking events**

- Applications in Lighting: How I Changed the San Francisco Bay Bridge with LEDs
- Market Profile Update at Exhibitor Breakfast

## JOB FAIR

### **Meet recruiters**

- Meet face-to-face with recruiters on the exhibit floor.

## EXHIBITION

### **Meet suppliers**

- Meet 180 suppliers face-to-face in the Sails Pavilion.

# SOCIAL NETWORKING/STUDENT EVENTS

## Social Networking Events

### Optics Outreach Games

Sunday 9 August 2015 · 7:30 PM - 9:30 PM

View optics and photonics demonstrations from student chapters worldwide while enjoying refreshments and networking in a casual atmosphere. Students relax and hang out with peers while engaging in a friendly competition. Challenge fellow students to a game of The Laser Game Khet 2.0 and don't miss this ever-popular student social. Check out demonstration videos from last year's Games! [www.SPIE.org/OutreachGames](http://www.SPIE.org/OutreachGames)

### Women in Optics Presentation and Reception

Monday 10 August 2015 · 5:00 PM - 6:30 PM

Join us for an early evening of networking and inspiration. The presentation will be followed by a reception, offering the opportunity to meet the speaker and connect with your peers. Light refreshments will be served.

### All-Conference Welcome Reception—Constellations + Connections

Monday 10 August 2015 · 7:00 PM - 8:30 PM

All registered conference attendees are invited to relax, socialize, and enjoy refreshments. Please remember to wear your conference registration badge (required). Dress is casual. Guest badge may be purchased during the registration process or at the registration desk onsite. Open to students and Early Career Professionals.

The International Year of Light gives us the opportunity to celebrate the role light plays in our fascination with the worlds beyond our planet. Through the physics of telescopes and optics and photonics technologies, we can peer into the past—or first light.

Stay out a little later and see the magic of the San Diego sky from 7:30 to 9:00 pm. Volunteers from the San Diego Astronomy Club will set up a variety of telescopes. The reception and sky viewing are open to all registered conference attendees who want to view the wonders of the night sky, learn about different telescopes, and share their interest in astronomy. Bring a jacket.

### Student Chapter Exhibit Mixer

Tuesday 11 August 2015 · 3:30 PM - 5:00 PM

Join us for refreshments and a late-afternoon mixer in the Student Chapter section of the Exhibition Hall. Meet our amazing students and learn about the innovative activities of some of the best and brightest Student Chapters across the globe!

### Speed Networking Social

Wednesday 12 August 2015 · 5:00 PM - 6:30 PM

It is the next generation of networking. Add a new contact to your network every three minutes while enjoying appetizers at an offsite venue. Bring plenty of business cards, practice your pitch, and prepare to expand your network. Location TBD

## Student Events

### Student Chapter Leadership Workshop

Saturday 8 August 2015 · 8:00 AM - 5:00 PM

Open to SPIE Student Chapter members

Participate in the SPIE Student Chapter Leadership Workshop with 250 other student chapter leaders from around the world. During this highly interactive, all-day event facilitated by Dr. Jean-luc Doumont, you will discuss what being a leader is all about (and what it is not about), how to communicate across cultures, and how to go from ideas to achievements for your chapter. Expect to gain new insights, make new friends, and overall spend a rich and enjoyable first day at the conference.

**Jean-luc Doumont**, Principiae

An engineer (Louvain) and PhD in applied physics (Stanford), Jean-luc is acclaimed worldwide for his no-nonsense approach, his highly applicable, often life-changing recommendations on a wide range of topics, and *Trees, maps, and theorems*, his book about "effective communication for rational minds." He is a visiting lecturer for SPIE. For more information about Jean-luc, please visit [www.principiae.be](http://www.principiae.be).

All SPIE Student Chapter Members are welcome but must register by Friday 31 July to attend. Please email [students@spie.org](mailto:students@spie.org) to register, or for more information.

### Career Choices Panel Discussion

Sunday 9 August 2015 · 9:00 AM - 10:15 AM

Open to all Students and Early Career Professionals. What are the critical career choices and decisions that face new graduates in optics and photonics? What are some strategies for navigating the transition from student to professional? Get a perspective from our panelists in this wide-ranging discussion.

### Professional Development Skills Workshop

Sunday 9 August 2015 · 10:30 AM - 12:30 PM

Open to all Students and Early Career Professionals. Join us for an exciting break-out session focusing on education and professional skills development. Come ready to share your thoughts and ideas!

### How to Persuade Others

Sunday 9 August 2015 · 1:30 PM - 5:00 PM

Being able to persuade others is an essential skill for a successful career: we must convince employers to hire us, persuade our boss to let us start a project, or get our coworkers to help us out for a given job. This workshop shows how to use personal/organizational power, how to deploy tactics, and how to harness social influences so we get other people to accede more easily to our requests.

*Facilitator: Jean-luc Doumont*

# PROFESSIONAL DEVELOPMENT/MEMBERSHIP EVENTS

## Lunch with the Experts - A Student Networking Event

Monday 10 August 2015 · 12:30 PM - 1:30 PM

Open to Student Attendees

Enjoy a casual meal with colleagues at this engaging networking opportunity. This event features experts willing to share their experience and wisdom on career paths in optics and photonics and an awards presentation for Newport travel grant winners and SPIE scholarships. Seating is limited and will be granted on a first-come, first-served basis.

Sponsored by:  **Newport**  
Experience | Solutions

## Newport Research Excellence Travel Awards

The Newport Research Excellence Travel Awards Program provides financial support for university students to attend the two largest SPIE meetings in order to present their research. These travel grants are open to any student who has an accepted paper for presentation at Photonics West or Optics + Photonics. Recipients will be selected based on both the quality of the original research described in the submitted paper(s) and financial need.

For application information for this and other SPIE travel grants visit Scholarships and Grants online at [spie.org/scholarships](http://spie.org/scholarships)

Learn more about Newport at [www.Newport.com](http://www.Newport.com)

## Student Chapter Poster Exhibit

Tuesday 11 August 2015 · 10:00 AM - 5:00 PM

Tuesday, Exhibition Hours

Discover the research of some of the brightest SPIE student groups and the programs they have developed to increase science awareness and literacy in their regions.

## Professional Development Events

### Career Advancement through SPIE Involvement

Tuesday 11 August 2015 · 1:00 PM - 2:00 PM

Get plugged in to the SPIE community. SPIE has volunteer opportunities at all levels of the organization. Come to this informal session to learn what opportunities best match your interests and career plans.

### Job Fair

Tuesday–Wednesday 11–12 August 2015 · 10:00 AM - 5:00 PM

Whether you're looking for a better job, re-entering the workforce or just starting out, plan to visit the Job Fair at Optics + Photonics. Come prepared to discuss your skills and talents with industry leaders.

All SPIE services are free to individuals seeking employment.

#### Post your resume today!

Visit the Career Center: <https://SPIECareerCenter.org>

More information: [www.spie.org/OPJobFair](http://www.spie.org/OPJobFair)

## Membership Events

### SPIE Fellows Luncheon

Tuesday 11 August 2015 · 12:00 PM - 1:30 PM

All SPIE Fellows are invited to join your colleagues for this SPIE-hosted luncheon. The new Optics and Photonics SPIE Fellows will be introduced and receive their SPIE Fellow plaques and pins. Please join us for this informal gathering and a chance to interact with other fellows.

Fellows planning to attend are asked to RSVP to Brent Johnson, [brentj@spie.org](mailto:brentj@spie.org).

### Annual General Meeting of the SPIE Corporation

Tuesday 11 August 2015 · 6:00 PM - 7:00 PM

Annual General Meeting of the SPIE Corporation

The Society of Photo-Optical Instrumentation Engineers (SPIE)

San Diego Marriott Hotel and Marina

Agenda

1. 2015 Election Results
2. Report on the "State of the Society"
3. Treasurer's Report
4. Q & A with SPIE Officers

This is the general business meeting of the Society. All SPIE Members are welcome and encouraged to attend. This is your forum for expressing your ideas about the Society. Results of the 2015 election will be announced and the President and Executive Director will report on the "State of the Society." This meeting will be followed by the Members Reception. Both events are open to members only.

### SPIE Members Reception

Tuesday 11 August 2015 · 7:00 PM - 8:30 PM

For SPIE Members Only. (Membership will be checked at the entrance for admission.)

All SPIE Members are invited to this reception in their honor. Come relax and talk with your colleagues. Refreshments will be served. Please note: this reception is limited to SPIE Members only. Membership cards or invitations will be requested at the entrance. If you join SPIE onsite, please bring your registration receipt. Dress is casual or business attire.

## PLENARY SESSIONS

# Symposium-wide Plenary Session

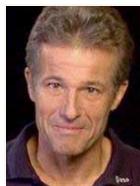
Sunday 9 August 2015  
6:00 PM - 7:30 PM

6:00 pm to 6:05 pm:

### WELCOME AND OPENING REMARKS

6:05 pm to 6:45 pm:

#### ROSETTA: COMET-CHASER, COMET-LANDER, AND COMET-HOPPER ALL IN ONE MISSION!



**Artur B. Chmielewski**, U.S. Rosetta Project Manager, NASA JPL (USA)

Abstract: Mission to Catch a Comet! Comets have inspired awe and wonder since the dawn of history. Many scientists today believe that comets crashed into Earth in its formative period spewing organic molecules that were crucial to the growth of life. Comets may have formed about the same time as the giant planets of our solar system (Jupiter, Saturn, Uranus, and Neptune) - about 4.6 billion years ago. Some scientists think that comets and planets were both made from the same clumps of dust and ice that spewed from our Sun's birth; others think that these roving time capsules are even older than that, and that they may contain grains of interstellar stuff that is even older than our solar system.

Biography: **Artur B. Chmielewski** is the US Rosetta Project Manager. He has managed several flight projects at JPL: the Space Technology 8 mission, Mars Telecommunication Orbiter Rendezvous Experiment, Space Technology 6 mission, Gossamer Program, Inflatable Antenna Flight Experiment and the Cryocooler Flight Experiment. He was also a Project Element Manager on Deep Space 1 mission and a power system engineer for Galileo, Ulysses and Cassini spacecraft. He was responsible for development of 9 space instruments and several new technology devices. He also managed a flagship pre-project - space radio astronomy mission ARISE. In the two years at NASA Headquarters he managed the space experiments program In-STEP. He has degrees in mechanical engineering and computer science from University of Michigan and USC.

6:45 pm to 7:30 pm:

### SCULPTING WAVES



**Nader Engheta**, H. Nedwill Ramsey Professor, University of Pennsylvania

Nader Engheta is the 2015 recipient of the SPIE Gold Medal Award in recognition of his transformative and groundbreaking contributions to optical engineering of metamaterials and nanoscale plasmonics, metamaterial-based optical nano circuits, and biologically-inspired optical imaging.

Abstract: In electronics controlling and manipulating flow of charged carriers has led to design of numerous functional devices. In photonics, by analogy, this is done through controlling photons and optical waves. However, the challenges and opportunities are different in these two fields. Materials control waves, and as such they can tailor, manipulate, redirect, and scatter electromagnetic waves and photons at will. Recent development in condensed matter physics, nanoscience, and nanotechnology has made it

possible to tailor materials with unusual parameters and extreme characteristics and with atomic precision and thickness. One can now construct structures much smaller than the wavelengths of visible light, thus ushering in unprecedented possibilities and novel opportunities for molding fields and waves at the nanoscale with desired functionalities. At such subwavelength scales, sculpting optical fields and waves provides a fertile ground for innovation and discovery. I will discuss some of the exciting opportunities in this area, and forecast some future directions and possibilities.

Biography: **Nader Engheta** is the H. Nedwill Ramsey Professor at the University of Pennsylvania, with affiliation in the Departments of Electrical and Systems Engineering, Bioengineering, Physics and Astronomy, and Materials Science and Engineering. He received the BS degree (with highest rank) in electrical engineering from the University of Tehran, the MS degree in electrical engineering and the Ph.D. degree in electrical engineering (with a minor in physics) both from the California Institute of Technology. His current research activities span a broad range of areas including metamaterials and plasmonics, nanooptics and nanophotonics, graphene metamaterials and graphene optics, one-way flow of photons and electrons, bio-inspired sensing and imaging, miniaturized antennas and nanoantennas, physics and reverse-engineering of polarization vision in nature, mathematics of fractional operators, and physics of fields and waves phenomena. He has published numerous journal papers, book chapters, and conference articles. He has organized and chaired various special sessions in international symposia and conferences, and has guest edited/co-edited several journal special issues. Dr. Engheta currently serves as Chair of the SPIE Conference on Metamaterials, Metadevices, and Metasystems 2015 at Optics + Photonics.

# Nanoscience + Engineering Plenary Session

Monday 10 August 2015  
9:15 AM - 12:00 PM

Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan) and **David L. Andrews**, Univ. of East Anglia (United Kingdom)

9:15 to 10:00 am:

### EXTREME IMAGING AND BEYOND



**Keisuke Goda**, The Univ. of Tokyo (Japan)

Abstract: Imaging is an effective tool in scientific research, manufacturing, and medical practice. However, despite its importance, it is not easy to observe dynamical events that occur much faster or slower than the human time scale (found in photochemistry, phononics, fluidics, MEMS, and tribology). Unfortunately, traditional methods for imaging fall short in visualizing them due to their technical limitations. In this talk, I will introduce radically different approaches to imaging. I will first discuss ultrafast imaging and then talk about ultraslow imaging. I will show how these imaging tools help us better understand dynamical processes.

Biography: **Keisuke Goda** is a Professor of Physical Chemistry at the University of Tokyo and an ImpACT Program Manager, Cabinet Office, Government of Japan. His research focuses on imaging and spectroscopy. He obtained a B.A. degree summa cum laude from UC Berkeley and a Ph.D. degree from MIT, both in physics.

Coffee Break 10:00 to 10:30 am

10:30 to 11:15 am:

## NANO-BIO-OPTOMECHANICS: NANOAPERTURE TWEEZERS PROBE SINGLE NANOPARTICLES, PROTEINS, AND THEIR INTERACTIONS



**Reuven Gordon**, Univ. of Victoria (Canada)

**Abstract:** Nanoparticles in the single digit nanometer range can be easily isolated and studied with low optical powers using nanoaperture tweezers. We have studied individual proteins and their interactions with small molecules, DNA and antibodies. Recently, using the fluctuations of the trapped object, we have pioneered a new way to "listen" to the vibrations of nanoparticles in the 100

GHz - 1 THz range; the approach is called extraordinary acoustic Raman (EAR). EAR gives unprecedented low frequency spectra of individual proteins in solution, allowing for identification and analysis, as well as probing their role in biological functions. We have also used EAR to study the elastic properties, shape and size of various individual nanoparticles.

**Biography:** **Reuven Gordon** is the Canada Research Chair in Nanoplasmonics and a Professor in ECE, University of Victoria (Canada). He has 120 papers (7 invited), 3 book chapters, 3 patents (+4 applications). His recent distinctions include the Craigdarroch Silver Medal, an AGAUR Visiting Professorship and an Accelerate BC Industry Impact Award.

11:15 am to 12:00 pm:

## DEVICE APPLICATIONS OF SEMICONDUCTOR NANOANTENNAS AND METAFILMS



**Mark Brongersma**, Geballe Lab. for Advanced Materials (GLAM) (USA)

**Abstract:** Semiconductor nanostructures are at the heart of modern-day electronic devices and systems. Due to their high refractive index, they also provide a myriad of opportunities to manipulate light. When properly sized and shaped, they can support strong optical resonances that boost light-matter interaction over bulk materials and enable their use

in controlling the flow of light at the nanoscale. In this presentation, I will discuss the use of individual, resonant nanostructures and dense arrays thereof (metafilms) in a variety of optoelectronic devices and illustrate how the performance of these devices can be improved by engineering the constituent nanostructure, size, shape, and/or spacing.

**Biography:** **Mark Brongersma** is a Professor in the Department of Materials Science and Engineering at Stanford University. He received his PhD from the FOM Institute in Amsterdam, The Netherlands, in 1998. From 1998-2001 he was a postdoctoral research fellow at the California Institute of Technology. Brongersma is a Fellow of the Optical Society of America, the SPIE, and the American Physical Society.

# Optics + Photonics for Sustainable Energy Plenary Session

Monday 10 August 2015

2:00 PM - 4:30 PM

Session Chair: **Oleg V. Sulima**, GE Global Research (USA)

2:00 to 2:30 pm:

## STATUS AND CHALLENGES OF CdTE PHOTOVOLTAICS



**Wyatt Metzger**, National Renewable Energy Lab. (USA)

**Abstract:** Current research in CdTe solar cells is targeting 24% efficiency to drive cost to less than 40 cents/W, displace silicon market share, and reach grid parity. By maximizing photocurrent, CdTe cell efficiency has recently reached 21.5% and surpassed multicrystalline silicon. There is still headroom to increase performance further by improving hole density, lifetime, and thereby photovoltage. However, this will require changing a stubborn defect chemistry that has caused photovoltage to be stagnant for decades. We will describe new work on single-crystal and polycrystalline CdTe designed to understand and overcome this challenge.

**Biography:** **Dr. Wyatt Metzger** is the CdTe Technology leader at the National Renewable Energy Laboratory and prior to this worked as a Principal Scientist and Manager at GE.

2:30 to 3:00 pm:

## PHOTOCHEMICAL UPCONVERSION OF LIGHT FOR RENEWABLE ENERGY AND MORE



**Timothy Schmidt**, The Univ. of New South Wales (Australia)

**Abstract:** It has been abundantly demonstrated that certain molecular compositions are capable of photochemical upconversion (PUC), where lower energy photons are converted to higher energy photons, sometimes with quantum efficiencies approaching 50%. PUC has been applied to solar cells, increasing the EQE of the devices in the region below the bandgap of the device. There remain challenges, though, to the realisation of efficient photochemical upconversion under low levels of incident light, and the incorporation of a liquid upconversion medium into a device. This talk will address these challenges and our progress towards meeting them.

**Biography:** **Tim Schmidt** obtained his PhD from Cambridge in 2002. He was appointed to The University of Sydney in 2004, and 2014 moved to UNSW as Professor and ARC Future Fellow. Tim's research straddles many areas of spectroscopy with applications to renewable energy, astrochemistry and atmospheric chemistry.

Coffee Break 3:00 to 3:30 pm

## PLENARY SESSIONS

3:30 to 4:00 pm:

### THE IMPORTANCE OF RELIABILITY TO THE SUNSHOT INITIATIVE



**Rebecca Jones-Albertus**, U.S. Dept. of Energy  
Solar Energy Technologies Office (USA)

**Abstract:** The Department of Energy's SunShot Initiative was launched in 2011 to make subsidy-free solar electricity cost competitive with conventional energy sources by 2020. Research in reliability plays a major role in realizing this goal. Improving photovoltaic module lifetime and reducing degradation rates increase the lifetime

energy output. Increasing confidence in photovoltaic system performance prediction can lower perceived investment risk and thus the cost of capital. In 2015, SunShot expects to award over \$40 million to impactful reliability research through its SunShot National Laboratory Multiyear Partnership and Physics of Reliability: Evaluating Design Insights for Component Technologies in Solar 2 programs.

**Biography:** Dr. Becca Jones-Albertus is the Program Manager for Photovoltaics Research and Development in the U.S. Department of Energy's Solar Energy Technologies Office. She oversees \$200 million in funding to reduce photovoltaic material and process costs, increase module efficiency and improve module reliability, towards and beyond the goals of the SunShot Initiative.

Dr. Jones-Albertus has over a decade of experience working with solar cell materials and devices, from fundamental research and development to manufacturing. Prior to the DOE, Dr. Jones-Albertus was the Characterization and Design Manager at Solar Junction, where she led work contributing to the development of the company's breakthrough dilute nitride solar cells, their two-time world record triple junction solar cells and then the successful transfer of that technology to a high volume manufacturing toolset. She has 34 technical publications and 4 patents.

4:00 to 4:30 pm:

### SOLAR HYDROGEN: HARVESTING LIGHT AND HEAT FROM SUN



**Liejin Guo**, International Research Ctr. for Renewable Energy, State Key Lab. of Multiphase Flow in Power Engineering, Xi'an Jiaotong Univ. (China)

**Abstract:** My research group in the State Key Laboratory of Multiphase Flow in Power Engineering (SKLMF), Xi'an Jiaotong University has been focusing on renewable energy, especially solar hydrogen, for about 20 years. In this presentation, I will present the most recent progress in our group on solar hydrogen production using light and heat. Firstly, "cheap"

photoelectrochemical and photocatalytic water splitting, including both nanostructured materials and pilot-scale demonstration in our group for light-driven solar hydrogen (artificial photosynthesis) will be introduced. Then I will make a deep introduction to the achievements on the thermal-driven solar hydrogen, i.e., biomass/coal gasification in supercritical water for large-scale and low-cost hydrogen production using concentrated solar light.

**Biography:** Dr. Liejin Guo is a professor and the director of State Key Laboratory of Multiphase Flow in Power Engineering, and also the founding director of International Research Center for Renewable Energy in Xi'an Jiaotong University, China.

He obtained his Ph.D. Degree in Engineering Thermophysics from Xi'an Jiaotong University in 1989. He has published several books/chapters and more than 400 papers, and been rewarded many times by Chinese government because of his distinguished contribution in science and technologies. His research interest includes multiphase flow, heat transfer, and renewable energy technologies.

## Organic Photonics + Electronics Plenary Session

Tuesday 11 August 2015

9:00 AM - 11:45 AM

Session Chair: **Zakya H. Kafafi**, Lehigh Univ. (USA)

9:00 to 9:30 am:

### CURRENT STATUS OF HIGH EFFICIENCY OLEDs BASED ON DELAYED FLUORESCENCE



**Chihaya Adachi**, Kyushu Univ. (Japan)

**Abstract:** In recent years, we have reported a series of highly efficient thermally activated delayed fluorescence (TADF) molecules and their OLED performance. We clarified that a large delocalization of the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) in charge transfer compounds provides a small energy gap between singlet and triplet excited states ( $\Delta E_{ST} < 0.2$  eV). Simultaneously, even when there is a small overlap between the two wavefunctions, we can successfully keep rather high radiative decay rate ( $k_r$ ) by inducing a large oscillator strength ( $f$ ). Thus, compatibility of both small  $\Delta E_{ST}$  and large  $k_r$  is fundamental for high efficiency delayed fluorescence. Based on this design concept, we systematically synthesized a wide variety of TADF molecules and demonstrated high efficiency OLEDs with maximum external quantum efficiencies of ~20%. In this talk, we review material design, synthesis, photophysics and OLED performance and discuss the future prospects.

**Biography:** Professor Chihaya Adachi obtained his doctorate degree in Materials Science and Technology in 1991 from Kyushu University. In 1991, Adachi began working for Ricoh Co., Chemical Products R&D Centre, Research Associate at Department of Functional Polymer Science, Shinshu University, Research Staff at Department of Electrical Engineering, Princeton University, Associate Professor and Professor at Chitose Institute of Science and Technology. In 2006, he became a professor at Centre for Future Chemistry and department of applied chemistry at Kyushu University. Since 2010, he is the director of Centre for Organic Photonics and Electronics Research (OPERA) at Kyushu University.

9:30 to 10:00 am:

## INTERFACING WITH THE BRAIN USING ORGANIC ELECTRONICS



**George G. Malliaras**, Ecole Nationale Supérieure des Mines de Saint-Étienne (France)

Abstract: Implantable electrodes are being used for diagnostic purposes, for brain-machine interfaces, and for delivering electrical stimulation to alleviate the symptoms of diseases such as Parkinson's. The field of organic electronics made available devices with a unique combination of attractive properties, including mixed ionic/electronic conduction, mechanical flexibility, enhanced biocompatibility, and capability for drug delivery. I will present examples of organic electrodes, transistors and other devices for recording and stimulation of brain activity and discuss how they can improve our understanding of brain physiology and pathology, and how they can be used to deliver new therapies.

Biography: Professor **George Malliaras** is the Head of the Department of Bioelectronics of the Ecole des Mines de St. Etienne (France). His research has been recognized with awards from the NY Academy of Sciences, the US National Science Foundation, and DuPont. He is a Fellow of the Royal Society of Chemistry. He received his PhD from the University of Groningen (Netherlands), did a postdoc at IBM Research, was a faculty member in Materials Science and Engineering at Cornell University, and served as the Lester B. Knight Director of the Cornell NanoScale Science & Technology Facility.

10:00 to 10:15 am:

## ANNOUNCEMENT OF THE ORGANIC PHOTONICS + ELECTRONICS BEST STUDENT PAPER AWARD WINNER

Coffee Break 10:15 to 10:45 am

10:45 to 11:15 am:

## ULTRAFLEXIBLE ORGANIC THIN-FILM DEVICES FOR WEARABLE AND IMPLANTABLE ELECTRONICS



**Takao Someya**, Univ. of Tokyo (Japan)

Abstract: Mechanically flexible and stretchable devices are expected to open new possibilities in fields of wearable and implantable electronics. Especially, conformability, ruggedness, lightweight, biocompatibility, and large-area are all important to create new electronic applications that can be directly mounted on the surface of human skins and/or even inside the body. From this viewpoint, ultraflexible organic thin-film devices, such as organic thin-film transistors (OTFTs), organic photovoltaic cells (OPVs), and organic light-emitting diodes (OLEDs), have attracted much attention recently. In this talk, we report recent progress of ultraflexible organic thin-film devices that are manufactured on ultrathin plastic film with the thickness of 1  $\mu\text{m}$ . We will also describe emerging applications using ultraflexible and stretchable electronic systems in the fields of biomedical electronics.

Biography: Professor **Takao Someya** received the Ph.D. degree in electrical engineering from the University of Tokyo in 1997. Since 2009, he has been a professor of Department of Electrical and Electronic Engineering, The University of Tokyo. His current research interests include organic transistors, flexible electronics, plastic integrated circuits, large-area sensors, and plastic actuators.

11:15 to 11:45 am:

## RECENT PROGRESS ON HYBRID ORGANIC-INORGANIC AND PEROVSKITE-BASED SOLAR CELLS



**Yang Yang**, Univ. of California, Los Angeles (USA)

Abstract: By combining the attributes from both organic and inorganic species, the light-harvesting hybrid perovskite (e.g.  $\text{CH}_3\text{NH}_3\text{PbI}_3$ ) materials possess amazing physical properties that led to high performance solar cells within only a few years of research. Film formation and interface engineering of perovskite materials are crucial parameters that determine the resulting solar cell efficiency. Besides single junction perovskite-based solar cells, research has turned to the tandem devices that combine another low band gap material such as Si in order to achieve even higher efficiency. My presentation will summarize recent progress in this field and report on new results from UCLA (e.g. interface engineering, perovskite-based photodetectors and tandem solar cells).

Biography: Professor **Yang Yang** holds a BS in Physics from the National Cheng-Kung Univ. in 1982, and he received his M.S. and Ph.D. in Physics and Applied Physics from the Univ. of Massachusetts, Lowell in 1988 and 1992, respectively. Before he joined UCLA in 1997, he served on the research staff of UNIAX (now DuPont Display) in Santa Barbara from 1992 to 1996. Yang is now the Carol and Lawrence E. Tannas Jr. Endowed Chair Professor of Materials Science and Engineering at UCLA. He is a materials physicist with expertise in the fields of organic electronics, organic/inorganic interface engineering, and the development and fabrication of related devices, such as photovoltaic cells, LEDs, and memory devices. His H-Index is ~90, and he has published more than 300 peer-reviewed papers, ~60 patents (filed or issued), and given 150 invited talks. He is Fellow of SPIE, the Electromagnetics (EM) Academy, and the Royal Society of Chemistry (FRSC).

## PLENARY SESSIONS

# Signal, Image, and Data Processing Plenary Session

Tuesday 11 August 2015  
1:30 PM - 2:30 PM

1:30 pm to 1:35 pm:

## WELCOME AND INTRODUCTIONS

1:35 pm to 2:30 pm:

## VISUAL SIGNAL ANALYSIS: FOCUS ON TEXTURE SIMILARITY



**Thrasivoulos N. Pappas**, Northwestern Univ. (USA)

Abstract: The focus of this talk will be on texture analysis.

Texture is an important visual attribute both for human perception and image analysis systems. We present new structural texture similarity metrics and applications that critically depend on such metrics, with emphasis on image compression and content-based retrieval. The new metrics account for human visual perception and the stochastic nature of textures. They rely entirely on local image statistics and allow substantial point-by-point deviations between textures that according to human judgment are similar or essentially identical.

We also present new testing procedures for objective texture similarity metrics. We identify three operating domains for evaluating the performance of such similarity metrics: the top of the similarity scale, where a monotonic relationship between metric values and subjective scores is desired; the ability to distinguish between perceptually similar and dissimilar textures; and the ability to retrieve "identical" textures. Each domain has different performance goals and requires different testing procedures. Experimental results demonstrate both the performance of the proposed metrics and the effectiveness of the proposed subjective testing procedures.

**Biography:** **Thrasivoulos Pappas** received his Ph.D. degree in Electrical Engineering and Computer Science from MIT in 1987. From 1987 until 1999, he was a Member of the Technical Staff at Bell Laboratories, Murray Hill, NJ. He joined the EECS Department at Northwestern in 1999. His research interests are in human perception and electronic media, and in particular, image and video quality and compression, image and video analysis, content-based retrieval, model-based halftoning, and tactile and multimodal interfaces. Professor Pappas is a Fellow of the IEEE and SPIE. He has served as editor-in-chief of the IEEE Transactions on Image Processing (2010-12), elected member of the Board of Governors of the Signal Processing Society of IEEE (2004-07), chair of the IEEE Image and Multidimensional Signal Processing Technical Committee (2002-03), and Technical Program co-chair of ICIP-01 and ICIP-09. Professor Pappas is currently serving as VP-Publications for the Signal Processing Society of IEEE.

# Optical Engineering Plenary Session

Tuesday 11 August 2015  
4:00 PM - 5:25 PM

Session Chair: **Craig Olson**, L-3 Communications (USA)

4:00 to 4:05 pm:

## WELCOME AND OPENING REMARKS

4:05 to 4:45 pm:

## DEMOCRATIZATION OF NEXT-GENERATION IMAGING, SENSING, AND DIAGNOSTICS TOOLS THROUGH COMPUTATIONAL PHOTONICS



**Aydogan Ozcan**, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA)

Abstract: My research focuses on the use of computation/algorithms to create new optical microscopy, sensing, and diagnostic techniques, significantly improving existing tools for probing micro- and nano-objects while also simplifying the designs of these analysis tools. In this presentation, I will introduce a new set of computational microscopes which use lens-free on-chip imaging to replace traditional lenses with holographic reconstruction algorithms. Basically, 3D images of specimens are reconstructed from their "shadows" providing considerably improved field-of-view (FOV) and depth-of-field, thus enabling large sample volumes to be rapidly imaged, even at nanoscale. These new computational microscopes routinely generate <1-2 billion pixels (giga-pixels), where even single viruses can be detected with a FOV that is <100 fold wider than other techniques. At the heart of this leapfrog performance lie self-assembled liquid nano-lenses that are computationally imaged on a chip. These self-assembled nano-lenses are stable for <1 hour at room temperature, and are composed of a biocompatible buffer that prevents nanoparticle aggregation while also acting as a spatial "phase mask." The field-of-view of these computational microscopes is equal to the active-area of the sensor-array, easily reaching, for example, <20 mm<sup>2</sup> or <10 cm<sup>2</sup> by employing state-of-the-art CMOS or CCD imaging chips, respectively.

# PLENARY SESSIONS

In addition to this remarkable increase in throughput, another major benefit of this technology is that it lends itself to field-portable and cost-effective designs which easily integrate with smartphones to conduct giga-pixel tele-pathology and microscopy even in resource-poor and remote settings where traditional techniques are difficult to implement and sustain, thus opening the door to various telemedicine applications in global health. Some other examples of these smartphone-based biomedical tools that I will describe include imaging flow cytometers, immunochromatographic diagnostic test readers, bacteria/pathogen sensors, blood analyzers for complete blood count, and allergen detectors. Through the development of similar computational imagers, I will also report the discovery of new 3D swimming patterns observed in human and animal sperm. One of this newly discovered and extremely rare motion is in the form of "chiral ribbons" where the planar swings of the sperm head occur on an osculating plane creating in some cases a helical ribbon and in some others a twisted ribbon. Shedding light onto the statistics and biophysics of various micro-swimmers' 3D motion, these results provide an important example of how biomedical imaging significantly benefits from emerging computational algorithms/theories, revolutionizing existing tools for observing various micro- and nano-scale phenomena in innovative, high-throughput, and yet cost-effective ways.

**Biography:** **Aydogan Ozcan** is the Chancellor's Professor at UCLA and an HHMI Professor with the Howard Hughes Medical Institute, leading the Bio- and Nano-Photonics Laboratory at UCLA School of Engineering and is also the Associate Director of the California NanoSystems Institute (CNSI). Dr. Ozcan holds 29 issued patents (all of which are licensed) and <20 pending patent applications and is also the author of one book and the co-author of more than 400 peer-reviewed research articles in major scientific journals and conferences. Dr. Ozcan is a Fellow of SPIE and OSA, and has received major awards including the Presidential Early Career Award for Scientists and Engineers (PECASE), SPIE Biophotonics Technology Innovator Award, SPIE Early Career Achievement Award, ARO Young Investigator Award, NSF CAREER Award, NIH Director's New Innovator Award, ONR Young Investigator Award, IEEE Photonics Society Young Investigator Award and MIT's TR35 Award for his seminal contributions to near-field and on-chip imaging, and telemedicine based diagnostics. Dr. Ozcan is also the recipient of the National Geographic Emerging Explorer Award, National Academy of Engineering (NAE) The Grainger Foundation Frontiers of Engineering Award, Popular Science Brilliant 10 Award, Gates Foundation Grand Challenges Award, Popular Mechanics Breakthrough Award, Netexplorateur Award, Microscopy Today Innovation Award, and the Wireless Innovation Award organized by the Vodafone Americas Foundation as well as the Okawa Foundation Award.

4:45 to 5:25 pm:

## RESTOCKING THE OPTICAL DESIGNER'S TOOLBOX FOR NEXT-GENERATION WEARABLE DISPLAYS



**Bernard C. Kress**, Google (USA)

Abstract: Three years ago, industry and consumers learned that there was more to Head Mounted Displays (HMDs) than the long-lasting but steady market for defense or the market for gadget video player headsets: the first versions of Smart Glasses were introduced to the public. Since then, most major consumer electronics companies unveiled their own versions of Connected Glasses, Smart Glasses or Smart Eyewear, AR (Augmented Reality) and VR (Virtual Reality) headsets. This rush resulted in the build-up of a formidable zoo of optical technologies, each claiming to be best suited for the task on hand. Today, the question is not so much anymore "will the Smart Glass market happen?", but rather "which optical technologies will be best fitted for the various declinations of the existing wearable display market", one of the main declination being the Smart Glasses market.

**Biography:** **Bernard Kress** has made significant scientific contributions as a researcher, professor, consultant, instructor and author, in the fields of micro-optics, diffractives and holography, for research, industry and consumer electronics for over twenty years. He has been involved in half a dozen start-ups in the Silicon Valley on optical data storage, optical telecom, biophotonics, optical sensors, imaging and display. Bernard holds 29 international granted patents. He is a short course instructor for SPIE on micro-optics and has published 3 books "Digital Diffractive Optics" (1999, Wiley), "Optical System Design: Diffractive Optics" (2005, Mac Graw Hill) and "Applied Digital Optics" (2007, Wiley), as well as a field guide "Digital Micro-Optics" (2014, SPIE). He is currently with Google [X] Labs as the Principal Optical Architect.



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Tuesday 11 August · 10:00 am to 5:00 pm  
Wednesday 12 August · 10:00 am to 5:00 pm  
Thursday 13 August · 10:00 am to 2:00 pm

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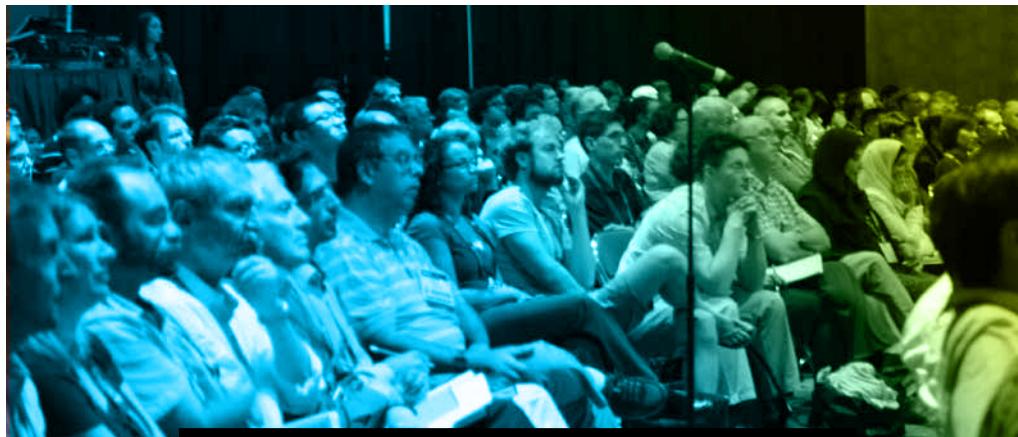
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# NANOSCIENCE + ENGINEERING.

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# Metamaterials, Metadevices, and Metasystems 2015

**Conference Chairs:** Nader Engheta, Univ. of Pennsylvania (USA); **Mikhail A. Noginov**, Norfolk State Univ. (USA); **Nikolay I. Zheludev**, Univ. of Southampton (United Kingdom), Nanyang Technological Univ. (Singapore)

**Program Committee:** Andrea Alù, The Univ. of Texas at Austin (USA); David L. Andrews, Univ. of East Anglia (United Kingdom); Pierre Berini, Univ. of Ottawa (Canada); Alexandra Boltasseva, Purdue Univ. (USA); Igal Brener, Sandia National Labs. (USA); Mark Brongersma, Standford Univ. (USA); Che Ting Chan, Hong Kong Univ. of Science and Technology (Hong Kong, China); Hongsheng Chen, Zhejiang Univ. (China); Jennifer A. Dionne, Stanford Univ. (USA); Harald W. Giessen, Univ. Stuttgart (Germany); Yuri S. Kivshar, The Australian National Univ. (Australia); Jacob B. Khurgin, Johns Hopkins Univ. (USA); Uriel Levy, The Hebrew Univ. of Jerusalem (Israel); Natalia M. Litchinitser, Univ. at Buffalo (USA); Martin W. McCall, Imperial College London (United Kingdom); Albert Polman, FOM Institute for Atomic and Molecular Physics (Netherlands); Gennady B. Shvets, The Univ. of Texas at Austin (USA); David R. Smith, Duke Univ. (USA); Costas M. Soukoulis, Iowa State Univ. (USA); Mark I. Stockman, Georgia State Univ. (USA); Philippe Tassin, Chalmers Univ. of Technology (Sweden); Sergei Tretyakov, Aalto Univ. School of Science and Technology (Finland); Din Ping Tsai, National Taiwan Univ. (Taiwan); Augustine M. Urbas, Air Force Research Lab. (USA); Martin Wegener, Karlsruher Institut für Technologie (Germany); Xiang Zhang, Univ. of California, Berkeley (USA)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 8:35 AM TO 10:10 AM

#### Toroids and Vortices

Session Chair: **Mikhail A. Noginov**, Norfolk State Univ. (USA)

**Propagating and localized toroidal excitations in free space and metamaterials (Invited Paper)**, Nikolay I. Zheludev, Optoelectronics Research Ctr. (United Kingdom) and Nanyang Technological Univ. (Singapore); Vassili A. Fedotov, Nikitas Papasimakis, Vassili Savinov, Univ. of Southampton (United Kingdom); Tim A. Raybould, Optoelectronics Research Ctr. (United Kingdom) ..... [9544-1]

**Observation of an anapole with dielectric nanoparticles (Invited Paper)**, Andrey E. Miroshnichenko, The Australian National Univ. (Australia) ..... [9544-2]

**Probing metamaterials with structured light**, Yun Xu, Jingbo Sun, Jinwei Zeng, Zhaxylyk Kudyshev, Univ. at Buffalo (USA); Apra Pandey, CST of America, Inc. (USA); Ying Liu, Natalia M. Litchinitser, Univ. at Buffalo (USA) ..... [9544-3]

**Large magnetic to electric field contrast in azimuthally polarized vortex beams generated by a metasurface**, Mehdi Veysi, Caner Guclu, Filippo Capolino, Univ. of California, Irvine (USA) ..... [9544-4]

**Plasmonic magnetization during circularly polarized excitation**, Matthew T. Sheldon, Texas A&M Univ. (USA) ..... [9544-5]

### SESSION 2 ..... SUN 10:35 AM TO 12:30 PM

#### Active Metamaterials I

Session Chair: **Andrey E. Miroshnichenko**, The Australian National Univ. (Australia)

**Transparency and coherence in rf SQUID metamaterials (Invited Paper)**, Steven M. Anlage, Univ. of Maryland, College Park (USA) ..... [9544-91]

**Enhanced light-matter coupling in Si-based metamaterials (Invited Paper)**, Luca Dal Negro, Boston Univ. (USA) ..... [9544-6]

**Recent advances in metamaterial multi-physics (Invited Paper)**, Mikhail Lapine, Univ. of Technology Sydney (Australia) ..... [9544-7]

**Coherent effects in nonlinear metamaterial-based devices (Invited Paper)**, Alessandro Salandrino, The Univ. of Kansas (USA) ..... [9544-8]

**Active control of light beam in transformation optics**, Hui Liu, Nanjing Univ. (China) ..... [9544-9]

Lunch Break ..... Sun 12:30 pm to 2:00 pm

### SESSION 3 ..... SUN 2:00 PM TO 3:45 PM

#### Active Metamaterials II

Session Chair: **Zubin Jacob**, Univ. of Alberta (Canada)

**Nanostructured photonic metamaterials reconfigurable with light, nanomechanical, and electromagnetic forces (Invited Paper)**, Jun-Yu Ou, Univ. of Southampton (United Kingdom); João Valente, Optoelectronics Research Ctr. (United Kingdom); Artemios Karounis, Univ. of Southampton (United Kingdom); Weiping Wu, Eric Plum, Optoelectronics Research Ctr. (United Kingdom); Kevin F. MacDonald, Univ. of Southampton (United Kingdom); Nikolay I. Zheludev, Univ. of Southampton (United Kingdom) and Nanyang Technological Univ. (Singapore) ..... [9544-10]

**Latest progress in spasers (Invited Paper)**, Mark I. Stockman, Georgia State Univ. (USA) ..... [9544-11]

**Active hyperbolic metamaterials (Invited Paper)**, Vinod M. Menon, The City College of New York (USA) ..... [9544-12]

**Gain-enhanced hyperbolic metamaterials at telecommunication frequencies**, Joseph S. T. Smalley, Univ. of California, San Diego (USA); Felipe Vallini, Univ. of California San Diego (USA); Boubacar Kante, Shiva Shahin, Conor Riley, Yeshaiahu Fainman, Univ. of California, San Diego (USA) ..... [9544-13]

**Giant gain enhancement in slow-wave photonic crystals with a degenerate band edge**, Mohamed A. K. Othman, Filippo Capolino, Alexander Figotin, Univ. of California, Irvine (USA); Farshad Yazdi, Univ. of California Irvine (USA) ..... [9544-14]

### SESSION 4 ..... SUN 4:00 PM TO 5:45 PM

#### Control of Physical Phenomena with Metamaterials

Session Chair: **Mikhail Lapine**, Univ. of Technology, Sydney (Australia)

**Collective Förster energy transfer modified by planar plasmonic mirror (Invited Paper)**, Alexander N. Poddubny, Ioffe Physical-Technical Institute (Russian Federation) ..... [9544-15]

**Nitrogen-vacancy single-photon emission enhanced with nanophotonic structures (Invited Paper)**, Vladimir M. Shalaev, Mikhail Y. Shalaginov, Purdue Univ. (USA); Vadim V. Vorobyov, Photonic Nano-Meta Technologies (Russian Federation); Simeon Bogdanov, Purdue Univ. (USA); Alexey V. Akimov, Russian Quantum Ctr. (Russian Federation); Alexei Lagutchev, Alexander V. Kildishev, Alexandra Boltasseva, Purdue Univ. (USA) ..... [9544-16]

**Super-coulombic Van der Waals interactions in metamaterials (Invited Paper)**, Cristian L. Cortes, Ward D. Newman, Zubin Jacob, Univ. of Alberta (Canada) ..... [9544-17]

**Effect of nonlocal dielectric environments on chemical reactions**, Vanessa N. Peters, Norfolk State Univ. (USA); Thejaswi U Tumkur, Guohua Zhu, Mikhail A. Noginov, Norfolk State Univ (USA) ..... [9544-18]

**Effect of photonic density of states on spin-flip induced fluorescence contrast in diamond nitrogen-vacancy center ensembles**, Mikhail Shalaginov, Simeon Bogdanov, Jing Liu, Alexei Lagutchev, Alexander V. Kildishev, Dimitrios Peroulis, Joseph M. Irudayaraj, Alexandra Boltasseva, Vladimir M. Shalaev, Purdue Univ. (USA) ..... [9544-19]

# CONFERENCE 9544

## SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING

#### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan);  
**David L. Andrews**, Univ. of East Anglia (United Kingdom)

**Extreme Imaging and Beyond (Plenary)**, Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

**Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary)**, Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

**Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary)**, Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch Break ..... Mon 12:00 pm to 1:30 pm

#### SESSION 5..... MON 1:30 PM TO 3:35 PM

### Hyperbolic Metamaterials I

Session Chair: **Luca Alloatti**, Massachusetts Institute of Technology (USA)

**Photonic hypercrystals (Invited Paper)**, Evgenii E. Narimanov, Purdue Univ. (USA) ..... [9544-20]

**Non-resonant hyperlens in the visible range (Invited Paper)**, Natalia M. Litchinitser, Jingbo Sun, Mikhail I. Shalaev, Univ. at Buffalo (USA) ..... [9544-21]

**Sub-diffractive, volume-confined polaritons in a natural hyperbolic material: hexagonal boron nitride**, Joshua D. Caldwell, U.S. Naval Research Lab. (USA); Andrei V. Kretinin, The Univ. of Manchester (United Kingdom); Yiguo Chen, Vincenzo Giannini, Imperial College London (United Kingdom); Michael M. Fogler, Univ. of California, San Diego (USA); Yan Francescato, Imperial College London (United Kingdom); Chase T. Ellis, Joseph G. Tischler, U.S. Naval Research Lab. (USA); Colin R. Woods, The Univ. of Manchester (USA); Alexander J. Giles, U.S. Naval Research Lab. (USA); Kenji Watanabe, Takashi Taniguchi, National Institute for Materials Science (Japan); Stefan A. Maier, Imperial College London (United Kingdom); Kostya S. Novoselov, The Univ. of Manchester (United Kingdom) ..... [9544-22]

**Practical realization of deeply subwavelength multilayer metal-dielectric nanostructures based on InGaAsP**, Joseph S. T. Smalley, Univ. of California, San Diego (USA); Felipe Vallini, Univ. of California San Diego (USA); Sergio Montoya, Eric E. Fullerton, Yeshaiahu Fainman, Univ. of California, San Diego (USA) [9544-23]

**Semiconductor-dielectric Multilayer surface magnetoplasmon planar hyperlens**, Bo Han Cheng, Academia Sinica (Taiwan); Hong Wen Chen, Yung-Chiang Lan, National Cheng Kung Univ. (Taiwan); Din Ping Tsai, Academia Sinica (Taiwan) ..... [9544-24]

**Probing the ultrathin limit of hyperbolic metamaterial: nonlocality induced topological transitions**, Long Chen, Cheng Zhang, Jing Zhou, L. Jay Guo, Univ. of Michigan (USA) ..... [9544-25]

**Tunable VO<sub>2</sub>/Au hyperbolic metamaterial**, Srujana Prayakarao, Norfolk State Univ. (USA); Brock Mendoza, Andrew Devine, Cornell Univ. (USA) and Norfolk State Univ. (USA); Chan Kyaw, Morehouse College (USA) and Norfolk State Univ. (USA); Robert B. Van Dover, Cornell Univ. (USA); Mikhail A. Noginov, Norfolk State Univ. (USA) ..... [9544-26]

#### SESSION 6..... MON 4:00 PM TO 5:15 PM

### Atomic Scale Metamaterials

Session Chair: **Natalia M. Litchinitser**, Univ. at Buffalo (USA)

**Atomic-scale metamaterials (Invited Paper)**, Javier Garcia de Abajo, ICFO - Institut de Ciències Fotòniques (Spain) ..... [9544-27]

**Nano-photonic phenomena in van der Waals heterostructures (Invited Paper)**, Dmitri N. Basov, Univ. of California, San Diego (USA) ..... [9544-28]

**Second-harmonic generation from atomic-scale ABC-type laminate optical metamaterials (Invited Paper)**, Luca Alloatti, Massachusetts Institute of Technology (USA) and Institute of Photonics and Quantum Electronics Karlsruhe Institute of Technology (Germany); Clemens M. Kieninger, Andreas M. Fröhlich, Matthias Lauermann, Tobias Frenzel, Kira Köhne, Wolfgang Freude, Karlsruher Institut für Technologie (Germany); Juerg Leuthold, ETH Zürich (Switzerland); Christian Koos, Martin Wegener, Karlsruher Institut für Technologie (Germany) ..... [9544-29]

## TUESDAY 11 AUGUST

#### SESSION 7..... TUE 9:00 AM TO 10:35 AM

### Dielectric and Semiconductor Metamaterials

Session Chair: **Adil-Gerai Kussow**, Univ. of Massachusetts Lowell (USA)

**Transparent conducting oxides as plasmonic component in near infrared (Invited Paper)**, Jongbum Kim, Nathaniel Kinsey, Aveek Dutta, Purdue Univ. (USA); Marcello Ferrera, Purdue Univ. (USA) and Heriot-Watt Univ. (United Kingdom); Clayton Devault, Alexander V. Kildishev, Vladimir M. Shalaev, Alexandra Boltasseva, Purdue Univ. (USA) ..... [9544-30]

**Towards low-loss, infrared and THz nanophotonics and metamaterials: surface phonon polariton modes in polar dielectric crystals (Invited Paper)**, Joshua D. Caldwell, U.S. Naval Research Lab. (USA); Lucas Lindsey, Oak Ridge National Lab. (USA); Vincenzo Giannini, Imperial College London (United Kingdom); Igor Vurgaftman, Thomas L. Reinecke, U.S. Naval Research Lab. (USA); Stefan A. Maier, Imperial College London (United Kingdom); Orest J. Glembocki, Oak Ridge National Lab. (USA) and U.S. Naval Research Lab. (USA) ..... [9544-31]

**Spectroscopy of semiconductor meta-device building blocks**, Nikita A. Butakov, Jon A. Schuller, Univ. of California, Santa Barbara (USA) ..... [9544-32]

**Properties of infrared doped semiconductor Mie resonators**, Tomer Lewi, Univ. of California Santa Barbara (USA); Prasad P. Iyer, Nikita A. Butakov, Jon A. Schuller, Univ. of California, Santa Barbara (USA) ..... [9544-33]

**All dielectric near-field transducers for optical field concentration at the nanometer scale and heat assisted magnetic recording (Invited Paper)**, Andrey K. Sarychev, Institute for Theoretical and Applied Electrodynamics (Russian Federation); Sergey Vergeles, L.D. Landau Institute for Theoretical Physics (Russian Federation) and Moscow Institute of Physics and Technology (Russian Federation); Alexei L. Bogdanov, Stanley Burgos, HGST (USA) ..... [9544-34]

#### SESSION 8..... TUE 11:00 AM TO 12:35 PM

### Hyperbolic Metamaterials II

Session Chair: **Adil-Gerai Kussow**, Univ. of Massachusetts Lowell (USA)

**Nonlinearities in hyperbolic plasmonic metamaterials (Invited Paper)**, Andres D. Barbosa Neira, Silvia Peruh, Giuseppe Marini, Mazhar Nasir, Alexey V. Krasavin, Nicolas Olivier, Wayne Dickson, Gregory A. Wurtz, Anatoly V. Zayats, King's College London (United Kingdom) ..... [9544-35]

**Mid-infrared hyperbolic metamaterial based on graphene-dielectric multilayers (Invited Paper)**, Theodore B. Norris, You-Chia Chang, Che-Hung Liu, Chang-Hua Liu, Univ. of Michigan (USA); Siyuan Zhang, Seth R. Marder, Georgia Institute of Technology (USA); Zhaohui Zhong, Univ. of Michigan (USA) .. [9544-36]

**LCR model for the design of hyperbolic metamaterials**, Christopher Rosenbury, Daniel B. Fullager, Michael A. Fiddy, The Univ. of North Carolina at Charlotte (USA) ..... [9544-37]

**Layered plasmonic metamaterials analysis using the plane wave equipotential contours EPCs**, Mohammed Al Shakhs, Kenneth J. Chau, UBC Okanagan (Canada); Peter Ott, Hochschule Heilbronn (Germany) ..... [9544-38]

**Optical mode confinement in three-dimensional Al/SiO<sub>2</sub> nano-cavities with hyperbolic dispersion**, Carla M. Bacco, Priscilla N. Kelly, Lyuba Kuznetsova, San Diego State Univ. (USA) ..... [9544-39]

Lunch/Exhibition Break ..... Tue 12:35 pm to 2:05 pm

# CONFERENCE 9544

SESSION 9 ..... TUE 2:05 PM TO 3:35 PM

## Mid Infrared and Thermal

Session Chair: **Viktor A. Podolskiy**, Univ. of Massachusetts Lowell (USA)

**Thermal radiation of metallic surfaces and hyperbolic metamaterials**, Mikhail A. Noginov, A. Mozafari, Thejaswi U. Tumkur, John K. Kitur, Norfolk State Univ. (USA); Evgenii E. Narimanov, Purdue Univ. (USA) ..... [9544-40]

**Rare-Earth frequency converters for thermophotovoltaics-revisiting century old claims**, Ekemba K. Tanyi, Brandy T. Burton, Norfolk State Univ. (USA); Evgenii E. Narimanov, Purdue Univ. (USA); Michael Noginov, Norfolk State Univ. (USA) ..... [9544-41]

**Energy conversion and photo-thermal effect within plasmonic absorption metamaterials in infrared region**, Yongqian Li, Chenglin Zhang, Lei Su, Northwestern Polytechnical Univ. (China) ..... [9544-42]

**Design and analysis of chevrons shaped split ring resonator in the mid-infrared region**, Neerad Nandan, Than Singh Saini, Ajeet Kumar, Ravindra K. Sinha, Delhi Technological Univ. (India) ..... [9544-43]

**Colossal optical transmission through buried metal gratings**, Christopher M. Roberts, Univ. of Massachusetts Lowell (USA); Runyu Liu, Xiang Zhao, Lan Yu, Xiuling Li, Daniel M. Wasserman, Univ. of Illinois at Urbana-Champaign (USA); Viktor A. Podolskiy, Univ. of Massachusetts Lowell (USA) ..... [9544-44]

**Experimental verification of classical electromagnetically induced transparency in conductors**, Adil-Gerai Kussow, Yassine Ait-Ei Aoud, Alkim Akyurtlu, Univ. of Massachusetts Lowell (USA) ..... [9544-45]

SESSION 10 ..... TUE 4:00 PM TO 5:30 PM

## Manipulating Light with Metamaterials

Session Chair: **Joshua D. Caldwell**, U.S. Naval Research Lab. (USA)

**Guiding electromagnetic waves around sharp corners: topologically protected photonic transport in meta-waveguides**, Gennady B. Shvets, The Univ. of Texas at Austin (USA); Alexander B. Khanikaev, Queens College (USA); Tzuhsuan Ma, Kueif Lai, The Univ. of Texas at Austin (USA) ..... [9544-46]

**Light emission in nonlocal plasmonic metamaterials**, Viktor A. Podolskiy, Brian Wells, Univ. of Massachusetts Lowell (USA); Pavel Ginzburg, Anatoly V. Zayats, King's College London (United Kingdom) ..... [9544-47]

**Metamaterials for group-velocity dispersion compensation**, Philippe Tassin, Chalmers Univ. of Technology (Sweden); Babak Dastmalchi, Thomas Koschny, Costas M. Soukoulis, Ames Lab. (USA) and U.S. Dept. of Energy (USA) and Iowa State Univ. of Science and Technology (USA) ..... [9544-48]

**Multi-foci metalens for spin and orbital angular momentum interaction**, Shengtao Mei, Cheng-Wei Qiu, Muhammad Qasim Mehmood, Kun Huang, National Univ. of Singapore (Singapore) ..... [9544-49]

**Birefringence modulation of thermally-driven metal nanograting**, Takashi Shimura, Miho Ishii, Kentaro Iwami, Hideaki Nagasaki, Norihiro Umeda, Tokyo Univ. of Agriculture and Technology (Japan) ..... [9544-50]

**Building novel nanophotonics devices using symmetry considerations**, Boubacar Kante, Univ. of California, San Diego (USA) ..... [9544-51]

WEDNESDAY 12 AUGUST

SESSION 11 ..... WED 8:30 AM TO 10:15 AM

## Metadevices and Metasystems I

Session Chair: **Ertugrul Cubukcu**, Univ. of Pennsylvania (USA)

**Laser processing of metamaterial structures (Invited Paper)**, Alberto Piqué, Nicholas A. Charipar, Heungsoo Kim, Eric Breckenfeld, Scott A. Mathews, U.S. Naval Research Lab. (USA) ..... [9544-52]

**Large-area, low-cost plasmonic perfect absorber sensor fabricated by laser interference lithography (Invited Paper)**, Shahin Bagheri, Nikolai Strohfeldt, Andreas Tittl, Harald Giessen, Univ. Stuttgart (Germany) ..... [9544-53]

**Design and analysis of near-perfect metamaterial reflector in visible range**, Ravindra K. Sinha, Nishant Shankhwar, Delhi Technological Univ. (India) ..... [9544-54]

**The Silicon photomultiplier as a metasystem with designed electronics as metadevice for a new receiver-emitter in visible light communications**, Rafael M. Gutierrez, Luis Castañeda, Javier Castaño, Univ. Antonio Nariño (Colombia) ..... [9544-55]

**Metamaterial-based single pixel imaging system (Invited Paper)**, Willie Padilla, Duke Univ. (USA); Claire M. Watts, Boston College (USA); Christian Nadell, Duke Univ. (USA); John A. Montoya, Sanjay Krishna, The Univ. of New Mexico (USA) ..... [9544-58]

SESSION 12 ..... WED 10:45 AM TO 12:35 PM

## Metadevices and Metasystems II

Session Chair: **Alberto Piqué**, U.S. Naval Research Lab. (USA)

**Mechanics meets plasmonics: new devices and sensors (Invited Paper)**, Ertugrul Cubukcu, Univ. of Pennsylvania (USA) ..... [9544-57]

**Device applications of metafilms and metasurfaces (Invited Paper)**, Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-56]

**Design theory of thin film hyperbolic metamaterial collimators**, Daniel B. Fullager, Michael A. Fiddy, The Univ. of North Carolina at Charlotte (USA) [9544-59]

**Engineering optical systems using transformation optics**, Saul Wiggin, Queen Mary, Univ. of London (United Kingdom) ..... [9544-60]

**Plasmonic photocathodes**, Rosa A. Lukaszew, Zhaozhu Li, Kaida Yang, Jose Riso, The College of William & Mary (USA) ..... [9544-61]

**Stripe-teeth metamaterial Al- and Nb-based rectennas**, Richard M. Osgood III, Stephen A. Giardini, Joel B. Carlson, U.S. Army Natick Soldier Research, Development and Engineering Ctr. (USA); Prabhuram Joghee, Ryan P. O'Hayre, Colorado School of Mines (USA); Kenneth Diest, Mordechai Rothschild, MIT Lincoln Lab. (USA) ..... [9544-62]

Lunch/Exhibition Break ..... Wed 12:35 pm to 2:05 pm

SESSION 13 ..... WED 2:05 PM TO 3:30 PM

## Randomness and Fluctuations

Session Chair: **Rosa A. Lukaszew**, The College of William & Mary (USA)

**Understanding of increased diffuse scattering in regular arrays of fluctuating resonant particles (Invited Paper)**, Andrei Andrievski, DTU Fotonik (Denmark); Mihail Petrov, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation); Andrei Lavrinenko, DTU Fotonik (Denmark); Sergei Tretyakov, Aalto Univ. School of Science and Technology (Finland) ..... [9544-63]

**Giant field fluctuations in dielectric metamaterials and SERS sensors**, Andrey K. Sarychev, Konstantin N. Afanasiev, Irina A. Boginskaya, Institute for Theoretical and Applied Electrodynamics (Russian Federation); Igor A. Budashov, N.M. Emanuel Institute of Biochemical Physics (Russian Federation); Igor V. Bykov, Institute for Theoretical and Applied Electrodynamics (Russian Federation); Ilya N. Kurochkin, N.M. Emanuel Institute of Biochemical Physics (Russian Federation); Andrey N. Lagarkov, Institute for Theoretical and Applied Electromagnetics (Russian Federation); Ilya A. Ryzhikov, Andrey V. Ivanov, Alexander V. Vaskin, Institute for Theoretical and Applied Electrodynamics (Russian Federation) [9544-64]

**Opto-mechanical interactions in split ball resonators**, Yue Sun, Sergey V. Suchkov, Andrey E. Miroshnichenko, Andrey A. Sukhorukov, The Australian National Univ. (Australia) ..... [9544-65]

**Ultrahigh-capacity non-periodic photon sieves operating in visible light**, Cheng-Wei Qiu, Shengtao Mei, National Univ. of Singapore (Singapore); Hong Liu, A\*STAR Institute of Materials Research and Engineering (Singapore); Kun Huang, National Univ. of Singapore (Singapore); Jinghua Teng, A\*STAR Institute of Materials Research and Engineering (Singapore) ..... [9544-66]

**A non-Monte Carlo approach to analyzing 1D Anderson localization in dispersive metamaterials**, Glen J. Kissel, Univ. of Southern Indiana (USA) ..... [9544-67]

# CONFERENCE 9544

SESSION 14 ..... WED 4:00 PM TO 5:50 PM

## Metasurfaces I

Session Chair: **Andrey Karlovich Sarychev**, Institute for Theoretical and Applied Electrodynamics (Russian Federation)

**Tunable metasurfaces** (*Invited Paper*), Harry A. Atwater Jr., California Institute of Technology (USA) ..... [9544-68]

**Vertical split-ring resonators for plasmon coupling, sensing, and metasurface** (*Invited Paper*), Din Ping Tsai, Academia Sinica (Taiwan) and National Taiwan Univ. (Taiwan); Pin Chieh Wu, Wei-Lun Hsu, Wei Ting Chen, Yao-Wei Huang, Chun Yen Liao, Wei-Yi Tsai, National Taiwan Univ. (Taiwan); Al Qun Liu, Nanyang Technological Univ. (Singapore); Nikolay I. Zheludev, Optoelectronics Research Ctr. (United Kingdom); Greg Sun, Univ. of Massachusetts Boston (USA) ..... [9544-69]

**Cascaded meta-surfaces for broadband antenna isolation**, Joseph A. Miragliotta, David Shrekenhamer, Robert Scott, Allan Jablon, Jerry Friedman, Derek Harshbarger, Johns Hopkins Univ. Applied Physics Lab., LLC (USA); Daniel F. Sievenpiper, Univ. of California, San Diego (USA) ..... [9544-70]

**Anisotropic meta-surfaces for enhanced antenna isolation**, Joseph A. Miragliotta, David Shrekenhamer, Johns Hopkins Univ. Applied Physics Lab., LLC (USA); Daniel F. Sievenpiper, Univ. of California, San Diego (USA) ..... [9544-71]

**Plasmon drag effect in plasmonic metasurfaces**, Vincent Rono, Norfolk State Univ. (USA); Matthew LePain, Georgia Southern Univ. (USA); Rabia Hussain, Norfolk State Univ. (USA); David Keene, Maxim Durach, Georgia Southern Univ. (USA); Natalia Noginova, Norfolk State Univ. (USA) ..... [9544-72]

**Cramér-Rao bounds for metasurfaces susceptibilities**, Thomas Lepetit, Boubacar Kante, Univ. of California, San Diego (USA) ..... [9544-73]

**POSTERS-WEDNESDAY** ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Hybrid plasmonic nanosandwich structures**, Soad Alsheheri, Marjan Saboktakin, Mohammed Matin, Univ. of Denver (USA) ..... [9544-95]

**Adjustment characteristics in terahertz transmission through a split ring resonator-based metamaterial**, Jun Luo, Yehua Bie, Xinyu Zhang, Hongshi Sang, Changsheng Xie, Huazhong Univ. of Science and Technology (China) ..... [9544-96]

**Plasmon coupling in vertical split-ring resonator magnetic metamolecules**, Mu Ku Chen, Pin Chieh Wu, Wei-Lun Hsu, Wei Ting Chen, National Taiwan Univ. (Taiwan); Din Ping Tsai, Academia Sinica (Taiwan); Yi-Teng Huang, Yao-Wei Huang, Chun Yen Liao, National Taiwan Univ. (Taiwan) ..... [9544-97]

**Active metasurface grating for broadband electronic modulation of free space terahertz waves**, Muhammad Tayyab Nouman, Jae Hyung Jang, Sungbae J. Lee, Gwangju Institute of Science and Technology (Korea, Republic of) ..... [9544-98]

**Shaping the light distribution of strongly focused systems for efficient excitation of optical nano-circuits**, Boris Okorn, Jordi Sancho-Parramon, Institut Ruder Bošković (Croatia); Silvio Hrabar, Univ. of Zagreb (Croatia) ..... [9544-99]

**Quantum toroidal moments of nanohelix eigenstates**, Johnny Williamson, Mario R. Encinosa, Florida Agricultural and Mechanical Univ. (USA) ..... [9544-100]

**Mie resonance in the arrays of dielectric rods in air**, Ravindra K. Sinha, Reena Dalal, Yogita Kalra, Delhi Technological Univ. (India) ..... [9544-101]

**Taming microwave propagation with hyperbolic and chiral metal-dielectric metamaterials**, Brittany Bates, Brandon Allison, Nicole Greene, Vincent Rono, Natalia Noginova, Norfolk State Univ. (USA) ..... [9544-102]

**Simulation of space-time cloaking using FDTD for terahertz frequency range**, Egor A Gurvitz, Mikhail V Sharaevsky, ITMO University (Russian Federation); Mikhail K. Khodzitky, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation) ..... [9544-103]

**Temperature-controlled infrared broadband cloaking with the bilayer of semiconductor and superconductor**, Xiaohua Wang, Nanjing Univ. of Aeronautics and Astronautics (China); Youwen Liu, Nanjing Univ. of Aeronautics and Astronautics (China) ..... [9544-104]

**A new type of metamaterial panel for invisible using**, Hongwei Sun, Fei Yan, Jari Tooling Technology Co. (China) ..... [9544-105]

**Controlling the bandwidth of metamaterial properties**, Morteza Karami, Michael A. Fiddy, The Univ. of North Carolina at Charlotte (USA) ..... [9544-106]

**Full control of light using plasmonic metasurfaces**, Jianxiong Li, Nankai Univ. (China); Shuqi Chen, Nankai Univ. (China); Jianguo Tian, Nankai Univ. (China) ..... [9544-107]

**Acoustic metamaterial panel for potential invisible using based on multi-cells**, Fei Yan, Hongwei Sun, Jari Tooling Technology Co., Ltd. (China) ..... [9544-108]

## THURSDAY 13 AUGUST

SESSION 15 ..... THU 8:30 AM TO 10:20 AM

## Metasurfaces II

Session Chair: **Mayer A. Landau**

**Visible-frequency metasurfaces for broadband anomalous reflection and high-efficiency spectrum splitting**, Zhongyang Li, Edgar Palacios, Serkan Bütin, Koray Aydin, Northwestern Univ. (USA) ..... [9544-74]

**Metasurfaces for amplitude, phase, and polarization control** (*Invited Paper*), Uriel Levy, Boris Desiatov, Meir Grajower, Jonathan Bar David, The Hebrew Univ. of Jerusalem (Israel) ..... [9544-75]

**Light manipulation by resonant dielectric nanostructures and metasurfaces** (*Invited Paper*), Arseniy I. Kuznetsov, A\*STAR - Data Storage Institute (Singapore) ..... [9544-76]

**Metasurface-enabled Quantum vacuum effects over macroscopic distances**, Pankaj K. Jha, Xingjie Ni, Chihhui Wu, Yuan Wang, Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9544-77]

**All-dielectric metasurfaces for structured light generation**, Mikhail Shalaev, Jingbo Sun, Univ. at Buffalo (USA); Apra Pandey, CST of America, Inc. (USA); Kirill Nikolsky, M.V. Lomonosov Moscow State Univ. (Russian Federation); Natalia M. Litchinitser, Univ. at Buffalo (USA) ..... [9544-78]

**Dynamically reconfigurable metasurfaces**, Prasad P. Iyer, Nikita A. Butakov, Jon A. Schuller, Univ. of California, Santa Barbara (USA) ..... [9544-79]

SESSION 16 ..... THU 10:50 AM TO 12:25 PM

## Metasurfaces III

Session Chair: **Arseniy I. Kuznetsov**, A\*STAR - Data Storage Institute (Singapore)

**Metagratings for tunable unidirectional steering and focusing of surface plasmons** (*Invited Paper*), Federico Capasso, Daniel Wintz, Harvard School of Engineering and Applied Sciences (USA); Patrice Genevet, Singapore Institute of Manufacturing Technology (Singapore) and Harvard School of Engineering and Applied Sciences (USA); Antonio Ambrosio, Harvard School of Engineering and Applied Sciences (USA) and Univ. degli Studi di Napoli Federico II (Italy); Alex Woolf, Harvard School of Engineering and Applied Sciences (USA) ..... [9544-80]

**Metasurfaces and epsilon-near-zero modes in semiconductors** (*Invited Paper*), Igal Brener, Salvatore Campione, Sandia National Labs. (USA); Francois Marquier, Institut d'Optique (France) ..... [9544-81]

**Carpet cloak with graded dielectric metasurface**, LiYi Hsu, Thomas Lepetit, Boubacar Kante, Univ. of California, San Diego (USA) ..... [9544-82]

**Ultra-thin metasurface carpet cloak**, Xingjie Ni, Zi Jing Wong, Michael Mrejen, Yuan Wang, Univ. of California, Berkeley (USA); Xiang Zhang, Univ. of California, Berkeley (USA) and Lawrence Berkeley National Lab. (USA) ..... [9544-83]

**Flat optical beam shapers based on all-dielectric Huygens' metasurfaces**, Katie E. Chong, Isabelle Staude, The Australian National Univ. (Australia); Anthony James, Jason Dominguez, Sheng Liu, Salvatore Campione, Ganapathi S. Subramania, Ting S. Luk, Sandia National Labs. (USA); Manuel Decker, Dragomir N. Neshev, The Australian National Univ. (Australia); Igal Brener, Sandia National Labs. (USA); Yuri S. Kivshar, The Australian National Univ. (Australia) ..... [9544-84]

Lunch/Exhibition Break ..... Thu 12:25 pm to 2:00 pm

# CONFERENCE 9544

SESSION 17 ..... THU 2:00 PM TO 3:40 PM

## Novel Phenomena and Methods

Session Chair: **Xingjie Ni**, Univ. of California, Berkeley (USA)

**An atom/metamaterial hybrid system (Invited Paper)**, David Wilkowski, Nanyang Technological Univ. (Singapore) ..... [9544-85]

**Metamaterial models of spacetime**, Tom G. Mackay, The Univ. of Edinburgh (United Kingdom); Akhlesh Lakhtakia, The Pennsylvania State Univ. (USA) [9544-86]

**Electron beam excitation of CSRR loaded waveguide for Cherenkov radiation**, Emmy Sharples, The Cockcroft Institute (United Kingdom) and Lancaster Univ. (United Kingdom); Rosa Letizia, Lancaster Univ. (United Kingdom) and The Cockcroft Institute (United Kingdom) ..... [9544-87]

**Synchrotron infra-red spectral microscopy of metal-dielectric-metal cavity metamaterial absorbers**, Janardan Nath, Deep Panjwani, Mehmet Yesilas, Univ. of Central Florida (USA); Carol J. Hirschmugl, Univ. of Wisconsin-Milwaukee (USA); Farnood K. Rezaie, Robert E. Peale, Univ. of Central Florida (USA) ..... [9544-88]

**Double Fano resonances in a composite metamaterial possessing tripod plasmonic resonances**, Jeong-Weon Wu, Y. U. Lee, E. Y. Choi, E. S. Kim, J. H. Woo, B. Kang, J. Kim, Ewha Womans Univ. (Korea, Republic of); Byung Cheol Park, T. Y. Hong, Jae Hoon Kim, Yonsei Univ. (Korea, Republic of) ..... [9544-89]

**Spooft plasmons in an array form sound hard to sound soft inclusions**, Jean-Francois Mercier, Ctr. National de la Recherche Scientifique (France); Maria Luisa Cordero, Felipe Barra, Univ. de Chile (Chile); Simon Felix, Ctr. National de la Recherche Scientifique (France) and Univ. du Maine (France); Agnes Maurel, Ctr. National de la Recherche Scientifique (France) and Institut Langevin (France) ..... [9544-90]

SESSION 18 ..... THU 4:00 PM TO 4:45 PM

## Low-Frequency Materials

Session Chair: **David Wilkowski**, Nanyang Technological Univ. (Singapore)

**Polarization and angle dependent electromagnetic response of microwave metamaterials**, David A. Lee, The MITRE Corp. (USA); James L. Vedral, Univ. of Colorado at Colorado Springs (USA); Randall Musselman, U.S. Air Force Academy (USA); Anatoliy O. Pinchuk, Univ. of Colorado at Colorado Springs (USA) [9544-92]

**Extraordinary terahertz transmission through electrically small particles**, Mohammed R. AlShareef, King Abdulaziz City for Science and Technology (Saudi Arabia); Omar M. Ramahi, Univ. of Waterloo (Canada) ..... [9544-93]

**Two layer metamaterials for selective frequency transmission in the terahertz region**, Mayer A. Landau, Air Force Research Lab. (USA) ..... [9544-94]

CLOSING REMARKS ..... 5:10 PM TO 5:20 PM

Session Chairs: **Nader Engheta**, Univ. of Pennsylvania (USA); **Mikhail A. Noginov**, Norfolk State Univ. (USA); **Nikolay I. Zheludev**, Optoelectronics Research Ctr. (United Kingdom)

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## Nanophotonic Materials XII

Conference Chairs: **Stefano Cabrini**, Lawrence Berkeley National Lab. (USA); **Gilles Lérondel**, Univ. de Technologie Troyes (France); **Adam M. Schwartzberg**, Lawrence Berkeley National Lab. (USA); **Taleb Mokari**, Ben-Gurion Univ. of the Negev (Israel)

Program Committee: **David L. Andrews**, Univ. of East Anglia (United Kingdom); **Angus J. Bain**, Univ. College London (United Kingdom); **Mireille H. Blanchard-Desce**, Univ. de Rennes 1 (France); **Robert W. Boyd**, Univ. of Rochester (USA); **Zeno Gaburro**, Univ. degli Studi di Trento (Italy); **Aaron W. Harper**, The Univ. of Southern California (USA); **Ghassan E. Jabbour**, Arizona State Univ. (USA); **François Kajzar**, Univ. Politehnica of Bucharest (Romania); **Dmitri I. Kovalev**, Univ. of Bath (United Kingdom); **Paras N. Prasad**, Univ. at Buffalo (USA); **Dmitri Talapin**, The Univ. of Chicago (USA); **Younan Xia**, Georgia Institute of Technology (USA)

### MONDAY 10 AUGUST

#### NANOSCIENCE + ENGINEERING

#### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan);  
**David L. Andrews**, Univ. of East Anglia (United Kingdom)

**Extreme Imaging and Beyond (Plenary)**, Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

**Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary)**, Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

**Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary)**, Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

### WEDNESDAY 12 AUGUST

#### SESSION 1..... WED 8:10 AM TO 10:00 AM

#### Nanoparticles and Nanoplates

Session Chair: **Adam M. Schwartzberg**, Lawrence Berkeley National Lab. (USA)

**Gold nanoparticle enhanced fluorescence of fluorescein dye: a thermal lens study**, Jisha John, Lincy Thomas, Catholicate College (India); Sajan D. George, Manipal Univ. (India); Achamma Kurian, Catholicate College (India) ..... [9545-1]

**Surface functionalized spherical nanoparticles: an optical assessment of local chirality**, Jamie M. Leeder, David L. Andrews, Henryk T. Haniewicz, Univ. of East Anglia (United Kingdom) ..... [9545-2]

**Semiconductor nanoplatelets: a new colloidal system for low-threshold, high-gain stimulated emission**, Matthew A. Pelton, Univ. of Maryland, Baltimore County (USA) and Argonne National Lab. (USA); Chunxing She, Univ. of Chicago (USA); Igor Fedin, Dmitriy Dolzhnikov, Sandrine Ithurria, The Univ. of Chicago (USA); Erfan Baghani, Stephen K. O'Leary, The Univ. of British Columbia (Canada); Arnaud Demortiere, Illinois Institute of Technology (USA); Richard D. Schaller, Argonne National Lab. (USA); Dmitri V. Talapin, The Univ. of Chicago (USA) and Argonne National Lab. (USA) ..... [9545-3]

**Controlling spontaneous emission of monolayer MoS<sub>2</sub> with single-crystal nanoplates**, Yingyi Yang, Matt Klug, Dafei Jin, Qing Hu, Nicholas Fang, Massachusetts Institute of Technology (USA) ..... [9545-4]

**Manipulating the spatial extent of the exciton diffusion through QDs assembly by controlling dimensionality, energy landscape, and exciton density (Invited Paper)**, Keiko Munechika, Jiye Lee, Dimitrios Simatos, Mauro Melli, Steve Whitelam, Alexander Weber-Bargioni, The Molecular Foundry (USA) ..... [9545-5]

#### SESSION 2..... WED 10:30 AM TO 12:00 PM

#### Nanoscale Semiconductor

Session Chair: **Keiko Munechika**, Lawrence Berkeley National Lab. (USA)

**Nitride semiconductor nanostructures for classical and quantum light generation (Invited Paper)**, Yong-Hoon Cho, KAIST (Korea, Republic of) .. [9545-6]

**Carrier localization in In-rich InGaN/GaN multiple quantum wells for green light-emitting**, Hyun Jeong, Univ. de Technologie Troyes (France); Mun Seok Jeong, Sungkyunkwan Univ. (Korea, Republic of); Gilles Lerondel, Univ. de Technologie Troyes (France) ..... [9545-7]

**CdTe quantum dots fluorescent probes for determination of 2,4-dichlorophenol compounds based on the Fe(III)PcTs-BuOOH catalysis system**, Tong Yilin, Hongqi Li, Haiqing Chen, Hankou Univ. (China) ..... [9545-8]

**Nanostructured organosilicon luminophores as a new concept of nanomaterials for highly efficient down-conversion of light**, Sergey A. Ponomarenko, Institute of Synthetic Polymeric Materials (Russian Federation), Moscow State Univ. (Russian Federation), LumInnoTech LLC (Russian Federation); Nikolay M. Surin, Oleg V. Borshchev, Maxim S. Skoroteckiy, Institute of Synthetic Polymeric Materials (Russian Federation), LumInnoTech LLC (Russian Federation); Aziz M. Muzafarov, Institute of Synthetic Polymeric Materials (Russian Federation), A.N. Nesmeyanov Institute of Organoelement Compounds (Russian Federation) ..... [9545-9]

Lunch/Exhibition Break ..... Wed 12:00 pm to 1:30 pm

#### SESSION 3..... WED 1:30 PM TO 3:30 PM

#### Enhanced Photonic Properties from UV to THz

Session Chair: **Gilles Lérondel**, Univ. de Technologie Troyes (France)

**Terahertz devices based on carbon nanomaterials (Invited Paper)**, Junichiro Kono, Rice Univ. (USA) ..... [9545-10]

**Theoretical design of nano-layered Al/SiO<sub>2</sub> metamaterial with hyperbolic dispersion with minimum losses**, Priscilla N. Kelly, Daniel White, Lyuba Kuznetsova, San Diego State Univ. (USA) ..... [9545-11]

**Spectral tunability of the spacer layer in metasurface absorbers**, Kai Liu, Nan Zhang, Dengxin Ji, Haomin Song, Xie Zeng, Qiaoqiang Gan, Univ. at Buffalo (USA) ..... [9545-12]

**Highly efficient excitonic emission of CBD grown ZnO micropods**, Roy Aad, Anisha Gokarna, Komla Nomenyo, Univ. de Technologie Troyes (France); Patrice Miska, Univ. de Lorraine (France); Wei Geng, Christophe Couteau, Gilles Lérondel, Univ. de Technologie Troyes (France) ..... [9545-13]

**High-speed tip-enhanced Raman imaging (Invited Paper)**, Marc Chaigneau, HORIBA Jobin Yvon S.A.S. (France); Andrey V. Krayez, AIST-NT Inc. (USA); Ophélie Lancy, HORIBA Jobin Yvon S.A.S. (France); Sergey A. Saunin, AIST-NT Inc. (USA) ..... [9545-14]

# CONFERENCE 9545

SESSION 4..... WED 4:00 PM TO 5:50 PM

## Active Devices

Session Chair: **Stefano Cabrini**, The Molecular Foundry (USA)

**Design of metal/dielectric/nanocrystals core/shell/shell nano-structures for the fluorescence enhancement of cadmium-free semiconductor nanocrystals (Invited Paper)**, Théo Chevallier, Gilles Le Blevennec, Frederic Chandeson, Commissariat à l'Énergie Atomique (France) ..... [9545-15]

**Adiabatic mode coupler on ion-exchanged waveguides for the efficient excitation of surface plasmon modes**, Josslyn Beltran Madrigal, Univ. de Technologie Troyes (France); Martin Berthel, Institut NÉEL (France); Florent Gardillou, Teem Photonics S.A. (France); Ricardo Tellez Limon, Christophe Couteau, Univ. de Technologie Troyes (France); Denis Barber, Teem Photonics S.A. (France); Aurelien Drezet, Institut NÉEL (France); Rafael Salas-Montiel, Univ. de Technologie Troyes (France); Serge Huant, Institut NÉEL (France); Sylvain Blaize, Univ. de Technologie Troyes (France) ..... [9545-16]

**Multiscale modeling of the plasmonic and light trapping response of random nanostructured TiO<sub>2</sub>-photoelectrodes**, Ivonne Carvajal, George P. Demopoulos, Raynald Gauvin, McGill Univ. (Canada) ..... [9545-17]

**New design of photonic band gap filter: the random dimer effect**, Brezini Abderrahmene, Univ. d'Oran (Algeria); Fares Kanouni, Ctr. de Recherche (Algeria); Qin Zou, Institut Telecom Sud Paris (France) ..... [9545-18]

**Optical properties of polyaniline-coated silica spheres: aging effect in acetone**, Byeong-Wu Kim, Sang-Jo Kim, So-Yeon Kang, Sang-Hyeon Moon, Eun-Hye Park, Kwang-Sun Kang, Kyungil Univ. (Korea, Republic of) ..... [9545-19]

**POSTERS-WEDNESDAY..... WED 5:30 PM TO 7:30 PM**

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Investigation of Ta nanoparticles characteristics produced by laser ablation method**, Fariba Azadi Kenari, Mohammad Reza Hantehzadeh, Islamic Azad Univ. (Iran, Islamic Republic of) ..... [9545-30]

**Resonant tunneling in 2D-photonic superlattices**, Fares Kanouni, Ctr. de Développement des Technologies Avancées (Algeria) ..... [9545-31]

**Broadband ENZ metamaterials based on metal-polymer composite films**, Pavlo Pinchuk, Ke Jiang, Univ. of Colorado at Colorado Springs (USA) .. [9545-32]

**Using of radiation intensity dependence on excitation level for the analysis of surface plasmon resonance effect on ZnO luminescence**, Stepan I. Rumyantsev, Mikhail V. Ryzhkov, Charus M. Briskina, Valery M. Markushev, Institute of Radio Engineering and Electronics (Russian Federation); Andrey P. Tarasov, Moscow Institute of Physics and Technology (Russian Federation) and Institute of Radio Engineering and Electronics (Russian Federation); Andrey A. Lotin, Institute on Laser and Information Technologies (Russian Federation) ..... [9545-33]

**Visible-light response of TiO<sub>2</sub> photocatalysts introduced by annealing**, Fangzhou Liu, The Univ. of Hong Kong (Hong Kong, China); Mu Yao Guo, Alan Man Ching Ng, South Univ. of Science and Technology of China (China) and The Univ. of Hong Kong (Hong Kong, China); Aleksandra B. Djurišić, Wai Kin Chan, The Univ. of Hong Kong (Hong Kong, China) ..... [9545-34]

**Photovoltaic study of dye sensitized solar cells based on TiO<sub>2</sub>, ZnO:Al<sup>3+</sup> nanoparticles**, Ruben A. Rodriguez-Rojas, Humberto E. Sanchez, Jesus Castañeda-Contreras, Virginia F. Marañon-Ruiz, Héctor Pérez Ladrón de Guevara, Univ. de Guadalajara (Mexico); Tzarara López-Luke, Elder De la Rosa-Cruz, Ctr. de Investigaciones en Óptica, A.C. (Mexico) ..... [9545-35]

**Photodisaggregation of silver nanoparticles suspended in ethanol**, Gabriel J. Ortega, Alfonso Padilla-Vivanco, Carina Toxqui-Quitl, Univ. Politécnica de Tulancingo (Mexico); Placido Zaca, Fernando Chávez, Benemérita Univ. Autónoma de Puebla (Mexico) ..... [9545-36]

**Suppressing spontaneous polarization of p-GaN by graphene oxide passivation: augmented light output of GaN UV-LED**, Hyun Jeong, Univ. de Technologie Troyes (France); Mun Seok Jeong, Sungkyunkwan Univ. (Korea, Republic of) ..... [9545-37]

**A simple method for p-type doping of monolayer MoS<sub>2</sub> using graphene oxide**, Hye Min Oh, Young Hee Lee, Mun Seok Jeong, Sungkyunkwan Univ. (Korea, Republic of) ..... [9545-38]

**Determination of refractive index and absorbance modulation amplitudes from angular selectivity of holograms in polymer material with phenanthrenequinone**, Vladimir N Borisov, Andrey N Veniaminov, ITMO University (Russian Federation) ..... [9545-39]

**THURSDAY 13 AUGUST**

SESSION 5..... THU 8:30 AM TO 10:20 AM

## Energy- and Sensing-Related Materials

Session Chair: **Junichiro Kono**, Rice Univ. (USA)

**Rh6G released from solid and nanoporous SiO<sub>2</sub> spheres prepared by sol-gel route**, Jorge A. Garcia-Macedo, Pedro Francisco-Santiago, Alfredo Franco, Univ. Nacional Autónoma de México (Mexico) ..... [9545-20]

**Fabrication and characterization of p-ZnO:(P,N)/n-ZnO:Al homojunction ultra-violet (UV) light emitting diodes**, Amiruddin Rafiudeen, T. Srinivasa Reddy, Shaheer Cheemadan, M.C. Santhosh Kumar, National Institute of Technology, Tiruchirappalli (India) ..... [9545-21]

**Control of photoinduced fluorescence enhancement of colloidal quantum dots using metal oxides**, Seyed M. Sadeghi, Waylin J. Wing, Kira Patty, The Univ. of Alabama in Huntsville (USA) ..... [9545-22]

**Optical thin film materials and devices for harsh environment, high temperature sensing applications**, Paul R. Ohodnicki Jr., Zsolt Poole, Thomas Brown, John Baltrus, National Energy Technology Lab. (USA); Kevin Chen, Aidong Yan, Univ. of Pittsburgh (USA) ..... [9545-23]

**Enhanced luminescence excitation via efficient optical energy transfer (Invited Paper)**, Roy Aad, Komla D. Nomenyo, Univ. de Technologie Troyes (France); Bogdan Bercu, Univ. de Reims Champagne-Ardenne (France); Christophe Couteau, Univ. de Technologie Troyes (France); Vincent Sallet, Univ. de Versailles Saint-Quentin-en Yvelines (France); David J. Rogers, Nanovation (France); Michael Molinari, Univ. de Reims Champagne-Ardenne (France); Gilles Lérondel, Univ. de Technologie Troyes (France) ..... [9545-24]

**SESSION 6..... THU 10:50 AM TO 12:40 PM**

## Multifunctional Oxides

Session Chair: **Yong-Hoon Cho**, KAIST (Korea, Republic of)

**Optical property tuning of bismuth chalcogenides using chemical intercalation (Invited Paper)**, Jie Yao, Univ. of California, Berkeley (USA) ..... [9545-25]

**Utilizing homogenous FRET to extend molecular photonic wires beyond 30 nm**, Sebastian A. Diaz, Susan Buckhout-White, Mario G. Ancona, Joseph S. Melinger, Igor L. Medintz, U.S. Naval Research Lab. (USA) ..... [9545-26]

**TiO<sub>2</sub> membranes for concurrent photocatalytic organic degradation and corrosion protection**, Robert Liang, Melisa Hatat, Horatio He, Y. Norman Zhou, Univ. of Waterloo (Canada) ..... [9545-27]

**Optically active quantum dots**, Yurii K. Gun'ko, Trinity College Dublin (Ireland) ..... [9545-28]

**UV-sensing TiO<sub>2</sub>-based films grown by streaming process for electrodeless electrochemical deposition**, Farrood Khalilzadeh-Rezaie, Janardan Nath, Univ. of Central Florida (USA); Isaiah O. Oladeji, SISOM Thin Films, LLC (USA); Winston V. Schoenfeld, Robert E. Peale, Univ. of Central Florida (USA) ..... [9545-29]

# CONFERENCE 9546

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## Active Photonic Materials VII

Conference Chairs: **Ganapathi S. Subramania**, Sandia National Labs. (USA); **Stavroula Foteinopoulou**, The Univ. of New Mexico (USA)

Program Committee: **Koray Aydin**, Northwestern Univ. (USA); **Paul V. Braun**, Univ. of Illinois at Urbana-Champaign (USA); **Kurt Busch**, Humboldt-Univ. zu Berlin (Germany); **Shanhui Fan**, Stanford Univ. (USA); **Didier Felbacq**, Univ. Montpellier 2 (France); **Alexander V. Kildishev**, Purdue Univ. (USA); **Yuri S. Kivshar**, The Australian National Univ. (Australia); **Michal F. Lipson**, Cornell Univ. (USA); **Cefe López**, Consejo Superior de Investigaciones Científicas (Spain); **Michelle L. Povinelli**, The Univ. of Southern California (USA); **Jörg Schilling**, Martin-Luther-Univ. Halle-Wittenberg (Germany); **Andrey A. Sukhorukov**, The Australian National Univ. (Australia); **Kosmas L. Tsakmakidis**, Univ. of California, Berkeley (USA); **Georgios Veronis**, Louisiana State Univ. (USA); **Ralf B. Wehrspohn**, Fraunhofer-Institut für Werkstoffmechanik (Germany); **Daniel M. Wasserman**, Univ. of Illinois at Urbana-Champaign (USA); **William Whelan-Curtin**, Univ. of St. Andrews (United Kingdom)

### SUNDAY 9 AUGUST

#### OPENING REMARKS ..... 8:10 AM TO 8:15 AM

Session Chair: **Ganapathi S. Subramania**, Sandia National Labs. (USA)

#### SESSION 1 ..... SUN 8:15 AM TO 10:00 AM

#### Tailoring IR Light I: Novel Emitters, Sources, and Detectors

Session Chair: **Michelle L. Povinelli**, The Univ. of Southern California (USA)

**Meta-infrared detectors for 4th generation infrared imagers** (*Invited Paper*), Sanjay Krishna, The Univ. of New Mexico (USA) ..... [9546-1]

**Wideband and wide angle thermal emitters for use as lightbulb filaments**, Christopher H. Granier, Simon G. Lorenzo, Jonathan P. Dowling, Georgios Veronis, Louisiana State Univ. (USA) ..... [9546-2]

**Intensity tunable mid-wavelength infrared broadband absorbers based on planar nanometric film coatings employing thermochromic phase change material**, Hasan Kocer, Turkish Military Academy (Turkey); Serkan Büttün, Edgar Palacios, Zizhuo Liu, Koray Aydin, Northwestern Univ. (USA) ..... [9546-3]

**Optimization of Er and Yb dopant concentrations and ratios for efficient high-brightness mid-infrared light sources**, Behsan Behzadi, Mani Hosseini-Zadeh, Ravi Jain, The Univ. of New Mexico (USA) ..... [9546-4]

**Phased arrays based on second harmonic generation from metamaterials coupled to semiconductor heterostructures** (*Invited Paper*), Omri Wolf, Salvatore Campione, Alexander Benz, Sandia National Labs. (USA); Arvind P. Ravikumar, Princeton Univ. (USA); Sheng Liu, Ting S. Luk, Emil A. Kadlec, Eric A. Shaner, John F. Klem, Michael B. Sinclair, Igali Brener, Sandia National Labs. (USA) ..... [9546-5]

#### SESSION 2 ..... SUN 10:30 AM TO 11:45 AM

#### Tailoring IR Light II: Extra-Ordinary Beam Control

Session Chair: **Sanjay Krishna**, The Univ. of New Mexico (USA)

**Hybrid optical-thermal nanoantennas for enhanced light focusing and radiative cooling** (*Invited Paper*), Svetlana V. Boriskina, Gang Chen, Massachusetts Institute of Technology (USA) ..... [9546-6]

**Broadband nonresonant funneling of light via ultrasubwavelength channels**, Ganapathi S. Subramania, Sandia National Labs. (USA); Stavroula Foteinopoulou, The Univ. of New Mexico (USA); Igali Brener, Sandia National Labs. (USA) ..... [9546-7]

**Mid-IR phonon-polaritonics: superabsorption and super-steering** (*Invited Paper*), Ganga C. R. Devarapu, Univ. of St Andrews (United Kingdom); Stavroula Foteinopoulou, The Univ. of New Mexico (USA) ..... [9546-8]

Lunch Break ..... Sun 11:45 am to 1:15 pm

#### SESSION 3 ..... SUN 1:15 PM TO 3:15 PM

#### Photonic-Crystal-Based Active Devices

Session Chair: **Arash Mafi**, The Univ. of New Mexico (USA)

**Recent progress in photonic crystals and their device applications** (*Invited Paper*), Susumu Noda, Kyoto Univ. (Japan) ..... [9546-9]

**Photonic crystal enhanced light emission from silicon** (*Invited Paper*), Liam O'Faolain, Univ. of St. Andrews (United Kingdom) ..... [9546-10]

**Exploiting lossy resonances for arbitrary nonlinear power response** (*Invited Paper*), Michelle L. Povinelli, Roshni Biswas, The Univ. of Southern California (USA) ..... [9546-11]

**Near thresholdless laser operation at room temperature** (*Invited Paper*), Pablo A. Postigo, Instituto de Microelectrónica de Madrid (Spain) ..... [9546-12]

#### SESSION 4 ..... SUN 3:45 PM TO 5:30 PM

#### From Order to Disorder: Molding Light by Breaking Periodic Order

Session Chair: **Susumu Noda**, Kyoto Univ. (Japan)

**Transverse Anderson localization and image transport through disordered fibers** (*Invited Paper*), Arash Mafi, The Univ. of New Mexico (USA); Salman Karbasi, Univ. of California, San Diego (USA); John Ballato, Clemson Univ. (USA); Karl Koch, Corning Incorporated (USA) ..... [9546-13]

**Hyperuniform photonic slabs for high-Q cavities and low-loss waveguides**, Timothy Amoah, Marian Florescu, Univ. of Surrey (United Kingdom) ..... [9546-14]

**Periodic, quasiperiodic, aperiodic, and random plasmon particle array lasers** (*Invited Paper*), A. Femius Koenderink, Hinke Schokker, FOM Institute for Atomic and Molecular Physics (Netherlands) ..... [9546-15]

**Engineering active aperiodic nanostructures** (*Invited Paper*), Luca Dal Negro, Boston Univ. (USA) ..... [9546-16]

#### SYMPOSIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

##### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)  
**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

### MONDAY 10 AUGUST

#### NANOSCIENCE + ENGINEERING PLENARY SESSION ..... MON 9:15 AM TO 12:00 PM

Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan); **David L. Andrews**, Univ. of East Anglia (United Kingdom)

**Extreme Imaging and Beyond** (*Plenary*), Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

**Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions** (*Plenary*), Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

**Device Applications of Semiconductor Nanoantennas and Metafilms** (*Plenary*), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch Break ..... Mon 12:00 pm to 1:45 pm

# CONFERENCE 9546

SESSION 5.....MON 1:45 PM TO 3:00 PM

## Advances in Fabrication for Active Photonics

Session Chair: **Alexandra Boltasseva**, Purdue Univ. (USA)

**Understanding disordered materials for new unconventional light sources (Invited Paper)**, Cefe López, Consejo Superior de Investigaciones Científicas (Spain) ..... [9546-17]

**High Q photonic crystal cavities realized using deep ultraviolet lithography**, Liam O'Faolain, Univ. of St. Andrews (United Kingdom) ..... [9546-18]

**3D optical metamaterials formed by holographic assembly and directed solidification of eutectics (Invited Paper)**, Paul V. Braun, Univ. of Illinois at Urbana-Champaign (USA) ..... [9546-19]

SESSION 6.....MON 3:30 PM TO 5:30 PM

## Dynamic Control of Optical Systems

Session Chair: **Rupert F. Oulton**, Imperial College London (United Kingdom)

**Highly-nonlinear quantum-engineered polaritonic metasurfaces (Invited Paper)**, Mikhail A. Belkin, The Univ. of Texas at Austin (USA) ..... [9546-20]

**Alternative materials lead to practical nanophotonic components (Invited Paper)**, Nathaniel Kinsey, Purdue Univ. (USA); Marcello Ferrera, Purdue Univ. (USA) and Heriot-Watt Univ. (United Kingdom); Clayton DeVault, Jongbum Kim, Alexander V. Kildishev, Vladimir M. Shalaev, Alexandra Boltasseva, Purdue Univ. (USA) ..... [9546-21]

**Understanding carrier injection effects upon the Reststrahlen band of SiC using transient infrared spectroscopy**, Bryan T. Spann, Ryan Compton, Adam D. Dunkelberger, James P. Long, U.S. Naval Research Lab. (USA); Paul Klein, Sotera Defense Solutions, Inc. (USA); Daniel Ratchford, Josh D. Caldwell, Jeff C. Owrusky, U.S. Naval Research Lab. (USA) ..... [9546-22]

**Ultrafast dynamics of Al-doped zinc oxide under optical excitation**, Nathaniel Kinsey, Clayton T. DeVault, Jongbum Kim, Purdue Univ. (USA); Marcello Ferrera, Purdue Univ. (USA) and Heriot-Watt Univ. (United Kingdom); Alexander V. Kildishev, Vladimir M. Shalaev, Alexandra Boltasseva, Purdue Univ. (USA) ..... [9546-23]

**Advanced electrodynamic mechanisms for the nanoscale control of light by light (Invited Paper)**, David L. Andrews, Univ. of East Anglia (United Kingdom) ..... [9546-24]

## TUESDAY 11 AUGUST

SESSION 7.....TUE 8:00 AM TO 11:30 AM

## Single Photons and Photonic Quantum Information Platforms

Session Chair: **Ganapathi S. Subramania**, Sandia National Labs. (USA)

**Photonic quantum technologies (Invited Paper)**, Jeremy L. O'Brien, Univ. of Bristol (United Kingdom) ..... [9546-25]

**Deterministic placement of fabricated InGaN quantum dots in photonic structures (Invited Paper)**, Arthur J. Fischer, Xiaoyin Xiao, Ping Lu, Ganapathi S. Subramania, Jeffrey Y. Tsao, Daniel D. Koleske, Sandia National Labs. (USA) ..... [9546-26]

**Towards scalable networks of solid state quantum memories in a photonic integrated circuit (Invited Paper)**, Dirk R. Englund, Massachusetts Institute of Technology (USA) ..... [9546-27]

**Quantum optics in directional one-dimensional photonic reservoirs (Invited Paper)**, Immo Söllner, Peter Lodahl, Niels Bohr Institute (Denmark) ..... [9546-28]

**Integrated single photon detectors for chip scale quantum key distribution (Invited Paper)**, Paul S. Davids, Chris DeRose, Nick Martinez, Douglas Trotter, Andrew Starbuck, Andrew Pomerene, Ryan Camacho, Anthony Lentine, Sandia National Labs. (USA) ..... [9546-29]

**Integrated laser-written quantum photonics (Invited Paper)**, Markus Gräfe, René Heilmann, Armando Perez-Leija, Maxime Lebugle, Diego Guzman-Silva, Matthias Heinrich, Alexander Szameit, Friedrich-Schiller-Univ. Jena (Germany) ... [9546-30]

Lunch/Exhibition Break ..... Tue 11:30 am to 12:45 pm

SESSION 8.....TUE 12:45 PM TO 3:30 PM

## New Lasing Paradigms

Session Chair: **Tsampikos Kottos**, Wesleyan Univ. (USA)

**Whispering-gallery-mode optical resonators around an exceptional point (Invited Paper)**, Bo Peng, Sahin K. Ozdemir, Huzeife Yilmaz, Washington Univ. in St. Louis (USA); M. Lierter, Technische Univ. Wien (Austria); Faraz Monifi, C. M. Bender, Washington Univ. in St. Louis (USA); Franco Nori, RIKEN (Japan) and Univ. of Michigan (USA); Lan Yang, Washington Univ. in St. Louis (USA) ..... [9546-31]

**Ultrafast plasmonic nanowire lasers near the surface plasmon frequency (Invited Paper)**, Themistoklis P. H. Sidiropoulos, Imperial College London (United Kingdom); Robert Roder, Sebastian Geburt, Friedrich-Schiller-Univ. Jena (Germany); Ortwin Hess, Stefan A. Maier, Imperial College London (United Kingdom); Carsten Ronning, Friedrich-Schiller-Univ. Jena (Germany); Rupert F. Oulton, Imperial College London (United Kingdom) ..... [9546-32]

**III-V GaAs based plasmonic lasers**, Lucas Lafone, Ngoc Nguyen, Imperial College London (United Kingdom); Ed Clarke, Univ. of Sheffield (United Kingdom); Paul Fry, The Univ. of Sheffield (United Kingdom); Rupert F. Oulton, Imperial College London (United Kingdom) ..... [9546-33]

**Time-resolved lasing dynamics for plasmonic system with gain**, Jieran Fang, Jingjing Liu, Zhuoxian Wang, Xiangeng Meng, Ludmila J. Prokopeva, Vladimir M. Shalaev, Alexander V. Kildishev, Purdue Univ. (USA) ..... [9546-34]

**Single mode parity-time laser**, Zi Jing Wong, Liang Feng, Renmin Ma, Yuan Wang, Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9546-35]

**Simultaneous unidirectional lasing and reflectionless modes in PT-symmetric cavities (Invited Paper)**, Hamidreza Ramezani, Hao-kun Li, Yuan Wang, Univ. of California, Berkeley (USA); Xiang Zhang, Univ. of California, Berkeley (USA) and Lawrence Berkeley National Lab. (USA) ..... [9546-36]

**Cavity-free stopped-light nanolasing in nanoplasmonic heterostructures (Invited Paper)**, Ortwin Hess, Imperial College London (United Kingdom) . [9546-37]

SESSION 9.....TUE 4:00 PM TO 5:45 PM

## Quantum Dots: New Functionalities and Fabrication

Session Chair: **Arthur J. Fischer**, Sandia National Labs. (USA)

**Auger-decay engineering in quantum dots in relation to applications in LEDs and lasers (Invited Paper)**, Victor I. Klimov, Los Alamos National Lab. (USA) ..... [9546-38]

**Nanowire quantum dots for quantum optics (Invited Paper)**, Valery Zwilfer, Michael Reimer, Klaus Joens, Lucas Schweickert, Technische Univ. Delft (Netherlands) ..... [9546-39]

**Redefining giant quantum dot functionality through synthesis and integration: from multifunctionality to directed photoluminescence (Invited Paper)**, Jennifer A. Hollingsworth, Los Alamos National Lab. (USA). ..... [9546-40]

**Controlled growth of CdSe quantum dots on silica spheres**, Byoung-Ju Kim, Donghyun Jo, Se-Han Lim, Do-Kyoon Kim, Jin-Young Park, Jong-Hwa Jeon, Kwang-Sun Kang, Kyungil Univ. (Korea, Republic of) ..... [9546-41]

# CONFERENCE 9546

WEDNESDAY 12 AUGUST

SESSION 10 ..... WED 8:15 AM TO 10:00 AM

## Weak and Strong Coupling

Session Chair: Stephen Hughes, Queen's Univ. (Canada)

Collective properties and strong coupling in the near-field of a meta-surface  
(*Invited Paper*), Didier Felbacq, Emmanuel Rousseau, Univ. Montpellier 2  
(France) ..... [9546-42]

Coherent coupling between a molecular vibration and Fabry-Perot optical cavity to give hybridized states in the strong coupling limit, James P. Long, Jeff C. Owrusky, Kenan P. Fears, Walter J. Dressick, Adam D. Dunkelberger, Ryan Compton, Bryan T. Spann, Blake S. Simpkins, U.S. Naval Research Lab.  
(USA) ..... [9546-43]

Applications of Fano resonances to active photonic devices (*Invited Paper*), Andrey E. Miroshnichenko, The Australian National Univ. (Australia) ..... [9546-44]

Strong light matter coupling in two-dimensional semiconductors (*Invited Paper*), Vinod M. Menon, The City College of New York (USA) ..... [9546-45]

SESSION 11 ..... WED 10:30 AM TO 11:45 AM

## New Platforms and Theoretical Methods for Spontaneous Emission

Session Chair: Gennady B. Shvets, The Univ. of Texas at Austin (USA)

Phonon-modified spontaneous emission from quantum dots in structured photonic reservoirs: breakdown of Fermi's golden rule (*Invited Paper*), Stephen Hughes, Queen's Univ. (Canada) ..... [9546-46]

Improving emission in nanorod arrays using quasi-aperiodic inverse design, P. Duke Anderson, Michelle L. Povinelli, The Univ. of Southern California (USA) ..... [9546-47]

Photonic and plasmonic nanoresonators: a modal approach (*Invited Paper*), Christophe Sauvan, Jean-Paul Hugonin, Lab. Charles Fabry (France); Philippe Lalanne, Lab. Photonique Numérique et Nanosciences (France) ..... [9546-48]

Lunch/Exhibition Break ..... Wed 11:45 am to 1:15 pm

SESSION 12 ..... WED 1:15 PM TO 3:45 PM

## Topological Effects and Effective Gauge Fields in Photonics

Session Chair: Hakan E. Tureci, Princeton Univ. (USA)

Transport properties of pseudospin-1 photons (*Invited Paper*), Che Ting Chan, Anan Fang, Zhao-Qing Zhang, Hong Kong Univ. of Science and Technology (Hong Kong, China); Steven G. Louie, Hong Kong Univ. of Science and Technology (Hong Kong, China) and Univ. of California, Berkeley (USA) and Lawrence Berkeley National Lab. (USA) ..... [9546-53]

Novel topological states in photonics (*Invited Paper*), Marin Soljacic, Massachusetts Institute of Technology (USA) ..... [9546-49]

Gyromagnetically induced transparency of metasurfaces (*Invited Paper*), Gennady B. Shvets, Hossein Mousavi, The Univ. of Texas at Austin (USA); Alexander Khanikaev, Queens College (USA); Jeffery W. Allen, Monica Allen, Air Force Research Lab. (USA) ..... [9546-50]

Using time-dependent effective gauge field for photons to achieve dynamic localization of light, Luqi Yuan, Shanhui Fan, Stanford Univ. (USA) ..... [9546-51]

Measuring topological invariants in small photonic lattices (*Invited Paper*), Oded Zilberberg, ETH Zürich (Switzerland); Charles-Edouard Bardyn, ETH Zürich (Switzerland) and California Institute of Technology (USA); Sebastian Huber, ETH Zürich (Switzerland) ..... [9546-52]

SESSION 13 ..... WED 4:00 PM TO 6:00 PM

## Exotic Transport and Amplification by Synergy of Gain and Loss

Session Chair: Stavroula Fotienopoulou, The Univ. of New Mexico (USA)

Light scattering in pseudo-passive media with uniformly balanced gain and loss (*Invited Paper*), Tsampikos Kottos, Ali Basiri, Wesleyan Univ. (USA); Ilya Vitebskiy, Air Force Research Lab. (USA) ..... [9546-54]

Giant amplification of light in non-hermitian photonic materials (*Invited Paper*), Hakan E. Tureci, Konstantinos G. Makris, Princeton Univ. (USA); Li Ge, College of Staten Island (USA) ..... [9546-55]

Parity-time anti-symmetric parametric amplifier (*Invited Paper*), Diana A. Antonosyan, Alexander S. Solntsev, Andrey A. Sukhorukov, The Australian National Univ. (Australia) ..... [9546-56]

PT-symmetric scatterers (*Invited Paper*), Mohammad-Ali Miri, Nicholas Nye, Mercedes Khajavikhan, Demetrios N. Christodoulides, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA) ..... [9546-57]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

Intense terahertz-pulse generation by four-wave mixing process in induced gas plasma, Surawut Wicharn, Srinakharinwirot Univ. (Thailand); Prathan Buranasiri, King Mongkut's Institute of Technology Ladkrabang (Thailand) [9546-73]

Direct measure of the photo-induced nanoscale surface displacement in solids using atomic force microscopy, Samuel T. Souza, Eduardo J. Fonseca, Carlos Jacinto, Univ. Federal de Alagoas (Brazil); Nelson G. C. Astrath, Thiago P. Rodrigues, Luis C. Malacarne, Univ. Estadual de Maringá (Brazil) ..... [9546-74]

Using dilute-P GaNP alloy as improved visible active region, Chee-Keong Tan, Zhangji Zhao, Nelson Tansu, Lehigh Univ. (USA) ..... [9546-75]

Selectively reflective transparent sheets, Remi Wache, Steven K. Clowes, Marian Florescu, Stephen J. Sweeney, Univ. of Surrey (United Kingdom) ..... [9546-76]

Omnidirectional mirror in two-dimensional photonic crystal with a periodic gain-loss modulation, Carlos Ivan Ham-Rodriguez, Jesus Manzanares-Martinez, Univ. de Sonora (Mexico); Paola Castro-Garay, Universidad de Sonora (Mexico); Betsabe Manzanares-Martinez, Yohan Jasid Rodriguez-Viveros, Univ. de Sonora (Mexico); Damian Moctezuma-Enriquez, Ctr. de Investigación en Materiales Avanzados, S.C. (Mexico) ..... [9546-77]

Moving femtosecond soliton in layered structure with cubic nonlinearity, Vyacheslav A. Trofimov, Tatyana M. Lysak, Lomonosov Moscow State Univ. (Russian Federation) ..... [9546-78]

# CONFERENCE 9546

THURSDAY 13 AUGUST

SESSION 14 ..... THU 8:15 AM TO 10:30 AM

## Extreme Light Control for Energy Applications

Session Chair: **Svetlana V. Boriskina**, Massachusetts Institute of Technology (USA)

**Engineering light absorption in semiconductor metafilms** (*Invited Paper*), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) .... [9546-58]

**Exchanging Ohmic losses in metamaterial absorbers with useful optical absorption for photovoltaics** (*Invited Paper*), Durdu O. Guney, Michigan Technological Univ. (USA) .... [9546-59]

**Optimized super-absorption in nano-structured thin films via a genetic algorithm** (*Invited Paper*), Alexandre Mayer, Jérôme Muller, Aline Herman, Olivier Deparis, Univ. of Namur (Belgium) .... [9546-60]

**A new avenue for high efficiency solar cells: interaction of hot electrons with plasmons** (*Invited Paper*), Krzysztof Kempa, Boston College (USA) .... [9546-61]

**Large-area, lithography-free perfect absorbers, color filters, and photodetectors at visible frequencies using ultra-thin silver or amorphous silicon films**, Zhongyang Li, Serkan Bütün, Koray Aydin, Northwestern Univ. (USA) ... [9546-62]

SESSION 15 ..... THU 11:00 AM TO 12:30 PM

## Tunable EM Phenomena and Devices

Session Chair: **Krzysztof Kempa**, Boston College (USA)

**Transforming Cherenkov radiation in metamaterials** (*Invited Paper*), Vincent Ginis, Jan Danckaert, Irina Veretennicoff, Vrije Univ. Brussel (Belgium); Philippe Tassin, Chalmers Univ. of Technology (Sweden) .... [9546-63]

**Guiding light by plasmonic resonant solitons in metallic nanosuspensions**, Trevor S. Kelly, Akbar Samadi, Anna Bezryadina, San Francisco State Univ. (USA); Zhigang Chen, San Francisco State Univ. (USA) and Nankai Univ. (China) [9546-64]

**Magneto-optical switches in metal-dielectric-metal plasmonic waveguides**, Ali Haddadpour, Vahid Foroughi Nezhad, Louisiana State Univ. (USA); Zongfu Yu, Univ. of Wisconsin-Madison (USA); Georgios Veronis, Louisiana State Univ. (USA) .... [9546-65]

**Second order nonlinearity in Si by inhomogeneous strain and electric fields** (*Invited Paper*), Jörg Schilling, Clemens Schriever, Martin-Luther-Univ. Halle-Wittenberg (Germany); Federica Bianco, Scuola Normale Superiore (Italy); Massimo Cazzanelli, Lorenzo Pavesi, Univ. degli Studi di Trento (Italy). .... [9546-66]

Lunch/Exhibition Break ..... Thu 12:30 pm to 2:00 pm

SESSION 16 ..... THU 2:00 PM TO 3:00 PM

## New EM Phenomena and Modeling Methods of Atomically Thick Materials

Session Chair: **Liam O'Faolain**, Univ. of St. Andrews (United Kingdom)

**Nano-optoelectronics with atomically thin material** (*Invited Paper*), Nick Vamivakas, Univ. of Rochester (USA) .... [9546-67]

**In-the-cloud optimization tool for retrieving experimentally fitted conductivity of graphene**, Ludmila J. Prokopeva, Purdue Univ. (USA) and Novosibirsk State Univ. (Russian Federation) and Institute of Computational Technologies (Russian Federation); You-Chia Chang, Univ. of Michigan (USA); Naresh K. Emani, Purdue Univ. (USA) and Data Storage Institute (Singapore); Ted Norris, Univ. of Michigan (USA); Alexander V. Kildishev, Purdue Univ. (USA). .... [9546-68]

**Enhanced infrared transmission from gold wire-grid arrays via surface plasmons in continuous graphene**, Zizhuo Liu, Serkan Bütün, Edgar Palacios, Koray Aydin, Northwestern Univ. (USA) .... [9546-69]

SESSION 17 ..... THU 3:30 PM TO 5:00 PM

## Extraordinary Nonlinear Phenomena and Systems

Session Chair: **Philippe Tassin**, Chalmers Univ. of Technology (Sweden)

**Enhancing and inhibiting stimulated Brillouin scattering in photonic integrated circuits** (*Invited Paper*), Benjamin J. Eggleton, Moritz Merklein, Thomas F. S. Buettner, Irina V. Kabakova, The Univ. of Sydney (Australia) .... [9546-70]

**Optical pulse engineering and processing using nonlinearities of tapered and photonic crystal waveguides made of silicon** (*Invited Paper*), Nicolae-Coriolan Panoiu, Spyros Lavdas, Jie You, Univ. College London (United Kingdom); Richard M. Osgood Jr., Columbia Univ. (USA) .... [9546-71]

**Nonlocal and quantum tunneling contributions to harmonic generation in nanostructures: electron cloud screening effects** (*Invited Paper*), Michael Scalora, U.S. Army Aviation and Missile Command (USA) .... [9546-72]

AWARD ANNOUNCEMENT  
AND CLOSING REMARKS ..... 5:00 PM TO 5:15 PM

Session Chairs: **Stavroula Foteinopoulou**, The Univ. of New Mexico (USA); **Ganapathi S. Subramania**, Sandia National Labs. (USA)

Sunday-Thursday 9–13 August 2015 • Proceedings of SPIE Vol. 9547

# Plasmonics: Metallic Nanostructures and Their Optical Properties XIII

*Conference Chair:* Allan D. Boardman, Univ. of Salford (United Kingdom)*Conference Co-Chair:* Din Ping Tsai, National Taiwan Univ. (Taiwan)

*Program Committee:* Martin Aeschlimann, Technische Univ. Kaiserslautern (Germany); Harry A. Atwater Jr., California Institute of Technology (USA); David J. Bergman, Tel Aviv Univ. (Israel); Che Ting Chan, Hong Kong Univ. of Science and Technology (Hong Kong, China); Harald W. Giessen, Univ. Stuttgart (Germany); Jean-Jacques Greffet, Institut d'Optique Graduate School (France); Naomi J. Halas, Rice Univ. (USA); Martti Kauranen, Tampere Univ. of Technology (Finland); Satoshi Kawata, Osaka Univ. (Japan); Fritz Keilmann, LASNIX (Germany); Dai-Sik Kim, Seoul National Univ. (Korea, Republic of); Laurens K. Kuipers, FOM Institute for Atomic and Molecular Physics (Netherlands); Mikhail Lapine, The Univ. of Sydney (Australia); Ai Qun Liu, Nanyang Technological Univ. (Singapore); Olivier J. F. Martin, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Peter Nordlander, Rice Univ. (USA); Lukas Novotny, Univ. of Rochester (USA); Vahid Sandoghdar, ETH Zurich (Switzerland); George C. Schatz, Northwestern Univ. (USA); Tigran V. Shahbazyan, Jackson State Univ. (USA); Vladimir M. Shalaev, Purdue Univ. (USA); Gennady B. Shvets, Institute for Fusion Studies (USA); Niek F. van Hulst, ICFO - Institut de Ciències Fotòniques (Spain); Hongxing Xu, Institute of Physics (China); Nikolay I. Zheludev, Univ. of Southampton (United Kingdom); Joseph Zyss, Ecole Normale Supérieure de Cachan (France)

## SUNDAY 9 AUGUST

**SESSION 1..... SUN 8:30 AM TO 10:10 AM**

### Fundamentals of Surface Plasmons I

Session Chair: David J. Bergman, Tel Aviv Univ. (Israel)

**Transverse spin of surface plasmon polaritons and spin-orbit coupling effects in light scattering by plasmonic nanostructures (Invited Paper)**, Francisco J. Rodríguez-Fortuño, Daniel O'Connor, Pavel Ginzburg, Gregory A. Wurtz, Anatoly V. Zayats, King's College London (United Kingdom) ..... [9547-1]

**Generation of quantum entangled states in nonlinear plasmonic structures and metamaterials**, Alexander N. Poddubny, Ioffe Physical-Technical Institute (Russian Federation) and National Research Univ. of ITMO (Russian Federation); Andrey A. Sukhorukov, The Australian National Univ. (Australia) ..... [9547-2]

**Efficient far field transmission of orbital angular momentum light states**, Denis Garoli, Pierfrancesco Zilio, Istituto Italiano di Tecnologia (Italy); Giuseppe Parisi, twistoff s.r.l. (Italy); Francesco Tantussi, Istituto Italiano di Tecnologia (Italy); Felix Ritor, Univ. de Barcelona (Spain); Tommaso Ongarello, Institut d'Électronique Fondamentale (France); Francesco De Angelis, Istituto Italiano di Tecnologia (Italy); Yuri Gorodetski, Ariel Univ. (Israel) ..... [9547-3]

**Magneto-optical response of a periodic metallic nano-structure (Invited Paper)**, Yakov M. Strelniker, Bar-Ilan Univ. (Israel); David J. Bergman, Tel Aviv Univ. (Israel) ..... [9547-4]

**SESSION 2..... SUN 10:40 AM TO 12:30 PM**

### Fundamentals of Surface Plasmons II

Session Chair: Anatoly V. Zayats, King's College London (United Kingdom)

**Perfect optical imaging of a Veselago lens: Eigenstate based analysis (Invited Paper)**, David J. Bergman, Asaf Farhi, Tel Aviv Univ. (Israel) ..... [9547-5]

**Beam engineering for selective and enhanced coupling to multipolar resonances**, Tanya Das, Jon A. Schuller, Univ. of California, Santa Barbara (USA) ..... [9547-6]

**Ultrafast coherent dynamics of Rydberg electrons bound in the image potential near a single metallic nanoobject (Invited Paper)**, Jörg Robin, Jan Vogelsang, Carl von Ossietzky Univ. Oldenburg (Germany); Benedek J. Nagy, Wigner Research Ctr. for Physics of the H.A.S. (Hungary); Petra Gross, Christoph Lienau, Carl von Ossietzky Univ. Oldenburg (Germany) ..... [9547-7]

**Heat generation, hot electrons, and transparency windows in plasmonic nanostructures (Invited Paper)**, Alexander Govorov, Ohio Univ. (USA).... [9547-8]

Lunch Break ..... Sun 12:30 pm to 2:00 pm

**SESSION 3..... SUN 2:00 PM TO 3:20 PM**

### Plasmonic Applications I

Session Chair: Georg Herink, Georg-August-Univ. Göttingen (Germany)

**Thermal phenomena in quantum plasmonics (Invited Paper)**, Andrey K. Sarychev, Institute for Theoretical and Applied Electrodynamics (Russian Federation); Gennady Tartakovsky, Advanced Systems and Technologies (USA); Sergey Vergeles, L.D. Landau Institute for Theoretical Physics (Russian Federation); Vladimir Parfenyev, Moscow Institute of Physics and Technology (Russian Federation) ..... [9547-9]

**Plasmonic laser sensors**, Renmin Ma, Sadao Ota, Yimin Li, Sui Yang, Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9547-10]

**Near-field imaging and spectroscopy of hybridized plasmons (Invited Paper)**, Martin Aeschlimann, Technische Univ Kaiserslautern (Germany). ..... [9547-11]

**SESSION 4..... SUN 3:50 PM TO 5:50 PM**

### Surface Plasmon Related Measurement

Session Chair: Andrey Karlovich Sarychev, Institute for Theoretical and Applied Electrodynamics (Russian Federation)

**Ultrafast nanoelectronics: steering electrons in infrared near-fields (Invited Paper)**, Georg Herink, Claus Ropers, Georg-August-Univ. Göttingen (Germany) ..... [9547-12]

**Mapping near-field plasmonic interactions of silver particles with scanning near-field optical microscope measurements**, Patrick Andrae, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany) and Freie Universität Berlin (Germany); Mohamed Haggui, Paul Fumagalli, Freie Univ. Berlin (Germany); Martina Schmid, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany) and Freie Univ. Berlin (Germany) ..... [9547-13]

**Probing plasmonic hot spots on single gold nanowires using combined near field techniques**, Patrick Hsia, Sylvie Marguet, CEA-Ctr. de SACLAY (France); Sergei Kostcheev, Renaud J. B. Bachelot, Institut Charles Delaunay (France) and Lab. de Nanotechnologie et Instrumentation Optique (France); Ludovic Douillard, Fabrice Charra, Céline Fiorini-Debuisschert, CEA-Ctr. de SACLAY (France) ..... [9547-14]

**Ultrafast dynamics via coherent exciton-plasmon coupling in quantum dot-metallic nanoparticle systems**, Seyed M. Sadeghi, The Univ. of Alabama in Huntsville (USA)..... [9547-15]

**Time-resolved propagation and interferometric lensing of surface plasmons (Invited Paper)**, Wayne P. Hess, Alan G. Joly, Yu Gong, Patrick El Khoury, Pacific Northwest National Lab. (USA) ..... [9547-16]

**SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM**

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

# CONFERENCE 9547

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING

#### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

- Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan);  
**David L. Andrews**, Univ. of East Anglia (United Kingdom)
- Extreme Imaging and Beyond (Plenary)**, Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]
- Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary)**, Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]
- Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary)**, Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch/Exhibition Break..... Mon 12:00 pm to 1:30 pm

#### SESSION 5..... MON 1:30 PM TO 3:20 PM

### Plasmonic Applications II

Session Chair: **Atsushi Sugita**, Shizuoka Univ. (Japan)

- Surface plasmon resonance gas sensing by electrons injection**, Enrico Gazzola, Michela Cittadini, Laura Brigo, Giovanna Brusatin, Massimo Guglielmi, Filippo Romanato, Alessandro Martucci, Univ. degli Studi di Padova (Italy) ..... [9547-17]
- Multicolor fluorescence microscopic imaging of cancer cells on the plasmonic chip**, Keiko Tawa, National Institute of Advanced Industrial Science and Technology (Japan) and Kwansei Gakuin Univ. (Japan); Chisato Sasakawa, Shohei Yamamura, Izumi Shibata, Masatoshi Kataoka, National Institute of Advanced Industrial Science and Technology (Japan) ..... [9547-18]
- NIR and MIR charge transfer plasmons in wire-bridged antennas**, Yue Zhang, Fangfang Wen, Samuel Gottheim, Nicholas S. King, Yu Zhang, Peter Nordlander, Naomi J. Halas, Rice Univ. (USA) ..... [9547-19]
- Nanoporous antennae for high quality factor infrared sensing**, Denis Garoli, Eugenio Calandrini, Istituto Italiano di Tecnologia (Italy); Sandro Cattarin, CNR-IENI (Italy); Pierfrancesco Zilio, Alessandro Alabastri, Andrea Toma, Ermanno Miele, Francesco De Angelis, Istituto Italiano di Tecnologia (Italy) ..... [9547-20]
- Plasmonic holography: obtaining wide angle, broadband, and high efficiency (Invited Paper)**, Jacob Scheuer, Yuval Yifat, Michal Eitan-Wiener, Zeev Iluz, Yael Hanein, Amir Boag, Tel Aviv Univ. (Israel) ..... [9547-21]

#### SESSION 6..... MON 3:50 PM TO 5:40 PM

### Plasmonic Coupling and Nonlinearity I

Session Chair: **Alessandro Martucci**, Univ. degli Studi di Padova (Italy)

- Strongly coupled plasmon-nanocavity modes for broadband, near-field induced absorption in ultrathin semiconductor coatings (Invited Paper)**, Carl Hagglund, Uppsala Univ. (Sweden) ..... [9547-22]
- Cooperative energy transfer in plasmonic systems**, Tigran V. Shahbazyan, Jackson State Univ. (USA); Vitaliy N. Pustovit, Augustine M. Urbas, Air Force Research Lab. (USA) ..... [9547-23]
- Surface plasmon strengthened nonlinearity in indium-tin-oxide coated Cu-doped potassium sodium barium strontium niobate crystals**, Hua Zhao, Liang Li, Jingwen Zhang, Harbin Institute of Technology (China) ..... [9547-24]
- Enhancing second-order nonlinearity on Au-nanorods at localized surface plasmon resonance with nonlinear optical polymers**, Atsushi Sugita, Takuma Hirabayashi, Shunsuke Nihashi, Atsushi Ono, Yoshimasa Kawata, Univ. of Shizuoka (Japan) ..... [9547-25]

- A comparative study of second-harmonic generation in plasmonic and dielectric gratings made of centrosymmetric materials**, Martin Weismann, Univ. College London (United Kingdom) and Photon Design Ltd. (United Kingdom); Dominic F. G. Gallagher, Photon Design (United Kingdom); Nicolae-Coriolan Panoiu, Univ. College London (United Kingdom) ..... [9547-26]

## TUESDAY 11 AUGUST

#### SESSION 7..... TUE 8:00 AM TO 10:10 AM

### Radiation Engineering

Session Chair: **Mikhail Lapine**, The Univ. of Sydney (Australia)

- Surface-enhanced Raman spectroscopy on engineered plasmonic metamaterials for "label free" biosensing (Invited Paper)**, Massimo Rippa, Rossella Capasso, Marianna Pannico, Pietro La Manna, Pellegrino Musto, Consiglio Nazionale delle Ricerche (Italy); Jun Zhou, Ningbo Univ. (China); Lucia L. Pettit, Consiglio Nazionale delle Ricerche (Italy) ..... [9547-27]
- Surface plasmon polaritons mediated energy transfer in stratified metal-dielectric nanostructure**, Sepideh Golmakaniyoon, Nanyang Technological Univ. (Singapore) and LUMINOUS! Ctr. of Excellence for Semiconductor Lighting and Displays (Singapore); Yoga Divayana, Hilmi V. Demir, Xiaowei Sun, Nanyang Technological Univ. (Singapore) ..... [9547-28]
- Integrated ring grating-nanoantenna structure for plasmon/emitter coupling**, Nancy Rahbany, Wei Geng, Rafael Salas-Montiel, Sylvain Blaize, Renaud J. B. Bachelot, Univ. de Technologie Troyes (France); Christophe Couteau, Univ. de Technologie Troyes (France) and Nanyang Technological Univ. (Singapore) ..... [9547-29]

- Fluorescence enhancement using Fano-resonant a plasmonic nanostructure with selective functionalization of molecules at the electromagnetic hot spot**, Xiaolong Wang, Olivier J. F. Martin, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9547-30]

- Plasmon enhanced linear and nonlinear photoluminescence in planar nanoparticle arrays**, Gary F. Walsh, U.S. Army Natick Soldier Research, Development and Engineering Ctr. (USA) and Boston Univ. (USA); Luca Dal Negro, Boston Univ. (USA) ..... [9547-31]

- Probing and controlling large Purcell enhancement in plasmonic nanoantennas**, Maiken H. Mikkelsen, Duke Univ. (USA) ..... [9547-32]

#### SESSION 8..... TUE 10:40 AM TO 12:20 PM

### Plasmonic Coupling and Nonlinearity II

Session Chair: **Lucia L. Pettit**, Consiglio Nazionale delle Ricerche (Italy)

- Second harmonic excitation spectroscopy in studies of Fano-type coupling in plasmonic arrays**, Gary F. Walsh, U.S. Army Natick Soldier Research, Development and Engineering Ctr. (USA) and Boston Univ. (USA); Jacob T. Trevino, The City Univ. of New York Advanced Science Research Ctr. (USA) and Boston Univ. (USA); Emanuele Francesco Pecora, Stanford Univ. (USA) and Boston Univ. (USA); Luca Dal Negro, Boston Univ. (USA) ..... [9547-33]

- Predicting nonlinear properties of metamaterials from the linear response**, Kevin O'Brien, Haim Suchowski, Junsuk Rho, Alessandro Salandrino, Boubacar Kante, Xiaobo Yin, Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9547-34]

- Multi-coupled resonant splitting with a nano-slot metasurface and PMMA phonons**, Michael F. Finch, Brian A. Lail, Florida Institute of Technology (USA) ..... [9547-35]

- Local field enhanced second-harmonic response of organic nanofibers**, Oksana Kostiučenko, Till Leibnner, Jacek Fiutowski, Jonathan R. Brewer, Horst-Günter Rubahn, Univ. of Southern Denmark (Denmark) ..... [9547-36]

- Plasmonic coupling of gold curvilinear nanorods with nanogap**, Yukie Yokota, Takuo Tanaka, RIKEN (Japan) ..... [9547-37]

Lunch/Exhibition Break..... Tue 12:20 pm to 1:50 pm

#### SESSION 9..... TUE 1:50 PM TO 3:10 PM

### Novel Material for Plasmonics

Session Chair: **Benjamin Gallinet**, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland)

- Graphene plasmonics: multiple sharp Fano resonances in silver split concentric nanoring resonator dimers on a metasurface**, Arash Ahmadivand, Nezh Pala, Florida International Univ. (USA) ..... [9547-38]

- Graphene supports the manipulating mode propagation in the hybrid plasmonic nanowaveguides**, Xiaosai Wang, Jiangnan Univ. (China); Jicheng Wang, Jiangnan Univ. (China) and Purdue Univ. (USA); Ci Song, Sinian Qu, Lin Sun, Jiangnan Univ. (China) ..... [9547-39]

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**Observation of Fano resonances in highly doped semiconductors plasmonic resonators**, Thierry Taliercio, Vianne Ntsame Guiengui, Univ. Montpellier 2 (France); Jean-Baptiste Rodriguez, Univ. of Montpellier (France); Laurent Cerutti, Eric Tournié, Univ. Montpellier 2 (France) ..... [9547-40]

**Alloyed thin-films and nanostructures with dielectric function on demand**, Chen Gong, Allen Chang, Ellen Cesewski, Marina S. Leite, Univ. of Maryland, College Park (USA) ..... [9547-41]

**SESSION 10** ..... **TUE 3:40 PM TO 6:30 PM**

## Plasmonic Applications III

Session Chair: **Marina S. Leite**, Univ. of Maryland, College Park (USA)

**Plasmonics for the industry (Invited Paper)**, Benjamin Gallinet, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland) ..... [9547-42]

**Optical dark field and electron energy loss imaging and spectroscopy of symmetry-forbidden modes in loaded nanogap antennas**, Todd Brinklinger, U.S. Naval Research Lab. (USA); Andrew Herzing, National Institute of Standards and Technology (USA); James P. Long, Igor Vurgaftman, Rhonda Stroud, Blake S. Simpkins, U.S. Naval Research Lab. (USA) ..... [9547-43]

**Epitaxial silver as a plasmonic materials platform: from plasmonic nanolasers to long range plasmonic wave propagations (Invited Paper)**, Chih-Kang Shih, The Univ. of Texas at Austin (USA) ..... [9547-44]

**Femtosecond control of magneto-optical effects in magnetoplasmonic crystals (Invited Paper)**, Andrey A Fedyakin, Maksim R Scherbakov, Polina P Vabishchevich, Lomonosov Moscow State Univ (Russian Federation); Aleksandr Yu. Frolov, Lomonosov Moscow State Univ. (Russian Federation); Artem V Chetvertukhin, Tatiana V Dolgova, Lomonosov Moscow State Univ (Russian Federation) ..... [9547-45]

**A plasmonic walker (Invited Paper)**, Na Liu, Max-Planck Institut für Intelligente Systeme (Germany) ..... [9547-46]

**From light modulation to far-field excitation of graphene plasmons: science and applications of graphene-integrated metasurfaces (Invited Paper)**, Gennady B. Shvets, The Univ. of Texas at Austin (USA) ..... [9547-47]

## WEDNESDAY 12 AUGUST

**SESSION 11** ..... **WED 8:00 AM TO 10:10 AM**

## Plasmonic Applications IV

Session Chair: **Bin Ren**, Xiamen Univ. (China)

**Comparison between plasmonic and dielectric nanoantennas for surface-enhanced spectroscopies (Invited Paper)**, Stefan A. Maier, Imperial College London (United Kingdom) ..... [9547-48]

**Analysis of plasmonical enhanced photodetectors with Au microantennae**, Avery M. Hill, Ahmad I. Nusir, Omar Manasreh, Joseph B. Herzog, Univ. of Arkansas (USA) ..... [9547-49]

**Wafer-scale plasmonic and photonic crystal sensors**, Matthew C. George, MOXTEK, Inc. (USA); Jui-Nung Liu, Univ. of Illinois at Urbana-Champaign (USA); Arash Farhang, Brent Williamson, Mike Black, Ted Wangenstein, James Fraser, Rumyana Petrova, MOXTEK, Inc. (USA); Brian T. Cunningham, Univ. of Illinois at Urbana-Champaign (USA) ..... [9547-50]

**Rectifying antenna**, Imran Hossain, Univ. of California, Santa Cruz (USA) [9547-51]

**Hot electron pump: a plasmonic rectifying antenna**, Ahmet A. Yanik, Golam I. Hossain, Univ. of California, Santa Cruz (USA) ..... [9547-52]

**Tunable optical extinction of nano-antennas for solar energy conversion from near-infrared to visible**, Darin T. Zimmerman, Penn State Altoona (USA) [9547-53]

**SESSION 12** ..... **WED 10:40 AM TO 12:30 PM**

## Plasmonic Nanostructures and Nanofabrication

Session Chair: **Stefan A. Maier**, Imperial College London (United Kingdom)

**3D chiral nanoplasmonics: fabrication, chiroptic engineering, mechanism, and application in enantioselection**, Zhipeng Huang, Hong Kong Baptist Univ. (Hong Kong, China) ..... [9547-54]

**Modeling and engineering of three-dimensional chiroplasmonic silver nano structures**, Junhong Deng, Fan Bai, Jack Ng, Zhipeng Huang, Hong Kong Baptist Univ. (Hong Kong, China) ..... [9547-55]

**Twisted nanosphere lithography: use colloidal Moiré patterns as masks**, Kai Chen, National Institute for Materials Science (Japan); Bharath B. Rajeeva, Michael Rukavina, The Univ. of Texas at Austin (USA); Thang Duy Dao, Satoshi Ishii, Masakazu Aono, Tadaaki Nagao, National Institute for Materials Science (Japan); Yuebing Zheng, The Univ. of Texas at Austin (USA) ..... [9547-56]

**Angled nanospherical-lens lithography as a high-throughput method to fabricate various nanodisk cluster arrays**, Yi-Hsin Chien, Chang-Han Wang, Chi-Ching Liu, Yun-Chorng Chang, Academia Sinica (Taiwan) ..... [9547-57]

**From nanoparticles to nanostructures for plasmonic-related applications (Invited Paper)**, Bin Ren, Bowen Liu, Xu Yao, Shu Chen, Liang Zhang, Lei Wang, Zhilin Yang, Xiamen Univ. (China) ..... [9547-58]

Lunch/Exhibition Break ..... Wed 12:30 pm to 2:00 pm

**SESSION 13** ..... **WED 2:00 PM TO 3:50 PM**

## Plasmon Control

Session Chair: **Mikhail A. Noginov**, Norfolk State Univ. (USA)

**Perfect light trapping in mid-IR using patterned ZnO structures (Invited Paper)**, Shivashankar R. Vangala, Nima Nader, Justin W. Cleary, Air Force Research Lab. (USA); Junpeng Guo, The Univ. of Alabama in Huntsville (USA); Kevin D. Leedy, Joshua R. Hendrickson, Air Force Research Lab. (USA) ..... [9547-59]

**Terahertz metal grid polarizer with bridges on quartz substrate**, John S. Cetnar, Air Force Research Lab. (USA); Junpeng Guo, The Univ. of Alabama in Huntsville (USA); Elliott R. Brown, Wright State Univ. (USA) ..... [9547-60]

**Optical force acting on metallic nanostructure (Invited Paper)**, Che Ting Chan, Shubo Wang, Kun Ding, Hong Kong Univ. of Science and Technology (Hong Kong, China); Xulin Zhang, Jilin Univ. (China) ..... [9547-61]

**Electrothermoplasmonic flow for plasmon-assisted optical trapping (Invited Paper)**, Justus Ndukaife, Alexander V. Kildishev, Agbai Agwu Nnanna, Steven T. Wereley, Vladimir M. Shalaev, Alexandra Boltasseva, Purdue Univ. (USA) [9547-62]

**SESSION 14** ..... **WED 4:10 PM TO 5:40 PM**

## Fundamentals of Surface Plasmons III

Session Chair: **Shivashankar Vangala**, Air Force Research Lab. (USA)

**Non-quasi-static eigenstates of Maxwell's equations in a two-constituent composite medium and their application to a calculation of the local electric field of a time dependent point charge**, David J. Bergman, Asaf Farhi, Tel Aviv Univ. (Israel) ..... [9547-63]

**Retrieving the polarizability tensor of wire media**, Jacob Ben-Yakar, Tel Aviv Univ. (Israel); Yonatan Sivan, Ben-Gurion Univ. of the Negev (Israel); David J. Bergman, Tel Aviv Univ. (Israel) ..... [9547-64]

**Distinguishing between plasmon-induced and photoexcited carriers in a device geometry**, Hangqi Zhao, Bob Y. Zheng, Alejandro Manjavacas, Michael J. McClain, Peter Nordlander, Naomi J. Halas, Rice Univ. (USA) ..... [9547-65]

**Taming surface plasmons with adjacent molecules (Invited Paper)**, Mikhail A. Noginov, Norfolk State Univ. (USA) ..... [9547-66]

**POSTERS-WEDNESDAY** ..... **WED 5:30 PM TO 7:30 PM**

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Nanoshell tuning for targeted cancer therapy**, Ahmed Abbas, EA (Egypt); Moustafa Elsaed, Cairo Univ. (Egypt); Samir Fahmy, Kuwait Univ. (Kuwait) [9547-96]

**Photoconductively excited plasmonic modulator-switch**, John S. Cetnar, David E. Zelmon, David H. Tomich, Air Force Research Lab. (USA) ..... [9547-97]

**Angular momentum transformation using multiple surface plasmon-polariton waves**, Farhat Abbas, Quaid-i-Azam Univ. (Pakistan); Muhammad Faryad, Lahore Univ. of Management Sciences (Pakistan); Qaisar A. Naqvi, Quaid-i-Azam Univ. (Pakistan) ..... [9547-98]

**Study of the plasmonic properties of ordered arrays of Ag and Au nanoparticles fabricated by a combination of nanosphere lithography with ion implantation**, Octavio Graniel, Cecilia Salinas, Erick Flores-Romero, Univ. Nacional Autónoma de México (Mexico); Ulises Morales, Univ. de Guanajuato (Mexico); Juan-Carlos Cheang-Wong, Univ. Nacional Autónoma de México (Mexico) [9547-99]

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**Plasmonic analog of electromagnetically induced transparency of unsymmetrical grooves shaped metal-insulator-metal waveguide**, Lin Sun, Jiangnan Univ. (China); Jicheng Wang, Jiangnan Univ. (China) and Purdue Univ. (USA); Baojie Tang, Xiaosai Wang, Jiangnan Univ. (China). . . . . [9547-100]

**Spectral magneto-optical tunability using Bragg plasmons**, Emil Melander, Sebastian M. George, Uppsala Univ. (Sweden); Evangelos Th. Papaioannou, Technische Univ. Kaiserslautern (Germany); Marc A. Verschuur, Philips Research (Netherlands); Björgvín Hjörvarsson, Vassilios Kapakis, Uppsala Univ. (Sweden). . . . . [9547-101]

**The effect of truncation in plasmon resonance of metal nanoprisms**, Soad Alshehri, Marjan Saboktakin, Mohammad Matin, Univ. of Denver (USA) [9547-102]

**Plasmonic devices based on the dual coupled graphene-integrated ring resonators**, Jicheng Wang, Jiangnan Univ. (China) and Purdue Univ. (USA); Xushan Xia, Jiangnan Univ. (China); Xiuye Liang, Jiangnan Univ. (China); Jing Chen, Jiangnan Univ. (China); Dongdong Liu, Nanjing Univ. of Science & Technology (China). . . . . [9547-103]

**Fano resonances in nanoscale plasmonic structure**, Yundong Zhang, Hui Li, Xuenan Zhang, Yongfeng Wu, Harbin Institute of Technology (China). . . . . [9547-104]

**Investigation of the reflection and transmission of nano-scale gold films**, Haoliang Qian, Yuzhe Xiao, Dominic Lepage, Zhaowei Liu, Univ. of California, San Diego (USA). . . . . [9547-105]

**High order gap modes in film-coupled  $\lambda/10$  nanoantennas**, Chua-Zu Huang, Ming-Jing Wu, National Cheng Kung Univ. (Taiwan); Shiu-Yeh Chen, National Cheng Kung Univ. (Taiwan). . . . . [9547-106]

**The influence of annealing on Au films deposited on Ge seed layers**, Vesna Janicki, Jordi Sancho-Parramon, Boris Okorn, Institut Ruder Bošković (Croatia); Eva Kovačević, CNRS/Université d'Orléans (France); Hrvoje Zorc, Institut Ruder Bošković (Croatia). . . . . [9547-107]

**Influence of plasmonic nanoantennas on the optical properties of ultra-thin conjugated polymer films**, Binxing Yu, Joseph Woo, Rutgers, The State Univ. of New Jersey (USA); Sarah Goodman, Massachusetts Institute of Technology (USA); Deirdre M. O'Carroll, Rutgers, The State Univ. of New Jersey (USA). . . . . [9547-108]

**Surface plasmon resonance in diabolo metal bar optical antenna arrays**, Junpeng Guo, Hong Guo, The Univ. of Alabama in Huntsville (USA). . . . . [9547-109]

**A two-electrode electrochemical surface plasmon resonance sensor for investigating the electropolymerization of polyaniline**, Bing Zhang, Zhejiang Univ. (China); Yazhuo Li, Jianghan Univ. (China); Yizhang Wen, Peijun Cai, Xiaoping Wang, Zhejiang Univ. (China). . . . . [9547-110]

**Surface plasmons leaky radiation of the flat metal**, Ping Wang, Sichuan University (China). . . . . [9547-111]

**Polarization conversion with crossed plasmonic polarizers**, Xiaobin Cui, Chengping Huang, Nanjing Tech Univ. (China). . . . . [9547-112]

**Hybrid spherical cap plasmonic waveguide for tight mode confinement and long propagation length**, Kai Li, Maojin Yun, Xiaohui Ge, Weijin Kong, Qingdao Univ. (China). . . . . [9547-113]

**Cylindrical hybrid plasmonic waveguide for a nano-scale light confinement**, Chao Liu, Mei Wang, Maojin Yun, Weijin Kong, Qingdao Univ. (China). . . . . [9547-114]

**Coupled plasmon hybrid modes in aggregates of metal nanowires**, Nadiia P. Stognii, Kharkiv National Univ. of Radio Electronics (Ukraine) and Institute of Radiophysics and Electronics (Ukraine); Nataliya K. Sakhnenko, Kharkiv National Univ. of Radio Electronics (Ukraine). . . . . [9547-115]

**Plasmon enhanced luminescence upconversion in Au and NaYF<sub>4</sub>:Yb<sup>3+</sup>, Er<sup>3+</sup> nanoparticle clusters**, Chenchen Mao, Univ. of Colorado at Boulder (USA); Liangcan He, Jennifer N. Cha, Univ. of Colorado Boulder (USA); Wounjang Park, Univ. of Colorado at Boulder (USA). . . . . [9547-116]

**Plasmonic local heating beyond diffraction limit by the excitation of magnetic polariton**, Liping Wang, Hassan Alshehri, Arizona State Univ. (USA). . . . . [9547-117]

**Enhancing resonance dynamics in plasmonics**, Ashok Kodigala, University of California, San Diego (USA); Thomas Lepetit, Boubacar Kante, Univ. of California, San Diego (USA). . . . . [9547-118]

**Optica fiber tip with point light source of SPPs driven by three-dimensional nanostructured asymmetric metal-insulator-metal layer cap**, Yasushi Oshikane, Motohiro Nakano, Osaka Univ. (Japan); Kensuke Murai, National Institute of Advanced Industrial Science and Technology (Japan). . . . . [9547-119]

**Revealing the dispersive phase change in a slit-groove plasmonic interferometer structure**, Xie Zeng, Univ. at Buffalo (USA); Haifeng Hu, Northeastern Univ. (China); Yongkang Gao, Alcatel-Lucent Bell Labs. (USA); Dengxin Ji, Nan Zhang, Haomin Song, Kai Liu, Qiaoqiang Gan, Univ. at Buffalo (USA). . . . . [9547-120]

**Enhanced light emission and absorption from monolayer MoS<sub>2</sub> using single plasmonic optical antenna**, Edgar Palacios, Serkan Bütin, Spencer Park, Lincoln J. Lauhon, Koray Aydin, Northwestern Univ. (USA). . . . . [9547-121]

**Plasmonic dark modes excited by strongly focused illumination**, Jordi Sancho-Parramon, Institut Ruder Bošković (Croatia) and Univ. de Barcelona (Spain); Salvador Bosch Puig, David Maluenda, Univ. de Barcelona (Spain); Hrvoje Zorc, Institut Ruder Bošković (Croatia). . . . . [9547-122]

**Fabrication of alternative plasmonic materials with room temperature high-power impulse magnetron sputtering**, Zih-Ying Yang, Yi-Hsun Chen, National Chiao Tung Univ. (Taiwan); Bo-Huei Liao, Instrument Technology Research Ctr. (Taiwan); Kuo-Ping Chen, National Chiao Tung Univ. (Taiwan). . . . . [9547-123]

**Plasmonic hydrogels for ultrasensitive and in situ detection of a quorum-sensing signaling molecule by surface-enhanced Raman scattering spectroscopy**, Verónica Montes García, Gustavo Bodelón-González, Sergio Rodal-Cedeira, Vanesa López Puente, Celina Costas, Univ. de Vigo (Spain); Luis M. Liz-Marzán, CIC BiomaGUNE (Spain); Isabel Pastoriza-Santos, Jorge Pérez-Juste, Univ. de Vigo (Spain). . . . . [9547-124]

**Mapping of transmission spectrum between plasmonic and nonplasmonic single slits**, Shih-Hui Chang, Yulun Su, National Cheng Kung Univ. (Taiwan). . . . . [9547-125]

**Detectivity comparison of bolometric optical antennas**, Alexander Cuadrado, José Manuel López-Alonso, Juan Carlos Martínez-Antón, Jose-Miguel Ezquerro, Univ. Complutense de Madrid (Spain); Francisco Javier González, Univ. Autónoma de San Luis Potosí (Mexico); Javier Alda, Univ. Complutense de Madrid (Spain). . . . . [9547-126]

**Analysis of the spectral response of fractal antennas related with its geometry and current paths**, Alexander Cuadrado, José Manuel López-Alonso, Juan Carlos Martínez-Antón, Jose-Miguel Ezquerro, Univ. Complutense de Madrid (Spain); Francisco J. González, Univ. Autónoma de San Luis Potosí (Mexico); Javier Alda, Univ. Complutense de Madrid (Spain). . . . . [9547-127]

**Nanoporous gold leaves: preparation, optical characterization, and biosensing capabilities from the visible up to the mid infrared spectral range**, Denis Garoli, Istituto Italiano di Tecnologia (Italy); Gianluca Ruffato, Univ. degli Studi di Padova (Italy); Eugenio Calandri, Pierfrancesco Zilio, Istituto Italiano di Tecnologia (Italy); Filippo Romanato, Univ. degli Studi di Padova (Italy); Francesco De Angelis, Istituto Italiano di Tecnologia (Italy); Sandro Cattarin, CNR-IENI (Italy). . . . . [9547-128]

**Optical monitoring of the doping level of semiconductor by Brewster "mode"**, Thierry Taliercio, Eric Tournié, Laurent Cerutti, Univ. Montpellier 2 (France); Jean-Jacques Greffet, Lab. Charles Fabry (France). . . . . [9547-129]

**Fabrication of plasmonic thin films and its characterization by optical method and FDTD simulation technique**, Anton Kuzma, František Uherek, Slovenska Technicka Univ. (Slovakia), International Laser Ctr. (Slovakia); Jaroslava Škrinjarová, Slovenska Technicka Univ. (Slovakia); Dušan Pudiš, Univ. of Žilina (Slovakia); Martin Weis, Martin Donoval, Slovenska Technicka Univ. (Slovakia). . . . . [9547-130]

**Bianisotropic metamaterials for enhanced chiral fields and forces**, Hossein Alizadeh, Björn M. Reinhard, Boston Univ. (USA). . . . . [9547-131]

**Engineering metal-nanoantennae/dye complexes for maximum fluorescence enhancement**, Xiang Meng, Richard R. Grote, Jerry I. Dadap Jr., Columbia Univ. (USA); Nicolae-Coriolan Panou, Univ. College London (United Kingdom); Richard M. Osgood Jr., Columbia Univ. (USA). . . . . [9547-132]

**Plasmon resonance in ellipsoids and ellipsoidal dimers**, Catalina B. Lopez-Bastidas, Univ. Nacional Autónoma de México (Mexico); Leonardo Baez, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico); Jesus Manzanarez-Martinez, Univ. de Sonora (Mexico). . . . . [9547-133]

**Prospect of detection and recognition of single biological molecules using ultrafast coherent dynamics in quantum dot-metallic nanoparticle systems**, Seyed M. Sadeghi, The Univ. of Alabama in Huntsville (USA). . . . . [9547-134]

**Field enhancement with plasmonic nano antennas on silicon-based waveguides**, Mahsa Darvishzadeh Varcheie, Caner Guclu, Regina Ragan, Ozdal Boyraz, Filippo Capolino, Univ. of California, Irvine (USA). . . . . [9547-135]

**Angle-resolved far-field scattering spectra of single Ag nanowire over the entire semi-meridian**, Jinhyung Kim, Ho-Seok Ee, KAIST (Korea, Republic of); Min-Soo Hwang, Kwang-Yong Jeong, Korea Univ. (Korea, Republic of); Ju-Hyung Kang, Korea Univ. (Korea, Republic of) and KAIST (Korea, Republic of); Hong-Gyu Park, Korea Univ. (Korea, Republic of); Min-Kyo Seo, KAIST (Korea, Republic of). . . . . [9547-136]

**A low-cost, high-sensitivity surface enhanced raman scattering substrate by Si nanowire arrays decorated with Au nanoparticles and backplane**, Bi-Shen Lee, National Tsing Hua Univ. (Taiwan); Ding-Zheng Lin, Industrial Technology Research Institute (Taiwan); Ta-Jen Yen, National Tsing Hua Univ. (Taiwan). . . . . [9547-137]

**Third-harmonic generation from core/shell structure nanoparticle**, Liwei Liu, Yue Wang, Yu Ren, Yueshu Feng, Siyi Hu, Changchun Univ. of Science and Technology (China). . . . . [9547-138]

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**Nanoscale dimples for field enhancement of organic thin films**, Arkadiusz J. Goszczak, Jost Adam, Paweł P. Cielecki, Jacek Fiutowski, Horst-Günter Rubahn, Univ. of Southern Denmark (Denmark) ..... [9547-139]

**Structure, configuration, and sizing of Ni nanoparticles generated by ultrafast laser ablation in different media**, David Muñetón Arboleda, Ctr. de Investigaciones Ópticas (Argentina); Jessica M. Santillán, Ctr. de Investigaciones Ópticas (Argentina) and Univ. Nacional de Catamarca (Argentina); Luis J. Mendoza Herrera, Ctr. de Investigaciones Ópticas (Argentina); Marcela B. Fernández van Raap, Univ. Nacional de la Plata (Argentina) and Facultad de Ciencias Exactas (Argentina); Diego Muraca, Univ. Estadual de Campinas (Brazil); Daniel C. Schinca, Lucia B. Scaffardi, Ctr. de Investigaciones Ópticas (Argentina) and Univ. Nacional de la Plata (Argentina) ..... [9547-140]

**Surface plasmon polariton interface of left-handed metamaterial with cylindrical anisotropy and dielectric medium**, Semen Andronaki, Egor Gurvitz, Mikhail Khodzitsky, Anna Vozianova, ITMO Univ (Russian Federation) .. [9547-141]

**Fabrication and optical properties of gold nano aperture array using plating technique for plasmonic infrared filter**, Hong-Kun Lyu, Hui-Sup Cho, Young-Jin Park, DGIST (Korea, Republic of); Sung-Hyun Jo, Jang-Kyoo Shin, Kyungpook National University (Korea, Republic of) ..... [9547-142]

**Solid state oxidation of copper nanoparticles: a plasmonic perspective**, Mariano D. Susman, Yishai Feldman, Tatyana Bendikov, Hagai Cohen, Alexander Vaskevich, Israel Rubinstein, Weizmann Institute of Science (Israel) .... [9547-143]

## THURSDAY 13 AUGUST

### SESSION 15 ..... THU 8:00 AM TO 10:10 AM

#### Plasmonic Applications V

Session Chair: **Frank Vollmer**, Max-Planck-Institut für die Physik des Lichts (Germany)

**Imaging metallic nanostructures with second and third order nonlinear optical response** (*Invited Paper*), Emeric Bergmann, Christian Jonin, Emmanuel Benichou, Pierre-François Brevet, Institut Lumière Matière (France) ..... [9547-77]

**Interfacing ion-exchanged waveguide for the efficient excitation of surface plasmons**, Josselyn Beltran Madrigal, Univ. de Technologie Troyes (France); Martin Berthel, Institut NÉEL (France); Florent Gardillou, Teem Photonics S.A. (France); Ricardo Tellez Limon, Christophe Couteau, Univ. de Technologie Troyes (France); Denis Barbier, Teem Photonics S.A. (France); Aurelien Drezen, Institut NÉEL (France); Rafael Salas-Montiel, Univ. de Technologie Troyes (France); Serge Huant, Institut NÉEL (France); Sylvain Blaize, Univ. de Technologie Troyes (France) ..... [9547-78]

**Controlling light scattering and emission at subwavelength scale with plasmonic nanopatch antennas**, Zilong Wu, Yuebing Zheng, The Univ. of Texas at Austin (USA) ..... [9547-79]

**Controlling the ultrafast hot electron dynamics in hybrid plasmonic nanostructures**, Hayk Harutyunyan, Emory Univ. (USA) ..... [9547-80]

**Resonant elements contactless coupled to bolometric micro-stripes**, Alexander Cuadrado, José Manuel López-Alonso, Juan Carlos Martínez-Antón, Jose-Miguel Ezquerro, Univ. Complutense de Madrid (Spain); Francisco J. González, Univ. Autónoma de San Luis Potosí (Mexico); Javier Alda, Univ. Complutense de Madrid (Spain) ..... [9547-81]

**Hybridization models of gold nanoantennas arrays in polarization dependent evanescent waves**, Kuo-Ping Chen, Yi-Hsun Chen, Che-Yuan Chang, Yu-Lun Kuo, Zhen-hong Yang, National Chiao Tung Univ. (Taiwan) ..... [9547-82]

### SESSION 16 ..... THU 10:40 AM TO 11:50 AM

#### Plasmonic Applications VI

Session Chair: **Pierre-François Brevet**, Institut Lumière Matière (France)

**Detecting single DNA molecule interactions with optical microcavities** (*Invited Paper*), Frank Vollmer, Max-Planck-Institut für die Physik des Lichts (Germany) ..... [9547-83]

**Impedance-matching analysis in IR leaky-wave antennas**, Navaneeth Premkumar, Yuancheng Xu, Brian A. Lail, Florida Institute of Technology (USA) ..... [9547-84]

**Infrared surface phonon polariton waveguides on SiC substrate**, Yuchen Yang, Franklin Manene, Brian A. Lail, Florida Institute of Technology (USA) .... [9547-85]

Lunch/Exhibition Break ..... Thu 11:50 am to 1:20 pm

### SESSION 17 ..... THU 1:20 PM TO 3:30 PM

#### Metamaterial

Session Chair: **Uriel Levy**, The Hebrew Univ. of Jerusalem (Israel)

**Broadband toroidal response in three-dimensional plasmonic metamaterial** (*Invited Paper*), Din Ping Tsai, Academia Sinica (Taiwan) and National Taiwan Univ. (Taiwan); Chun Yen Liao, Wei Ting Chen, Pin Chieh Wu, Yao-Wei Huang, Wei-Yi Tsai, Mu Ku Chen, Hao Tsun Lin, Yi-Teng Huang, Ting-Yu Chen, Jia Wern Chen, National Taiwan Univ. (Taiwan); Vassili Savinov, Nikolay I. Zheludev, Univ. of Southampton (United Kingdom) ..... [9547-86]

**Tuning plasmonic cavity modes by the symmetry breaking of metasurface** (*Invited Paper*), Hui Liu, Nanjing Univ. (China) ..... [9547-87]

**Low-cost and high-throughput realization of metasurface-based absorber/emitter for thermal-photovoltaic cells**, Alireza Bonakdar, Sung Jun Jang, Hooman Mohseni, Northwestern Univ. (USA) ..... [9547-88]

**Determination of effective permittivity and permeability for plasmonic absorber metamaterials in infrared**, Yongqian Li, Northwestern Polytechnical Univ. (China) ..... [9547-89]

**Structured light-matter interactions in optical nanostructures** (*Invited Paper*), Natalia M. Litchinitser, Jingbo Sun, Mikhail I. Shalaev, Tianboyu Xu, Yun Xu, Univ. at Buffalo (USA); Apra Pandey, CST of America, Inc. (USA) ..... [9547-90]

### SESSION 18 ..... THU 4:00 PM TO 6:00 PM

#### Active Control

Session Chair: **Hui Liu**, Nanjing Univ. (China)

**On chip integration and light-matter interactions in active plasmonic devices** (*Invited Paper*), Uriel Levy, Liron Stern, Boris Desiatov, Meir Grajower, The Hebrew Univ. of Jerusalem (Israel) ..... [9547-91]

**Optical switching of nematic liquid crystal film arising from induced electric field of localized surface plasmon resonance**, Makiko T. Quint, Silverio Delgado, Zachary S. Nuno, Linda S. Hirst, Sayantani Ghosh, Univ. of California, Merced (USA) ..... [9547-92]

**TCO/metal hybrid structures for surface plasmon enhanced light emitting in the near infrared range**, Xu Fang, Shiyu Zhang, Liang Xia, Hui Ye, Zhejiang Univ. (China) ..... [9547-93]

**Optics and nonlinear buckling mechanics in large-area, highly stretchable arrays of plasmonic nanostructures**, Hui Zhang, Rice Univ. (USA); Li Gao, Univ. of Illinois at Urbana-Champaign (USA); Yihui Zhang, Northwestern Univ. (USA); Xu Xie, Univ. of Illinois at Urbana-Champaign (USA); Sage Doshey, Stanford Univ. (USA); Hui Fang, Univ. of Illinois at Urbana-Champaign (USA); Jonathan A. Fan, Stanford Univ. (USA); Peter Nordlander, Rice Univ. (USA); Yonggang Huang, Northwestern Univ. (USA); John A. Rogers, Shad Deesha, Siyi Xu, Univ. of Illinois at Urbana-Champaign (USA) ..... [9547-94]

**Title to be determined** (*Invited Paper*), Laurens K. Kuipers, FOM Institute for Atomic and Molecular Physics (Netherlands) ..... [9547-95]

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# Optical Trapping and Optical Micromanipulation XII

**Conference Chairs:** **Kishan Dholakia**, Univ. of St. Andrews (United Kingdom); **Gabriel C. Spalding**, Illinois Wesleyan Univ. (USA)**Program Committee:** **Roberto Di Leonardo**, Univ. degli Studi di Roma La Sapienza (Italy); **Jesper Glückstad**, Technical Univ. of Denmark (Denmark); **Simon Hanna**, Univ. of Bristol (United Kingdom); **Masud Mansuripur**, College of Optical Sciences, The Univ. of Arizona (USA); **Daniel H. Ou-Yang**, Lehigh Univ. (USA); **Thomas T. Perkins**, JILA (USA); **David B. Phillips**, Univ. of Glasgow (United Kingdom); **Ruben Ramos-Garcia**, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); **Halina Rubinsztein-Dunlop**, The Univ. of Queensland (Australia)

## SUNDAY 9 AUGUST

**SESSION 1 . . . . . SUN 8:30 AM TO 10:30 AM**

### OAM Transfer: Celebrating 20 Years

Session Chair: **Halina Rubinsztein-Dunlop**, The Univ. of Queensland (Australia)**Interaction between spin and orbital angular momentum of light in optical tweezers** (*Invited Paper*), Halina Rubinsztein-Dunlop, David Carberry, Timo A. Nieminen, The Univ. of Queensland (Australia); Daryl C. Preece, Univ. of California, San Diego (USA); Alexander B. Stilgoe, The Univ. of Queensland (Australia) [9548-1]**Transverse spin and momentum of structured light** (*Invited Paper*), Konstantin Y. Bliokh, RIKEN (Japan) . . . . . [9548-2]**Angular momentum transfer to trapped particles in vacuum**, Kishan Dholakia, Yoshihiko Arita, Tom Vettenburg, Juan Aunon, Univ. of St. Andrews (United Kingdom); Ewan Wright, College of Optical Sciences, The Univ. of Arizona (USA); Susan E. Skelton, Michael Mazilu, Univ. of St. Andrews (United Kingdom) . . . . . [9548-3]**Optical trapping using focused optical vortices with broadband flat spiral zone plates**, Mark Jayson M. Villangca, DTU Fotonik (Denmark); Muhammad Qasim Mehmood, Cheng-Wei Qui, National Univ. of Singapore (Singapore); Jesper Glückstad, DTU Fotonik (Denmark) . . . . . [9548-4]**Resonance near field coupling induced optical counter torque for plasmonic particle cluster**, Jun Chen, Shanxi Univ. (China) and Hong Kong Baptist Univ. (Hong Kong, China); Neng Wang, Fudan Univ. (China) and Hong Kong Baptist Univ. (Hong Kong, China); Liyong Cui, Xiao Li, Hong Kong Baptist Univ. (Hong Kong, China); Zhifang Lin, Fudan Univ. (China); Jack Ng, Hong Kong Baptist Univ. (Hong Kong, China) . . . . . [9548-5]**SESSION 2 . . . . . SUN 11:00 AM TO 12:00 PM**

### Outreach and Education: International Year of Light

Session Chair: **Gabriel C. Spalding**, Illinois Wesleyan Univ. (USA)**Trapping of highly birefringent rutile nanocylinders in the optical torque wrench**, Yera Y. Ussembayev, Seungkyu Ha, Richard Janissen, Maarten M. van Oene, Nynke H. Dekker, Technische Univ. Delft (Netherlands) . . . . . [9548-6]**Initiating optics immersions**, Gabriel C. Spalding, Illinois Wesleyan Univ. (USA) . . . . . [9548-7]**A simple explanation of opto-mechanical cooling by the back action of cavity photons**, Masud Mansuripur, College of Optical Sciences, The Univ. of Arizona (USA) . . . . . [9548-8]

Lunch Break . . . . . Sun 12:00 pm to 1:30 pm

**SESSION 3 . . . . . SUN 1:30 PM TO 3:10 PM**

### Toward (Or In) the Quantum Limit of Opto-Mechanics

Session Chair: **Masud Mansuripur**, College of Optical Sciences, The Univ. of Arizona (USA)**Nano-optomechanics with optically levitated dielectric nanoparticles** (*Invited Paper*), Levi Neukirch, Brandon Rodenburg, Mishkatul Bhattacharya, Nick Vamivakas, Univ. of Rochester (USA) . . . . . [9548-9]**Experimental opto-mechanics with levitated nanoparticles: towards quantum control and thermodynamic cycles** (*Invited Paper*), Nikolai Kiesel, Florian Blaser, Uros Delic, David Grass, Univ. Wien (Austria); Andreas Dechant, Eric Lutz, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Marzieh Bathaei, Sharif Univ. of Technology (Iran, Islamic Republic of); Markus Aspelmeyer, Univ. Wien (Austria) . . . . . [9548-10]**Dispersive light-matter interaction in programmable optical tweezers**, Bianca J. Sawyer, Milena Horvath, Amita B. Deb, Niels Kjærgaard, Univ. of Otago (New Zealand) . . . . . [9548-11]**Advances in optical trapping with conical refraction**, Alejandro Turpin, Joan Polo, Univ. Autònoma de Barcelona (Spain); Yury V. Loiko, Aston Univ. (United Kingdom); Vladlen G. Shvedov, Cyril Hnatovsky, The Australian National Univ. (Australia); Johannes Küber, Felix Schmaltz, Technische Univ. Darmstadt (Germany); Todor K. Kalkandjiev, Univ. Autònoma de Barcelona (Spain) and Conrefringent optics SL (Spain); Verònica Ahufinger, Univ. Autònoma de Barcelona (Spain); Wieslaw Z. Krolkowski, The Australian National Univ. (Australia) and Texas A&M Univ. at Qatar (Qatar); Gerhard Birk, Technische Univ. Darmstadt (Germany); Jordi Mompart, Univ. Autònoma de Barcelona (Spain) . . . . . [9548-12]**SESSION 4 . . . . . SUN 3:40 PM TO 5:10 PM**

### Optical Manipulation of Matter Through Gaseous Media

Session Chair: **Kishan Dholakia**, Univ. of St. Andrews (United Kingdom)**Extinction cross section measurements for a single optically trapped particle** (*Invited Paper*), Michael I. Cotterell, Univ. of Bristol (United Kingdom); Thomas C. Preston, McGill Univ. (Canada); Bernard J. Mason, Andrew J Orr-Ewing, Jonathan P Reid, Univ. of Bristol (United Kingdom) . . . . . [9548-13]**Quadruple Bessel beam trap for single droplet studies**, Grégoire David, Ruth Signorell, ETH Zürich (Switzerland) . . . . . [9548-14]**Measuring forces and dynamics for optically levitated 20um PS particles in air using electrostatic modulation**, Haesung Park, Thomas W LeBrun, National Institute of Standards and Technology (USA) . . . . . [9548-15]**Optical trapping of individual gold nanoparticles in air**, Liselotte Jauffred, Lund Univ. (Sweden); Seyed Mohammad-Reza Taheri, Univ. of Zanjan (Iran, Islamic Republic of); Regina K. Schmitt, Heiner Linke, Lund Univ. (Sweden); Lene B. Oddershede, Niels Bohr Institute (Denmark) . . . . . [9548-16]

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SESSION 5..... SUN 5:10 PM TO 6:40 PM

## Trapping at Extremes (i.e., “Gonzo” Trapping)

Session Chair: David B. Phillips, Univ. of Glasgow (United Kingdom)

**Optical trapping of microdroplet containing a single nanomaterial in helium gas (Invited Paper)**, Yosuke Minowa, Masaaki Ashida, Ryoichi Kawai, Osaka Univ. (Japan)..... [9548-17]

**Steering a jet of particles into an x-ray beam with optically induced forces**, Richard A. Kirian, Arizona State Univ. (USA); Niko Eckerskorn, The Australian National Univ. (Australia); Salah Awel, Max Wiedorn, Jochen Küpper, Henry N. Chapman, Ctr. for Free-Electron Laser Science (Germany); Andrei V. Rode, The Australian National Univ. (Australia) ..... [9548-18]

**All-optical three-dimensional electron pulse compression**, Liang Jie Wong, Singapore Institute of Manufacturing Technology (Singapore) and Massachusetts Institute of Technology (USA); Timm Rohwer, Byron Freelon, Nuh Gedik, Steven G. Johnson, Massachusetts Institute of Technology (USA). ..... [9548-19]

**Bistable dynamics of a levitated nanoparticle**, Francesco Ricci, ICFO - Institut de Ciències Fotòniques (Spain); M. Spasenovic, Univ. of Belgrade (Serbia) and ICFO - Institut de Ciències Fotòniques (Italy); Raúl A. Rica, ICFO - Institut de Ciències Fotòniques (Spain); Lukas Novotny, ETH Zürich (Switzerland); Romain Quidant, ICFO - Institut de Ciències Fotòniques (Spain). ..... [9548-20]

**SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM**

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING

**PLENARY SESSION..... MON 9:15 AM TO 12:00 PM**

Session Chairs: Satoshi Kawata, Osaka Univ. (Japan);  
David L. Andrews, Univ. of East Anglia (United Kingdom)

**Extreme Imaging and Beyond (Plenary)**, Keisuke Goda, The Univ. of Tokyo (Japan)..... [9548-500]

**Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary)**, Reuven Gordon, Univ. of Victoria (Canada). ..... [9548-501]

**Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary)**, Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9548-502]

Lunch/Exhibition Break..... Mon 12:00 pm to 1:30 pm

SESSION 6..... MON 1:30 PM TO 3:30 PM

## Foundations of the Electromagnetic Theory of Force and Momentum

Session Chair: Simon Hanna, Univ. of Bristol (United Kingdom)

**Continuum electrodynamics and the Abraham-Minkowski controversy**, Michael E. Crenshaw, U.S. Army Aviation & Missile Research, Development & Engineering Ctr. (USA). ..... [9548-21]

**Electromagnetic angular momentum**, Masud Mansuripur, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9548-22]

**Physics of electromagnetic and material stresses in optical manipulation**, Brandon A. Kemp, Cheyenne J. Sheppard, Arkansas State Univ. (USA) .. [9548-23]

**Discriminatory effects in the optical binding of chiral nanoparticles**, Kayn A. Forbes, Univ. of East Anglia (United Kingdom); David S Bradshaw, David L Andrews, Univ. of East Anglia (United Kingdom)..... [9548-24]

**1D problems of radiation pressure on elastic solids**, Tomaz Pozar, Janez Možina, Univ. of Ljubljana (Slovenia). ..... [9548-25]

**Optodynamic description of optical manipulation**, Tomaz Pozar, Janez Možina, Univ. of Ljubljana (Slovenia) ..... [9548-26]

SESSION 7..... MON 4:00 PM TO 5:00 PM

## Laser-Induced Shockwaves and Cavitation

Session Chair: Tomaz Pozar, Univ. of Ljubljana (Slovenia)

**A model for traumatic brain injury using laser induced shockwaves**, Aaron R. Selfridge, Daryl C. Preece, Veronica Gomez, Linda Z. Shi, Univ. of California, San Diego (USA); Michael W. Berns, Univ. of California, Irvine (USA) ..... [9548-27]

**Periodic cavitation in an optical tweezer**, Viridiana Carmona-Sosa, José E. Alba-Arroyo, Pedro A. Quinto-Su, Univ. Nacional Autónoma de México (Mexico)[9548-28]

**Interesting physics and applications using microbubbles in thermo-optic tweezers**, Basudeb Roy, Subhrokoli Ghosh, Soumyajit Roy, Ayan Banerjee, Indian Institute of Science Education and Research Kolkata (India) ..... [9548-29]

SESSION 8..... MON 5:00 PM TO 6:00 PM

## Using the Photonic Toolbox to Study Cells and Their Organelles I

Session Chair: Anna S. Bezryadina, San Francisco State Univ. (USA)

**Reactive oxygen species production in single cells following laser irradiation**, Michelle L. Duquette, Justine Kim, Linda Z. Shi, Michael W. Berns, Univ. of California, San Diego (USA). ..... [9548-30]

**Integrated 3D macro-trapping and light-sheet imaging system**, Zhengyi Yang, Peeter Piksav, David E. K. Ferrier, Frank J. Gunn-Moore, Kishan Dholakia, Univ. of St. Andrews (United Kingdom) ..... [9548-31]

**Refractive index reconstruction with optical diffraction tomography**, Paul Müller, Mirjam Schürmann, Jochen Guck, Technische Univ. Dresden (Germany) ..... [9548-32]

**OTOM CONFERENCE PHOTO .....** 6:00 PM TO 6:15 PM

All Optical Trapping and Optical Micromanipulation conference participants are encouraged to gather for a group photo at the end of the day.

## TUESDAY 11 AUGUST

SESSION 9..... TUE 8:00 AM TO 10:00 AM

## Enhanced Sensitivity, Resolution, and Range of Force Actuators

Session Chair: Anna M. Linnenberger, Meadowlark Optics, Inc. (USA)

**Acoustic force spectroscopy (Invited Paper)**, Iddo Heller, Vrije Univ. Amsterdam (Netherlands) ..... [9548-33]

**Structured interference force for enhanced optical trapping (Invited Paper)**, Michael A. Taylor, The Univ. of Queensland (Australia) and Research Institute of Molecular Pathology (Austria); Muhammad Waleed, Alexander B. Stilgoe, Halina Rubinsztein-Dunlop, Warwick P. Bowen, The Univ. of Queensland (Australia). ..... [9548-34]

**Mapping of independent force and position measurements for calibration of non-Hookean optical traps**, Ann A. Bui, Alexander B. Stilgoe, Timo A. Nieminen, Halina Rubinsztein-Dunlop, The Univ. of Queensland (Australia) ..... [9548-35]

**A new method for calibrating the nonlinear range of a single-beam optical trap**, Jamianne C. Wilcox, Benjamin J. Lopez, Otger Campas, Megan T. Valentine, Univ. of California, Santa Barbara (USA). ..... [9548-36]

**Measurement of radiation pressure in an ambient environment**, Dakang Ma, Joseph L. Garrett, Jeremy N. Munday, Univ. of Maryland, College Park (USA) ..... [9548-37]

# CONFERENCE 9548

SESSION 10 ..... TUE 10:30 AM TO 11:30 AM

## Photonic Devices for Optically Induced Forces

Session Chair: **Jeremy N. Munday**, Univ. of Maryland, College Park (USA)

**Photonic force microscopy of surface electromagnetic waves in a one-dimensional photonic crystal**, Daniil Shilkin, Evgeny V. Lyubin, Lomonosov Moscow State Univ. (Russian Federation); Irina V. Soboleva, Lomonosov Moscow State Univ. (Russian Federation) and A.N. Frumkin Institute of Physical Chemistry and Electrochemistry (Russian Federation); Andrey A. Fedyanin, Lomonosov Moscow State Univ. (Russian Federation) ..... [9548-38]

**Optical epitaxial growth of gold nanoparticle arrays**, Ningfeng Huang, The Univ. of Southern California (USA); Luis J. Martinez, The Univ. of Southern California (USA) and Ecole Normale Supérieure de Cachan (France); Eric Jaquay, Michelle L. Povinelli, The Univ. of Southern California (USA) ..... [9548-39]

**Submicron particle manipulation using slotted tapered optical fibers**, Mark J. Daly, Viet Giang Truong, Sile Nic Chormaic, Okinawa Institute of Science and Technology Graduate Univ. (Japan) ..... [9548-40]

SESSION 11 ..... TUE 11:30 AM TO 12:30 PM

## Optical Lab-on-a-Chip

Session Chair: **Ayan Banerjee**, Indian Institute of Science Education and Research Kolkata (India)

**Optical manipulation of single microparticle for microfluidic flow rate sensing**, Yuan Gong, Univ. of Electronic Science and Technology of China (China) [9548-41]

**Optically-induced circulation of dielectric particles with fiber optic Bessel beam**, Boram Joo, Sungrae Lee, Kyunghwan K. Oh, Yonsei Univ. (Korea, Republic of) ..... [9548-42]

**Ultrathin optical fibers for particle trapping and manipulation**, Sile G. Nic Chormaic, Okinawa Institute of Science and Technology Graduate Univ. (Japan); Aili Maimaiti, Okinawa Institute of Science and Technology Graduate Univ. (Japan) and Univ. College Cork (Ireland); Marios Sergides, Ivan Gusachenko, Viet Giang Truong, Okinawa Institute of Science and Technology Graduate Univ. (Japan) ..... [9548-43]

Lunch/Exhibition Break ..... Tue 12:30 pm to 2:00 pm

SESSION 12 ..... TUE 2:00 PM TO 3:50 PM

## Statistical Mechanics of Small Systems

Session Chair: **Daniel H. Ou-Yang**, Lehigh Univ. (USA)

**Stochastic thermodynamics with a Brownian particle in an optical trap (Invited Paper)**, Ignacio A. Martinez, ICFO - Institut de Ciències Fotòniques (Spain) and Ecole Normale Supérieure de Lyon (France); Édgar Roldán, ICFO - Institut de Ciències Fotòniques (Spain) and Max-Planck-Institut für Physik komplexer Systeme (Germany) and Grupo Interdisciplinar de Sistemas Complejos (Spain); Luis Dinis, Grupo Interdisciplinar de Sistemas Complejos (Spain) and Univ. Complutense de Madrid (Spain); Pau Mestres, ICFO - Institut de Ciències Fotòniques (Spain); Juan M. R. Parrondo, Grupo Interdisciplinar de Sistemas Complejos (Spain) and Univ. Complutense de Madrid (Spain); Raúl A. Rica, ICFO - Institut de Ciències Fotòniques (Spain). ..... [9548-44]

**Auto correlation and relaxation time measurements on metal oxide core: dielectric shell beads in an optical trap**, Shruthi S. Iyengar, Praveen Parthasarathi, Rekha Selvan, Sarbari Bhattacharya, Sharath Ananthamurthy, Bangalore Univ. (India) ..... [9548-45]

**Tailoring defects in colloidal crystals using an external “non-affine” field**, Saswati Ganguly, Indian Association for the Cultivation of Science (India); Surajit Sengupta, TIFR Ctr. for Interdisciplinary Sciences (India); Peter Sollich, King's College London (United Kingdom) ..... [9548-46]

**Plasticity avalanches for colloidal crystals in dynamical optical traps**, Cynthia J. Reichhardt, Los Alamos National Lab. (USA); Danielle McDermott, Wabash College (USA); Charles M. Reichhardt, Los Alamos National Lab. (USA) .. [9548-47]

**Combined magneto- and optofluidic assembly of colloidal chains of controllable length**, Tao Yang, Ning Wu, David WM Marr, Colorado School of Mines (USA) ..... [9548-48]

SESSION 13 ..... TUE 4:10 PM TO 6:40 PM

## Micro-Scale Studies of Hydrodynamics, Opto-Fluidics, and Binding

Session Chair: **Giovanni S. Volpe**, Bilkent Univ. (Turkey)

**Controlling hydrodynamic interactions in driven systems (Invited Paper)**, David B. Phillips, Rebecca F. Hay, Graham Gibson, Univ. of Glasgow (United Kingdom); Stephen H. Simpson, Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic); Miles J. Padgett, Univ. of Glasgow (United Kingdom) ..... [9548-49]

**Hydrodynamic synchronisation in arrays of hollow beams**, Luke J. Debono, Univ. of Bristol (United Kingdom); Stephen Simpson, Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic); Simon Hanna, Univ. of Bristol (United Kingdom) ..... [9548-50]

**Hydrodynamics of micro-objects near curved surfaces**, Shu Zhang, David Carberry, Timo A. Nieminen, Halina Rubinsztein-Dunlop, The Univ. of Queensland (Australia) ..... [9548-51]

**Boundary element method for optical force calibration in microfluidic dual-beam optical trap**, Mehmet E. Solmaz, Izmir Katip Celebi Univ. (Turkey); Barbaros Cetin, Bilkent Univ. (Turkey); Besim Baranoglu, Attilim Üniv. (Turkey); Murat Serhatlioglu, Bilkent Univ. (Turkey) ..... [9548-52]

**Rotational behavior of oblate spheroids in circularly polarized dual beam optical trap**, Martin Šíler, Ote Brzobohatý, Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic); Alejandro V. Arzola, Univ. Nacional Autónoma de México (Mexico); Lukáš Chvátal, Petr Jákl, Stephen H. Simpson, Pavel Zemanek, Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic) ... [9548-53]

**Spatial optical solitons in bidisperse fluorescent nanocolloids**, M. Yadira Y. Salazar Romero, Instituto de Investigaciones en Materiales (Mexico); Juan Hernández-Cordero, Karen P. Volke-Sepúlveda, Alejandro V. Arzola, Univ. Nacional Autónoma de México (Mexico); Yareni Ayala, Univ. Nacional Autónoma de México (Mexico) ..... [9548-54]

**Spatio-temporal formation of amyloid aggregates by laser trapping of domain-swapped dimeric cytochrome c**, Ken-ichi Yuyama, National Chiao Tung Univ. (Taiwan); Mariko Ueda, Satoshi Nagao, Shun Hirota, Nara Institute of Science and Technology (Japan); Teruki Sugiyama, National Applied Research Labs. (Taiwan); Hiroshi Masuhara, National Chiao Tung Univ. (Taiwan) ..... [9548-55]

## WEDNESDAY 12 AUGUST

SESSION 14 ..... WED 8:30 AM TO 10:00 AM

## Optical Force Studies of Active Micro-Swimmers

Session Chair: **Samira Aghayee**, Univ. of Maryland, College Park (USA)

**Behavior and applications of active Brownian particles in complex and crowded environments (Invited Paper)**, Giovanni S. Volpe, Bilkent Univ. (Turkey) ..... [9548-56]

**Pattern formation for active particles on optically created ordered and disordered substrates**, Charles M. Reichhardt, Dipanjan Ray, Cynthia J. Reichhardt, Los Alamos National Lab. (USA) ..... [9548-57]

**Study of microparticles' anomalous diffusion in active bath using speckle light fields**, Ercag Pince, Sabareesh K. P. Sabareesh, Bilkent Univ. (Turkey); Giorgio Volpe, Univ. College London (United Kingdom); Sylvain Gigan, Univ. Pierre et Marie Curie (France); Giovanni S. Volpe, Bilkent Univ. (Turkey) ..... [9548-58]

**Noise, fluctuations, and nonlinear mechanical properties of living cells**, H. Daniel Ou-Yang, Ming Tzo Wei, Dimitrios Vavylonis, Sabrina Jedlicka, Lehigh Univ. (USA) ..... [9548-59]

SESSION 15 ..... WED 10:30 AM TO 11:40 AM

## Optically Driven Micro rheology and Mechanical Properties

Session Chair: **Daniel H. Ou-Yang**, Lehigh Univ. (USA)

**Using optical tweezers to assess the role of inter-protein interactions in collagen self-assembly (Invited Paper)**, Tuba Altindal, Marjan Shayegan, Evan Kiefl, Nancy R. Forde, Simon Fraser Univ. (Canada) ..... [9548-60]

**Viscoelastic properties of subcellular structures measured by fluorescence correlation spectroscopy**, Jens-Christian D. Meiners, Rudra P. Kafle, Molly R. Liebskind, Univ. of Michigan (USA) ..... [9548-61]

**Calibration of femtosecond optical tweezer as a sensitive thermometer**, Dipankar Mondal, Debabrata Goswami, Indian Institute of Technology Kanpur (India) ..... [9548-62]

Lunch/Exhibition Break ..... Wed 11:40 am to 1:10 pm

# CONFERENCE 9548

SESSION 16 ..... WED 1:10 PM TO 2:30 PM

## Using the Photonic Toolbox to Study Cells and their Organelles II

Session Chair: Michael W. Berns, Univ. of California, San Diego (USA)

**Three dimensional living neural networks**, Anna M. Linnenberger, Meadowlark Optics, Inc. (USA) ..... [9548-63]

**Multi-point optical manipulation and simultaneous imaging of neural circuits through wavefront phase modulation**, Samira Aghayee, Dan Winkowski, Patrick Kanold, Wolfgang Losert, Univ. of Maryland, College Park (USA) ..... [9548-64]

**Trapping and manipulation of bacteria with circular Airy beams**, Drew Bischel, Anna S. Bezryadina, Joseph C. Chen, Zhigang Chen, San Francisco State Univ. (USA) ..... [9548-65]

**Label-free dynamic optical chromatography for laser analysis of biological samples**, Alex V. Terray, U.S. Naval Research Lab. (USA) ..... [9548-66]

SESSION 17 ..... WED 2:30 PM TO 5:00 PM

## Near-Field Micromanipulation, Plasmonic, and Nanoparticle Trapping

Session Chair: Gabriel C. Spalding, Illinois Wesleyan Univ. (USA)

**Listening to proteins and viruses with nanoaperture optical tweezers (Invited Paper)**, Reuven Gordon, Univ. of Victoria (Canada) ..... [9548-67]

**Plasmonic optical trapping of DNA: micro-pattern formation based on radiation force and temperature gradient**, Tatsuya Shoji, Yasuyuki Tsuboi, Osaka City Univ. (Japan) ..... [9548-68]

**Characterization of periodic plasmonic nanoring devices for nanomanipulation**, Marios Sergides, Viet Giang Truong, James R. Schloss, Bishwajeet S. Bhardwaj, Sile G. Nic Chormaic, Okinawa Institute of Science and Technology Graduate Univ. (Japan) ..... [9548-69]

**Optical trapping of nanoparticles with significantly reduced laser powers by using counter-propagating beams**, Chenglong Zhao, Thomas W. LeBrun, National Institute of Standards and Technology (USA) ..... [9548-70]

**Plasmonic hybridization induced trapping and manipulation of metallic nano-objects**, Changjun Min, Shenzhen Univ. (China); Yuquan Zhang, Nankai Univ. (China); Lichao Zhang, Xiaocong Yuan, Shenzhen Univ. (China) ..... [9548-71]

**Aggregation of gold nanorods by optical forces for SERS biosensing in liquid environment**, Barbara Fazio, Antonino Foti, Cristiano D'Andrea, Elena Messina, Valentina Villari, Onofrio M. Maragò, Norberto Micali, Istituto per i Processi Chimico-Fisici (Italy); Pietro G. Guicciardi, Consiglio Nazionale delle Ricerche (Italy) ..... [9548-72]

SESSION 18 ..... WED 5:00 PM TO 5:40 PM

## Considering Shaped Particles in Optical Traps

Session Chair: Halina Rubinsztein-Dunlop, The Univ. of Queensland (Australia)

**Tilted optical trapping of anisotropic single crystal nanorod**, Paul Brule-Bareil, Yunlong Sheng, Univ. Laval (Canada) ..... [9548-73]

**Studies on shape anisotropy in red blood cells**, Argha Mondal, Basudev Roy, Sudipta Bera, Ayan Banerjee, Indian Institute of Science Education and Research Kolkata (India) ..... [9548-74]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Absolute calibration of forces in optical tweezers**, Rafael S. Dutra, Instituto Federal do Rio de Janeiro (Brazil); Nathan B. Viana, Paulo M. Neto, Herch M. Nussenzveig, UFRJ (Brazil) ..... [9548-75]

**Low frequency dynamical stabilisation in optical tweezers**, Christopher J. Richards, Thomas J. Smart, Univ. College London (United Kingdom); David Cubero, Univ. de Sevilla (Spain); Philip H. Jones, Univ. College London (United Kingdom) ..... [9548-76]

**Laser trapping and assembling of nanoparticles at solution surface studied by reflection micro-spectroscopy**, Shun-Fa Wang, Ken-ichi Yuyama, National Chiao Tung Univ. (Taiwan); Teruki Sugiyama, National Applied Research Labs. (Taiwan); Hiroshi Masuhara, National Chiao Tung Univ. (Taiwan) ..... [9548-77]

**Stability of gap solitons in partially PT-symmetric optical lattices**, Lijuan Ge, Suzhou Univ. of Science and Technology (China) ..... [9548-78]

**Magnon-like properties of spin-3/2 chains**, Jhon James J. Hernández Sarria Sr., Karem Cecilia C. Rodríguez Ramírez, Univ. del Valle (Colombia) ..... [9548-79]

**Correlated fluctuations of optically trapped particles**, Thomas J. Smart, Christopher J. Richards, Univ. College London (United Kingdom); Xian Han, National Univ. of Defense Technology (China); Stefan Siwiak-Jaszek, Philip H. Jones, Univ. College London (United Kingdom) ..... [9548-80]

**Three-dimensional thermal noise imaging of collagen networks**, Tobias F. Bartsch, The Rockefeller Univ. (USA); Martin D. Kochanczyk, Emanuel N. Lissek, The Univ. of Texas at Austin (USA); Janina Lange, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Ernst-Ludwig Florin, The Univ. of Texas at Austin (USA) ..... [9548-81]

**A study of red blood cell deformability in diabetic retinopathy using optical tweezers**, Thomas J. Smart, Christopher J. Richards, Rhythm Bhatnagar, Univ. College London (United Kingdom); Carlos Pavesio, Moorfields Eye Hospital NHS Foundation Trust (United Kingdom) and Univ. College London (United Kingdom); Philip H. Jones, Univ. College London (United Kingdom); Rupesh Agrawal, Moorfields Eye Hospital NHS Foundation Trust (United Kingdom) and Univ. College London (United Kingdom) and Tan Tock Seng Hospital (Singapore) ..... [9548-82]

**Absorption model of different fluids in an optical fiber trap using CFD**, Jenny Emmanuelle Hernández Zavala, Univ. Veracruzana (Mexico); Hector H. Cerecedo, Univ. Autónoma Veracruzana (Mexico) ..... [9548-83]

**Noticeable nonlinear optical effect in plasmon-assisted radiation force**, Masayuki Hoshina, Osaka Prefecture Univ. (Jordan) ..... [9548-84]

**Three-dimensional trapping with a focused Bessel beam**, Yareni Ayala, Karen P. Volke-Sepúlveda, Alejandro V. Arzola, Univ. Nacional Autónoma de México (Mexico) ..... [9548-85]

**Non-radially symmetric dark-hollow optical beams for manipulation elongated microobjects**, Aleksey P. Porfirev, Samara State Aerospace Univ. (Russian Federation); Roman V. Skidanov, Image Processing Systems Institute (Russian Federation) ..... [9548-86]

**Creation of three-dimensional volume chain under high numerical aperture illumination**, Jiming Wang, Nanjing Univ. of Aeronautics and Astronautics (China) ..... [9548-87]

**Single-shot multiphoton fabrication of polygonized structures by a novel fresnel zone lens via spatial light modulator**, Chenchu Zhang, Dong Wu, Yanlei Hu, Jiawen Li, Zhaoxin Lao, Bin Xu, Jiaru Chu, Wenhao Huang, Univ. of Science and Technology of China (China) ..... [9548-88]

**Analysis of the phage lambda DNA packaging motor by optical tweezers measurements and site-directed mutagenesis of residues involved in ATP binding**, Mariam Ordyan, Damian J. Deltoro, Douglas E. Smith, Univ. of California, San Diego (USA) ..... [9548-89]

**Single-molecule mechanics of the molecular spring that underlies hearing**, Tobias F. Bartsch, Albert J. Hudspeth, The Rockefeller Univ. (USA) ..... [9548-90]

Sunday-Wednesday 9-12 August 2015 • Proceedings of SPIE Vol. 9549

# Physical Chemistry of Interfaces and Nanomaterials XIV

Conference Chairs: **Sophia C. Hayes**, Univ. of Cyprus (Cyprus); **Eric R. Bittner**, Univ. of Houston (USA)Conference Co-Chair: **Natalie Banerji**, Univ. de Fribourg (Switzerland)Program Committee: **John B. Asbury**, The Pennsylvania State Univ. (USA); **Artem A. Bakulin**, Univ. of Cambridge (United Kingdom); **Jenny Clark**, The Univ. of Sheffield (United Kingdom); **Gitti Frey**, Technion-Israel Institute of Technology (Israel); **Alexandre Fürstenberg**, Univ. de Genève (Switzerland); **David S. Ginger**, Univ. of Washington (USA); **Naomi S. Ginsberg**, Univ. of California, Berkeley (USA); **Jeanne L. McHale**, Washington State Univ. (USA); **Linda A. Peteanu**, Carnegie Mellon Univ. (USA); **Sergei Tretiak**, Los Alamos National Lab. (USA); **Lauren Webb**, The Univ. of Texas at Austin (USA)

## SUNDAY 9 AUGUST

**SESSION 1 ..... SUN 8:30 AM TO 10:30 AM**

### Physical Processes in Solar Energy Conversion I

Session Chair: **Paul Meredith**, The Univ. of Queensland (Australia)**Interface design principles for high efficiency organic semiconductor devices** (*Invited Paper*), Aditya D. Mohite, Los Alamos National Lab. (USA) ..... [9549-1]**Electronic coupling at hybrid organic/inorganic interfaces** (*Invited Paper*), Oliver L. A. Monti, The Univ. of Arizona (USA) ..... [9549-2]**In situ transient optical studies of bulk and interfacial recombination processes in nanostructured photocatalytic materials** (*Invited Paper*), Matthew Y. Sfeir, Kannatassen Appavoo, Mingzhao Liu, Brookhaven National Lab. (USA) ..... [9549-3]**Avoding the kinetics of the bulk heterojunction: self-assembled materials and sequential processing for organic photovoltaics** (*Invited Paper*), Benjamin Schwartz, Univ. of California, Los Angeles (USA) ..... [9549-4]**SESSION 2 ..... SUN 11:00 AM TO 12:15 PM**

### Photophysics of Novel Perovskite-Based Nanomaterials

Session Chair: **Annamaria Petrozza**, Istituto Italiano di Tecnologia (Italy)**Interfacial considerations in organo-halide perovskite optoelectronics** (*Invited Paper*), Paul Meredith, Qianqian Lin, Ardalan Armin, Dani Lyons, Ravi Nagiri, Paul L. Burn, The Univ. of Queensland (Australia) ..... [9549-5]**Investigation on the initial photophysics in hybrid perovskite-polymer solar cells**, Jan C. Brauer, Univ. de Fribourg (Switzerland); Arianna Marchioro, Univ. of Washington (USA); Yong Hui Lee, Mohammad K. Nazeeruddin, Jacques-Edouard Moser, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Natalie Banerji, Univ. de Fribourg (Switzerland) ..... [9549-6]**Mapping the electrical properties of methylammonium lead triiodide perovskite films using conductive tip atomic force microscopy for photovoltaic applications**, James G. Stanfill, R. Clayton Shallcross, Neal R. Armstrong, The Univ. of Arizona (USA) ..... [9549-7]**Induction of photocurrent by the hole transporting layer to adjacent photoactive perovskite sensitized TiO<sub>2</sub> thin film for the solar cell application**, Sadia Ameen, Mohammed Nazim, Hyung-Kee Seo, Hyung-Shik Shin, Chonbuk National Univ. (Korea, Republic of) ..... [9549-8]

Lunch Break ..... Sun 12:15 pm to 1:45 pm

**SESSION 3 ..... SUN 1:45 PM TO 3:45 PM**

### Advances in Modeling of Electronic Processes in Nanomaterials

Session Chair: **David J. Yaron**, Carnegie Mellon Univ. (USA)**Linking molecular features of conjugated polymers, acceptors, and additives to the blend morphology for organic electronics applications** (*Invited Paper*), Arithi Jayaraman, Univ. of Delaware (USA) ..... [9549-9]**Describing and quantifying tightly packed molecular aggregate properties using innovative electronic structure methods** (*Invited Paper*), Clémence Corminboeuf, Ecole Polytechnique Fédérale de Lausanne (Switzerland) .. [9549-10]**Diffusion, recombination, and photon emission properties of interacting excitons in semiconductor carbon nanotubes** (*Invited Paper*), Andrei Piryatinski, Los Alamos National Lab. (USA); David H. Dunlap, The Univ. of New Mexico (USA); Oleksiy Roslyak, Fordham Univ. (USA); Han Htoon, Los Alamos National Lab. (USA) ..... [9549-11]**Impact of mesoscale order on open-circuit voltage in organic solar cells**, Carl Poelking, Max-Planck-Institut für Polymerforschung (Germany); Max L. Tietze, Chris Eischner, Technische Univ. Dresden (Germany); Selina Olthof, Dirk Hertel, Univ. zu Köln (Germany); Björn Baumeier, Max-Planck-Institut für Polymerforschung (Germany); Frank Würthner, Julius-Maximilians-Univ. Würzburg (Germany); Klaus Meerholz, Univ. zu Köln (Germany); Karl Leo, Technische Univ. Dresden (Germany); Denis Andrienko, Max-Planck-Institut für Polymerforschung (Germany) .. [9549-12]**Modeling electric field-induced quenching in conjugated polymers and oligomers**, Christian M. Legaspi, Linda A. Peteanu, David J. Yaron, Carnegie Mellon Univ. (USA) ..... [9549-13]**SESSION 4 ..... SUN 4:00 PM TO 5:30 PM**

### Carrier Transport in Complex Nanostructured Systems

Session Chair: **Garry Rumbles**, National Renewable Energy Lab. (USA)**Critical and interfacial phenomena in chemical reactions revealed by single-nanocrystal studies** (*Invited Paper*), Prashant K. Jain, Univ. of California, Berkeley (USA) ..... [9549-14]**Singlet, triplet, electron and hole transport along single polymer chains** (*Invited Paper*), Matthew Bird, Brookhaven National Lab. (USA); Gina Mauro, Brookhaven National Lab. (USA) and Dowling College (USA); Xiang Li, Brookhaven National Lab. (USA); Lori Zaikowski, Brianne Karten, Dowling College (USA); Sada Asauoka, Kyoto Institute of Technology (Japan); Qin Wu, Hung-Cheng Chen, Andrew Cook, John Miller, Brookhaven National Lab. (USA) ..... [9549-15]**Cross-linking high-k fluoropolymer gate dielectrics enhances the charge mobility in rubrene field effect transistors**, Jwala M. Adhikari, Enrique D. Gomez, Matthew R. Gadinski, Qing Wang, The Pennsylvania State Univ. (USA) .. [9549-16]**The deactivation of a conducting polymer**, Ricardo I. Tucceri, Univ. Nacional de la Plata (Argentina) ..... [9549-17]**SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM**

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

# CONFERENCE 9549

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING

#### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: <b>Satoshi Kawata</b> , Osaka Univ. (Japan); <b>David L. Andrews</b> , Univ. of East Anglia (United Kingdom)
<b>Extreme Imaging and Beyond (Plenary)</b> , Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]
<b>Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary)</b> , Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]
<b>Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary)</b> , Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch/Exhibition Break ..... Mon 12:00 pm to 1:30 pm

#### SESSION 5..... MON 1:30 PM TO 3:15 PM

### Physical Processes in Solar Energy Conversion II

Session Chair: **Carlos Silva**, Univ. de Montréal (Canada)

**Excited state dynamics in next-generation photovoltaic materials (Invited Paper)**, Cody W. Schlenker, Univ. of Washington (USA) ..... [9549-18]

**Photo-induced electron transfer processes in doped conjugated polymer films (Invited Paper)**, Garry Rumbles, National Renewable Energy Lab. (USA) and Univ. of Colorado (USA); Obadiah G. Reid, Univ. of Colorado at Boulder (USA) and National Renewable Energy Lab. (USA); Jaehong Park, National Renewable Energy Lab. (USA); Jessica Ramirez, Hilary Marsh, Univ. of Colorado at Boulder (USA); Tyler T. Clikeman, Colorado State Univ. (USA) ..... [9549-19]

**Using the Stark effect to understand charge generation in organic solar cells**, Natalie Banerji, Univ. de Fribourg (Switzerland) ..... [9549-20]

**Exciton dissociation at organic small molecule donor-acceptor interfaces**, Steven W. Robey, National Institute of Standards and Technology (USA) ..... [9549-21]

**Fluorescence and UV/VIS absorption spectroscopy studies on polymer blend films for photovoltaics**, Jan van Stam, Camilla Lindqvist, Rickard Hansson, Leif K. E. Ericsson, Ellen Moons, Karlstad Univ. (Sweden) ..... [9549-22]

#### SESSION 6..... MON 3:45 PM TO 5:15 PM

### Electron Transfer Mechanisms at Interfaces

Session Chair: **Natalie Banerji**, Univ. de Fribourg (Switzerland)

**Ultrafast excited-state dynamics at liquid-liquid interfaces (Invited Paper)**, Eric Vauthhey, Giuseppe Licari, Cho-Shuen Hsieh, Univ. de Genève (Switzerland) ..... [9549-23]

**Absolute polaron yield generated in donor-acceptor P3HT:fullerene bulk heterojunction composites (Invited Paper)**, Saptaparna Das, Alia A. Latif, William Thombury, Barry C. Thompson, Stephen E. Bradforth, The Univ. of Southern California (USA) ..... [9549-24]

**Photoinduced carrier generation and recombination dynamics of a trilayer cascade heterojunction composed of poly(3-hexylthiophene), titanyl phthalocyanine, and C60**, Jaehong Park, Obadiah G. Reid, Garry Rumbles, National Renewable Energy Lab. (USA) ..... [9549-25]

**Cause of absorption band shift of disperse red-13 attached on silica spheres**, Byoung-Ju Kim, Hyung-Deok Kim, Na-Rae Kim, Byeong-Gyu Bang, Eun-Hye Park, Tea Wuk Kang, Kwang-Sun Kang, Kyungil Univ. (Korea, Republic of) ..... [9549-26]

## TUESDAY 11 AUGUST

#### SESSION 7..... TUE 8:30 AM TO 10:30 AM

### Multidimensional Spectroscopies

Session Chair: **Benjamin J. Schwartz**, Univ. of California, Los Angeles (USA)

**Title to be determined (Invited Paper)**, James P. Schuck, The Molecular Foundry (USA) ..... [9549-27]

**Surface-enhanced, multi-dimensional attenuated total reflectance spectroscopy (Invited Paper)**, Jan Philip Kraack, Univ. of Zürich (Switzerland); Davide Lotti, Univ. of Zurich (Switzerland); Peter Hamm, Univ. of Zürich (Switzerland) ..... [9549-28]

**Ultrafast carrier photogeneration dynamics in polymer: fullerene solar cells probed by photocurrent-detected two-dimensional coherence spectroscopy (Invited Paper)**, Carlos Silva, Univ. de Montréal (Canada) ..... [9549-29]

**Controlling electron transfer in condensed phase with bond specific Infrared excitation (Invited Paper)**, Milan Delor, Paul A. Scuttergood, The Univ. of Sheffield (United Kingdom); Igor V. Sazanovich, Gregory M. Greetham, STFC Rutherford Appleton Lab. (United Kingdom); Anthony J. H. M. Meijer, The Univ. of Sheffield (United Kingdom); Anthony W. Parker, Michael Towrie, STFC Rutherford Appleton Lab. (United Kingdom); Julia A. Weinstein, The Univ. of Sheffield (United Kingdom) ..... [9549-30]

#### SESSION 8..... TUE 11:00 AM TO 12:15 PM

### Structure-Property Relations in Nanomaterials

Session Chair: **Sophia C. Hayes**, Univ. of Cyprus (Cyprus)

**Exciton and polaron interactions in self-assembled conjugated polymer aggregates (Invited Paper)**, John K. Grey, The Univ. of New Mexico (USA); Jian Gao, Lawrence Berkeley National Lab. (USA); Alan Thomas, The Univ. of New Mexico (USA) ..... [9549-31]

**Controllable supramolecular architectures for modulating the optical properties**, Yongjun Li, Runsheng Jiang, Institute of Chemistry (China) .. [9549-32]

**Characterization of nano-sized iron particle layers spin coated on glass substrate**, Sunil Dehipawala, Queensborough Community College (USA); Pubudu Samarasekara, Rasika Dahanayake, Univ. of Peradeniya (Sri Lanka); George Tremberger Jr., Tak D. Cheung, Queensborough Community College (USA); Harry D. Gafney, Queens College (USA) ..... [9549-33]

**Influence of the molecular orientation on the optical properties and photomodification of cyanine thin film**, Anton A Starovoytov, ITMO University (Russian Federation); Elena N. Kaliteevskaya, Valentina P. Krutiyakova, Tatiana K. Razumova, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation) ..... [9549-34]

Lunch/Exhibition Break ..... Tue 12:15 pm to 1:45 pm

#### SESSION 9..... TUE 1:45 PM TO 3:00 PM

### Advanced Imaging Techniques

Session Chair: **Jan Philip Kraack**, Univ. of Zürich (Switzerland)

**Title to be determined (Invited Paper)**, Alexander Weber-Bargioni, The Molecular Foundry (USA) ..... [9549-35]

**Interfacial energy landscapes of organic semiconductors probed on the sub-molecular scale by STM (Invited Paper)**, Sarah A. Burke, Agustin E. Schiffrin, Katherine Cochrane, Martina Capsoni, Tanya Roussy, The Univ. of British Columbia (Canada) ..... [9549-36]

**Super-resolution imaging with mid-IR photothermal microscopy on the single particle level**, Zhongming Li, Gregory V. Hartland, Univ. of Notre Dame (USA) ..... [9549-37]

# CONFERENCE 9549

SESSION 10 ..... TUE 3:30 PM TO 5:30 PM

## Single Particle Tracking of (Bio-) Nanomaterials

Session Chair: Sarah A. Burke, The Univ. of British Columbia (Canada)

**Emergence of collective luminescence in mesoscopic conjugated polymer aggregates by coherent and incoherent processes (Invited Paper)**, Jan Vogelsang, Thomas Stangl, Philipp Wilhelm, Univ. Regensburg (Germany); Klaas Remmerssen, Sigurd Höger, Univ. Bonn (Germany); John Lupton, Univ. Regensburg (Germany) ..... [9549-38]

**Transient absorption microscopy studies of single metal and semiconductor nanostructures (Invited Paper)**, Paul Johns, Mary Sajini-Devasadas, Tuphan Devkota, Zhongming Li, Gregory V. Hartland, Univ. of Notre Dame (USA) ..... [9549-39]

**Single-molecule methods to quantify adsorptive separations (Invited Paper)**, Christy Landes, Rice Univ. (USA) ..... [9549-40]

**Single particle studies on ligands binding reveal distinct active sites on surface of CdS quantum dots**, Xin Li, Ming Lee Tang, Univ. of California, Riverside (USA) ..... [9549-41]

**Stability studies on promethazine unexposed and exposed to UV laser radiation**, Agota Simon, Adriana Loredana Smarandache, Tatiana Tozar, Viorel V. Nastasa, National Institute for Laser, Plasma and Radiation Physics (Romania), Univ. of Bucharest (Romania); Ruxandra Pirvulescu, Univ. of Medicine and Pharmacy Carol Davila (Romania); Mihail Lucian Pascu, National Institute for Laser, Plasma and Radiation Physics (Romania), Univ. of Bucharest (Romania) ..... [9549-42]

## WEDNESDAY 12 AUGUST

SESSION 11 ..... WED 8:30 AM TO 10:15 AM

## Emerging Experimental Tools to Study Interfaces

Session Chair: Matt Law, Univ. of California, Irvine (USA)

**Effect of surface stoichiometry and interfacial interactions on ultrafast carrier dynamics of crystalline CdTe (Invited Paper)**, Xing He, Napat Punpongjareern, Chengyi Wu, Karjini Rajagopal, Ding-Shyue Yang, Univ. of Houston (USA) [9549-43]

**Quadratic nonlinear optics of liquids: from bulk to surfaces and interfaces (Invited Paper)**, Anthony Maurice, Isabelle Russier-Antoine, Christian Jonin, Emmanuel Benichou, Pierre-François Brevet, Institut Lumière Matière (France) ..... [9549-44]

**High resolution patterning electronic polymers using dopant induced solubility control (Invited Paper)**, Adam J. Moule, Ian E. Jacobs, Jun Li, Stephanie L. Burg, David J. Bilsky, Brandon T. Rotondo, Pieter Stroeven, Univ. of California, Davis (USA) ..... [9549-45]

**Effect of substrate on Scanning Kelvin Probe Microscopy (SKPM) of interface polarity at carbon nanotube/fullerene junctions**, Olivia Alley, Johns Hopkins Univ. (USA); Meng-Yin Wu, Univ. of Wisconsin-Madison (USA); Josue F. Martinez Hardigree, Johns Hopkins Univ. (USA); Michael S. Arnold, Univ. of Wisconsin-Madison (USA); Howard E. Katz, Johns Hopkins Univ. (USA) ..... [9549-46]

SESSION 12 ..... WED 10:45 AM TO 12:00 PM

## Confinement Effects in Nanostructures and Nanowires

Session Chair: Pierre-François Brevet, Institut Lumière Matière (France)

**Interface engineering to eliminate bias-stress effect in quantum dot transistors (Invited Paper)**, Matt Law, Univ. of California, Irvine (USA) ... [9549-47]

**Exciton formation dynamics in Si quantum dots and functionalized CdSe nanorods studied with time-resolved THz spectroscopy**, Matthew C. Beard, National Renewable Energy Lab. (USA) ..... [9549-48]

**Tunable emission properties of Au nanoclusters**, Woong Young So, Anindita Das, Hee Young Byun, Carnegie Mellon Univ. (USA); Santosh Kumar, Henkel Corp. (USA); Rongchao Jin, Linda A. Peteanu, Carnegie Mellon Univ. (USA) ... [9549-49]

**Electronic logic gates from three-segment nanowires featuring two P-N heterojunctions**, Huibiao Liu, Yuliang Li, Chinese Academy of Sciences (China) ..... [9549-50]

Lunch/Exhibition Break ..... Wed 12:00 pm to 1:30 pm

SESSION 13 ..... WED 1:30 PM TO 3:05 PM

## Perovskite Solar Cells: Joint Session with Conferences 9549 and 9567

Session Chairs: David G. Lidzey, The Univ. of Sheffield (United Kingdom); Sophia C. Hayes, Univ. of Cyprus (Cyprus)

**Photophysical versus structural properties in hybrid lead-halide perovskites (Invited Paper)**, Annamaria Petrozza, Istituto Italiano di Tecnologia (Italy) . [9549-51]

**Photocurrent hysteresis and switchable organometal trihalide perovskite photovoltaics**, Jinsong Huang, Univ. of Nebraska-Lincoln (USA) ..... [9567-19]

**A comparison of perovskite and colloidal quantum dot solar cells (Invited Paper)**, Brandon R. Sutherland, Edward H. Sargent, Univ. of Toronto (Canada) ..... [9567-20]

**Effect of substrate surface free energy on the optoelectronic and morphological properties of organolead halide perovskite solar cell materials**, R. Clayton Shallcross, James G. Stanfill, Neal R. Armstrong, The Univ. of Arizona (USA) ..... [9549-52]

**Hysteresis-free, stable and efficient perovskite solar cells achieved by vacuum-treated thermal annealing of  $\text{CH}_3\text{NH}_3\text{PbI}_3$** , Feng-Xian Xie, Di Zhang, Wallace C. H. Choy, The Univ. of Hong Kong (Hong Kong, China) ..... [9567-21]

SESSION 14 ..... WED 3:35 PM TO 5:20 PM  
**Advances in Modeling of Electronic Processes in Nanomaterials**

Session Chair: Eric R. Bittner, Univ. of Houston (USA)

**Optical processes in molecular junctions (Invited Paper)**, Abraham Nitzan, Tel Aviv Univ. (Israel); Michael Galperin, Univ. of California, San Diego (USA); Maxim Sukharev, Arizona State Univ. (USA) ..... [9549-53]

**Site models for including effects of torsions and disorder on charge and energy transport in organic semiconductors (Invited Paper)**, David J. Yaron, Nicolae M. Albu, Christopher R. Collins, Christian M. Legaspi, Carnegie Mellon Univ. (USA) ..... [9549-54]

**Size-dependent Hamaker-Lifshitz constant for silver and gold nanoparticles**, Pavlo Pinchuk, Ke Jiang, Univ. of Colorado at Colorado Springs (USA) .. [9549-55]

**Effect of excess charge on metallic nanoclusters**, Shideh Ahmadi, Nanyang Technological Univ. (Singapore); Xi Zhang, Shenzhen Univ. (China); Yinyan Gong, China Jiliang Univ. (China); Changqing Sun, Nanyang Technological Univ. (Singapore) ..... [9549-56]

**Multiscale molecular modeling of supported and tethered lipid bilayers (Invited Paper)**, Holden T. Ranz, Roland Faller, Univ. of California, Davis (USA) ... [9549-57]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Physical and theoretical study of bithiophene: electronic effects of substitution**, Christian M. Legaspi, Angela P. Hu, Linda A. Peteanu, Carnegie Mellon Univ. (USA); Katheryn A. Penrod, The Pennsylvania State Univ. (USA); David J. Yaron, Carnegie Mellon Univ. (USA); Racquel C. Jemison, The Dow Chemical Co. (USA); Richard D. McCullough, Harvard Univ. (USA) ..... [9549-58]

**Growth of axial nested P-N heterojunction nanowires for high performance diode**, Huibiao Liu, Chinese Academy of Sciences (China) ..... [9549-59]

# CONFERENCE 9550

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## Biosensing and Nanomedicine VIII

Conference Chairs: **Hooman Mohseni**, Northwestern Univ. (USA); **Massoud H. Agahi**, Harbor-UCLA Medical Ctr. (USA), Cedars-Sinai Medical Ctr. (United States); **Manijeh Razeghi**, Northwestern Univ. (USA)

Program Committee: **Gert Cauwenberghs**, Univ. of California, San Diego (USA); **Philippe M. Fauchet**, Vanderbilt Univ. (USA); **Guilhem Gallot**, Ecole Polytechnique (France); **Ryan M. Gelfand**, Univ. of Victoria (Canada); **David H. Gracias**, Johns Hopkins Univ. (USA); **Kimberly S. Hamad-Schifferli**, Massachusetts Institute of Technology (USA); **Keon Jae Lee**, KAIST (Korea, Republic of); **Yu-Hwa Lo**, Univ. of California, San Diego (USA); **Ryan McClintock**, Northwestern Univ. (USA); **Omer G. Memis**, Northwestern Univ. (USA); **Masoud Panjehpour**, Thompson Cancer Survival Ctr. (USA); **Adam T. Woolley**, Brigham Young Univ. (USA); **John M. Zavada**, Polytechnic Institute of New York Univ. (USA)

### SUNDAY 9 AUGUST

#### SESSION 1 ..... SUN 8:30 AM TO 12:10 PM

##### Biosensing I: Imaging and Spectroscopy

Semiconductor quantum dots as delivery and imaging platforms for intracellular assembly, Lauren D. Field, James B. Delehanty, Igor L. Medintz, U.S. Naval Research Lab. (USA) ..... [9550-1]

Using a narrow linewidth spectral filter for calibration of the spectrometer in spectral domain optical coherence tomography, Tong Wu, Nanjing Univ. of Aeronautics and Astronautics (China) ..... [9550-2]

Biodegradable bisphosphonate nanoparticles for imaging and therapeutic applications in osteosarcoma, Safra Rudnick-Glick, Enav Corem-Salkmon, Igor Grinberg, Eran Gluz, Shlomo Margel, Bar-Ilan Univ. (Israel) ..... [9550-3]

Enhanced in-vivo optical coherence tomography of live mouse brain by the use of implanted micro-lens (*Invited Paper*), Iman Hassani Nia, Daniel Dombeck, Hooman Mohseni, Northwestern Univ. (USA) ..... [9550-4]

Probing cellular forces with an elastic optical micro-cavity, Nils M. Kronenberg, Philipp Liehm, Anja Steude, Matte C. Gather, Univ. of St. Andrews (United Kingdom) ..... [9550-5]

Beta-cyclodextrin functionalized gold nanoparticles for trace cancer biomarker quantification, Jian Wu, Fraser Hof, Reuven Gordon, Univ. of Victoria (Canada) ..... [9550-6]

A three-camera imaging microscope for high-speed single-molecule tracking and super-resolution imaging in living cells (*Invited Paper*), Brian P. English, Timothée Lionnet, Robert H. Singer, Howard Hughes Medical Institute (USA) ..... [9550-7]

Nanostructured silicon biosensors (*Invited Paper*), Sharon M. Weiss, Vanderbilt Univ. (USA) ..... [9550-8]

Lunch Break ..... Sun 12:10 pm to 1:30 pm

#### SESSION 2 ..... SUN 1:30 PM TO 3:00 PM

##### Biosensing II: SERS

Detection of cancerous biological tissue areas by means of SERS spectroscopy of intercellular fluid, Martynas Velicka, Vida Urboniene, Milda Pucetaite, Feliksas Jankevicius M.D., Valdas Sablinskas, Vilnius Univ. (Lithuania) ..... [9550-9]

Colloidal assembly of surface enhanced Raman scattering sensors for monitoring airway infections (*Invited Paper*), Regina Ragan, Nicholas Sharac, Univ. of California, Irvine (USA); Salvatore Campione, Sandia National Labs. (USA); Katrine Whiteson, Filippo Capolino, Univ. of California, Irvine (USA) ..... [9550-10]

Detection of p17-1 peptide (HIV) based in surface enhanced Raman scattering (SERS), Leandro de B. Carneiro, Chemistry Institute (Brazil) and Univ. of Victoria (Canada); Alexandre Brolo, Univ. of Victoria (Canada); Sidney Ribeiro, Univ. Estadual Paulista "Júlio de Mesquita Filho" (Brazil) ..... [9550-11]

Using Raman spectroscopy and SERS for in-situ studies of rhizosphere bacteria, Sneha Polisetty, Nameera Baig, Univ. of Notre Dame (USA); Amber Bible, Jennifer Morrell-Falvey, Mitchel Doktycz, Oak Ridge National Lab. (USA); Paul W. Bohn, Univ. of Notre Dame (USA) ..... [9550-12]

#### SESSION 3 ..... SUN 3:30 PM TO 5:35 PM

##### Keynote Joint Session with Conferences 9550 and 9568

Session Chair: **Ruth Shinar**, Iowa State Univ. of Science and Technology (USA)

Advances in macromolecular data storage (*Keynote Presentation*), Masud Mansuripur, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9550-13]

Imperceptible sheet-type active matrix sensors for cyber-physical systems (*Keynote Presentation*), Tsuyoshi Sekitani, Osaka Univ. (Japan) ..... [9568-214]

Mid-infrared (~2.8 μm to ~7.1 μm) interband cascade lasers (*Keynote Presentation*), Sven Höfling, Univ. of St. Andrews (United Kingdom); Robert Weih, Matthias Dallner, Julius-Maximilians-Univ. Würzburg (Germany); Julian Scheuermann, Lars Nähle, Marc Fischer, Johannes Koeth, nanoplus GmbH (Germany); Martin Kamp, Julius-Maximilians-Univ. Würzburg (Germany) ..... [9550-14]

Artificial neuronal systems based on organic bioelectronic circuits: Towards new tools and therapy methods in cell biology and healthcare (*Keynote Presentation*), Magnus Berggren, Linköping Univ. (Sweden) ..... [9568-215]

Towards novel compact laser sources for non-invasive diagnostics and treatment (*Keynote Presentation*), Edik U. Rafailov, Aston Univ. (United Kingdom) ..... [9550-15]

### SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

### MONDAY 10 AUGUST

#### NANOSCIENCE + ENGINEERING PLENARY SESSION ..... MON 9:15 AM TO 12:00 PM

Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan); **David L. Andrews**, Univ. of East Anglia (United Kingdom)

**Extreme Imaging and Beyond (Plenary)**, Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

**Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary)**, Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

**Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary)**, Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch/Exhibition Break ..... Mon 12:00 pm to 1:30 pm

# CONFERENCE 9550

SESSION 4..... MON 1:30 PM TO 5:10 PM

## Biosensing and Drug Delivery

**Switchable bioelectronics on graphene interface (Invited Paper)**, Onur Parlak, Linköping Univ. (Sweden); Ashutosh Tiwari, Linköping Univ (Sweden); Anthony P. F. Turner, Linköping Univ. (Sweden) ..... [9550-16]

**Evaluating cells and protocells as therapeutic vehicles (Invited Paper)**, Natalie Adolphi, The Univ. of New Mexico (USA); Jaclyn Murton, Sandia National Labs. (USA); Helen Hathaway, The Univ. of New Mexico (USA); Yu-Shen Lin, Jason Townson, Oncotherapy (USA); Jeff Norenberg, The Univ. of New Mexico (USA); Eric Carnes, Carlee Ashley, Jeff Brinker, Sandia National Labs. (USA) ..... [9550-17]

**Effect of PKC $\alpha$  expression to cell death after photoactivation of Hypericin delivered to cell through different drug delivery systems**, Matúš Mišúth, Jaroslava Joniova, Pavol Jozef Šafárik Univ. in Košice (Slovakia); Pavol Miškovský, Zuzana Nadová, Pavol Jozef Šafárik Univ. in Košice (Slovakia), Ctr. for Interdisciplinary Sciences (Slovakia) ..... [9550-18]

**Enhanced kinetics of quantum dot bound enzymatic nanosensors**, Joyce Breger, Scott Walper, Mario G. Ancona, Michael Stewart, Kimihiro Susumu, Sebastian A. Diaz, Igor L. Medintz, U.S. Naval Research Lab. (USA) ..... [9550-19]

**Nanoplasmonic lenses for bacteria sorting (Invited Paper)**, Xiangchao Zhu, Ahmet A. Yanik, Univ. of California, Santa Cruz (USA) ..... [9550-20]

**Nano scaffolds and stem cell therapy in liver tissue engineering**, Laila M. Montaser, Menoufia Univ. (Egypt) ..... [9550-21]

**A creatinine biosensor based on admittance measurement**, Congo Tak-Shing Ching, Tai-Ping Sun, Deng-Yun Jheng, Hou-Wei Tsai, Hsiu-Li Shieh, National Chi Nan Univ. (Taiwan) ..... [9550-22]

**Quantitative fluorescence nanoscopy for cancer biomedicine**, Li-Jung Lin, Oregon Health & Science Univ. (USA); Tao Huang, Oregon Health and Science Univ (USA); Alec Peters, Xiaolin Nan, Oregon Health & Science Univ. (USA) ... [9550-23]

## TUESDAY 11 AUGUST

SESSION 5..... TUE 8:30 AM TO 11:50 AM

## Biosensing III: Plasmonics

**Resonant waveguide grating imagers for single cell analysis and high throughput screening (Invited Paper)**, Ye Fang, Corning Incorporated (USA) ..... [9550-24]

**Motion behaviour of mammalian AT-SC under evanescent field illumination**, Mukhzeer Mohamad Shahimin, Univ. Malaysia Perlis (Malaysia); Phataheya Buang, Univ. Kebangsaan Malaysia (Malaysia); Nor Azura Malini B. Ahmad Hamzali, Vithyacharan Retnasamy, Mohamad Halim Abdul Wahid, Univ. Malaysia Perlis (Malaysia); Ali Hussain Reshak, Univ. of West Bohemia (Czech Republic). [9550-25]

**Rational design of on-chip refractive index sensors based on lattice plasmon resonances**, Linhan Lin, Yuebing Zheng, The Univ. of Texas at Austin (USA) ..... [9550-26]

**Controlled nanoparticle growth and plasmonic resonance tuning for fluorescence enhancement of micro-scale optical fiber sensors**, Leyla N. Kahyaoglu, Rajtarun Madangopal, Jenna L. Rickus, Purdue Univ. (USA) . [9550-27]

**Ultra-broadband plasmonic super absorbers for universal surface enhanced Raman spectroscopy substrate**, Nan Zhang, Kai Liu, Haomin Song, Xie Zeng, Dengxin Ji, Qiaoqiang Gan, Univ. at Buffalo (USA) ..... [9550-28]

**Plasmonic nanoparticles sensors utilizing hybrid modes, electrical excitation, and anisotropic particles**, Wolfgang Fritzsche, Andre Dathe, Pavel Kliuiev, Jacqueline Jatschka, Uwe Hübner, Mario Ziegler, Matthias Thiele, Steffen Trautmann, Janina Wirth, Frank Garwe, Andrea Csaki, Ondrej Stranik, Leibniz-Institut für Photonische Technologien e.V. (Germany) ..... [9550-29]

**Wafer scale aluminum plasmonics for hybrid biosensors**, Arash Farhang, Matthew C. George, Brent Williamson, Mike Black, Ted Wangensteen, James Fraser, Rumyana Petrova, MOXTEK, Inc. (USA) ..... [9550-30]

**Real-time protein aggregation monitoring based on a simultaneous light scattering investigation and a bloch surface wave-based approach**, Sara Santi, Elsie Barakat, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Reinhard Neier, Univ. of Neuchâtel (Switzerland); Hans Peter Herzig, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9550-31]

## WEDNESDAY 12 AUGUST

POSTERS-WEDNESDAY..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Fluorescent cy5 silica nanoparticles for cancer cell imaging**, Claire L. O'Connell, Robert I. Nooney, Macdara Glynn, Jens Ducrée, Colette McDonagh, Dublin City Univ. (Ireland) ..... [9550-32]

**Probing the interaction between Congo Red and  $\beta$ -amyloid for diagnosis and inhibition of brain plaque formation in Alzheimer's disease**, Kristine A. Zhang, Yat Li, Univ. of California, Santa Cruz (USA) ..... [9550-33]

**Effect of various chain lengths of the capping ligand on water stability of PbS-based semiconductor nanocrystals**, Anna Zelazo, Wrocław Univ. of Technology (Poland); Jakub Cichos, Univ. of Wrocław (Poland); Mateusz Banski, Wrocław Univ. of Technology (Poland); Miroslaw Karbowiak, Univ. of Wrocław (Poland); Artur P. Podhorodecki, Wrocław Univ. of Technology (Poland) ..... [9550-34]

**Evaluation of performance of portable respiratory monitoring system based on micro-electro-mechanical-system for respiratory gated radiotherapy**, Jiwon Sung, Korea Univ. (Korea, Republic of) and Kyung Hee Univ. Hospital at Gangdong (Korea, Republic of); Weon Koo Chung, Dong Wook Kim, Kyung Hee Univ. Hospital at Gangdong (Korea, Republic of) ..... [9550-35]

**Decoding the LasR quorum sensing communication system of *Pseudomonas aeruginosa* by SERS**, Vanesa Lopez-Puente, Celina Costas, Cristina Fernandez-Lopez, Gustavo Bodelon-Gonzalez, Jorge Perez-Juste, Isabel Pastoriza-Santos, Univ. de Vigo (Spain); Luis M. Liz-Marzan, CIC biomaGUNE (Spain) and IKERBASQUE. Basque Foundation for Science (Spain) ..... [9550-36]

**Low-temperature UV-resonance Raman spectroscopy: toward less damaging biomolecular imaging**, Yuika Saito, Hikaru Yoshino, Yasuaki Kumamoto, Atsushi Taguchi, Satoshi Kawata, Osaka Univ. (Japan) ..... [9550-37]

# CONFERENCE 9551

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## Spintronics VIII

Conference Chairs: **Henri-Jean Drouhin**, Ecole Polytechnique (France); **Jean-Eric Wegrowe**, Ecole Polytechnique (France); **Manijeh Razeghi**, Northwestern Univ. (USA)

Program Committee: **Franco Ciccacci**, Politecnico di Milano (Italy); **Russell P. Cowburn**, Univ. of Cambridge (United Kingdom); **Scott A. Crooker**, Los Alamos National Lab. (USA); **Vincent Cros**, Unité Mixte de Physique CNRS/Thales (France); **Hanan Dery**, Univ. of Rochester (USA); **Rogério de Sousa**, Univ. of Victoria (Canada); **Michel I. Dyakonov**, Univ. Montpellier 2 (France); **Michael E. Flatté**, The Univ. of Iowa (USA); **Jean-Marie George**, Unité Mixte de Physique CNRS/Thales (France); **Erez Hasman**, Technion-Israel Institute of Technology (Israel); **Henri Jaffrès**, Unité Mixte de Physique CNRS/Thales (France); **Tomas Jungwirth**, Institute of Physics of the ASCR, v.v.i. (Czech Republic); **Giti A. Khodaparast**, Virginia Polytechnic Institute and State Univ. (USA); **Mathias Klauin**, Univ. Konstanz (Germany); **Connie H. Li**, U.S. Naval Research Lab. (USA); **Xavier Marie**, INSA - Univ. of Toulouse (France); **Laurens W. Molenkamp**, Julius-Maximilians-Univ. Würzburg (Germany); **Hiro Munekata**, Tokyo Institute of Technology (Japan); **Yoshichika Otani**, The Univ. of Tokyo (Japan); **Dafiné Ravelosona**, Institut d'Électronique Fondamentale (France); **Georg Schmidt**, Martin-Luther-Univ. Halle-Wittenberg (Germany); **Jing Shi**, Univ. of California, Riverside (USA); **Luc Thomas**, Headway Technology (USA); **Evgeny Tsymbal**, Univ. of Nebraska-Lincoln (USA); **Olaf M. J. van 't Erve**, U.S. Naval Research Lab. (USA); **Joerg Wunderlich**, Hitachi Cambridge Lab. (United Kingdom); **Igor Zutic**, Univ. at Buffalo (USA)

### SUNDAY 9 AUGUST

Sessions 1 and 2 run concurrently.

#### SESSION 1 ..... SUN 8:30 AM TO 10:30 AM

##### Spin-Orbit Torque I

Session Chair: **Henri Jaffrès**, Unité Mixte de Physique CNRS/Thales (France)

**Electrical control of the perpendicular magnetization in Pt/[Co/Ni]3/AI multilayers** (*Invited Paper*), Juan-Carlos Rojas-Sánchez, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France); Joao Sampaio, Univ. Paris-Sud 11 (France); Piotr Laczkowski, Nicolas Reyren, Cyrille Deranlot, Sophie Collin, Henri Jaffrès, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France); Alexandra Mougin, Univ. Paris-Sud 11 (France); Albert Fert, Jean-Marie George, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France) ..... [9551-1]

**Ultra-fast three terminal perpendicular spin-orbit torque MRAM** (*Invited Paper*), Olivier Boulle, Murat Cubukcu, Claire Hamelin, SPINTEC (France); Nathalie Lamard, CEA-LETI (France); Liliana Buda-Prejbeanu, SPINTEC (France); Nikolai Mikuszeit, CEA-LETI (France); Kevin Garello, Pietro Gambardella, ETH Zürich (Switzerland); Juergen Langer, Berthold Ocker, SINGULUS TECHNOLOGIES AG (Germany); Mihai Miron, Gilles Gaudin, SPINTEC (France) ..... [9551-2]

**Spin-transfer torques from spin-orbit interactions in heavy metals and topological insulators** (*Invited Paper*), Daniel C. Ralph, Cornell Univ. (USA) [9551-3]

**Spin-transfer torque excited by spin-orbit effects in ferromagnetic bilayers** (*Invited Paper*), Tomohiro Taniguchi, National Institute of Advanced Industrial Science and Technology (Japan); Julie Grollier, Unité Mixte de Physique CNRS/Thales (France); Mark D. Stiles, National Institute of Standards and Technology (USA) ..... [9551-4]

Sessions 3 and 4 run concurrently.

#### SESSION 3 ..... SUN 11:00 AM TO 12:30 PM

##### Spin-Orbit Torque II

Session Chair: **Daniel C. Ralph**, Cornell Univ. (USA)

**Spin-orbit torques in magnetic bilayers** (*Invited Paper*), Paul M. Haney, Mark D. Stiles, National Institute of Standards and Technology (USA); Hyun-Woo Lee, Pohang Univ. of Science and Technology (Korea, Republic of); Aurélien Manchon, King Abdullah Univ. of Science and Technology (Saudi Arabia); Kyung-Jin Lee, Korea Univ. (Korea, Republic of) ..... [9551-8]

**Spin orbit torques and chiral spin textures in ultrathin magnetic films** (*Invited Paper*), Geoffrey S. Beach, Massachusetts Institute of Technology (USA) .. [9551-9]

**Anatomy of spin-orbit phenomena at ferromagnetic/nonmagnetic material interfaces** (*Invited Paper*), Hongxin Yang, Ali Hallal, Bernard Dieny, SPINTEC (France) and Univ. Grenoble Alps (France) and Ctr. National de la Recherche Scientifique (France); Andre Thiaville, Stanislas Rohart, Univ. Paris-Sud 11 (France) and Ctr. National de la Recherche Scientifique (France); Albert Fert, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France); Mairbek Chshiev, SPINTEC (France) and Univ. Grenoble Alps (France) and CEA-INAC (France) ..... [9551-10]

Lunch Break ..... Sun 12:30 pm to 1:30 pm

#### SESSION 2 ..... SUN 8:30 AM TO 10:00 AM

##### Spin Coherence in Confined Semiconductor Structures

Session Chair: **Ezekiel Johnston-Halperin**, The Ohio State Univ. (USA)

**Resonant optical control of the current-induced spin polarization in a two-dimensional electron system** (*Invited Paper*), Felix G. G. Hernandez, Gennady Gusev, Univ. de São Paulo (Brazil); Askhat Bakarov, A.V. Rzhanov Institute of Semiconductor Physics (Russian Federation) ..... [9551-5]

**Dynamics of coupled carriers and Mn spins in a positively charged Mn-doped quantum dot** (*Invited Paper*), Lucien Besombes, Institut NÉEL (France) ... [9551-6]

**Semiconductor-based interface between photons and quantum registers using spins in self-assembled quantum dots** (*Invited Paper*), Danny Kim, Thaddeus D. Ladd, Matthew Rakher, Nathan C. Jones, Andrey A. Kiselev, Richard S. Ross, HRL Labs., LLC (USA) ..... [9551-7]

Sessions 3 and 4 run concurrently.

#### SESSION 3 ..... SUN 10:30 AM TO 12:00 PM

##### Spin Coherence and Ultrafast Optical Spectroscopy

Session Chair: **Giti A. Khodaparast**, Virginia Polytechnic Institute and State Univ. (USA)

**Long-range transfer of spin information using a single electron** (*Invited Paper*), Tristan Meunier, Ctr. National de la Recherche Scientifique (France) .... [9551-11]

**Spin dynamics of isolated carrier spins in semiconductors** (*Invited Paper*), Michael Oestreich, Fabian Berski, Ramin Dahbashi, Julia Wiegand, Leibniz Univ. Hannover (Germany); Klaus Pierz, Physikalisch-Technische Bundesanstalt (Germany); Andreas D. Wieck, Ruhr-Univ. Bochum (Germany); Jens Hübler, Leibniz Univ. Hannover (Germany) ..... [9551-12]

**Ultrafast phase-sensitive probes of the exchange interaction at ferromagnet/semiconductor interfaces** (*Invited Paper*), Ezekiel Johnston-Halperin, The Ohio State Univ. (USA) ..... [9551-13]

Lunch Break ..... Sun 12:00 pm to 1:00 pm

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Sessions 5 and 6 run concurrently.

## SESSION 5..... SUN 1:30 PM TO 3:00 PM

### Spin Injection in Semiconductors

Session Chair: Roberto Raimondi, Univ. degli Studi di Roma Tre (Italy)

**Spin-pumping-induced spin transport in semiconductors and related phenomena (Invited Paper)**, Masashi Shiraishi, Yuichiro Ando, Kyoto Univ. (Japan) ..... [9551-14]

**Hot electrons transport in devices combining tunnel and Schottky barriers (Invited Paper)**, Christopher Vautrin, Yuan Lu, Sylvain Le Gall, Guillaume Salla, Sylvie Robert, Olivier Lenoble, François Montaigne, Institut Jean Lamour (France); Ming-Wei Wu, Univ. of Science and Technology of China (China); Daniel Lacour, Michel Hehn, Institut Jean Lamour (France) ..... [9551-15]

**The role of interface states in the electrical and dynamical spin injection in silicon and germanium (Invited Paper)**, Matthieu Jamet, Commissariat à l'Energie Atomique (France) and Univ. Grenoble Alps (France); Fabien Rortais, Simon Oyarzun, Commissariat à l'Énergie Atomique (France) and Univ. Grenoble Alps (France); Juan-Carlos Rojas-Sánchez, Piotr Laczkowski, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France); Céline Vergnaud, Commissariat à l'Energie Atomique (France) and Univ. Grenoble Alps (France); Clarisse Ducruet, Crocus Technology (France); Cyrille Beigné, Commissariat à l'Énergie Atomique (France) and Univ. Grenoble Alps (France); Nicolas Reyren, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France); Jean-Philippe Attané, Commissariat à l'Énergie Atomique (France) and Univ. Grenoble Alps (France); Laurent Vila, Commissariat à l'Energie Atomique (France) and Univ. Grenoble Alps (France); Gérard Desfonds, Serge Gambarelli, Commissariat à l'Énergie Atomique (France) and Univ. Grenoble Alps (France); Julie Widiez, Commissariat à l'Energie Atomique (France); Henri Jaffrès, Jean-Marie George, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France) ..... [9551-16]

## SESSION 6..... SUN 1:00 PM TO 3:30 PM

### Spin Pumping and Inverse Spin Hall Effect

Session Chair: Jean-Eric Wegrowe, Ecole Polytechnique (France)

**Understanding bilayers of metals and magnetic insulators (Invited Paper)**, Gerrit E. W. Bauer, Tohoku Univ. (Japan) and Delft Univ. of Technology (Netherlands) ..... [9551-17]

**Spintronics in complex oxide hybrid and heterostructures (Invited Paper)**, Georg Schmidt, Martin-Luther-Univ. Halle-Wittenberg (Germany) ..... [9551-18]

**Spin wave propagation in magnetic insulator thin film of nanometer thickness (Invited Paper)**, Haiping Yu, BeiHang Univ. (China) and Technische Univ. München (Germany); Olivier d'Alivy Kelly, Unité Mixte de Physique CNRS/Thales (France) and Univ Paris-Sud 11 (France); Vincent Cros, Rozenn Bernard, Paolo Bortolotti, Abdelmadjid Anane, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France); Florian Brandl, Rupert Huber, Ioannis Stasinopoulos, Dirk Grundler, Technische Univ. München (Germany) ..... [9551-19]

**Role of transparency of platinum-ferromagnet interface in determining intrinsic magnitude of spin Hall effect (Invited Paper)**, Wei Han, Peking Univ. (China) ..... [9551-20]

**Quantum Well state oscillations of pure spin currents in Fe/Au/Pd(001) structures (Invited Paper)**, Bret V. Heinrich, Eric Montoya, Simon Fraser Univ. (Canada) ..... [9551-21]

## Sessions 7 and 8 run concurrently.

## SESSION 7..... SUN 3:30 PM TO 6:00 PM

### Rashba, Dresselhaus, and Dzyaloshinskii-Moriya Interactions

Session Chair: Paul M. Haney, National Institute of Standards and Technology (USA)

**Rashba spin-orbit effect and its electric field control at the surfaces and interfaces for spintronics applications (Invited Paper)**, Sashi Satpathy, Univ. of Missouri (USA) ..... [9551-23]

**Microscopic theory of the inverse Edelstein effect (Invited Paper)**, Roberto Raimondi, Univ. degli Studi di Roma Tre (Italy); Ka Shen, Giovanni Vignale, Univ. of Missouri (USA) ..... [9551-24]

**Origin of the spin-orbit interaction (Invited Paper)**, Gianfranco Spavieri, Univ. de los Andes (Venezuela); Masud Mansuripur, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9551-22]

**Spin-orbit torques and the Dzyaloshinskii-Moriya interaction in Ta/CoFeB/MgO nanowires (Invited Paper)**, Thomas A. Moore, Univ. of Leeds (United Kingdom) ..... [9551-25]

**Transport at spin-orbit and exchange-split interfaces and universal giant asymmetry**, Huong Thi Dang, Ecole Polytechnique (France); Henri Jaffrès, Unité Mixte de Physique CNRS/Thales (France); T. L. Hoai Nguyen, Vietnam Academy of Science and Technology (Viet Nam); Henri-Jean Drouhin, Ecole Polytechnique (France) ..... [9551-26]

## SESSION 8..... SUN 4:00 PM TO 5:30 PM

### Spin Dynamics and Ultrafast Spectroscopy

Session Chair: Georg Schmidt, Martin-Luther-Univ. Halle-Wittenberg (Germany)

**Spin and phase relaxation dynamics in GaN and GaN/AlGaN quantum wells (Invited Paper)**, Mathieu Gallart, Marc Ziegler, Bernd H. Hönerlage, Pierre Gilliot, Institut de Physique et Chimie des Matériaux de Strasbourg (France); Eric Feltin, Jean-François Carlin, Raphaël Butté, Nicolas Grandjean, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9551-27]

**Ultrafast magneto-optical spectroscopy of BiFeO<sub>3</sub>-BaTiO<sub>3</sub> based structures (Invited Paper)**, Giti A. Khodaparast, Brenden A. Magill, Michael A. Meeker, Anuj Chopra, Yoon Zhou, Hyun-Cheol Song, Virginia Polytechnic Institute and State Univ. (USA); Michael Bishop, Stephen A. McGill, National High Magnetic Field Lab. (USA); Christopher J. Stanton, Univ. of Florida (USA); Shashank Priya, Virginia Polytechnic Institute and State Univ. (USA) ..... [9551-28]

**Ultrafast spectroscopy in high magnetic fields using the 25 Tesla Split Florida Helix (Invited Paper)**, David J. Hilton, The Univ. of Alabama at Birmingham (USA) ..... [9551-29]

## SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

# CONFERENCE 9551

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING

#### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: Satoshi Kawata, Osaka Univ. (Japan); David L. Andrews, Univ. of East Anglia (United Kingdom)	
Extreme Imaging and Beyond (Plenary), Keisuke Goda, The Univ. of Tokyo (Japan) .....	[9544-500]
Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary), Reuven Gordon, Univ. of Victoria (Canada) .....	[9544-501]
Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) .....	[9544-502]

Lunch/Exhibition Break..... Mon 12:00 pm to 1:00 pm

#### SESSION 9..... MON 1:00 PM TO 3:30 PM

### Spin in 2D Transition Metal Dichalcogenides

Session Chair: Masashi Shiraishi, Osaka Univ. (Japan)

Time-resolved spectroscopy of coupled spin-valley-dynamics in monolayer transition metal dichalcogenides at low temperatures (Invited Paper), Gerd Plechinger, Philipp Nagler, Christian Schüller, Tobias Korn, Univ. Regensburg (Germany) .....	[9551-30]
Disentangling intra and intervalley dynamics in monolayer MoS <sub>2</sub> by ultrafast optical techniques (Invited Paper), Stefano Dal Conte, CNR-Istituto di Fotonica e Nanotecnologie (Italy) and Politecnico di Milano (Italy) .....	[9551-31]

Exciton fine structure and spin/valley dynamics in nanosystems (Invited Paper), Mikhail M. Glazov, Ioffe Physical-Technical Institute (Russian Federation) [9551-32]

Generation of valley-spin currents in 2D transition metal dichalcogenides (Invited Paper), Wang Yao, The Univ. of Hong Kong (Hong Kong, China) .. [9551-33]

Spin relaxation and intervalley scattering in 2D semiconductors (Invited Paper), Aubrey Hanbicki, Marc Currie, U.S. Naval Research Lab. (USA); George Kioseoglou, Univ. of Crete (Greece); C. Stephen Hellberg, Kathleen M. McCreary, Adam L. Friedman, Berend T. Jonker, U.S. Naval Research Lab. (USA) .....

[9551-34]

#### SESSION 10..... MON 4:00 PM TO 6:30 PM

### Spins in 2D Transition Metal Dichalcogenides and Graphene

Session Chair: Mikhail M. Glazov, Ioffe Physical-Technical Institute (Russian Federation)

Valley dynamics and excitonic effects in transition metal dichalcogenide monolayers (Invited Paper), Gang Wang, Xavier Marie, Iann Gerber, Thierry Amand, Delphine Lagarde, Louis Bouet, Maël Vidal, Andréa Balocchi, Bernhard Urbaszek, Lab. de Physique et Chimie des Nano-objets (France) and Ctr. National de la Recherche Scientifique (France) and Univ. de Toulouse (France) .....

[9551-35]

Homoepitaxial graphene tunnel barriers for spin transport (Invited Paper), Adam L. Friedman, U.S. Naval Research Lab. (USA) .....

[9551-36]

Long distance spin transport in CVD graphene and spin filtering with h-BN barrier (Invited Paper), Saroj P. Dash, Chalmers Univ. of Technology (Sweden) .....

[9551-37]

Spintronic and optical properties of 2D materials (Invited Paper), Roland K. Kawakami, Univ. of California, Riverside (USA) .....

[9551-38]

Graphene: new venues for spintronics (Invited Paper), Pierre Seneor, Unité Mixte de Physique CNRS/Thales (France) .....

[9551-39]

## TUESDAY 11 AUGUST

#### SESSION 11 ..... TUE 8:00 AM TO 10:00 AM

### Spin Lasers

Session Chair: Michael Oestreich, Leibniz Univ. Hannover (Germany)

Properties of light emission from multilayer InGaAs/GaAsP solid-state spin-lasers and VECSELs, Tibor Fördös, Ecole Polytechnique (France), VSB-Technical Univ. of Ostrava (Czech Republic); Henri Jaffrès, Unité Mixte de Physique CNRS/Thales (France); Kamil Postava, VSB-Technical Univ. of Ostrava (Czech Republic); Jean-Marie George, Unité Mixte de Physique CNRS/Thales (France); Jaromír Pištora, VSB-Technical Univ. of Ostrava (Czech Republic); Henri-Jean Drouhin, Ecole Polytechnique (France) .....

[9551-40]

Electron spin injection and transport in (110) quantum wells for room temperature operation of spin-controlled vertical-cavity surface-emitting lasers (Invited Paper), Nobuhide Yokota, Kazuhiro Ikeda, Nara Institute of Science and Technology (Japan); Nozomi Nishizawa, Hiro Munekata, Tokyo Institute of Technology (Japan); Hitoshi Kawaguchi, Nara Institute of Science and Technology (Japan) .....

[9551-41]

Growth condition dependence of carrier and spin lifetimes in GaAs-based quantum wells (Invited Paper), Satoshi Iba, Hidekazu Saito, National Institute of Advanced Industrial Science and Technology (Japan); Ken Watanabe, Yuzo Ohno, Univ. of Tsukuba (Japan); Shinji Yuasa, National Institute of Advanced Industrial Science and Technology (Japan) .....

[9551-42]

Continuous visible-light emission at room temperature in Mn-doped GaAs and Si light-emitting diodes (Invited Paper), Masaaki Tanaka, Pham Nam Hai, Le Duc Anh, The Univ. of Tokyo (Japan) .....

[9551-43]

#### SESSION 12 ..... TUE 10:30 AM TO 12:30 PM

### Skyrmions and Topological Insulators

Session Chair: Yoshinori Onose, The Univ. of Tokyo (Japan)

Time-evolution of wave-packets in topological insulators (Invited Paper), Gerson J. Ferreira, Univ. Federal de Uberlândia (Brazil); Poliana H. Penteado, José Carlos Egues, Univ. de São Paulo (Brazil) .....

[9551-44]

Skyrmions in quasi-2D chiral magnets with broken bulk and surface inversion symmetry (Invited Paper), Mohit Randeria, The Ohio State Univ. (USA); Sumilan Banerjee, Weizmann Institute of Science (Israel); James Rowland, The Ohio State Univ. (USA) .....

[9551-45]

Spirals and skyrmions in two dimensional oxide heterostructures (Invited Paper), Xiaopeng Li, Univ. of Maryland, College Park (USA); W. Vincent Liu, Univ. of Pittsburgh (USA); Leon Balents, Univ. of California, Santa Barbara (USA) .....

[9551-46]

Electrical injection and detection of spin-polarized currents in 3D topological insulators (Invited Paper), Jifa Tian, Purdue Univ. (USA) .....

[9551-47]

Lunch/Exhibition Break .....

Tue 12:30 pm to 1:30 pm

#### SESSION 13 ..... TUE 1:30 PM TO 3:00 PM

### Magnon Hall Effect

Session Chair: Gerrit E. W. Bauer, Tohoku Univ. (Japan)

Magnon Hall effect (Invited Paper), Yoshinori Onose, The Univ. of Tokyo (Japan) .....

[9551-48]

Magnonic Hall effect and topological magnonic crystals (Invited Paper), Shuichi Murakami, Tokyo Institute of Technology (Japan) .....

[9551-49]

Magnon Hall effect and planar Righi-Leduc effect measured in NiFe and YIG ferromagnets, Benjamin Madon, Do Chung Pham, Ecole Polytechnique (France); Daniel Lacour, Institut Jean Lamour (France); Abdelmadjid Anane, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris-Sud 11 (France); Rozenn Bernard, Vincent Cros, Unité Mixte de Physique CNRS/Thales (France) and Univ. Paris Sud 11 (France); Michel Hehn, Institut Jean Lamour (France); Jean-Eric Wegrowe, Ecole Polytechnique (France) .....

[9551-50]

# CONFERENCE 9551

SESSION 14 ..... TUE 3:30 PM TO 6:00 PM

## Nanomagnetism and Topological Phase

Session Chair: Shuichi Murakami, The Univ. of Tokyo (Japan)

**Helimagnetism in nanometer small bilayer iron islands** (*Invited Paper*), Dirk Sander, Max-Planck-Institut für Mikrostrukturphysik (Germany) ..... [9551-51]

**Toward the realization of a single atom magnet** (*Invited Paper*), Fabio Donati, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9551-52]

**Geometrical phase and inertial regime of the magnetization: Hannay angle and magnetic monopole** (*Invited Paper*), Jean-Eric Wegrowe, Ecole Polytechnique (France) ..... [9551-53]

**Laser-induced spin precession for magnetic alloy films in THz wave range** (*Invited Paper*), Shigemi Mizukami, Tohoku Univ. (Japan) ..... [9551-54]

**Magnetism in thin films: a spin-resolved investigation of single and multi-layer systems** (*Invited Paper*), Alberto Calloni, Politecnico di Milano (Italy) ..... [9551-55]

## WEDNESDAY 12 AUGUST

SESSION 15 ..... WED 8:00 AM TO 10:30 AM

## Voltage Control of Magnetic Properties and Multiferroics

Session Chair: Edson Vernek, UFU (Brazil)

**Voltage control of nanoscale magnetoelastic elements: theory and experiments** (*Invited Paper*), Gregory P. Carman, Univ. of California, Los Angeles (USA) ..... [9551-56]

**Reversible electric field driven magnetic domain wall motion** (*Invited Paper*), Kevin J. A. Franke, Aalto Univ. School of Science and Technology (Finland); Ben Van de Wiele, Univ. Gent (Belgium); Yasuhiro Shirahata, Tokyo Institute of Technology (Japan); Sampo J. Hämäläinen, Aalto Univ. School of Science and Technology (Finland); Tomoyasu Taniyama, Tokyo Institute of Technology (Japan); Sebastiaan van Dijken, Aalto Univ. School of Science and Technology (Finland) ..... [9551-57]

**Magnetoelectric imaging of multiferroic heterostructures** (*Invited Paper*), Massimo Ghidini, Arnaud Lesaine, Bonan Zhu, Xavier Moya, Wenjing Yan, Sam Crossley, Bhasi Nair, Rhodri Mansell, Russell P. Cowburn, Crispin H. W. Barnes, Univ. of Cambridge (United Kingdom); Florian Kronast, Sergio Valencia, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Francesca Maccherozzi, Sumeet S. Dhesi, Diamond Light Source Ltd. (United Kingdom); Neil Mathur, Univ. of Cambridge (United Kingdom) ..... [9551-58]

**Non-collinear magnetic structure in  $\text{La}_2/\text{Sr}_2\text{MnO}_3/\text{LaNiO}_3$  superlattices** (*Invited Paper*), Anand Bhattacharya, Argonne National Lab. (USA) ..... [9551-59]

**Efficient spin-to-charge conversion at  $\text{LaAlO}_3/\text{SrTiO}_3$  interfaces** (*Invited Paper*), Edouard Lesne, Juan-Carlos Rojas-Sánchez, Unité Mixte de Physique CNRS/Thales (France); Simon Oyarzon, Yu Fu, CEA-INAC (France); Nicolas Reyren, Eric Jacquet, Vincent Cros, Unité Mixte de Physique CNRS/Thales (France); Gérard Desfonds, Serge Gambarelli, Matthieu Jamet, Jean-Philippe Attané, CEA-INAC (France); Jean-Marie George, Albert Fert, Agnès Barthélémy, Unité Mixte de Physique CNRS/Thales (France); Laurent Vila, CEA-INAC (France); Henri Jafrès, Unité Mixte de Physique CNRS/Thales (France) and Peter Grünberg Institute (Germany) and Institute for Advanced Simulation (Germany); Manuel Bibes, Unité Mixte de Physique CNRS/Thales (France) ..... [9551-60]

SESSION 16 ..... WED 11:00 AM TO 12:30 PM

## Spin Ice I

Session Chair: Cristiano Nisoli, Los Alamos National Lab. (USA)

**Periodic and quasiperiodic artificial spin ices: magnetic structure and dynamics** (*Invited Paper*), Christopher H. Marrows, Univ. of Leeds (United Kingdom) ..... [9551-61]

**Unconventional spin textures in magnetically frustrated topologies** (*Invited Paper*), Nicolas Rougemaille, Ioan Chioar, Institut NÉEL (France); Michel Hehn, Daniel Lacour, François Montaigne, Institut Jean Lamour (France); Benjamin Canals, Institut NÉEL (France) ..... [9551-62]

**Direct visualization of the thermodynamics of artificial spin ice systems** (*Invited Paper*), Alan Farhan, Paul Scherrer Institut (Switzerland) ..... [9551-63]

Lunch/Exhibition Break ..... Wed 12:30 pm to 2:00 pm

SESSION 17 ..... WED 2:00 PM TO 3:30 PM

## Spin Ice II

Session Chair: Daniel Lacour, Institut Jean Lamour (France)

**Artificial spin ice: from scientific toy to material by design** (*Invited Paper*), Cristiano Nisoli, Los Alamos National Lab. (USA); Peter Schiffer, Ian Gilbert, Univ. of Illinois at Urbana-Champaign (USA) ..... [9551-64]

**Controlling electric and magnetic currents in artificial spin ice** (*Invited Paper*), Will R. Branford, Imperial College London (United Kingdom) ..... [9551-65]

**Ordering and thermal excitations in dipolar coupled single domain magnet arrays** (*Invited Paper*), Erik Östman, Uppsala Univ. (Sweden); Unnar Arnalds, Univ. of Iceland (Iceland); Vassilios Kapakis, Björn Hjörvarsson, Uppsala Univ. (Sweden) ..... [9551-66]

SESSION 18 ..... WED 4:00 PM TO 6:00 PM

## Majorana Fermions and Superconductivity

Session Chair: Christopher H. Marrows, Univ. of Leeds (United Kingdom)

**Majorana modes and Kondo effect in a quantum dot attached to a topological superconducting wire** (*Invited Paper*), Edson Vernek, Univ. Federal de Uberlândia (Brazil); David Ruiz-Tijerina, Luis G. Dias da Silva, José Carlos Egues, Univ. de São Paulo (Brazil) ..... [9551-67]

**Universal parity-crossing statistics in spin-polarized hybrid normal-superconductor nanostructures** (*Invited Paper*), Inanc Adagideli, Sabanci Univ. (Turkey) ..... [9551-68]

**Magnetic noise from Kondo charge traps** (*Invited Paper*), Luis G. Dias da Silva, Univ. de São Paulo (Brazil); Rogério de Sousa, Univ. of Victoria (Canada) [9551-69]

**Hybrid superconducting magnetic tunnel junctions: coexistence of TMR and Josephson effects**, Ondrej Vavra, Petra Högl, Jaroslav Fabian, Univ. Regensburg (Germany); Hermann Kohlstedt, Christian-Albrechts-Univ. zu Kiel (Germany); Christoph Strunk, Univ. Regensburg (Germany) ..... [9551-70]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Intrinsic photonic spin Hall effect of vector beam with rotational symmetry-breaking**, Xiaohui Ling, Shenzhen Univ. (China); Zhiping Dai, Hengyang Normal Univ. (China); Xunong Yi, Shenzhen Univ. (China); Liezun Chen, Youwen Wang, Hengyang Normal Univ. (China); Shuangchun Wen, Shenzhen Univ. (China) ..... [9551-99]

**Fabrication of  $\text{Fe}/\text{MgO}/\text{Fe}$  low-resistance nano-contact on pn-GaAs photodetector as a memory element for a high-speed non-volatile optical memory**, Vadym Zayets, Hidekazu Saito, Koji Ando, Shinji Yuasa, National Institute of Advanced Industrial Science and Technology (Japan) ..... [9551-100]

**Band structure of thin films materials**, Amine Elhaimeur, Zouhair Sofiani, Univ. Ibn Tofail (Morocco) ..... [9551-101]

**The titanium-antisite ( $\text{TiO}$ ) magnetism effect on  $\text{Ti}_{0.98}\text{Cr}_{0.02}\text{O}_{2(0.98)}(\text{TiO})_{0.02}$  system within ab-initio calculation**, Zakaryaa Zahri, Univ. Mohammed V (Morocco) ..... [9551-102]

**Description of the spin proximity effect from a solution of the modified Boltzmann transport equations**, Vadym Zayets, National Institute of Advanced Industrial Science and Technology (Japan) ..... [9551-103]

**Ultrafast affection of electron spin dynamics in GaAs by a ferromagnetic film**, Dagmar Butková, Petr Němec, Charles Univ. in Prague (Czech Republic); Kamil Olejník, Vít Novák, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Tomáš Janda, František Trojánek, Charles Univ. in Prague (Czech Republic); Tomáš Jungwirth, Institute of Physics of the ASCR, v.v.i. (Czech Republic) ..... [9551-104]

**Giant stress field in a single Ni nanowire generated by an external mechanical strain**, Giuseppe Melilli, CEA-Ctr. de SACLAY (France); Marie-Claude Clochard, Commissariat à l'Énergie Atomique (France); Mohamed tabellout, Univ. du Maine (France); Daniel Lacour, Laurent Bouvet, Univ. de Lorraine (France); Nicolas Biziere, Ctr. d'Elaboration de Matériaux et d'Etudes Structurales (France); Jean-Eric Wegrowe, Ecole Polytechnique (France) ..... [9551-105]

# CONFERENCE 9551

THURSDAY 13 AUGUST

Sessions 19 and 20 run concurrently.

## SESSION 19 ..... THU 8:00 AM TO 10:00 AM

### Spin-Photonic Devices

Session Chair: **Aurelie Solignac**, CEA-IRAMIS (France)

**Spin photonics and spin-photonic devices with dielectric metasurfaces (Invited Paper)**, Hailu Luo, Yachao Liu, Shizhen Chen, Yougang Ke, Xinxing Zhou, Hunan Univ. (China) ..... [9551-71]

**Spin-photonic devices based on crystalline-AlOx / GaAs for emission and detection of circular polarized light (Invited Paper)**, Hiro Munekata, Masaki Aoyama, Ronel Roca, Nozomi Nishizawa, Tokyo Institute of Technology (Japan) ..... [9551-72]

**Development of plasmonic isolator for integration into photonic integrated circuits (Invited Paper)**, Vadym Zayets, Hidekazu Saito, Koji Ando, Shinji Yuasa, National Institute of Advanced Industrial Science and Technology (Japan) [9551-73]

**Integrated optical isolators using magnetic surface plasmon (Invited Paper)**, Hiromasa Shimizu, Terunori Kaihara, Saori Umetsu, Masashi Hosoda, Tokyo Univ. of Agriculture and Technology (Japan) ..... [9551-74]

## SESSION 20 ..... THU 8:00 AM TO 10:00 AM

### Spin-Charge Coupling in Semiconductors

Session Chair: **Christopher J. Stanton**, Univ. of Florida (USA)

**Electrical generation and manipulation of spin polarization in semiconductors (Invited Paper)**, Vanessa Sih, Univ. of Michigan (USA) ..... [9551-75]

**Spinor effects in the pattern formation of polaritons in semiconductor microcavities (Invited Paper)**, Rudolf Binder, Ming Ho Luk, The Univ. of Arizona (USA); K. P. Chan, The Chinese Univ. of Hong Kong (Hong Kong, China); Przemyslaw Lewandowski, Univ. Paderborn (Germany); Ombline Lafont, Ctr. National de la Recherche Scientifique (France); Vincenzo Ardizzone, Emmanuel Baudin, Lab. Pierre Aigrain (France); Nai-Hang Kwong, College of Optical Sciences, The Univ. of Arizona (USA); Yuen Chi Tse, The Chinese Univ. of Hong Kong (Hong Kong, China); Andreas Luecke, Univ. Paderborn (Germany); C.Y. Tsang, The Chinese Univ. of Hong Kong (Hong Kong, China); Marco Abbarchi, Lab. de Photonique et de Nanostructures (France); Philippe Roussignol, Lab. Pierre Aigrain (France); Pui Tang Leung, The Chinese Univ. of Hong Kong (Hong Kong, China); Jérôme Tignon, Lab. Pierre Aigrain (France); Stefan Schumacher, Univ. Paderborn (Germany) ..... [9551-76]

**Effect of the Pauli principle on photoelectron spin transport in p+ GaAs (Invited Paper)**, Daniel Paget, Ecole Polytechnique (France) ..... [9551-77]

**Efficient conversion of light to charge and spin in Hall-bar microdevices**, Lukas Nadovnik, Institute of Physics of the ASCR, v.v.i. (Czech Republic); James A. Haigh, Hitachi Cambridge Lab. (United Kingdom); Kamil Olejnik, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Andrew C. Irvine, Univ. of Cambridge (United Kingdom); Vit Novak, Tomáš Jungwirth, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Joerg Wunderlich, Hitachi Cambridge Lab. (United Kingdom) ..... [9551-78]

Sessions 21 and 22 run concurrently.

## SESSION 21 ..... THU 10:30 AM TO 12:30 PM

### Magnetic Sensors and Memories

Session Chair: **Hiro Munekata**, Tokyo Institute of Technology (Japan)

**Current-induced magnetization dynamics and thermal stability of perpendicular STT-MRAM devices (Invited Paper)**, Huanlong Liu, Luc Thomas, Guenole Jan, Son Le, Yuan-Jen Lee, Jian Zhu, Ru-Ying Tong, Keyu Pi, Yu-Jen Wang, Tom X. Zhong, Terry Tong, Po-Kang Wang, Headway Technologies, Inc. (USA) ..... [9551-79]

**Spiraltronics devices for space applications (Invited Paper)**, Malik Mansour, Lab. de Physique des Plasmas (France) ..... [9551-80]

**Monolithic integration of focused 2D GMR spin valve magnetic field sensor for high-sensitivity (compass) applications (Invited Paper)**, Olaf Ueberschär, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); Maria J. Almeida, Fraunhofer-Institut für Elektronische Nanosysteme (Germany) and Technische Univ. Chemnitz (Germany); Patrick Matthes, Technische Univ. Chemnitz (Germany); Mathias Müller, Hochschule Mittweida (Germany); Ramona Ecke, Fraunhofer-Institut für Elektronische Nanosysteme (Germany); Horst Exner, Hochschule Mittweida (Germany); Stefan E. Schulz, Fraunhofer-Institut für Elektronische Nanosysteme (Germany) and Technische Univ. Chemnitz (Germany) ..... [9551-81]

**State of the art of the equivalent magnetic sensor noise: from intrinsic sensor performances to application, the challenges (Invited Paper)**, Christophe Dolabdjian, Univ. de Caen Basse-Normandie (France) ..... [9551-82]

Lunch/Exhibition Break ..... Thu 12:30 pm to 1:30 pm

## SESSION 22 ..... THU 10:30 AM TO 12:30 PM

### Tayloring Magnetic Properties and Materials

Session Chair: **Vanessa Sih**, Univ. of Michigan (USA)

**Tayloring and manipulating spin in semiconductor nanostructures (Invited Paper)**, Christopher J. Stanton, Gary D. Sanders, Univ. of Florida (USA) .. [9551-83]

**100% spin polarized surface resonance in the half metallic Heusler compound Co<sub>2</sub>MnSi (Invited Paper)**, Martin Jourdan, Johannes Gutenberg Univ. Mainz (Germany); Jan Minar, Juergen Braun, Ludwig-Maximilians-Univ. München (Germany); Alexander Kronenberg, Johannes Gutenberg Univ. Mainz (Germany); Stanislav Chadov, Max-Planck-Institut für Chemische Physik Fester Stoffe (Germany); Benjamin Balke, Johannes Gutenberg Univ. Mainz (Germany); Andrej Gloskovskii, Deutsches Elektronen-Synchrotron (Germany); Michaela Kolbe, Hans-Joachim Elmers, Gerd Schoenhense, Johannes Gutenberg Univ. Mainz (Germany); Hubert Ebert, Ludwig-Maximilians-Univ. München (Germany); Claudia Felser, Max-Planck-Institut für Chemische Physik Fester Stoffe (Germany); Mathias Kläui, Johannes Gutenberg Univ. Mainz (Germany) ..... [9551-84]

**Valence control of Eu ions in Eu-doped GaN grown by organometallic vapor phase epitaxy (Invited Paper)**, Yasufumi Fujiwara, Masaaki Matsuda, Wanxin Zhu, Takanori Kojima, Atsushi Koizumi, Osaka Univ. (Japan) ..... [9551-85]

**Novel 2D electron gases at the surface of transition-metal oxides: fundamentals and perspectives for spintronics (Invited Paper)**, Andrés F. Santander-Syro, Univ Paris-Sud 11 (France) ..... [9551-86]

Lunch/Exhibition Break ..... Thu 12:30 pm to 1:30 pm

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Sessions 23 and 24 run concurrently.

SESSION 23 ..... THU 1:30 PM TO 3:00 PM

## Magnetic Sensors I

Session Chair: **Olaf Ueberschär**, Fraunhofer-Institut für Elektronische Nanosysteme (Germany)

**Spin electronic magnetic sensor based on functional oxides for medical imaging** (*Invited Paper*), Aurelie Solignac, Commissariat à l'Énergie Atomique (France); Georg Kurij, Ruben Guerrero, Guillaume Agnus, Thomas Maroutian, Institut d'Électronique Fondamentale (France); Claude Fermon, Myriam Pannetier-Lecoeur, Commissariat à l'Énergie Atomique (France); PHILIPPE LECOEUR, Institut d'Électronique Fondamentale (France) ..... [9551-87]

**Development of micronic GMR-magnetoresistive sensors for non-destructive sensing applications** (*Invited Paper*), Henri Jaffrès, Yves LeMaitre, Sophie Collin, Frédéric Nguyen Vandau, Unité Mixte de Physique CNRS/Thales (France); Natalia Sergeeva-Chollet, CEA-Ctr. de SACLAY (France); Jean-Marc Decitre, CEA-Ctr. de SACLAY (France) ..... [9551-88]

**3D magnetic surfaces** (*Invited Paper*), Denys Makarov, Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden (Germany) ..... [9551-89]

SESSION 24 ..... THU 1:30 PM TO 3:00 PM

## Organic Materials I

Session Chair: **Chanoch Carmeli**, Tel Aviv Univ. (Israel)

**Organic analogues of diluted magnetic semiconductors: bridging quantum chemistry to condensed matter physics** (*Invited Paper*), Madalina I. Furis, Naveen Rawat, Kim Ngan Hua, The Univ. of Vermont (USA); Stephen A. McGill, National High Magnetic Field Lab. (USA) ..... [9551-90]

**Photocontrol of magnetism above 77 K in nanoscaled heterostructures of cyanometallate coordination networks** (*Invited Paper*), Mark W. Meisel, Daniel R. Talham, Univ. of Florida (USA) ..... [9551-91]

**Tailoring spintronics interfaces with organic molecules** (*Invited Paper*), Mirko Cinchetti, Technische Univ. Kaiserslautern (Germany) ..... [9551-92]

Sessions 25 and 26 run concurrently.

SESSION 25 ..... THU 3:20 PM TO 4:50 PM

## Magnetic Sensors II

Session Chair: **Christophe Dolabdjian**, Univ. de Caen Basse-Normandie (France)

**Fundamental electric circuit elements based on the linear and nonlinear magnetoelectric effects** (*Invited Paper*), Young Sun, Dashan Shang, Yisheng Chai, Zexian Cao, Jun Lu, Institute of Physics (China) ..... [9551-93]

**Emerging functionalities in devices with complex oxides** (*Invited Paper*), Tamalika Banerjee, Univ. of Groningen (Netherlands) ..... [9551-94]

**Tuning magnetic nanostructures and flux concentrators for magnetoresistive sensors** (*Invited Paper*), Xiaolu Yin, Yen-Fu Liu, Sy-Hwang Liou, Univ. of Nebraska-Lincoln (USA) ..... [9551-95]

SESSION 26 ..... THU 3:20 PM TO 4:50 PM

## Organic Materials II

Session Chair: **Madalina I. Furis**, The Univ. of Vermont (USA)

**An efficient biological source for light induced spin injection: photosystem I** (*Invited Paper*), Chanoch Carmeli, Tel Aviv Univ. (Israel); Ron Naaman, Weizmann Institute of Science (Israel); Itai Carmeli, Omri Heifler, Tel Aviv Univ. (Israel); Karuppannan S. Kumar, National Univ. of Singapore (Singapore) ..... [9551-96]

**Spin injection and relaxation in a highly doped organic polymer film** (*Invited Paper*), Motoi Kimata, Daisuke Nozaki, Yasuhiro Niimi, The Univ. of Tokyo (Japan); Hiroyuki Tajima, Univ. of Hyogo (Japan); YoshiChika Otani, The Univ. of Tokyo (Japan) ..... [9551-97]

**Tuning exchange interactions in organometallic semiconductors**, Naveen Rawat, Madalina I. Furis, The Univ. of Vermont (USA) ..... [9551-98]

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# Carbon Nanotubes, Graphene, and Emerging 2D Materials for Electronic and Photonic Devices VIII

Conference Chairs: **Manijeh Razeghi**, Northwestern Univ. (USA); **Maziar Ghazinejad**, California State Univ., Fresno (USA); **Can Bayram**, Univ. of Illinois at Urbana-Champaign (USA); **Jae Su Yu**, Kyung Hee Univ. (Korea, Republic of)

Program Committee: **Seunghyun Baik**, Sungkyunkwan Univ. (Korea, Republic of); **Paolo Bondavalli**, Thales Research & Technology (France); **Markus Buehler**, Massachusetts Institute of Technology (USA); **Costel-Sorin Cojocaru**, Ecole Polytechnique (France); **Ertugrul Cubukcu**, Univ. of Pennsylvania (USA); **Christos D. Dimitrakopoulos**, Univ. of Massachusetts Amherst (USA); **Charles M. Falco**, College of Optical Sciences, The Univ. of Arizona (USA); **Talia Gershon**, IBM Thomas J. Watson Research Ctr. (USA); **Kenji Hata**, National Institute of Advanced Industrial Science and Technology (Japan); **Mark C. Hersam**, Northwestern Univ. (USA); **Seong Chan Jun**, Yonsei Univ. (Korea, Republic of); **Jeehwan Kim**, IBM Thomas J. Watson Research Ctr. (USA); **Horacio Lamela Rivera**, Univ. Carlos III de Madrid (Spain); **Seung Hee Lee**, Chonbuk National Univ. (Korea, Republic of); **Young Hee Lee**, Sungkyunkwan Univ. (Korea, Republic of); **Xiuling Li**, Univ. of Illinois at Urbana-Champaign (USA); **Annick Loiseau**, ONERA (France); **Jean-Pierre Luberton**, Univ. of Illinois at Urbana-Champaign (USA); **Masud Mansuripur**, College of Optical Sciences, The Univ. of Arizona (USA); **Ryan McClintock**, Northwestern Univ. (USA); **William I. Milne**, Univ. of Cambridge (United Kingdom); **Sedat Nizamoglu**, Ozyegin Univ. (Turkey); **Cengiz S. Ozkan**, Univ. of California, Riverside (USA); **Hongsik Park**, Kyungpook National Univ. (Korea, Republic of); **Philip W. T. Pong**, The Univ. of Hong Kong (Hong Kong, China); **Fengnian Xia**, Yale Univ. (USA); **Wenjuan Zhu**, Univ. of Illinois at Urbana-Champaign (USA)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 1:20 PM TO 3:20 PM

#### Synthesis and Characterization I

Session Chairs: **Can Bayram**, Univ. of Illinois at Urbana-Champaign (USA); **Maziar Ghazinejad**, California State Univ., Fresno (USA)

Title to be determined (*Invited Paper*), Cengiz Sinan Ozkan, Univ. of California, Riverside (USA) ..... [9552-40]

Using wafer-scale epitaxial graphene for producing twisted bilayers with controlled twist angle for electronics applications (*Invited Paper*), Christos D. Dimitrakopoulos, Univ. of Massachusetts Amherst (USA) ..... [9552-1]

Lithographically defined 3-dimensional graphene scaffolds (*Invited Paper*), D. Bruce Burckel, Sandia National Labs. (USA) ..... [9552-2]

III-V nanowires and 2D van der Waals sheets: interfaces and devices (*Invited Paper*), Xiuling Li, Univ. of Illinois at Urbana-Champaign (USA) ..... [9552-3]

Engineering heterogeneous catalysts for carbon nanotube growth via substrate ion beam bombardment (*Invited Paper*), Ahmad E. Islam, Air Force Research Lab. (USA) and National Research Council (USA) and National Academy of Sciences (USA); Pasha Nikolaev, Air Force Research Lab. (USA); Placidus B. Amama, Kansas State Univ. (USA); Sammy Saber, Air Force Research Lab. (USA); Dmitri Zakharov, Brookhaven National Lab. (USA); Daniel Huffman, Gordon Sargent, Michelle Erford, Sheldon Semiatin, Air Force Research Lab. (USA); Eric A. Stach, Brookhaven National Lab. (USA); Benji Maruyama, Air Force Research Lab. (USA) ..... [9552-4]

Noncontact carrier dynamic characterization of hybrid graphene-based thin films by terahertz pulsed and CW techniques, Ehsan Dadrasnia, Sujitha Puthukodan, Univ. Carlos III de Madrid (Spain); Guillaume Ducournau, Jean-François Lampin', Univ. des Sciences et Technologies de Lille (France); Frédéric Garet, Jean-Louis Coutaz, IMEP-LAHC (France); Horacio R. Lamela Rivera, Univ. Carlos III de Madrid (Spain) ..... [9552-5]

### SESSION 2 ..... SUN 3:40 PM TO 6:00 PM

#### Devices I

Session Chairs: **Can Bayram**, Univ. of Illinois at Urbana-Champaign (USA); **Maziar Ghazinejad**, California State Univ., Fresno (USA)

Genomics with graphene nanotechnology (*Invited Paper*), Jean-Pierre Luberton, Univ. of Illinois at Urbana-Champaign (USA) ..... [9552-7]

Optoelectronic properties of CZTS(e) as revealed by low-temperature photoluminescence studies (*Invited Paper*), Talia Gershon, IBM Thomas J. Watson Research Ctr. (USA); Byungha Shin, KAIST (Korea, Republic of); Tayfun Gokmen, Yun S. Lee, Supratik Guha, IBM Thomas J. Watson Research Ctr. (USA) ..... [9552-8]

Bromination of graphene: a new route to making high performance transparent conducting electrodes with low optical losses, Ahmed E. Mansour, Aram Amassian, King Abdullah Univ. of Science and Technology (Saudi Arabia); Minas H. Tanielian, Boeing Research and Technology (USA) ..... [9552-9]

Thermal stability of field emission from carbon nanotube studied using multi-physics simulation by considering space charge effect, Ahmad E. Islam, Air Force Research Laboratory (USA) and National Research Council (USA) and National Academy of Sciences (USA); Steven B. Fairchild, Benji Maruyama, Air Force Research Lab. (USA) ..... [9552-10]

Study of 2D triangular lattice of multiwall carbon nanotube arrays, Xingxing Wu, Mei Wang, Maojin Yun, Weijin Kong, Qingdao Univ. (China) ..... [9552-11]

Mitigation of charged impurity effects in graphene field-effect transistors with polar organic molecules, Barrett C. Worley, Seohee Kim, Deji Akinwande, The Univ. of Texas at Austin (USA); Peter J. Rossky, Rice Univ. (USA); Ananth Dodabalapur, The Univ. of Texas at Austin (USA) ..... [9552-12]

On-chip high power porous silicon lithium ion batteries with stable capacity over 10000 cycles (*Invited Paper*), Andrew S. Westover, Daniel Freudiger, Zarif Gani, Keith Share, Landon Oakes, Rachel E. Carter, Cary L. Pint, Vanderbilt Univ. (USA) ..... [9552-13]

## SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

### NANO SCIENCE + ENGINEERING PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan); **David L. Andrews**, Univ. of East Anglia (United Kingdom)

Extreme Imaging and Beyond (*Plenary*), Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

**Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions** (*Plenary*), Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

**Device Applications of Semiconductor Nanoantennas and Metafilms** (*Plenary*), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch/Exhibition Break ..... Mon 12:00 pm to 1:30 pm

# CONFERENCE 9552

SESSION 3.....MON 1:30 PM TO 5:40 PM

## Emerging 2D Materials for Electronic and Photonic Devices

Session Chairs: **Can Bayram**, Univ. of Illinois at Urbana-Champaign (USA); **Maziar Ghazinejad**, California State Univ., Fresno (USA)

**Two-dimensional material electronics and photonics (Invited Paper)**, Wenjuan Zhu, Univ. of Illinois at Urbana-Champaign (USA) ..... [9552-14]

**Optical selection rule based on valley-exciton locking in monolayer TMDC**, Jun Xiao, Ziliang Ye, Ying Wang, Hanyu Zhu, Yuan Wang, Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9552-15]

**Second-harmonic generation in an atomic phase-matched nonlinear 2D crystal**, Mervin Zhao, Ziliang Ye, Yu Ye, Hanyu Zhu, Yuan Wang, Univ. of California, Berkeley (USA); Yoshihiro Iwasa, The Univ. of Tokyo (Japan); Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9552-16]

**Monolayer tungsten disulfide laser**, Yu Ye, Zi Jing Wong, Univ. of California, Berkeley (USA); Xiufang Lu, Univ. of Science and Technology of China (China); Hanyu Zhu, Yuan Wang, Univ. of California, Berkeley (USA); Xianhui Chen, Univ. of Science and Technology of China (China); Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9552-17]

**Plasmonic gold nanorods enhance the photoluminescence of a two-dimensional molybdenum disulfide (MoS<sub>2</sub>) monolayer**, Min-Hsiung Shih, Kevin Lee, Yi-Huan Chen, Academia Sinica (Taiwan) ..... [9552-18]

**Silicene and germanene: new 2D materials rivals of graphene**, Guy Le Lay, Aix-Marseille Univ. (France) ..... [9552-19]

**Pulsed laser annealing for advanced performance of mechanically flexible and optically transparent multilayer MoS<sub>2</sub> transistors (Invited Paper)**, Hyuk-Jun Kwon, Univ. of California Berkeley (USA); Woong Choi, Kookmin Univ. (Korea, Republic of); Min Suk Oh, Display Convergence Research Center, Korea Electronics Technology Institute (Korea, Republic of); Sunkook Kim, Kyung Hee Univ. (Korea, Republic of); Costas P Grigoropoulos, Univ. of California Berkeley (USA) ..... [9552-20]

**Cavity coupled MoS<sub>2</sub> light sources (Invited Paper)**, Ertugrul Cubukcu, Jason C. Reed, Fei Yi, Hai Zhu, Univ. of Pennsylvania (USA) ..... [9552-21]

**Towards graphene electronics (Invited Paper)**, Eric Borguet, Temple Univ. (USA) ..... [9552-22]

**Tin disulfide: large-area growth and characterization**, Zafer Mutlu, Mihrimah Ozkan, Cengiz S. Ozkan, Univ. of California, Riverside (USA) ..... [9552-23]

**Control of light-matter interaction in 2D atomic crystals (Invited Paper)**, Vinod M. Menon, The City College of New York (USA) ..... [9552-24]

## TUESDAY 11 AUGUST

KEYNOTE SESSION .....TUE 8:00 AM TO 8:30 AM

Session Chairs: **Can Bayram**, Univ. of Illinois at Urbana-Champaign (USA); **Maziar Ghazinejad**, California State Univ., Fresno (USA)

**Plastic events in soft glass materials (Keynote Presentation)**, Roberto Benzi, Univ. degli Studi di Roma "Tor Vergata" (Italy) ..... [9552-25]

SESSION 4.....TUE 8:30 AM TO 10:30 AM

## Devices II

Session Chairs: **Can Bayram**, Univ. of Illinois at Urbana-Champaign (USA); **Maziar Ghazinejad**, California State Univ., Fresno (USA)

**A non-volatile memory based on disordered graphene**, Loïc Loisel, Ecole Polytechnique (France) and Nanyang Technological Univ. (Singapore); Ange Maurice, Nanyang Technological Univ. (Singapore); Bérengère Lebental, Ecole Polytechnique (France) and Institut Français des Sciences et Technologies des Transports de l'aménagement et des Réseaux (France); Stefano Vezzoli, Nanyang Technological Univ. (Singapore); Costel-Sorin Cojocaru, Ecole Polytechnique (France); Beng Kang Tay, Nanyang Technological Univ. (Singapore) ..... [9552-26]

**Plasmonic sensing structure of carbon nanotubes and gold nanoparticles for hydrogen detection**, Marco Angiola, Univ. degli Studi di Padova (Italy); Chris Rutherford, Carbonics, Inc. (USA); Kosmas Galatsis, Univ. of California, Los Angeles (USA); Alessandro Martucci, Univ. degli Studi di Padova (Italy) ..... [9552-27]

**Perfect extinction of terahertz waves in monolayer graphene over 2-nm-wide metallic apertures (Invited Paper)**, Hyeong-Ryeol Park, Univ. of Minnesota Twin Cities (USA); Seon Namgung, Univ. of Minnesota, Twin Cities (USA); Xiaoshu Chen, Univ. of Minnesota Twin Cities (USA); Nathan C Lindquist, Bethel University (USA); Yan Francescato, Vincenzo Giannini, Stefan A Maier, Imperial College London (United Kingdom); Sang-Hyun Oh, Univ. of Minnesota Twin Cities (USA) ..... [9552-28]

**Controlling the functionalization of carbon nanostructures for energy related materials**, Teresa Gatti, Patrizio Salice, Simone Silvestrini, Tommaso Carofiglio, Michele Maggini, Enzo Menna, Univ. degli Studi di Padova (Italy) ..... [9552-29]

**Materials and other needs for advanced phase change memory (Invited Paper)**, Norma E. Sosa, IBM Thomas J. Watson Research Ctr. (USA) ..... [9552-30]

**Photodetector based on carbon nanotubes**, Valeri Timoshenkov, National Research Univ. of Electronic Technology (Russian Federation); Alexandr Pavlov, Evgeni Kitsyuk, Roman Ryazanov, Institute of Nanotechnologies of Microelectronics Russian Academy of Sciences (Russian Federation); Yuri Adamov, National Research Univ. of Electronic Technology (Russian Federation) ..... [9552-31]

SESSION 5.....TUE 10:50 AM TO 1:10 PM

## Synthesis and Characterization II

Session Chairs: **Can Bayram**, Univ. of Illinois at Urbana-Champaign (USA); **Maziar Ghazinejad**, California State Univ., Fresno (USA)

**Wafer-scale single-crystalline graphene and its application for semiconductor layer transfers (Invited Paper)**, Jeehwan Kim, IBM Thomas J. Watson Research Ctr. (USA); Hong Sik Park, Kyungpook National Univ. (Korea, Republic of); Can Bayram, Univ. of Illinois at Urbana-Champaign (USA); Christos D. Dimitrakopoulos, Univ. of Massachusetts Amherst (USA); James Hannon, IBM Thomas J. Watson Research Ctr. (USA) ..... [9552-32]

**Metal-assisted exfoliation (MAE): green process for transferring graphene to flexible substrates and templating of sub-nanometer plasmonic gaps (Invited Paper)**, Aliaksandr V. Zaretski, Brandon C. Marin, Herad Moetamedi, Tyler J Dill, Liban Jibril, Casey Kong, Andrea R. Tao, Darren J. Lipomi, Univ. of California, San Diego (USA) ..... [9552-33]

**Graphene growth on SiC(0001) and SiC(000-1): effect of substrate termination, hydrogen etching, and growth ambient (Invited Paper)**, Zachary R. Robinson, Gell Jernigan, Marc Currie, Jennifer Hite, Konrad Bussmann, U.S. Naval Research Lab. (USA); Luke Nyakiti, Texas A&M Univ. (USA); Nelson Garces, Anindya Nath, Virginia Wheeler, Rachael Myers-Ward, James Wollmershauser, Boris Feygelson, U.S. Naval Research Lab. (USA); James Hannon, IBM T.J. Watson Research Laboratory (USA); D. Kurt Gaskill, Charles Eddy Jr., U.S. Naval Research Lab. (USA) ..... [9552-34]

**Theoretical insights into multibandgap hybrid perovskites for photovoltaic applications (Invited Paper)**, Jacky EVEN, Laurent Pédesseau, Institut National des Sciences Appliquées de Rennes (France); Mikael KEPENEKIAN, Institut des Sciences Chimiques de Rennes (France); Daniel Saporì, Institut National des Sciences Appliquées de Rennes (France); Claudine Katan, Institut des Sciences Chimiques de Rennes (France) ..... [9552-35]

**High aspect ratio CNT structures produced by energetic ion bombardment**, Gregory A. Konesky, National Nanotech, Inc. (USA) ..... [9552-36]

**Large-size CVD graphene for nanoelectronics**, Zhengtang Luo Luo, Hong Kong Univ. of Science and Technology (Hong Kong, China) ..... [9552-37]

**Nanoscale thermocapillarity enabled purification for horizontally aligned arrays of single-walled carbon nanotubes (Invited Paper)**, Sung Hun Jin, Incheon National Univ. (Korea, Republic of) ..... [9552-38]

POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Study of SWCNT functionalization by means of SERS**, Justinas Ceponkus, Martynas Velicka, Milda Pucetaite, Jorinta Jakubauskaite, Valdas Sablinskas, Vilnius Univ. (Lithuania) ..... [9552-6]

**Use of carbon nanotubes as an anti-icing and de-icing material for aircrafts**, Ashwin Kumar Kuchibhotla, Kumar Ravi, Badrinarayanan Vadakkattu Canthadai, B. V. Reddi, Esakkimuthu Murugan, Vidya Jyothi Institute of Technology (India) ..... [9552-39]

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## Low-Dimensional Materials and Devices

Conference Chairs: Nobuhiko P. Kobayashi, Univ. of California, Santa Cruz (USA); A. Alec Talin, Sandia National Labs. (USA); M. Saif Islam, Univ. of California, Davis (USA); Albert V. Davydov, National Institute of Standards and Technology (USA)

Program Committee: Kristine A. Bertness, National Institute of Standards and Technology (USA); Shadi A. Dayeh, Los Alamos National Lab. (USA); Supratik Guha, IBM Thomas J. Watson Research Ctr. (USA); Jung Han, Yale Univ. (USA); Chennupati Jagadish, The Australian National Univ. (Australia); Mutsumi Kimura, Ryukoku Univ. (Japan); Takhee Lee, Gwangju Institute of Science and Technology (Korea, Republic of); Marina S. Leite, Univ. of Maryland, College Park (USA); Francois Leonard, Sandia National Labs., California (USA); Samuel S. Mao, Lawrence Berkeley National Lab. (USA); Sanjay Mathur, Univ. zu Köln (Germany); Samuel T. Picraux, Los Alamos National Lab. (USA); Paola Prete, Istituto per la Microelettronica e Microsistemi (Italy); Sharka M. Prokes, U.S. Naval Research Lab. (USA); Zifeng Ren, Boston College (USA); Atsuhito Sawabe, Aoyama Gakuin Univ. (Japan); Fred Semendy, U.S. Army Research Lab. (USA); Loucas Tsakalakos, GE Global Research (USA); Emanuel Tutuc, The Univ. of Texas at Austin (USA); Lionel Vayssières, Xi'an Jiaotong Univ. (China); George T. Wang, Sandia National Labs. (USA)

### MONDAY 10 AUGUST

#### NANOSCIENCE + ENGINEERING

##### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

- Session Chairs: Satoshi Kawata, Osaka Univ. (Japan); David L. Andrews, Univ. of East Anglia (United Kingdom)
- Extreme Imaging and Beyond (Plenary), Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]
- Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary), Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]
- Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

### WEDNESDAY 12 AUGUST

##### SESSION 1..... WED 8:00 AM TO 10:20 AM

#### 1D Growth and Devices I

- Session Chairs: Nobuhiko P. Kobayashi, Univ. of California, Santa Cruz (USA); M. Saif Islam, Univ. of California, Davis (USA)

Using electric field manipulation to fabricate nanoscale fibers on large areas: a path to electronic and photonic devices (Invited Paper), Jack L Skinner, Montana Tech (USA) ..... [9553-1]

Structural modulation of nanowire interfaces grown over selectively disrupted single crystal surfaces, Elias J Garratt, Babak Nikoobakht, National Institute of Standards and Technology (USA) ..... [9553-2]

Integrated vapor-liquid-solid silicon mass sensors (Invited Paper), Brian A Bryce, NIST (USA); Jason J. Gorman, National Institute of Standards and Technology (USA); Sergiy Keylyuk, National Institute of Science and Technology (USA); Albert Davydov, NIST (USA) ..... [9553-3]

Silicon-Germanium epitaxy for radial nanowire heterostructures (Invited Paper), Yung-Chen Lin, Jinkyung Yoo, Los Alamos National Lab. (USA) ..... [9553-4]

On the MOVPE growth and properties of device-quality GaAs-AlGaAs core-(multi)shell nanowire structures (Invited Paper), Paola Prete, Istituto per la Microelettronica e Microsistemi (Italy); Nico Lovergne, Univ. del Salento (Italy) ..... [9553-5]

Broadband quantum efficiency enhancement in high index nanowires resonators (Invited Paper), Dong Yu, Univ. of California, Davis (USA) ..... [9553-6]

##### SESSION 2..... WED 10:40 AM TO 12:20 PM

#### 1D Growth and Devices II

- Session Chair: A. Alec Talin, Sandia National Labs. (USA)

Ordered arrays of bottom-up III-nitride core-shell nanostructures (Invited Paper), Daniel F. Feezell, Ashwin K. Rishnaramangalam, Rhett Eller, Saadat Mishkat Ul Masabih, Michael Fairchild, Darryl M. Shima, Ganesh Balakrishnan, Steven R. J. Brucek, The Univ. of New Mexico (USA) ..... [9553-7]

Interfacial reactions of gold and tolerance of nanoscale heterojunctions to crystal disorder in surface-directed vapor-liquid-solid growth of nanocrystals (Invited Paper), Babak Nikoobakht, National Institutes of Standards and Technology (USA) ..... [9553-8]

Consequences of quantum size effects in 2D and 1D nano-epitaxy (Invited Paper), Bene Poelsema, University of Twente (Netherlands) ..... [9553-9]

Understanding and controlling III-V nanowire growth at the atomic scale (Invited Paper), Jerry Terhoff, IBM Watson Research Center (USA) ..... [9553-10]

Lunch/Exhibition Break ..... Wed 12:20 pm to 1:50 pm

##### SESSION 3..... WED 1:50 PM TO 3:05 PM

#### 1D Materials and Devices III

- Session Chair: Paola Prete, Istituto per la Microelettronica e Microsistemi (Italy)

Template-assisted synthesis of III-nitride and metal-oxide nano-heterostructures using low-temperature atomic layer deposition for energy, sensing, and catalysis applications (Invited Paper), Necmi Biyiikli, Cagla Ozgut-Akgun, Hamit Eren, Ali Haider, Tamer Uyar, Fatma Kayaci, Mustafa Ozgur Guler, Ruslan Garifullin, Ali K. Okyay, Gamze M. Ulusoy, Eda Goldenberg, Bilkent Univ. (Turkey) ..... [9553-11]

Simultaneous optical and structural investigation of nanomaterials and nanostructures for LEDs (Invited Paper), Marcus Mueller, Otto-von-Guericke Univ. Magdeburg (Germany); Frank Bertram, Gordson Schmidt, Jürgen Christen, Otto-von-Guericke-Univ. Magdeburg (Germany) ..... [9553-12]

Sonochemically grown 1D ZnO nanostructures and their applications (Invited Paper), Yavuz Bayam, Gediz Univ. (Turkey); Debora Rodrigues, Univ. of Houston (USA); Rukayya K. Bala, Gediz Univ. (Turkey); Tugba O. Okyay, Univ. of Houston (USA); Enis E. Tural, Sinem Duyar, Gediz Univ. (Turkey) ..... [9553-13]

##### SESSION 4..... WED 3:35 PM TO 4:40 PM

#### Low-D Structures and Characterization

- Session Chair: Francois Leonard, Sandia National Labs. (USA)

Imaging local electrical and optical responses in nanostructured devices (Invited Paper), Marina S. Leite, Univ. of Maryland, College Park (USA) ..... [9553-14]

Latest advances in low-cost solar water splitting nanodevices (Invited Paper), Lionel Vayssières, Xi'an Jiaotong Univ. (China) ..... [9553-15]

Thermoelectric pellets made of Si nanowires, Kate J Norris, Univ. of California Santa Cruz (USA); Gary S Tompa, Nick M Sbrockey, Structured Materials Industries, Inc. (USA); Nobuhiko P Kobayashi, Univ. of California Santa Cruz (USA) ..... [9553-16]

##### SESSION 5..... WED 4:40 PM TO 5:40 PM

#### OD Materials and Devices

- Session Chair: Albert V. Davydov, National Institute of Standards and Technology (USA)

Resonant spectroscopy of individual CdSe quantum dots containing single Mn<sup>2+</sup> ions in (Zn,Cd)Se barrier, Justyna Piwowar, Wojciech Pacuski, Tomasz Smolenski, Mateusz Goryca, Aleksander M. Bogucki, Andrzej Golnik, Piotr Kossacki, Jan Suffczynski, Univ. of Warsaw (Poland) ..... [9553-17]

Photoluminescence study of the increased hole confinement in CdTe quantum dots, Małgorzata M. Pilat, Univ. of Warsaw (Poland); Lukasz Klopotowski, Piotr Wojnar, Krzysztof Fronc, Grzegorz Karczewski, Tomasz Wojtowicz, Jacek Kosut, Institute of Physics (Poland) ..... [9553-18]

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- HgTe colloidal quantum dot LWIR infrared photodetectors**, Richard E. Pimpinella, Anthony Ciani, Sivananthan Labs., Inc. (USA); Philippe Guyot-Sionnest, The Univ. of Chicago (USA); Christoph H. Grein, Univ. of Illinois at Chicago (USA) ..... [9553-19]
- Novel quantum dot cascade laser**, Ning Zhuo, Feng-Qi Liu, Institute of Semiconductors (China) ..... [9553-20]

## POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

- Fatigue analysis of optimized chevron with Z shape arms**, Margarita Tecpoyotl-Torres, Ramón Cabello-Ruiz, Jose Gerardo Vera-Dimas, Alejandra Ocampo Díaz, Univ. Autónoma del Estado de Morelos (Mexico) ..... [9553-43]

- Structural and electrical properties of zinc oxide doped with aluminium oxide thin films prepared via atomic layer deposition**, Baojun Yan, Shulin Liu, Institute of High Energy Physics (China) ..... [9553-44]

- Charge trapping and recombination in Ge nanoislands grown on Si (001)**, Anastasiia A. Mykytiuk, Sergey V. Kondratenko, National Taras Shevchenko Univ. of Kyiv (Ukraine); Yu. N. Kozyrev, Chuiko Institute of Surface Chemistry (Ukraine); Volodymyr S. Lysenko, V.E. Lashkaryov Institute of Semiconductor Physics (Ukraine) ..... [9553-45]

- Logic gates based on nonlinear light interaction in subwavelength discrete systems**, Gregorio Mendoza González, Erwin A. Martí Panameño, Benemérita Univ. Autónoma de Puebla (Mexico) ..... [9553-46]

- Raman spectroscopy studying of guanajuatite (Bi<sub>2</sub>Se<sub>3</sub>): natural topological insulator**, Małgorzata M. Pilat, Katarzyna Gólska, Małgorzata Grzeszczyk, Adam Babinski, Univ. of Warsaw (Poland) ..... [9553-47]

## THURSDAY 13 AUGUST

### SESSION 6 ..... THU 8:00 AM TO 10:00 AM

#### 2D Materials and Devices I

Session Chairs: **M. Saif Islam**, Univ. of California, Davis (USA); **A. Alec Talin**, Sandia National Labs. (USA)

- Physics of artificially-engineered AlGaN and InGaN based digital alloys**, Wei Sun, Chee-Keong Tan, Nelson Tansu, Lehigh Univ. (USA) ..... [9553-21]

- Electrical generation and control of valley carrier in monolayer TMDC**, Yu Ye, Xiaobo Yin, Univ. of California, Berkeley (USA); Hailong Wang, Institute of Semiconductors (China); Ziliang Ye, Hanyu Zhu, Yuan Wang, Univ. of California, Berkeley (USA); Jianhua Zhao, Institute of Semiconductors (China); Xiang Zhang, Univ. of California, Berkeley (USA) ..... [9553-22]

- Optical study of interlayer coupling and stacking-dependent electronic structure in MoS<sub>2</sub>**, Ze-Xiang Shen, Jiaxu Yan, Juan Xia, Zheng Liu, Nanyang Technological Univ. (Singapore) ..... [9553-23]

- The role of ultra-thin SiO<sub>2</sub> layers in metal-insulator-semiconductor (MIS) photoelectrochemical devices** (*Invited Paper*), Daniel V. Esposito, Columbia Univ. (USA) ..... [9553-24]

- Challenges and future perspectives in HVPE-GaN growth** (*Invited Paper*), Michal Bockowski, Institute of High Pressure Physics (Poland) and TopGaN Ltd. (Poland) ..... [9553-25]

- Functional 2-dimensional nanomaterial inks for photonics and (opto) electronics** (*Invited Paper*), Tawfique Hasan, Univ. of Cambridge (United Kingdom) ..... [9553-26]

### SESSION 7 ..... THU 10:20 AM TO 11:50 AM

#### 2D Materials and Devices II

Session Chairs: **Sharka M. Prokes**, U.S. Naval Research Lab. (USA); **Babak Nikoobakht**, NanoRods, LLC (USA)

- Synthesis of one-dimentional nanostructures for gas sensing and photovoltaic applications** (*Invited Paper*), Hakan Karaagac, Istanbul Technical Univ. (Turkey) ..... [9553-27]

- Flexible and stackable non-volatile resistive memory for high integration** (*Invited Paper*), Shawkat Ali, Jinho Bae, Chong Hyun Lee, Jeju National Univ. (Korea, Republic of) ..... [9553-28]

- Nanoscale characterization and modeling of the variability in metal oxide resistive switching memory** (*Invited Paper*), Matthew J. Marinella, David R. Hughart, Patrick R. Mickel, Stephen W. Howell, Ed Bielejec, George Vizkelethy, Jose L. Pacheco, Rudeger H.T. Wilke, Sapan Agarwal, Conrad D. James, Sandia National Labs. (USA) ..... [9553-29]

- Tantalum oxide nanoscale resistive switching devices: TEM/EELS study**, Kate J Norris, Univ of California Santa Cruz (USA); Jiaming Zhang, Emmanuelle Merced-Grafals, Sriranya Musunuru, Max Zhang, Katy Samuels, Hewlett-Packard Labs. (USA); Jianhua J Yang, Hewlett-Packard Laboratories (USA); Nobuhiko P Kobayashi, Univ of California Santa Cruz (USA) ..... [9553-30]

Lunch/Exhibition Break ..... Thu 11:50 am to 1:20 pm

### SESSION 8 ..... THU 1:20 PM TO 3:25 PM

#### Low-D Optoelectronics

Session Chairs: **Albert V. Davydov**, National Institute of Standards and Technology (USA); **Nobuhiko P. Kobayashi**, Univ. of California, Santa Cruz (USA)

- Extended defect structures observed in (Al<sub>x</sub>Ga<sub>1-x</sub>)<sub>0.5</sub>In<sub>0.5</sub>P light emitting diodes grown by MOVPE** (*Invited Paper*), Andreas Rudolph, OSRAM Opto Semiconductors GmbH (Germany) ..... [9553-31]

- Electrically injected AlGaN nanowire deep ultraviolet lasers** (*Invited Paper*), Zetian Mi, McGill Univ. (Canada) ..... [9553-32]

- Selective area metal-organic vapor-phase epitaxy growth of InP nanowires for optoelectronic device applications** (*Invited Paper*), Lan Fu, Australian National Univ (Australia); Q. Gao, The Australian National Univ. (Australia); F. Wang, Y. Guo, Australian National Univ (Australia); Z. Y. Li, K. Peng, L. Li, K. Vora, The Australian National Univ. (Australia); H. H. Tan, Australian National Univ (Australia); C. Jagadish, The Australian National Univ. (Australia) ..... [9553-33]

- Engineering heterojunctions with carbon nanostructures: towards high-performance optoelectronics** (*Invited Paper*), Judy Z Wu, Univ of Kansas (USA) ..... [9553-34]

- Optoelectronics in two-dimensional semiconductor alloys** (*Invited Paper*), François Léonard, Sandia National Labs. (USA) ..... [9553-35]

### SESSION 9 ..... THU 3:45 PM TO 5:40 PM

#### Novel Low-D Structures

Session Chairs: **Daniel V. Esposito**, Columbia Univ. (USA); **Lan Fu**, The Australian National Univ. (Australia)

- Formation and properties of 3D metamaterial composites fabricated using nanometer scale laser lithography** (*Invited Paper*), Sharka M. Prokes, Frank K. Perkins, Orest J. Glembotck, U.S. Naval Research Lab. (USA) ..... [9553-36]

- Observation of direct electron-electron interaction in suspended MQW structures**, Iman Hassani Nia, Sung Jun Jang, Hooman Mohseni, Northwestern Univ. (USA) ..... [9553-37]

- Chemical modification approaches for improved performance of Na-ion battery electrodes**, Bryan Byles, Mallory Clites, Ekaterina Pomerantseva, Drexel Univ. (USA) ..... [9553-38]

- Deposition and characterizations of ultrasmooth silver thin films assisted with a germanium wetting layer**, Junce Zhang, David M. Fryauf, Matthew P. Garrett, Univ. of California, Santa Cruz (USA); Logeeswaran Veerayah Jayaraman, Univ. of California, Davis (USA); Atsuhito Sawabe, Aoyama Gakuin Univ. (Japan); M. Saif Islam, Univ. of California, Davis (USA); Nobuhiko P. Kobayashi, Univ. of California, Santa Cruz (USA) ..... [9553-39]

- Thin film thermoelectric metal-organic framework with high Seebeck coefficient and low thermal conductivity**, Kristopher J. Erickson, Francois Leonard, Vitalie N. Stavila, Michael E. Foster, Catalin D. Spataru, Reese Jones, Sandia National Labs. (USA); Brian Foley, Patrick Hopkins, Univ. of Virginia (USA); Mark D. Allendorf, A. Alec Talin, Sandia National Labs. (USA) ..... [9553-40]

- High-throughput screening of substrates for synthesis and functionalization of 2D materials**, Arunima Singh, Albert V Davydov, Francesca Tavazza, National Institute of Standards and Technology (USA); Kiran Mathew, Cornell Univ. (USA); Richard Hennig, Univ. of Florida (USA) ..... [9553-41]

- Titanium hafnium oxide alloys: study of the dependence of microstructures and optical properties on RF substrate bias during deposition**, Juan Jose Diaz Leon, Matthew P Garrett, David M Fryauf, Junce Zhang, Kate J Norris, Univ of California Santa Cruz (USA); Sharka M. Prokes, U.S. Naval Research Lab. (USA); Nobuhiko P Kobayashi, Univ of California Santa Cruz (USA) ..... [9553-42]

# CONFERENCE 9554

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Sunday-Wednesday 9–12 August 2015 • Proceedings of SPIE Vol. 9554

## Nanoimaging and Nanospectroscopy III

Conference Chairs: **Prabhat Verma**, Osaka Univ. (Japan); **Alexander Egner**, Laser-Lab. Göttingen e.V. (Germany)

Program Committee: **Balpreet Singh Ahluwalia**, Univ. of Tromsø (Norway); **Joerg Bewersdorf**, Yale School of Medicine (USA); **Alberto Diaspro**, Istituto Italiano di Tecnologia (Italy); **Christian Eggeling**, Univ. of Oxford (United Kingdom); **Joerg Enderlein**, Georg-August-Univ. Göttingen (Germany); **Katsumasa Fujita**, Osaka Univ. (Japan); **Stefan W. Hell**, Max-Planck-Institut für Biophysikalische Chemie (Germany); **Samuel Hess**, Univ. of Maine (USA); **Bo Huang**, Univ. of California, San Francisco (USA); **Satoshi Kawata**, Osaka Univ. (Japan); **Thomas A. Klar**, Johannes Kepler Univ. Linz (Austria); **Alfred J. Meixner**, Eberhard Karls Univ. Tübingen (Germany); **Peter Nordlander**, Rice Univ. (USA); **Bruno Pettinger**, Fritz-Haber-Institut der Max-Planck-Gesellschaft (Germany); **Markus B. Raschke**, Univ. of Colorado at Boulder (USA); **Bin Ren**, Xiamen Univ. (China); **Vahid Sandoghdar**, Max-Planck-Institut für die Physik des Lichts (Germany); **Markus Sauer**, Julius-Maximilians-Univ. Würzburg (Germany); **Yung Doug Suh**, Korea Research Institute of Chemical Technology (Korea, Republic of); **Din Ping Tsai**, National Taiwan Univ. (Taiwan); **Renato Zenobi**, ETH Zürich (Switzerland); **Xiaowei Zhuang**, Harvard Univ. (USA)

### SUNDAY 9 AUGUST

SESSION 1 ..... SUN 8:30 AM TO 10:15 AM

#### Super Resolution Microscopy I

Session Chair: **Prabhat Verma**, Osaka Univ. (Japan)

New results on the single molecule localization problem in two and three dimensions (*Invited Paper*), Raimund J. Ober, Texas A&M Univ (USA) . . . [9554-53]

Super-resolution imaging of plasmonic nanostructures (*Invited Paper*), Katherine A. Willets, Temple Univ. (USA) . . . . . [9554-2]

Transient absorption microscopy for label-free super-resolution Imaging (*Invited Paper*), Christophe Silien, Ning Liu, University of Limerick (Ireland); Aladin Mani, LaserSpec (Belgium); Susan Daly, Mahendar Kumbham, Kevin O'Dwyer, University of Limerick (Ireland); Paolo Bianchini, Alberto Diaspro, Istituto Italiano di Tecnologia (IIT) (Italy); Yurij Fedutik, Alexei Antipov, PlasmaChem GmbH (Germany); Syed A.M. Tofail, University of Limerick (Ireland); André Peremans, Laserspec (Belgium) . . . . . [9554-3]

Developments in fluorescence nanoscopy, Alexander Egner, Claudia Geisler, Haugen Grefe, Jennifer Schubert, Laser-Lab. Göttingen e.V. (Germany) . . . [9554-4]

isoSTED microscopy in living cells, Rene Siegmund, Claudia Geisler, Alexander Egner, Laser-Laboratory Göttingen e.V. (Germany) . . . . . [9554-5]

SESSION 2 ..... SUN 10:45 AM TO 12:15 PM

#### Tip-Enhanced Raman Spectroscopy/ Microscopy I

Session Chair: **Debdulal Roy**, National Physical Lab. (United Kingdom)

Expanding the horizon of plasmon-enhanced Raman spectroscopy: from SERS to SHINERS, TERS, and EERS (*Invited Paper*), Jian-Feng Li, Yi-Fan Huang, Song-Yuan Ding, Zhi-Lin Yang, De-Yin Wu, Bin Ren, Zhong-Qun Tian, Xiamen Univ. (China) . . . . . [9554-6]

Photo induced force microscopy: nanoscale imaging of optical polarizability (*Invited Paper*), Hemantha K. Wickramasinghe, Univ. of California, Irvine (USA) . . . . . [9554-7]

Experimental correlation of electric fields and Raman signals in SERS and TERS (*Invited Paper*), Zachary D. Schultz, Hao Wang, Daniel T. Kwasnieski, James M. Marr, Univ. of Notre Dame (USA) . . . . . [9554-8]

Nano-antenna-controlled tunable enhancement in tip-enhanced Raman spectroscopy, Prabhat Verma, Osaka Univ. (Japan) . . . . . [9554-9]

Lunch Break . . . . . Sun 12:15 pm to 1:45 pm

SESSION 3 ..... SUN 1:45 PM TO 3:15 PM

#### Spectroscopy at Nanoscale

Session Chair: **Alexander Egner**, Laser-Lab. Göttingen e.V. (Germany)

Nanospectroscopy for nano-chemistry and nanostructures (*Invited Paper*), Debdulal Roy, National Physical Lab. (United Kingdom) . . . . . [9554-10]

Seeing molecular vibrations: chemical imaging for biomedicine (*Invited Paper*), Wei Min, Columbia Univ. (USA) . . . . . [9554-11]

Infrared near-field nanospectroscopy: chemical identification, nanoellipsometry, and nanotomography (*Invited Paper*), Alexander A. Govyadinov, CIC nanoGUNE Consolider (Spain) . . . . . [9554-12]

Investigation of surface plasmons in nano-squares using electron energy loss spectroscopy, Yue Zhang, Rice Univ. (USA); Edson Bellido Sosa, McMaster Univ. (Canada); Alejandro Manjavacas, Yang Cao, Rice Univ. (USA); Gianluigi A. Botton, McMaster Univ. (Canada); Peter Nordlander, Rice Univ. (USA) . . . . . [9554-13]

SESSION 4 ..... SUN 3:45 PM TO 5:30 PM

#### New Techniques for Nanoimaging and Nanospectroscopy I

Session Chair: **Katsumasa Fujita**, Osaka Univ. (Japan)

Accelerating beams for advanced imaging in biomedicine (*Invited Paper*), Kishan Dholakia, Univ. of St. Andrews (United Kingdom) . . . . . [9554-14]

Nanophotonic measurement of the dark fraction in red fluorescent proteins (*Invited Paper*), Jord C. Prangsma, Robert Molenaar, Christian Blum, Univ. Twente (Netherlands); Vinod Subramaniam, FOM Institute for Atomic and Molecular Physics (Netherlands) . . . . . [9554-15]

Supercritical angle fluorescence for absolute super-localization nanoscopy (*Invited Paper*), Nicolas Bourg, Institut des Sciences Moléculaires d'Orsay (France); Guillaume Dupuis, Sandrine Lécart, Univ. Paris-Sud 11 (France); Emmanuel Fort, Institut Langevin (France); Sandrine Lévéque-Fort, Institut des Sciences Moléculaires d'Orsay (France) . . . . . [9554-16]

Optical coherence tomography for nanoparticles quantitative characterization, Michał Trojanowski, Maciej Kraszewski, Marcin R. Strąkowski, Jerzy Pluciński, Gdańsk Univ. of Technology (Poland) . . . . . [9554-17]

Microscopic ellipsometry image of microspheres on a substrate, Fu-Chen Hsiao, Yu-Da Chen, Buu Trong H. Ngo, Huai-Yi Xie, Yia-Chung Chang, Academia Sinica (Taiwan) . . . . . [9554-18]

### SYMPOSIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)  
**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

### MONDAY 10 AUGUST

#### NANO SCIENCE + ENGINEERING PLENARY SESSION ..... MON 9:15 AM TO 12:00 PM

Session Chairs: **Satoshi Kawata**, Osaka Univ. (Japan); **David L. Andrews**, Univ. of East Anglia (United Kingdom)

Extreme Imaging and Beyond (*Plenary*), Keisuke Goda, The Univ. of Tokyo (Japan) . . . . . [9544-500]

Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (*Plenary*), Reuven Gordon, Univ. of Victoria (Canada) . . . . . [9544-501]

Device Applications of Semiconductor Nanoantennas and Metalfilms (*Plenary*), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) . . . . . [9544-502]

Lunch/Exhibition Break . . . . . Mon 12:00 pm to 1:30 pm

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SESSION 5..... MON 1:30 PM TO 3:40 PM

## Super Resolution Microscopy II

Session Chair: **Martin J. Booth**, Univ. of Oxford (United Kingdom)

**Nanoscopy of thick specimens using adaptive optics (Invited Paper)**, Martin J. Booth, Univ. of Oxford (United Kingdom) ..... [9554-1]

**Optimizing STED and single-molecule switching nanoscopy for biological applications (Invited Paper)**, Edward Allgeyer, Xiang Hao, Fang Huang, Emil Kromann, Yu Lin, Mary Grace Velasco, Yongdeng Zhang, Joerg Bewersdorf, Yale Univ. (USA) ..... [9554-19]

**Quantitative high spatiotemporal resolution imaging of biological processes (Invited Paper)**, Melike Lakadamyali, ICFO - Institut de Ciències Fotòniques (Spain) ..... [9554-20]

**Optical nanoscopy to reveal structural and functional properties of liver cells (Invited Paper)**, Peter McCourt, UiT The Arctic Univ. of Norway (Norway); Thomas R. Huser, Univ. Bielefeld (Germany); Karen K. Sørensen, Cristina I. Øie, UiT The Arctic Univ. of Norway (Norway); Viola Mönkemöller, Univ. of Bielefeld (Germany); Balpreet S. Ahluwalia, UiT The Arctic Univ. of Norway (Norway) ..... [9554-21]

**Chip-based optical microscopy for imaging membrane sieve plates of liver scavenger cells**, Øystein I. Helle, Cristina I. Øie, Peter McCourt, Balpreet S. Ahluwalia, UiT The Arctic Univ. of Norway (Norway) ..... [9554-22]

**Nanoscopic lithography and applications**, Jaroslaw Jacak, Richard Wollhofen, Thomas A. Klar, Johannes Kepler Univ. Linz (Austria) ..... [9554-23]

SESSION 6..... MON 4:00 PM TO 5:45 PM

## New Techniques for Nanoimaging and Nanospectroscopy II

Session Chair: **Kishan Dholakia**, Univ. of St. Andrews (United Kingdom)

**Visualisation of plasmonic fields at the nanoscale with single molecule localisation microscopy (Invited Paper)**, Christian Steuwe, KU Leuven (Belgium) and Univ. of Cambridge (United Kingdom); Miklos Erdelyi, Univ. of Cambridge (United Kingdom); Gabor Szekeres, Mária Csete, Univ. of Szeged (Hungary); Jeremy J. Baumberg, Univ. of Cambridge (United Kingdom); Sumeet Mahajan, Univ. of Southampton (United Kingdom); Clemens F. Kaminski, Univ. of Cambridge (United Kingdom) ..... [9554-24]

**Visible-wavelength two-photon excitation microscopy (Invited Paper)**, Katsumasa Fujita, Masahito Yamanaka, Kumiko Uegaki, Yoshiyuki Arai, Kenta Saito, Nicholas I. Smith, Yasuo Yonemaru, Kentaro Mochizuki, Satoshi Kawata, Takeharu Nagai, Osaka Univ. (Japan) ..... [9554-25]

**Resolution enhancement in a double-helix phase engineered scanning microscope (RESCH microscope) (Invited Paper)**, Alexander Jesacher, Monika Ritsch-Marte, Medizinische Univ. Innsbruck (Austria); Rafael Piestun, Univ. of Colorado at Boulder (USA) ..... [9554-26]

**Nonlinear fluorescence probe using photoinduced charge separation**, Kentaro Mochizuki, Lanting Shi, Shin Mizukami, Masahito Yamanaka, Osaka Univ. (Japan); Mamoru Tanabe, FUJIFILM Corp. (Japan); Wei-Tao Gong, Almar F. Paloppon, Shogo Kawano, Satoshi Kawata, Kazuya Kikuchi, Katsumasa Fujita, Osaka Univ. (Japan) ..... [9554-27]

**A new method of single-particle spectroscopy with optical microresonators**, Kevin Heylman, Randall H. Goldsmith, Cassandra A. Knapper, Erik Horak, Univ. of Wisconsin-Madison (USA) ..... [9554-28]

TUESDAY 11 AUGUST

SESSION 7..... TUE 8:00 AM TO 9:55 AM

## Tip-enhanced Raman Spectroscopy/ Microscopy II

Session Chair: **Zachary D. Schultz**, Univ. of Notre Dame (USA)

**Electrochemical tip-enhanced Raman spectroscopy (Invited Paper)**, Zhicong Zeng, Shengchao Huang, Tengxiang Huang, Maohua Li, Bin Ren, Xiamen Univ. (China) ..... [9554-29]

**Nanoscale chemical identification of different molecular species by plasmon enhanced Raman spectroscopy (Invited Paper)**, Zhenchao Dong, Univ. of Science and Technology of China (China) ..... [9554-30]

**Tip-enhanced Raman spectroscopy in graphene and GaN nanostructures (Invited Paper)**, Janina Maultzsch, Technische Univ. Berlin (Germany) ..... [9554-31]

**Polarization analysis in near-field Raman spectroscopy (Invited Paper)**, Yuika Saito, Toshihiro Mino, Prabhat Verma, Osaka Univ. (Japan) ..... [9554-32]

**Fast reproducible TERS imaging for real world applications**, Dmitry Evllov, Vasily Gavriluk, Andrey Krayev, Sergey Saunin, AIST-NT Inc. (USA) ..... [9554-33]

SESSION 8..... TUE 10:30 AM TO 12:05 PM

## Surface Enhanced Spectroscopy

Session Chair: **Bin Ren**, Xiamen Univ. (China)

**Molecule-to-nanoantenna coupling investigated by polarization-sensitive SERS (Invited Paper)**, Pietro G. Gucciardi, Consiglio Nazionale delle Ricerche (Italy) ..... [9554-34]

**Multi-targeting SERS bio-imaging (Invited Paper)**, Aiguo Shen, Jiming Hu, Wuhan Univ. (China) ..... [9554-35]

**Fan-shaped gold nanoantennas above reflective substrates for surface-enhanced infrared absorption (SEIRA)**, Xiao Yang, Lisa V. Brown, Ke Zhao, Bob Y. Zheng, Peter Nordlander, Naomi J. Halas, Rice Univ. (USA) ..... [9554-36]

**Shell-isolated nanoparticle-enhanced Raman spectroscopy: principle and applications**, Jian-Feng Li, Zhong-Qun Tian, Xiamen Univ. (China) ..... [9554-37]

**Dynamic placement of plasmonic hotspots for super-resolution chemical imaging**, Nathan C. Lindquist, Christopher T. Ertsgaard, Rachel M. McKoskey, Isabel S. Rich, Bethel Univ. (USA) ..... [9554-38]

Lunch/Exhibition Break ..... Tue 12:05 pm to 1:35 pm

SESSION 9..... TUE 1:35 PM TO 3:30 PM

## Plasmonics for Nanospectroscopy

Session Chair: **Pietro G. Gucciardi**, Consiglio Nazionale delle Ricerche (Italy)

**Nanospectroscopy of hybrid metallic-inorganic and metallic-organic systems (Invited Paper)**, Monika Fleischer, Eberhard Karls Univ. Tübingen (Germany) ..... [9554-39]

**Live cell imaging using Au-NNP (Nanobridged Nanogap Particles) (Invited Paper)**, Yung Doug Suh, Korea Research Institute of Chemical Technology (Korea, Republic of) ..... [9554-40]

**Morphologically controlled devices for SERS/TERS-like applications at the nanoscale (Invited Paper)**, Remo Proietti Zaccaria, Istituto Italiano di Tecnologia (Italy) ..... [9554-41]

**Magnetic plasmonic Fano resonance at optical frequency (Invited Paper)**, Zheyu Fang, Yanjun Bao, Peking Univ. (China) ..... [9554-42]

**Metallic nanorods array for magnified subwavelength imaging**, Yoshiro Ohashi, Bikas Ranjan, Yuika Saito, Prabhat Verma, Osaka Univ. (Japan) ..... [9554-43]

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SESSION 10.....TUE 4:00 PM TO 5:15 PM

## Nanoimaging and Nanospectroscopy in Graphene

Session Chair: **Janina Maultzsch**, Technische Univ. Berlin (Germany)

**Raman identification of edge misalignment of bilayer graphene down to the nanometer scale (Invited Paper)**, Ping-Heng Tan, Institute of Semiconductors (China) .....

[9554-44]

**Space and time localization of the Raman scattering in graphene systems (Invited Paper)**, Ado Jorio, Univ. Federal de Minas Gerais (Brazil) .....

[9554-45]

**Nonlinear photo-oxidation of graphene and carbon nanotubes probed by four wave mixing imaging and spectroscopy (Invited Paper)**, Mika Pettersson, Jukka Aumanen, Andreas Johansson, Juha Koivisto, Pasi Myllyperkiö, Univ. of Jyväskylä (Finland) .....

[9554-46]

## WEDNESDAY 12 AUGUST

POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Corrugated metal probe for tip enhanced spectroscopy with directional enhanced spontaneous emission**, Guowei Lu, Hongming Shen, Qihuang Gong, Peking Univ. (China) .....

[9554-47]

**Multiplexed label-free detection of single proteins**, Aleksandar Sebesta, Alexander Weigel, Philipp Kukura, Univ. of Oxford (United Kingdom) .....

[9554-48]

**Spectral analysis of photonic nanojet and exploring different microstructures with jet-like photonic beam for imaging applications**, Mohsen Rezaei, Alireza Bonakdar, Hooman Mohseni, Northwestern Univ. (USA) .....

[9554-49]

**Photo-induced magnetic force using nano probes**, Cansu Guclu, Univ of California Irvine (USA); Venkata A. Tamma, H. Kumar Wickramasinghe, Filippo Capolino, Univ. of California, Irvine (USA) .....

[9554-50]

**Shell-isolated silver nanoparticles for plasmon-enhanced spectroscopies**, Chaoyu Li, Meng Meng, Shaorong Huang, Jianfeng Li, Zhongqun Tian, Xiamen Univ. (China) .....

[9554-51]

**Nanodiamonds as cellular marker for super-resolution STED-TEM correlative microscopy**, Neeraj Prabhakar, Åbo Akademi Univ. (Finland) .....

[9554-52]

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# Optical Sensing, Imaging, and Photon Counting: Nanostructured Devices and Applications

*Conference Chairs:* Manijeh Razeghi, Northwestern Univ. (USA); Dorota S. Temple, RTI International (USA)*Conference Co-Chair:* Gail J. Brown, Air Force Research Lab. (USA)*Program Committee:* Ravi Athale, Office of Naval Research (USA); James W. Beletic, Teledyne Imaging Sensors (USA); Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc. (USA); Takeharu Goji Etoh, Ritsumeikan Univ. (Japan); Christoph H. Grein, Univ. of Illinois at Chicago (USA); Carl Jackson, SensL (Ireland); Gerasimos Konstantatos, ICFO - Institut de Ciències Fotòniques (Spain); Jay Lewis, Defense Advanced Research Projects Agency (USA); Aizhen Li, Shanghai Institute of Microsystem and Information Technology (China); Ryan McClintock, Northwestern Univ. (USA); Hooman Mohseni, Northwestern Univ. (USA); Philip Perconti, U.S. Army Research Lab. (USA); Usha Varshney, National Science Foundation (USA); Yong-Hang Zhang, Arizona State Univ. (USA)

## TUESDAY 11 AUGUST

**SESSION 1 ..... TUE 1:30 PM TO 3:00 PM**

### UV Detectors and Focal Plane Arrays

Session Chairs: Manijeh Razeghi, Northwestern Univ. (USA); Dorota S. Temple, RTI International (USA)

**Solar-blind photodetectors and focal plane arrays based on AlGaN**, Ryan McClintock, Northwestern Univ. (USA) [9555-1]**Ar+ ion implantation for demonstration of solar-blind AlGaN ultraviolet photodetectors**, John Bulmer, Jeffrey M. Leathersich, Jonathan Marini, Isra Mahabob, Neil Newman, Fatemah Shadi Shahedipour-Sandvik, SUNY CNSE/SUNYIT (USA); L. Douglas Bell, John Hennessy, Shouleh Nikzad, Jet Propulsion Lab. (USA) [9555-2]**Growth of AlGaN on silicon substrates: a novel way to make back-illuminated ultraviolet photodetectors** (*Invited Paper*), Ryan McClintock, Manijeh Razeghi, Northwestern Univ. (USA) [9555-3]**Ultraviolet avalanche photodiodes**, Ryan McClintock, Manijeh Razeghi, Northwestern Univ. (USA) [9555-4]**SESSION 2 ..... TUE 3:30 PM TO 6:00 PM**

### IR Detectors and Focal Plane Arrays: Colloidal Quantum Dots and Superlattices

Session Chairs: Philip Perconti, U.S. Army Research Lab. (USA); Gail J. Brown, Air Force Research Lab. (USA)

**Colloidal quantum dots for mid-infrared detection** (*Invited Paper*), Philippe Guyot-Sionnest, The Univ. of Chicago (USA) [9555-5]**Colloidal quantum dot Vis-SWIR imaging: demonstration of a focal plane array and camera prototype** (*Invited Paper*), Ethan J. D. Klem, Christopher W. Gregory, Dorota S. Temple, Jay S. Lewis, RTI International (USA) [9555-6]**Colloidal quantum dot photodetectors** (*Invited Paper*), Valerio Adinolfi, Edward H. Sargent, Univ. of Toronto (Canada) [9555-7]**Superlattice infrared photodetector research at the jet propulsion laboratory** (*Invited Paper*), Sarath D. Gunapala, David Z. Y. Ting, Alexander Soibel, Sir B. Rafol, Arezou Khoshakhlagh, Linda Höglund, Cory J. Hill, Sam A. Keo, John K. Liu, Jason M. Mumolo, Edward M. Luong, Jet Propulsion Lab. (USA) [9555-8]**Identification of point defect candidates in strained-layer type-II superlattices for infrared detectors: ab initio electronic structure studies** (*Invited Paper*), Nicholas Kioussis, California State Univ., Northridge (USA) [9555-9]

## WEDNESDAY 12 AUGUST

**SESSION 3 ..... WED 8:00 AM TO 10:00 AM**

### Avalanche Photodiodes and Single-Photon Detectors

Session Chairs: Jay S. Lewis, Defense Advanced Research Projects Agency (USA); Martina Baeumer, Fraunhofer-Institut für Angewandte Festkörperphysik (Germany)

**III-V strain layer superlattice based band engineered avalanche photodiodes** (*Invited Paper*), Sid Ghosh, Raytheon Space and Airborne Systems (USA) [9555-10]**Single photon imaging hybrid test electron-injection detectors with in-pixel ADC**, Farah Fahim, Northwestern Univ. (USA); Grzegorz Deptuch, Fermi National Accelerator Lab. (USA); Hooman Mohseni, Northwestern Univ. (USA) [9555-11]**Recent progress in high gain InAs avalanche photodiodes** (*Invited Paper*), Seth Bank, Scott J. Maddox, The Univ. of Texas at Austin (USA); Wenlu Sun, Univ. of Virginia (USA); Hari P. Nair, The Univ. of Texas at Austin (USA); Joe C. Campbell, Univ. of Virginia (USA) [9555-12]**Evaluation of different processing steps on the dark current of electron-injection detectors**, Mohsen Rezaei, Sung Jun Jang, Hooman Mohseni, Northwestern Univ. (USA) [9555-13]**Effect of temperature on superconducting nanowire single-photon detector noise**, Andrea Bahgat Shehata, Alessandro Ruggeri, Franco Stellari, Alan J. Weger, Peilin Song, IBM Thomas J. Watson Research Ctr. (USA); Kristen Sunter, Karl K. Berggren, Massachusetts Institute of Technology (USA); Vikas Anant, Photon Spot, Inc. (USA) [9555-14]**SESSION 4 ..... WED 10:30 AM TO 12:20 PM**

### Optical Sensors and Imagers for IR, and THz

Session Chairs: James W. Beletic, Teledyne Imaging Sensors (USA); Richard D. Schaller, Argonne National Lab. (USA)

**IR CMOS: near infrared enhanced digital imaging** (*Invited Paper*), Martin U. Pralle, James E. Carey, Thomas Joy, Chris J. Vineis, Chintamani Palusule, SiOnyx Inc. (USA) [9555-15]**Si based mid-infrared GeSn photo detectors and light emitters on silicon substrates** (*Invited Paper*), Shui-Qing Yu, Wei Du, Benjamin R. Conley, Seyed A. Ghettimi, Aboozar Mosleh, Thach Pham, Perry Grant, Yiyin Zhou, Huong Tran, Sattar Al Kabi, Univ. of Arkansas (USA); Amjad Nazzal, Wilkes Univ. (USA); Greg Sun, Richard A. Soref, Univ. of Massachusetts Boston (USA); Joe Margetis, John Tolle, ASM America Inc. (USA); Baohua Li, Arktonics, LLC (USA); Hameed A. Naseem, Univ. of Arkansas (USA) [9555-16]**Optical absorption in 3D topological insulator Bi<sub>2</sub>Te<sub>3</sub> with applications to THz detectors**, Parijat Sengupta, Enrico Bellotti, Boston Univ. (USA) [9555-17]**Design tradeoffs of II-VI and III-V superlattices for VLWIR sensing** (*Invited Paper*), Gail J. Brown, Frank Szmulowicz, Air Force Research Lab. (USA) [9555-18]

Lunch/Exhibition Break ..... Wed 12:20 pm to 1:50 pm

# CONFERENCE 9555

SESSION 5 ..... WED 1:50 PM TO 3:30 PM

## Modeling and Spectroscopy of Nanostructured Optical Sensors

Session Chairs: Arvind I. D'Souza, DRS Sensors & Targeting Systems, Inc. (USA); Yong-Hang Zhang, Arizona State Univ. (USA)

**Full-band structure modeling of the radiative and non-radiative properties of semiconductor materials and devices (Invited Paper)**, Enrico Bellotti, Hanqing Wen, Benjamin Pinkie, Masahiko Matsubara, Boston Univ. (USA); Francesco Bertazzi, Politecnico di Torino (Italy) ..... [9555-19]

**Three-dimensional numerical modeling for ultra-sensitive noninvasive size-dependent nanoparticle detection technique using subwavelength silicon microcavities**, Jeffrey P. Dionne, Lyuba Kuznetsova, San Diego State Univ. (USA) ..... [9555-20]

**Electro-optical characteristics of p+n In<sub>0.53</sub>Ga<sub>0.47</sub>As photodiodes in large format dense focal plane arrays (Invited Paper)**, Roger E. DeWames, FulcrumIT (USA); Kyle Witte, Patrick G. Maloney, U.S. Army Night Vision & Electronic Sensors Directorate (USA); Adam R. Wichman, Enrico Bellotti, Boston Univ. (USA) [9555-21]

**Real-time baseline correction technique for MWIR and LWIR time-resolved photoluminescence spectroscopy**, Zhi-Yuan Lin, Yong-Hang Zhang, Arizona State Univ. (USA) ..... [9555-22]

SESSION 6 ..... WED 4:00 PM TO 5:50 PM

## Advanced ROIC and Imager Concepts

Session Chairs: Hooman Mohseni, Northwestern Univ. (USA); Philippe Guyot-Sionnest, The Univ. of Chicago (USA)

**Benefits of small pixel focal plane array technology (Invited Paper)**, John T. Caulfield, Jon Paul Curzan, Cyan Systems (USA) ..... [9555-23]

**Design methodology: ASICs with complex in-pixel processing for pixel detectors**, Farah Fahim, Hooman Mohseni, Northwestern Univ. (USA); Grzegorz Deptuch, James R. Hoff, Alpana Shenai, Fermi National Accelerator Lab. (USA); Bruce Cauble, Cadence Design Systems, Inc. (USA) ..... [9555-24]

**Fusion: ultra-high-speed and ir image sensors (Invited Paper)**, Takeharu Goji Etoh, Ritsumeikan Univ. (Japan) ..... [9555-25]

**Infrared detectors based on InAs/GaSb superlattice materials (Invited Paper)**, Sanjay Krishna, The Univ. of New Mexico (USA) ..... [9555-26]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**A new 3D stitching method with large scope and low overlap rate in micro-structures non-destructive detection**, Long Ma, Dan Wang, Hong Yan Zhang, Yi Fan Niu, Civil Aviation Univ. of China (China); Tong Guo, Tianjin Univ. (China); Li Hua Lei, Shanghai Institute of Measurement and Testing Technology (China) ..... [9555-41]

**Tunable sensitivity phase detection of multichannel transmitted-type guided-mode resonance (GMR) sensor**, Wen-Kai Kuo, National Formosa Univ. (Taiwan) ..... [9555-42]

**Ellipsoid type microchannel plate photomultiplier tube for neutrino center detector**, Shulin Liu, Baojun Yan, Institute of High Energy Physics (China) [9555-43]

**Whispering-gallery microresonators and microlasers for nanoscale sensing and beyond**, Sahin Kaya Ozdemir, Lan Yang, Washington Univ. in St. Louis (USA) ..... [9555-44]

**Modeling and analysis of hybrid pixel detector deficiencies for scientific applications**, Farah Fahim, Hooman Mohseni, Northwestern Univ. (USA); Grzegorz Deptuch, Fermi National Accelerator Lab. (USA); James R. Hoff, Fermi National Accelerator Lab. (USA) ..... [9555-45]

THURSDAY 13 AUGUST

SESSION 7 ..... THU 8:20 AM TO 10:10 AM

## Novel Concepts in Nanoengineered Sensors

Session Chairs: Gail J. Brown, Air Force Research Lab. (USA); Ravi Athale, Office of Naval Research (USA)

**High grain, low noise organic and nanoelectronic photodetectors (Invited Paper)**, Jinsong Huang, Univ. of Nebraska-Lincoln (USA) ..... [9555-27]

**Dielectrophoresis based integration of nanostructures and their sensorial application**, Christian Leiterer, Macquarie Univ. (Australia); Gerald Brönstrup, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Steffen Berg, Norbert Jahr, Institut für Photonische Technologien eV (Germany); Wolfgang Fritzsche, Leibniz-Institut für Photonische Technologien e.V. (Germany) ..... [9555-28]

**Spectrometer with nanophotonic structure based on compressive sensing**, Zhu Wang, Zongfu Yu, Univ. of Wisconsin-Madison (USA) ..... [9555-29]

**Localised surface plasmon fiber device coated with carbon nanotubes for the specific detection of CO<sub>2</sub>**, Thomas Allsop, Raz Arif, Aston Univ. (United Kingdom); Ron Neal, Plymouth Univ. (United Kingdom); Kyriacos Kallli, Cyprus Univ. of Technology (Cyprus); Vojta Kudrat, Aleksey G. Rozhin, Aston Univ. (United Kingdom); Philip F. Culverhouse, Plymouth Univ. (United Kingdom); David J. Webb, Aston Univ. (United Kingdom) ..... [9555-30]

**A novel sensing and tracing technology based on the hollow-core plastic optical fiber and cone-shape optical coupler in a sun-lighting system**, Lingyu Zhang, Deming Liu, Xiaolei Li, Huazhong Univ. of Science and Technology (China) ..... [9555-31]

SESSION 8 ..... THU 10:40 AM TO 11:50 AM

## Applications I

Session Chairs: Takeharu Goji Etoh, Ritsumeikan Univ. (Japan); Martin U. Pralle, SiOnyx Inc. (USA)

**Colloidal semiconductor nanocrystals for biosensing and optoelectronic applications (Invited Paper)**, Richard D. Schaller, Argonne National Lab. (USA) and Northwestern Univ. (USA) ..... [9555-32]

**Development of optical nanosensor for intracellular pH measurement and imaging**, Aleksandar Secenji, Barbara Horváth, Univ. of Pécs (Hungary) ..... [9555-33]

**Fresnel-zones-patterned nanoparticles as fluorophore in biological sensing and imaging**, Luijiang Qian, Yu Zhou, Qingfeng Zhang, Rui Wang, Yifan Chen, South Univ. of Science and Technology of China (China) ..... [9555-34]

Lunch/Exhibition Break ..... Thu 11:50 am to 1:20 pm

SESSION 9 ..... THU 1:20 PM TO 4:20 PM

## Applications II

Session Chairs: Dorota S. Temple, RTI International (USA); Seth Bank, The Univ. of Texas at Austin (USA)

**With electroluminescence microscopy towards more reliable AlGaN/GaN transistors (Invited Paper)**, Martina Baeumler, Michael Dammann, Matthias Wespel, Helmer Konstanzer, Vladimir M. Polyakov, Stefan Müller, Stephan Maroldt, Wolfgang Bronner, Peter Brückner, Fouad Benkhelifa, Patrick Waltereit, Rüdiger Quay, Michael Mikulla, Joachim Wagner, Oliver Ambacher, Fraunhofer-Institut für Angewandte Festkörperphysik (Germany) ..... [9555-35]

**Micro-nanofluidic biochip and detector for fast clinical diagnostic at aM nucleic acid concentration**, Guoliang Huang, Tsinghua Univ. (China); Qin Huang, National Engineering Research Ctr. for Beijing Biochip Technology (China) [9555-36]

**Polarization-based optical fiber sensor of steel corrosion**, Wenbin Hu, Xing Zheng, Cheng Zhu, Min Gao, Donghai Guo, Wuhan Univ. of Technology (China); Wei Chen, School of Materials Science and Engineering, Wuhan Univ. of Technology (China) ..... [9555-37]

**An optical fiber lateral stress sensor based on a Sagnac interferometer structure**, Shun Wang, Ping Lu, Li Liu, Hao Liao, Deming Liu, Huazhong Univ. of Science and Technology (China) ..... [9555-38]

**Spectropolarimetry screening of cytological smears from cervical on the presence of HPV**, Sergey B. Yermolenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Alexander P. Peresunko, Julia G. Karpenko, Bukovinian State Medical Univ. (Ukraine) ..... [9555-39]

**An overview of the European patent system with particular emphasis on IP issues for imaging devices, solar cells, and OLEDs**, Ana Cabrita, Mauro Boero, European Patent Office (Netherlands) ..... [9555-40]

**Interaction of two nano particle plasmons for sensor application**, Naresh C. Das, U.S. Army Research Lab. (USA) ..... [9555-46]

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# Nanoengineering: Fabrication, Properties, Optics, and Devices XII

Conference Chairs: **Eva M. Campo**, Bangor Univ. (United Kingdom); **Elizabeth A. Dobisz**, Spin Transfer Technologies, Inc. (USA); **Louay A. Eldada**, Quanergy, Inc. (USA)

Program Committee: **André-Jean Attias**, Univ. Pierre et Marie Curie (France); **Irene Fernandez-Cuesta**, Lawrence Berkeley National Lab. (USA); **Sarah Haigh**, The Univ. of Manchester (United Kingdom); **Sondra Hellstrom**, California Institute of Technology (USA); **Ghassan E. Jabbour**, Arizona State Univ. (USA); **Robert Magnusson**, The Univ. of Texas at Arlington (USA); **Ndubuisi George Orji**, National Institute of Standards and Technology (USA); **Balaji Panchapakesan**, Worcester Polytechnic Institute (USA); **Won Park**, Univ. of Colorado at Boulder (USA); **Dorota A. Pawlak**, Institute of Electronic Materials Technology (Poland); **Michael T. Postek**, National Institute of Standards and Technology (USA); **Jun Tanida**, Osaka Univ. (Japan); **Richard Tiberio**, Stanford Univ. (USA); **Chee Wei Wong**, Columbia Univ. (USA)

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING

#### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: <b>Satoshi Kawata</b> , Osaka Univ. (Japan); <b>David L. Andrews</b> , Univ. of East Anglia (United Kingdom)	
<b>Extreme Imaging and Beyond (Plenary)</b> , Keisuke Goda, The Univ. of Tokyo (Japan) .....	[9544-500]
<b>Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary)</b> , Reuven Gordon, Univ. of Victoria (Canada) .....	[9544-501]
<b>Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary)</b> , Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) .....	[9544-502]

## TUESDAY 11 AUGUST

#### SESSION 1..... TUE 8:20 AM TO 10:10 AM

### Nanofabrication for Energy Harvest

<b>Applications of electronic waste (Invited Paper)</b> , Hannah Harding, Vijay K. Rangari, Tuskegee Univ. (USA) .....	[9556-1]
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<b>Technical requirements, manufacturing processes, and cost efficiency for transparent electrodes based on silver nanowires and carbon nanotubes</b> , Thomas Ackermann, Univ. Stuttgart (Germany) and Fraunhofer-Institut für Produktionstechnik und Automatisierung (Germany); Serhat Sahakalkan, Ivica Kolaric, Fraunhofer-Institut für Produktionstechnik und Automatisierung (Germany); Engelbert Westkämper, Univ. Stuttgart (Germany); Siegmar Roth, Sineurop Nanotech GmbH (Germany) .....	[9556-2]
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<b>Fast water vapor transmission rate measurement system by graphene-based device</b> , Yung-Hsiang Hsieh, Cheng-Chung Lee, Chien-Cheng Kuo, National Central Univ. (Taiwan) .....	[9556-3]
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<b>Measurements of electron lifetime and electron transport time in dye sensitized solar cells using laser induced photovoltage and photocurrent decay</b> , Hamid M. Ghaithan, Saif M. Qaid, Mahmoud Hezam, King Saud Univ. (Saudi Arabia); Muhammad B. Siddique, Univ. of Management and Technology (Pakistan); Idriss M. Bedja, Abdullah S. Aldwayyana, King Saud Univ. (Saudi Arabia) .....	[9556-4]
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<b>Optical and structural properties of co-sputtered Cu-Si-O and Cu-Ge-O thin films</b> , Lirong Sun, Air Force Research Lab. (USA) and General Dynamics Information Technology (USA); Neil R. Murphy, John G. Jones, Air Force Research Lab. (USA); John T. Grant, Air Force Research Lab. (USA) and Univ. of Dayton Research Institute (USA) .....	[9556-5]
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#### SESSION 2..... TUE 10:40 AM TO 12:10 PM

### Nanofabrication for Novel Optical Surface Properties

<b>Ultra-slim coherent backlight unit for mobile holographic display (Invited Paper)</b> , Chil-Sung Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Alexander V. Morozov, Alexander Koshelev, Sergey Dubynin, German Dubinin, SAMSUNG Advanced Institute of Technology (Russian Federation); Sung-Hoon Lee, Jae-Seung Chung, Geeyoung Sung, Jungkwon An, Hoon Song, Juwon Seo, Hojung Kim, Wontaek Seo, Samsung Advanced Institute of Technology (Korea, Republic of); Andrey Putilin, P.N. Lebedev Physical Institute (Russian Federation); Sergey Kopenkin, Yuriy Borodin, P.N. Lebedev Physical Institute (Russian Federation); Sun Il Kim, Hong-Seok Lee, U-i Chung, Sungwoo Hwang, Samsung Advanced Institute of Technology (Korea, Republic of) .....	[9556-6]
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<b>Scalable nanostructuring on polymer by a SiC stamp: optical and wetting effects</b> , Aikaterini Argyraki, Weifang Lu, Paul M. Petersen, Haiyan Ou, DTU Fotonik (Denmark) .....	[9556-7]
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<b>Re-usable metal-metal stamping for three-dimensional active metamaterial fabrication</b> , Robert L. Brown, Alan Selewa, Sung Jun Jang, Alireza Bonakdar, Mohsen Rezaei, Hooman Mohseni, Northwestern Univ. (USA) .....	[9556-8]
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<b>Nanofabrication of ultra-low reflectivity black silicon surfaces and devices</b> , Victor E. White, Karl Y. Yee, Kunjithapatham Balasubramanian, Pierre M. Echternach, Richard E. Muller, Matthew R. Dickie, Eric Cady, Daniel J. Ryan, Michael Eastwood, Byron E. Van Gorp, Jet Propulsion Lab. (USA); A. J. Eldorado Riggs, Niel Zimmerman, N. Jeremy Kasdin, Princeton Univ. (USA) .....	[9556-9]
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Lunch/Exhibition Break .....	Tue 12:10 pm to 1:30 pm
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#### SESSION 3..... TUE 1:30 PM TO 3:10 PM

### Nanophotonics

<b>Development of 3D photonic crystals using sol-gel process for high power laser applications</b> , Florence Benoit, Bertrand Bertussi, Eva Dieudonné, Nicolas Maljejac, Karine Vallé, Philippe Belleville, Commissariat à l'Énergie Atomique (France); Clément Sanchez, Collège de France (France) .....	[9556-10]
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<b>Enhancement in light emission efficiency of silicon-rich oxide/SiO<sub>2</sub> multilayer structures deposited by hydrogen ion-beam assisted sputtering</b> , Sheng Wen Fu, National Cheng Kung Univ. (Taiwan) .....	[9556-11]
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<b>Auger recombination in nanoscale III-Nitride material system</b> , Chee-Keong Tan, Nelson Tansu, Lehigh Univ. (USA) .....	[9556-12]
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<b>Development, electrical, and optical characterization of nanoscale FDSOI MOSFET devices based on quantum well structure for optical communication between chips and internal blocks</b> , Avi Karsenty, Jerusalem College of Technology (Israel); Avraham Chelly, Bar-Ilan Univ. (Israel); Roi Zolberg, Roi Sabo, Jerusalem College of Technology (Israel) .....	[9556-13]
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<b>PbSe/PbSrSe MQW characteristic temperature relationship with laser cavity length</b> , Majed Khodr, American Univ. of Ras Al Khaimah (United Arab Emirates) .....	[9556-14]
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# CONFERENCE 9556

SESSION 4.....TUE 3:40 PM TO 6:00 PM

## Micro, Nano, and Optical Materials

**Investigation of electron beam and ion beam irradiation effect on Au nanopore formation**, Seong Soo Choi, Myoung Jin Park, Chul Hee Han, Sun Moon Univ. (Korea, Republic of); Namkyoo Park, Seoul National Univ. (Korea, Republic of); Yong-Sang Kim, Sungkyunkwan Univ. (Korea, Republic of).....[9556-15]

**All-polymer based fabrication process for an all-polymer flexible and parallel optical interconnect**, Jilin Yang, Tao Ge, Chris Summitt, Sunglin Wang, Yuzuru Takashima, Thomas D. Milster, College of Optical Sciences, The Univ. of Arizona (USA).....[9556-16]

**Tolerance analysis of the pulse signal of a novel lateral deformable optical NEMS grating transducer**, Chen Wang, Jian Bai, Zhejiang Univ. (China) [9556-17]

**Design of SiO<sub>x</sub> slab optical waveguides**, Eder Lizarraga, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico); Alicia Oliver, Univ. Nacional Autónoma de México (Mexico); Rafael Salas, Univ. de Technologie Troyes (France); Heriberto Márquez, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) .....

[9556-18]  
**Design and fabrication of sinusoidal spectral filters for multispectral imaging**, Chuan Ni, Jie Jia, Keigo Hirakawa, Andrew M. Sarangan, Univ. of Dayton (USA).....[9556-19]

**Detection of coating fluorophores' densities in improved Q-factor cavities**, Nader Shehata, Ishac L. N. Kandas, Virginia Polytechnic Institute and State Univ. (USA) and Alexandria Univ. (Egypt); Chalongrat Daengngam, Prince of Songkla Univ. (Thailand) .....

[9556-20]  
**Applications of silicon microspheres as microphtonic filters**, Muhammad Zakwan, Ulas S. Gökay, Ali Serpengüzel, Koç Univ. (Turkey). [9556-21]

## WEDNESDAY 12 AUGUST

SESSION 5.....WED 8:00 AM TO 10:00 AM

## Nanodevices

**Nanofabrication at 1nm resolution by quantum optical lithography**, Eugen Pavel, Storex Technologies Inc. (Romania).....[9556-22]

**Tracking memristor switching in metal oxides**, Alexandre Zimmers, Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris (France) .....

[9556-23]  
**Plasmonic structures fabricated via nanomasking sub-10 nm lithography technique**, Stephen J. Bauman, Gabrielle Abraham, David A. French, Joseph B. Herzog, Univ. of Arkansas (USA).....[9556-24]

**Optomechanical nanoantenna**, Alireza Bonakdar, Sung Jun Jang, Robert L. Brown, Iman Hassani Nia, Mohsen Rezaei, Hooman Mohseni, Northwestern Univ. (USA).....[9556-25]

**Optimizing a subwavelength grating lens for large incidence angles**, Lukas Elsinger, Technische Univ. Graz (Austria) and ams AG (Austria); Rainer Minixhofer, ams AG (Austria); Peter Hadley, Technische Univ. Graz (Austria).....[9556-26]

**Research on input shaping algorithm for rapid positioning of ultra-precision dual-stage**, Xinglin Chen, Fazhi Song, Yue Dong, Yan Wang, Harbin Institute of Technology (China).....[9556-27]

SESSION 6.....WED 10:30 AM TO 12:10 PM

## Nanometrology and Precision

**Nanomanufacturing concerns about measurements made in the SEM: Part IV: charging and its mitigation** (*Invited Paper*), Michael T. Postek, András E. Vladár, National Institute of Standards and Technology (USA).....[9556-28]

**Helium ion microscopy of electrospun nano-composites** (*Invited Paper*), Eva M. Campo, Bangor Univ. (United Kingdom); Chuong T. Huynh, Carl Zeiss Microscopy, LLC (USA); Eduardo Larios, Univ. of Texas at San Antonio (USA); Mohan Ananth, Carl Zeiss Microscopy, LLC (USA) .....

[9556-29]  
**Controlling orientation of carbon nanotubes by using direct laser writing**, Shota Ushiba, Osaka Univ. (Japan); Satoru Shoji, The Univ. of Electro-Communications (Japan); Kyoko Masui, Osaka Univ. (Japan); Junichiro Kono, Rice Univ. (USA); Satoshi Kawata, Osaka Univ. (Japan).....[9556-30]

**Self-assembly based nanometre scale patterning for nanowire growth**, Abhishek Chandramohan, Durham Univ. (United Kingdom); Rong Sun, Lund Univ. (Sweden); Natalia Kaliteevskaya, Durham Univ. (United Kingdom); Jonas Johansson, Kimberly A. Dick, Lund Univ. (Sweden); Budhika Mendis, Michael C. Petty, Andrew J. Gallant, Dagou A. Zeze, Durham Univ. (United Kingdom)[9556-31]

Lunch/Exhibition Break.....Wed 12:10 pm to 1:30 pm

SESSION 7.....WED 1:30 PM TO 3:00 PM

## Nanopatterning for Surface Chemistry

**Janus tectons: a versatile platform for self-assembling chromophores on sp2-carbon based substrates** (*Invited Paper*), Ping Du, David Kreher, Fabrice Mathevet, Univ. Pierre et Marie Curie (France); Fabrice Charra, Commissariat à l'Énergie Atomique (France); André-Jean Attias, Univ. Pierre et Marie Curie (France) .....

[9556-32]  
**Linear and nonlinear optical processing of polymer matrix nanocomposites**, Travis J. DeJournett, Karen Han, Lauren R. Olasov, Fan W. Zeng, Brennan Lee, James B. Spicer, Johns Hopkins Univ. (USA) .....

[9556-33]  
**High contact angle hysteresis of nanopillared quartz surfaces**, Ming-Tsung Hung, Shing-Lung Chen, Shang Yang, National Central Univ. (Taiwan)....[9556-34]

**Nanoscale patterning of poly (L-lactic acid) (PLLA) films with nano-imprinting methods**, Akshit Peer, Iowa State Univ. (USA) and Ames Lab. (USA); Rabin Dhakal, Rana Biswas, Jaeyoun Kim, Iowa State Univ. (USA) .....

[9556-35]

SESSION 8.....WED 3:30 PM TO 5:30 PM

## Nanomanufacturing and Metrology

**Nanomanufacturing-related programs at NSF** (*Invited Paper*), Khershed P. Cooper, National Science Foundation (USA) .....

[9556-36]  
**Challenges and needs for automating nano image processing for nanomanufacturing applications** (*Invited Paper*), Yu Ding, Satish T. S. Bukkanpatham, Texas A&M Univ. (USA) .....

[9556-37]  
**Scatterometry reference standards to improve tool matching and traceability in lithographical nanomanufacturing**, Emil Agocs, Bernd Bodermann, Physikalisch-Technische Bundesanstalt (Germany); Sven Burger, JCMwave GmbH (Germany); Gaoliang Dai, Johannes Endres, Hermann Gross, Physikalisch-Technische Bundesanstalt (Germany); Poul-Erik Hansen, Danish Fundamental Metrology Institut (Denmark); Sebastian Heidenreich, Michael Krumrey, Physikalisch-Technische Bundesanstalt (Germany); Bernd Loechel, Juergen Probst, Helmholz-Zentrum Berlin für Materialien und Energie GmbH (Germany); Frank Scholze, Victor Soltwisch, Matthias Wurm, Physikalisch-Technische Bundesanstalt (Germany) .....

[9556-38]  
**Quantitative tool characterization of 193 nm scatterfield microscope**, Martin Y. Sohn, Bryan M. Barnes, Hui Zhou, Richard M. Silver, National Institute of Standards and Technology (USA) .....

[9556-39]  
**Laser velocimetry for measurement of non-sinusoidal vibration in sub-nanometer scale without lock-in amplifiers**, How-Foo Chen, Wei-Lun Chiang, National Yang-Ming Univ. (Taiwan) .....

[9556-40]

POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Self-assembly of composite materials based on carbon nanotubes**, Dmitrii Zhukalin, Andrei V. Tuchin, Larisa A. Bityutskaya, Voronezh State Univ. (Russian Federation) .....

[9556-41]  
**Non-circular nanohole array as selective emitter for thermophotovoltaic system**, Jin Hwan Kim, Moo Whan Shin, Yonsei Univ. (Korea, Republic of)[9556-42]

**Design and fabrication of multilayer dielectric gratings for spectral beam combining**, Hyun-Ju Cho, Daeduk College (Korea, Republic of); Yong-Soo Lee, Hyun-Tae Kim, Doosan DST Co., Ltd. (Korea, Republic of) .....

[9556-43]  
**Advanced length scaling method of optical nanoantennas**, Seunguk Kim, Jeonghee Shin, Byoungok Jun, Jae-Eun Jang, Daegu Gyeongbuk Institute of Science & Technology (Korea, Republic of) .....

[9556-44]  
**Design of optical channel waveguides in SiO<sub>2</sub> by ion implantation**, Helena De los Reyes, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico); Gloria V. Vázquez, Ctr. de Investigaciones en Óptica, A.C. (Mexico); David M. Salazar, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico); Alicia Oliver, Univ. Nacional Autónoma de México (Mexico); Heriberto Márquez, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) .....

[9556-45]  
**Influence of wetting states on optical characteristics of Si nanopatterns**, Minji Gwon, Sujung Kim, Ewha Womans Univ. (Korea, Republic of); Jiaqi Li, IMEC (Belgium) and KU Leuven (Belgium); Xiumei Xu, IMEC (Belgium); Eunsongyi Lee, Ewha Womans Univ. (Korea, Republic of) and The Univ. of Manchester (United Kingdom); Dong-Wook Kim, Ewha Womans Univ. (Korea, Republic of); Chang Chen, IMEC (Belgium) and KU Leuven (Belgium) .....

[9556-46]

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**Nanoindentation for surface modification of nanofilms**, Angelika Luchenko, V.E. Lashkaryov Institute of Semiconductor Physics (Ukraine); Mykola M. Melnichenko, National Taras Shevchenko Univ. of Kyiv (Ukraine) . . . . . [9556-47]

**Optical properties of LED with patterned 1D photonic crystal**, Pavol Hronec, Jaroslava Škriniarová, Anton Kuzma, Jaroslav Kováč Jr., Slovenska Technicka Univ. (Slovakia); Anna Bencurova, Stefan Hascik, Pavol Nemec, Slovak Academy of Sciences (Slovakia) . . . . . [9556-48]

**The significance of the number of periods and period size in 2D photonic crystal waveguides**, Mirsaeid Sarollahi, Paul Millett, Joseph B. Herzog, Univ. of Arkansas (USA) . . . . . [9556-49]

**Optical characterization of sub-10 nm plasmonic nanostructures**, Gabrielle Abraham, David A. French, Stephen J. Bauman, Desalegn Debu, Cameron Saylor, Joseph B. Herzog, Univ. of Arkansas (USA) . . . . . [9556-50]

**Asymmetric propagation between subwavelength waveguides**, Betsabe Manzanares-Martinez, Jesus Manzanares-Martinez, Paola Castro-Garay, Carlos Ivan Ham-Rodriguez, Yohan Jasid Rodriguez-Viveros, Univ. de Sonora (Mexico); Damian Moctezuma-Enriquez, Ctr. de Investigación en Materiales Avanzados, S.C. (Mexico) . . . . . [9556-51]

**Wearable and stretchable substrates fabricate for display by O<sub>2</sub>-plasma surface treatment**, Sang Chul Lim, Myung Chan An, Dong IC Lee, Se Hyuk Yeom, Chang Taek Seo, Gyu Seok Choi, Gumi Electronics & Information Technology Research Institute (Korea, Republic of) . . . . . [9556-52]

**Keratin/poly (vinyl alcohol) blended nanofibers with high optical transmittance**, Hak Yong Kim, Chonbuk National University (Korea, Republic of) . . . . . [9556-53]

**Development of EUV scatterometer with high-harmonic-generation EUV source for nano-scale grating**, Chia-Liang Yeh, Industrial Technology Research Institute (Taiwan) . . . . . [9556-54]

**Modeling and adaptive neural network control of the short-stroke wafer stage**, Yiguang Wang, Xinglin Chen, Yan Wang, Zhenxian Fu, Sheng Qiang, Harbin Institute of Technology (China) . . . . . [9556-55]

**Analysis of optical reflectivity as an inspection tool for nanoparticle monolayers on a flat substrate**, Omar W. Vázquez-Estrada, Ctr. de Ciencias Aplicadas y Desarrollo Tecnológico (Mexico); Alejandro Reyes-Coronado, Gesuri Morales-Luna, Univ. Nacional Autónoma de México (Mexico); Augusto García-Valenzuela, Ctr. de Ciencias Aplicadas y Desarrollo Tecnológico (Mexico); Alipio G. Calles, Rubén G. Barrera, Univ. Nacional Autónoma de México (Mexico) . [9556-56]

**Viability of sizing metallic nanoparticles in suspension from effective refractive index measurements**, Augusto García-Valenzuela, Univ. Nacional Autónoma de México (Mexico); Gesuri Morales-Luna, Univ Nacional Autónoma de México (Mexico); Roberto Márquez-Islas, Univ. Nacional Autónoma de Mexico (Mexico); Omar W. Vázquez-Estrada, Univ Nacional Autónoma de México (Mexico); Celia A. Sánchez-Pérez, Univ. Nacional Autónoma de México (Mexico) . . . . . [9556-57]

**Wafer defect inspection using component tree of SEM images**, SungHyon Kim, Il-suk Oh, Chonbuk National Univ. (Korea, Republic of) . . . . . [9556-58]

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# Nanobiosystems: Processing, Characterization, and Applications VIII

Conference Chairs: Norihisa Kobayashi, Chiba Univ. (Japan); Fahima Ouchen, Air Force Research Lab. (USA); Ileana Rau, Polytechnical Univ. of Bucharest (Romania)

Program Committee: Carrie M. Bartsch, Air Force Research Lab. (USA); Liming Dai, Case Western Reserve Univ. (USA); Ananth Dodabalapur, The Univ. of Texas at Austin (USA); James G. Grote, Air Force Research Lab. (USA); Emily M. Heckman, Air Force Research Lab. (USA); Kuniharu Ijiri, Hokkaido Univ. (Japan); Jung-II Jin, Korea Univ. (Korea, Republic of); Francois Kajzar, Polytechnical Univ. of Bucharest (Romania); Sang Nyon Kim, Air Force Research Lab. (USA); Oksana Krupka, Univ. d'Angers (France); Charles Y. C. Lee, Air Force Office of Scientific Research (USA); Misoon Y. Mah, Asian Office of Aerospace Research and Development (Japan); Naoya Ogata, Chitose Institute of Science and Technology (Japan); Bruce H. Robinson, Univ. of Washington (USA); Anna Samoc, The Australian National Univ. (Australia); Marek J. Samoc, Wroclaw Univ. of Technology (Poland); Niyazi Serdar Sariciftci, Johannes Kepler Univ. Linz (Austria); Kristi M. Singh, Air Force Research Lab. (USA); Andrew J. Steckl, Univ. of Cincinnati (USA); Morley O. Stone, Air Force Research Lab. (USA); Perry P. Yaney, Univ. of Dayton (USA)

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING

#### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: Satoshi Kawata, Osaka Univ. (Japan); David L. Andrews, Univ. of East Anglia (United Kingdom)

Extreme Imaging and Beyond (Plenary), Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary), Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch Break ..... Mon 12:00 pm to 1:45 pm

#### SESSION 1..... MON 1:45 PM TO 3:25 PM

### DNA-Based Materials

Session Chair: James G. Grote, Air Force Research Lab. (USA)

Developments of salmon DNA as intelligent materials (Keynote Presentation), Naoya Ogata, Chitose Institute of Science and Technology (Japan) ..... [9557-1]

DNA-based membranes: development and applications (Invited Paper), Francois Kajzar, Mihaela Mindroiu, Gratiela Tihan, Ana-Maria Manea, Univ. Politehnica of Bucharest (Romania); Agnieszka Pawlicka, Univ. de São Paulo (Brazil); Ileana Rau, Univ. Politehnica of Bucharest (Romania) ..... [9557-2]

Nucleobase passivation layers for photonic and electronic devices (Invited Paper), Fahima Ouchen, Adrienne Williams, Donna M. Joyce, Emily M. Heckman, Air Force Research Lab. (USA); Perry P. Yaney, Univ. of Dayton (USA); James G. Grote, Air Force Research Lab. (USA) ..... [9557-3]

#### SESSION 2..... MON 3:55 PM TO 5:25 PM

### Nano-Biomaterials

Session Chair: Fahima Ouchen, Air Force Research Lab. (USA)

3D printing by nonlinear photochemistry for bio-applications (Invited Paper), Patrice L. Baldeck, Univ. Joseph Fourier (France) ..... [9557-4]

Single molecule spectroscopy of conjugated polymers in solution (Invited Paper), Ifor D. Samuel, Paul A. Dalgarino, Francisco Tenopala Carmona, Univ. of St. Andrews (United Kingdom); Stephanie Fronk, Guillermo C. Bazan, Univ. of California, Santa Barbara (USA); Carlos Penedo, Univ. of St. Andrews (United Kingdom) ..... [9557-5]

Novel photonics polymers for 4K/8K real color display system in bio-imaging (Invited Paper), Yasuhiro Koike, Keio Univ. (Japan) ..... [9557-6]

## TUESDAY 11 AUGUST

#### SESSION 3..... TUE 8:30 AM TO 10:30 AM

### Biomaterials Applications

Session Chair: Ileana Rau, Univ. Politehnica of Bucharest (Romania)

Biological matrices for light amplification (Keynote Presentation), Jaroslaw Myslwiec, Konrad Cyprych, Lech Sznitko, Adam Szukalski, Kacper Parafiniuk, Andrzej Miniewicz, Marek Samoc, Piotr Hanczyk, Antoni C. Mitus, Grzegorz Pawlik, Wroclaw Univ. of Technology (Poland); Francois Kajzar, Ileana Rau, Univ. Politehnica of Bucharest (Romania) ..... [9557-7]

Optical amplification in DNA-surfactant complexes incorporating hemicyanine dyes with long and short alkyl chains (Invited Paper), Yutaka Kawabe, Yuki Suzuki, Chitose Institute of Science and Technology (Japan) ..... [9557-8]

DNA based electrolyte/separator for lithium battery application, Jitendra Kumar, University of Dayton (USA); Fahima Ouchen, Air Force Research Lab (USA); Guru Subramanyam, University of Dayton (USA); James G. Grote, Air Force Research Lab. (USA) ..... [9557-9]

Disorder and broad-angle iridescence from morpho-inspired structures (Invited Paper), Bokwang Song, Seok Chan Eom, Jung Hoon Shin, KAIST (Korea, Republic of) ..... [9557-10]

#### SESSION 4..... TUE 11:00 AM TO 12:30 PM

### Bionanomaterials I

Session Chair: Jaroslaw Myslwiec, Wroclaw Univ. of Technology (Poland)

Nanoparticle-based biomimetic functional materials (Invited Paper), Kuniharu Ijiri, Hokkaido Univ. (Japan) ..... [9557-11]

Gold based hybrid nanosystems as potential agents for diagnostic and therapy (Invited Paper), Frederic Lerouge, Ecole Normale Supérieure de Lyon (France); Julien R. G. Navarro, KTH Royal Institute of Technology (Sweden); Cristina Cepraga, BASF SE (France); Arnaud Favier, Marie Thérèse Charreyre, Denis Chateau, Frederic Chaput, Cyrille Monnerie, Chantal Andraud, Patrice L. Baldeck, Ecole Normale Supérieure de Lyon (France) ..... [9557-12]

Solution-processed low dimensional nanomaterials with self-assembled polymers for flexible photo-electronic devices (Invited Paper), Cheolmin Park, Yonsei Univ. (Korea, Republic of) ..... [9557-13]

Lunch/Exhibition Break ..... Tue 12:30 pm to 2:00 pm

# CONFERENCE 9557

SESSION 5..... TUE 2:00 PM TO 3:30 PM

## Bionanomaterials II

Session Chair: **François Kajzar**, Univ. Politehnica of Bucharest (Romania)

**Quick response AC-operated electrochemiluminescent cell with DNA/Ru complex** (*Invited Paper*), Norihisa Kobayashi, Chiba Univ. (Japan) ..... [9557-14]

**Exploring surface plasmon-polariton resonance (SPR) in an interferometer configuration** (*Invited Paper*), Perry P. Yaney, University of Dayton (USA); Fahima Ouchen, Air Force Research Lab (USA); James G. Grote, University of Dayton (USA) ..... [9557-15]

**Towards modeling of random lasing in dye doped bio-organic based systems: ray-tracing ad cellular automaton analysis** (*Invited Paper*), Antoni C. Mitus, Krzysztof Lankowski, Paweł Stopa, Witold Zaklukiewicz, Grzegorz Pawlik, Jarosław Mysliwiec, Wrocław Univ. of Technology (Poland); François Kajzar, Ileana Rau, Univ. Politehnica of Bucharest (Romania) ..... [9557-16]

SESSION 6..... TUE 4:00 PM TO 6:20 PM

## Bionanomaterials III

Session Chair: **Norihisa Kobayashi**, Chiba Univ. (Japan)

**DNA-nucleobases: gate dielectric for flexible GFET-based sensor applications** (*Invited Paper*), Adrienne Williams, Fahima Ouchen, Steve S. N. Kim, Air Force Research Lab. (USA); Said Elhamri, Univ. of Dayton (USA); Eva M. Campo, A. Douglas Winter, Bangor Univ. (United Kingdom); Gregory Kozlowski, Wright State Univ. (USA); Rajesh R. Naik, James G. Grote, Air Force Research Lab. (USA) ..... [9557-17]

**Harvesting of living cell sheets from conjugated polymer surfaces via photothermal disassembly of a protein layer** (*Invited Paper*), Eunkyoung Kim, Yonsei Univ. (Korea, Republic of) ..... [9557-18]

**Creation of carbon nanotube based biosensors through dielectrophoretic assembly**, Nilan S. Mani, Centerville High School (USA); Steve Kim, UES (USA); Kaushik Annam, Danielle Bane, Univ. of Dayton (USA); Guru Subramanyam, University of Dayton (USA) Nilan S. Mani, Centerville High School (USA); Steve Kim, UES (USA); Kaushik Annam, Danielle Bane, Univ. of Dayton (USA); Guru Subramanyam, University of Dayton (USA) ..... [9557-19]

**Metal pattern formation by using DNA brushes** (*Invited Paper*), Hideyuki Mitomo, Satoshi Nakamura, Shigeaki Suzuki, Yasutaka Matsuo, Kenichi Niikura, Kuniharu Ijiro, Hokkaido Univ. (Japan) ..... [9557-20]

**Ordered auditory neuron growth on micro-structured nanocrystalline diamond surface** (*Invited Paper*), Yixiao Cai, Fredrik Edin, Hao Li, Mikael Karlsson, Uppsala Univ. (Sweden) ..... [9557-21]

## WEDNESDAY 12 AUGUST

POSTERS-WEDNESDAY..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Picogreen dye as an active medium for plastic lasers**, Pradeep Chandran, P. Radhakrishnan, V. P. N. Nampoori, Cochin Univ. of Science & Technology (India) ..... [9557-22]

**Enhanced brightness from all solution processable biopolymer LED**, Pradeep Chandran, International School of Photonics (India); Manoj A. G. Namboothiry, Indian Institute of Science Education and Research (India); C. P. G. Vallabhan, P. Radhakrishnan, V. P. N. Nampoori, International School of Photonics (India) ..... [9557-23]

**Photoresponsive behavior of azobenzene hybrid materials**, Valentin Victor Jercă, "Costin D. Nenitescu" Institute of Organic Chemistry (Romania) and Univ. Politehnica of Bucharest (Romania); Florica Adriana Jercă, "Costin D. Nenitescu" Institute of Organic Chemistry (Romania); Ileana Rau, Ana-Maria Manea, Univ. Politehnica of Bucharest (Romania); François Kajzar, Univ. Politehnica of Bucharest (Romania) and Univ. d'Angers (France); Dan Sorin Vasilescu, Univ. Politehnica of Bucharest (Romania); Dumitru Mircea Vuluga, "Costin D. Nenitescu" Institute of Organic Chemistry (Romania) ..... [9557-24]

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## Nanostructured Thin Films VIII

Conference Chairs: Akhlesh Lakhtakia, The Pennsylvania State Univ. (USA); Tom G. Mackay, The Univ. of Edinburgh (United Kingdom); Motofumi Suzuki, Kyoto Univ. (Japan)

Program Committee: Bharat Bhushan, The Ohio State Univ. (USA); Pankaj K. Choudhury, Univ. Kebangsaan Malaysia (Malaysia); Didier Felbacq, Univ. Montpellier 2 (France); Flavio Horowitz, Univ. Federal do Rio Grande do Sul (Brazil); Yi-Jun Jen, National Taipei Univ. of Technology (Taiwan); Raúl J. Martín-Palma, Univ. Autónoma de Madrid (Spain); Anders Kristensen, Technical Univ. of Denmark (Denmark); Sidney J. Ribeiro, Univ. Estadual Paulista (Brazil); Geoffrey B. Smith, Univ. of Technology, Sydney (Australia)

### MONDAY 10 AUGUST

#### NANOSCIENCE + ENGINEERING

##### PLENARY SESSION..... MON 9:15 AM TO 12:00 PM

Session Chairs: Satoshi Kawata, Osaka Univ. (Japan); David L. Andrews, Univ. of East Anglia (United Kingdom)

Extreme Imaging and Beyond (Plenary), Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions (Plenary), Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

Device Applications of Semiconductor Nanoantennas and Metafilms (Plenary), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Structural and electrical properties of N doped SiC nanostructures obtained by TVA method, Victor Ciupina, Univ. Ovidius Constanta (Romania) and Academy of Romanian Scientists (Romania); Cristian P. Lungu, National Institute for Laser, Plasma and Radiation Physics (Romania); Rodica Vladoiu, Gabriel Prodan, Univ. Ovidius Constanta (Romania); Eugeniu Vasile, Univ. Politehnica of Bucharest (Romania); Cornelius Porosnicu, National Institute for Laser, Plasma and Radiation Physics (Romania); Stefan Antohe, Univ. of Bucharest (Romania); Iuliana M. Stanescu, Marius Belc, Aurelia Mandes, Virginia Dinca, Univ. Ovidius Constanta (Romania); Sorina Iftimie, Univ. of Bucharest (Romania); Valeriu N. Zarovski, National Institute for Laser, Plasma and Radiation Physics (Romania); Virginia Nicolescu, Ceronav (Romania) ..... [9558-7]

Lunch/Exhibition Break ..... Wed 12:30 pm to 2:00 pm

##### SESSION 3..... WED 2:00 PM TO 3:30 PM

#### Control and Modification I

Session Chair: Didier Felbacq, Univ. Montpellier 2 (France)

Constructive and destructive routes to prepare nanostructures on surfaces by low-energy ion beam sputtering (Invited Paper), Bernd Rauschenbach, Leibniz-Institut für Oberflächenmodifizierung e.V. (Germany) ..... [9558-8]

Absorption intensity tunability in the near infrared region using phase-change nanostructure, Abdurrahman Ozdemir, Safak Saraydemir, Bilal Barut, Hasan Kocer, Kara Harp Okulu (Turkey) ..... [9558-9]

Optical and structural properties of noble metal nanoisLAND, Davide Bacchelli, Alain J. Corso, Francesca Gerlin, Paola Zuppella, Enrico Tessaro, Marco Nardello, Maria G. Pelizzetti, CNR-IFN UoS Padova (Italy) ..... [9558-10]

Nanostructured thin films for normal angle polarizer, Tomas Tolenis, Ramutis Drazdys, Ctr. for Physical Sciences and Technology (Lithuania) ..... [9558-11]

##### SESSION 4..... WED 4:00 PM TO 5:20 PM

#### Theoretical Studies

Session Chair: Bernd Rauschenbach, Leibniz-Institut für Oberflächenmodifizierung e.V. (Germany)

Scattering from bulk material with surface states, Akhlesh Lakhtakia, The Pennsylvania State Univ. (USA); Tom G. Mackay, The Univ. of Edinburgh (United Kingdom) ..... [9558-12]

A multiple scattering approach to solving scattering problems by complex objects, Didier Felbacq, Univ. Montpellier 2 (France); Emmanuel Kling, Sagem (France) ..... [9558-13]

Nanoengineered composite materials with giant dielectric anisotropy, Tom G. Mackay, Univ. of Edinburgh (United Kingdom) ..... [9558-14]

A new fast and accurate spectrophotometric method for the determination of the optical constants of arbitrary absorptance thin films from a single transmittance curve: application to dielectric materials, Jean Desforges, Univ. de Moncton (Canada); Clement Deschamps, Univ. de Poitiers (France); Serge Gauvin, Univ. de Moncton (Canada) ..... [9558-46]

##### POSTERS-WEDNESDAY..... WED 5:30 PM TO 7:30 PM

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Nano-heterostructures based on solid solution HgCdTe obtained using silver ion implantation, Ruslana S. Udovytcka, Alexey B. Smirnov, Rada K. Savkina, Fiodor F. Sizov, V.E. Lashkaryov Institute of Semiconductor Physics (Ukraine) ..... [9558-31]

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- Atomically thin adhesion promoter for highly stable silver nanowire film,** Sungjun Lee, Hyungseok Kang, SungKyunKwan Univ. (Korea, Republic of) [9558-32]
- Growth of  $\text{Bi}_2\text{O}_3$  nanocones over large areas by magnetron sputtering,** Li-Chia Tien, Ying-Hong Liou, National Dong Hwa Univ. (Taiwan) [9558-33]
- Surface treatment of multiferroic thin films using nano-second Nd: YAG laser,** Ola G. Allam, National Research Ctr. (Egypt) [9558-34]
- Growth and characterization of  $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3$  thin film prepared by pulsed laser deposition,** Ali A. A. Abdel Gaied, National Institute of Laser Enhanced Sciences (Egypt) [9558-35]
- Simulation and analysis of back scattered light in thin film solar cells with finite difference time domain method,** Birhanu Tamene Abebe, Christoph Pflaum, Erlangen Graduate School in Advanced Optical Technologies (Germany) [9558-36]
- Microwave plasma chemical synthesis of nanocrystalline carbon film structures and study their properties,** Valery Timoshenkov, National Research Univ. of Electronic Technology (Russian Federation); Nikolay A. Bushuev, Federal State Unitary Enterprise (Russian Federation); Raval Yaafarov, Institute of Radio Engineering and Electronics (Russian Federation); Sergey Orlov, Dmitri Starykh, Molecular Electronics Research Institute (Russian Federation) [9558-37]
- Arrange an asymmetrical metal-dielectric multilayer as a low loss metamatериал,** Yi-Jun Jen, Ci-Yao Jheng, Kun-Han Lu, Chien-Ying Chiang, National Taipei Univ. of Technology (Taiwan) [9558-38]
- Helical structured thin films deposited at a glancing angle,** Yi-Jun Jen, Ci-Yao Jheng, San Chan, Chien-Hoa Tseng, National Taipei Univ. of Technology (Taiwan) [9558-39]
- Influence of low temperature on the morphology and optical property of a deposited silver nanorod array,** Yi-Jun Jen, Ci-Yao Jheng, Jyong-Wei Huang, Yuan-Tai Chang, National Taipei Univ. of Technology (Taiwan) [9558-40]
- Nanoengineered hyperbolic materials for optical sensing applications,** Tom G. Mackay, The Univ. of Edinburgh (United Kingdom) [9558-41]
- Realization of highly transparent conducting multicomponent  $\text{CdO-ZnO}$  thinfilms by R.F. Magnetron sputtering for photovoltaics.,** Saheer Cheemadan, Amiruddin Rafiuddin, Srinivasa R. Tippasani, M.C. Santhosh Kumar, National Institute of Technology, Tiruchirappalli (India) [9558-42]
- Statistical analysis of partial discharges evolved during aging of synthetic nanofilled polypropylene,** Prathap Basappa, Charles M. Taylor Jr., Antwarr E. Watson, Rohitha Dhara, Norfolk State Univ. (USA) [9558-43]
- Partial discharge characteristics and residual breakdown strength of natural nanofilled polypropylene films when aged with different voltage profiles,** Antwarr Watson, Charles M. Taylor, Rohitha Dhara, Prathap Basappa, Norfolk State Univ. (USA) [9558-44]
- Effect of type of aging voltage on the residual breakdown strength of polypropylene films with natural and synthetic nanofillers,** Charles M. Taylor, Antwarr Watson, Rohitha Dhara, Prathap Basappa, Norfolk State Univ. (USA) [9558-45]

## THURSDAY 13 AUGUST

### SESSION 5..... THU 8:40 AM TO 10:10 AM

#### Applications and Devices II

- Session Chair: Yi-Jun Jen, National Taipei Univ. of Technology (Taiwan)
- Plasma-etched nanostructures for optical applications (Invited Paper),** Ulrike Schulz, Friedrich Rickett, Peter Munzert, Norbert Kaiser, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) [9558-15]
- Low temperature near infrared plasmonic gas sensing of gallium and aluminum doped zinc oxide thin films from colloidal inks,** Marco Sturaro, Univ. degli Studi di Padova (Italy); Enrico Della Gaspera, Commonwealth Scientific and Industrial Research Organisation (Australia); Alessandro Martucci, Massimo Guglielmi, Univ. degli Studi di Padova (Italy) [9558-16]
- Graphene-metal interfaces for biosensors devices,** Paola Zuppella, Francesca Gerlin, Alain J. Corso, Davide Bacco, Enrico Tessarolo, Marco Nardello, Maria G. Pelizzo, CNR-IFN UoS Padova (Italy) [9558-17]
- Microfluidic control on nano-plasmonic thin films using Marangoni effect,** Kyoko Namura, Kaoru Nakajima, Kenji Kimura, Motofumi Suzuki, Kyoto Univ. (Japan) [9558-18]

### SESSION 6..... THU 10:40 AM TO 12:00 PM

#### Characterization II

Session Chair: Stephane Bruynooghe, Carl Zeiss AG (Germany)

- The optical and electronic properties of pyrite nanocrystals and solid thin film,** Guangmei Zhai, Taiyuan Univ. of Technology (China) and Changzhou Univ. (China) and State Key Lab. of Electronic Thin Films & Integrated Devices (China); Rongwei Xie, Heng Wang, Jitao Zhang, Yongzhen Yang, Hua Wang, Xuemin Li, Xuguang Liu, Bingshe Xu, Taiyuan Univ. of Technology (China) [9558-19]

- Investigation the stress of the  $\text{SiOxCyHz}$  thin film deposited by HMDSO/O<sub>2</sub> plasma polymerization,** Wei-Bo Liao, Ching-Long Cheng, Cheng-Chung Lee, National Central Univ. (Taiwan); Cheng-Chung Jaing, Minghsin Univ. of Science and Technology (Taiwan); Chien-Cheng Kuo, National Central Univ. (Taiwan) [9558-20]

- Investigation of the optoelectronic characteristics of graphene/perovskite/porous silicon nanowires heterostructure,** Wun Wei Lin, National Taipei Univ. of Technology (Taiwan) [9558-21]

- Surface morphology of ultrathin graphene oxide films obtained by the SAW atomization,** Olga Balachova, Sergey Balashov, Aristides Pavani Filho, Ctr. de Tecnologia da Informacao Renato Archer (Brazil) [9558-22]

Lunch/Exhibition Break ..... Thu 12:00 pm to 1:40 pm

### SESSION 7..... THU 2:00 PM TO 3:10 PM

#### Control and Modification II

Session Chair: Akio Takada, Dexerials Corp. (Japan)

- Periodic nanostructures for tunable thin optics (Invited Paper),** Francesco Simoni, Univ. Politecnica delle Marche (Italy); Luigino Criante, Istituto Italiano di Tecnologia (Italy) and Univ. Politecnica delle Marche (Italy); Francesco Scotognella, Luca Passoni, Istituto Italiano di Tecnologia (Italy) and Politecnico di Milano (Italy); Francesco Fumagalli, Istituto Italiano di Tecnologia (Italy); Guglielmo Lanzani, Istituto Italiano di Tecnologia (Italy) and Politecnico di Milano (Italy); Fabio Di Fonzo, Istituto Italiano di Tecnologia (Italy) [9558-23]

- Effects of silver-nanoparticle layer in chiral sculptured thin films for multiplasmonic sensing,** Stephen E. Swiontek, Akhlesh Lakhtakia, The Pennsylvania State Univ. (USA) [9558-24]

- Phoxonic one-dimensional heterostructure with photonic and phononic band gaps at the same frequency,** Jesus Manzanares-Martinez, Paola Castro-Garay, Betsabe Manzanares-Martinez, Univ. de Sonora (Mexico); Damian Moctezuma-Enriquez, Ctr. de Investigación en Materiales Avanzados, S.C. (Mexico); Yohan Jasid Rodriguez-Viveros, Carlos Ivan Ham-Rodriguez, Univ. de Sonora (Mexico) [9558-26]

### SESSION 8..... THU 3:40 PM TO 5:00 PM

#### Fabrication

Session Chair: Luigino Criante, Istituto Italiano di Tecnologia (Italy)

- Self-assembled molecular nanowires of discotic liquid crystals,** Ji Hyun Park, Kyungho Kim, Seoul National Univ. (Korea, Republic of); Yoichi Takanishi, Jun Yamamoto, Kyoto Univ. (Japan); Yung Woo Park, Youn Sang Kim, Seoul National Univ. (Korea, Republic of); Giusy Scalia, Seoul National Univ. (Korea, Republic of) and Univ. du Luxembourg (Luxembourg) [9558-27]

- Room temperature deposition of highly dense  $\text{TiO}_2$  thin films by filtered cathodic vacuum arc,** Elena Guillén, Irene Heras, Gonzalo Rincón Llorente, Abengoa (Spain); Frank Lungwitz, Helmholtz-Zentrum Dresden-Rossendorf e. V. (Germany); Mercedes Alcon Camas, Ramon Escobar, Abengoa (Spain) [9558-28]

- Deposition and characterization of Fe-Si based ionic glass thin films,** Neil R. Murphy, Air Force Research Lab. (USA); Lirong Sun, General Dynamics Information Technology (USA); John G. Jones, Air Force Research Lab. (USA); John T. Grant, General Dynamics Information Technology (USA) [9558-29]

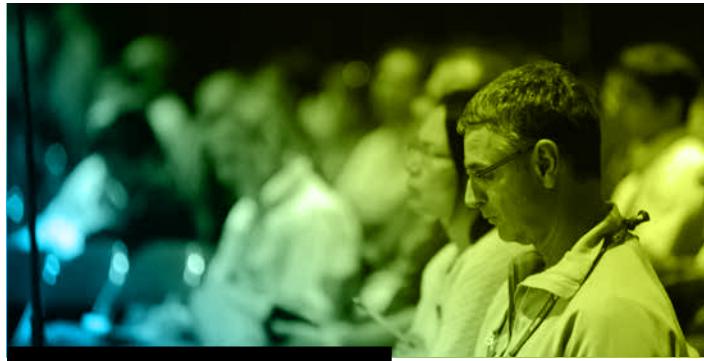
- Fabrication and characterization of film coatings of silver nanoparticles with different composite agents,** Vasyl J. Syrvatka, Yuri I. Slyvchuk, Ivan I. Rozgoni, Institute of Animal Biology NAAS (Ukraine); Nestor O. Piasetskyi, Ivan Franko National Univ. of L'viv (Ukraine); Oksana V. Shtapenko, Ivan I. Gevkan, Institute of Animal Biology NAAS (Ukraine); Oleksandr I. Bilyy, Roman Y. Serkiz, Ivan Franko National Univ. of L'viv (Ukraine); Iryna O. Matyukha, Svitlana V. Fyodorova, Institute of Animal Biology NAAS (Ukraine) [9558-30]

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# OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY.

A conference focused on the development of new sustainable energy sources, and other renewable technologies, materials, and systems.

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- THIN FILMS
  - CONCENTRATORS
  - RELIABILITY
  - CELL TECHNOLOGIES
  - SOLAR HYDROGEN
  - NONIMAGING OPTICS
  - OPVs
- 

## Optics + Photonics for Sustainable Energy

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- 9559 High and Low Concentrator Systems for Solar Energy Applications X (*Plesniak, Prescod*) ..... p. 72
- 9560 Solar Hydrogen and Nanotechnology X (*Shen*) ..... p. 73
- 9561 Thin Films for Solar and Energy Technology VII (*Eldada, Heben*) ..... p. 76
- 9562 Next Generation Technologies for Solar Energy Conversion VI (*Sulima, Conibeer*) ..... p. 78
- 9563 Reliability of Photovoltaic Cells, Modules, Components, and Systems VIII (*Dhere, Wohlgemuth, Jones-Albertus*) ..... p. 80
- 9567 Organic Photovoltaics XVI (*Kafafi, Lane, Samuel*) ..... p. 92
- 9572 Nonimaging Optics: Efficient Design for Illumination and Solar Concentration XII (*Winston, Gordon*) ..... p. 112



**Oleg V. Sulima,**  
GE Global Research (USA)  
*Symposium Chair*

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
Symposium-wide Plenary Session, 6:00 to 7:30 PM	Sustainable Energy Plenary Session, 2:00 to 4:30 PM  Poster Session, 5:30 to 7:30 PM			
<b>SOLAR ENERGY + TECHNOLOGY</b>				
		9559 High and Low Concentrator Systems for Solar Energy Applications X <i>(Plesniak, Prescod)</i>		
9560 Solar Hydrogen and Nanotechnology X ( <i>Shen</i> )				
9561 Thin Films for Solar and Energy Technology VII <i>(Eldada, Heben)</i>	9562 Next Generation Technologies for Solar Energy Conversion VI <i>(Sulima, Conibeer)</i>			
9563 Reliability of Photovoltaic Cells, Modules, Components, and Systems VIII <i>(Dhere, Wohlgemuth, Jones-Albertus)</i>				
9572 Nonimaging Optics: Efficient Design for Illumination and Solar Concentration XII <i>(Winston, Gordon)</i>	9567 Organic Photovoltaics XVI <i>(Kafafi, Lane, Samuel)</i>			



SPIE Optics + Photonics is a leading conference on green photonics technologies such as energy, sustainability, conservation, and environmental monitoring.

Monday-Tuesday 10-11 August 2015 • Proceedings of SPIE Vol. 9559

# High and Low Concentrator Systems for Solar Energy Applications X

Conference Chairs: Adam P. Plesniak, Arzon Solar, LLC (USA); Andru J. Prescod, SunShot Initiative, U.S. Dept. of Energy (USA), ManTech International Corp. (United States)

Program Committee: Harry A. Atwater Jr., California Institute of Technology (USA); Noel C. Giebink, The Pennsylvania State Univ. (USA); Raymond K. Kostuk, The Univ. of Arizona (USA)

## MONDAY 10 AUGUST

<b>OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY</b>
<b>PLENARY SESSION..... 2:00 PM TO 4:30 PM</b>
Session Chair: Oleg V. Sulima, GE Global Research (USA)
<b>Status and challenges of CuTe photovoltaics (Plenary)</b> , Wyatt K. Metzger, National Renewable Energy Lab. (USA) ..... [9561-201]
<b>Photochemical upconversion of light for renewable energy and more (Plenary)</b> , Timothy W. Schmidt, The Univ. of New South Wales (Australia) ..... [9562-202]
<b>The importance of reliability to the SunShot Initiative (Plenary)</b> , Rebecca Jones-Albertus, U.S. Dept. of Energy (USA) ..... [9563-203]
<b>Solar hydrogen: harvesting light and heat from sun (Plenary)</b> , Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-204]

## POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>

<b>New trends in solar</b> , Divya Mereddy, Mounica Gampa, Vijay Ram Raju V., Gokaraju Rangaraju Institute of Engineering & Technology (India) ..... [9559-17]
<b>A method of large Fresnel lens characterization</b> , Christi K. Madsen, Mark Hallam, William Harris, Texas A&M Univ. (USA) ..... [9559-18]

## TUESDAY 11 AUGUST

## SESSION 1..... TUE 8:40 AM TO 10:00 AM

### Concentrating Optics and Transmission

Session Chair: Andru J. Prescod, SunShot Initiative, U.S. Dept. of Energy (USA), ManTech International Corp. (USA)

<b>Fresnel lens characterization for solar concentration efficiency</b> , Christi K. Madsen, Mark Hallam, William Harris, Texas A&M Univ. (USA) ..... [9559-1]
<b>Demonstration of an intermediate-scale lens-to-channel waveguide solar concentrator</b> , Ran Huang, Yuxiao Liu, Christi K. Madsen, Texas A&M Univ. (USA) ..... [9559-2]
<b>Direct transmission of concentrated solar radiation via optical fibre bundles to thermal applications</b> , Maryam Rahou, John Andrews, Gary Rosengarten, RMIT Univ. (Australia) ..... [9559-3]
<b>Fabrication and comparison of selective, transparent optics for concentrating solar systems</b> , Robert A. Taylor, Yasitha Hewakuruppu, The Univ. of New South Wales (Australia); Todd Otanicar, The Univ. of Tulsa (USA) ..... [9559-4]

## SESSION 2 ..... TUE 10:30 AM TO 11:50 AM

### Absorbers, Coatings, and Receivers

Session Chair: Andru J. Prescod, SunShot Initiative, U.S. Dept. of Energy (USA), ManTech International Corp. (USA)

<b>High-temperature selective solar thermal absorber based on Fabry-Perot resonance cavity</b> , Hao Wang, Liping Wang, Arizona State Univ. (USA) ... [9559-5]
<b>Solar selective coatings based on carbon:transition metal nanocomposites</b> , Irene Heras, Elena Guillén, Abengoa Research (Spain); Matthias Krause, Helmholtz-Zentrum Dresden-Rossendorf e. V. (Germany); Almoha Pardo, Fundació CTM Ctr. Tecnològic (Spain); Jose Luis Endrino, Ramon Escobar, Abengoa Research (Spain) ... [9559-6]
<b>Coupled optical-thermal-fluid and structural analyses of novel light-trapping tubular panels for concentrating solar power receivers</b> , Jesus D. Ortega, Joshua M. Christian, Julius E. Yellowhair, Clifford K. Ho, Sandia National Labs. (USA) ... [9559-7]

<b>Testing and optical modeling of novel concentrating solar receiver geometries to increase light trapping and effective solar absorptance</b> , Clifford K. Ho, Julius E. Yellowhair, Jesus D. Ortega, Joshua M. Christian, Charles E. Andraka, Sandia National Labs. (USA) ... [9559-8]
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Lunch/Exhibition Break ..... Tue 11:50 am to 1:50 pm

## SESSION 3 ..... TUE 1:50 PM TO 3:10 PM

### PV and Hybrid PV-thermal

Session Chair: Adam P. Plesniak, Arzon Solar, LLC (USA)

<b>Design and analysis of combined photovoltaic-thermal electric systems for reducing intermittency effects of solar illumination</b> , Silvana Ayala Pelaez, Shelby D. Vorndran, Yuechen Wu, Juan Manuel Russo, Raymond K. Kostuk, The Univ. of Arizona (USA) ... [9559-9]
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<b>Design and feasibility of high temperature nanoparticle fluid filter in hybrid thermal/photovoltaic concentrating solar power</b> , Drew DeJarnette, Nick Brekke, Ebrima Tunkara, Hari Parameswar, Kenneth Roberts, Todd Otanicar, The Univ. of Tulsa (USA) ... [9559-10]
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<b>A high temperature hybrid photovoltaic-thermal receiver employing spectral beam splitting for linear solar concentrators</b> , Ahmad Mojiri, Cameron C. Stanley, Gary Rosengarten, RMIT Univ. (Australia) ... [9559-11]
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<b>Concentrating PV module output power using a wireless microcontroller based automatic sun tracker</b> , Ali Abou-Elnour, Ajman Univ. of Science & Technology (United Arab Emirates) ... [9559-12]
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## SESSION 4 ..... TUE 3:40 PM TO 5:00 PM

### Holographic Systems and Electrowetting

Session Chair: Adam P. Plesniak, Arzon Solar, LLC (USA)

<b>Simulation of an electrowetting solar concentration cell</b> , K.I. Iftekhar Uddin Khan, Gary Rosengarten, RMIT Univ. (Australia) ... [9559-13]
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<b>Holographic lens spectrum splitting photovoltaic system for increased diffuse collection and annual energy yield</b> , Shelby D. Vorndran, Yuechen Wu, Silvana Ayala Pelaez, Raymond K. Kostuk, The Univ. of Arizona (USA) ... [9559-14]
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<b>Compound Holographic concentrating system for laterally arranged multiple band gap solar cells</b> , Hiralal L. Yadav, Shivam Nigam, National Institute of Technology, Jamshedpur (India); Asghar Khan, Karim City College (India); N. R. Cakraborty, Kolhan Univ., Chaibasa (India) ... [9559-15]
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<b>Design of a holographic micro-scale spectrum-splitting photovoltaic system</b> , Yuechen Wu, Shelby D. Vorndran, Silvana Ayala Pelaez, Juan Manuel Russo, Raymond K. Kostuk, The Univ. of Arizona (USA) ... [9559-16]
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Sunday-Thursday 9-13 August 2015 • Proceedings of SPIE Vol. 9560

# Solar Hydrogen and Nanotechnology X

Conference Chair: Shaohua Shen, Xi'an Jiaotong Univ. (China)

Program Committee: Hironori Arakawa, Tokyo Univ. of Science (Japan); Jan Augustynski, Univ. of Warsaw (Poland); Michael Grätzel, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Jinghua Guo, Lawrence Berkeley National Lab. (USA); Hicham Idriss, SABIC (Saudi Arabia); Yosuke Kanai, The Univ. of North Carolina at Chapel Hill (USA); Claude Levy-Clement, Ctr. National de la Recherche Scientifique (France); Sanjay Mathur, Univ. zu Köln (Germany); Frank E. Osterloh, Univ. of California, Davis (USA); David Prendergast, Lawrence Berkeley National Lab. (USA); Yasuhiro Tachibana, RMIT Univ. (Australia); John A. Turner, National Renewable Energy Lab. (USA); Lionel Vayssières, Xi'an Jiaotong Univ. (China); Heli Wang, National Renewable Energy Lab. (USA); Gunnar Westin, Uppsala Univ. (Sweden); Upul Wijayantha, Loughborough Univ. (United Kingdom); Jin Zhang, Univ. of California, Santa Cruz (USA)

## SUNDAY 9 AUGUST

### A DECADE OF SPIE SOLAR HYDROGEN AND NANOTECHNOLOGY ..... 1:30 PM TO 1:40 PM

Shaohua Shen, Xi'an Jiaotong Univ. (China)

### SESSION 1 ..... SUN 1:40 PM TO 3:30 PM

#### Session 1

Session Chair: Shaohua Shen, Xi'an Jiaotong Univ. (China)

**Low-cost and high-efficiency solar hydrogen conversion: On materials design and pilot-scale demonstration** (*Keynote Presentation*), Liejin Guo, Shaohua Shen, Xi'an Jiaotong Univ. (China) ..... [9560-1]

**Kinetically optimised sensitized TiO<sub>2</sub> structures for solar energy conversion** (*Keynote Presentation*), Yasuhiro Tachibana, RMIT Univ. (Australia) ..... [9560-2]

**A theoretical study of photo-induced electron kinetics in composite photocatalytic system** (*Invited Paper*), Jun Jiang, Univ. of Science and Technology of China (China) ..... [9560-3]

### SESSION 2 ..... SUN 4:00 PM TO 5:50 PM

#### Session 2

Session Chair: Yasuhiro Tachibana, RMIT Univ. (Australia)

**In situ/operando soft x-ray spectroscopy characterization of interfacial phenomena in energy materials and devices** (*Keynote Presentation*), Yi-Sheng Liu, Per-Anders Glans, Jinghua Guo, Lawrence Berkeley National Lab. (USA) ..... [9560-4]

**Metal-complex/semiconductor hybrids for carbon dioxide fixation** (*Invited Paper*), Kazuhiko Maeda, Tokyo Institute of Technology (Japan) ..... [9560-5]

**Developing plasmonic nanostructures towards enhanced photocatalytic activity** (*Invited Paper*), Dongling Ma, Institut National de la Recherche Scientifique (Canada) ..... [9560-42]

**The heteropolyacid based photocatalytic intercalated nanomaterials**, Jihuai Wu, Jianming Lin, Miaoliang Huang, Huajiao Univ. (China) ..... [9560-6]

### SYMPOSIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

### NANOSCIENCE + ENGINEERING PLENARY SESSION ..... MON 9:15 AM TO 12:00 PM

Session Chairs: Satoshi Kawata, Osaka Univ. (Japan); David L. Andrews, Univ. of East Anglia (United Kingdom)

**Extreme Imaging and Beyond** (*Plenary*), Keisuke Goda, The Univ. of Tokyo (Japan) ..... [9544-500]

**Nano-Bio-Optomechanics: Nanoaperture Tweezers Probe Single Nanoparticles, Proteins, and their Interactions** (*Plenary*), Reuven Gordon, Univ. of Victoria (Canada) ..... [9544-501]

**Device Applications of Semiconductor Nanoantennas and Metafilms** (*Plenary*), Mark L. Brongersma, Geballe Lab. for Advanced Materials (GLAM) (USA) ..... [9544-502]

Lunch Break ..... Mon 12:00 pm to 2:00 pm

### OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY PLENARY SESSION ..... 2:00 PM TO 4:30 PM

Session Chair: Oleg V. Sulima, GE Global Research (USA)

**Status and challenges of CdTe photovoltaics** (*Plenary*), Wyatt K. Metzger, National Renewable Energy Lab. (USA) ..... [9561-201]

**Photochemical upconversion of light for renewable energy and more** (*Plenary*), Timothy W. Schmidt, The Univ. of New South Wales (Australia) ..... [9562-202]

**The importance of reliability to the SunShot Initiative** (*Plenary*), Rebecca Jones-Albertus, U.S. Dept. of Energy (USA) ..... [9563-203]

**Solar hydrogen: harvesting light and heat from sun** (*Plenary*), Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-204]

### POSTERS-MONDAY ..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Water splitting by copper oxide photocathodes**, Chia-Ying Chiang, National Taiwan Univ. of Science and Technology (Taiwan) ..... [9560-47]

**Preparation of N<sub>2</sub>-plasma assisted visible light active ordered mesoporous nitrogen doped TiO<sub>2</sub> thin films for solar energy conversion**, Syed Z. Islam, Allen D. Reed, Doo-Young Kim, Stephen E. Rankin, Univ. of Kentucky (USA) .. [9560-48]

# CONFERENCE 9560

TUESDAY 11 AUGUST

SESSION 3 ..... TUE 8:30 AM TO 10:10 AM

## Session 3

Session Chair: **Lionel Vayssières**, Xi'an Jiaotong Univ. (China)

A dynamic perspective on charge carriers in quantum-dot sensitized metal oxide nanostructures for photoelectrochemical solar hydrogen generation (*Keynote Presentation*), Jin Zhong Zhang, Univ. of California, Santa Cruz (USA) ..... [9560-8]

Enabling overall water splitting with hematite and Si (*Invited Paper*), Dunwei Wang, Boston College (USA) ..... [9560-9]

Insight into materials properties for a photo electrochemical based solar refinery (*Invited Paper*), Joan Ramón Morante, Institut de Recerca en Energia de Catalunya (Spain) and The Univ. de Barcelona (Spain) ..... [9560-10]

SESSION 4 ..... TUE 10:30 AM TO 12:00 PM

## Session 4

Session Chair: **Ke Sun**, California Institute of Technology (USA)

Surface science insights into surface and interface properties of photoelectrocatalysts for solar fuels (*Keynote Presentation*), Bruce E. Koel, Coleman X. Kronawitter, Peng Zhao, Zhu Chen, Princeton Univ. (USA) .. [9560-11]

Surface chemistry of molecular catalysts on model photoelectrodes for solar fuels by CO<sub>2</sub> reduction (*Invited Paper*), Coleman X. Kronawitter, Peng Zhao, Bruce E. Koel, Princeton Univ. (USA) ..... [9560-12]

Photocatalytic hydrogen production over CdS: Effects of reaction atmosphere studied by *in situ* Raman spectroscopy, Lijing Ma, Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-13]

Lunch/Exhibition Break ..... Tue 12:00 pm to 1:30 pm

SESSION 5 ..... TUE 1:30 PM TO 3:30 PM

## Session 5

Session Chair: **Bruce E. Koel**, Princeton Univ. (USA)

Synchrotron-based spectroscopy for solar energy conversion (*Keynote Presentation*), Franz J. Himpel, Univ. of Wisconsin-Madison (USA) .... [9560-14]

Interfacial atomic and electronic structure of energy-related material characterized by synchrotron x-ray spectroscopy (*Invited Paper*), Chung-Li Dong, National Synchrotron Radiation Research Ctr. (Taiwan) ..... [9560-15]

Thin film catalyst integration onto silicon: Engineering materials and interfaces for efficient and stable photoanodic water oxidation (*Invited Paper*), Ian D. Sharp, Jinhui Yang, Lawrence Berkeley National Lab. (USA) ..... [9560-16]

High aspect ratio WO<sub>3</sub> nanorod arrays based WO<sub>3</sub>/BiVO<sub>4</sub> Heterojunction for photoelectrochemical water splitting, Jinzhuan Su, Xi'an Jiaotong Univ. (China) ..... [9560-17]

SESSION 6 ..... TUE 4:00 PM TO 5:30 PM

## Session 6

Session Chair: **Zetian Mi**, McGill Univ. (Canada)

Rational design of titania-based functional nanostructures (*Keynote Presentation*), Yadong Yin, Univ. of California, Riverside (USA) ..... [9560-18]

From UV/visible to near-infrared light activity: Recent progress in photocatalysis (*Invited Paper*), Hong Liu, Shandong Univ. (China) ..... [9560-19]

Preparation of Cu<sub>2</sub>O/TiO<sub>2</sub> nanotube arrays and its photoelectrochemical properties as hydrogen-evolving photoanode, Lixia Sang, Jing Zhang, Beijing Univ. of Technology (China) ..... [9560-20]

WEDNESDAY 12 AUGUST

SESSION 7 ..... WED 8:30 AM TO 10:10 AM

## Session 7

Session Chair: **Frank E. Osterloh**, Univ. of California, Davis (USA)

Electron dynamics at semiconductor-molecule interfaces: Insights from first-principles dynamics simulation (*Keynote Presentation*), Yosuke Kanai, The Univ. of North Carolina at Chapel Hill (USA) ..... [9560-21]

Solution-processed photocathodes for solar water splitting tandem cells (*Invited Paper*), Kevin Sivula, Néstor Guijarro, Florian Le Formal, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9560-22]

Exploring the time-scale of photo-initiated interfacial electron transfer through first-principles interpretation of ultrafast X-ray spectroscopy (*Invited Paper*), David Prendergast, Lawrence Berkeley National Lab. (USA) ..... [9560-23]

SESSION 8 ..... WED 10:30 AM TO 12:00 PM

## Session 8

Session Chair: **Gunnar Westin**, Uppsala Univ. (Sweden)

Nanoscale junctions for water splitting photocatalysis (*Keynote Presentation*), Frank E. Osterloh, Benjamin A. Nail, Jing Zhao, Jiarui Wang, Kathryn A. Newton, Yuxin Yang, Po Wu, Zongkai Wu, Geetu Sharma, Univ. of California, Davis (USA) ..... [9560-24]

Rapid flame processing of metal oxides photoanodes for enhanced solar water-splitting (*Invited Paper*), Xiaolin Zheng, Stanford Univ. (USA) ..... [9560-25]

NH<sub>3</sub>-treated MoS<sub>2</sub> nanosheets for enhanced H<sub>2</sub> evolution under visible-light irradiation, Jinwen Shi, Yazhou Zhang, Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-26]

Lunch/Exhibition Break ..... Wed 12:00 pm to 1:30 pm

SESSION 9 ..... WED 1:30 PM TO 3:30 PM

## Session 9

Session Chair: **Chung-Li Dong**, National Synchrotron Radiation Research Ctr. (Taiwan)

On the surface, confinement, and dimensionality effects of large bandgap oxide semiconductors (*Keynote Presentation*), Lionel Vayssières, Xi'an Jiaotong Univ. (China) ..... [9560-27]

Photocatalytic water splitting: Using a 2-photon approach (*Invited Paper*), Brian J. Seger, Bastian Timo Mei, Dowon Bae, Mauro Malizia, Thomas Pedersen, Peter C. Vesborg, Ole Hansen, Ib Chorkendorff, Technical Univ. of Denmark (Denmark) ..... [9560-28]

Photocatalytic evolution of molecular hydrogen and oxygen over La-doped NaTaO<sub>3</sub> particles: Effect of different cocatalysts (*Invited Paper*), Irina Ivanova, Leibniz Univ. Hannover (Germany); Tarek Kandiel, Sohag Univ. (Egypt); Amer Hakki, Ralf Dillert, Detlef W. Bahnemann, Leibniz Univ. Hannover (Germany) ..... [9560-29]

Effect of potential on the conductivity of electrodeposited Cu<sub>2</sub>O film, Ying Yang, Juan Han, Xiaohui Ning, Hongsheng Tang, Northwest Univ. (China) [9560-30]

SESSION 10 ..... WED 4:00 PM TO 5:40 PM

## Session 10

Session Chair: **Hicham Idriss**, SABIC (Saudi Arabia)

Materials and devices for efficient solar-to-hydrogen production (*Keynote Presentation*), Heli Wang, National Renewable Energy Lab. (USA); Joel W. Ager III, Joint Ctr. for Artificial Photosynthesis (USA) and Lawrence Berkeley National Lab. (USA); Nicolas M. Gaillard, Univ. of Hawai'i (USA) and Hawaii Natural Energy Institute (USA); Eric L. Miller, U.S. Dept. of Energy (USA) ..... [9560-31]

Simultaneous photocharging and photoelectrochemical water splitting over oxide semiconductor thin films (*Invited Paper*), Yun Hau Ng, The Univ. of New South Wales (Australia) ..... [9560-32]

Efficient and low-cost photoelectrodes for solar water splitting (*Invited Paper*), Wenjun Luo, Nanjing Tech Univ. (China) ..... [9560-33]

# CONFERENCE 9560

THURSDAY 13 AUGUST

SESSION 11 ..... THU 9:00 AM TO 10:10 AM

## Session 11

Session Chair: **Yosuke Kanai**, The Univ. of North Carolina at Chapel Hill  
(USA)

**Hydrogen production from water by thermal and photo-excited methods**  
(*Keynote Presentation*), Hicham Idriss, SABIC (Saudi Arabia) ..... [9560-34]

**Functional NiO<sub>x</sub> catalyst protected small band gap semiconductors for efficient and stable solar driven water oxidation** (*Invited Paper*), Ke Sun, Nathan S. Lewis, California Institute of Technology (USA) ..... [9560-35]

SESSION 12 ..... THU 10:30 AM TO 12:00 PM

## Session 12

Session Chair: **Mahendra K. Sunkara**, Univ. of Louisville (USA)

**Synthesis and assembly of 1D inorganic semiconductor for solar energy conversion** (*Invited Paper*), Xinjian Feng, Suzhou Institute of Nano-tech and Nanobionics (China) ..... [9560-36]

**Photoelectrochemical water splitting and hydrogen generation using InGaN/GaN nanowires grown directly on Si** (*Invited Paper*), Zetian Mi, Bandar M. AlOttaibi, Shizhao Fan, McGill Univ. (Canada) ..... [9560-38]

**Design of inorganic hybrid structures for photocatalytic energy conversion** (*Invited Paper*), Yujie Xiong, Univ. of Science and Technology of China (China) ..... [9560-39]

Lunch/Exhibition Break ..... Thu 12:00 pm to 1:30 pm

SESSION 13 ..... THU 1:30 PM TO 3:40 PM

## Session 13

Session Chair: **Lionel Vayssières**, Xi'an Jiaotong Univ. (China)

**Complex composition and shape materials for renewable energy applications** (*Keynote Presentation*), Gunnar Westin, Uppsala Univ. (Sweden) ..... [9560-40]

**New III-V semiconductor alloys for solar hydrogen production** (*Invited Paper*), Mahendra K. Sunkara, Harry B. Russell, Alejandro Garcia, Swathi Sunkara, Jacek B. Jasinski, Univ. of Louisville (USA); Madhusudan K. Menon, Univ. of Kentucky (USA) ..... [9560-41]

**Plasmonic metal nanostructures as photosensitizers** (*Invited Paper*), Nianqiang Wu, West Virginia Univ. (USA) ..... [9560-43]

**Electrophoretic deposition of composition-tunable (Cu<sub>2</sub>Sn)<sub>x</sub>Zn<sub>3(1-x)</sub>S<sub>3</sub> nanocrystal films as efficient photocathodes for photoelectrochemical water splitting**, Yubin Chen, Zhixiao Qin, Liejin Guo, Xi'an Jiaotong Univ. (China) [9560-7]

SESSION 14 ..... THU 4:00 PM TO 5:30 PM

## Session 14

Session Chair: **Shaohua Shen**, Xi'an Jiaotong Univ. (China)

**Ag-Au bimetallic nanocubes with excellent SERS activity and chemical stability** (*Invited Paper*), Dong Qin, Yin Yang, Xiaojun Sun, Jiawei Zhang, Georgia Institute of Technology (USA) ..... [9560-44]

**Experimental and numerical study on an annular fluidized-bed photocatalytic reactor** (*Invited Paper*), Dengwei Jing, Xi'an Jiaotong Univ. (China) ..... [9560-45]

**Hydrogen storage in high surface area materials: Amorphous graphene oxide and hybrid nanoporous oxides** (*Invited Paper*), Vassilios D. Binas, Foundation for Research and Technology-Hellas (Greece) and Univ. of Crete (Greece) .. [9560-46]

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# Thin Films for Solar and Energy Technology VII

Conference Chairs: **Louay A. Eldada**, Quanergy Systems, Inc. (USA); **Michael J. Heben**, The Univ. of Toledo (USA)

Program Committee: **Bulent Basol**, EncoreSolar, Inc. (USA); **Howard M. Branz**, National Renewable Energy Lab. (USA); **Paola Delli Veneri**, ENEA (Italy); **David S. Ginley**, National Renewable Energy Lab. (USA); **Ivan Gordon**, IMEC (Belgium); **William N. Shafarman**, Univ. of Delaware (USA); **Ayodhya N. Tiwari**, EMPA (Switzerland)

## SUNDAY 9 AUGUST

SESSION 1 ..... SUN 2:00 PM TO 3:20 PM

### Simulation, Modelling, Testing, and Metrology

Session Chair: **Zhaoning Song**, The Univ. of Toledo (USA)

**A combined optical-electrical finite-element simulation of nonhomogeneous thin-film solar cells**, Tom H. Anderson, The Univ. of Edinburgh (United Kingdom); Muhammad Faryad, Lahore Univ. of Management Sciences (Pakistan); Tom G. Mackay, The Univ. of Edinburgh (United Kingdom); Akhlesh Lakhtakia, The Pennsylvania State Univ. (USA) ..... [9561-1]

**Theoretical limits of the multistacked 1-D and 2-D microstructured inorganic solar cells**, Emre Yengel, Çankaya Univ. (Turkey); Hakan Karaagac, Istanbul Technical Univ. (Turkey); Logeeswaran Veerayah Jayaraman, M. Saif Islam, Univ. of California, Davis (USA) ..... [9561-2]

**On the broadband continuous excitation of surface-plasmon-polariton waves in an amorphous silicon solar cell**, Mahmoud Atalla, The Pennsylvania State Univ. (USA) ..... [9561-3]

**Robust measurement of thin-film photovoltaic modules exhibiting light-induced transients**, Michael G. Deceglie, Timothy J. Silverman, Bill Marion, Sarah R. Kurtz, National Renewable Energy Lab. (USA) ..... [9561-5]

SESSION 2 ..... SUN 3:50 PM TO 4:50 PM

### Perovskites

Session Chair: **Carina Bronnbauer**, iMEET (Germany)

**Manipulate the grain size and crystallinity of hybrid perovskite films for device efficiency and stability improvement**, Jinsong Huang, Univ. of Nebraska-Lincoln (USA) ..... [9561-6]

**Novel materials for stable perovskite solar cells**, Antonio Abate, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9561-7]

**Investigation of degradation mechanisms of perovskite-based photovoltaic devices using LBIC mapping**, Zhaoning Song, Suneth C. Watthage, Adam B. Phillips, Brandon L. Tompkins, Randy J. Ellingson, Michael J. Heben, The Univ. of Toledo (USA) ..... [9561-8]

## SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

SESSION 3 ..... MON 8:40 AM TO 10:00 AM

### Materials and Processes

Session Chair: **Zhaoning Song**, The Univ. of Toledo (USA)

**Fabrication of aluminum-doped zinc oxide transparent conductive electrodes using plasma treatment for solar cell applications**, Zhaozhao Zhu, Trent Mankowski, Kaushik Balakrishnan, College of Optical Sciences, The Univ. of Arizona (USA); Ali Sehpar Shikoh, Farid Touati, Mohieddine A. Benammar, Qatar Univ. (Qatar); Masud Mansuripur, Charles M. Falco, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9561-9]

**Cd-Zn-O-S alloys for optimal buffer layers in thin-film photovoltaics**, Joel B. Varley, Lawrence Livermore National Lab. (USA); Xiaoqing He, Univ. of Illinois at Urbana-Champaign (USA); Neil Mackie, MiSolé Hi-Tech Corp. (USA); Angus A. Rockett, Univ. of Illinois at Urbana-Champaign (USA); Vincenzo Lordi, Lawrence Livermore National Lab. (USA) ..... [9561-10]

**Eco-friendly spray coating of organic solar cells through water-based nanoparticles ink**, Jeroen Stryckers, Lien D'Olieslaeger, Jean Manca, Univ. Hasselt (Belgium) and IMEC (Belgium); Anitha Ethirajan, Univ. Hasselt (Belgium) and IMEC (Belgium); Wim Deferne, Univ. Hasselt (Belgium) and IMEC (Belgium) ..... [9561-11]

**A novel method for mapping open-circuit voltage in solar cells with nanoscale resolution**, Elizabeth Tennyson, Joseph L. Garrett, Univ. of Maryland, College Park (USA); Jesse A. Frantz, Jason D. Myers, Robel Y. Bekele, U.S. Naval Research Lab. (USA); Jasbinder S. Sanghera, Univ. Research Foundation (USA); Jeremy N. Munday, Marina S. Leite, Univ. of Maryland, College Park (USA) ..... [9561-4]

SESSION 4 ..... MON 10:30 AM TO 12:30 PM

### Light Management

Session Chair: **Michael G. Deceglie**, National Renewable Energy Lab. (USA)

**On the interplay of light trapping and plasmonic losses in honeycomb textured silicon thin film solar cells**, Asman Tamang, Jacobs Univ. Bremen (Germany); Hitoshi Sai, National Institute of Advanced Industrial Science and Technology (Japan); Vladislav Jovanov, Jacobs Univ. Bremen (Germany); Koji Matsubara, National Institute of Advanced Industrial Science and Technology (Japan); Dietmar Knipp, Jacobs Univ. Bremen (Germany) ..... [9561-12]

**Integrated colored solar selective absorbers array by using the combinatorial deposition technique**, Shao-Wei Wang, Feiliang Chen, Xingxing Liu, Shanghai Institute of Technical Physics (China) and Shanghai Engineering Research Ctr. of Energy-Saving Coatings (China); Zhifeng Li, Shanghai Institute of Technical Physics (China); Xiaoshuang Chen, Wei Lu, Shanghai Institute of Technical Physics (China) and Shanghai Engineering Research Ctr. of Energy-Saving Coatings (China) ..... [9561-13]

**Light trapping enhancement in elliptical nanohole array thin film silicon solar cell**, Yonggang Wu, Zihuan Xia, Xuefei Qin, Jian Zhou, Zhongyi Zhang, Tongji Univ. (China) ..... [9561-14]

**Design of broadband omnidirectional antireflection coatings using ant colony algorithm**, Xia Guo, Beijing Univ. of Technology (China) ..... [9561-15]

**Efficiency enhancement of semitransparent organic solar cells by using printed dielectric mirrors**, Carina Bronnbauer, Karen K. Forberich, Fei Guo, Nicola Gasparini, Christoph J. Brabec, iMEET (Germany) ..... [9561-16]

**Photon-electron harvesting in thin-film flexible solar cells**, Javaneh Boroumand, Debasish Chanda, Univ. of Central Florida (USA) ..... [9561-17]

Lunch Break ..... Mon 12:30 pm to 2:00 pm

# CONFERENCE 9561

OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY PLENARY SESSION..... 2:00 PM TO 4:30 PM	
Session Chair: Oleg V. Sulima, GE Global Research (USA)	
Status and challenges of CdTe photovoltaics ( <i>Plenary</i> ), Wyatt K. Metzger, National Renewable Energy Lab. (USA) .....	[9561-201]
Photochemical upconversion of light for renewable energy and more ( <i>Plenary</i> ), Timothy W. Schmidt, The Univ. of New South Wales (Australia) .....	[9562-202]
The importance of reliability to the SunShot Initiative ( <i>Plenary</i> ), Rebecca Jones-Albertus, U.S. Dept. of Energy (USA) .....	[9563-203]
Solar hydrogen: harvesting light and heat from sun ( <i>Plenary</i> ), Liejin Guo, Xi'an Jiaotong Univ. (China) .....	[9560-204]

## POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Influence of Se interlayer in CIGS absorption layer for solar cell devices,** Suthan Kissinger Nallathambi Jones, Jubail Univ. College (Saudi Arabia); Jae Kwan Sim, Cheul-Ro Lee, Chonbuk National Univ. (Korea, Republic of) .....

[9561-18]  
**Simple 'one step' spray process for CuInS<sub>2</sub> / In<sub>2</sub>S<sub>3</sub> heterojunctions on flexible substrates for photovoltaic applications,** Titu Thomas, K. P. Vijayakumar, Cochin Univ. of Science & Technology (India) .....

[9561-19]  
**A comparison between Zn rich and Zn poor Cu<sub>2</sub>ZnSnS<sub>4</sub> thin film solar cells fabricated by one step electrodeposition method,** Ye Chan Kim, Gwangju Institute of Science and Technology (Korea, Republic of); Ho Jung Jeong, Guk Jin Jeon, Gwangju Institute of Science and Technology (Korea, Republic of); Jae Hyung Jang, Gwangju Institute of Science and Technology (Korea, Republic of) .....

[9561-20]  
**Characterization of Cu<sub>2</sub>ZnSnS<sub>4</sub> thin films prepared by the sulfurization of co-sputtered metal precursors,** Mohamed Abusnina, Univ. of Denver (USA) and National Renewable Energy Lab. (USA); Mohammad Matin, Univ. of Denver (USA); Helio R. Moutinho, Mowafak M. Al-Jassim, National Renewable Energy Lab. (USA) .....

[9561-21]  
**The optical enhancement and dust reduction of photovoltaic module by cleaner liquid,** Cheng-Yu Peng, Shang-Yeh Wen, Industrial Technology Research Institute (Taiwan) .....

[9561-22]  
**Tunability of graphene: Utilizing multilayered nanoclusters,** Shivani Bhardwaj, Alok Ji Shukla, Nilesh Patak, R. P. Sharma, Indian Institute of Technology Delhi (India) .....

[9561-23]  
**Device characteristics of antenna-coupled metal-insulator-metal diodes (rectenna) using Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub> and Cr<sub>2</sub>O<sub>3</sub> as insulator layer for energy harvesting applications,** Mesut Inac, Atia Shafique, Meriç Özcan, Yasar Gurbuz, Sabancı Univ. (Turkey) .....

[9561-24]  
**The electrodeposition of multilayers on a polymeric substrate in flexible organic photovoltaic solar cells,** Andre Guedes, Idaulo Cunha, Simone Tartari, Vilmar P. Guedes, Monica L. Souza, INTELLECTOS (Brazil) .....

Sunday-Tuesday 9-11 August 2015 • Proceedings of SPIE Vol. 9562

# Next Generation Technologies for Solar Energy Conversion VI

Conference Chairs: **Oleg V. Sulima**, GE Global Research (USA); **Gavin Conibeer**, The Univ. of New South Wales (Australia)

Program Committee: **Amanda J. Chatten**, Imperial College London (United Kingdom); **Andrew J. Ferguson**, National Renewable Energy Lab. (USA); **Alberto Salleo**, Stanford Univ. (USA); **Sean E. Shaheen**, Univ. of Colorado at Boulder (USA); **Wilfried G. J. H. M. van Sark**, Utrecht Univ. (Netherlands); **Xianfan Xu**, Purdue Univ. (USA)

## MONDAY 10 AUGUST

<b>OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY</b>
<b>PLENARY SESSION..... 2:00 PM TO 4:30 PM</b>
Session Chair: <b>Oleg V. Sulima</b> , GE Global Research (USA)
<b>Status and challenges of CdTe photovoltaics (Plenary)</b> , Wyatt K. Metzger, National Renewable Energy Lab. (USA) ..... [9561-201]
<b>Photochemical upconversion of light for renewable energy and more (Plenary)</b> , Timothy W. Schmidt, The Univ. of New South Wales (Australia) ..... [9562-202]
<b>The importance of reliability to the SunShot Initiative (Plenary)</b> , Rebecca Jones-Albertus, U.S. Dept. of Energy (USA) ..... [9563-203]
<b>Solar hydrogen: harvesting light and heat from sun (Plenary)</b> , Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-204]

## POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

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**Theoretical calculation of light trapping enhancement in Si SiO<sub>2</sub> core shell nanowires**, Weijian Chen, Jianfeng Yang, Santosh Shrestha, Shujuan Huang, Gavin Conibeer, The Univ. of New South Wales (Australia) ..... [9562-23]

**Analysis of metallic nanoantennas for solar energy conversion**, Brhayllan Mora Ventura, Univ. de Guadalajara (Mexico); Ramón Díaz de León, Univ. Autónoma de San Luis Potosí (Mexico); Guillermo García-Torales, Jorge L. Flores-Nuñez, Univ. de Guadalajara (Mexico); Javier Alda, Univ. Complutense de Madrid (Spain); Francisco Javier González, Univ. Autónoma de San Luis Potosí (Mexico) ..... [9562-24]

**Charge recombination dynamics of perovskite solar cells**, Hee Won Shin, Tae Kyu Ahn, Sungkyunkwan Univ. (Korea, Republic of) ..... [9562-25]

**Mie-resonance-mediated enhanced light trapping in Si nanopillar arrays**, Eunah Kim, Yunae Cho, Ahrum Sohn, Ewha Womans Univ. (Korea, Republic of); Hyeong-Ho Park, Korea Advanced Nano Fab Ctr. (Korea, Republic of); Joondong Kim, Incheon National Univ. (Korea, Republic of); Dong-Wook Kim, Ewha Womans Univ. (Korea, Republic of) ..... [9562-26]

## TUESDAY 11 AUGUST

### SESSION 1..... TUE 8:20 AM TO 10:00 AM

#### **Hot Carriers, Quantum Dots, Nanowires I**

Session Chair: **Gavin Conibeer**, The Univ. of New South Wales (Australia)

**On the road to hot carrier solar cells (Invited Paper)**, P. Craig Taylor, Reuben T. Collins, Colorado School of Mines (USA) ..... [9562-1]

**Carrier multiplication and energy dissipation in Si and Ge nanocrystals (Invited Paper)**, Tom Gregorkiewicz, Saba Saeed, Univ. van Amsterdam (Netherlands) ..... [9562-2]

**Ultrafast carrier dynamics study in zirconium nitride**, Neeti Gupta, Xiaoming Wen, Shujuan Huang, Simon Chung, Santosh Shrestha, Gavin Conibeer, The Univ. of New South Wales (Australia) ..... [9562-3]

**Photovoltage transients in GaAs/InGaAs solar cells**, Roman Holubenko, Artem Yakovliev, Sergey V. Kondratenko, National Taras Shevchenko Univ. of Kyiv (Ukraine) ..... [9562-4]

### SESSION 2 ..... TUE 10:30 AM TO 12:10 PM

#### **Hot Carriers, Quantum Dots, Nanowires II**

Session Chair: **Xianfan Xu**, Purdue Univ. (USA)

**Quantifying energy transfer in semiconductor nanocrystals using coherent phonon manipulation and ultrafast spectroscopy (Invited Paper)**, Bryan T. Spann, U.S. Naval Research Lab. (USA) and Purdue Univ. (USA); Xianfan Xu, Purdue Univ. (USA) ..... [9562-5]

**Hot carrier solar cell absorbers: Investigation of phonon properties of candidate materials (Invited Paper)**, Gavin Conibeer, Santosh Shrestha, Shujuan Huang, Robert Patterson, Hongze Xia, Yu Feng, Suntrana Smyth, Simon Chung, Neeti Gupta, Yi Zhang, Jianfeng Yang, Weijian Chen, Xi Dai, The Univ. of New South Wales (Australia) ..... [9562-6]

**Surface passivated colloidal CuIn(S,Se)<sub>2</sub> quantum dots for quantum dot heterojunction solar cells**, Emre Yassitepe, Univ. Estadual de Campinas (Brazil); Oleksandr Voznyy, Edward Sargent, Univ. of Toronto (Canada); Ana Flavia F. Nogueira, Univ. Estadual de Campinas (Brazil) ..... [9562-7]

**Charge carriers recombination and photogeneration in p-i-n solar cells with InAs quantum dots grown on GaAs substrate**, Artem Yakovliev, Sergiy V. Kondratenko, Roman Holubenko, National Taras Shevchenko Univ. of Kyiv (Ukraine) ..... [9562-8]

Lunch/Exhibition Break ..... Tue 12:10 pm to 1:40 pm

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## SESSION 3 ..... TUE 1:40 PM TO 3:30 PM

### Photon Management

Session Chair: **Sean E. Shaheen**, Univ. of Colorado at Boulder (USA)

**Quasi-random nanopatterns in Blu-ray movie discs for photon management** (*Invited Paper*), Jiaxing Huang, Northwestern University (USA) ..... [9562-9]

**High efficiency photonic nanostructures for thin film solar cells**, Xiaowei Guo, Jia Liu, Univ. of Electronic Science and Technology of China (China) .... [9562-10]

**Singlet-based photon upconversion in multichromophore organic thin films**, Daniel H. Weingarten, Univ. of Colorado at Boulder (USA); Michael LaCount, Colorado School of Mines (USA); Garry Rumbles, Jao van de Lagemaat, National Renewable Energy Lab. (USA); Mark T. Lusk, Colorado School of Mines (USA); Sean E. Shaheen, Univ. of Colorado at Boulder (USA) ..... [9562-11]

**Surface plasmon enhanced infrared absorption in P3HT-based organic solar cells: The effect of infrared sensitizer**, Sungmo Ahn, Univ. of Colorado at Boulder (USA); Alexandre M. Nardes, National Renewable Energy Lab. (USA); Devin Rourke, Univ. of Colorado at Boulder (USA); Jao van de Lagemaat, Nikos Kopidakis, National Renewable Energy Lab. (USA); Wounjhang Park, Univ. of Colorado at Boulder (USA) ..... [9562-12]

**Novel down-converter architecture for Si-based solar efficiency enhancement based on silicon-carbon-oxynitride ( $\text{SiC}_x\text{O}_y\text{N}_z$ ) nanowire arrays**, Vasileios Nikas, Brian Ford, Natasha Tabassum, Mengbing Huang, John G. Hartley, Alain E. Kaloyerous, Spyros Gallis, SUNY CNSE/SUNYIT (USA) ..... [9562-13]

## SESSION 4 ..... TUE 4:00 PM TO 5:00 PM

### New Concepts I

Session Chair: **Oleg V. Sulima**, GE Global Research (USA)

**Embedding solar cell materials with on-board integrated energy storage for load-leveling and dark power delivery**, Cary L. Pint, Andrew S. Westover, Adam P. Cohn, William R. Erwin, Keith Share, Thomas Metke, Rizia Bardhan, Vanderbilt Univ. (USA) ..... [9562-14]

**Organic photovoltaic devices with concurrent solar energy harvesting and charge storage capability**, Arash Takshi, Anand K. Santhanakrishna, Tete Tevi, Houman Yaghoubi, Univ. of South Florida (USA) ..... [9562-15]

**Monolithically self-assembled organic active materials integrated with thermoelectric for large spectrum solar harvesting system**, Tito L. Busani, Olga Lavrova, Matthew Erdman, Julio Martinez, The Univ. of New Mexico (USA) [9562-16]

## WEDNESDAY 12 AUGUST

## SESSION 5 ..... WED 9:00 AM TO 10:10 AM

### Perovskites and DSSC

Session Chair: **Andrew J. Ferguson**, National Renewable Energy Lab. (USA)

**Hot-phonon bottleneck in lead iodide perovskites** (*Invited Paper*), Matthew C. Beard, Ye Yang, National Renewable Energy Lab. (USA) ..... [9562-17]

**Plasmonic enhancement of mesoporous solar cells with shape controlled nanostructures**, Rizia Bardhan, Vanderbilt Univ. (USA) ..... [9562-18]

**Ultrafast time-resolved spectroscopy of lead halide Perovskite films**, Mopeola A Idowu, Federal Univ. of Agriculture (Nigeria) and Univ. of Michigan (USA); Oleg P. Varnavski, Theodore G. Goodson III, Univ. of Michigan (USA) ..... [9562-19]

## SESSION 6 ..... WED 10:40 AM TO 11:40 AM

### New Concepts II

Session Chair: **Oleg V. Sulima**, GE Global Research (USA)

**Emitter thickness optimization for GaSb thermophotovoltaic cells grown by molecular beam epitaxy**, Shaimaa A. Abdallah, Daniel J. Herrera, Nassim Rahimi, Luke F. Lester, Virginia Polytechnic Institute and State Univ. (USA) ..... [9562-20]

**Performance comparison of front-side silver pastes using polyalkylene carbonates for cleaner burning binder system**, Richard Stephenson, Stephenson & Associates, Inc. (USA); Peter Ferraro, Empower Materials, Inc. (USA) .. [9562-21]

**Optimizing the energy band alignment at the  $\text{CdS}/\text{Cu}_2\text{ZnSnS}_4$  heterojunction by Nickel Incorporation**, Hui Ju Chen, National Cheng Kung Univ. (Taiwan) ..... [9562-22]

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# Reliability of Photovoltaic Cells, Modules, Components, and Systems VIII

Conference Chair: **Neelkanth G. Dhere**, Univ. of Central Florida (USA)Conference Co-Chairs: **John H. Wohlgemuth**, National Renewable Energy Lab. (USA); **Rebecca Jones-Albertus**, U.S. Dept. of Energy (USA)

Program Committee: **David S. Albin**, National Renewable Energy Lab. (USA); **Glenn Alers**, Univ. of California, Santa Cruz (USA); **Ward I. Bower**, Sandia National Labs. (USA); **Leila R. O. Cruz**, Instituto Militar de Engenharia (Brazil); **Takuya Doi**, National Institute of Advanced Industrial Science and Technology (Japan); **Fernando Fabero**, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain); **Vivek S. Gade**, Jabil Circuit, Inc. (USA); **William J. Gambogi Jr.**, DuPont (USA); **Werner Herrmann**, TÜV Rheinland Group (Germany); **Stephen J. Hogan**, Spire Corp. (USA); **Aravinda Kar**, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); **Michael Köhl**, Fraunhofer-Institut für Solare Energiesysteme (Germany); **Ralf Leutz**, Concentrator Optics GmbH (Germany); **Xavier Mathew**, Ctr. de Investigación en Energía (Mexico); **Robert McConnell**, Arzon Solar, LLC (USA); **Yoichi Murakami**, Japan Electrical Safety & Environment Technology Labs. (Japan); **F. J. John Pern**, Sunshine Sci-Tech LLC (USA); **Laure-Emmanuelle Perret-Aebi**, Ecole Polytechnique Fédérale de Lausanne (Switzerland); **Shirish Pethe**, Applied Materials, Inc. (USA); **Marianne Rodgers**, Univ. of Central Florida (USA); **Ivan Sinicco**, Oerlikon Solar Ltd. (Switzerland); **Oleg V. Sulima**, GE Global Research (USA); **Bolko von Roedern**, von Roedern & Associates LLC (USA)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 8:30 AM TO 10:10 AM

#### Encapsulant, Backsheet and Packaging Materials

Session Chair: **Keiichiro Sakurai**, National Institute of Advanced Industrial Science and Technology (Japan)

**Development of a resistivity standard for polymeric materials used in photovoltaic modules** (*Invited Paper*), Michael D. Kempe, David C. Miller, Dylan L. Nobles, National Renewable Energy Lab. (USA); Keiichiro Sakurai, National Institute of Advanced Industrial Science and Technology (Japan); John Tucker, Keithley Instruments, Inc. (USA); Jayesh G. Bokria, Specialized Technology Resources, Inc. (USA); Tsuyoshi Shiota, Mitsui Chemicals, Inc. (Japan); Kumar Nanjundiah, The Dow Chemical Co. (USA); Toshio Yoshihara, Dai Nippon Printing Co., Ltd. (Japan); Jeff Birchmier, DNP America, LLC (USA); Ohana Zubillaga, TECNALIA (Spain); John H. Wohlgemuth, National Renewable Energy Lab. (USA) ..... [9563-1]

**Application of new measurement technologies to backsheet durability testing to improve correlation of accelerated exposures to fielded modules** (*Invited Paper*), Thomas C. Felder, William J. Gambogi Jr., Katherine M. Stika, Alexander Z. Bradley, Lucas Amspacher, Bao-Ling Yu, Babak Hamzaviyehshy, R. Scott Peacock, DuPont (USA); Hongjie Hu, DuPont (China) Research & Development and Management Co., Ltd. (China) and DuPont China (China); Lucie A. G. Garreau-Illes, DuPont International Operations Sarl (Switzerland) ..... [9563-2]

**Adhesion and delamination behaviours of photovoltaic backsheet after accelerated laboratory weathering**, Chiao-Chi Lin, Yadong Lyu, Donald L. Hunston, Tinh Nguyen, Xiaohong Gu, National Institute of Standards and Technology (USA) ..... [9563-3]

**Depth profiling of chemical and mechanical degradation for PV backsheets after UV exposure**, Xiaohong Gu, Chiao-Chi Lin, Peter J. Krommenhoek, Stephanie S. Watson, National Institute of Standards and Technology (USA) ..... [9563-4]

### SESSION 2 ..... SUN 10:40 AM TO 12:20 PM

#### PV Module Reliability Accelerated and Outdoor Testing

Session Chair: **Michael D. Kempe**, National Renewable Energy Lab. (USA)

**UV-DH-TC and UV-DML-HF-DH sequential tests for PV modules** (*Invited Paper*), Takuya Doi, National Institute of Advanced Industrial Science and Technology (Japan); Hideyuki Morita, Takao Amioka, Toray Industries, Inc. (Japan); Atsushi Masuda, National Institute of Advanced Industrial Science and Technology (Japan) ..... [9563-5]

**Effects of current injection during damp heat tests on thin film photovoltaic modules** (*Invited Paper*), Keiichiro Sakurai, National Institute of Advanced Industrial Science and Technology (Japan) and Photovoltaic Power Generation Technology Research Association (Japan); Akihiro Takano, Photovoltaic Power Generation Technology Research Association (Japan); Masaaki Yamamichi, National Institute of Advanced Industrial Science and Technology (Japan) and Photovoltaic Power Generation Technology Research Association (Japan); Hiroko Saito, Masayoshi Takani, Photovoltaic Power Generation Technology Research Association (Japan) ..... [9563-6]

**Experimental and computational investigation of microcrack behavior under combined environments in monocrystalline Si**, Wei-Jie Huang, Stefan Bringuier, Kelly Simmons-Potter, Krishna Muralidharan, Barrett G. Potter Jr., The Univ. of Arizona (USA) ..... [9563-7]

**Environmental aging in polycrystalline-Si photovoltaic modules: Comparison of chamber-based accelerated degradation studies with field-test data**, Kelly Simmons-Potter, Teh Lai, Ryan P. Biggie, Adria Brooks, Barrett G. Potter Jr., The Univ. of Arizona (USA) ..... [9563-8]

Lunch Break ..... Sun 12:20 pm to 1:50 pm

### SESSION 3 ..... SUN 1:50 PM TO 3:10 PM

#### Potential Induced Degradation (PID)

Session Chair: **Takuya Doi**, National Institute of Advanced Industrial Science and Technology (Japan)

**PID: From material properties to outdoor performance and quality control counter measures** (*Invited Paper*), Julianne Berghold, Simon Koch, PI Berlin AG (Germany); Sebastian Pingel, PI Solar Technology GmbH (Germany); Paul Grunow, PI Berlin AG (Germany) ..... [9563-9]

**Survey of potential-induced degradation in thin film modules** (*Invited Paper*), Peter Hacke, Kent Terwilliger, Stephen H. Glick, Greg Perrin, Sarah R. Kurtz, National Renewable Energy Lab. (USA) ..... [9563-10]

**A modeling framework for potential induced degradation and soiling in PV modules**, Peter Bermel, Reza Asadpour, Muhammad A. Alam, Purdue Univ. (USA) ..... [9563-11]

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SESSION 4 ..... SUN 3:40 PM TO 5:20 PM

## PV Module Reliability I

Session Chair: **Juliane Berghold**, PI Photovoltaik-Institut Berlin AG (Germany)

**In-situ monitoring of moisture ingress in PV modules (Invited Paper)**, Laure-Emmanuelle Perret-Aebi, Federico Galliano, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland); Fanny Sculati-Meillaud, Eleonora Annigoni, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Heng-Yu Li, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland); Marko Jankovec, Univ. of Ljubljana (Slovenia); Christophe Ballif, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland) ..... [9563-12]

**Investigation of power values of PV rooftop systems based on heat gain reduction (Invited Paper)**, Tanokkorn Chenvidhya, King Mongkut's Univ. of Technology Thonburi (Thailand); Manit Seapan, King Mongkut's Univ. of Technology Thonburi (Thailand); Panom Parinya, King Mongkut's Univ. of Technology Thonburi (Thailand); Buntoon Wiengmoon, Naresuan Univ. (Thailand); Dhirayut Chenvidhya, Roongrojana Songprakorp, Chamnan Limnakul, Yaowannee Sangpongsanont, King Mongkut's Univ. of Technology Thonburi (Thailand) ..... [9563-13]

**Partial illumination stress test for thin-film photovoltaic modules**, Timothy J. Silverman, Michael G. Deceglie, Chris Deline, Sarah R. Kurtz, National Renewable Energy Lab. (USA) ..... [9563-14]

**PV industry growth and module reliability in Thailand**, Dhirayut Chenvidhya, King Mongkut's Univ. of Technology Thonburi (Thailand); Manit Seapan, King Mongkut's Univ. of Technology Thonburi (Thailand); Yaowannee Sangpongsanont, Tanokkorn Chenvidhya, Chamnan Limnakul, Roongrojana Songprakorp, King Mongkut's Univ. of Technology Thonburi (Thailand) ..... [9563-15]

## SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

SESSION 5 ..... MON 8:30 AM TO 10:20 AM

## Thin Film PV Module Reliability

Session Chair: **Rebecca Jones-Albertus**, U.S. Dept. of Energy (USA)

**The impact of atmospheric species on CIGS solar cells (Invited Paper)**, Mirjam Theelen, TNO (Netherlands) and Technische Univ. Delft (Netherlands); Christopher Foster, Zeger Vroon, TNO (Netherlands); Nicolas Barreau, Institut des Matériaux Jean Rouxel (France); Miro Zeman, TNO (Netherlands) and Technische Univ. Delft (Netherlands) ..... [9563-16]

**Activities of the PVQAT Thin Film Module Reliability Group 8**, Neelkanth G. Dhere, Univ. of Central Florida (USA) ..... [9563-17]

**Thin film PV standing tall side-by-side with mx-Si, also in terms of reliability**, Neelkanth G Dhere, Univ. of Central Florida (USA) ..... [9563-18]

**Numerical simulation of wind flow over a photovoltaic solar panel using RANS equations**, Andre L. Rezende, Instituto Militar de Engenharia (Brazil); Neelkanth G. Dhere, Univ. of Central Florida (USA) ..... [9563-19]

**Analysis of PV modules based on thin films solar cells by dark measurements technique**, Kamel Agroui, Unité de Développement de la Technologie du Silicium (Algeria); Michelle Pelegri, Flaminio Giovanni, ENEA (Italy) ..... [9563-20]

SESSION 6 ..... MON 10:50 AM TO 12:30 PM

## PV Module Reliability II

Session Chair: **William J. Gambogi Jr.**, DuPont (USA)

**Rapid field measurement of cells performance within PV modules (Invited Paper)**, Alessandra Colli, Klaus Attenkofer, Brookhaven National Lab. (USA) ..... [9563-21]

**PV system reliability program at Sandia National Labs: From material-level to system-level analysis (Invited Paper)**, Olga Lavrova, Sandia National Labs. (USA) ..... [9563-22]

**When PV modules are becoming real building elements: White solar module, a revolution for BIPV**, Laure-Emmanuelle Perret-Aebi, Jordi Escarré, Heng-Yu Li, Laurent Sansonnens, Federico Galliano, Gianluca Cattaneo, Patrick Heinstein, Sylvain Nicolay, Julien Bailat, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland); Sébastien Eberhard, Solaxess SA (Switzerland); Christophe Ballif, Ctr. Suisse d'Electronique et de Microtechnique SA (Switzerland) ..... [9563-23]

**Photovoltaic Reliability Group activities in USA and Brazil**, Neelkanth G. Dhere, Univ. of Central Florida (USA); Leila R. O. Cruz, Instituto Militar de Engenharia (Brazil) ..... [9563-24]

Lunch Break ..... Mon 12:30 pm to 2:00 pm

## OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY

### PLENARY SESSION..... 2:00 PM TO 4:30 PM

Session Chair: **Oleg V. Sulima**, GE Global Research (USA)

**Status and challenges of CdTe photovoltaics (Plenary)**, Wyatt K. Metzger, National Renewable Energy Lab. (USA) ..... [9561-201]

**Photochemical upconversion of light for renewable energy and more (Plenary)**, Timothy W. Schmidt, The Univ. of New South Wales (Australia) ..... [9562-202]

**The importance of reliability to the SunShot Initiative (Plenary)**, Rebecca Jones-Albertus, U.S. Dept. of Energy (USA) ..... [9563-203]

**Solar hydrogen: harvesting light and heat from sun (Plenary)**, Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-204]

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**Fabrication of homogeneous and high aspect ratio nanogratings on GaAs surface by femtosecond laser ablation**, Xiaohu Han, Yahui Su, Zhenzhu Fan, Huayong Zhang, Anhui Univ. (China); Dong Wu, Jiawen Li, Univ. of Science and Technology of China (China) ..... [9563-25]

**FTIR spectroscopy of silicon carbide thin films prepared by PECVD technology for solar cell application**, Angela Kleinová, Polymer Institute (Slovakia) ..... [9563-26]

**Raman spectroscopy study of SiC thin films prepared by PECVD for solar cell working in hard environment**, Vlasta Sasinkova, Institute of Chemistry (Slovakia) ..... [9563-27]

**Critical analysis on degradation mechanism of dye sensitized solar cells**, Mukhzeer Mohamad Shahimini, Suriahi Suahimi, Mohamad Halim Abdul Wahid, Univ. Malaysia Perlis (Malaysia); Vitthyacharan Retnasamy, Univ. Malaysia Perlis (Malaysia); Nor Azura Malini B. Ahmad Hamzali, Univ. Malaysia Perlis (Malaysia); Ali Hussain Reshak, Univ. of West Bohemia (Czech Republic) ..... [9563-28]

**The role of transition metal precipitates in limiting efficiency and stability in silicon photovoltaics cells**, Matthew P. Halsall, Bruce Hamilton, Janet Jacobs, Vladimir Markevich, Anthony R. Peaker, The Univ. of Manchester (United Kingdom) ..... [9563-29]

**Non-destructive luminescence polarization study related to recombination mechanisms and silicon material properties**, Radek Stojan, Jiri Vanek, Brno Univ. of Technology (Czech Republic) ..... [9563-30]

**Characterizing different defects in multicrystalline silicon solar cells via modern imaging methods**, Shishu Lou, Huishi Zhu, Peide Han, Institute of Semiconductors (China) ..... [9563-31]

# ORGANIC PHOTONICS + ELECTRONICS.

Organic-based materials have great potential for providing renewable energy sources, as well as playing a major role in creating significant commercial applications. If you work with organic materials and devices, this conference is a good fit for you.



- OLEDs
- OTFTs
- OPVs
- LIQUID CRYSTALS
- ORGANIC SEMICONDUCTORS
- PRINTED MEMORY AND CIRCUITS

## Organic Photonics + Electronics

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9566	Organic Light Emitting Materials and Devices XIX (So, Adachi, Kim)	p. 88
9567	Organic Photovoltaics XVI (Kafafi, Lane, Samuel)	p. 92
9568A	Organic Field-Effect Transistors XIV (McCulloch, Jurchescu)	p. 96
9568B	Organic Sensors and Bioelectronics VIII (Kymissis, Shinar, Torsi)	p. 98
9569	Printed Memory and Circuits (List Kratochvil)	p. 100



**Zakya H. Kafafi,**  
Lehigh Univ. (USA)  
*Symposium Chair*

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
Symposium-wide Plenary Session, 6:00 to 7:30 PM	Poster Session, 5:30 to 7:30 PM	Organic Photonics + Electronics Plenary Session, 9:00 to 11:45 AM		

**ORGANIC PHOTONICS + ELECTRONICS**

9565 Liquid Crystals XIX ( <i>Khoo</i> )	9564 Light Manipulating Organic Materials and Devices II ( <i>Schuller, Jakubiak, Eich, Nunzi</i> )
9566 Organic Light Emitting Materials and Devices XIX ( <i>So, Adachi, Kim</i> )	9567 Organic Photovoltaics XVI ( <i>Kafafi, Lane, Samuel</i> )
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Monday–Thursday 10–13 August 2015 • Proceedings of SPIE Vol. 9564

# Light Manipulating Organic Materials and Devices II

Conference Chair: **Jon A. Schuller**, Univ. of California, Santa Barbara (USA)

Conference Co-Chairs: **Rachel Jakubiak**, Air Force Research Lab. (USA); **Manfred Eich**, Technische Univ. Hamburg-Harburg (Germany); **Jean-Michel Nunzi**, Queen's Univ. (Canada)

Program Committee: **Dean R. Evans**, Air Force Research Lab. (USA); **Theodore G. Goodson III**, Univ. of Michigan (USA); **Mark G. Kuziky**, Washington State Univ. (USA); **Charles Y. C. Lee**, Air Force Office of Scientific Research (USA); **Kwang-Sup Lee**, Hannam Univ. (Korea, Republic of); **André P. Persoons**, Katholieke Univ. Leuven (Belgium); **Zouheir Sekkat**, Univ. Mohammed V (Morocco); **Matthew Y. Steir**, Brookhaven National Lab. (USA); **Jayan Thomas**, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); **Naoto Tsutsumi**, Kyoto Institute of Technology (Japan)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Studies on thermally induced third-order nonlinearity and optical power limiting of Aniline blue diammmonium salt investigated using CW He-Ne laser at 633nm excitation**, Poornesh P., Pramodini S., Manipal Univ. (India) . . . . [9564-29]

**Synthesis, growth, characterization and molecular hyperpolarizabilities of a novel NLO organic material**, Ashwatha Narayana Prabhu, Vyasa Upadhyaya, Manipal Univ. (India) . . . . . [9564-30]

**Growth and characterization of a new nonlinear optical organic crystal: 2,4,6-Trimethylacetanilide**, Vyasa Upadhyaya, Manipal Univ. (India); Sharada G. Prabhu, NMAM Institute of Technology (India) . . . . . [9564-31]

**Study of large nonlinear change phase in Hibiscus Sabdariffa**, Edgar Alvarado-Méndez, Mónica Trejo-Durán, José A. Andrade-Lucio, Roberto Rojas-Laguna, M. A. Vazquez-Guevara, Univ. de Guanajuato (Mexico) . . . . . [9564-32]

**Photorefractive polymer device with improved sensitizing property**, Tam V. Nguyen, Ha N. Giang, Kenji Kinashi, Wataru Sakai, Naoto Tsutsumi, Kyoto Institute of Technology (Japan) . . . . . [9564-33]

**Effect of metal films on the photostabilities of emissive organic layers as probed by fluorescence microscopy**, Sikandar Abbas, Linda A. Peteanu, Carnegie Mellon Univ. (USA) . . . . . [9564-34]

**Composition dependent structural, thermal, and mechanical properties of Sm<sub>2</sub>O<sub>3</sub> doped zinc fluoroborate glasses**, Sudha D. Kamath, Manipal Institute of Technology (India) . . . . . [9564-35]

## WEDNESDAY 12 AUGUST

### SESSION 1.....WED 8:15 AM TO 10:15 AM

#### **Exciton-Polaritons and Organic Plasmonics**

Session Chair: **Jon A. Schuller**, Univ. of California, Santa Barbara (USA)

**Coupling J-aggregate excitons with confined photons in a strongly-coupled planar microcavity** (*Invited Paper*), David G. Lidzey, The Univ. of Sheffield (United Kingdom) . . . . . [9564-1]

**Control of light-matter interaction using organic-inorganic hybrid excitons** (*Invited Paper*), Vinod M. Menon, The City College of New York (USA) . . . . . [9564-2]

**Measuring optical anisotropies in organic semiconductors**, Steven J. Brown, Ruth A. Schlitz, Niva A. Ran, Xiaofeng Liu, John A. Love, Christopher J. Takacs, Michael L. Chabinyc, Thuc-Quyen Nguyen, Guillermo C. Bazan, Jon A. Schuller, Univ. of California, Santa Barbara (USA) . . . . . [9564-3]

**Engineering the photophysical properties of organic semiconductors using plasmonic nanostructures** (*Invited Paper*), Jean-Charles Ribierre, Kyushu Univ. (Japan) . . . . . [9564-4]

**Ag nanoparticles on a cellulose nanocrystal scaffold for applications in organic photovoltaics** (*Invited Paper*), Nathan J. Dawson, Case Western Reserve Univ. (USA); Stephen Spinella, Anthony Maiorana, Rensselaer Polytechnic Institute (USA); Kenneth D. Singer, Case Western Reserve Univ. (USA); Richard A. Gross, Rensselaer Polytechnic Institute (USA) . . . . . [9564-5]

### SESSION 2 .....WED 10:45 AM TO 11:55 AM

#### **Nonlinear Processes and Materials**

Session Chair: **Timothy J. White**, Air Force Research Lab. (USA)

**Universal scaling in nonlinear optical molecules** (*Invited Paper*), Javier Perez-Moreno, Skidmore College (USA) . . . . . [9564-6]

**Design rules for quasi-linear nonlinear optical structures**, Richard Lytel, Sean M. Mossman, Mark G. Kuziky, Washington State Univ. (USA) . . . . . [9564-7]

**Development and characterization of thermally stable electro-optic polymers and devices** (*Invited Paper*), Akira Otomo, Isao Aoki, Chiyumi Yamada, Toshiaki Yamada, National Institute of Information and Communications Technology (Japan) . . . . . [9564-8]

Lunch/Exhibition Break . . . . . Wed 11:55 am to 1:45 pm

# CONFERENCE 9564

SESSION 3 ..... WED 1:45 PM TO 3:25 PM

## Ultrafast Spectroscopy and Infrared Properties

Session Chair: **Matthew Y. Sfeir**, Brookhaven National Lab. (USA)

**Optical and magnetic probes of hot singlet exciton fission in pi-conjugated polymers for photovoltaic applications** (*Invited Paper*), Zeev V. Vardeny, Yaxin Zhai, Ella Olejnik, The Univ. of Utah (USA) ..... [9564-9]

**Interfacial structure and dynamics at organic / metal interfaces** (*Invited Paper*), Oliver L. A. Monti, The Univ. of Arizona (USA) ..... [9564-10]

**Nonlinear coherent spectroscopy in the single molecule limit** (*Invited Paper*), Eric O. Potma, Univ. of California, Irvine (USA) ..... [9564-11]

**Narrow band gap conjugated polymers for emergent optoelectronic technologies** (*Invited Paper*), Jason D. Azoulay, Benjamin A. Zhang, The Univ. of Southern Mississippi (USA); Bryan M. Wong, Univ. of California, Riverside (USA); Matthew Y. Sfeir, Brookhaven National Lab. (USA) ..... [9564-12]

SESSION 4 ..... WED 3:55 PM TO 5:05 PM

## Nonlinear Optical Device Design and Fabrication

Session Chair: **Jon A. Schuller**, Univ. of California, Santa Barbara (USA)

**Dynamic filtering with liquid crystals** (*Invited Paper*), Timothy J. White, Air Force Research Lab. (USA); Kyung Min Lee, Air Force Research Lab. (USA) and Azimuth Corp. (USA); Vincent P. Tondiglia, Air Force Research Lab. (USA) and Leidos (USA) ..... [9564-13]

**Optical switching with sign control using a nonlinear layer structure**, Pengfei Wu, Nankai Univ (China) ..... [9564-14]

**From nonlinear magneto-optics to magnetism in conducting polymers** (*Invited Paper*), André P. Persoons, Katholieke Univ. Leuven (Belgium); Palash Gangopadhyay, College of Optical Sciences, The Univ. of Arizona (USA); Philippe Dubois, Olivier Coulombier, Nicolas Delbosc, Univ. de Mons (Belgium); Thierry Verbiest, Guy Koecckelberghs, Katholieke Univ. Leuven (Belgium) ..... [9564-15]

## THURSDAY 13 AUGUST

SESSION 5 ..... THU 8:30 AM TO 10:20 AM

## Photo-mechanics, Light-triggered, and Light-actuated Materials I

Session Chair: **Yi Liao**, Florida Institute of Technology (USA)

**Thermoreversible networks for moldable photo-responsive elastomers** (*Invited Paper*), Julia A. Kornfield, California Institute of Technology (USA); Zuleikha Kurji, Washington State Univ. (USA) ..... [9564-16]

**Model photo-responsive elastomers based on the self-assembly of side group liquid crystal triblock copolymers**, Zuleikha Kurji, Washington State Univ. (USA) and California Institute of Technology (USA); Julia A. Kornfield, California Institute of Technology (USA); Mark G. Kuzyk, Washington State Univ. (USA) ..... [9564-17]

**On photomigration in azo-polymers**, Zouheir Sekkat, Moroccan Foundation for Advanced Science, Innovation and Research (Morocco) ..... [9564-18]

**Study on visible-light-curable polycaprolactone and poly(ethylene glycol) diacrylate for LCD-projected maskless additive manufacturing system**, Yih-Lin Cheng, Hao-Lun Kao, National Taiwan Univ. of Science and Technology (Taiwan) ..... [9564-19]

**Light manipulating vector polyphotochromatic behavior in organic polarization-sensitive materials**, Irakli Chaganava, Institute of Cybernetics (Georgia) and Georgian Technical Univ (Georgia); Barbara N. Kilosanidze, George Kakauridze, Institute of Cybernetics (Georgia) and Georgian Technical Univ. (Georgia) ..... [9564-20]

SESSION 6 ..... THU 10:50 AM TO 12:20 PM

## Photo-mechanics, Light-triggered, and Light-actuated Materials II

Session Chair: **Zouheir Sekkat**, Moroccan Foundation for Advanced Science, Innovation and Research (Morocco)

**Visible light responsive systems based on metastable-state photoacids** (*Invited Paper*), Yi Liao, Florida Institute of Technology (USA) ..... [9564-21]

**Characterization of photomechanical elastomers for device applications**, Elizabeth A. Bernhardt, Joseph T. Lanska, Nathan F. Rasmussen, Mark G. Kuzyk, Washington State Univ. (USA); Mykhailo Y. Pevnyi, Fred Minkowski, Peter Palfy-Muhoray, Kent State Univ. (USA); Zuleikha Kurji, California Institute of Technology (USA) and Washington State Univ. (USA); Julia A. Kornfield, California Institute of Technology (USA) ..... [9564-22]

**Fabrication and modeling of fiber Bragg grating device networks in photomechanical polymer optical fibers**, Joseph T. Lanska, Mark G. Kuzyk, Washington State Univ. (USA); Dennis M. Sullivan, Univ. of Idaho (USA) ..... [9564-23]

**Adaptable and dynamic soft colloidal photonics**, Alexander J. C. Kuehne, Dennis Go, DWI an der RWTH Aachen e.V. (Germany) ..... [9564-24]

Lunch/Exhibition Break ..... Thu 12:20 pm to 2:00 pm

SESSION 7 ..... THU 2:00 PM TO 3:30 PM

## Photorefractive Materials and Applications

Session Chair: **Mark G. Kuzyk**, Washington State Univ. (USA)

**Advances in photorefractive polymers and applications** (*Invited Paper*), Pierre-Alexandre J. Blanche, Brittany Lynn, Robert A. Norwood, Nasser N. Peyghambarian, College of Optical Sciences, The Univ. of Arizona (USA) [9564-25]

**Electrostatic modification of ITO/ZnSe interface in polymer-nematogen composite and its impact on photorefractive hologram**, Jingwen Zhang, Jiayin Fu, Hua Zhao, Harbin Institute of Technology (China) ..... [9564-26]

**Photopolymerizable polymer nanocomposites incorporated with hyperbranched polymer having ultrahigh index of refraction for holographic light manipulation**, Yasuo Tomita, Hiroshi Urano, Taka-aki Fukamizu, Yasuhiro Kametani, The Univ. of Electro-Communications (Japan); Naoya Nishimura, Keisuke Odoi, Nissan Chemical Industries, Ltd. (Japan) ..... [9564-27]

**Photorefractive amplification of moving light signals by photoconductive ferroelectric liquid crystal blends**, Takeo Sasaki, Masanori Yoshino, Tokyo Univ. of Science (Japan) ..... [9564-28]

# CONFERENCE 9565

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## Liquid Crystals XIX

Conference Chair: Iam Choon Khoo, The Pennsylvania State Univ. (USA)

Program Committee: Timothy J. Bunning, Air Force Research Lab. (USA); Shaw-Horng Chen, Univ. of Rochester (USA); Neil Collings, Two Trees Photonics Ltd. (United Kingdom); Jean-Pierre Huignard, Jphopto (France); Tomiki Ikeda, Chuo Univ. (Japan); Oleg D. Lavrentovich, Kent State Univ. (USA); Francesco Simoni, Univ. Politecnica delle Marche (Italy); David M. Walba, Univ. of Colorado at Boulder (USA)

### SUNDAY 9 AUGUST

#### SESSION 1 ..... SUN 8:15 AM TO 10:10 AM

##### Novel Photonic Materials and Processes

Session Chair: Iam Choon Khoo, The Pennsylvania State Univ. (USA)

**Electrically tunable selective reflection of light by heliconical cholesteric structures** (*Keynote Presentation*), Oleg D. Lavrentovich, Jie Xiang, Sergii V. Shyanovskii, Quan Li, Kent State Univ. (USA) ..... [9565-1]

**Light-driven motion of micro-particles by means of photoisomerization of azobenzene groups as molecular motor on a liquid crystalline film** (*Invited Paper*), Seiji Kurihara, Yutaka Kuwahara, Sunnam Kim, Tomonari Ogata, Kumamoto Univ. (Japan) ..... [9565-2]

**Liquid crystal based adaptive holography for optical sensing applications** (*Invited Paper*), Stefania Residori, Umberto Bortolozzo, Institut Non Linéaire de Nice Sophia Antipolis (France) and Univ. de Nice Sophia Antipolis (France) and CNRS (France); Jean-Pierre Huignard, Jphopto (France) ..... [9565-3]

**Photodeformation of azobenzene containing liquid crystalline polymer networks** (*Invited Paper*), Vladimir P. Tschchepikov, Leibniz-Institut für Polymerforschung Dresden e.V. (Germany) and Institute of Macromolecular Compounds (Russian Federation); Tatiana Petrova, Leibniz-Institut für Polymerforschung Dresden e.V. (Germany) and Cherepovets State Univ. (Russian Federation); Marina Saphiannikova, Leibniz-Institut für Polymerforschung Dresden e.V. (Germany) ..... [9565-4]

**Studies of the underlying mechanisms for optical nonlinearities of blue phase liquid crystals**, Chun-Wei Chen, National Sun Yat-Sen Univ. (Taiwan); Iam Choon Khoo, Shuo Zhao, The Pennsylvania State Univ. (USA); Tsung-Hsien Lin, National Sun Yat-Sen Univ. (Taiwan); Tsung-Jui Ho, The Pennsylvania State Univ. (USA) ..... [9565-5]

**Recent results on the heliconical nematic phase**, Eva D. Korblova, Alyssa Scarbrough, Mark Moran, Lee Foley, Michael Tuchband, Min Shuai, Renfan Shao, Joseph E. MacLennan, Matthew A. Glaser, Noel A. Clark, David M. Walba, Univ. of Colorado at Boulder (USA) ..... [9565-6]

#### SESSION 2 ..... SUN 10:40 AM TO 12:00 PM

##### Electro-Optical Processes

Session Chair: Oleg D. Lavrentovich, Kent State Univ. (USA)

**Tailoring complex optical fields via anisotropic microstructures** (*Keynote Presentation*), Yan-Qing Lu, Wei Hu, Guo-Xin Cui, Nanjing Univ. (China) ..... [9565-7]

**Electrical induction and optical erasure of birefringence in the isotropic liquid phase of a dichiral azobenzene liquid-crystalline compound** (*Invited Paper*), Takahiro Yamamoto, National Institute of Advanced Industrial Science and Technology (Japan); Isa Nishiyama, DIC Corp. (Japan) ..... [9565-8]

**Low voltage driving and ultra-fast switching of SmC\* on the slippery interfaces**, Jun Yamamoto, Kyoto Univ. (Japan); Isa Nishiyama, DIC Corp. (Japan) ..... [9565-9]

**Shape programming with light: Voxelated liquid crystal elastomers** (*Invited Paper*), Timothy J. White, Air Force Research Lab. (USA); Taylor H. Ware, Air Force Research Lab. (USA) and Azimuth Corp. (USA); Michael E. McConney, Air Force Research Lab. (USA); Jeong Jae Wie, Air Force Research Lab. (USA) and Azimuth Corp. (USA); Vincent P. Tondiglia, Air Force Research Lab. (USA) and Leidos (USA) ..... [9565-10]

Lunch Break ..... Sun 12:00 pm to 1:30 pm

#### SESSION 3 ..... SUN 1:30 PM TO 3:25 PM

##### Optical Control, Manipulation, and Modulation

Session Chair: David M. Walba, Univ. of Colorado at Boulder (USA)

**Manipulating lipid membrane architecture by liquid crystal-analog curvature elasticity** (*Keynote Presentation*), Sin-Doo Lee, Seoul National Univ. (Korea, Republic of) ..... [9565-11]

**Liquid crystals under the spotlight: Light based measurements of electrical and flow properties of liquid crystals** (*Invited Paper*), Giampaolo D'Alessandro, Thomas P. Bennett, Matthew B. Proctor, Malgosia Kaczmarek, Univ. of Southampton (United Kingdom) ..... [9565-12]

**Nematic and blue phase liquid crystals for temperature stabilization and active optical tuning of silicon photonic devices** (*Invited Paper*), Joanna N Ptasiński, Space and Naval Warfare Systems Ctr. Pacific (USA); Iam Choon Khoo, The Pennsylvania State Univ. (USA); Yeshaiahu Fainman, Univ. of California, San Diego (USA) ..... [9565-13]

**Photoalignment control for photonic and mechanical applications** (*Invited Paper*), Atsushi Shishido, Tokyo Institute of Technology (Japan) ..... [9565-14]

**Enhanced electro-optical properties of liquid crystal microlens: Low driving voltage and large dynamic operating range**, Yun-Tzu Lin, National Taipei Univ. of Technology (Taiwan); Guan-Jhong Lin, National Taiwan Univ. (Taiwan); Yen-Hsing Lin, Tien-Jung Chen, National Taipei Univ. of Technology (Taiwan); Ying-Jay Yang, National Taiwan Univ. (Taiwan); Chung-Ping Chen, Jin-Jei Wu, National Taipei Univ. of Technology (Taiwan) ..... [9565-15]

**Strengthened nonlinearity in liquid crystal panel with ZnSe aligning layers due to surface charge accumulation**, Jingwen Zhang, Tingyu Xue, Hua Zhao, Harbin Institute of Technology (China) ..... [9565-16]

#### SESSION 4 ..... SUN 3:55 PM TO 5:30 PM

##### Novel Materials, Phenomena, and Applications

Session Chair: Iam Choon Khoo, The Pennsylvania State Univ. (USA)

**Hysteresis on a liquid crystal and polymer composite film** (*Invited Paper*), Yi-Hsin Lin, Ming-Syuan Chen, National Chiao Tung Univ. (Taiwan); Chun-Yu Hsu, National Tsing Hua Univ. (Taiwan); Jing-Yi Wang, National Chiao Tung Univ. (Taiwan) ..... [9565-17]

**Structural dynamics in azobenzene liquid crystal polymer films studied by microscopic and time-resolved techniques** (*Invited Paper*), Kenji Katayama, Shota Kuwahara, Tomiki Ikeda, Chuo Univ. (Japan) ..... [9565-18]

**Thermoelectricity in liquid crystals** (*Invited Paper*), Suhana B. Mohd Said, Norbani Abdullah, Abdul Rahman Nordin, Univ. of Malaya (Malaysia) ..... [9565-19]

**A composite lens by integrating a polarization switch of ferroelectric liquid crystals with a passively anisotropic polymeric lens for ultrafast laser system**, Chia-Ming Chang, Yu-Jen Wang, Hung-Shan Chen, Yi-Hsin Lin, National Chiao Tung Univ. (Taiwan); Abhishek K. Srivastava, Vladimir G. Chigrinov, Hong Kong Univ. of Science and Technology (China) ..... [9565-20]

**Programmable lattices of optical vortices in nematic liquid crystal** (*Invited Paper*), Marcel G. Clerc, Univ. de Chile (Chile); Stefania Residori, Umberto Bortolozzo, Institut Non Linéaire de Nice Sophia Antipolis (France) and Univ. de Nice Sophia Antipolis (France); Raouf Barboza, Estefania Vidal-Henriquez, Univ. de Chile (Chile); Gaetano Assanto, Univ. degli Studi di Roma Tre (Italy) ..... [9565-21]

#### SYMPOSIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

##### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

# CONFERENCE 9565

MONDAY 10 AUGUST

SESSION 5 ..... MON 8:15 AM TO 10:20 AM

## Advanced Photonic Applications

Session Chair: Kenneth L. Marshall, Univ. of Rochester (USA)

**Recent advances in IR liquid crystal spatial light modulators (Keynote Presentation)**, Fenglin Peng, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); Robert J. Twieg, Kent State Univ. (USA); Shin-Tson Wu, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA) ..... [9565-22]

**Vortex grating diffractive waveplate**, Gary F. Walsh, Brian R. Kimball, U.S. Army Natick Soldier Research, Development and Engineering Ctr. (USA); Nelson V. Tabiryan, BEAM Engineering for Advanced Measurements Co. (USA) ..... [9565-23]

**Imaging in natural light with nematic liquid crystals (Invited Paper)**, Tigran V. Galstian, Univ. Laval (Canada) ..... [9565-24]

**Device and material technologies for advanced flexible liquid crystal displays (Invited Paper)**, Hideo Fujikake, Takahiro Ishinabe, Tohoku Univ. (Japan) ..... [9565-25]

**Bent LC molecules with a 60° central core that can form B7 and B2 phases (Invited Paper)**, Junji Watanabe, Tokyo Institute of Technology (Japan) ..... [9565-26]

**Nonlinear doped liquid crystals for dynamic holographic displays (Invited Paper)**, Yikai Su, Shanghai Jiao Tong Univ. (China) ..... [9565-27]

SESSION 6 ..... MON 10:45 AM TO 12:05 PM

## Novel Optical and Material Processes

Session Chair: Tsung-Hsien Lin, National Sun Yat-Sen Univ. (Taiwan)

**Reflective-emissive liquid-crystal displays constructed from AIE luminogens (Keynote Presentation)**, Ben Zhong Tang, Dongyu Zhao, Hong Kong Univ. of Science and Technology (Hong Kong, China); Anjun Qin, Hong Kong Univ. of Science and Technology (China) ..... [9565-28]

**Computational chemistry modeling and design of photoswitchable alignment materials for optically addressable liquid crystal devices (Invited Paper)**, Kenneth L. Marshall, Emily R. Sekera, Kyle Xiao, Univ. of Rochester (USA) [9565-29]

**Photonic band-gap modulation of blue phase liquid crystal (Invited Paper)**, Tsung-Hsien Lin, National Sun Yat-Sen Univ. (Taiwan) ..... [9565-30]

**Asymmetrical phase difference distribution properties of a liquid-crystal micro-lens array with tetragonally-patterned electrodes**, Marenori Kawamura, Kento Nakamura, Akita Univ. (Japan); Susumu Sato, LC-Lens Institute (Japan) ..... [9565-31]

Lunch Break ..... Mon 12:05 pm to 1:35 pm

SESSION 7 ..... MON 1:35 PM TO 3:30 PM

## Complex Optical and Material Processes

Session Chair: Nelson V. Tabiryan, BEAM Co. (USA)

**Complex topological structures of frustrated liquid crystals with potential for optics and photonics (Keynote Presentation)**, Slobodan Žumer, Univ. of Ljubljana (Slovenia) and Jozef Stefan Institute (Slovenia); Miha Cancula, Simon Copar, Miha Ravnik, Univ. of Ljubljana (Slovenia) ..... [9565-32]

**Acquiring three dimensional images based on electronically controlled liquid crystal micro lens array**, Hui Li, Fan Pan, Wuhan Institute of Technology (China); Kan Liu, Wuhan Institute of Physics and Mathematics (China); Yuntao Wu, Yanduo Zhang, Wuhan Institute of Technology (China); Xiaolin Xie, Huazhong Univ. of Science and Technology (China) ..... [9565-33]

**Digital confocal microscopy through a multimode fiber (Invited Paper)**, Christophe Moser, Damien Loterie, Salma Farahi, Demetri Psaltis, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9565-34]

**The helical nanofilament phase as a host for creation of aligned, nanostructured composites (Invited Paper)**, David M. Walba, Rebecca A. Callahan, Eva D. Korbova, Dong Chen, Yongqiang Shen, Michael Tuchband, Eric Carlson, Univ. of Colorado at Boulder (USA); Hanlim Kim, KAIST (Korea, Republic of); Garry Rumbles, National Renewable Energy Lab. (USA); Sean E. Shaheen, Univ. of Colorado at Boulder (USA); Dong Ki Yoon, KAIST (Korea, Republic of); Noel A. Clark, Univ. of Colorado at Boulder (USA) ..... [9565-35]

**Liquid-crystal-based immunodetection beyond texture observations (Invited Paper)**, Mon-Juan Lee, Chang Jung Christian Univ. (Taiwan); Chi-Hao Lin, Wei Lee, National Chiao Tung Univ. (Taiwan) ..... [9565-36]

**Revealing pathologies in the liquid crystalline structures of the brain by polarimetric studies**, Karen Bakhtshetyan, Gurgen G. Melkonyan, Tigran V. Galstian, Armen Saghatelian, Univ. Laval (Canada) ..... [9565-37]

SESSION 8 ..... MON 3:55 PM TO 5:30 PM

## Advanced Materials and Photonic Applications

Session Chair: Iam Choon Khoo, The Pennsylvania State Univ. (USA)

**The next horizon for diffractive waveplate technology (Keynote Presentation)**, Nelson V. Tabiryan, BEAM Engineering for Advanced Measurements Co. (USA); Diane Steeves, Brian Kimball, U.S. Army Natick Soldier Research, Development and Engineering Ctr. (USA) ..... [9565-38]

**One- and two-dimensional liquid crystal structures for lasing applications (Invited Paper)**, Inge Nys, Jeroen Beeckman, Kristiaan Neyts, Univ. Gent (Belgium) ..... [9565-39]

**Photopatterning of complex molecular orientation fields in liquid crystals**, Qi-Huo Wei, Yubing Guo, Miao Jiang, Kent State Univ. (USA); Kai Sun, Univ. of Michigan (USA); Chenhui Peng, Kent State Univ. (USA); Oleg V. Yaroshchuk, National Academy of Sciences of Ukraine (Ukraine); Oleg D. Lavrentovich, Kent State Univ. (USA) ..... [9565-40]

**Study of liquid crystal formation of graphene oxide flakes**, Ji Hyun Park, Min Jae Kim, HyeRan Jo, Kieup Lee, YoungBeom Jo, Seoul National Univ. (Korea, Republic of); Stephane Campidelli, CEA-IRAMIS (France); Jun Yamamoto, Kyoto Univ. (Japan); Youn Sang Kim, Seoul National Univ. (Korea, Republic of); Giusy Scalia, Seoul National Univ. (Korea, Republic of) and Univ. du Luxembourg (Luxembourg) ..... [9565-41]

**Tunable Bragg extraction of light in photonic quasi crystals: Dispersed liquid crystalline metamaterials (Invited Paper)**, Massimo Rippa, Rossella Capasso, Consiglio Nazionale delle Ricerche (Italy); Cesare Umeton, Univ. della Calabria (Italy); Lucia Petti, Consiglio Nazionale delle Ricerche (Italy) ..... [9565-42]

POSTERS-MONDAY ..... MON 5:30 PM TO 7:30 PM

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**Analysis of selective reflection spectrum in cholesteric liquid crystal cells for solar-ray controller**, Akifumi Ogiwara, Kobe City College of Technology (Japan); Hiroshi Kakiuchiwa, National Institute of Advanced Industrial Science and Technology (Japan) ..... [9565-43]

**LCD**, Dongyu Zhao, Beijing Univ. of Aeronautics and Astronautics (China) [9565-44]

**Multifocal liquid-crystal-lens properties with additional ring-electrodes**, Marenori Kawamura, Kensuke Tamura, Makoto Chida, Akita Univ. (Japan); Susumu Sato, LC-Lens Institute (Japan) ..... [9565-45]

**Three-dimensional imaging system by using a low-voltage-driving LC lens**, Marenori Kawamura, Shunsuke Ishikuro, Akita Univ. (Japan) ..... [9565-46]

**Bragg diffraction for normal and obliquely circularly polarized light due a new chiral mixture**, Paola Castro-Garay, Jesus Manzanares-Martinez, Adalberto Corella-Madueño, Arturo Rosas-Burgos, Marielena Clark, Josue Lizola-Leon, Lillian Gracia, Univ. de Sonora (Mexico) ..... [9565-47]

**An optical image stabilization using a droplet manipulation on a liquid crystal and polymer composite film**, Yu-Jen Wang, Chia-Ming Chang, Yu-Shih Tsou, Ming-Syuan Chen, Hung-Shan Chen, Yi-Hsin Lin, National Chiao Tung Univ. (Taiwan) ..... [9565-48]

**Thermodielectric effect in dual-frequency cholesteric liquid crystals**, Yu Cheng Hsiao, Wei Lee, National Chiao Tung Univ. (Taiwan) ..... [9565-49]

**Field induced lattice reorientation, deformation, and optical nonlinearities in blue phase liquid crystals**, Iam Choon Khoo, Tsung-Jui Ho, Shuo Zhao, The Pennsylvania State Univ. (USA); Chun-Wei Chen, Tsung-Hsien Lin, National Sun Yat-Sen Univ. (Taiwan) ..... [9565-50]

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# Organic Light Emitting Materials and Devices XIX

Conference Chair: **Franky So**, Univ. of Florida (USA)

Conference Co-Chairs: **Chihaya Adachi**, Kyushu Univ. (Japan); **Jang-Joo Kim**, Seoul National Univ. (Korea, Republic of)

Program Committee: **Malte C. Gather**, Univ. of St. Andrews (United Kingdom); **Hisao Ishii**, Chiba Univ. (Japan); **Hironori Kaji**, Kyoto Univ. (Japan); **Jaewon Lee**, LG Display (Korea, Republic of); **Jian Li**, Arizona State Univ. (USA); **Mathew K. Mathai**, Apple Inc. (USA); **Jongwook Park**, The Catholic Univ. of Korea (Korea, Republic of); **Yong-Jin Pu**, Yamagata Univ. (Japan); **Ifor D. W. Samuel**, Univ. of St. Andrews (United Kingdom); **Joseph Shinar**, Iowa State Univ. (USA)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 8:00 AM TO 10:05 AM

#### Novel Materials I

Session Chairs: **Chihaya Adachi**, Kyushu Univ. (Japan); **Jang-Joo Kim**, Seoul National Univ. (Korea, Republic of)

**The development of materials and architectures for light-emitting diodes (Invited Paper)**, Paul L. Burn, Ross Jansen-van Vuuren, Fatemah Maasoumi, Paul Meredith, Ebinazar Namdas, The Univ. of Queensland (Australia) ..... [9566-1]

**Novel emission types in organic molecules: TADF and biluminescence (Invited Paper)**, Sebastian Reineke, Technische Univ. Dresden (Germany) ..... [9566-2]

**Excimer formation and AIE effect in blue fluorescence core-side materials (Invited Paper)**, Jongwook Park, Seungho Kim, Jaehyun Lee, Hyocheol Jung, The Catholic Univ. of Korea (Korea, Republic of); Daisuke Yokoyama, Yamagata Univ. (Japan); Chihaya Adachi, Kyushu Univ. (Japan) ..... [9566-3]

**High efficiency blue fluorescent organic light-emitting diodes (Invited Paper)**, Jun Yeob Lee, Sang Kyu Jeon, Wook Song, Sungkyunkwan Univ. (Korea, Republic of) ..... [9566-4]

**Highly efficient exciplex-based OLEDs (Invited Paper)**, Ken-Tsung Wong, National Taiwan Univ. (Taiwan) ..... [9566-5]

**Novel conjugated polymer colloids with applications in photonics (Invited Paper)**, Alexander J. Kuehne, DWI an der RWTH Aachen e.V. (Germany) .. [9566-6]

### SESSION 2 ..... SUN 10:30 AM TO 12:00 PM

#### Novel Materials II

Session Chairs: **Chihaya Adachi**, Kyushu Univ. (Japan); **Jang-Joo Kim**, Seoul National Univ. (Korea, Republic of)

**New trends in the design of transition-metal OLED phosphors (Invited Paper)**, Yun Chi, National Tsing Hua Univ. (Taiwan) ..... [9566-7]

**Towards printed organic light-emitting devices: A solution-stable, highly soluble Cu(I)-N<sub>HeT</sub>PHOS-complex for inkjet processing (Invited Paper)**, Daniel Volz, Charlotte Fléchon, cynora GmbH (Germany); Manuela Wallesch, Karlsruher Institut für Technologie (Germany); Thomas Baumann, cynora GmbH (Germany) ..... [9566-8]

**Facial and meridional N-heterocyclic carbene iridium complexes enable deep blue organic light-emitting diodes**, Jaesang Lee, Univ. of Michigan (USA); Hsiao-Fan Chen, The Univ. of Southern California (USA); Xiao Liu, Caleb Coburn, Univ. of Michigan (USA); Peter I. Djurovich, Mark E. Thompson, The Univ. of Southern California (USA); Stephen R. Forrest, Univ. of Michigan (USA) ..... [9566-9]

Lunch Break ..... Sun 12:00 pm to 1:20 pm

### SESSION 3 ..... SUN 1:20 PM TO 3:00 PM

#### Novel Materials III

Session Chairs: **Bernard Kippelen**, Georgia Institute of Technology (USA); **Hany Aziz**, Univ. of Waterloo (Canada)

**Organic light-emitting diodes: Multiscale charge transport simulation and fabrication of new thermally activated delayed fluorescence (TADF) materials (Invited Paper)**, Hironori Kaji, Katsuyuki Shizu, Furitsu Suzuki, Tatsuya Fukushima, Katsuki Suzuki, Kyoto Univ. (Japan); Chihaya Adachi, Kyushu Univ. (Japan) ..... [9566-10]

**N-type organic luminescent materials based on AIE-active siloles (Invited Paper)**, Han Nie, Zujin Zhao, South China Univ. of Technology (China); Ben Zhong Tang, Hong Kong Univ. of Science and Technology (Hong Kong, China) . [9566-11]

**High efficiency quantum dot based light-emitting devices (Invited Paper)**, Weiran Cao, Univ. of Florida (USA); Huaibin Shen, Univ. of Florida (USA) and Henan Univ. (China); Nathan T. Shewmon, Univ. of Florida (USA); Paul Holloway, Univ. of Florida (USA) and NanoPhotonica, Inc. (USA); Lin Song Li, Henan Univ. (China); Jiangeng Xue, Univ. of Florida (USA) ..... [9566-12]

**Multi-layered quantum dot light-emitting diodes and full-color displays by dry pick-and-place transfer (Invited Paper)**, Tae-Ho Kim, Samsung Advanced Institute of Technology (Korea, Republic of) ..... [9566-13]

### SESSION 4 ..... SUN 3:25 PM TO 5:35 PM

#### Novel Processing (Including Solution Processing)

Session Chairs: **Bernard Kippelen**, Georgia Institute of Technology (USA); **Hany Aziz**, Univ. of Waterloo (Canada)

**Tandem organic light-emitting devices fabricated by solution-processes (Invited Paper)**, Yong-Jin Pu, Yamagata Univ. (Japan) ..... [9566-14]

**Solution-processed flexible organic light emitting diodes (Invited Paper)**, Jiajie Liang, Shu-Yu Charlotte Chou, Fangchao Zhao, Lu Li, Qibing Pei, Univ. of California, Los Angeles (USA) ..... [9566-15]

**Advantages and disadvantages of vacuum- and solution-processed OLED films: Differences in molecular orientation, thermal stability, and interfacial mixing (Invited Paper)**, Daisuke Yokoyama, Maki Shibata, Yoshiya Sakai, Yamagata Univ. (Japan) ..... [9566-16]

**Charge generation layers for all-solution processed organic tandem light emitting diodes with regular device architecture**, Stefan Hoeffle, Christoph Bernhard, Michael Bruns, Christian Kuebel, Torsten Scherer, Alexander Colsmann, Karlsruhe Institute for Technology (Germany)..... [9566-17]

**R2R processed flexible OLEDs for lighting and their mechanical stress testing**, Takashi Minakata, CEREBRA (Japan) ..... [9566-18]

**High-index substrates with optical haze as a low-cost platform for efficient flexible OLEDs: Joint theoretical and experimental study (Invited Paper)**, Eunhye Kim, Jinouk Song, Seunghyup Yoo, KAIST (Korea, Republic of) ..... [9566-50]

### SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

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MONDAY 10 AUGUST

SESSION 5 ..... MON 8:00 AM TO 10:20 AM

## Organic Lasers

Session Chairs: **Malte C. Gather**, Univ. of St. Andrews (United Kingdom); **Dongge Ma**, Changchun Institute of Applied Chemistry (China)

**Triplet related losses in organic thin film lasers (Invited Paper)**, Thomas Riedl, Bergische Univ. Wuppertal (Germany) ..... [9566-19]

**Solid-state fluorescent protein as a novel optical gain material for lasers and amplifiers (Invited Paper)**, Malte C. Gather, Univ. of St. Andrews (United Kingdom) ..... [9566-20]

**Laser nanostructuring for high-performance organic optoelectronic devices (Invited Paper)**, Hong-Bo Sun, Jing Feng, Yue-Feng Liu, Jilin Univ. (China) [9566-21]

**Solution-processable, photo-stable, low-threshold, and broadly tunable thin film organic lasers based on novel high-performing laser dyes (Invited Paper)**, Maria A. Diaz-Garcia, Marta Morales-Vidal, Manuel G. Ramirez, Jose M. Villalvilla, Pedro G. Boj, Jose A. Quintana, Univ. de Alicante (Spain); Aritz Retolaza, Santos Merino, Tekniker (Spain) ..... [9566-22]

**Coherence measurements of organic light-emitting diodes and lasers (Invited Paper)**, Ifor D. Samuel, Univ. of St. Andrews (United Kingdom) ..... [9566-23]

**Photonic lattices in organic microcavities: Bloch states and control of lasing**, Andreas Mischok, Robert Brückner, Hartmut Fröb, Vadim G. Lyssenko, Karl Leo, Technische Univ. Dresden (Germany) ..... [9566-24]

SESSION 6 ..... MON 10:45 AM TO 12:15 PM

## Device Physics and Mechanisms I

Session Chairs: **Malte C. Gather**, Univ. of St. Andrews (United Kingdom); **Dongge Ma**, Changchun Institute of Applied Chemistry (China)

**AC quantum efficiency harmonic analysis of exciton annihilation in organic light emitting diodes (Invited Paper)**, Noel C. Giebink, The Pennsylvania State Univ. (USA) ..... [9566-25]

**Degradation of wide band-gap electroluminescent materials by exciton-polaron interactions (Invited Paper)**, Hany Aziz, Qi Wang, Univ. of Waterloo (Canada) ..... [9566-26]

**Exciton formation and diffusion in OLEDs (Invited Paper)**, Grayson L. Ingram, Zheng-Hong Lu, Univ. of Toronto (Canada) ..... [9566-27]

**Analysis of self-heating in organic semiconductor devices**, Evelyne Knapp, Beat Ruhstaller, Zürcher Hochschule für Angewandte Wissenschaften (Switzerland) ..... [9566-28]

Lunch Break ..... Mon 12:15 pm to 1:30 pm

SESSION 7 ..... MON 1:30 PM TO 3:35 PM

## Device Physics and Mechanisms II

Session Chairs: **Yong-Jin Pu**, Yamagata Univ. (Japan); **Jian Li**, Arizona State Univ. (USA)

**Determining the rate-limiting steps for the purification of organic semiconductors by thermal gradient sublimation (Invited Paper)**, Nathan T. Morgan, Yi Zhang, Univ. of Minnesota, Twin Cities (USA); Matthew L. Grandbois, Bruce M. Bell, The Dow Chemical Co. (USA); E. L. Cussler, Russell J. Holmes, Univ. of Minnesota, Twin Cities (USA) ..... [9566-29]

**Optically and electrically detected magnetic resonance (ODMR and EDMR, respectively) of phosphorescent, thermally activated delayed fluorescence (TADF), and exciplex OLEDs (Invited Paper)**, Chamika Hippola, Dusan Danilovic, Min Cai, Ruth Shinar, Joseph Shinar, Iowa State Univ. of Science and Technology (USA) ..... [9566-30]

**Kinetic Monte Carlo simulation of the efficiency roll-off, emission color, and degradation of organic light-emitting diodes (Invited Paper)**, Reinder Coehoorn, Philips Research Nederland B.V. (Netherlands); Harm van Eersel, Peter A. Bobbert, Rene A. J. Janssen, Technische Univ. Eindhoven (Netherlands) ..... [9566-31]

**Modeling of organic light emitting diodes: From molecular to device properties (Invited Paper)**, Pascal Kordt, Jeroen J. M. van der Holst, Max-Planck-Institut für Polymerforschung (Germany); Mustapha Al Helwi, BASF SE (Germany) and Technische Univ. Braunschweig (Germany); Wolfgang Kowalsky, Technische Univ. Braunschweig (Germany); Falk May, Alexander Badinski, Christian Lennartz, BASF SE (Germany); Denis Andrienko, Max-Planck-Institut für Polymerforschung (Germany) ..... [9566-32]

**Development of operationally stable inverted organic light-emitting diode prepared without using alkali metals (Invited Paper)**, Hirohiko Fukagawa, NHK Japan Broadcasting Corp. (Japan); Katsuyuki Morii, Munehiro Hasegawa, Shun Gouda, NIPPON SHOKUBAI CO., LTD. (Japan); Toshimitsu Suzuki, Takahisa Shimizu, Toshihiro Yamamoto, NHK Japan Broadcasting Corp. (Japan) .. [9566-33]

SESSION 8 ..... MON 4:00 PM TO 5:40 PM

## Novel Devices I

Session Chairs: **Yong-Jin Pu**, Yamagata Univ. (Japan); **Jian Li**, Arizona State Univ. (USA)

**Next generation organic light-emitting materials and devices (Invited Paper)**, Bernard Kippelen, Georgia Institute of Technology (USA) ..... [9566-34]

**Construction of charge generation layer for high efficiency tandem organic light-emitting diodes (Invited Paper)**, Dongge Ma, Changchun Institute of Applied Chemistry (China) ..... [9566-35]

**Ultraflexible high-efficiency organic light-emitting diodes using graphene anode (Invited Paper)**, Tae-Woo Lee, Tae-Hee Han, Min-Ho Park, Sung-Joo Kwon, Pohang Univ. of Science and Technology (Korea, Republic of); Sang-Hoo Bae, Yonsei Univ. (Korea, Republic of); Hong-Kyu Seo, Pohang Univ. of Science and Technology (Korea, Republic of); Jong-Hyun Ahn, Yonsei Univ. (Korea, Republic of) ..... [9566-36]

**Emitting dipole orientation of iridium complexes in OLEDs (Invited Paper)**, Kwon-Hyeon Kim, Seoul National Univ. (Korea, Republic of); Jae-yeol Ma, Gyeongsang National Univ. (Korea, Republic of); Chang-Ki Moon, Seoul National Univ. (Korea, Republic of); Yun-Hi Kim, Gyeongsang National Univ. (Korea, Republic of); Jang-Joo Kim, Seoul National Univ. (Korea, Republic of) ... [9566-94]

POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**High thermal conducting diamond/gold-grids as transparent electrode for organic light emitting diodes**, Koen Gilissen, Univ. Hasselt (Belgium) and IMEC (Belgium); Pieter Robaeys, Univ. Hasselt (Belgium); Matthew McDonald, Emilie Bourgeois, Jan D'Haen, Univ. Hasselt (Belgium) and IMEC (Belgium); Zdenek Remes, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Ken Haenen, Jean V. Manca, Michael Daenens, Milos Nesladek, Wim Deferme, Univ. Hasselt (Belgium) and IMEC (Belgium) ..... [9566-46]

**Hybrid structure of AgNWs-graphene-PEDOT as anode for organic light-emitting diodes**, Xiaoqing Du, Chongqing Univ. (China) ..... [9566-47]

**Influence of electrode materials on current characteristic of flexible organic electroluminescent devices**, Jun Bao, Xiaoqing Du, Chongqing Univ. (China) ..... [9566-48]

**High-efficiency flexible organic light-emitting diodes with novel light-outcoupling structures**, Jianxin Tang, Yan-Qing Li, Lei Zhou, Hengyang Xiang, Soochow Univ. (China) ..... [9566-49]

**High-efficiency wet-processed blue OLED with a cross-linkable hole-transport material having a high lumo level and high triple energy**, Jwo-Huei Jou, Tsung-Han Li, Chih-Chia An, National Tsing Hua Univ. (Taiwan); Gintare Kruciaite, Saulius Grigalevicius, Kaunas Univ. of Technology (Lithuania); Chao-Feng Sung, Industrial Technology Research Institute (Taiwan) ..... [9566-51]

**Control of the orientation of the light-emitting molecules in spin-coated glassy organic films**, Li Zhao, Kyushu Univ. (Japan); Takeshi Komino, Kyushu Univ. (Japan) and Japan Science and Technology Agency (Japan); Munetomo Inoue, Ju-Hyung Kim, Kyushu Univ. (Japan); Jean-Charles Ribierre, Kyushu Univ. (Japan) and Japan Science and Technology Agency (Japan); Chihiaya Adachi, Kyushu Univ. (Japan) and Japan Science and Technology Agency (Japan) ..... [9566-52]

**Photopolymerizable fluorescent small molecule-based materials: An all-in approach for solution-processed OLEDs**, Simon Olivier, Commissariat à l'Énergie Atomique (France) and Univ. de Nantes (France); Lionel Derue, Bernard Geffroy, Ecole Polytechnique (France) and CEA Saclay (France); Eléna Ishow, Univ. de Nantes (France); Tony Maindron, CEA Grenoble (France) ..... [9566-53]

**Direct observation of surface anions relaxed by spontaneous orientation polarization in OLED films by high sensitivity photoemission**, Hiroumi Kinjo, Tomoya Sato, Junki Yamazaki, Chiba Univ. (Japan); Yutaka Noguchi, Meiji Univ. (Japan); Yasuo Nakayama, Hisao Ishii, Chiba Univ. (Japan) ..... [9566-55]

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- Highly transparent and low resistance ZnO/Ag/ZnO multilayer electrodes for organic photovoltaic devices**, Jun Ho Kim, Dae-Hyun Kim, Jae-Ho Kim, Korea Univ. (Korea, Republic of); Young-Zo Yoo, Duksan Hi-Metal Co., Ltd. (Korea, Republic of); Tae-Yeon Seong, Korea Univ. (Korea, Republic of) . . . . . [9566-56]
- Singlet harvesting technology for OLED applications**, Daniel M. Zink, Charlotte Fléchon, Thomas Baumann, cynora GmbH (Germany) . . . . . [9566-57]
- Synthesis and characterization of red phosphorescent iridium(III) complexes based on electron-acceptor modulation of main ligand for high efficiency organic light-emitting diodes**, Sang Yong Park, Hongik Univ. (Korea, Republic of) . . . . . [9566-58]
- Tuning the singlet-triplet energy gap by the means of steric hindrance in carbazolyl-containing compounds**, Tomas Matulaitis, Juozas V. Gražulevičius, Kaunas Univ. of Technology (Lithuania) . . . . . [9566-59]
- Development of the efficient deep-blue organic emitters exhibiting thermally activated delayed fluorescence: Design, experimental, and theoretical studies**, Nadzeya A. Kukhta, Juozas V. Gražulevičius, Kaunas Univ. of Technology (Lithuania) . . . . . [9566-60]
- Dependent of light outcoupling in organic light-emitting devices on ITO thickness and roughness**, Yingjie Zhang, Hany Aziz, Univ. of Waterloo (Canada) . . . . . [9566-61]
- High performance inverted top-emitting organic light-emitting diodes with enhanced intrinsic quantum yield**, Yu-Kun Wu, Runda Guo, Hongbo Wang, Zhensong Zhang, Yi Zhao, Jilin Univ. (China) . . . . . [9566-62]
- An electro-optical characteristics test equipment for OLED lighting panels with homogeneity and non-uniformity test function**, Hector H. Y. Lin, Gilbert C. W. Chen, Jamie J. M. Liu, Paul B. Y. Wu, MPI Corp. (Taiwan); Chih-Ming Lai, Wen-Yung Yeh, Chi-Yi Leu, Chao-Feng Sung, Mei-Ju Lee, Industrial Technology Research Institute (Taiwan) . . . . . [9566-63]
- OLED microdisplay in 0.35 um complementary metal-oxide semiconductor technologies for wearable electronic display applications**, Chih Hsiang Chang, Po-Tsun Liu, National Chiao Tung Univ. (Taiwan) . . . . . [9566-64]
- Precise color-tuning using solution processed LECs in a hybrid device architecture**, Serpil Tekoglu, Karlsruher Institut für Technologie (Germany) and InnovationLab GmbH (Germany); Martin Petzoldt, Ruprecht-Karls-Univ. Heidelberg (Germany) and InnovationLab GmbH (Germany); Sebastian Stolz, Karlsruher Institut für Technologie (Germany) and InnovationLab GmbH (Germany); Uli Lemmer, Karlsruher Institut für Technologie (Germany); Manuel Hamburger, Ruprecht-Karls-Univ. Heidelberg (Germany) and InnovationLab GmbH (Germany); Gerardo Hernandez-Sosa, Karlsruher Institut für Technologie (Germany) and InnovationLab GmbH (Germany) . . . . . [9566-65]
- Computer simulation of OLED devices: From chemical structures to drift-diffusion equations**, Pascal Kordt, Max-Planck-Institut für Polymerforschung (Germany); Sven Stodtmann, Mustapha Al Helwi, Alexander Badinski, BASF SE (Germany); Denis Andrienko, Max-Planck-Institut für Polymerforschung (Germany) . . . . . [9566-66]
- To enhancement illuminance efficiency of OLED by thin film included microparticle**, Chuang-Hung Chiu, Chunghwa Picture Tubes, Ltd. (Taiwan); Chao-Heng Chien, Jen-Chi Lee, Wei-Cheng Chien, Tatung Univ. (Taiwan) . . . . . [9566-67]
- Photophysical studies of the thermally-activated delayed fluorescence of a highly luminescent mononuclear copper(I) compound**, Larissa Bergmann, cynora GmbH (Germany); Gordon J. Hedley, Univ. of St. Andrews (United Kingdom); Thomas Baumann, cynora GmbH (Germany); Ifor D. W. Samuel, Univ. of St. Andrews (United Kingdom) . . . . . [9566-68]
- Study on cadmium sulphide nanoparticles on blue and green light emitting polymers**, Pradeep Chandran, Cochin Univ. of Science and Technology (India); Mathew Sebastian, Cochin Univ. of Science & Technology (India); Manoj A. G. Namboothiry, Indian Institute of Science Education and Research (India); C. P. G. Vallabhan, Cochin Univ. of Science & Technology (India); P. Radhakrishnan, International School of Photonics (India); V. P. N. Nampoori, Cochin Univ. of Science & Technology (India) . . . . . [9566-69]
- Measurement of charge balance and its effect on electrophosphorescent organic light emitting device lifetime**, Caleb Coburn, Stephen R. Forrest, Univ. of Michigan (USA) . . . . . [9566-70]
- A systematic comparison of the effect of joule heating vs thermal annealing on the morphology of typical hole transport layers in organic light emitting devices**, Tyler Davidson-Hall, Hany Aziz, Univ. of Waterloo (Canada) . . . . . [9566-71]
- Vacuum nano-hole array embedded organic light emitting diodes with high efficiency**, Sohee Jeon, Korea Institute of Machinery & Materials (Korea, Republic of) . . . . . [9566-72]
- Correlation of carrier mobility with energetic disorder of host molecules in p-doped amorphous organic semiconductors**, Seung-Jun Yoo, Seoul National Univ. (Korea, Republic of); Jeong-Hwan Lee, Seoul National Univ. (Korea, Republic of) and IMEC (Belgium); Jae-Min Kim, Jang-Joo Kim, Seoul National Univ. (Korea, Republic of) . . . . . [9566-73]
- Controlling orientation of emitting dipoles of iridium complexes for highly efficient phosphorescent organic light-emitting diodes**, Kwon-Hyeon Kim, Seoul National Univ. (Korea, Republic of); Jae-yeol Ma, Gyeongsang National Univ. (Korea, Republic of); Chang-Ki Moon, Seoul National Univ. (Korea, Republic of); Yun-Hi Kim, Gyeongsang National Univ. (Korea, Republic of); Jang-Joo Kim, Seoul National Univ. (Korea, Republic of) . . . . . [9566-74]
- Introducing a thermally activated delayed fluorescence emitter for a highly efficient blue fluorescent organic light emitting diode**, Jin-Won Sun, Kwon-Hyun Kim, Seoul National Univ. (Korea, Republic of); Yun-Hi Kim, Gyeongsang National Univ. (Korea, Republic of); Jang-Joo Kim, Seoul National Univ. (Korea, Republic of) . . . . . [9566-75]
- Efficiency loss in solution processed organic light emitting diodes**, Szuheng Ho, Ying Chen, Franky So, Univ. of Florida (USA) . . . . . [9566-76]
- Organic light emitting diodes with enhanced out-coupling efficiency and operational stability due to spontaneously formed corrugated structure within active layers**, Cheng Peng, Xiangyu Fu, Shuyi Liu, Ying Chen, Franky So, Univ. of Florida (USA) . . . . . [9566-77]
- Passivation of metal oxides surfaces for high performance organic and hybrid optoelectronic devices**, Franky So, Shuyi Liu, Szuheng Ho, Ying Chen, Univ. of Florida (USA) . . . . . [9566-78]
- Probing the structural integrity and stability of TADF-Cu(I) emitters for printed OLEDs**, Manuela Wallesch, Karlsruher Institut für Technologie (Germany); Daniel Volz, cynora GmbH (Germany) . . . . . [9566-79]
- Delayed fluorescence on triazine phenothiazine derivative**, Ikbal Marghad, Ecole Polytechnique (France) . . . . . [9566-80]
- Optical effect of graphene electrodes on organic light-emitting diodes**, Hyunsoo Cho, Jin-Wook Shin, Nam Sung Cho, Jaehyun Moon, Jun-Han Han, Electronics and Telecommunications Research Institute (Korea, Republic of); Young-Duck Kwon, Seungmin Cho, SAMSUNG Techwin Co., Ltd. (Korea, Republic of); Jeong-Ik Jeong-Ik, Electronics and Telecommunications Research Institute (Korea, Republic of) . . . . . [9566-81]
- Efficient OLEDs based on embedded silver grid electrodes for flexible lighting applications**, Jaeho Lee, KAIST (Korea, Republic of); Jee-Hoon Seo, HANA Microelectronics, Inc. (Korea, Republic of); Sungyeon Kim, Jin Chung, Eunhye Kim, Sunghiee Park, Eungjun Kim, Seung S. Lee, Seunghyup Yoo, KAIST (Korea, Republic of) . . . . . [9566-82]
- Photophysical properties of the thermally activated delayed fluorescence from highly efficient blue electroluminescence**, DaSom Kim, Hee Won Shin, Tae Kyu Ahn, Sungkunkwan Univ. (Korea, Republic of) . . . . . [9566-83]
- Hollow-core polymeric nanoparticles for the enhancement of OLED outcoupling efficiency**, Jun-Hwan Park, Pusan National Univ. (Korea, Republic of) . . . . . [9566-84]
- Highly enhanced green phosphorescent organic light-emitting diodes with cesium fluoride doped electron injection layer**, Jongseok Han, Yongwon Kwon, Changhee Lee, Seoul National Univ. (Korea, Republic of) . . . . . [9566-85]
- Numerical characteristics of the intensity distribution for a white organic light-emitting diode**, Henglong Yang, Wei-Cheng Li, National Taipei Univ. of Technology (Taiwan) . . . . . [9566-86]
- Improved light out-coupling efficiency of organic light emitting diodes with a simple processed light-extraction layer**, Jae-Hyun Lee, Chur-Hyun Shin, Min-Hoi Kim, Hanbat National Univ. (Korea, Republic of); Yoonseuk Choi, Hanbat National Univ (Korea, Republic of) . . . . . [9566-87]
- Delayed electroluminescence studies of emission mechanism in quantum dot light emitting devices with a phosphorescent sensitizer**, Hossein Zamani Siboni, Hany Aziz, Univ. of Waterloo (Canada) . . . . . [9566-88]
- Shape-memory polymer resonators for novel continuously tunable organic distributed feedback lasers**, Senta Schauer, Xin Liu, Matthias Worgull, Uli Lemmer, Hendrik Hölscher, Karlsruher Institut für Technologie (Germany) [9566-89]
- Towards fully solution processed OLEDs: Introducing a novel amino-functionalized polyfluorene as electron injection layer**, Sebastian Stolz, Karlsruher Institut für Technologie (Germany) and InnovationLab GmbH (Germany); Martin Petzoldt, Ruprecht-Karls-Univ. Heidelberg (Germany) and InnovationLab GmbH (Germany); Uli Lemmer, Karlsruher Institut für Technologie (Germany); Manuel Hamburger, Ruprecht-Karls-Univ. Heidelberg (Germany) and InnovationLab GmbH (Germany); Gerardo Hernandez-Sosa, Karlsruher Institut für Technologie (Germany) and InnovationLab GmbH (Germany) . . . . . [9566-90]
- The effect of plasmonic nanostructure at the interface of optoelectronics**, Seong Jun Kang, Kyung Hee Univ. (Korea, Republic of) . . . . . [9566-91]
- Solution-processed sodium hydroxide as electron injection layer in inverted bottom-emitting organic light-emitting diodes**, Hongmei Zhang, Nanjing Univ. of Posts and Telecommunications (China) . . . . . [9566-92]
- Organic/inorganic (F8T2/p-GaN) white-light emitting device**, Yen-Ju Wu, Cheng-Yi Liu, National Central Univ. (Taiwan) . . . . . [9566-93]

# CONFERENCE 9566

TUESDAY 11 AUGUST

## ORGANIC PHOTONICS + ELECTRONICS

### PLENARY SESSION ..... 9:00 AM TO 11:45 AM

Session Chair: **Zakya H. Kafafi**, Lehigh Univ. (USA)

**Current status of high efficiency OLEDs based on delayed fluorescence (Plenary)**, Chihaya Adachi, Kyushu Univ. (Japan) ..... [9566-301]

**Interfacing with the brain using organic electronics (Plenary)**, George G. Malliaras, Ecole Nationale Supérieure des Mines de Saint-Étienne (France) ..... [9568-302]

**Ultraflexible organic thin-film devices for wearable and implantable electronics (Plenary)**, Takao Someya, The Univ. of Tokyo (Japan) ..... [9568-303]

**Recent progress on hybrid organic-inorganic and perovskite-based solar cells (Plenary)**, Yang Yang, Univ. of California, Los Angeles (USA) ..... [9567-304]

Lunch/Exhibition Break ..... Tue 11:45 am to 1:20 pm

### SESSION 9 ..... TUE 1:20 PM TO 3:00 PM

#### Novel Devices II

Session Chairs: **Sebastian Reineke**, Massachusetts Institute of Technology (USA); **Barry P. Rand**, Princeton Univ. (USA)

**Light emitting transistors: A new route for display pixels (Invited Paper)**, Ebinazar B. Namdas, The Univ. of Queensland (Australia) ..... [9566-37]

**OLEDs: Light-emitting thin film thermistors revealing advanced self-heating effects (Invited Paper)**, Axel Fischer, Technische Univ. Dresden (Germany); Thomas Koprucki, Annegret Glitzky, Matthias Liero, Weierstrass-Institut für Angewandte Analysis und Stochastik (Germany); Klaus Gärtner, Univ. della Svizzera italiana (Switzerland); Jacqueline Hauptmann, Fraunhofer-Einrichtung für Organik, Materialien und Elektronische Bauelemente COMEDD (Germany); Sebastian Reineke, Daniel Kasemann, Technische Univ. Dresden (Germany); Björn Lüssem, Kent State Univ. (USA); Karl Leo, Reinhard Scholz, Technische Univ. Dresden (Germany) ..... [9566-38]

**Highly transparent electrodes for flexible electronics: Ultra-thin metal, 2D materials and their hybrid structures (Invited Paper)**, Illhwon Lee, Pohang Univ. of Science and Technology (Korea, Republic of); Ki Chang Kwon, Chung-Ang Univ. (Korea, Republic of); Juyoung Ham, Seung O Gim, Pohang Univ. of Science and Technology (Korea, Republic of); Soo Young Kim, Chung-Ang Univ. (Korea, Republic of); Jong-Lam Lee, Pohang Univ. of Science and Technology (Korea, Republic of) ..... [9566-39]

**Efficient inverted organic light-emitting devices by amine-based solvent treatment (Invited Paper)**, Myoung Hoon Song, Kyong-Jin Choi, Ulsan National Institute of Science and Technology (Korea, Republic of) ..... [9566-54]

SESSION 10 ..... TUE 3:25 PM TO 5:35 PM

#### WOLED and Light Extraction

Session Chairs: **Sebastian Reineke**, Massachusetts Institute of Technology (USA); **Barry P. Rand**, Princeton Univ. (USA)

**Enhanced light extraction from organic light-emitting devices using a sub-anode grid**, Yue Qu, Michael Slootsky, Stephen R. Forrest, Univ. of Michigan (USA) ..... [9566-40]

**Extracting and directing light out of organic light emitting diodes (Invited Paper)**, Uli Lemmer, Amos Egel, Matthias Hecht, Jan B. Preinfalk, Guillaume Gomard, Karlsruhe Institut für Technologie (Germany) ..... [9566-41]

**Outcoupling enhancement of ITO-free white organic light-emitting diodes with an air void-mediated scattering layer (Invited Paper)**, Tae-Wook Koh, Joshua Spechler, Craig B. Arnold, Barry P. Rand, Princeton Univ. (USA) ..... [9566-42]

**Simple fabrication of a three-dimensional porous polymer film as a diffuser for microcavity OLEDs (Invited Paper)**, Min Chul Suh, Kyung Hee Univ. (Korea, Republic of) ..... [9566-43]

**Anisotropy in OLEDs (Invited Paper)**, Michiel Callens, Kristiaan Neyts, Univ. Gent (Belgium); Daisuke Yokoyama, Yamagata Univ. (Japan) ..... [9566-44]

**Extracting and shaping the light of OLED devices**, Daniel Riedel, OSRAM Opto Semiconductors GmbH (Germany) and Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Thomas Wehlus, OSRAM Opto Semiconductors GmbH (Germany); Christoph J. Brabec, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) ..... [9566-45]

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## Organic Photovoltaics XVI

Conference Chair: **Zakya H. Kafafi**, Lehigh Univ. (USA)

Conference Co-Chairs: **Paul A. Lane**, U.S. Naval Research Lab. (USA); **Ifor D. W. Samuel**, Univ. of St. Andrews (United Kingdom)

Program Committee: **Natalie Banerji**, Univ. de Fribourg (Switzerland); **Pierre M. Beaujuge**, King Abdullah Univ. of Science and Technology (Saudi Arabia); **Christoph J. Brabec**, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); **Paul L. Burn**, The Univ. of Queensland (Australia); **Antonio F. Faccetti**, Polyera Corp. (USA); **René A. J. Janssen**, Technische Univ. Eindhoven (Netherlands); **Bernard Kippelen**, Georgia Institute of Technology (USA); **David G. Lidzey**, The Univ. of Sheffield (United Kingdom); **Thuc-Quyen Nguyen**, Univ. of California, Santa Barbara (USA); **Ana F. Nogueira**, Univ. of Campinas (Brazil); **Dana C. Olson**, National Renewable Energy Lab. (USA); **Barry P. Rand**, Princeton Univ. (USA); **Sean E. Shaheen**, Univ. of Colorado at Boulder (USA); **Natalie Stingelin**, Imperial College London (United Kingdom); **He Yan**, Hong Kong Univ. of Science and Technology (Hong Kong, China); **Yang Yang**, Univ. of California, Los Angeles (USA)

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### MONDAY 10 AUGUST

#### OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY PLENARY SESSION..... 2:00 PM TO 4:30 PM

- Session Chair: **Oleg V. Sulima**, GE Global Research (USA)
- Status and challenges of CdTe photovoltaics (Plenary)**, Wyatt K. Metzger, National Renewable Energy Lab. (USA) ..... [9561-201]
- Photochemical upconversion of light for renewable energy and more (Plenary)**, Timothy W. Schmidt, The Univ. of New South Wales (Australia) ..... [9562-202]
- The importance of reliability to the SunShot Initiative (Plenary)**, Rebecca Jones-Albertus, U.S. Dept. of Energy (USA) ..... [9563-203]
- Solar hydrogen: harvesting light and heat from sun (Plenary)**, Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-204]]

#### POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

Session Chairs: **Pierre M. Beaujuge**, King Abdullah Univ. of Science and Technology (Saudi Arabia); **Natalie Stingelin**, Imperial College London (United Kingdom)

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Interface trap density effect on efficiency of Fullerene organic Schottky diode**, Mebarka Daoudi, Univ. Tahri Mohammed Béchar (Algeria) ..... [9567-49]

**Conformation modulated quinoxaline-based low band gap polymers with non-covalent Coulomb interaction for photovoltaic cells with efficiency of 8%**, Yuxiang Li, Pusan National Univ. (Korea, Republic of); Seo-jin Ko, Jin Young Kim, Ulsan National Institute of Science and Technology (Korea, Republic of); Han Young Woo, Pusan National Univ. (Korea, Republic of) ..... [9567-50]

**Varification of effect of electric field on electron transport in TiO<sub>2</sub> electrode**, Kai-Ling Chuang, Ming-Show Wong, Yi-Jia Chen, Chih-Hung Tsai, National Dong Hwa Univ. (Taiwan); Hong Syuan Ling, Chien Chin Wang, National Dong Hwa Univ. (Taiwan) ..... [9567-51]

**Structure-property correlations of merocyanines and their application in organic solar cells**, Julian Krumrain, Univ. zu Köln (Germany); Alhama Arjona-Esteban, Julius-Maximilians-Univ. Würzburg (Germany); Selina Olthof, Dirk Hertel, Univ. zu Köln (Germany); Matthias Stolte, Frank Würthner, Julius-Maximilians-Univ. Würzburg (Germany); Klaus Meerholz, Univ. zu Köln (Germany) ..... [9567-52]

**Femtosecond transient absorption spectroscopy of thiophlenylenevinylene-phthalimide copolymer and of bulk heterojunction blend with PC<sub>71</sub>BM**, In-Sik Kim, Terry Park, Juhwan Kim, Dongkyu Kim, Do-Yeong Ko, Gwangju Institute of Science and Technology (Korea, Republic of) ..... [9567-53]

**Criteria for stabilizing polymer and small molecule solar cells**, Rongrong Cheacharoen, William R. Mateker, I. T. Sachs-Quintana, Thomas Heumüller, Michael D. McGehee, Stanford Univ. (USA) ..... [9567-54]

**Effect of thermal annealing on charge transfer states and exciton dissociation in PCDTBT: PC<sub>70</sub>BM bulk heterojunction solar cells**, Iordanica Constantinou, Tzung-Han Lai, Erik D. Klump, Univ. of Florida (USA); Hsien-Yi Hsu, The Univ. of Texas System (USA); Kirk S. Schanze, Franky So, Univ. of Florida (USA) ..... [9567-55]

**Probing the organic-inorganic interfaces of organic photovoltaic devices**, Andrew J. Clulow, Hui Jin, Mike Hambisch, Jake A. McEwan, Paul L. Burn, Ian R. Gentle, Paul Meredith, The Univ. of Queensland (Australia) ..... [9567-56]

**Time-resolved terahertz spectroscopy (TRTS) of conducting metal-organic frameworks (MOFs) doped with redox active species**, Brian G. Alberding, Edwin Heilweil, National Institute of Standards and Technology (USA) ..... [9567-57]

**Plasmon-induced selectively chemical growth of flexible and transparent silver nano-network electrode for organic optoelectronic devices**, Haifei Lu, The Chinese Univ. of Hong Kong (Hong Kong, China); Di Zhang, Xingang Ren, Wallace C. H. Choy, The Univ. of Hong Kong (Hong Kong, China) ..... [9567-58]

**INKjet transparent top electrode for semi-transparent organic solar cell devices**, Jian Lin, Hui Lu, Suzhou Institute of Nano-Tech and Nano-Bionics (China) ..... [9567-59]

**ZnO:Al films modified by Zn<sub>1-x</sub>Mg<sub>x</sub>O:Al surface layer as low work function transparent electrodes**, Grzegorz Luka, Institute of Physics (Poland); Wojciech Lisowski, Janusz W. Sobczak, Aleksander Jablonski, Institute of Physical Chemistry (Poland); Petro S. Smertenko, V.E. Lashkaryov Institute of Semiconductor Physics (Ukraine) ..... [9567-60]

**Understanding the degradation of polymer solar cells: A comparative study realized on working devices**, Mario Prosa, Istituto per lo Studio dei Materiali Nanostrutturati (Italy); Mirko Seri, Istituto per la Sintesi Organica e la Fotoreattività (Italy); Marta Tessarolo, Istituto per lo Studio dei Materiali Nanostrutturati (Italy) ..... [9567-61]

**Tracking water diffusion as the cause for device failure in inverted and encapsulated organic solar cells**, Michael Salvador, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Jens Adams, Bayerisches Zentrum für Angewandte Energieforschung e.V. (Germany); Stefan Langner, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Luca Lucera, Bayerisches Zentrum für Angewandte Energieforschung e.V. (Germany); Ulf Dettinger, Eberhard Karls Univ. Tübingen (Germany); Bas van der Wiel, BELECTRIC OPV (Germany); Thomas Chasse, Eberhard Karls Univ. Tübingen (Germany); Hans J. Egelhaaf, Bayerisches Zentrum für Angewandte Energieforschung e.V. (Germany); Christoph Brabec, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) ..... [9567-62]

**Efficient perovskite solar cells and their application to semitransparent devices**, Hoyeon Kim, Jaewon Ha, KAIST (Korea, Republic of); Hui-Seon Kim, Nam-Gyu Park, Sungkyunkwan Univ. (Korea, Republic of); Seunghyup Yoo, KAIST (Korea, Republic of) ..... [9567-63]

**Thiazolo [5,4-d]thiazole based D-A-D type Chromophore with furan spacer for BHJ organic solar cells**, Mohammed Nazim, Sadia Ameen, Mohammed S. Akhtar, Hyung Kee Seo, Hyung Shik Shin, Chonbuk National Univ. (Korea, Republic of) ..... [9567-64]

**Optimization of interfacial layer for double and triple junction polymer solar cell**, Abu Mitul, South Dakota State Univ. (USA) ..... [9567-65]

**Non-oligoacence molecules exhibiting singlet fission in organic photovoltaic devices**, Yong-Jin Pu, Yamagata Univ. (Japan) ..... [9567-66]

**Hybrid perovskite solar cells based on zinc oxide scaffolds synthesized by different methods**, Fangzhou Liu, Qi Dong, Man Kwong Wong, Aleksandra B. Djurić, The Univ. of Hong Kong (Hong Kong, China); Annie Ng, Charles Surya, The Hong Kong Polytechnic Univ. (Hong Kong, China); Wai Kin Chan, The Univ. of Hong Kong (Hong Kong, China) ..... [9567-67]

**Long lived polarisation anisotropy in organometallic halide perovskites**, Jasmine P. H. Rivett, Aditya Sadanala, Univ. of Cambridge (United Kingdom); Pablo Docampo, Ludwig-Maximilians-Univ. München (Germany); Richard H. Friend, Dan Credgington, Felix Deschler, Univ. of Cambridge (United Kingdom) ..... [9567-68]

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- Sn/Pb binary perovskite solar cells with improved stability in air and organic amine-free perovskite solar cells with improved stability against light exposure**, Koji Nishinaka, Yuhei Ogomi, Kyushu Institute of Technology (Japan); Qing Shen, The Univ. of Electro-Communications (Japan); Kosei Fujiwara, Keita Sakaguchi, Kyushu Institute of Technology (Japan); Taro Toyoda, The Univ. of Electro-Communications (Japan); Shuzi Hayase, Kyushu Institute of Technology (Japan) ..... [9567-69]
- Overcoming the “light-soaking” issue in organic solar cells**, Sara Trost, Bergische Univ. Wuppertal (Germany); Philip Reckers, Thomas Mayer, Technische Univ. Darmstadt (Germany); Tim Becker, Andreas Behrendt, Andreas Polywka, Ralf Heiderhoff, Patrick Görnr, Thomas Riedl, Bergische Univ. Wuppertal (Germany) ..... [9567-70]
- Effects of organic and inorganic templating layers on phthalocyanine/C<sub>60</sub> planar and bulk heterojunction organic solar cells**, Sibi Sutty, Hany Aziz, Univ. of Waterloo (Canada) ..... [9567-71]
- Advanced imaging characterization and modelling of defects in organic solar cells**, Roland Rösch, Daniel Flühr, Rolf Öttinger, Burhan Muhsin, Harald Hoppe, Technische Univ. Ilmenau (Germany) ..... [9567-72]
- The effect of oxygen induced degradation on charge carrier dynamics in P3HT:PCBM solar cells**, Tobias Sauermann, BELECTRIC OPV (Germany) and Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) ..... [9567-73]
- Multiscale analysis of the effect of micro phase separation on the charge transfer at the PEDOT:PSS and P3HT:PCBM layer interface**, Min Huang, Tongji Univ. (China) ..... [9567-74]
- Efficient photoluminescence and optically-pumped lasing in mixed halide perovskite photovoltaic semiconductors**, Felix Deschler, Michael B. Price, Univ. of Cambridge (United Kingdom); Sandeep Pathak, Univ. of Oxford (United Kingdom); Sven Huetter, Univ. Bayreuth (Germany); Richard H. Friend, Univ. of Cambridge (United Kingdom) ..... [9567-75]
- Control of ultrafast singlet exciton fission in antradi thiophene derivatives: From 1 exciton to 2 exciton generation**, Chaw Keong Yong, Olga Bubnova, Stavros Athanasopoulos, Univ. of Cambridge (United Kingdom); Jenny Clark, The Univ. of Sheffield (United Kingdom); John Anthony, Univ. of Kentucky (USA); Henning Sirringhaus, Univ. of Cambridge (United Kingdom) ..... [9567-76]
- Copper (I) oxide (Cu<sub>2</sub>O) as a hole transport layer for inverted perovskite solar cells**, Rodrigo Szostak, Ivo B. Freitas, Ana Flavia F. Nogueira, Univ. Estadual de Campinas (Brazil) ..... [9567-77]
- Understanding the photo current generation in organic tandem solar cells utilizing a 3-terminal device architecture**, Daniel Bahro, Manuel Koppitz, Adrian Mertens, Konstantin Glaser, Jan Mescher, Alexander Colsmann, Karlsruher Institut für Technologie (Germany) ..... [9567-78]
- Automated spray deposition for plastic electronics**, Kirsty A. Roy, James Bannock, Neil Treat, John de Mello, Martyn McLachlan, Imperial College London (United Kingdom) ..... [9567-79]
- Selective non-contact modification of the polymer chain orientation and morphology in conducting polymers by femtosecond laser writing**, Hyo Jung Kim, Sang Min Chae, See Wo Lee, Pusan National Univ. (Korea, Republic of); Jiyeon Choi, Korea Institute of Machinery & Materials (Korea, Republic of); Hyun Hwi Lee, Pohang Univ. of Science and Technology (Korea, Republic of) ..... [9567-80]
- Optimization of PEDOT: PSS and BCP thicknesses on carrier mobility of organic heterojunction solar cell by based of SubPc/C<sub>60</sub>**, Nesrine Zoulikha Mendil, Mebarka Daoudi, Univ. Tahri Mohammed Béchar (Algeria) ..... [9567-81]
- Bulk-heterojunction morphologies of solution processed BODIPY solar cells**, Alexander Colsmann, Jens Ludwig, Martin Hochberg, Karlsruher Institut für Technologie (Germany); Alexandre Cheminal, Jérémie Léonard, Univ. de Strasbourg (France); Stefan Haacke, Univ. de Strasbourg (France); Laure Biniek, Martin Brinkmann, Institut Charles Sadron (France); Nicolas Leclerc, Antoine Mirloup, Raymond Ziessel, Univ. de Strasbourg (France); Markus Kohlstaedt, Uli Würfel, Nils Hofmann, Fraunhofer-Institut für Solare Energiesysteme (Germany); Patrick Lévéque, Univ. de Strasbourg (France); Thomas Heiser, Univ. de Strasbourg (France) ..... [9567-82]
- Using hydrogen-bond mediated supramolecular self-assembly to direct the formation of organic bulk heterojunction**, Jiangeng Xue, Ronald K. Castellano, Nathan T. Shewmon, Davita L. Watkins, Weiran Cao, Benjamin M. Schulze, Xueying Zhao, Scott S. Perry, Johan F. Galindo, Adrian E. Roitberg, Univ. of Florida (USA) ..... [9567-83]
- Study of electrical transport properties of P3HT using impedance spectroscopy**, Camilo A. Otalora, Andres F. Loaiza, Gerardo Gordillo, Univ. Nacional de Colombia (Colombia) ..... [9567-85]

- Accurate correlation between panchromaticity and power conversion efficiencies in small molecule organic photovoltaic devices**, Chenyu Zheng, Anirudh Raju Penmetcha, Brandon Cona, Jeremy Cody, Christopher J. Collison, Rochester Institute of Technology (USA) ..... [9567-86]
- Nanostructure control in crystalline polymer-fullerene blends and its impact on the charge carrier dynamics in bulk heterojunction solar cells**, Swaminathan Venkatesan, Qiquan Qiao, Devendra Khatiwada, Cheng Zhang, South Dakota State Univ. (USA); Jihua Chen, Oak Ridge National Lab. (USA) ..... [9567-87]
- Thermal and photo-stability of non-halide lead precursors in perovskite material**, Fadi Kamal Aldibaja, Univ. degli Studi di Roma La Sapienza (Italy); Eva Unger, Lund Univ. (Sweden) ..... [9567-88]
- The comparison of photoinduced excited energy transfer and electron transfer in organic-inorganic compound**, Wenping Yin, Yan Cui, Hee-won Shin, Jungwoon Yang, Sungkyunkwan Univ. (Korea, Republic of); Arkady P. Yartsev, Lund Univ. (Sweden); Tae Kyu Ahn, Sungkyunkwan Univ. (Korea, Republic of) ..... [9567-89]
- Enhanced performance in organic photovoltaics incorporating luminescent down-shifting nanotemplates**, Minwoo Nam, Hyungduk Ko, Il Ki Han, Doo-Hyun Ko, Korea Institute of Science and Technology (Korea, Republic of) ..... [9567-90]
- Sterically protected small molecules as novel donors for efficient bulk heterojunction solar cells**, Swaminathan Venkatesan, Qiquan Qiao, South Dakota State Univ. (USA); Jihua Chen, Oak Ridge National Lab. (USA); Cheng Zhang, South Dakota State Univ. (USA) ..... [9567-91]
- Impact of the Poole-Frenkel effect on charge transport in PDTSiTzTz:PCBM based photovoltaic devices**, Oleksiy Slobodyan, Kelly Liang, Eric Danielson, Marlene Gutierrez, Sarah Moench, Bradley Holliday, David Vanden Bout, Ananth Dodabalapur, The Univ. of Texas at Austin (USA) ..... [9567-92]
- Efficient perovskite solar cells employing polymers as effective hole transport layer**, Ashish Dubey, Nirmal Adhikari, Swaminathan Venkatesan, Devendra Khatiwada, Qiquan Qiao, South Dakota State Univ. (USA) ..... [9567-93]
- Surface modification of electron selective metal oxide thin films in organic solar cells for enhanced efficiency and stability**, Swaminathan Venkatesan, Evan C. Ngo, Qiquan Qiao, Cheng Zhang, South Dakota State Univ. (USA) ..... [9567-94]
- Inkjet printing of organic photovoltaics using a water-based active layer ink**, Anirudh Penmetcha, James Sinka, Chenyu Zheng, Christopher J. Collison, Rochester Institute of Technology (USA) ..... [9567-95]
- Photo-stability of crystalline large-grain planar perovskite solar cell**, Wanyi Nie, Hsinhan Tsai, Amanda Neukirch, Jean-Christophe Blancon, Hsing-Lin Wang, Jared Crochet, Gautam Gupta, Los Alamos National Lab. (USA); Muhammad Alam, Purdue Univ. (USA); Sergei Tretiak, Aditya Mohite, Los Alamos National Lab. (USA) ..... [9567-96]
- Efficient vacuum-deposited tandem organic solar cells with fill factor higher than single junction subcells**, Hyun-Sub Shim, Seoul National Univ. (Korea, Republic of); Francis Lin, National Taiwan Univ. (Taiwan); Jihun Kim, Bomim Sim, Tae-Min Kim, Chang-Ki Moon, Yongsok Seo, Seoul National Univ. (Korea, Republic of); Chun-Kai Wang, Ken-Tsung Wong, National Taiwan Univ. (Taiwan); Jang-Joo Kim, Seoul National Univ. (Korea, Republic of) ..... [9567-97]
- Application of metal nanoparticle-conducting polymer composite to organic based solar cells**, Sungho Woo, Wook Hyun Kim, Shi-Joon Sung, Daegu Gyeongbuk Institute of Science & Technology (Korea, Republic of) ..... [9567-98]
- Dye anchoring functional groups on performance of dye sensitized solar cells: Comparison between alkoxysilyl and carboxyl groups**, Sri Kasi V N R. Matta, RMIT Univ. (Australia); Yasuhiro Tachibana, RMIT Univ. (Australia) and Osaka Univ. (Japan); Kenji Kakiage, Yano Toru, Adeka Corp. (Japan) ..... [9567-99]
- Improved hole transport layers in perovskite solar cells based on functionalized carbon nanostructures doped P3HT**, Teresa Gatti, Univ. degli Studi di Padova (Italy); Simone Casaluci, Univ. degli Studi di Roma “Tor Vergata” (Italy) and Ctr. for Hybrid and Organic Photovoltaics (Italy); Aldo Di Carlo, Univ. degli Studi di Roma “Tor Vergata” (Italy); Enzo Menna, Univ. degli Studi di Padova (Italy) ..... [9567-100]
- High-performance planar-heterojunction perovskite solar cell using surface modified hole-transport layer**, Santanu Bag, UES, Inc. (USA); Michael F. Durstock, Air Force Research Lab. (USA) ..... [9567-101]

# CONFERENCE 9567

TUESDAY 11 AUGUST

## ORGANIC PHOTONICS + ELECTRONICS

### PLENARY SESSION.....9:00 AM TO 11:45 AM

Session Chair: **Zakya H. Kafafi**, Lehigh Univ. (USA)

Current status of high efficiency OLEDs based on delayed fluorescence  
(*Plenary*), Chihaya Adachi, Kyushu Univ. (Japan) ..... [9566-301]

Interfacing with the brain using organic electronics (*Plenary*), George G. Malliaras, Ecole Nationale Supérieure des Mines de Saint-Étienne (France) ..... [9568-302]

Ultraflexible organic thin-film devices for wearable and implantable electronics (*Plenary*), Takao Someya, The Univ. of Tokyo (Japan) ..... [9568-303]

Recent progress on hybrid organic-inorganic and perovskite-based solar cells (*Plenary*), Yang Yang, Univ. of California, Los Angeles (USA) ..... [9567-304]

Lunch/Exhibition Break ..... Tue 11:45 am to 1:45 pm

### SESSION 1.....TUE 1:45 PM TO 3:25 PM

#### Organic Photovoltaics Keynote Session

Session Chair: **Zakya H. Kafafi**, Lehigh Univ. (USA)

To live and let die: The role of excitons in the life of organic devices (*Keynote Presentation*), Stephen R. Forrest, Univ. of Michigan (USA) ..... [9567-1]

Poly(sulfobetaine methacrylate)s as electrode modifiers for inverted solar cells (*Invited Paper*), Hyunbok Lee, Egle Puodziukynaitė, Todd Emrick, Alejandro L. Briseño, Univ. of Massachusetts Amherst (USA) ..... [9567-44]

Design principles in polymer-fullerene bulk-heterojunction solar cells: A focus on PBDTPD and wide-bandgap analogs (*Invited Paper*), Pierre M. Beaujuge, King Abdullah Univ. of Science and Technology (Saudi Arabia) ..... [9567-3]

Aggregation and morphology control enables polymer solar cells with efficiencies near 11.5%, He Yan, Hong Kong Univ. of Science and Technology (Hong Kong, China) ..... [9567-4]

### SESSION 2.....TUE 4:00 PM TO 5:45 PM

#### Solution Processed Perovskite Solar Cells

Session Chair: **Ifor D. W. Samuel**, Univ. of St. Andrews (United Kingdom)

Fabricating thin-film photovoltaic devices using ultra-sonic spray-coating (*Invited Paper*), David G. Lidzey, The Univ. of Sheffield (United Kingdom) ..... [9567-5]

Activating grain boundaries for high-performance hybrid perovskite solar cells, Bin Yang, Oak Ridge National Lab. (USA); Ondrej Dyck, The Univ. of Tennessee Knoxville (USA); Jonathan Poplawsky, Jong Keum, Alexander Puretzky, Oak Ridge National Lab. (USA); Sanjib Das, The Univ. of Tennessee Knoxville (USA); Ilia Ivanov, Christopher Rouleau, Oak Ridge National Lab. (USA); Gerd Duscher, The Univ. of Tennessee Knoxville (USA); David Geohegan, Kai Xiao, Oak Ridge National Lab. (USA) ..... [9567-6]

Additive controlled solution process for high efficiency perovskite solar cells (*Invited Paper*), Kai Zhu, National Renewable Energy Lab. (USA) ..... [9567-7]

Electric field-induced manipulation of charge carrier recombination in methylammonium lead halide perovskite devices, Johannes M. Richter, Felix Deschler, Luis Pazos, Aditya Sadhanala, Univ. of Cambridge (United Kingdom); Giles Eperon, Henry Snaith, Univ. of Oxford (United Kingdom); Richard H. Friend, Univ. of Cambridge (United Kingdom) ..... [9567-8]

Perovskite thin film formation during solution processing: An In situ time-resolved multiprobe investigation (*Invited Paper*), Aram Amassian, King Abdullah Univ. of Science and Technology (Saudi Arabia) ..... [9567-9]

WEDNESDAY 12 AUGUST

### SESSION 3.....WED 8:30 AM TO 10:00 AM

#### Applications of Nanophotonics

Session Chair: **Vladimir Dyakonov**, Julius-Maximilians-Univ. Würzburg (Germany)

Colored ultra-thin hybrid photovoltaics with high quantum efficiency for decorative PV applications (*Invited Paper*), L. Jay Guo, University of Michigan (USA) ..... [9567-10]

Nano-photonic organic solar cell architecture for advanced light management utilizing dual photonic crystals (*Invited Paper*), Akshit Peer, Rana Biswas, Iowa State Univ. of Science and Technology (USA) ..... [9567-11]

Nanophotonic light management strategies for ultrathin solar cells (*Invited Paper*), Mark Brongersma, Stanford University (USA) ..... [9567-13]

### SESSION 4.....WED 10:30 AM TO 12:05 PM

#### Photophysics of Organic Semiconductors with Photovoltaic Applications

Session Chair: **Natalie Banerji**, Univ. de Fribourg (Switzerland)

Sub-ns triplet state formation in polymer:fullerene photovoltaic blends (*Invited Paper*), Frédéric Laquai, Max Planck Institute for Polymer Research (Germany) ..... [9567-14]

2D- and trap-assisted 2D-Langevin recombination in polymer:fullerene blends, Mathias Nyman, Oskar J. Sandberg, Ronald Österbacka, Åbo Akademi Univ. (Finland) ..... [9567-15]

Manipulation of the dielectric constant of non-fullerene organic semiconductors (*Invited Paper*), Paul L. Burn, Jenny Donaghey, Ardalan Armin, Paul Meredith, The Univ. of Queensland (Australia) ..... [9567-16]

Exciton binding energy limitations in organic materials and potentials for improvements, Stefan Krämer, Reinhard Scholz, Technische Univ. Dresden (Germany); Eric Müller, Martin Knupfer, Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden (Germany); Christian Koerner, Karl Leo, Technische Univ. Dresden (Germany) ..... [9567-17]

Conditions for charge transport without recombination in low mobility organic solar cells and photodiodes, Martin Stoltzfus, Ardalan Armin, The Univ. of Queensland (Australia); Bronson Philippa, Ronald D. White, James Cook Univ. (Australia); Paul L. Burn, Paul Meredith, The Univ. of Queensland (Australia); Gytis Ju?ka, Vilnius Univ. (Lithuania); Almantas Pivrikas, The Univ. of Queensland (Australia) ..... [9567-18]

Lunch/Exhibition Break ..... Wed 12:05 pm to 1:30 pm

### SESSION 5.....WED 1:30 PM TO 3:05 PM

#### Perovskite Solar Cells: Joint Session with Conferences 9549 and 9567

Session Chairs: **David G. Lidzey**, The Univ. of Sheffield (United Kingdom); **Sophia C. Hayes**, Univ. of Cyprus (Cyprus)

Photophysical versus structural properties in hybrid lead-halide perovskites (*Invited Paper*), Annamaria Petrozza, Istituto Italiano di Tecnologia (Italy) ..... [9549-51]

Photocurrent hysteresis and switchable organometal trihalide perovskite photovoltaic, Jinsong Huang, Univ. of Nebraska-Lincoln (USA) ..... [9567-19]

A comparison of perovskite and colloidal quantum dot solar cells (*Invited Paper*), Brandon R. Sutherland, Edward H. Sargent, Univ. of Toronto (Canada) ..... [9567-20]

Effect of substrate surface free energy on the optoelectronic and morphological properties of organolead halide perovskite solar cell materials, R. Clayton Shallcross, James G. Stanfill, Neal R. Armstrong, The Univ. of Arizona (USA) ..... [9549-52]

Hysteresis-free, stable and efficient perovskite solar cells achieved by vacuum-treated thermal annealing of  $\text{CH}_3\text{NH}_3\text{PbI}_3$ , Feng-Xian Xie, Di Zhang, Wallace C. H. Choy, The Univ. of Hong Kong (Hong Kong, China) ..... [9567-21]

### SESSION 6.....WED 3:35 PM TO 5:35 PM

#### Charge Transfer States and Processes

Session Chair: **Paul L. Burn**, The Univ. of Queensland (Australia)

Charge generation and charge transfer processes in organic and hybrid (organic-inorganic) solar cell materials (*Invited Paper*), Natalie Banerji, Univ. de Fribourg (Switzerland) ..... [9567-22]

The role of charge transfer states in organic photovoltaic blends, Remco W. Havenith, Hilde D. de Gier, Ria Broer, Univ. of Groningen (Netherlands) ..... [9567-23]

Charge transfer and triplet states in OPV materials and devices (*Invited Paper*), Vladimir Dyakonov, Julius-Maximilians-Univ. Würzburg (Germany) ..... [9567-24]

Charge transfer states as traps in organic solar cells, Andreas Arndt, Karlsruhe Institut für Technologie (Germany); Marina Gerhard, Philipps-Univ. Marburg (Germany); Aina Quintilla, Ian Howard, Karlsruhe Institut für Technologie (Germany); Martin Koch, Philipps-Univ. Marburg (Germany); Uli Lemmer, Karlsruhe Institut für Technologie (Germany) ..... [9567-25]

# CONFERENCE 9567

**Charge-transfer absorption, emission, and the open-circuit voltage of organic solar cells (Invited Paper)**, Koen Vandewal, Technische Univ. Dresden (Germany) ..... [9567-26]

**Theory and assignment of intermolecular charge transfer states in squaraines and their impact on efficiency in bulk heterojunction solar cells**, Christopher J. Collison, Chenyu Zheng, Rochester Institute of Technology (USA); Nicholas Hestand, Temple Univ. (USA); Brandon Cona, Anirudh Penmetcha, Susan Spencer, Jeremy Cody, Rochester Institute of Technology (USA); Frank Spano, Temple Univ. (USA) ..... [9567-27]

## THURSDAY 13 AUGUST

### SESSION 7 ..... THU 8:30 AM TO 9:55 AM

#### Advances in Organic Solar Cells and Detectors

Session Chair: **He Yan**, Hong Kong Univ. of Science and Technology (Hong Kong, China)

**Rational material, interface, and device engineering for high-performance polymer and perovskite solar cells (Invited Paper)**, Alex K-Y Jen, University of Washington (USA) ..... [9567-28]

**Vacuum deposited triple absorber organic solar cells (OSCs)**, Karsten Walzer, Heliatek GmbH (Germany) ..... [9567-29]

**High performance x-ray imaging detectors on foil using solution-processed organic photodiodes with extremely low dark leakage current**, Abhishek Kumar, Date Moet, Jan Laurens van der Steen, Albert van Breemen, Santhosh Shanmugam, Jan Gilot, Ronn Andriessen, Holst Ctr. (Netherlands); Matthias Simon, Philips Research (Netherlands); Walter Ruetten, Alexander Douglas, Philips Research (Netherlands); Rob Raaijmakers, Philips Healthcare (Netherlands); Pawel E. Malinowski, Kris Myny, IMEC (Belgium); Gerwin Gelink, Holst Ctr. (Netherlands) and Technische Univ. Eindhoven (Netherlands) ..... [9567-30]

**High performance all polymer solar cells fabricated via non-halogenated solvents**, Yan Zhou, Zhenan Bao, Stanford Univ. (USA) ..... [9567-31]

**Design of low band gap small molecules with alkylidicyanovinyl acceptor and different donor groups for efficient bulk heterojunction organic solar cells**, Sergey A. Ponomarenko, Institute of Synthetic Polymeric Materials (Russian Federation) and Lomonosov Moscow State Univ. (Russian Federation); Yury N. Luponosov, Institute of Synthetic Polymeric Materials (Russian Federation); Jie Min, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Alexander N. Solodukhin, Maxim A. Shcherbina, Sergey N. Chvalun, Institute of Synthetic Polymeric Materials (Russian Federation); Tayebeh Ameri, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Christoph J. Brabec, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) and Bayerisches Zentrum für Angewandte Energieforschung e.V. (Germany) ..... [9567-32]

### SESSION 8 ..... THU 10:30 AM TO 12:10 PM

#### Morphology and Processing of Organic Solar Cells

Session Chair: **Aram Amassian**, King Abdullah Univ. of Science and Technology (Saudi Arabia)

**Harnessing the diffusion of small molecules in OPV films for processing and characterization of BHJs (Invited Paper)**, Gitti Frey, Technion-Israel Institute of Technology (Israel) ..... [9567-33]

**Impact of molecular mixing on open circuit voltage of bulk heterojunction solar cells**, Swaminathan Venkatesan, Qiquan Qiao, Cheng Zhang, South Dakota State Univ. (USA); Jihua Chen, Oak Ridge National Lab. (USA); Wei Chen, Argonne National Lab. (USA) ..... [9567-34]

**Morphology control for efficient and stable small molecule organic solar cells**, Hideyuki Tanaka, Eiichi Nakamura, The Univ. of Tokyo (Japan) ..... [9567-35]

**Morphological study on small molecule acceptor-based organic solar cells with efficiencies beyond 7%**, Wei Ma, Xi'an Jiaotong Univ. (China); He Yan, Hong Kong Univ. of Science and Technology (Hong Kong, China) ..... [9567-36]

**Mechanical stability of organic solar cells: Molecular and microstructural determinants**, Darren J. Lipomi, Suchol Savagatrup, Adam D. Printz, Timothy F. O'Connor, Aliaksandr V. Zaretski, Univ. of California, San Diego (USA) ... [9567-37]

**Ultrashort-pulsed laser processing and solution based coating in roll-to-roll manufacturing of organic photovoltaics**, Christian J. Hördemann, Katrin Hirschfelder, Malte A. Schulz-Ruhtenberg, Arnold Gillner, Malte A. Schulz-Ruhtenberg, Fraunhofer-Institut für Lasertechnik (Germany) ..... [9567-38]

Lunch/Exhibition Break ..... Thu 12:10 pm to 1:30 pm

### SESSION 9 ..... THU 1:30 PM TO 3:05 PM

#### Lifetime and Stability Issues for Organic and Perovskite Solar Cells

Session Chair: **Antonio F. Facchetti**, Polyera Corp. (USA)

**Dominant degradation mechanisms of organic photovoltaic devices (Invited Paper)**, Thomas Heumueller, Markus Biele, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Jens Adams, Bayerisches Zentrum für Angewandte Energieforschung e.V. (Germany); Timothy Burke, William Mateker, Stanford Univ. (USA); Michael Salvador, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Andreas Distler, BELECTRIC OPV (Germany); Hans-Joachim Egelhaaf, Energie Campus Nürnberg (Germany) and BELECTRIC OPV (Germany) and Bayerisches Zentrum für Angewandte Energieforschung e.V. (Germany); Michael McGeehee, Stanford Univ. (USA); Christoph J. Brabec, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) and Bayerisches Zentrum für Angewandte Energieforschung e.V. (Germany) and Energie Campus Nürnberg (Germany) ..... [9567-39]

**Degradation mechanism of planar perovskite solar cells**, Chuanjiang Qin, Toshinori Matsushima, Chihaya Adachi, Kyushu Univ. (Japan) ..... [9567-40]

**Predicting thermal stability of organic solar cells through real-time capacitive techniques**, Marta Tessarolo, Istituto per lo Studio dei Materiali Nanostrutturati (Italy); Antonio Guerrero, Univ. Jaume I (Spain); Mirko Seri, Istituto per la Sintesi Organica e la Fotoreattività (Italy); Mario Prosa, Istituto per lo Studio dei Materiali Nanostrutturati (Italy); Margherita Bolognesi, Consiglio Nazionale delle Ricerche (Italy); Germà Garcia Belmonte, Univ. Jaume I (Spain) ..... [9567-41]

**Perovskite solar cells: From device fabrication to device degradation (Invited Paper)**, Jinli Yang, Dianyi Liu, Braden Siempelkamp, Timothy Kelly, Univ. of Saskatchewan (Canada) ..... [9567-42]

**High-efficiency perovskite solar cells with long operation lifetime**, Chenchen Yang, Weiran Cao, Nathan T. Shewmon, Jiangeng Xue, Univ. of Florida (USA) ..... [9567-43]

### SESSION 10 ..... THU 3:30 PM TO 4:55 PM

#### Organic and Electrode Interfaces in Organic Solar Cells

Session Chair: **Sean E. Shaheen**, Univ. of Colorado at Boulder (USA)

**Photoactive and interfacial materials for flexible photovoltaic devices (Invited Paper)**, Antonio F. Facchetti, Polyera Corp. (USA) ..... [9567-2]

**Polymer solar cells with efficiency >10% enabled via a facile solution-processed Al-doped ZnO electron transporting layer**, Lethy K. Jagadamma, Mohammed Al-Senani, Aram Amassian, King Abdullah Univ. of Science and Technology (Saudi Arabia) ..... [9567-45]

**Polymer-facilitated low temperature fusing of spray-coated silver nanowire networks as transparent top and bottom electrodes in small molecule organic photovoltaics**, Franz Selzer, Nelli Weiß, David Knepppe, Ludwig Bormann, Christoph Sachse, Nikolai Gaponik, Alexander Eychmüller, Karl Leo, Lars Müller-Meskamp, Technische Univ. Dresden (Germany) ..... [9567-46]

**A solution-doped small molecule hole transport layer for efficient ITO-free organic solar cells**, Ludwig Bormann, Franz Selzer, Karl Leo, Lars Mueller-Meskamp, Technische Univ. Dresden (Germany) ..... [9567-47]

**Transparent conductive thin-film encapsulation layers**, Andreas Behrendt, Tobias Gahlmann, Sara Trost, Andreas Polywka, Patrick Görn, Thomas Riedl, Bergische Univ. Wuppertal (Germany) ..... [9567-48]

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# Organic Field-Effect Transistors XIV

Conference Chairs: Iain McCulloch, King Abdullah Univ. of Science and Technology (Saudi Arabia); Oana D. Jurchescu, Wake Forest Univ. (USA)

## MONDAY 10 AUGUST

### SESSION 1 ..... MON 1:30 PM TO 2:55 PM

#### Device Physics I

Session Chair: Ananth Dodabalapur, The Univ. of Texas at Austin (USA)

**OFET surface treatments on copper and silver source and drain electrodes (Invited Paper)**, Zhang Jia, Columbia Univ. (USA); Chang-Hyun Kim, Yvan Bonnassieux, Gilles Horowitz, Ecole Polytechnique (France); Luca Floreano, Alberto Verdini, INFM (Italy); Dean Cvetko, Ljubljana Univ. (Slovenia); Alberto Morgante, INFM (Italy); Ioannis Kymissis, Columbia Univ. (USA) ..... [9568-101]

**Scaling effects of organic thin-film transistors**, Anita Risteska, Jacobs Univ. Bremen (Germany); Kris Myny, Sören Steudel, IMEC (Belgium); Masakazu Nakamura, Nara Institute of Science and Technology (Japan); Dietmar Knipp, Jacobs Univ. Bremen (Germany) ..... [9568-102]

**Molecular-layer thick organic semiconductor materials and electronic devices**, Liqiang Li, Suzhou Institute of Nano-Tech and Nano-Bionics (China) ..... [9568-103]

**Operation mechanism of the organic permeable base transistor**, Felix Kaschura, Institut für Angewandte Photophysik (Germany) and Technische Univ. Dresden (Germany); Axel Fischer, Markus Klinger, Institut für Angewandte Photophysik (Germany); Duy Hai Doan, Weierstrass-Institut für Angewandte Analysis und Stochastik (Germany); Klaus Gärtner, Univ. della Svizzera Italiana (Switzerland); Thomas Koprucki, Annetret Glitzky, Weierstrass-Institut für Angewandte Analysis und Stochastik (Germany); Daniel Kasemann, Institut für Angewandte Photophysik (Germany); Karl Leo, Institut für Angewandte Photophysik (Germany) ..... [9568-104]

**Hybrid light emitting transistors**, Khalid Muhieddine, Mujeeb Ullah, Ebinazar B. Namdas, Paul L. Burn, The Univ. of Queensland (Australia) ..... [9568-105]

### SESSION 2 ..... MON 3:25 PM TO 5:10 PM

#### Novel Devices / Applications

Session Chair: David J. Gundlach, National Institute of Standards and Technology (USA)

**On the use of organic transistors in flexible large-area sensor arrays (Invited Paper)**, Gerwin H. Gelinck, Holst Ctr. (Netherlands) and Technische Univ. Eindhoven (Netherlands); Abhishek Kumar, Holst Ctr. (Netherlands) ..... [9568-106]

**New polymer dielectrics for low-voltage high transconductance organic transistors**, Chao Wang, Desheng Kong, Wen-Ya Lee, Zhenan Bao, Stanford Univ. (USA) ..... [9568-107]

**Top-gate organic field-effect transistors and circuits on shape-memory polymer substrates**, Sangmoo Choi, Canek Fuentes-Hernandez, Cheng-Yin Wang, Georgia Institute of Technology (USA); Andrew Wei, Walter E. Voit, The Univ. of Texas at Dallas (USA); Bernard Kippelen, Georgia Institute of Technology (USA) ..... [9568-108]

**Organic transistors for electrophysiology (Invited Paper)**, Jonathan Rivnay, Ecole Nationale Supérieure des Mines de Saint-Étienne (France) ..... [9568-109]

**Transcap: A new integrated hybrid supercapacitor and electrolyte-gated transistor device (Invited Paper)**, Clara Santato, Ecole Polytechnique de Montréal (Canada) ..... [9568-110]

### POSTERS-MONDAY ..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Well-balanced carrier mobilities of ambipolar transistors based on a low band gap small molecule semiconductor**, Min Je Kim, Woonggi Kang, Sungkyunkwan Univ. (Korea, Republic of) ..... [9568-137]

**High performance ferroelectric organic field-effect transistor using soft contact process**, Min-Hoi Kim, Hanbat National Univ. (Korea, Republic of); Gyu Jeong Lee, Seoul National Univ. (Korea, Republic of); Jae-Hyun Lee, Hanbat National Univ. (Korea, Republic of); Jin-Hyuk Bae, Kyungpook National Univ. (Korea, Republic of) ..... [9568-138]

**Indium gallium zinc oxide-based stretchable organic-inorganic hybrid transistors using stiff island structure**, Soon-Won Jung, Jae Bon Koo, Chan Woo Park, Bock Soon Na, Ji-Young Oh, Sang Seok Lee, Electronics and Telecommunications Research Institute (Korea, Republic of) ..... [9568-139]

**Improvement of micro-contact patterning fidelity of organic semiconductors through ultraviolet ozone treatment on nanoporous stamps**, Hea-Lim Park, Bo-Yeon Lee, Chang-Min Keum, Se-Um Kim, Seoul National Univ. (Korea, Republic of); Min-Hoi Kim, Hanbat National Univ. (Korea, Republic of); Sin-Doo Lee, Seoul National Univ. (Korea, Republic of) ..... [9568-140]

**Tunable solubility parameter of poly(3-hexyl thiophene) with hydrophobic side-chains to achieve rubbery semiconducting films**, Mi Jang, Hyeonji Bae, Hoichang Yang, Inha Univ. (Korea, Republic of) ..... [9568-141]

**Air-processable silane-coupled polymers to modify a dielectric for solution-processed organic field-effect semiconductors**, Mi Jang, Young Chang Yu, Ji Ho Youk, Hoichang Yang, Inha Univ. (Korea, Republic of) ..... [9568-142]

**Analysis of different deposition patterns for semiconductor at organic field-effect transistors using inkjet printing technique**, Josiani Cristina Stefanelo, Lilian Soares Cardoso, Roberto Mendonça Faria, Univ. de São Paulo (Brazil) ..... [9568-143]

**Photo-physics and charge transport in hetero-structure organic light emitting transistors**, Fatemeh Maasoumi, Mujeeb Ullah, Paul E. Shaw, The Univ. of Queensland (Australia); Jun Li, National Univ. of Singapore (Singapore); Paul L. Burn, Paul Meredith, Ebinazar B. Namdas, The Univ. of Queensland (Australia) ..... [9568-144]

**Gate dielectric surface treatments for performance improvement of poly(3-hexylthiophene-2,5-diyl) based organic field-effect transistors**, Ali Nawaz, Cristiane D. Col, Isidro C. Cruz, Univ. Federal do Paraná (Brazil); Anshu Kumar, Anil Kumar, Indian Institute of Technology Bombay (India); Ivo A. Hümmelgen, Univ. Federal do Paraná (Brazil) ..... [9568-145]

**Natural dielectrics in flexible organic field-effect transistors**, Tzung-Fang Guo, Chun-Ting Yeh, Tzung-Da Tsai, National Cheng Kung Univ. (Taiwan) ..... [9568-146]

**Dimensional extendibility in conjugation and ordering of solution-processed semiconducting polymers**, Hoichang Yang, Mi Jang, Inha Univ. (Korea, Republic of); Ji-Hoon Kim, Pusan National Univ. (Korea, Republic of); Yun-Hi Kim, Gyeongsang National Univ. (Korea, Republic of); Do-Hoon Hwang, Pusan National Univ. (Korea, Republic of) ..... [9568-147]

## TUESDAY 11 AUGUST

### ORGANIC PHOTONICS + ELECTRONICS PLENARY SESSION ..... 9:00 AM TO 11:45 AM

Session Chair: Zakya H. Kafafi, Lehigh Univ. (USA)

**Current status of high efficiency OLEDs based on delayed fluorescence (Plenary)**, Chihaya Adachi, Kyushu Univ. (Japan) ..... [9568-301]

**Interfacing with the brain using organic electronics (Plenary)**, George G. Malliaras, Ecole Nationale Supérieure des Mines de Saint-Étienne (France) ..... [9568-302]

**Ultraflexible organic thin-film devices for wearable and implantable electronics (Plenary)**, Takao Someya, The Univ. of Tokyo (Japan) ..... [9568-303]

**Recent progress on hybrid organic-inorganic and perovskite-based solar cells (Plenary)**, Yang Yang, Univ. of California, Los Angeles (USA) ..... [9567-304]

Lunch/Exhibition Break ..... Tue 11:45 am to 1:45 pm

# CONFERENCE 9568A

SESSION 3 ..... TUE 1:45 PM TO 3:05 PM

## From Single Crystals to Large-area Electronics

Session Chair: John E. Anthony, Univ. of Kentucky (USA)

Fundamental aspects in single crystal OFETs and large area crystalline films for applications (*Invited Paper*), Marta Mas-Torrent, Freddy Del Pozo, Raphael Pfattner, Francisco Otón, Jaume Veciana, Concepció Rovira, Institut de Ciència de Materials de Barcelona (Spain) ..... [9568-111]

**Polymerism in the organic charge-transfer complex dibenzotetrathiafulvalene-7,7,8,8-tetracyanoquinodimethane (DBTTF-TCNQ) and its effect on optical and electrical properties**, Katelyn P. Goetz, Wake Forest Univ. (USA); Jun Ya Tsutsumi, National Institute of Advanced Industrial Science and Technology (Japan); Sujitra Pookpanratana, National Institute of Standards and Technology (USA); Jihua Chen, Oak Ridge National Lab. (USA); Tatsuo Hasegawa, National Institute of Advanced Industrial Science and Technology (Japan) and The Univ. of Tokyo (Japan); Oana D. Jurchescu, Wake Forest Univ. (USA) .. [9568-112]

**Fabrication of water-stable organic transistors using crystalline rubrene thin-film and polymer-treated dielectric**, Jaejoon Kim, KAIST (Korea, Republic of); Hyoek Moo Lee, LG Chem, Ltd. (Korea, Republic of); Sung Oh Cho, KAIST (Korea, Republic of) ..... [9568-113]

**Charge transport and device physics of layered-crystalline organic semiconductors (*Invited Paper*)**, Tatsuo Hasegawa, The Univ. of Tokyo (Japan)..... [9568-114]

SESSION 4 ..... TUE 3:35 PM TO 5:05 PM

## Device Physics II

Session Chair: Gerwin H. Gelinck, Holst Ctr. (Netherlands)

Characterizing the channel properties and operation of organic transistors with non-ideal behavior (*Invited Paper*), David J. Gundlach, National Institute of Standards and Technology (USA) ..... [9568-115]

**Charge transport and device operation mechanisms in field-effect transistors with high mobility donor-acceptor polymer semiconductors (*Invited Paper*)**, Takayuki Okachi, Tomoya Kashiki, Kenichiro Ohya, Sumitomo Chemical Co., Ltd. (Japan)..... [9568-116]

**Study on contact and channel resistance of pentacene-based ambipolar organic thin-film transistors**, Tsung Jun Ho, Horng-Long Cheng, Guo En Yan, National Cheng Kung Univ. (Taiwan)..... [9568-117]

**Charge transport physics of high mobility conjugated polymers (*Invited Paper*)**, Henning Sirringhaus, Univ. of Cambridge (United Kingdom) ..... [9568-118]

## WEDNESDAY 12 AUGUST

SESSION 5 ..... WED 8:30 AM TO 10:05 AM

## Fabrication

Session Chair: Aram Amassian, King Abdullah Univ. of Science and Technology (Saudi Arabia)

**Sub-15-nm patterning of asymmetric metal electrodes and devices by adhesion lithography (*Invited Paper*)**, David Beesley, Thomas D. Anthopoulos, John C. de Mello, Imperial College London (United Kingdom) ..... [9568-119]

**Fabrication of a high-resolution roll for gravure printing of 2μm features**, Gerd Grau, Rungrot Kitsomboonloha, Vivek Subramanian, Univ. of California, Berkeley (USA) ..... [9568-120]

**Orthogonal lithography and doped organic semiconductors and their application in organic transistors**, Daniel Kasemann, Alrun Günther, Xuhai Liu, Technische Univ. Dresden (Germany); Björn Lüssem, Kent State Univ. (USA); Karl Leo, Technische Univ. Dresden (Germany) ..... [9568-121]

**The study for hydrogen bond rich dendron as dielectric layer for N-type OTFTs device**, You-Yi Syu, National Taiwan Univ. (Taiwan) ..... [9568-122]

**Fully printed flexible thin film transistor arrays (*Invited Paper*)**, Adrien Pierre, Mahsa Sadeghi, Ana Claudia Arias, Univ. of California, Berkeley (USA) .. [9568-123]

SESSION 6 ..... WED 10:35 AM TO 12:20 PM

## New Materials

Session Chair: Iain McCulloch, King Abdullah Univ. of Science and Technology (Saudi Arabia)

**Higher-dimensional organic semiconductors (*Invited Paper*)**, John E. Anthony, Thilanga Liyanage, Anthony Petty, Univ. of Kentucky (USA) ..... [9568-124]

**Novel nature-inspired conjugated polymers for high performance transistors and solar cells (*Invited Paper*)**, Hugo A. Bronstein, Kealan Falon, Univ. College London (United Kingdom); Nir Yaacobi-Gross, Raja Shahid Ashraf, Iain McCulloch, Thomas D. Anthopoulos, Imperial College London (United Kingdom) ... [9568-125]

**Controlling conjugation and solubility of diketopyrrolopyrrole derivative copolymers for organic field-effect transistors**, Mi Jiang, Inha Univ. (Korea, Republic of); Ji-Hoon Kim, Do-Hoon Hwang, Pusan National Univ. (Korea, Republic of); Hoichang Yang, Inha Univ. (Korea, Republic of) ..... [9568-126]

**Intertwined co-assemblies in liquid-crystalline semi-conducting materials: Towards a new class of nanostructured supramolecular organic semiconductors**, Fabrice Mathevet, Yiming Xiao, Danli Zeng, Univ. Pierre et Marie Curie (France); Martin Brinkmann, Institut Charles Sadron (France); Benoît Heinrich, Bertrand Donnio, Institut de Physique et Chimie des Matériaux de Strasbourg (France); Jeong Weon Wu, Jean-Charles Ribierre, Ewha Womans Univ. (Korea, Republic of); Emmanuelle Lacaze, David Kreher, André-Jean Attias, Univ. Pierre et Marie Curie (France) ..... [9568-127]

**Printable semiconductors for all-polymer transistors and circuits (*Invited Paper*)**, Antonio F. Facchetti, Polyera Corp. (USA) ..... [9568-128]

Lunch Break ..... Wed 12:20 pm to 1:50 pm

SESSION 7 ..... WED 1:50 PM TO 3:10 PM

## Morphology

Session Chair: Hugo A. Bronstein, Univ. College London (United Kingdom)

**Charge transport in highly aligned conjugated polymers (*Invited Paper*)**, Brendan O'Connor, Xiao Xue, Tianlei Sun, North Carolina State Univ. (USA) ..... [9568-129]

**Percolation, tie-molecules, and microstructural origins of charge transport in semicrystalline conjugated polymers**, Sonya A. Mollinger, Brad Krajina, Stanford Univ. (USA); Rodrigo J. Noriega-Manez, Univ. of California, Berkeley (USA); Alberto Salleo, Andrew J. Spakowitz, Stanford Univ. (USA) ..... [9568-130]

**Organic blend semiconductors and transistors with hole mobility exceeding 10 cm<sup>2</sup>/Vs**, Alexandra F. Paterson, Thomas D. Anthopoulos, Imperial College London (United Kingdom) ..... [9568-131]

**Decoupling the semiconductor crystallization from the coating process to the benefit of solution-processed small-molecule organic thin film transistors (*Invited Paper*)**, Aram Amassian, King Abdullah Univ. of Science and Technology (Saudi Arabia) ..... [9568-132]

SESSION 8 ..... WED 3:40 PM TO 5:00 PM

## Processing Effects on Performance

Session Chair: Oana D. Jurchescu, Wake Forest Univ. (USA)

**Thermocleavable side chains: A gateway to new processing routes for semiconducting polymers (*Invited Paper*)**, Bob C. Schroeder, Zhenan Bao, Stanford Univ. (USA) ..... [9568-133]

**Oligothiophene-based monolayer OFETs by Langmuir techniques**, Sergey A. Ponomarenko, Institute of Synthetic Polymeric Materials (Russian Federation) and Lomonosov Moscow State Univ. (Russian Federation); Elena V. Agina, Alexey S. Sizov, Institute of Synthetic Polymeric Materials (Russian Federation); Daniil S. Anisimov, Lomonosov Moscow State Univ. (Russian Federation); Oleg V. Borschhev, Maxim A. Shcherbina, Institute of Synthetic Polymeric Materials (Russian Federation); Sergey N. Chvalun, Institute of Synthetic Polymeric Materials (Russian Federation); Dmitry Y. Paraschuk, Lomonosov Moscow State Univ. (Russian Federation) ..... [9568-134]

**Organic vertical field effect transistors: Achieving high on-off ratio and vertical integration with OLEDs**, Hyukyun Kwon, Mincheol Kim, Hyunsu Cho, Seunghyup Yoo, KAIST (Korea, Republic of) ..... [9568-135]

**Sub-threshold charge transport in polymer/organic field-effect transistor (*Invited Paper*)**, Seohee Kim, The Univ. of Texas at Austin (USA); Tae-Jun Ha, Kwangwoon Univ. (Korea, Republic of); Prashant M. Sonar, Queensland Univ. of Technology (Australia); Ananth Dodabalapur, The Univ. of Texas at Austin (USA) ..... [9568-136]

# CONFERENCE 9568B

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## Organic Sensors and Bioelectronics VIII

Conference Chairs: Ioannis Kymmissis, Columbia Univ. (USA); Ruth Shinar, Iowa State Univ. (USA); Luisa Torsi, Univ. degli Studi di Bari (Italy)

Program Committee: Magnus Berggren, Linköping Univ. (Sweden); Annalisa Bonfiglio, Univ. degli Studi di Cagliari (Italy); Fabio Cicora, Ecole Polytechnique de Montréal (Canada); Alon Gorodetsky, Univ. of California, Irvine (USA); Emil J. W. List-Kratochvil, Technische Univ. Graz (Austria); George G. Malliaras, Ecole Nationale Supérieure des Mines de Saint-Étienne (France); Paul Meredith, The Univ. of Queensland (Australia); Róisín M. Owens, Ecole Nationale Supérieure des Mines de Saint-Étienne (France); Manijeh Razeghi, Northwestern Univ. (USA); Ifor D. W. Samuel, Univ. of St. Andrews (United Kingdom); Franky So, Univ. of Florida (USA)

### SUNDAY 9 AUGUST

#### SESSION 1 ..... SUN 8:30 AM TO 10:05 AM

##### Organic Sensors and Bioelectronics I

Session Chair: Luisa Torsi, Univ. degli Studi di Bari Aldo Moro (Italy)

**Organic charge modulated FETs for multimodal tactile sensing (Invited Paper)**, Piero Cosseddu, Fabrizio Viola, Univ. degli Studi di Cagliari (Italy); Andrea Spanu, Univ. degli Studi di Cagliari (Italy) and Univ. degli Studi di Genova (Italy); Stefano Lai, Annalisa Bonfiglio, Univ. degli Studi di Cagliari (Italy) ..... [9568-201]

**Fully printed metabolite sensor using organic electrochemical transistor**, Gaëtan Scheiblin, CEA-LETI (France) and Ecole Nationale Supérieure des Mines de Saint-Étienne (France); Abdelkader Aliane, CEA-LETI (France); Romain Coppard, CEA-LITEN (France); Roisin M. Owens, Ecole Nationale Supérieure des Mines de Saint-Étienne (France); Pascal Mailley, CEA-LETI (France); George G. Malliaras, Ecole Nationale Supérieure des Mines de Saint-Étienne (France) ..... [9568-202]

**Electrolyte gated transistors as biosensors (Invited Paper)**, C. Daniel Frisbie, Univ. of Minnesota, Twin Cities (USA) ..... [9568-203]

**Flexible organic electrochemical transistors for highly selective enzyme biosensors (Invited Paper)**, Feng Yan, Caizhi Liao, The Hong Kong Polytechnic Univ. (Hong Kong, China) ..... [9568-204]

**A better understanding of organic electrochemical transistors for biosensing applications (Invited Paper)**, Jacob T. Friedlein, Univ. of Colorado at Boulder (USA); George G. Malliaras, Ecole Nationale Supérieure des Mines de Saint-Étienne (France); Sean E. Shaheen, Robert R. McLeod, Univ. of Colorado at Boulder (USA) ..... [9568-205]

#### SESSION 2 ..... SUN 10:35 AM TO 11:55 AM

##### Organic Sensors and Bioelectronics II

Session Chair: Marco Rolandi, Univ. of Washington (USA)

**Organic electronics: A powerful tool for point of care biosensors development (Invited Paper)**, Maria Magliulo, Kyriaki Manoli, Mohammad Yusuf Mulla, Preethi Seshadri, Gerardo Palazzo, Luisa Torsi, Univ. degli Studi di Bari Aldo Moro (Italy) ..... [9568-206]

**Sensitive and selective real-time electrochemical monitoring of DNA repair (Invited Paper)**, Jason D. Slinker, Marc McWilliams, Fadwa Anka, Kenneth Balkus, The Univ. of Texas at Dallas (USA) ..... [9568-207]

**Selective and reversible ion-detecting sensor elements in aqueous environment (Invited Paper)**, Emil J. W. List-Kratochvil, Technische Univ. Graz (Austria) and NanoTecCenter Weiz Forschungsgesellschaft mbH (Austria) [9568-208]

**Thin films of eumelanin pigment: Charge carrier transport, ion storage, and interaction with metal electrodes (Invited Paper)**, Clara Santato, Ecole Polytechnique de Montréal (Canada) ..... [9568-209]

Lunch Break ..... Sun 11:55 am to 1:40 pm

#### SESSION 3 ..... SUN 1:40 PM TO 3:00 PM

##### Organic Sensors and Bioelectronics III

Session Chair: Paul L. Burn, The Univ. of Queensland (Australia)

**Cephalopod-derived materials for photonic and protonic devices (Invited Paper)**, Alon Gorodetsky, Univ. of California, Irvine (USA) ..... [9568-210]

**De-novo design of peptides for electronics and sensing applications (Invited Paper)**, Nurit Ashkenasy, Ben-Gurion Univ. of the Negev (Israel) ..... [9568-211]

**Melanin: Spin behaviour and implications for bioelectronic devices (Invited Paper)**, Paul Meredith, Margarita Sheliakina, Bernard Mostert, The Univ. of Queensland (Australia) ..... [9568-212]

**Taking electrons out of bioelectronics: Bioprotonic memories and enzymatic logic gates (Invited Paper)**, Marco Rolandi, Univ. of Washington (USA) ..... [9568-213]

#### SESSION 4 ..... SUN 3:30 PM TO 5:35 PM

##### Keynote Joint Session with Conferences 9550 and 9568

Session Chair: Ruth Shinar, Iowa State Univ. of Science and Technology (USA)

**Advances in macromolecular data storage (Keynote Presentation)**, Masud Mansuripur, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9550-13]

**Imperceptible sheet-type active matrix sensors for cyber-physical systems (Keynote Presentation)**, Tsuyoshi Sekitani, Osaka Univ. (Japan) ..... [9568-214]

**Mid-infrared (~2.8 μm to ~7.1 μm) interband cascade lasers (Keynote Presentation)**, Sven Höfling, Univ. of St. Andrews (United Kingdom); Robert Weih, Matthias Dallner, Julius-Maximilians-Univ. Würzburg (Germany); Julian Scheuermann, Lars Nähle, Marc Fischer, Johannes Koeth, nanoplus GmbH (Germany); Martin Kamp, Julius-Maximilians-Univ. Würzburg (Germany) ..... [9550-14]

**Artificial neuronal systems based on organic bioelectronic circuits: Towards new tools and therapy methods in cell biology and healthcare (Keynote Presentation)**, Magnus Berggren, Linköping Univ. (Sweden) ..... [9568-215]

**Towards novel compact laser sources for non-invasive diagnostics and treatment (Keynote Presentation)**, Edik U. Rafailov, Aston Univ. (United Kingdom) ..... [9550-15]

#### SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

##### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

# CONFERENCE 9568B

## MONDAY 10 AUGUST

### SESSION 5 ..... MON 8:15 AM TO 10:00 AM

#### Organic Sensors and Bioelectronics IV

Session Chair: **Joseph Shinar**, Iowa State Univ. of Science and Technology (USA)

**Integrated sensors for point of care detection (Invited Paper)**, John C. de Mello, Imperial College London (United Kingdom) ..... [9568-216]

**Sensitive organometal trihalide perovskite photodetectors with high gain and low noise for sub pW/cm<sup>2</sup> light detection at room temperature**, Jinsong Huang, Yanjun Fang, Univ. of Nebraska-Lincoln (USA). ..... [9568-217]

**Controlling the spectral response of organic photodiodes (Invited Paper)**, Paul L. Burn, Ardalan Armin, Qianqian Lin, Ravi Nagiri, Dani Lyons, Ross Jansen-van Vuuren, Paul Meredith, The Univ. of Queensland (Australia). ..... [9568-218]

**Solution-processed non-polymeric organic photodiodes**, Il Ku Kim, Mujeeb Ullah, Paul Meredith, Paul L. Burn, Shih-Chun Lo, Ebinazar B. Namdas, The Univ. of Queensland (Australia). ..... [9568-219]

**Fully aerosol printed flexible organic photodiodes**, Ralph Eckstein, Gerardo Hernandez-Sosa, Norman Mechau, Karlsruher Institut für Technologie (Germany) and InnovationLab GmbH (Germany); Uli Lemmer, Sebastian Valouch, Karlsruher Institut für Technologie (Germany) ..... [9568-220]

**Solution processed inorganic UV-visible-SWIR photodetector using highly monodispersed PbS nanocrystals (Invited Paper)**, Franky So, Jae Woong Lee, Do Young Kim, Univ. of Florida (USA) ..... [9568-221]

### SESSION 6 ..... MON 10:30 AM TO 12:10 PM

#### Organic Sensors and Bioelectronics V

Session Chair: **Ioannis Kymissis**, Columbia Univ. (USA)

**NeuroGrid: Large-scale recording of action potentials from the surface of the brain (Invited Paper)**, Dion Khodagholy, New York Univ. Langone Medical Ctr. (USA) ..... [9568-222]

**Near-infrared (NIR) emitting conjugated polymers for biomedical applications**, Tatjana Repenko, Alexander J. C. Kuehne, DWI an der RWTH Aachen e.V. (Germany) ..... [9568-223]

**Conjugated polymer and molecular beacon aptamer-based chemo- and bioassay**, Han Young Woo, Pusan National Univ. (Korea, Republic of) .. [9568-224]

**Molecularly imprinted polymers for selective fluorescence and laser sensing (Invited Paper)**, Ifor D. Samuel, Hien Nguyen, Graham A. Turnbull, Univ. of St. Andrews (United Kingdom) ..... [9568-225]

**Label-free sensors based on perylenediimide-doped polystyrene distributed feedback lasers**, Maria A. Diaz-Garcia, Marta Morales-Vidal, Pedro G. Boj, Jose M. Villalvilla, Jose A. Quintana, Univ. de Alicante (Spain); Aritz Retolaza, IK4 Tekniker (Spain); Santos Merino, IK4-Tekniker (Spain) ..... [9568-226]

**Steering the photo-tactic locomotion of live cells with a 100,000 OLEDs**, Anja Steude, Malte C. Gather, Univ. of St. Andrews (United Kingdom) ..... [9568-227]

### POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Stress-free wavy substrates for stretchable electronic circuits**, Bock Soon Na, Chan Woo Park, Soon-Won Jung, Ji-Young Oh, Sang Seok Lee, Jae Bon Koo, Electronics and Telecommunications Research Institute (Korea, Republic of) ..... [9568-229]

**Spontaneous wavy substrates for conventional stretchable electronics**, Ji-Young Oh, Chan Woo Park, Bock Soon Na, Joo Yeon Kim, Soon-Won Jung, Jeong Seon Choi, Sang Seok Lee, Jae Bon Koo, Electronics and Telecommunications Research Institute (Korea, Republic of) ..... [9568-230]

**A high performance semitransparent organic photodetector with green color selectivity using 1,4,5,8,9,11-hexaazatriphenylenehexacarbonitrile as an organic buffer layer**, Dae-Ho Kim, Seoul National Univ. (Korea, Republic of); Kyu-Sik Kim, Samsung Advanced Institute of Technology (Korea, Republic of); Hyun-Sub Shim, Chang-Ki Moon, Seoul National Univ. (Korea, Republic of); Yong Wan Jin, Samsung Advanced Institute of Technology (Korea, Republic of); Jang-Joo Kim, Seoul National Univ. (Korea, Republic of) ..... [9568-231]

**Application of temperature-dependent fluorescent dyes to the measurement of microwave absorption in water**, Oleksandr Popenko, Danylo P. Babich, Andrey Yakunov, National Taras Shevchenko Univ. of Kyiv (Ukraine) ..... [9568-232]

## TUESDAY 11 AUGUST

### ORGANIC PHOTONICS + ELECTRONICS PLENARY SESSION..... 9:00 AM TO 11:45 AM

Session Chair: **Zakya H. Kafafi**, Lehigh Univ. (USA)

**Current status of high efficiency OLEDs based on delayed fluorescence (Plenary)**, Chihaya Adachi, Kyushu Univ. (Japan) ..... [9566-301]

**Interfacing with the brain using organic electronics (Plenary)**, George G. Malliaras, Ecole Nationale Supérieure des Mines de Saint-Étienne (France) ..... [9568-302]

**Ultraflexible organic thin-film devices for wearable and implantable electronics (Plenary)**, Takao Someya, The Univ. of Tokyo (Japan).... [9568-303]

**Recent progress on hybrid organic-inorganic and perovskite-based solar cells (Plenary)**, Yang Yang, Univ. of California, Los Angeles (USA) ... [9567-304]

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## Printed Memory and Circuits

Conference Chair: **Emil J. W. List Kratochvil**, Technische Univ. Graz (Austria)

Program Committee: **Wen-Chang Chen**, National Taiwan Univ. (Taiwan); **Dago M. de Leeuw**, Max-Planck-Institut für Polymerforschung (Germany); **Jan Genoe**, IMEC (Belgium); **Norbert Koch**, Humboldt-Univ. zu Berlin (Germany); **Ronald Österbacka**, Åbo Akademi Univ. (Finland); **Tsuyoshi Sekitani**, Osaka Univ. (Japan); **Barbara Stadlober**, JOANNEUM RESEARCH Forschungsgesellschaft mbH (Austria); **Arul Lenus Roy Vellaisamy**, City Univ. of Hong Kong (Hong Kong, China); **Fei Zeng**, Tsinghua Univ. (China)



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### MONDAY 10 AUGUST

#### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Frequency dependent learning achieved using a type of semiconducting polymer/electrolyte composite**, Wenshuai Dong, Fei Zeng, Tsinghua Univ. (China) ..... [9569-17]

**Band-pass filtering phenomenon of a semiconducting polymer/electrolyte composite**, Xiaojun Li, Wenshuai Dong, Fei Zeng, Tsinghua Univ. (China) [9569-18]

**Conjugated polymer nanoparticles as nano floating gate electrets for high performance non-volatile organic transistor memory devices**, Chien-Chung Shih, Wen-Chang Chen, Wen-Ya Lee, Yu-Cheng Chiu, Jung-Yao Chen, National Taiwan Univ. (Taiwan) ..... [9569-19]

**Oligosaccharide dielectrics towards high performance non-volatile transistor memory devices**, Yu-Cheng Chiu, Han-Sheng Sun, Wen-Ya Lee, National Taiwan Univ. (Taiwan); Halila Sami, Redouane Borsali, Ctr. de Recherches sur les Macromolécules Végétales (France); Wen-Chang Chen, National Taiwan Univ. (Taiwan) ..... [9569-20]

**Inkjet-printing of non-volatile organic resistive devices and crossbar array structures**, Stefan Sax, Sebastian Nau, Alexander Blümel, Karl Popovic, NanoTecCenter Weiz Forschungsgesellschaft mbH (Austria); Emil J. W. List-Kratochvil, NanoTecCenter Weiz Forschungsgesellschaft mbH (Austria) and Technische Univ. Graz (Austria) ..... [9569-21]

**Recent progress in printed 2/3D electronic devices**, Andreas Klug, Karl Popovic, Alexander Blümel, Stefan Sax, Emil J. W. List-Kratochvil, NanoTecCenter Weiz Forschungsgesellschaft mbH (Austria) ..... [9569-22]

**Optical memory effect in ZnO nanowire based organic bulk heterojunction devices**, Arash Takshi, Anand K. Santhanakrishna, Univ. of South Florida (USA) ..... [9569-23]

**Flash memory based on solution processed hafnium dioxide charge trapping layer**, Jiaqing Zhuang, Su-Ting Han, Ye Zhou, Roy Vellaisamy, City Univ. of Hong Kong (Hong Kong, China) ..... [9569-24]

**Cellulose-based material as dielectric layer in organic complementary inverters**, Barbara Stadlober, Alexander Fian, JOANNEUM RESEARCH Forschungsgesellschaft mbH (Austria); Archim Wolfberger, Thomas Grießer, Montan Univ. Leoben (Austria); Mihai Irimia-Vladu, Andreas Petritz, JOANNEUM RESEARCH Forschungsgesellschaft mbH (Austria) ..... [9569-25]

### THURSDAY 13 AUGUST

#### SESSION 1.....THU 8:30 AM TO 10:10 AM

##### Hybrid Memories I

Session Chair: **Emil J. W. List-Kratochvil**, Technische Univ. Graz (Austria)

**Printed organic nanowire synaptic transistors (Invited Paper)**, Wentao Xu, Sung-Yong Min, Hyunsang Hwang, Pohang Univ. of Science and Technology (Korea, Republic of); Tae-Woo Lee, Pohang Univ. of Science and Technology (Korea, Republic of) ..... [9569-1]

**Unraveling the role of space-charge switch mechanism in hybrid non-volatile memory devices**, Giovanni Ligorio, Marco Vittorio Nardi, Humboldt-Univ. zu Berlin (Germany); Martin Brinkmann, Institut Charles Sadron (France); Dieter Neher, Univ. Potsdam (Germany); Norbert Koch, Humboldt-Univ. zu Berlin (Germany) and Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany) .. [9569-2]

**Electroforming and resistive switching in alkalihalide - polymer diodes**, Stefan C..J. Meskers, Benjamin F. Bory, Technische Univ. Eindhoven (Netherlands); Paulo Rocha, Max-Planck-Institut für Polymerforschung (Germany); Henrique L. Gomes, Univ. do Algarve (Portugal); Dago M. de Leeuw, Max-Planck-Institut für Polymerforschung (Germany) ..... [9569-3]

**Characterizing filamentary switching in resistive memories (Invited Paper)**, Yan Busby, Jean-Jacques Pireaux, Univ. of Namur (Belgium) ..... [9569-4]

#### SESSION 2 ..... THU 10:40 AM TO 12:20 PM

##### Hybrid Memories II

Session Chair: **Ute Zschieschang**, Max-Planck-Institut für Festkörperforschung (Germany)

**Flexible non volatile memory devices based on organic semiconductors (Invited Paper)**, Piero Cossetti, Giulia Casula, Stefano Lai, Annalisa Bonfiglio, Univ. degli Studi di Cagliari (Italy) ..... [9569-5]

**Ion-dependent frequency selectivity and learning of semiconducting polymer/electrolyte composites**, Fei Zeng, Siheng Lu, Wenshuai Dong, Xiaojun Li, Ao Liu, Tsinghua Univ. (China). ..... [9569-6]

**Non-volatile resistive photo-switches for flexible image detector arrays**, Sebastian Nau, Christoph Wolf, Stefan Sax, NanoTecCenter Weiz Forschungsgesellschaft mbH (Austria); Emil J. W. List-Kratochvil, NanoTecCenter Weiz Forschungsgesellschaft mbH (Austria) and Technische Univ. Graz (Austria) ..... [9569-7]

**Design rules and prototype examples for additive printing of organic complementary circuits (Invited Paper)**, Tse Nga Ng, David E. Schwartz, Ping Mei, Brent S. Krusor, Sivheng Kor, Janos Veres, PARC, A Xerox Co. (USA) .... [9569-8]

Lunch/Exhibition Break ..... Thu 12:20 pm to 1:50 pm

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SESSION 3 ..... THU 1:50 PM TO 3:30 PM

## Printed Circuits and Printing Processes

Session Chair: **Barbara Stadlober**, JOANNEUM RESEARCH  
Forschungsgesellschaft mbH (Austria)

**Large area formation of self-aligned crystalline domains of organic semiconductors on transistor channels using CONNECT** (*Invited Paper*), Steve Park, Stanford Univ. (USA) and Columbia Univ. (USA) ..... [9569-9]

**High-resolution gravure printed lines: Proximity effects and design rules**, Gerd Grau, William J. Scheideler, Vivek Subramanian, Univ. of California, Berkeley (USA) ..... [9569-10]

**Inkjet printed carbon nanotubes and zinc tin oxide based thin-film complementary circuits**, Bongjun Kim, The Univ. of Texas at Austin (USA); Michael L. Geier, Mark C. Hersam, Northwestern Univ. (USA); Ananth Dodabalapur, The Univ. of Texas at Austin (USA) ..... [9569-11]

**Flexible thin film circuitry enabling ubiquitous electronics via post-fabrication customization** (*Invited Paper*), Brian Cobb, Holst Ctr. (Netherlands) .... [9569-12]

SESSION 4 ..... THU 4:00 PM TO 5:40 PM

## Integrated Printed Devices

Session Chair: **Tse Nga Ng**, PARC, A Xerox Co. (USA)

**Flexible low-voltage organic integrated circuits with megahertz switching frequencies** (*Invited Paper*), Ute Zschieschang, Max-Planck-Institut für Festkörperforschung (Germany); Kazuo Takimiya, RIKEN Ctr. for Emergent Matter Science (Japan); Tarek Zaki, Univ. Stuttgart (Germany); Florian Letzkus, Harald Richter, Joachim N. Burghartz, Institut für Mikroelektronik Stuttgart (Germany); Hagen Klauk, Max-Planck-Institut für Festkörperforschung (Germany) ... [9569-13]

**Fully printed 2-bit shift register based on organic electrochemical transistors**, Philipp C. Hüttner, Thomas Rothländer, Gregor Scheipl, Barbara Stadlober, JOANNEUM RESEARCH Forschungsgesellschaft mbH (Austria) ..... [9569-14]

**Field-effect memory transistors based on arrays of nanowires of a ferroelectric polymer**, Ronggang Cai, Hailu G. Kassa, Univ. Catholique de Louvain (Belgium); Alessio Marrani, Solvay Specialty Polymers Italy S.P.A. (Italy); Albert J. van Breemen, Gerwin H. Gelinck, Holst Ctr. (Netherlands); Bernard L. Nysten, Univ. Catholique de Louvain (Belgium); Zhijun Hu, Soochow Univ. (China); Alain M. Jonas, Univ. Catholique de Louvain (Belgium) ..... [9569-15]

**Printed circuits and their applications: Which way forward?** (*Invited Paper*), Eugenio Cantatore, Technische Univ. Eindhoven (Netherlands) .... [9569-16]

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- ASTRONOMICAL OPTICS AND INSTRUMENTATION
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*Program Chair: Ian T. Ferguson*, The Univ. of North Carolina at Charlotte (USA)

- 9571 **Fourteenth International Conference on Solid State Lighting and LED-based Illumination Systems** (*Kane, Jiao, Dietz, Huang*) ..... p. 110  
9572 **Nonimaging Optics: Efficient Design for Illumination and Solar Concentration XII** (*Winston, Gordon*) ..... p. 112

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- Program Chair: H. Philip Stahl*, NASA Marshall Space Flight Ctr. (USA)  
9573 **Optomechanical Engineering 2015** (*Hatheway*) ..... p. 114  
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9580 **Zoom Lenses V** (*Betensky, Yamanashi*) ..... p. 129  
9581 **Laser Beam Shaping XVI** (*Forbes, Lizotte*) ..... p. 131  
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- 9584 **Ultrafast Nonlinear Imaging and Spectroscopy III** (Liu, Khoo, Psaltis, Shi) ..... p. 135  
9585 **Terahertz Emitters, Receivers, and Applications VI** (Razeghi, Baranov, Zavada, Pavlidis) ..... p. 137  
9586 **Photonic Fiber and Crystal Devices: Advances in Materials and Innovations in Device Applications IX** (Yin, Guo) ..... p. 139  
9587 **Optical Data Storage 2015** (Katayama, Milster) ..... p. 141  
9571 **Fourteenth International Conference on Solid State Lighting and LED-based Illumination Systems** (Kane, Jiao, Dietz, Huang) ..... p. 110  
9609 **Infrared Sensors, Devices, and Applications V** (LeVan, Sood, Wijewarnasuriya, D'Souza) ..... p. 194

## X-RAY, GAMMA-RAY, AND PARTICLE TECHNOLOGIES

- Program Chairs: Ali M. Khounsary, X-ray Optics, Inc. (USA) and Illinois Institute of Technology (USA); Ralph B. James, Brookhaven National Lab. (USA)
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- Program Chair: Khan M. Iftekharuddin, Old Dominion Univ. (USA)
- 9596 **Signal and Data Processing of Small Targets 2015** (Drummond, Teichgraeber) ..... p. 158  
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- Program Chair: Oswald H. W. Siegmund, Univ. of California, Berkeley (USA)
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- 9614 **Laser Communication and Propagation through the Atmosphere and Oceans IV** (van Eijk, Davis, Hammel) ..... p. 203  
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<b>SPECIAL PROGRAM</b>				
9570 <b>The Nature of Light: What are Photons? VI</b> (Roychoudhuri, Kracklauer, De Raedt)				

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
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9572 Nonimaging Optics: Efficient Design for Illumination and Solar Concentration XII <i>(Winston, Gordon)</i>			9571 Fourteenth International Conference on Solid State Lighting and LED-based Illumination Systems <i>(Kane, Jiao, Dietz, Huang)</i>	
<b>OPTOMECHANICS AND OPTICAL MANUFACTURING</b>		Program Chair: <b>H. Philip Stahl</b> , NASA Marshall Space Flight Ctr. (USA)		
		9573 Optomechanical Engineering 2015 <i>(Hatheway)</i>		
9575 Optical Manufacturing and Testing XI <i>(Fähnle, Williamson, Kim)</i>		9574 Material Technologies and Applications to Optics, Structures, Components, and Sub-Systems II <i>(Krödel, Robichaud, Goodman)</i>		
		9576 Applied Advanced Optical Metrology Solutions <i>(Novak, Trolinger)</i>	9577 Optical Modeling and Performance Predictions VII <i>(Kahan, Levine-West)</i>	
<b>OPTICAL DESIGN AND SYSTEMS ENGINEERING</b>		Program Chairs: <b>José Sasián</b> , College of Optical Sciences, The Univ. of Arizona (USA) and <b>R. John Koshel</b> , College of Optical Sciences, The Univ. of Arizona (USA)		
9582 Optical System Alignment, Tolerancing, and Verification IX <i>(Sasián, Youngworth)</i>	9578 Current Developments in Lens Design and Optical Engineering XVI <i>(Johnson, Mahajan, Thibault)</i>	9580 Zoom Lenses V <i>(Betensky, Yamanashi)</i>		
	9581 Laser Beam Shaping XVI <i>(Forbes, Lizotte)</i>	9579 Novel Optical Systems Design and Optimization XVIII <i>(Gregory, Davis, Hahlweg)</i>		
9583 An Optical Believe It or Not: Key Lessons Learned IV <i>(Kahan)</i>				
9572 Nonimaging Optics: Efficient Design for Illumination and Solar Concentration XII <i>(Winston, Gordon)</i>				
<b>PHOTONIC DEVICES AND APPLICATIONS</b>		Program Chairs: <b>Shizhuo Yin</b> , The Pennsylvania State Univ. (USA) and <b>Ruyan Guo</b> , The Univ. of Texas at San Antonio (USA)		
9584 Ultrafast Nonlinear Imaging and Spectroscopy III <i>(Liu, Khoo, Psaltis, Shi)</i>		9571 Fourteenth International Conference on Solid State Lighting and LED-based Illumination Systems <i>(Kane, Jiao, Dietz, Huang)</i>		
9585 Terahertz Emitters, Receivers, and Applications VI <i>(Razeghi, Baranov, Zavada, Pavlidis)</i>		9609 Infrared Sensors, Devices, and Applications V <i>(LeVan, Sood, Wijewarnasuriya, D'Souza)</i>		
9586 Photonic Fiber and Crystal Devices: Advances in Materials and Innovations in Device Applications IX <i>(Yin, Guo)</i>				
9587 Optical Data Storage 2015 <i>(Katayama, Milster)</i>				
<b>ASTRONOMICAL OPTICS AND INSTRUMENTATION</b>		Program Chair: <b>Oswald H. W. Siegmund</b> , Univ. of California, Berkeley (USA)		
9601 UV, X-Ray, and Gamma-Ray Space Instrumentation for Astronomy XIX <i>(Siegmund)</i>	9603 Optics for EUV, X-Ray, and Gamma-Ray Astronomy VII <i>(O'Dell, Pareschi)</i>			
9602 UV/Optical/IR Space Telescopes and Instruments: Innovative Technologies and Concepts VII <i>(MacEwen, Breckinridge)</i>	9605 Techniques and Instrumentation for Detection of Exoplanets VII <i>(Shaklan)</i>			
9604 Solar Physics and Space Weather Instrumentation VI <i>(Fineschi, Fennelly)</i>				
9606 Instruments, Methods, and Missions for Astrobiology XVII <i>(Hoover, Levin, Rozanov, Wickramasinghe)</i>				

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
<b>X-RAY, GAMMA-RAY, AND PARTICLE TECHNOLOGIES</b>				<i>Program Chair: Ali M. Khounsary, X-ray Optics, Inc. (USA) and Illinois Institute of Technology (USA) and Ralph B. James, Brookhaven National Lab. (USA)</i>
9590 <b>Advances in Laboratory-based X-Ray Sources, Optics, and Applications IV</b> ( <i>Khounsary, MacDonald</i> )	9588 <b>Advances in X-Ray/EUV Optics and Components X</b> ( <i>Goto, Morawe, Khounsary</i> )		9589 <b>X-Ray Lasers and Coherent X-Ray Sources: Development and Applications XI</b> ( <i>Klisnick, Menoni</i> )	
			9591 <b>Target Diagnostics Physics and Engineering for Inertial Confinement Fusion IV</b> ( <i>Koch, Grim</i> )	
			9592 <b>X-Ray Nanoimaging: Instruments and Methods II</b> ( <i>Lai</i> )	9594 <b>Medical Applications of Radiation Detectors V</b> ( <i>Barber, Furenlid, Roehrig</i> )
			9595 <b>Radiation Detectors: Systems and Applications XVI</b> ( <i>Grim, Barber</i> )	
<b>SIGNAL, IMAGE, AND DATA PROCESSING</b>				<i>Program Chair: Khan M. Iftekharuddin, Old Dominion Univ. (USA)</i>
			9596 <b>Signal and Data Processing of Small Targets 2015</b> ( <i>Drummond, Teichgraeber</i> )	
	9597 <b>Wavelets and Sparsity XVI</b> ( <i>Papadakis, Goyal, Van De Ville</i> )			
	9598 <b>Optics and Photonics for Information Processing IX</b> ( <i>Awwal, Iftekharuddin, Matin, Garcia Vázquez, Márquez</i> )			
	9599 <b>Applications of Digital Image Processing XXXVIII</b> ( <i>Tescher</i> )		9600 <b>Image Reconstruction from Incomplete Data VIII</b> ( <i>Bones, Fiddy, Millane</i> )	
<b>REMOTE SENSING</b>				<i>Program Chair: Allen H.-L. Huang, Univ. of Wisconsin-Madison (USA)</i>
	9607 <b>Earth Observing Systems XX</b> ( <i>Butler, Xiong, Gu</i> )		9609 <b>Infrared Sensors, Devices, and Applications V</b> ( <i>LeVan, Sood, Wijewarnasuriya, D'Souza</i> )	
	9608 <b>Infrared Remote Sensing and Instrumentation XXIII</b> ( <i>Strojnik Scholl, Páez</i> )			
		9610 <b>Remote Sensing and Modeling of Ecosystems for Sustainability XII</b> ( <i>Gao, Chang, Wang</i> )	9612 <b>Lidar Remote Sensing for Environmental Monitoring XV</b> ( <i>Singh</i> )	
	9611 <b>Imaging Spectrometry XX</b> ( <i>Pagano, Silny</i> )			
		9613 <b>Polarization Science and Remote Sensing VII</b> ( <i>Shaw, LeMaster</i> )		
<b>ATMOSPHERIC AND SPACE OPTICAL SYSTEMS</b>				<i>Program Chairs: Stephen M. Hammel, Space and Naval Warfare Systems Command (USA) and Alexander M. J. van Eijk, TNO Defence, Security and Safety (Netherlands)</i>
	9614 <b>Laser Communication and Propagation through the Atmosphere and Oceans IV</b> ( <i>van Eijk, Davis, Hammel</i> )		9617 <b>Unconventional Imaging and Wavefront Sensing XI</b> ( <i>Dolne, Karr, Gamiz, Dayton</i> )	
9615 <b>Quantum Communications and Quantum Imaging XIII</b> ( <i>Meyers, Shih, Deacon</i> )				
	9616 <b>Nanophotonics and Macrophotonics for Space Environments IX</b> ( <i>Taylor, Cardimona, Pirich</i> )			

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# The Nature of Light: What are Photons? VI

Conference Chairs: Chandrasekhar Roychoudhuri, Univ. of Connecticut (USA), Femto Macro Continuum (USA); Al F. Kracklauer, Consultant (Germany); Hans De Raedt, Univ. of Groningen (Netherlands)

Program Committee: Michael Ambroselli, Univ. of Connecticut (USA); Antonio Badolato, Univ. of Rochester (USA); Ana María Cetto, Univ. Nacional Autónoma de Mexico (Mexico); Debasish Chanda, Univ. of Central Florida (USA); Luis de la Peña, Univ. Nacional Autónoma de México (Mexico); Benjamin J. Eggleton, The Univ. of Sydney (Australia); Tepper L. Gill, Howard Univ. (USA); Karl Otto Greulich, Fritz Lipmann Institute (Germany); Manuel Fernández-Guasti, Univ. Autónoma Metropolitana-Iztapalapa (Mexico); Habib Hamam, Univ. de Moncton (Canada); François Hénault, Lab. d'Astrophysique de l'Observatoire de Grenoble (France); Subhash C. Kak, Oklahoma State Univ. (USA); Andrei Yu. Khrennikov, Linnaeus Univ. (Sweden); Akhlesh Lakhtakia, The Pennsylvania State Univ. (USA); Kristel F. Michielsen, Forschungszentrum Jülich GmbH (Germany); John M. Myers, Harvard Univ. (USA); Narasimha S. Prasad, NASA Langley Research Ctr. (USA); Chary Rangacharyulu, Univ. of Saskatchewan (Canada); William T. Rhodes, Florida Atlantic Univ. (USA); Wolfgang P. Schleich, Univ. Ulm (Germany); Marlan O. Scully, Texas A&M Univ. (USA), Princeton Univ. (USA); Luping Shi, Tsinghua Univ. (China); Riccardo C. Storti, Delta Group Engineering, P/L (Australia); Din Ping Tsai, Academia Sinica (Taiwan); Arnt Inge Vistnes, Univ. of Oslo (Norway); Ewan Malcolm Wright, College of Optical Sciences, The Univ. of Arizona (USA)

## MONDAY 10 AUGUST

### WELCOME AND OPENING REMARKS ..... 1:30 PM TO 1:40 PM

Chandrasekhar Roychoudhuri, Univ. of Connecticut (USA) and Femto Macro Continuum (USA)

### SESSION 1 ..... MON 1:40 PM TO 3:30 PM

#### Quantum Concepts/Epistemology I

Session Chairs: Hans De Raedt, Univ. of Groningen (Netherlands); Albrecht Giese, Consultant (Germany)

Quantum theory as the most robust treatment of reproducible experiments:

application to Einstein-Podolsky-Rosen-Bohm experiments (*Invited Paper*), Hans De Raedt, Univ. of Groningen (Netherlands); Mikhail I. Katsev, Hylke C. Donker, Radboud Univ. Nijmegen (Netherlands); Kristel F. Michielsen, Forschungszentrum Jülich GmbH (Germany) ..... [9570-1]

The rise and fall of quantum nonlocality, Donald A. Graft, STMicroelectronics (USA) ..... [9570-2]

A convergence: Special relativity, zitterbewegung, and new models for the subcomponent structure of quantum particles., Michael J. Mobley, Grand Canyon Univ. (USA) ..... [9570-3]

Classical explanations of results of quantum mechanics, Albrecht Giese, Consultant (Germany) ..... [9570-4]

Photons as observer transitions in the event-oriented world view, Wolfgang Baer, Nascent Systems Inc. (USA) ..... [9570-5]

### SESSION 2 ..... MON 4:00 PM TO 5:30 PM

#### Quantum Concepts/Epistemology II

Session Chairs: Chandrasekhar Roychoudhuri, Univ. of Connecticut (USA), Femto Macro Continuum (United States); Michael Ambroselli, Univ. of Connecticut (USA)

Genesis of quantization of matter and radiation field (*Invited Paper*), Luis de la Peña, Univ. Nacional Autónoma de México (Mexico); Ana María Cetto, Univ. Nacional Autónoma de Mexico (Mexico). ..... [9570-6]

Urgency of evolution-process congruent thinking in physics, Chandrasekhar Roychoudhuri, Univ. of Connecticut (USA) ..... [9570-7]

A critical examination of EPR-B non-locality experimental tests, A. F. Kracklauer, Consultant (Germany) ..... [9570-8]

Did Planck, Einstein, Bose count indivisible photons, or discrete emission/absorption processes in a black-body cavity?, Michael Ambroselli, Chandrasekhar Roychoudhuri, Univ. of Connecticut (USA) ..... [9570-9]

## TUESDAY 11 AUGUST

### SESSION 3 ..... TUE 8:00 AM TO 10:00 AM

#### What Is a Photon I

Session Chairs: Richard Gauthier, Santa Rosa Junior College (USA); Luping Shi, Tsinghua Univ. (China)

Spatial photon localization and magnetic monopoles (*Invited Paper*), Ole Keller, Aalborg Univ. (Denmark) ..... [9570-10]

Temporal light dispersion in intergalactic space, Luiz C. Barbosa, Univ. Estadual de Campinas (Brazil) ..... [9570-11]

The photon: EM fields, electrical potentials, and AC charge, Andrew Meulenbergh Jr., Hi Pi Consulting (USA); Robert W. Hudgins, Science for Humanity Trust, Inc. (USA); Ralph F. Penland Jr., Science for Humanity Trust, Inc. (India) ..... [9570-12]

The electron is a charged photon, Richard Gauthier, Santa Rosa Junior College (USA) ..... [9570-13]

A study of the nature of light by comparing real and digital universes (*Invited Paper*), Luping Shi, Tsinghua Univ. (China) ..... [9570-14]

### SESSION 4 ..... TUE 10:30 AM TO 12:10 PM

#### What Is a Photon II

Session Chairs: Chary Rangacharyulu, Univ. of Saskatchewan (Canada); Al F. Kracklauer, Consultant (Germany)

Biomimetic antennas for light (*Invited Paper*), Dmitri V. Voronine, Texas A&M Univ. (USA) ..... [9570-16]

Are there photons in fact?, Sergey A. Rashkovskiy, A. Ishlinsky Institute for Problems in Mechanics (Russian Federation) ..... [9570-17]

Electron-positron annihilation models, Randy T. Dorn, Independent Researcher (USA) ..... [9570-18]

An epitaph for all photons: thou revealest thyself in thy demise (*Invited Paper*), Chary Rangacharyulu, Univ. of Saskatchewan (Canada) ..... [9570-19]

Lunch/Exhibition Break ..... Tue 12:10 pm to 1:40 pm

### SESSION 5 ..... TUE 1:40 PM TO 3:10 PM

#### Particle Wave Duality I

Session Chairs: Kristel F. Michielsen, Forschungszentrum Jülich GmbH (Germany); Narasimha S. Prasad, NASA Langley Research Ctr. (USA)

Harnessing infrared photons in optical antenna (*Invited Paper*), Debasish Chanda, Univ. of Central Florida (USA) ..... [9570-20]

Visualizing electrons and photons, Azizul Haque, Independent Researcher (USA) ..... [9570-21]

Wave interference: mechanics of the standing wave component and the illusion of 'which way' information?, Robert W. Hudgins, Science for Humanity Trust, Inc. (USA); Andrew Meulenbergh Jr., Hi Pi Consulting (India); Ralph F. Penland Jr., Science for Humanity Trust, India (India) ..... [9570-22]

Detection of superposition effects of polarized light by Photo-EMF detectors, Narasimha S. Prasad, NASA Langley Research Ctr. (USA) ..... [9570-23]

# CONFERENCE 9570

SESSION 6..... TUE 3:40 PM TO 5:50 PM

## Particle Wave Duality II

Session Chairs: **François B. Hénaudt**, Institut de Planétologie et d'Astrophysique de Grenoble (France); **Michael J. Mobley**, Grand Canyon Univ. (USA)

**Mysterious quantum Cheshire cat: an illusion resulting from interference (Invited Paper)**, Kristel F. Michielsen, Forschungszentrum Jülich GmbH (Germany); Hans De Raedt, Univ. of Groningen (Netherlands) ..... [9570-24]

**New experiments call for a continuous absorption alternative to the photon model**, Eric S. Reiter, Unquantum Lab. (USA) ..... [9570-25]

**Quantum physics and the beam splitter mystery**, François B. Hénaudt, Institut de Planétologie et d'Astrophysique de Grenoble (France). ..... [9570-26]

**Photon diffraction described by virtual particle momentum exchange: What more can straight-edge diffraction tell us?**, Michael J. Mobley, Grand Canyon Univ. (USA) ..... [9570-27]

**The photon to electron/positron-pair transition**, Andrew Meulenberg Jr., Hi Pi Consulting (USA); Ralph F. Penland Jr., Science for Humanity Trust, Inc. (India); Robert W. Hudgins, Science for Humanity Trust, Inc. (USA) ..... [9570-28]

**Matter in the form of toroidal electromagnetic vortices**, Wilhelm F. Hagen, Consultant (Germany) ..... [9570-29]

## THE NATURE OF LIGHT: WHAT ARE PHOTONS? TECHNICAL EVENT..... 7:30 PM TO 10:00 PM

Session Chair: **Chandrasekhar Roychoudhuri**, Univ. of Connecticut (USA) and Femto Macro Continuum (USA)

Join us for a special technical event featuring Prof. Marlan Scully's Keynote Talk. Prof. Scully holds joint appointments with Texas A&M Univ. (USA), Princeton Univ. (USA), and Baylor Univ. (USA). He is an eminent scientist and a very well-known author in the field of Quantum Optics. Prof. Scully's pioneering work includes the first quantum theory of the laser with Nobel laureate, Lamb; the first demonstrations of lasing without inversion; the first demonstration of ultraslow light in hot gases, and the use of quantum coherence to detect anthrax in real time. Furthermore, Marlan Scully's work on quantum coherence and correlation effects has shed new light on the foundations of quantum mechanics, e.g., the quantum eraser. Because of his involvement in cattle ranching and research in beef cattle production, Prof. Marlan Scully is also known as the "quantum cowboy." Prof. Scully will shed more light on the continuing debate over wave-particle duality of light waves and "indivisible quanta," which started in late 1600 with Newton (corpuscular) and Huygens (secondary wavelets). Prof. Scully's one-hour talk will begin at 8:00 pm following an informal brief reception at 7:30 pm. Discussions and networking, after his talk, will continue until 10:00 pm. Light snacks and beverages will be provided.

**The photon: From Newton and Maxwell to Einstein and Schwinger (Keynote Presentation)**, Marlan O. Scully, Texas A&M Univ. (USA) and Princeton Univ. (USA) and Baylor Univ. (USA) ..... [9570-101]

WEDNESDAY 12 AUGUST

SESSION 7..... WED 8:30 AM TO 10:00 AM

## Space Medium/Non-Interaction of Waves I

Session Chairs: **Hans De Raedt**, Univ. of Groningen (Netherlands); **Ana María Cetto**, Univ. Nacional Autónoma de Mexico (Mexico)

**Could space be considered as the inertial rest frame?**, Chandrasekhar Roychoudhuri, Michael Ambroselli, Univ. of Connecticut (USA) ..... [9570-30]

**Is the natural linewidth due to spontaneous emission life-times or due to time-finite envelopes of the emitted-wave packets?**, Negussie Tirfessa, Manchester Community College (USA); Chandrasekhar Roychoudhuri, Michael Ambroselli, Univ. of Connecticut (USA) ..... [9570-31]

**Phase shift between Michelson two beam due to propagation in an optical waveguide**, Octavio N. Sanchez, Manuel Fernández-Guasti, Univ. Autónoma Metropolitana-Unidad Iztapalapa (Mexico) ..... [9570-32]

**Light and harmonicity: The golden section**, Dionysios G. Raftopoulos, Independent Researcher (Greece) ..... [9570-33]

SESSION 8..... WED 10:30 AM TO 11:50 AM

## Space Medium/Non-Interaction of Waves II

Session Chairs: **Martin B. van der Mark**, Philips Research Nederland B.V. (Netherlands); **Albrecht Giese**, Consultant (Germany)

**Can the photon be described by a general particle model?**, Albrecht Giese, Consultant (Germany) ..... [9570-34]

**Quantum mechanical probability current as electromagnetic 4-current from topological EM fields**, Martin B. van der Mark, Philips Research Nederland B.V. (Netherlands) ..... [9570-35]

**On a heuristic framework for modeling the fundamental particles and interactions**, Ted Silverman, IIAS (USA) ..... [9570-36]

**Quantum mechanics beyond Gaussians: from coarse graining to tower of scales**, Antonina N. Fedorova, Michael G. Zeitlin, Institute of Problems of Mechanical Engineering (Russian Federation) ..... [9570-37]

Lunch/Exhibition Break ..... Wed 11:50 am to 1:20 pm

SESSION 9..... WED 1:20 PM TO 3:20 PM

## What Is a Photon III

Session Chairs: **Din Ping Tsai**, Academia Sinica (Taiwan); **Karl Otto Greulich**, Fritz Lipmann Institute (Germany)

**The fine structure constant alpha: relevant for a model of a self-propelling photon and for particle masses (Invited Paper)**, Karl Otto Greulich, Fritz Lipmann Institute (Germany) ..... [9570-38]

**The electron is a confined photon**, Charles G. Akins, Akins Enterprises LLC (USA) [9570-39]

**The nature of the photon and the electron (Invited Paper)**, John G. Williamson, Univ. of Glasgow (United Kingdom) ..... [9570-40]

**Absolute relativity and the quantisation of light**, John G. Williamson, Univ. of Glasgow (United Kingdom) ..... [9570-41]

**A meta-analyzer for circular polarization resolved spectroscopy (Invited Paper)**, Din Ping Tsai, Academia Sinica (Taiwan) and National Taiwan Univ. (Taiwan); Wei-Yi Tsai, Chun Yen Liao, Wei Ting Chen, Pei Ru Wu, National Taiwan Univ. (Taiwan); Greg Sun, Univ. of Massachusetts Boston (USA); Peter Török, Imperial College London (United Kingdom) ..... [9570-42]

# CONFERENCE 9570

SESSION 10 ..... WED 3:50 PM TO 5:20 PM

## Space Medium/Non-Interaction of Waves III

- Session Chairs: **Narasimha S. Prasad**, NASA Langley Research Ctr.  
(USA); **Reginald T. Cahill**, Flinders Univ. (Australia)
- Discovery of dynamical space: experiments and theory (Invited Paper)**, Reginald T. Cahill, Flinders Univ. (Australia) ..... [9570-44]
- Spacetime-based model of EM radiation II**, John A. Macken, Macken Instruments Inc. (USA) ..... [9570-45]
- Modelling superposition of many polarized beams on an isotropic photo detector**, Chandrasekhar Roychoudhuri, Michael Ambroselli, Univ. of Connecticut (USA) ..... [9570-46]
- Tabletop demonstration of non-Interaction of photons and non-interference of waves**, Narasimha S. Prasad, NASA Langley Research Ctr. (USA); Chandra Roychoudhuri, Univ. of Connecticut (USA) ..... [9570-47]

## THURSDAY 13 AUGUST

SESSION 11 ..... THU 8:30 AM TO 10:00 AM

## Space Medium/Non-Interaction of Waves IV

- Session Chairs: **John Duffield**, The Univ. of Manchester (United Kingdom);  
**Xinhang Shen**, NAC Geographic Products Inc. (Canada)
- Clock time is absolute and universal (Invited Paper)**, Xinhang Shen, NAC Geographic Products Inc. (Canada) ..... [9570-48]
- Special relativity from observer's mathematics point of view**, Boris Khots, Dmitriy Khots, Compressor Controls Corp. (USA) ..... [9570-49]
- Faster than light?: The variable refractive index of the quantum vacuum**, Todd J. Desiato, Consultant (USA) ..... [9570-55]
- Photon-based standard model**, David Mathes, Parsec (USA) ..... [9570-51]

SESSION 12 ..... THU 10:30 AM TO 11:30 AM

## Space Medium/Non-Interaction of Waves V

- Session Chairs: **Riccardo C. Storti**, Delta Group Engineering, P/L (Australia); **Martin B. van der Mark**, Philips Research Nederland B.V. (Netherlands)
- Quantum mechanics via sheaves and schemes: on the route to categorification**, Michael G. Zeitlin, Antonina N. Fedorova, Institute of Problems of Mechanical Engineering (Russian Federation) ..... [9570-52]
- On the nature of "stuff": (non)scaling and the hierarchy of forces**, Martin B. van der Mark, Philips Research Nederland B.V. (Netherlands) ..... [9570-53]
- The electrostatic to gravitational force ratio within the electro-gravi-magnetic (EGM) construct**, Riccardo C. Storti, Delta Group Engineering, P/L (Australia) ..... [9570-54]
- Lunch/Exhibition Break ..... Thu 11:30 am to 1:00 pm

PANEL DISCUSSION ..... 1:00 PM TO 3:00 PM

### Are Electrons Oscillating Photons or Oscillations of the Vacuum Itself?

Wednesday-Thursday 12-13 August 2015 • Proceedings of SPIE Vol. 9571

# Fourteenth International Conference on Solid State Lighting and LED-based Illumination Systems

**Conference Chairs:** **Matthew H. Kane**, Texas A&M Univ. at Galveston (USA); **Jianzhong Jiao**, OSRAM Opto Semiconductors Inc. (USA); **Nikolaus Dietz**, Georgia State Univ. (USA); **Jian-Jiang Huang**, National Taiwan Univ. (Taiwan)

**Program Committee:** **Lianghui Chen**, Institute of Semiconductors (China); **Wood-Hi Cheng**, National Sun Yat-Sen Univ. (Taiwan); **John W. Curran**, LED Transformations, LLC (USA); **Christoph Hoelen**, Philips Lighting B.V. (Netherlands); **Asif M. Khan**, Univ. of South Carolina (USA); **Michael R. Krames**, Soraa, Inc. (USA); **Yung Sheng Liu**, National Tsing Hua Univ. (Taiwan); **Eun-Hyun Park**, Kyung Hee Univ. (Korea, Republic of); **Seong-Ju Park**, Gwangju Institute of Science and Technology (Korea, Republic of); **Jeff Quinlan**, Acuity Brands Lighting, Inc. (USA); **Christian Wetzel**, Rensselaer Polytechnic Institute (USA); **Chih-Chung Yang**, National Taiwan Univ. (Taiwan); **Yiting Zhu**, Rensselaer Polytechnic Institute (USA)

**Founding Chair:** **Ian T. Ferguson**, The Univ. of North Carolina at Charlotte (USA)

## WEDNESDAY 12 AUGUST

### SESSION 1 ..... WED 8:45 AM TO 10:05 AM

#### Lasers and UV LEDs

Session Chair: **Nikolaus Dietz**, Georgia State Univ. (USA)

**Semiconductor lasers (VCSEL, laser diode, and LEDs) characterization**, Mahmoud Gadalla, Vrije Univ. Brussel (Belgium) and Tanta Univ. (Egypt) . [9571-1]

**Next-generation glass-base phosphor-converted laser light engine**, Jin-Kai Chang, National Sun Yat-Sen Univ. (Taiwan); Wei-Chih Cheng, Taiwan Color Optics, Inc. (Taiwan); Yi-Yin Kuo, National Sun Yat-Sen Univ. (Taiwan); Chun-Chin Tsai, Far East Univ. (Taiwan); Yung-Peng Chang, Taiwan Color Optics, Inc. (Taiwan); Yi-Chung Huang, Brogent Technologies, Inc. (Taiwan); Li-Yin Chen, National Sun Yat-Sen Univ. (Taiwan); Wood-Hi Cheng, National Chung Hsing Univ. (Taiwan) . [9571-2]

**Extraction efficiency enhancement in ultra-violet LEDs based on microlenses made by hydrophilic confinement effect**, Chi-min Liu, Guo-Dung J. Su, National Taiwan Univ. (Taiwan) . [9571-3]

**Standardization of UV LED measurements**, George P. Eppeldauer, Thomas C. Larson, Howard W. Yoon, National Institute of Standards and Technology (USA) . [9571-4]

### SESSION 2 ..... WED 10:35 AM TO 11:35 AM

#### Novel Packaging Methods for SSL

Session Chair: **Ivan Moreno**, Univ. Autónoma de Zacatecas (Mexico)

**Thermoresponsive scattering coating for smart white LEDs**, Hugo J. Cornelissen, Joan Yu, Giovanni Cennini, Philips Research (Netherlands); Jurica Bauer, Paul P. C. Verbunt, Cees W. M. Bastiaansen, Dick J. Broer, Technische Univ. Eindhoven (Netherlands) . [9571-5]

**High efficient packaging structure with high concentration phosphor matrix**, Yu-Yu Chang, Hsin-Ying Lin, Zi-Yan Ting, Tsung-Hsun Yang, Ching-Cherng Sun, National Central Univ. (Taiwan) . [9571-6]

**Direct growth and controlled coalescence of thick AlN template on circle patterned-Si substrate**, Tinh Binh Tran, Hideki Hirayama, Shiro Toyoda, Noritoshi Maeda, RIKEN (Japan) . [9571-7]

Lunch/Exhibition Break ..... Wed 11:35 am to 1:15 pm

### SESSION 3 ..... WED 1:15 PM TO 2:55 PM

#### Colors and Chromaticity Issues in SSL

Session Chair: **Jianzhong Jiao**, OSRAM Opto Semiconductors Inc. (USA)

**Köhler integration in color mixing collimators**, Oliver Dross, Philips Research (Netherlands) . [9571-8]

**Selecting "pleasing" correlated color temperature for illumination of outdoor environments**, Andrius Petruslis, Pranci?kus Vitta, Rimantas Vaicekauskas, Arturas ?ukauskas, Vilnius Univ. (Lithuania) . [9571-9]

**A color management system for multi-colored LED lighting**, Maumita Chakrabarti, Anders Thorseth, Jørgen Jepsen, Dennis D. Corell, Carsten Dam-Hansen, DTU Fotonik (Denmark) . [9571-10]

**The stability of spectrum reproduction by LEDs**, Hua Yang, Jing Li, Ran Yao, Pengzhi Lu, Yanrong Pei, Institute of Semiconductors (China) . [9571-11]

**Investigation of effect of dimming schemes on photometric performance of LED based visible light communication (VLC) systems**, Fahad Zafar, Rajendran Parthiban, Monash Univ. Malaysia (Malaysia) . [9571-12]

### SESSION 4 ..... WED 3:25 PM TO 5:25 PM

#### Applications of LED for SSL

Session Chair: **Hugo J. Cornelissen**, Philips Research (Netherlands)

**Necessity of mixed-level simulations for optical modeling of light-emitting diodes with patterned substrates**, Mayank Bahl, Synopsys, Inc. (USA); Alexander Linkov, OSRAM Opto Semiconductors GmbH (Germany); Evan Heller, Synopsys, Inc. (USA); Georg Rossbach, OSRAM Opto Semiconductors GmbH (Germany); William Cassarly, Robert Scarmozzino, Synopsys, Inc. (USA) . [9571-13]

**A novel design for high-performance dental lamp based on white-LEDs**, Jhih-You Cai, National Central Univ. (Taiwan); Hsin-Yang Ho, Witslight Technology Group (Taiwan); Wei-Ting Chien, National Central Univ. (Taiwan) and Witslight Technology Group (Taiwan); Ching-Cherng Sun, National Central Univ. (Taiwan) . [9571-14]

**Modular fixture designs for downlight, wallwash, and accent adjustable applications**, Zhuo Wang, Bruce M. Radl, OSRAM SYLVANIA Inc. (USA) [9571-15]

**LED streetlight analysis from outer space**, Ivan Moreno, José Samuel Pérez Huerta, Tonatiuh Saucedo Anaya, Univ. Autónoma de Zacatecas (Mexico) [9571-16]

**Freeform TIR lens design by sampling LED's intensity distribution in multiple Cartesian coordinate systems: A composite ray mapping method**, Donglin Ma, College of Optical Sciences, The Univ. of Arizona (USA); Zexin Feng, The Univ. of Arizona (USA); Rongguang Liang, College of Optical Sciences, The Univ. of Arizona (USA) . [9571-17]

**LEDs-based multiwavelength photoreactor for photocatalysis applications**, Luis Armando Díaz-Torres, Ctr. de Investigaciones en Óptica, A.C. (Mexico); Daniel Berrones, Carlos R. García, Univ. Autónoma de Coahuila (Mexico); Jorge Roberto Oliva-Uc, Ctr. de Investigaciones en Óptica, A.C. (Mexico); Raul Ochoa-Valiente, Univ. Autónoma de Coahuila (Mexico) . [9571-18]

# CONFERENCE 9571

## POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**High performance near-ultraviolet flip-chip light-emitting diodes with distributed Bragg reflector**, Il-Gyun Choi, Geun-Mo Jin, Jun-Cheon Park, Soo-Kun Jeon, Eun-Hyun Park, Semicon Light Co., Ltd. (Korea, Republic of) . [9571-27]

**High performance GaN based blue flip-chip light-emitting diodes**, Geun Mo Jin, Il-Gyun Choi, Jun-Cheon Park, Soo-Kun Jeon, Eun-Hyun Park, Semicon Light Co., Ltd. (Korea, Republic of) . [9571-28]

**An LED array reflecting light solutions for on-line visual ferrograph from Key Laboratory of Education Ministry**, Bo Li, Xi'an Jiaotong Univ. (China) . [9571-29]

**White LED motorcycle headlamp design**, Wen-Shing Sun, National Central Univ. (Taiwan) . [9571-30]

**Trap-assisted tunneling contributions to subthreshold forward current in InGaN/GaN LEDs**, Giovanni Verzellesi, Univ. degli Studi di Modena e Reggio Emilia (Italy); Marco Mandurrino, Michele Goano, Stefano Dominici, Marco Vallone, Francesco Bertazzi, Giovanni Ghione, Politecnico di Torino (Italy); Mario Bernabei, Luigi Rovati, Univ. degli Studi di Modena e Reggio Emilia (Italy); Matteo Meneghini, Gaudenzio Meneghesso, Enrico Zanoni, Univ. degli Studi di Padova (Italy)[9571-31]

**RGB color sensor implemented with LEDs**, José David Filoteo, Julián Móises Estudillo-Ayala, Univ. de Guanajuato (Mexico); Juan Carlos Hernández-García, Consejo Nacional de Ciencia y Tecnología (Mexico); Mónica Trejo-Durán, Alberto Muñoz Lopez, Daniel Jauregui-Vázquez, Roberto Rojas-Laguna, Univ. de Guanajuato (Mexico) . [9571-32]

**Numerical and experimental study on the evaluation of light collecting performance of the bio-fluorescence sensor**, Bonghyun Jo, YiSeul Jo, Sun-Seok Byeon, Hee Won Shin, Tae Kyu Ahn, Sungkyunkwan Univ. (Korea, Republic of); Jong-Chul Lee, Gangneung-Wonju National Univ. (Korea, Republic of); Youn-Jea Kim, Sungkyunkwan Univ. (Korea, Republic of) . [9571-33]

**Design of high power LED-based UVA emission system and a photosensitive substance for clinical application in corneal radiation**, Alessandro D. Mota, André M. Cestari, Opto Eletrônica S.A. (Brazil); André Orlandi, Opto Eletrônica S.A. (Brazil) and Univ. de São Paulo (Brazil); Anselmo G. Oliveira, Univ. Estadual Paulista "Júlio de Mesquita Filho" (Brazil); Giuliano Rossi, Opto Eletrônica S.A. (Brazil); Jarbas C. Castro Neto, Univ. de São Paulo (Brazil) and Opto Eletrônica S.A. (Brazil); Tiago A. Ortega, Univ. de São Paulo (Brazil); Tiago Rosa, Opto Eletrônica S.A. (Brazil) . [9571-34]

**Process research of LED full-color display matrix with small pixel**, Jing Li, Hua Yang, Ran Yao, Institute of Semiconductors (China) . [9571-35]

## THURSDAY 13 AUGUST

### SESSION 5 ..... THU 9:00 AM TO 10:20 AM

#### **Nitride LEDs for SSL I**

Session Chair: Jian-Jang Huang, National Taiwan Univ. (Taiwan)

**Carrier-distribution studies in GaN-based light-emitting-diodes**, Dinh Chuong Nguyen, David Vaufrey, CEA Grenoble (France); Mathieu Leroux, Ctr. de Recherche sur l'Hétéro-Epitaxie et ses Applications (France) . [9571-19]

**Design analysis of InGaN-GaNAs active region for long wavelength visible emission**, Chee-Keong Tan, Nelson Tansu, Lehigh Univ. (USA) . [9571-20]

**Effect of barrier materials on the polarization field in the active region of blue InGaN LED using Sentaurus**, Karunavani Sarukunaselan, Vithyacharan Retnasamy, Zaliman Sauli, Mukhzeer Mohamad Shahimin, Univ. Malaysia Perlis (Malaysia) . [9571-21]

**Effect on enhancement and optical performance of blue InGaN LED**, Karunavani Sarukunaselan, Vithyacharan Retnasamy, Zaliman Sauli, Mukhzeer Mohamad Shahimin, Univ. Malaysia Perlis (Malaysia) . [9571-22]

### SESSION 6 ..... THU 10:50 AM TO 12:10 PM

#### **Nitride LEDs for SSL II**

Session Chair: Matthew H. Kane, Texas A&M Univ. at Galveston (USA)

**Understanding the dopant activation for improved manufacturing yield in InGaN based light emitting diodes**, Nicholas A. Lacroce, Guangyu Liu, Chee-Keong Tan, Lehigh Univ. (USA); Ronald A. Arif, Soo Min Lee, Veeco Instruments Inc. (USA); Nelson Tansu, Lehigh Univ. (USA) . [9571-23]

**Nanoscale epitaxial lateral overgrowth of GaN-based light-emitting diodes on an AlN nanorod-array template**, Wen-Yi Lan, Yu-Feng Yin, Chen-Hung Tsai, National Taiwan Univ. (Taiwan); Mu-Xin Ma, National Cheng Kung Univ. (Taiwan); Hsiang-Wei Li, National Taiwan Univ. (Taiwan); Wei-Chi Lai, National Cheng Kung Univ. (Taiwan); Jian-Jang Huang, National Taiwan Univ. (Taiwan) . [9571-24]

**Optoelectronic and structural properties of InGaN nanostructures grown by plasma-assisted MOCVD**, Daniel Seidlitz, Matara K. I. Senevirathna, Yohannes Abate, Nikolaus Dietz, Georgia State Univ. (USA); Axel Hoffmann, Technische Univ. Berlin (Germany) . [9571-25]

**Quantum barrier thickness study on blue InGaN LED optical performance using Sentaurus**, Karunavani Sarukunaselan, Vithyacharan Retnasamy, Zaliman Sauli, Mukhzeer Mohamad Shahimin, Univ. Malaysia Perlis (Malaysia) . [9571-26]

Sunday-Monday 9-10 August 2015 • Proceedings of SPIE Vol. 9572

# Nonimaging Optics: Efficient Design for Illumination and Solar Concentration XII

**Conference Chairs:** Roland Winston, Univ. of California, Merced (USA); Jeffrey M. Gordon, Ben-Gurion Univ. of the Negev (Israel)**Program Committee:** Pablo Benítez, CeDInt-UPM (Spain), Light Prescriptions Innovators LLC (United States); William J. Cassarly, Synopsys, Inc. (USA); Daniel Feuermann, Ben-Gurion Univ. of the Negev (Israel); Juan Carlos Miñano, Univ. Politécnica de Madrid (Spain), Light Prescriptions Innovators LLC (United States); Narkis E. Shatz, SAIC (USA)

## SUNDAY 9 AUGUST

### WELCOME AND OPENING COMMENTS ..... 8:45 AM TO 9:00 AM

Roland Winston, Univ. of California, Merced (USA) and Jeffrey M. Gordon, Ben-Gurion Univ. of the Negev (Israel)

### SESSION 1 ..... SUN 9:00 AM TO 10:20 AM

#### Novel Designs and Core Concepts

Session Chair: Narkis E. Shatz, SAIC Gemini, Inc. (USA)

**String method of nonimaging optics from a radiation theory perspective**, Bob Colabewala, Roland Winston, Lun Jiang, Univ. of California, Merced (USA) [9572-1]

**Asymmetric design for compound elliptical concentrators (CEC)**, Lun Jiang, Roland Winston, Univ. of California, Merced (USA) [9572-2]

**All fiber actively mode-locked fiber laser emitting cylindrical vector beam**, Yong Zhou, An-Ting Wang, Chun Gu, Lixin Xu, Hai Ming, Univ. of Science and Technology of China (China) [9572-3]

**Improved and customized secondary optics for solar concentrators**, Daniel Vázquez, Antonio A. Fernandez-Balbuena, Univ. Complutense de Madrid (Spain); Angel Garcia-Botella, Univ. Politécnica de Madrid (Spain); Javier Alda, Univ. Complutense de Madrid (Spain) [9572-4]

### SESSION 2 ..... SUN 10:50 AM TO 11:50 AM

#### Solar Concentrators and Systems I

Session Chair: Jeffrey M. Gordon, Ben-Gurion Univ. of the Negev (Israel)

**Dielectric totally internally reflecting concentrator structure for vertical bifacial photovoltaic receivers**, Elizabeth Thomsen, Matthew Stocks, Andrew W. Blakers, The Australian National Univ. (Australia) [9572-5]

**Advances in luminescent and microtracking solar concentration (Invited Paper)**, Noel C. Giebink, The Pennsylvania State Univ. (USA) [9572-6]

Lunch Break ..... Sun 11:50 am to 1:20 pm

### SESSION 3 ..... SUN 1:20 PM TO 3:00 PM

#### Solar Concentrators and Systems II

Session Chair: Daniel Feuermann, Ben-Gurion Univ. of the Negev (Israel)

**Hybrid solar collector using nonimaging optics and photovoltaic components (Invited Paper)**, Eli Yablonovitch, Gregg Scranton, Univ. of California, Berkeley (USA); Roland Winston, Lun Jiang, Bennett K. Widjolar, Univ. of California, Merced (USA); David Cygan, Alexandr Kozlov, Gas Technology Institute (USA) [9572-7]

**Design and indoor testing of a compact optical concentrator for roof-integrated solar thermal applications**, Cheng Zheng, Qiyuan Li, Evatt Hawkes, The Univ. of New South Wales (Australia); Gary Rosengarten, RMIT Univ. (Australia); Robert A. Taylor, The Univ. of New South Wales (Australia) [9572-8]

**Self-tracking concentrator based on switchable transparency and rejected-ray recycling**, Harry N. Apostoleris, Matteo Chiesa, Masdar Institute of Science & Technology (United Arab Emirates); Marco Stefancich, National Research Council (Italy) [9572-9]

**Design of a solar collector system formed by a Fresnel lens and a CEC coupled to plastic fibers**, Perla M. Viera-Gonzalez, Guillermo E. Sánchez-Guerrero, Daniel E. Ceballos-Herrera, Romeo J. Selvas-Aguilar, Univ. Autónoma de Nuevo León (Mexico) [9572-10]

### SESSION 4 ..... SUN 3:30 PM TO 4:50 PM

#### Solar Concentrators and Systems III

Session Chair: Roland Winston, Univ. of California, Merced (USA)

**Experimental flux mapping for linear solar concentrators**, Cameron C. Stanley, Ahmad Mojiri, Gary Rosengarten, RMIT Univ. (Australia) [9572-11]

**Fundamentally new classes of aplanatic lenses (Invited Paper)**, Heylal Mashaal, Daniel Feuermann, Jeffrey M. Gordon, Ben-Gurion Univ. of the Negev (Israel) [9572-12]

**Design and optical analysis of solar dish and linear secondary concentrator for photovoltaics**, Nicholas W. Fette, Arizona State Univ. (USA); Herb Hayden, Tyler Beehey, Chao-han Lin, Southwest Solar Technology, LLC (USA); Zihan Zhang, Exa Corp. (USA) [9572-13]

## SYMPORIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

### SESSION 5 ..... MON 8:20 AM TO 10:00 AM

#### Illumination and Irradiation Optics

Session Chair: Pablo Benítez, CeDInt-UPM (Spain), Light Prescriptions Innovators LLC (United States)

**Six-primary laser-phosphor illuminator for cinema projector**, Junejei Huang, Yuchang Wang, Delta Electronics, Inc. (Taiwan) [9572-14]

**Compact etendue-preserving light-mixing optics**, Simone Sorgato, Light Prescriptions Innovators Europe, S. L. (Spain) and Vrije Univ Brussel (Belgium); Julio C. P. Chaves, Rubén Mohedano, Aleksandra Cvetkovic, Maikel Hernandez, Light Prescriptions Innovators Europe, S. L. (Spain); Fabian Duerr, Vrije Univ. Brussel (Belgium); Juan Carlos Miñano, Pablo Benítez, Light Prescriptions Innovators Europe, S. L. (USA); Hugo Thienpont, Brussels Photonics Team, Vrije Universiteit Brussel (Belgium) [9572-15]

**Illumination system design with random optimization**, Simon Magarill, William Cassarly, Synopsys, Inc. (USA) [9572-16]

**Light extraction method for mixing rods based in grooves with elliptical shape**, Guillermo E. Sánchez-Guerrero, Perla M. Viera-González, Daniel E. Ceballos-Herrera, Romeo J. Selvas-Aguilar, Univ. Autónoma de Nuevo León (Mexico) [9572-17]

**Etendue-squeezing light injector**, Julio C. Chaves, Simone Sorgato, Light Prescriptions Innovators Europe, S. L. (Spain); Pablo Benítez, Juan Carlos Miñano, Light Prescriptions Innovators, LLC (USA) and Univ. Politécnica de Madrid (Spain); Waqidi Falicoff, Light Prescriptions Innovators, LLC (USA); Ruben Mohedano, Light Prescriptions Innovators Europe, S. L. (Spain) [9572-18]

# CONFERENCE 9572

SESSION 6.....MON 10:30 AM TO 12:30 PM

## Freeform Optics

Session Chair: **William Cassarly**, Synopsys, Inc. (USA)

**Design of diffractive optical surfaces within the SMS design method (Invited Paper)**, João Mendes-Lopes, Pablo Benítez, Juan Carlos Miñano, Univ. Politécnica de Madrid (Spain) ..... [9572-19]

**Exact wavefront surface refracted by a smooth arbitrary surface considering a plane wavefront incident**, Maximino M. Avendaño-Alejo, Univ. Nacional Autónoma de México (Mexico) ..... [9572-20]

**Freeform aplanatic concentrators**, Bharathwaj Narasimhan, Pablo Benítez, Dejan Grabovickic, Juan Carlos Miñano, Univ. Politécnica de Madrid (Spain); Milena I. Nikolic, Univ. Politécnica de Madrid (Spain); Jose M. Infante Herrero, Univ. Politécnica de Madrid (Spain) ..... [9572-21]

**Freeform reflector construction by ray mapping method in modified double pole coordinate system**, Donglin Ma, Zexin Feng, Rongguang Liang, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9572-22]

**Diffraction effects in freeform optics**, Melissa N. Ricketts, Roland Winston, Univ. of California, Merced (USA); Vladimir I. Oliker, Emory Univ. (USA) ..... [9572-23]

Lunch/Exhibition Break ..... Mon 12:30 pm to 2:00 pm

## OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY PLENARY SESSION..... 2:00 PM TO 4:30 PM

Session Chair: **Oleg V. Sulima**, GE Global Research (USA)

**Status and challenges of CdTe photovoltaics (Plenary)**, Wyatt K. Metzger, National Renewable Energy Lab. (USA) ..... [9561-201]

**Photochemical upconversion of light for renewable energy and more (Plenary)**, Timothy W. Schmidt, The Univ. of New South Wales (Australia) ..... [9562-202]

**The importance of reliability to the SunShot Initiative (Plenary)**, Rebecca Jones-Albertus, U.S. Dept. of Energy (USA) ..... [9563-203]

**Solar hydrogen: harvesting light and heat from sun (Plenary)**, Liejin Guo, Xi'an Jiaotong Univ. (China) ..... [9560-204]

POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Development of daylighting systems with non-imaging concentrator**, Seoyong Shin, Myongji Univ. (Korea, Republic of) ..... [9572-24]

**Day lightening system with fibre optics using non imaging concentrator**, Shivaji B. Sadale, Pratika G. Patil, Sanskruti J. Power, Madhavi N. Nikam, Shivaji Univ. (India) ..... [9572-25]

## ILLUMINATION TECHNICAL EVENT .... 8:00 PM TO 10:00 PM

Chair: **Jake Jacobsen**, Synopsys, Inc. (USA)

Please join us for an evening of stimulating discussion.

Since we last discussed this topic five years ago, solar energy production in the US has seen substantial growth. What is the state of solar technology and what is coming down the road? Join us for evening of discussion of the current state of solar energy production and a look into the future. At the end of the planned event, time permitting, any member of the audience may present information within the broad field of illumination. Light refreshments will be served.

Light refreshments sponsored by:

The Optical Solutions Group at **SYNOPSYS®**

# CONFERENCE 9573

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Monday–Wednesday 10–12 August 2015 • Proceedings of SPIE Vol. 9573

# Optomechanical Engineering 2015

Conference Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

Program Committee: **Anees Ahmad**, Raytheon Missile Systems (USA); **Patrick A. Bourne**, MicroMeasure, Inc. (USA); **James H. Burge**, College of Optical Sciences, The Univ. of Arizona (USA); **John M. Casstevens**, Dallas Optical Systems, Inc. (USA); **Robert Gifford Chave**, RCAP Inc. (USA); **Patrick A. Coronato**, Raytheon Missile Systems (USA); **John G. Daly**, Vector Engineering (USA); **Keith B. Doyle**, MIT Lincoln Lab. (USA); **Robert C. Guyer**, BAE Systems (USA); **Mark J. Hegge**, Ball Aerospace & Technologies Corp. (USA); **Tony Hull**, Univ. of New Mexico at Albuquerque (USA); **Frank W. Kan**, Simpson Gumpertz & Heger Inc. (USA); **William Jeffrey Lees**, Johns Hopkins Univ. Applied Physics Lab. (USA); **John J. Polizotti**, BAE Systems (USA); **Santiago Royo Rojo**, Univ. Politécnica de Catalunya (Spain); **Ann F. Shipley**, Univ. of Colorado at Boulder (USA); **Deming Shu**, Argonne National Lab. (USA); **David M. Stubbs**, Lockheed Martin Space Systems Co. (USA); **Linda C. Usher**, Executive Search Group (USA); **Daniel Vukobratovich**, Raytheon Missile Systems (USA); **Paul R. Yoder Jr.**, Consultant (USA); **Carl H. Zweben**, Consultant (USA)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Analysis investigation of supporting and restraint conditions on the surface deformation of a collimator primary mirror**, Chia-Yen Chan, Instrument Technology Research Ctr. (Taiwan); Zhen-Ting You, Bo-Kai Huang, Yi-Cheng Chen, National Central Univ. (Taiwan); Ting-Ming Huang, Instrument Technology Research Ctr. (Taiwan) ..... [9573-30]

**Development of 1-m primary mirror for a spaceborne camera**, Hagyong Kihm, Korea Research Institute of Standards and Science (Korea, Republic of) ..... [9573-31]

## TUESDAY 11 AUGUST

### SESSION 1..... TUE 8:30 AM TO 10:10 AM

#### System Testing and Materials

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

**ICESat-2 ATLAS telescope testing and integration**, Tyler C. Evans, SGT, Inc. (USA) ..... [9573-1]

**In-situ mitigation of radiation-induced attenuation in optical fiber used for sensing at nuclear facilities**, Reinhold Povilaitis, Keith E. Holbert, Arizona State Univ. (USA) ..... [9573-2]

**ZERODUR®: new stress corrosion data improve strength fatigue prediction**, Peter Hartmann, SCHOTT AG (Germany); Günter Kleer, Fraunhofer-Institut für Werkstoffmechanik (Germany) ..... [9573-3]

**Aligning and measuring the curvature and thickness of high-precision lens**, Kun-Huan Wu, Sheng-Tsong Chang, Ming-Ying Hsu, Ting-Ming Huang, Wei-Yao Hsu, Shih-Feng Tseng, Instrument Technology Research Ctr. (Taiwan) ..... [9573-4]

**Effect of major factors on damage threshold of optical rectification crystals**, Qinglong Meng, Zhuolin Su, Junli Yu, Bin Zhang, Sichuan Univ. (China) ..... [9573-5]

### SESSION 2..... TUE 10:40 AM TO 12:00 PM

#### Applications of 3D Printing

Session Chair: **David M. Stubbs**, Lockheed Martin Space Systems Co. (USA)

**Optomechanical performance of 3D-printed mirrors with embedded cooling channels and substructures**, Joni Mici, Paul Zorabedian, Saatyam S. Zalawadia, David M. Stubbs, Lockheed Martin Space Systems Co. (USA) ..... [9573-6]

**Extended volume and surface scatterometer for characterization of 3D-printed optical elements**, Florian Dannenberg, Cornelius F. Hahlweg, bbw Hochschule (Germany) ..... [9573-7]

**Fabrication of light-weighted 3D-printed mirrors**, Harrison Herzog, Richard Bates, Alyssa De La Torre, Jacob Calis, Jacob Segal, Jeremy Smith, The Univ. of Arizona (USA) ..... [9573-8]

**3D-additive manufactured optical mount**, Paul V. Mammini, Lockheed Martin Space Systems Co. (USA); David Ciscek, John Wooten, CalRAM Inc. (USA) [9573-9]

Lunch/Exhibition Break ..... Tue 12:00 pm to 1:30 pm

### SESSION 3.....TUE 1:30 PM TO 2:40 PM

#### System Design

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

**Leveraging semiconductor lithography technology for projection lens applications (Invited Paper)**, Brian M. McMaster, Corning Tropel Corp. (USA) ..... [9573-10]

**An elliptically-framed tip-tilt mirror optimized for stellar tracking**, James H. Clark III, U.S. Naval Research Lab. (USA); F. Ernesto Penado, Northern Arizona Univ. (USA) ..... [9573-11]

**Contamination and UV lasers: lessons learned**, John G. Daly, Vector Engineering (USA) ..... [9573-12]

#### OPTICAL ENGINEERING PLENARY SESSION..... 4:00 PM TO 5:25 PM

Session Chair: **Craig Olson**, L-3 Communications (USA)

4:00 pm: **Welcome and Opening Remarks**

**Democratization of next-generation imaging, sensing, and diagnostics tools through computational photonics (Plenary)**, Aydogan Ozcan, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA) ..... [9579-101]

**Restocking the optical designers' toolbox for next-generation wearable displays (Plenary)**, Bernard C. Kress, Google (USA) ..... [9579-102]

#### OPTOMECHANICAL/INSTRUMENT TECHNICAL GROUP EVENT ..... 8:00 PM TO 10:00 PM

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

This is the annual meeting of the premier group of optomechanical engineers that design and analyze the world's optical instruments and systems. This gathering is open to all technical attendees of SPIE Optics+Photonics.

Anyone who wishes to put an item on the agenda should contact the Chair, Al Hatheway, at [aeh@aehinc.com](mailto:aeh@aehinc.com). The featured speaker is Jacob Egan of Northrop Grumman Electronic Systems. His talk will be "Opto-Mechanical Ground Testing of Space-Based Optical Systems." Following the featured speaker, the floor will be open for other agenda items and a workshop session on Problems and Solutions. Come prepared to present some challenges to the Group.

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## WEDNESDAY 12 AUGUST

### SESSION 4..... WED 8:05 AM TO 8:50 AM

#### Optical Product Readiness

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

**Criteria to asses production readiness of complex optical systems (Keynote Presentation)**, Anees Ahmad, Raytheon Missile Systems (USA) . . . . . [9573-13]

### SESSION 5..... WED 8:50 AM TO 10:10 AM

#### Low Cost Space Optics

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

**Cost-optimized methods extending the solution space of lightweight spaceborne monolithic ZERODUR® mirrors to larger sizes**, Antoine Leys, SCHOTT AG (Germany); Tony B. Hull, The Univ. of New Mexico (USA); Thomas Westerhoff, SCHOTT AG (Germany) . . . . . [9573-14]

**Selection considerations between ZERODUR and silicon carbide for dimensionally-stable spaceborne optical telescopes in low-earth-orbit**, Tony B. Hull, The Univ. of New Mexico (USA); Antoine Leys, Thomas Westerhoff, SCHOTT AG (Germany) . . . . . [9573-15]

**Evolving design criteria for very large aperture space-based telescopes and their influence on the need for intergrated tools in the optimization process**, William R. Arnold Sr., NASA Marshall Space Flight Ctr. (USA) . . . . . [9573-16]

**Recent updates to the Arnold Mirror Modeler and integration into the evolving NASA overall design system for large space-based optical systems**, William R. Arnold Sr., NASA Marshall Space Flight Ctr. (USA) . . . . . [9573-17]

### SESSION 6..... WED 10:40 AM TO 12:00 PM

#### Optomechanical Analysis

Session Chair: **Anees Ahmad**, Raytheon Missile Systems (USA)

**Novel applications of active mirror analysis**, Victor L. Genberg, Gregory J. Michels, Sigmadyne, Inc. (USA) . . . . . [9573-18]

**Shear stresses in cemented and bonded optics due to temperature changes**, Paul R. Yoder Jr., Consultant (USA); Daniel Vukobratovich, Raytheon Missile Systems (USA) . . . . . [9573-19]

**Tracing structural deficiencies in optomechanical designs: unified optomechanical modeling**, Alson E. Hatheway, Alson E. Hatheway Inc. (USA) . . . . . [9573-20]

**Dyson type lithography lens light source heat absorption analysis**, Ming-Ying Hsu, Instrument Technology Research Ctr. (Taiwan) . . . . . [9573-21]

Lunch/Exhibition Break . . . . . Wed 12:00 pm to 1:30 pm

### SESSION 7..... WED 1:30 PM TO 3:20 PM

#### Optical Element Fabrication

Session Chair: **Mark J. Hegge**, Ball Aerospace & Technologies Corp. (USA)

**Glass properties and statistical outcomes from lens manufacturing data (Invited Paper)**, Morris I. Kaufman, National Security Technologies, LLC (USA); Brandon B. Light, Optimax Systems, Inc. (USA); Robert M. Malone, National Security Technologies, LLC (USA); Michael K. Gregory, Optimax Systems, Inc. (USA) . . . . . [9573-22]

**Dependency between removal characteristics and defined measurement categories of pellet-tools**, Christian Vogt, Rolf Rascher, Christine Wuensche, Martin Rohrbacher, Hochschule Deggendorf (Germany) . . . . . [9573-23]

**Q-switched 1064nm laser source for photomechanical ablation in obsidianus lapis**, Alfredo I. Aguilar-Morales, José Alfredo Alvarez-Chávez, Ctr. de Investigación e Innovación Tecnológica (Mexico); Moises A. Ortega Delgado, Michael Panzner, Fraunhofer IWS Dresden (Germany) . . . . . [9573-24]

**The aspherical plastic lens molding stress residue and OPD analysis**, Ming-Ying Hsu, Instrument Technology Research Ctr. (Taiwan) . . . . . [9573-25]

**A high-contrast 400- to 2500-nm hyperspectral checkerboard consisting of Acktar material cut with a femtosecond laser**, Janos C. Keresztes, KU Leuven (Belgium); Anne Henrotin, Laser Engineering Applications S.A. (Belgium); Mohammad Goodarzi, Niels Wouters, Jeroen Van Roy, Wouter Saeyns, KU Leuven (Belgium) . . . . . [9573-26]

### SESSION 8..... WED 3:50 PM TO 4:50 PM

#### Component Mounting

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

**Unit moment analysis as a guide to mirror mount design**, Daniel Vukobratovich, Patrick A. Coronato, Raytheon Missile Systems (USA) . . . . . [9573-27]

**Mechanical design of a precision linear flexural stage for 3D x-ray diffraction microscope at the Advanced Photon Source**, Deming Shu, Wenjun Liu, Argonne National Lab. (USA); Steven Kearney, Argonne National Lab. (USA) and Univ. of Illinois at Chicago (USA); Jonathan Z. Tischler, Argonne National Lab. (USA) . . . . . [9573-28]

**Pre-construction of giant steerable science mirror for TMT**, Fei Yang, Changchun Institute of Optics, Fine Mechanics and Physics (China) . . . . . [9573-29]

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# Material Technologies and Applications to Optics, Structures, Components, and Sub-Systems II

Conference Chairs: **Matthias Krödel**, ECM GmbH (Germany); **Joseph L. Robichaud**, L-3 Communications IOS-SSG (USA); **William A. Goodman**, Trex Enterprises Corp. (USA)

Program Committee: **Shyam S. Bayya**, U.S. Naval Research Lab. (USA); **A. Marcel Bluth**, ATK Aerospace Structures (USA); **Nathan Carlie**, SCHOTT North America, Inc. (USA); **Vince M. Cowan**, Air Force Research Lab. (USA); **Hans-Peter Dumm**, Air Force Research Lab. (USA); **Richard A. Haber**, Rutgers, The State Univ. of New Jersey (USA); **Haeng Bok Lee**, Agency for Defense Development (Korea, Republic of); **Robert Michel**, Materion Brush Beryllium & Composites (USA); **Ted Mooney**, ITT Exelis (USA); **Takao Nakagawa**, Japan Aerospace Exploration Agency (Japan); **Tsuyoshi Ozaki**, Composites Research and Development Co., Ltd. (Japan); **John W. Pepi**, L-3 Communications SSG-Tinsley (USA); **Margie F. Pinnell**, Univ. of Dayton (USA); **Stefan Risse**, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); **Michael N. Sweeney**, General Dynamics-Global Imaging Technologies (USA); **David B. Witkin**, The Aerospace Corp. (USA)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

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**Numerically modeling diffraction efficiency of holographic volume grating formatted in photopolymer materials**, Haoyu Li, Yue Qi, Ra'ed Malallah, John T. Sheridan, Univ. College Dublin (Ireland) ..... [9574-25]

**White-emitting SrAlO<sub>4</sub>:Ce<sup>3+</sup> phosphor for solid-state lighting**, Luis Armando Díaz-Torres, Ctr. de Investigaciones en Óptica, A.C. (Mexico); David A. Chavez, Carlos R. García, María T. Romero, Univ. Autónoma de Coahuila (Mexico); Jorge Oliva, Ctr. de Investigaciones Ópticas (Mexico) ..... [9574-26]

**Low-voltage autofocus device with microlens arrays based on ionic polymer metal composite**, Yi Wei Zhang, Guo-Dung J. Su, National Taiwan Univ. (Taiwan) ..... [9574-27]

## TUESDAY 11 AUGUST

### OPTICAL ENGINEERING

#### PLENARY SESSION..... 4:00 PM TO 5:25 PM

Session Chair: **Craig Olson**, L-3 Communications (USA)

4:00 pm: **Welcome and Opening Remarks**

**Democratization of next-generation imaging, sensing, and diagnostics tools through computational photonics (Plenary)**, Aydogan Ozcan, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA) ..... [9579-101]

**Restocking the optical designers' toolbox for next-generation wearable displays (Plenary)**, Bernard C. Kress, Google (USA) ..... [9579-102]

### OPTOMECHANICAL/INSTRUMENT

#### TECHNICAL GROUP EVENT ..... 8:00 PM TO 10:00 PM

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

This is the annual meeting of the premier group of optomechanical engineers that design and analyze the world's optical instruments and systems. This gathering is open to all technical attendees of SPIE Optics+Photonics. Anyone who wishes to put an item on the agenda should contact the Chair, Al Hatheway, at [aeh@ahinc.com](mailto:aeh@ahinc.com). The featured speaker is Jacob Egan of Northrop Grumman Electronic Systems. His talk will be "Opto-Mechanical Ground Testing of Space-Based Optical Systems." Following the featured speaker, the floor will be open for other agenda items and a workshop session on Problems and Solutions. Come prepared to present some challenges to the Group.

## WEDNESDAY 12 AUGUST

### SESSION 1..... WED 1:30 PM TO 3:10 PM

#### Metal Materials I

Session Chair: **Robert Michel**, Materion Brush Beryllium & Composites (USA)

**Design and manufacturing considerations for 0.25-1.5 meter beryllium telescopes for current and future space missions**, Mike N. Sweeney, Mark R. Warren, Joseph Ho, Jeff Calvert, Jeff Ruzan, General Dynamics Corp. (USA) ..... [9574-1]

**New decade of shaped beryllium blanks**, Don Hashiguchi, Jeffrey Campbell, Materion Brush Beryllium & Composites (USA); Aaron Sayer, Amanda Morales, Materion Corp. (USA) ..... [9574-2]

**Design and manufacturing considerations for high-performance gimbals used for land, sea, air, and space**, Mike N. Sweeney, Lafe Redd, Tom Vettese, David Uchida, General Dynamics Corp. (USA) ..... [9574-3]

**Fabrication of stable lightweight Be-38Al optics and optical support structures**, Robert Hardesty, Kelsey Parker, Peregrine Falcon Corp. (USA) [9574-4]

**Application and testing of additive manufacturing for mirrors and precision structures**, Mike N. Sweeney, Martyn Acreman, Tom Vettese, Ray Myatt, General Dynamics Corp. (USA); Mike Thompson, General Dynamics Corp3 (USA) ..... [9574-5]

### SESSION 2..... WED 3:40 PM TO 4:40 PM

#### Metal Materials II

Session Chair: **Robert Michel**, Materion Brush Beryllium & Composites (USA)

**Structured surfaces on metal optics**, Ralf Steinkopf, Johannes Hartung, Andreas Gebhardt, Stefan Risse, Ramona Eberhardt, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) ..... [9574-6]

**Physical and mechanical properties of LoVAR: a new lightweight particle-reinforced Fe-36Ni alloy**, Robert Michel, Materion Brush Beryllium & Composites (USA); Andrew Tarrant, Materion Aerospace Metal Composites Ltd. (United Kingdom); Jason R. Clune, Materion Brush Beryllium & Composites (USA); David Tricker, Materion Aerospace Metal Composites Ltd. (United Kingdom); Tim A. Stephenson, NASA Goddard Space Flight Ctr. (USA) ..... [9574-7]

**Advanced thermal control for spacecraft applications**, Robert Hardesty, Kelsey Parker, Peregrine Falcon Corp. (USA) ..... [9574-8]

# CONFERENCE 9574

SESSION 3 ..... WED 4:40 PM TO 5:40 PM

## Ceramic Materials I

Session Chair: Joseph L. Robichaud, L-3 Communications IOS-SSG  
(USA)

- New polishable R-SiC layer on ultra-lightweighted SiC substrates**, Eric Ruch, REOSC (France) ..... [9574-9]  
**RAP paper**, Flemming Tinker, Aperture Optical Sciences Inc. (USA). .... [9574-10]  
**Low-stress silicon cladding made by pulsed-ion-assisted evaporation**, David A. Sheikh, ZeCoat Corp. (USA) ..... [9574-11]

## THURSDAY 13 AUGUST

SESSION 4 ..... THU 8:30 AM TO 10:00 AM

## Ceramic Materials II

Session Chair: William A. Goodman, Trex Enterprises Corp. (USA)

- Trade-off study of all-SiC lightweight primary mirror and metering structure for spaceborne telescope (Invited Paper)**, Haeng Bok Lee, Agency for Defense Development (Korea, Republic of); Jinyoung SUK, Chungnam National Univ. (Korea, Republic of) ..... [9574-12]  
**T300HoneySiC: a new near-zero CTE molded C/SiC material**, William A. Goodman, Trex Enterprises Corp. (USA) ..... [9574-13]  
**Fabrication of extreme light-weighted ceramic mirrors**, Matthias Krödel, ECM Engineered Ceramic Materials GmbH (Germany); Daniel Waechter, Fraunhofer-Institut für Produktionstechnologie (Germany); Frank Stahr, FAP Plasmatechnik GmbH (Germany); Claus-Peter Soose, fineoptix GmbH (Germany) ..... [9574-14]  
**Extreme stable and complex structures for optomechanical application**, Matthias Krödel, ECM Engineered Ceramic Materials GmbH (Germany). . [9574-15]

SESSION 5 ..... THU 10:30 AM TO 12:40 PM

## Glass Materials

Session Chair: Ted Mooney, Exelis Inc. (USA)

- GRIN and homogeneous infrared materials for compact broadband IR imagers (Invited Paper)**, Daniel J. Gibson, Shyam Bayya, Vinh Q. Nguyen, Jasbinder S. Sanghera, U.S. Naval Research Lab. (USA); Mikhail Kotov, Sotera Defense Solutions, Inc. (USA); Gryphon Drake, Univ. Research Foundation (USA) . [9574-16]  
**Homogeneity of material and optical properties in HEM grown sapphire**, Melissa Stout, Douglas L. Hibbard, II-VI Optical Systems (USA) ..... [9574-17]  
**Strength of Zerodur(R) for mirror applications**, Stephanie Behar-Lafenetre, Thales Alenia Space (France) ..... [9574-18]  
**Low-temperature GRISM direct bonding**, Gerhard Kalkowski, Gerd Harnisch, André L. Matthes, Uwe D. Zeitner, Stefan Risse, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) ..... [9574-19]  
**Polymers with customizable optical and rheological properties based on an epoxy acrylate-based host-guest system**, Uwe Gleissner, Thomas Hanemann, Jost Hobmaier, Univ. of Freiburg (Germany) . . [9574-20]  
**Low-strain laser-based solder joining of mounted lenses**, Thomas Burkhardt, Marcel Hornaff, Andreas Kamm, Diana Burkhardt, Erik Schmidt, Erik Beckert, Ramona Eberhardt, Andreas Tünnermann, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) ..... [9574-21]

SESSION 6 ..... THU 2:00 PM TO 3:10 PM

## Innovative Metrology Concepts

Session Chair: Matthias Krödel, ECM Engineered Ceramic Materials GmbH (Germany)

- State-of-the-art cryogenic CTE measurements of ultra-low thermal expansion materials (Invited Paper)**, Thomas Middelmann, Alexander Walkov, René Schödel, Physikalisch-Technische Bundesanstalt (Germany) ..... [9574-22]  
**Next-generation dilatometer for highest accuracy thermal expansion measurement of ZERODUR(R)**, Raif Jedamzik, Axel Engel, Clemens Kunisch, Gerhard Westenberger, Peter Fischer, Thomas Westerhoff, SCHOTT AG (Germany) ..... [9574-23]  
**Measurement of an optical surface roughness by of optical gradient waveguide method**, Nikolai D. Espinosa, Univ. de las Fuerzas Armadas (Ecuador) ..... [9574-24]

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## Optical Manufacturing and Testing XI

Conference Chairs: **Oliver W. Fähnle**, FISBA OPTIK AG (Switzerland); **Ray Williamson**, Ray Williamson Consulting (USA); **Dae Wook Kim**, College of Optical Sciences, The Univ. of Arizona (USA); **Olaf Dambon**

Program Committee: **Haobo Cheng**, Tsinghua Univ. (China); **Olaf Dambon**, Fraunhofer-Institut für Produktionstechnologie (Germany); **Peter J. de Groot**, Zyg Corporation (USA); **Jessica E. DeGroote Nelson**, Optimax Systems, Inc. (USA); **Richard R. Freeman**, Zeeko Ltd. (United Kingdom); **Roland Geyl**, Sagem Défense Sécurité (France); **John E. Greivenkamp**, College of Optical Sciences, The Univ. of Arizona (USA); **Steve E. Kendrick**, Ball Aerospace & Technologies Corp. (USA); **Sugwhan Kim**, Yonsei Univ. (Korea, Republic of); **Sven R. Kiontke**, asphericon GmbH (Germany); **Cody B. Kreischer**, Kreischer Optics, Ltd. (USA); **Gary W. Matthews**, Exelis Visual Information Solutions (USA); **Robert E. Parks**, Optical Perspectives Group, LLC (USA); **Rolf Rascher**, Hochschule Deggendorf (Germany); **Joseph L. Robichaud**, L-3 Communications SSG-Tinsley (USA); **Joanna Schmit**, Bruker Corp. (USA); **Sven Schröder**, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); **Shai N. Shafir**, Corning Incorporated (USA); **Tayyab I. Suratwala**, Lawrence Livermore National Lab. (USA); **Flemming Tinker**, Aperture Optical Sciences Inc. (USA); **Martin J. Valente**, College of Optical Sciences, The Univ. of Arizona (USA); **David D. Walker**, Zeeko Research Ltd. (United Kingdom); **Konrad Wegener**, ETH Zürich (Switzerland); **Christine Wünsche**, Hochschule Deggendorf (Germany); **Takashi Yatsui**, The Univ. of Tokyo (Japan); **Xue-jun Zhang**, Changchun Institute of Optics, Fine Mechanics and Physics (China)

### SUNDAY 9 AUGUST

SESSION 1 ..... SUN 1:50 PM TO 3:10 PM

#### Optical Systems I

Session Chair: **Dae Wook Kim**, College of Optical Sciences, The Univ. of Arizona (USA)

**Examination of the quality of 120 degree silicon double mirror for a micro-optical laser gyroscope**, Thalke Niesel, Ingmar Leber, Andreas H. Dietzel, Technische Univ. Braunschweig (Germany) ..... [9575-1]

**INAF-OAB deflectometry facility calibration**, Giorgia Sironi, Rodolfo Canestrari, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9575-2]

**JWST pathfinder telescope optical alignment, integration, and test program**, Gary W. Matthews, Scott Kennard, Ronald Broccolo, John Amon, Stephen Mt.Pleasant, James Ellis, Walter Hahn, Exelis Inc. (USA); Lee D. Feinberg, NASA Goddard Space Flight Ctr. (USA) ..... [9575-3]

**JWST pathfinder telescope risk reduction cryo test program**, Gary W. Matthews, Thomas R. Scorse, John Spina, Exelis Inc. (USA); Ritva A. Keski-Kuha, Juli A. Lander, Mark F. Voyton, Lee D. Feinberg, NASA Goddard Space Flight Ctr. (USA); Carl A. Reis, NASA Johnson Space Ctr. (USA); Tony L. Whitman, Exelis Inc. (USA) ..... [9575-4]

SESSION 2 ..... SUN 3:40 PM TO 5:00 PM

#### Optical Systems II

Session Chair: **Robert E. Parks**, Optical Perspectives Group, LLC (USA)

**Optomechanical design and tolerance of a microscope objective at 121.6 nm**, Derek S. Keyes, Thiago S. Jota, Dakota Luepke, Thomas D. Milster, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9575-5]

**Thermal optical metrology development for large lightweight UV to IR mirrors and future space observatory missions**, Ron Eng, Markus A. Baker, William D. Hogue, Jeffrey R. Kegley, Richard D. Siler, H. Philip Stahl, John M. Tucker, Ernest R. Wright, NASA Marshall Space Flight Ctr. (USA) ..... [9575-6]

**Metrology requirements for the serial production of ELT primary mirror segments**, Paul C. T. Rees, Caroline Gray, Glyndwr Univ. (United Kingdom) [9575-7]

**Functionalization of UV-curing adhesives for surface-integrated single-mode polymer optical fibers**, Bechir M. Hachicha, Ludger Overmeyer, Leibniz Univ. Hannover (Germany) ..... [9575-9]

### SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

### MONDAY 10 AUGUST

SESSION 3 ..... MON 8:00 AM TO 10:00 AM

#### Optical Manufacturing I

Session Chair: **Oliver W. Fähnle**, FISBA OPTIK AG (Switzerland)

**Surface roughness when diamond turning RSA 905 optical aluminium**, Timothy Otieno, Khaled Abou-El-Hossein, Nelson Mandela Metropolitan Univ. (South Africa); Wei-Yao Hsu, Yuan -Chieh Cheng, Instrument Technology Research Ctr. (Taiwan); Zwelinzima Mkoko, Nelson Mandela Metropolitan Univ. (South Africa) ..... [9575-10]

**Aspects of ultra-high-precision diamond machining of RSA443 optical aluminium**, Zwelinzima Mkoko, Khaled Abou-El-Hossein, Nelson Mandela Metropolitan Univ. (South Africa) ..... [9575-11]

**The role of robotics in computer-controlled polishing of large and small optics**, David D. Walker, Zeeko Research Ltd. (United Kingdom) and Univ. College London (United Kingdom) and Glyndwr Univ. (United Kingdom); Matthew Bibby, Zeeko Research Ltd. (United Kingdom); Guoyu Yu, Caroline Gray, Paul C. T. Rees, Glyndwr Univ. (United Kingdom); Hsing Yu Wu, Univ. College London (United Kingdom); Xiao Zheng, Peng Zhang, Glyndwr Univ. (United Kingdom); Christina R. Dunn, Univ. College London (United Kingdom) ..... [9575-12]

**Evaluation and control of spatial frequency errors in reflective telescopes**, Xue-jun Zhang, Li-gong Zheng, Xuefeng Zeng, Changchun Institute of Optics, Fine Mechanics and Physics (China) ..... [9575-13]

**Correction of mid-spatial-frequency errors by smoothing in spin motion for CCOS**, Yizhong Zhang, Chaoyang Wei, Jianda Shao, Xueke Xu, Shijie Liu, Chen Hu, Haichao Zhang, Haojin Gu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9575-57]

**Combined fabrication technique for ultra-precision optical surfaces**, Wenlin Liao, Yifan Dai, Feng Shi, Guilin Wang, National Univ. of Defense Technology (China) ..... [9575-14]

SESSION 4 ..... MON 10:30 AM TO 12:10 PM

#### Optical Manufacturing II

Session Chair: **Jessica DeGroote Nelson**, Optimax Systems, Inc. (USA)

**Spectral characteristics and control of machining errors of KDP optical elements in ultra-precision turning**, Guilin Wang, Feng Shi, Shengyi Li, Wenlin Liao, Furen Li, National Univ. of Defense Technology (China) ..... [9575-15]

**Monolithical freeform element**, Sven R. Kiontke, asphericon GmbH (Germany) ..... [9575-16]

**The fabrication of freeform optics**, Todd Blalock, Kate Medicus, Jessica D. Nelson, Optimax Systems, Inc. (USA) ..... [9575-17]

**Ion beam figuring technique used as final step in the manufacturing of the mirror segments for the EELT**, Mauro Ghigo, Gabriele Vecchi, Stefano Basso, Roberto Citterio, Marta Civitani, Enrico G. Mattaini, Giovanni Pareschi, Giorgia Sironi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9575-18]

**Ion beam figuring of glass moulds for the integration of x-ray optics**, Mauro Ghigo, Gabriele Valsecchi, Stefano Basso, Marta Civitani, Enrico G. Mattaini, Giovanni Pareschi, Giorgia Sironi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9575-19]

Lunch Break ..... Mon 12:10 pm to 1:20 pm

# CONFERENCE 9575

SESSION 5..... MON 1:20 PM TO 3:20 PM

## Optical Manufacturing III

Session Chair: **Martin J. Valente**, Arizona Optical Systems, LLC (USA)

**Development of practical Ge immersion grating**, Takashi Sukegawa, Takeshi Suzuki, Yukinobu Okura, Yukiya Enokida, Masatsugu Koyama, Canon Inc. (Japan)..... [9575-20]

**Status of the Advanced Mirror Technology Development (AMTD) phase 2 1.5m ULE mirror**, Robert M. Egerman, Gary W. Matthews, Albert J. Ferland, Matthew Johnson, Exelis Inc. (USA) .....

**Improving profitability through slurry management: A look at the impact of slurry pH on various glass types**, Abigail R. Hooper, Harry W. Sarkas, Nathan Hoffmann, Kevin Cureton, Nanophase Technologies Corp. (USA)..... [9575-22]

**Material removal characteristics of orthogonal velocity polishing tool for efficient fabrication of CVD SiC mirror surfaces**, Hyunju Seo, Yonsei Univ. (Korea, Republic of) and Korea Astronomy and Space Science Institute (Korea, Republic of); Jeong-Yeol Han, Korea Astronomy and Space Science Institute (Korea, Republic of); Sug-Whan Kim, Yonsei Univ. (Korea, Republic of); Sehyun Seong, SphereDyne Co., Ltd. (Korea, Republic of) and Yonsei Univ. (Korea, Republic of); Siyoung Yoon, Kyungmook Lee, Samsung Thales Co., Ltd. (Korea, Republic of); Haengbok Lee, Agency for Defense Development (Korea, Republic of) .....

**Surface errors in the course of machining precision optics**, Rolf Rascher, Christine Wuensche, Heiko Biskup, Alexander Haberl, Hochschule Deggendorf Technologiecampus Teisnach (Germany) .....

**The effect of HF etching on the surface quality and figure of fused silica optics**, Jiafeng Xu, Xueke Xu, Chaoyang Wei, Wenlan Gao, Minghong Yang, Jianda Shao, Shijie Liu, Shanghai Institute of Optics and Fine Mechanics (China) [9575-59]

SESSION 6..... MON 3:50 PM TO 5:50 PM

## Optical Manufacturing IV

Session Chair: **David D. Walker**, Zeeko Research Ltd. (United Kingdom)

**Influence of different rigid tool groove in polishing process**, Kai Meng, Institute of Optics and Electronics (China) .....

**The effect of the pad groove feature on the material removal rate and mid-spatial frequency error in CCOS**, Jianwei Ji, Chaoyang Wei, Shijie Liu, Xueke Xu, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China) .....

**Using frictional power to model LSST removal with conventional abrasives**, Richard G. Allen, William H. Hubler, The Univ. of Arizona (USA) .....

**Influence of coolant on ductile mode processing of binderless nanocrystalline tungsten carbide through ultraprecision diamond turning**, Marius Doetz, Fritz Klocke, Olaf Dambon, Fraunhofer-Institut für Produktionstechnologie (Germany); Oliver W. Fähnle, FISBA OPTIK AG (Switzerland) .....

**Influence of temperature distribution in the workpiece-lap interface on surface figure controlling during continuous polishing**, Meijuan Hong, Xueke Xu, Minghong Yang, Chaoyang Wei, Shijie Liu, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China) .....

**Optimizing computer control ball polishing of spherical surfaces**, Rasool Koosha, Peiman Mosaddegh, Hosein Hashemi, Isfahan Univ. of Technology (Iran, Islamic Republic of) .....

POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

## Posters-Monday

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Investigation of rapidly-solidified aluminum with diamond turning and magnetorheological finishing (MRF) process**, Yuan-Chieh Cheng, Wei-Yao Hsu, Ching-Hsiang Kuo, Instrument Technology Research Ctr. (Taiwan); Khaled Abou-El-Hossein, Timothy Otieno, Nelson Mandela Metropolitan Univ. (South Africa) .....

**Optical diffraction interpretation: an alternative to interferometers**, Stephane Bouillet, Commissariat à l'Énergie Atomique (France) .....

**Effect of aging on photoelectrical properties of AlInGaP LEDs**, Donatas Meškauskas, Laurynas Dabašinskas, Arturas Žukauskas, Vilnius Univ. (Lithuania) .....

**Noninvasive method for determination of parameters of cemented doublet**, Jiří Novák, Pavel Novák, Antonín Mikš, Petr Pokorný, Czech Technical Univ. in Prague (Czech Republic) .....

**Measuring skew in average surface roughness as a function of surface preparation**, Mark T Stahl, NASA (USA) .....

**Detection of subsurface defects and measurement of thickness of screen layers made of graphene and carbon nanotubes with application of full-field optical coherence tomography in Linnik configuration**, Paulina Mlynarska, Sławomir Tomczewski, Anna Pakula, Grzegorz Wróblewski, Marcin Sioma, Leszek Salbut, Warsaw Univ. of Technology (Poland) .....

**Subsurface damage characterization with nonlinear high-numerical microscopy**, Phat Lu, Thomas D. Milster, The Univ. of Arizona (USA) .....

**Comparison of experimental and simulation results of pupil plane polarization effects in a 1.6 numerical aperture solid immersion lens microscope from surface and subsurface damage**, Victor E. Densmore, Phat Lu, Young-Sik Kim, The Univ. of Arizona (USA); Geon-Hee Kim, Korea Basic Science Institute (Korea, Republic of); Thomas D. Milster, The Univ. of Arizona (USA) .....

**Designing null phase screens to test a fast plano-convex aspheric lens**, Jesús DelOlmo-Márquez, Diana N. Castán-Ricáñ, Maximino M. Avendaño-Alejo, Jose Rufino Díaz-Uribé, Univ. Nacional Autónoma de México (Mexico) .....

**Null screens type Hartmann to test simple lenses**, Alfredo Gozález-Galindo, Gabriel Castillo-Santiago, Maximino M. Avendaño-Alejo, Jose Rufino Díaz-Uribé, Univ. Nacional Autónoma de México (Mexico) .....

**Fringe projection method to evaluate the quality of the shape of a parabolic solar collector**, Agustín Santiago-Alvarado, Univ. Tecnológica de la Mixteca (Mexico); Eduardo Torres Moreno, Víctor I. Moreno-Olivá, Univ. del Istmo (Mexico); Moisés E. Ramírez Guzmán, Univ. Tecnológica de la Mixteca (Mexico); Cuauhtémoc H. Castañeda Roldán, Univ. Tecnológica de la Mixteca (Mexico); Ángel S. Cruz-Félix, Univ. Tecnológica de la Mixteca (Mexico) .....

**Estimation of optimal parameters of material removal by milling to minimize the surface roughness**, Agustín Santiago-Alvarado, Univ. Tecnológica de la Mixteca (Mexico); Orquídea Sánchez López, Univ. Tecnológica de la Mixteca (Mexico); Ignacio Hernández Castillo, Univ. Tecnológica de la Mixteca (Mexico); Cuauhtémoc H. Castañeda Roldán, Ángel S. Cruz-Félix, Univ. Tecnológica de la Mixteca (Mexico) .....

# CONFERENCE 9575

TUESDAY 11 AUGUST

SESSION 7..... TUE 8:30 AM TO 10:10 AM

## Optical Testing I

Session Chair: **Ray Williamson**, Ray Williamson Consulting (USA)

**Measuring the tilt and decenter of bi-aspHERIC lenses**, Scott DeFisher, Mitchell Sedore, David E. Mohring, OptiPro Systems (USA) ..... [9575-30]

**Bamboo book stitching interferometer**, Po-Chih Lin, Chao-Wen Liang, Yi-Chun Chen, Hung-Sheng Chang, Jia-Wei Chen, National Central Univ. (Taiwan) [9575-31]

**Subaperture stitching surface errors due to noise in a circular subaperture ring**, Greg A. Smith, James H. Burge, The Univ. of Arizona (USA) ..... [9575-32]

**An iterative subaperture position correction algorithm**, Weng-Hou Lo, Po-Chih Lin, Yi-Chun Chen, National Central Univ. (Taiwan) ..... [9575-33]

**Wavefront analysis of a large sic mirror of 700 mm in diameter due to the surface figure error**, Jinsuk Hong, Samsung Thales Co., Ltd. (Korea, Republic of) ..... [9575-38]

SESSION 8..... TUE 10:40 AM TO 12:00 PM

## Optical Testing II

Session Chair: **Xue-jun Zhang**, Changchun Institute of Optics, Fine Mechanics and Physics (China)

**Direct light scattering characterization of optical components**, Sven Schröder, Alexander von Finck, Angela Duparré, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) ..... [9575-34]

**Roughness, homogeneity, and defect characterization using light scattering techniques**, Sven Schröder, Marcus Trost, Tobias Herfurth, Angela Duparré, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) ..... [9575-35]

**Measuring and quantifying scatter from non-isotropic sources**, John C. Stover, The Scatter Works Inc. (USA) ..... [9575-36]

**Fabrication and qualification of roughness reference samples for industrial testing of surface roughness levels below 0.5 nm Sq**, Oliver W. Fähnle, Eckhard Langenbach, Frank Zygalsky, FISBA OPTIK AG (Switzerland); Frank Frost, Renate Fechner, Axel Schindler, Leibniz-Institut für Oberflächenmodifizierung e.V. (Germany); Matthias Cumme, Carl Zeiss Jena GmbH (Germany); Christine Wuensche, Heiko Biskup, Rolf Rascher, Technische Hochschule Deggendorf (Germany) ..... [9575-37]

Lunch/Exhibition Break ..... Tue 12:00 pm to 1:30 pm

SESSION 9..... TUE 1:30 PM TO 3:30 PM

## Optical Testing III

Session Chair: **Sven Schröder**, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany)

**Integrated Ray Tracing (IRT) simulation of SCOTS measurement of GMT fast steering mirror surface**, Ji Nyeong Choi, Yonsei Univ (Korea, Republic of); Dongok Ryu, Sug-Whan Kim, Yonsei Univ. (Korea, Republic of); Dae Wook Kim, Peng Su, Run Huang, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9575-39]

**Oil defect detection of electrowetting display**, Hou-Chi Chiang, National Chiao Tung Univ. (Taiwan); Yu-Hsiang Tsai, Industrial Technology Research Institute (Taiwan); Yung-Jhe Yan, Ting-Wei Huang, Ou-Yang Mang, National Chiao Tung Univ. (Taiwan) ..... [9575-40]

**Deflectometry measurement of Daniel K. Inouye Solar Telescope primary mirror**, Run Huang, Peng Su, James H. Burge, The Univ. of Arizona (USA) [9575-41]

**The use of diffractive imitator optics as calibration artefacts**, Paul C. T. Rees, John B. Mitchell, Glyndwr Univ. (United Kingdom); Andy Volkov, Nanomobile Ltd. (United Kingdom); Jean-Michel Asfour, Frank Weidner, Dioptic GmbH (Germany); Alexander G. Poleschuk, Ruslan K. Nasirov, Institute of Automation and Electrometry (Russian Federation) ..... [9575-42]

**Local frequency estimation from intensity gradients in spatial carrier fringe pattern analysis**, Ruihua Zhang, Hongwei Guo, Shanghai Univ. (China) .. [9575-43]

**Triple-wavelength phase unwrapping for dispersive objects**, Behnam Tayebi, Yonsei Univ. (Korea, Republic of) ..... [9575-44]

## OPTICAL ENGINEERING

### PLENARY SESSION..... 4:00 PM TO 5:25 PM

Session Chair: **Craig Olson**, L-3 Communications (USA)

4:00 pm: Welcome and Opening Remarks

**Democratization of next-generation imaging, sensing, and diagnostics tools through computational photonics (Plenary)**, Aydogan Ozcan, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA) ..... [9579-101]

**Restocking the optical designers' toolbox for next-generation wearable displays (Plenary)**, Bernard C. Kress, Google (USA) ..... [9579-102]

## OPTOMECHANICAL/INSTRUMENT

### TECHNICAL GROUP EVENT ..... 8:00 PM TO 10:00 PM

Session Chair: **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA)

This is the annual meeting of the premier group of optomechanical engineers that design and analyze the world's optical instruments and systems. This gathering is open to all technical attendees of SPIE Optics+Photonics. Anyone who wishes to put an item on the agenda should contact the Chair, Al Hatheway, at aeh@aeihinc.com. The featured speaker is Jacob Egan of Northrop Grumman Electronic Systems. His talk will be "Opto-Mechanical Ground Testing of Space-Based Optical Systems." Following the featured speaker, the floor will be open for other agenda items and a workshop session on Problems and Solutions. Come prepared to present some challenges to the Group.

Monday-Wednesday 10-12 August 2015 • Proceedings of SPIE Vol. 9576

# Applied Advanced Optical Metrology Solutions

Conference Chairs: Erik Novak, 4D Technology Corp. (USA); James D. Trolinger, MetroLaser, Inc. (USA)

Program Committee: Anand Krishna Asundi, Nanyang Technological Univ. (Singapore); Jan Burke, Bremer Institut für angewandte Strahltechnik GmbH (Germany); Claas Falldorf, Bremer Institut für angewandte Strahltechnik GmbH (Germany); Sen Han, Univ. of Shanghai for Science and Technology (China); Kevin G. Harding, GE Global Research (USA); Kate Medicus, Optimax Systems, Inc. (USA); Matthew J. Novak, Bruker AXS, Inc. (USA); Wolfgang Osten, Institut für Technische Optik (Germany); Peter Roos, Bridger Photonics, Inc. (USA); Robert A. Smythe, R.A.Smythe Management Consultants (USA); Joe Wehrmeyer, Arnold Engineering Development Ctr. (USA)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Study of high-contrast mark used for imprint lithography alignment**, Liang Wang, Li Ding, Jin Qin, Univ. of Science and Technology of China (China) [9576-23]

**New method to achieve full-field object measurement using a movable binocular vision system**, Feifei Gu, Chunwei Zhang, Xi'an Jiaotong Univ. (China) .....

**Rapid three-dimensional chromoscan system of body surface based on digital fringe projection**, Bin Wei, Jin Liang, Xi'an Jiaotong Univ. (China); Jie Li, Shijiazhuang Information Engineering Vocational College (China); Maodong Ren, Xi'an Jiaotong Univ. (China) .....

**Two-detector digital holographic smart camera for holographic imaging and digital holographic interferometry**, Jakub P. Zak, Michal Józwik, Małgorzata Kujawińska, Warsaw Univ. of Technology (Poland) .....

**Uncertainties in strain measurements with birefringence**, José G. Suárez-Romero, Instituto Tecnológico de Querétaro (Mexico); Eduardo Hernandez-Gomez, Instituto Tecnológico de Queretaro (Mexico) .....

**Evaluation of optical surfaces using heuristic techniques in the information integration stage**, Agustín Santiago-Alvarado, Moisés E. Ramírez Guzmán, Erik G. Ramos Pérez, José Y. Luis-García, Ángel S. Cruz-Félix, Univ. Tecnológica de la Mixteca (Mexico) .....

**A model to perform bandwidth-spectral-correction in spectrophotometers**, Juan B. Hurtado-Ramos, Paulina Arrieta-Navarro, Instituto Politécnico Nacional (Mexico); José G. Suárez-Romero, Instituto Tecnológico de Querétaro (Mexico) .....

**Auto-elimination of fiber optical path-length drift in a frequency-scanning interferometer for absolute distance measurements**, Long Tao, Zhigang Liu, Weibo Zhang, Xi'an Jiaotong Univ. (China) .....

## TUESDAY 11 AUGUST

### OPTICAL ENGINEERING PLENARY SESSION..... 4:00 PM TO 5:25 PM

Session Chair: Craig Olson, L-3 Communications (USA)

4:00 pm: Welcome and Opening Remarks

**Democratization of next-generation imaging, sensing, and diagnostics tools through computational photonics** (Plenary), Aydogan Ozcan, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA) .....

[9579-101]

**Restocking the optical designers' toolbox for next-generation wearable displays** (Plenary), Bernard C. Kress, Google (USA) .....

[9579-102]

### OPTOMECHANICAL/INSTRUMENT TECHNICAL GROUP EVENT ..... 8:00 PM TO 10:00 PM

Session Chair: Alison E. Hatheway, Alison E. Hatheway Inc. (USA)

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## WEDNESDAY 12 AUGUST

### SESSION 1..... WED 8:00 AM TO 10:00 AM

#### Surface Measurements

Session Chair: Erik Novak, 4D Technology Corp. (USA)

**A rugged stereoscopical device for surface inspection**, Florian Dannenberg, Cornelius F. Hahlweg, bbw Hochschule (Germany); Lukas Pescolier, Peret GmbH (Italy) .....

[9576-1]

**In-line roll-to-roll metrology for flexible electronics**, Bradley T. Kimbrough, 4D Technology Corp. (USA) .....

[9576-2]

**Three-dimensional speckle imaging employing a frequency-locked tunable diode laser**, Bret D. Cannon, Bruce E. Bernacki, John T. Schiffen, Albert M. Mendoza, Pacific Northwest National Lab. (USA) .....

[9576-3]

**Aperiodic sinusoidal fringes in comparison to phase-shifted sinusoidal fringes for high-speed three-dimensional shape measurement**, Stefan Heist, Peter Lutzke, Peter Kühmstedt, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); Gunther Notni, Technische Univ. Ilmenau (Germany) .....

[9576-4]

**Development of three-dimensional speckle deformation measurement method with same sensibilities in three directions**, Yasuhiko Arai, Kansai Univ. (Japan) .....

[9576-5]

**3D interferometric microscope: visualization of sample in real color appearance benefits industrial samples assessment**, Joanna Schmit, Matt Novak, Bruker Nano Surfaces, Inc. (USA) .....

[9576-6]

# CONFERENCE 9576

SESSION 2 ..... WED 10:30 AM TO 11:50 AM

## Techniques for Performance Characterization and Enhancement

Session Chair: **Peter Roos**, Bridger Photonics, Inc. (USA)

**Binary pseudorandom test standard to determine the modulation transfer function of optical microscopes**, Ian Lacey, Valeriy V. Yashchuk, Erik H. Anderson, Nikolay A. Artemiev, Lawrence Berkeley National Lab. (USA); Christophe Peroz, Sergey Babin, Giuseppe Calafiore, Abeam Technologies, Inc. (USA); Elaine R. Chan, Stefano Cabrini, Lawrence Berkeley National Lab. (USA); Peter Z. Takacs, Brookhaven National Lab. (USA) ..... [9576-7]

**Performance analysis of a full-field full-range swept-source OCT system**, Johann Krauter, Institut für Technische Optik (Germany) ..... [9576-8]

**Framework for removal of outliers in high-speed fringe projection profilometry**, Shijie Feng, Yuzhen Zhang, Qian Chen, Chao Zuo, Nanjing Univ. of Science and Technology (China) ..... [9576-9]

**Geometric superresolution using an optical mask**, Ihtsham U. Haq, Pakistan Council of Scientific & Industrial Research (Pakistan) and Pakistan Institute of Engineering and Applied Sciences (Pakistan); Asloob A. Mudassar, Pakistan Institute of Engineering and Applied Sciences (Pakistan); Ihram U. Haq, Univ. of Karachi (Pakistan) ..... [9576-10]

Lunch/Exhibition Break ..... Wed 11:50 am to 1:20 pm

SESSION 3 ..... WED 1:20 PM TO 3:00 PM

## Strain, Flow, and Gradient Measurements

Session Chair: **Sen Han**, Univ. of Shanghai for Science and Technology (China)

**Digital focusing schlieren imaging**, Benjamin D. Buckner, Spectabit Optics, LLC (USA); James D. Trolinger, MetroLaser, Inc. (USA); Drew M. L'Esperance, Spectabit Optics, LLC (USA) and Pomona College (USA) ..... [9576-11]

**Digital speckle-based stereo microscope strain measurement system for forming limit diagram prediction by hydraulic bulge tests**, Maodong Ren, Jin Liang, Lihong Wang, Bin Wei, Xi'an Jiaotong Univ. (China) ..... [9576-12]

**Background-oriented schlieren for the study of large flow fields**, James D. Trolinger, MetroLaser, Inc. (USA); Benjamin D. Buckner, Spectabit Optics, LLC (USA) ..... [9576-13]

**SM fiber strain gauge with a fiber-contained heterodyne interferometer**, Ethan D. Burnham-Fay, Univ. of Rochester (USA) ..... [9576-14]

**An iterative approach to measuring two-dimensional gradient-index profiles based on external measurements of laser beam deflection**, Di Lin, James R. Leger, Univ. of Minnesota, Twin Cities (USA) ..... [9576-15]

SESSION 4 ..... WED 3:30 PM TO 5:50 PM

## Volumetric and Distance Based Methods

Session Chair: **James D. Trolinger**, MetroLaser, Inc. (USA)

**Three-dimensional digital holographic aperture synthesis for rapid and highly-accurate large-volume metrology**, Randy R. Reibel, Brant M. Kaylor, Stephen Crouch, Bridger Photonics, Inc. (USA); Zeb Barber, Montana State Univ. (USA) ..... [9576-16]

**Development of a non-contact center thickness optical metrology system**, Peter Roos, Michael Thorpe, Jason Brasseur, Bridger Photonics, Inc. (USA) ..... [9576-17]

**Moiré interferometry patterns for rotational alignment of structures**, Esmaeil Heidari, Kevin G. Harding, GE Global Research (USA) ..... [9576-18]

**Digital holography microscopic array for measuring of mechanical properties on biological samples**, Cesar G. Tavera, J. M. Flores, Ctr. de Investigaciones en Óptica, A.C. (Mexico) ..... [9576-19]

**A novel extrinsic calibration method of ToF cameras based on a virtual multi-cubes shaped object**, Lei Ao, Yongqi Liu, Xin Dong, Ze Zhang, Chinese Academy of Sciences (China) ..... [9576-20]

**Fiber coupler end face wavefront surface metrology**, David C. Compartore, Filipp V. Ignatovich, Michael A. Marcus, Lumetrics, Inc. (USA) ..... [9576-21]

**Optical range finder using semiconductor laser frequency noise**, Takahiro Saito, Katsuki Kondo, Yuuya Tokutake, Shinya Maehara, Niigata Univ. (Japan); Kohei Doi, Tokyo Univ. (Japan); Hideaki Arai, Takashi Sato, Masashi Ohkawa, Yasuo Ohdaira, Shuichi Sakamoto, Niigata Univ. (Japan) ..... [9576-22]

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# Optical Modeling and Performance Predictions VII

Conference Chairs: **Mark A. Kahan**, Synopsys, Inc. (USA); **Marie B. Levine-West**, Jet Propulsion Lab. (USA)

Program Committee: **George Z. Angeli**, Thirty Meter Telescope Observatory Corp. (USA), California Institute of Technology (United States); **Edward B. Bragg**, Consultant (USA); **Robert P. Breault**, Breault Research Organization, Inc. (USA); **Robert J. Brown**, Ball Aerospace & Technologies Corp. (USA); **Thomas G. Brown**, Univ. of Rochester (USA); **William J. Cassarly**, Synopsys, Inc. (USA); **Mike Chainyk**, Jet Propulsion Lab. (USA); **Russell A. Chipman**, College of Optical Sciences, The Univ. of Arizona (USA); **Keith B. Doyle**, MIT Lincoln Lab. (USA); **G. Groot Gregory**, Synopsys, Inc. (USA); **James B. Hadaway**, The Univ. of Alabama in Huntsville (USA); **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA); **Tony Hull**, The Univ. of New Mexico (USA); **Richard C. Juergens**, Raytheon Missile Systems (USA); **George N. Lawrence**, Applied Optics Research (USA); **Steven Peter Levitan**, Univ. of Pittsburgh (USA); **H. Angus Macleod**, Thin Film Center, Inc. (USA); **Gary W. Matthews**, Exelis Visual Information Solutions (USA); **Gregory J. Michels**, Sigmadyne, Inc. (USA); **Duncan T. Moore**, Univ. of Rochester (USA); **James D. Moore Jr.**, ManTech SRS Technologies (USA); **Gary E. Mosier**, NASA Goddard Space Flight Ctr. (USA); **Steven R. Murrill**, U.S. Army Research Lab. (USA); **Sean G. O'Brien**, U.S. Army Research Lab. (USA); **Malcolm Panthaki**, Comet Solutions, Inc. (USA); **David C. Redding**, Jet Propulsion Lab. (USA); **Harold Schall**, The Boeing Co. (USA); **David A. Thomas**, Consultant (USA); **David A. Vaughn**, NASA Goddard Space Flight Ctr. (USA); **James C. Wyant**, College of Optical Sciences, The Univ. of Arizona (USA); **Richard N. Youngworth**, Ryo LLC (USA); **Feng Zhao**, Jet Propulsion Lab. (USA)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

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**Laser generation of ultrasound in adhesively-bonded multilayered structure**, Yan Zhao, Bixing Zhang, Liping Xue, Nanjing Univ. of Science and Technology (China) ..... [9577-21]

**Sensitivity of a capillary fiber resonator for measuring the fluid pressure and humidity**, Duber A. Avila Padilla, Univ. Popular del Cesar (Colombia) and Univ. de Sucre (Colombia); César O. Torres Moreno, Univ. Popular del Cesar (Colombia) ..... [9577-22]

**Modeling of waveguide-couplers for the use in a micro-optical laser gyroscope**, Ingmar Leber, Thalke Niesel, Andreas H. Dietzel, Technische Univ. Braunschweig (Germany) ..... [9577-23]

## THURSDAY 13 AUGUST

### SESSION 1..... THU 8:00 AM TO 10:00 AM

#### Exoplanet Systems, Mirrors, and Structures/ Materials

Session Chair: **Marie B. Levine-West**, Jet Propulsion Lab. (USA)

**Using integrated modeling to assess performance of the Transiting Exoplanet Survey Satellite**, Gerhard P. Stoeckel, Keith B. Doyle, MIT Lincoln Lab. (USA) ..... [9577-1]

**Advanced Mirror Technology Development (AMTD) thermal trade studies**, Thomas Brooks, H. Philip Stahl, NASA Marshall Space Flight Ctr. (USA); William R. Arnold Sr., a.i. solutions, Inc. (USA); Brent Knight, Mike R. Effinger, W. Scott Smith, NASA Marshall Space Flight Ctr. (USA) ..... [9577-2]

**AMTD: Advanced mirror technology development in mechanical stability**, Joseph B. Knight, NASA Marshall Space Flight Ctr. (USA) ..... [9577-3]

**Unified optomechanical modeling: Tracing structural deficiencies in optomechanical designs**, Alson E. Hatheway, Alson E. Hatheway Inc. (USA) ..... [9577-4]

**Research on model identification of ultra-precision motion stage**, Sheng Qiang, Bin Wang, Harbin Institute of Technology (China) ..... [9577-5]

**Integrated modeling: a look back**, Clark Briggs, ATA Engineering, Inc. (USA) ..... [9577-6]

### SESSION 2..... THU 10:30 AM TO 11:50 AM

#### Stray Light, Illumination, and DOEs

Session Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

**The different (yet similar) realms of illumination and stray light modeling**, Edward Freniere, Lambda Research Corp. (USA); Richard N. Youngworth, Ryo LLC (USA) ..... [9577-7]

**Simulating the 2D PSF of multiple-reflection optical systems with rough surfaces**, Kashmira Tayabaly, INAF - Osservatorio Astronomico di Brera (Italy) and Politecnico di Milano (Italy); Daniele Spiga, Giorgia Sironi, Rodolfo Canestrari, Giovanni Pareschi, Paolo Conconi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9577-8]

**General physically-realistic BRDF models for computing stray-light from arbitrary isotropic surfaces**, Alan W. Greynolds, Retired (USA) ..... [9577-9]

**Optomechanical analysis of diffractive optical elements**, Gregory J. Michels, Victor L. Genberg, Sigmadyne, Inc. (USA) ..... [9577-10]

Lunch/Exhibition Break ..... Thu 11:50 am to 1:30 pm

### SESSION 3..... THU 1:30 PM TO 2:30 PM

#### Polarization, Telecom, and Microlithography

Session Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

**Minimize polarization aberrations to use all of the photons all of the time**, James B. Breckinridge, California Institute of Technology (USA) and The Univ. of Arizona (USA); Wal Sze T. Lam, College of Optical Sciences, The Univ. of Arizona (USA); Russell A. Chipman, The Univ. of Arizona (USA) ..... [9577-11]

**Simultaneous and independent optical impairments monitoring using singular spectrum analysis of asynchronously-sampled signal amplitudes**, Latifa Guesmi, Mourad Menif, SUP'COM (Tunisia) ..... [9577-12]

**Combining topology optimization and computational lithography for micro-/nano-device design**, Mingdong Zhou, Technical Univ. of Denmark (Denmark) and Dassault Systemes Deutschland GmbH (Germany); Boyan S. Lazarov, Ole Sigmund, Technical Univ. of Denmark (Denmark) ..... [9577-13]

### SESSION 4..... THU 2:30 PM TO 3:10 PM

#### Fiber Optics in Testing and Radiation Sensing

**System simulation method for fiber-based homodyne multiple target interferometers using short coherence length laser sources**, Maik Fox, Thorsten Beuth, Karlsruher Institut für Technologie (Germany); Andreas Streck, ELOVIS GmbH (Germany); Wilhelm Stork, Karlsruher Institut für Technologie (Germany) ..... [9577-14]

**Calculation of detection efficiency of the fiber-optic sensor to measure radioactive contamination using MCNP simulation**, Hanyoung Joo, Arim Lee, Chan Hee Park, Rinah Kim, Joo Hyun Moon, Dongguk Univ. (Korea, Republic of) ..... [9577-15]

# CONFERENCE 9577

SESSION 5 ..... THU 3:40 PM TO 5:20 PM

## Gratings: Manufacturing, Beam Combining, and Temperature Sensing

**Numerical investigation of the high spatial frequency gratings in photopolymer materials**, Haoyu Li, Yue Qi, Ra'ed Malallah, John T. Sheridan, Univ. College Dublin (Ireland) ..... [9577-16]

**Experimental study on high-brightness semiconductor laser based on spectral beam combining**, Hao Tan, China Academy of Engineering Physics (China) ..... [9577-17]

**Spectral beam combining of four fiber lasers based on a pair of parallel diffraction gratings**, Fei Tian, Hong Yan, Gengcheng Xie, Jianmin Li, Shufeng Wang, Institute of Applied Electronics (China) ..... [9577-18]

**Temperature sensing on tapered single-mode fibre using mechanically-induced long-period fibre gratings**, Sigifredo Marrujo-García, Ernesto González-Ocaña, Jesus Salvador Velazquez-Gonzalez, Fernando Martínez-Piñón, María Guadalupe Pulido-Navarro, Ctr. de Investigación e Innovación Tecnológica (Mexico); Daniel Enrique Ceballos-Herrera, Univ. Autónoma de Nuevo León (Mexico) ..... [9577-19]

**Low-cost and high-resolution interrogation scheme for LPG temperature sensor**, Venkata Reddy Mamidi, Srimannarayana Kamineni, National Institute of Technology, Warangal (India) ..... [9577-20]

Monday-Tuesday 10-11 August 2015 • Proceedings of SPIE Vol. 9578

# Current Developments in Lens Design and Optical Engineering XVI

Conference Chairs: **R. Barry Johnson**, Alabama A&M Univ. (USA); **Virendra N. Mahajan**, The Aerospace Corp. (USA); **Simon Thibault**, Univ. Laval (Canada)

Program Committee: **Robert M. Bates**, FiveFocal LLC (USA); **Julie L. Bentley**, Univ. of Rochester (USA); **Florian Bociort**, Technische Univ. Delft (Netherlands); **Robert M. Bunch**, Rose-Hulman Institute of Technology (USA); **Pierre H. Chavel**, Institut d'Optique (France); **Chung-Tse Chu**, The Aerospace Corp. (USA); **Apostolos Deslis**, JENOPTIK Optical Systems (USA); **José Antonio Díaz Navas**, Univ. de Granada (Spain); **James E. Harvey**, Photon Engineering LLC (USA); **Lakshminarayanan Hazra**, Univ. of Calcutta (India); **Irina L. Livshits**, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation); **Steven A. Macenka**, Jet Propulsion Lab. (USA); **Michael Mandina**, Optimax Systems, Inc. (USA); **Pantazis Mouroulis**, Jet Propulsion Lab. (USA); **Alfonso Padilla-Vivanco**, Univ. Politécnica de Tulancingo (Mexico); **Ching-Cherng Sun**, National Central Univ. (Taiwan); **Yuzuru Takashima**, College of Optical Sciences, The Univ. of Arizona (USA); **Yongtian Wang**, Beijing Institute of Technology (China); **Cornelius Willers**, Airbus DS Optronics (Pty) Ltd. (South Africa); **Andrew P. Wood**, Qioptiq Ltd. (United Kingdom); **María J. Yzuel**, Univ. Autònoma de Barcelona (Spain)

## MONDAY 10 AUGUST

### SESSION 1 ..... MON 8:30 AM TO 10:20 AM

#### **Lens Design Methodology**

Session Chair: **R. Barry Johnson**, Alabama A&M Univ. (USA)

**Simulation of the optical performance of refractive elements to mimic the human eye focusing**, Gerardo Diaz-Gonzalez, Agustín Santiago-Alvarado, Ángel S. Cruz-Félix, Univ. Tecnológica de la Mixteca (Mexico) ..... [9578-1]

**The point spread function in paraxial optics**, Russell A. Chipman, Wai Sze T. Lam, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9578-2]

**Fast robust non-sequential optical ray-tracing with implicit algebraic surfaces**, Alan W. Greynolds, Retired (USA) ..... [9578-3]

**Mathematical modeling and analysis for self-radiation stray light of infrared imaging system**, Jian Du, Beijing Simulation Ctr. (China) ..... [9578-4]

**Comparison of geometrical and diffraction optical transfer functions (Invited Paper)**, Virendra N. Mahajan, College of Optical Sciences, The Univ. of Arizona (USA); José Antonio Diaz Navas, Univ. de Granada (Spain) ..... [9578-5]

### SESSION 2 ..... MON 11:00 AM TO 12:30 PM

#### **Applications and Analysis I**

Session Chair: **Virendra N. Mahajan**, The Aerospace Corp. (USA)

**Integration design of endoscopes with different viewing directions (Invited Paper)**, Dewen Cheng, Yongtian Wang, Beijing Institute of Technology (China) ..... [9578-6]

**Recent experience with design and manufacture of cine lenses**, Michael D. Thorpe, Kristy Dalzell, Raytheon ELCAN Optical Technologies (Canada) .. [9578-7]

**Ultra-compact hourglass lens for integrated cameras**, Mohsen Rezaei, Hooman Mohseni, Northwestern Univ. (USA) ..... [9578-8]

**Landsat-swath imaging spectrometer: optical design**, Pantazis Mouroulis, Robert O. Green, Byron E. Van Gorp, Lori Moore, Jet Propulsion Lab. (USA) [9578-9]

Lunch Break ..... Mon 12:30 pm to 2:00 pm

### SESSION 3 ..... MON 2:00 PM TO 3:30 PM

#### **Optical Testing and Analysis**

Session Chair: **Yongtian Wang**, Beijing Institute of Technology (China)

**Testing and alignment of freeform-based multi-mirror telescopes (Invited Paper)**, Xue-jun Zhang, Donglin Xue, Ming Li, Changchun Institute of Optics, Fine Mechanics and Physics (China) ..... [9578-10]

**Tolerancing an optical freeform surface: an optical fabricator's perspective**, Jessica D. Nelson, Kate Medicus, Michael P. Mandina, Optimax Systems, Inc. (USA) ..... [9578-11]

**Manufacture and analysis of a refractive surface with variable asphericity to model the human cornea**, Ángel S. Cruz-Félix, Agustín Santiago Alvarado, Fernando Iturbide Jiménez, Univ. Tecnológica de la Mixteca (Mexico); Eduardo Tepichín-Rodríguez, Estela López-Olazagasti, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [9578-12]

**Research on the collimators' position method for nanometer accuracy aberration inspection with Shack-Hartmann method**, Jian Su, Zengxiong Lu, Yuejing Qi, Guangyi Liu, Qingbin Meng, Academy of Opto-Electronics (China) ..... [9578-13]

### SESSION 4 ..... MON 4:00 PM TO 5:20 PM

#### **Applications and Analysis II**

Session Chair: **Pantazis Mouroulis**, Jet Propulsion Lab. (USA)

**The design of spherical aberration free multi-layer lenses for the K- and W-bands**, Alex Orange, David Schurig, The Univ. of Utah (USA) ..... [9578-14]

**Rainbow station via geometric phase holograms**, Jihwan Kim, North Carolina State Univ. (USA) ..... [9578-15]

**Assessment of technological need and availability to use optical imaging devices in augmented reality devices for cancer detection and improved removal**, Rose Ann M. Haft, MUIH (USA) ..... [9578-16]

**Reducing chromatic aberrations of a multichannel multiresolution imaging system using hybrid lenses**, Gebrie Y. Belay, Heidi Ottevaere, Michael Vervaeke, Jürgen Van Erps, Youri Meuret, Hugo Thienpont, Vrije Univ. Brussel (Belgium) ..... [9578-17]

### POSTERS-MONDAY ..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Laser-strength interference coatings at 1540-2100 nm**, Vladimir V. Novopashin, Aleksandr V. Shestakov, JSC "Research Institute" POLYUS "them. M.F. Stelmaha" (Russian Federation) ..... [9578-26]

**Microresonator based on a polymer capillary fiber PMMA for the measurement of humidity**, Duber A. Avila Padilla, Univ. Popular del Cesar (Colombia) and Univ. de Sucre (Colombia); César O. Torres Moreno, Univ. Popular del Cesar (Colombia) ..... [9578-27]

# CONFERENCE 9578

- All-reflective zoom system based on foveae technology**, Jun Chang, Ke Zhang, YiFan Huang, Jing Chen, Jian Yang, Beijing Institute of Technology (China) ..... [9578-28]
- Design considerations for an unconventional infrared prism with a 90-degree ray deviation**, Beyza Akarca, Goktug G. Artan, TÜBITAK SAGE (Turkey) ..... [9578-29]
- Optical modeling with precise spatial-chromatic light distribution in phosphor-converted white LEDs**, Ching-Cherng Sun, Yu-Yu Chang, Yu-Huan Wang, Ching-Yi Chen, Yi-Chien Lo, Han-Hsiang Cheng, National Central Univ. (Taiwan) [9578-30]
- Analysis of three-element zoom systems for laser beam expanders with tunable-focus lenses**, Pavel Kulmon, Antonín Mik?, Pavel Novák, Ji?í Novák, Czech Technical Univ. in Prague (Czech Republic) ..... [9578-31]
- Recovery of objects in move with digital holographic techniques**, Martín Hernández-Romo, Pedro Soto-López, Alfonso Padilla-Vivanco, Univ. Politécnica de Tulancingo (Mexico) ..... [9578-32]
- The fractional Fourier transform of the aperiodic and fractal functions**, Alfonso Padilla-Vivanco, Aldo Yuck-Franco, Univ. Politécnica de Tulancingo (Mexico) ..... [9578-33]
- Design and fabrication of a tunable solid elastic lens**, Agustín Santiago-Alvarado, Univ. Tecnológica de la Mixteca (Mexico); Emilio Reyes Pérez, Univ. Tecnológica de la Mixteca (Mexico); Daniel Arriaga Martínez, Fernando Iturbide Jiménez, Ángel S. Cruz Félix, Jorge González García, Enrique A. López López, Univ. Tecnológica de la Mixteca (Mexico) ..... [9578-34]
- Design of an optical system that mimics the human eye image formation**, Agustín Santiago-Alvarado, Cristian Á. Domínguez Osante, Ángel S. Cruz Félix, Univ. Tecnológica de la Mixteca (Mexico) ..... [9578-35]
- Extending the depth-of-field for microscopic imaging by means of digital image fusion**, Alfonso Padilla-Vivanco, Carina Toxqui-Quitl, Roman Hurtado-Perez, Univ. Politécnica de Tulancingo (Mexico) ..... [9578-36]
- Optical model of optical volume diffusion plate: polycarbonate plate doped with silicon dioxide micro particle**, Yeh-Wei Yu, Yu-Heng Chen, Ming Le, Ching-Cherng Sun, National Central Univ. (Taiwan); Jong-Wu Chen, Plastic Industry Development Ctr. (Taiwan); Chih-Yuan Cheng, National Central Univ. (Taiwan) ..... [9578-37]
- Coaxial fundus camera for ophthalmology**, Jarbas C. Castro Neto, Univ. de São Paulo (Brazil) ..... [9578-38]

## TUESDAY 11 AUGUST

### SESSION 5 ..... TUE 8:30 AM TO 9:50 AM

#### Optical Material Under Cold Conditions

Session Chair: Simon Thibault, Univ. Laval (Canada)

- Temperature-dependent refractive index measurements of L-BBH2 glass for the Subaru CHARIS integral field spectrograph**, Douglas B. Leviton, Leviton Metrology Solutions, Inc. (USA); Kevin H. Miller, Manuel A. Quijada, NASA Goddard Space Flight Ctr. (USA); Tyler D. Groff, Princeton Univ. (USA) ..... [9578-18]

- The need for accurate cryo refractive indices and mechanical properties of optical materials (Lithosil 3001, CaF<sub>2</sub> and S-FTM16 for EUCLID NISP)**, Frank U. Grupp, Univ.-Sternwarte München (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); Douglas B. Leviton, Manuel A. Quijada, Kevin H. Miller, NASA Goddard Space Flight Ctr. (USA); Hans D. Thiele, OHB-System AG (Germany); Ralf Bender, Max-Planck-Institut für extraterrestrische Physik (Germany) ..... [9578-19]

- Cryogenic refractive indices of S-LAH55, S-LAH55V, S-LAH59, S-LAM3, S-NBM51, S-NPH2, S-PHM52, and S-TIH14 Glasses**, Kevin H. Miller, Manuel A. Quijada, NASA Goddard Space Flight Ctr. (USA); Douglas B. Leviton, Genesis Engineering Solutions, Inc. (USA) ..... [9578-20]

- Temperature-dependent refractive index measurements of CaF<sub>2</sub>, Suprasil 3001, and S-FTM16 for the Euclid Near-Infrared Spectrometer and Photometer**, Douglas B. Leviton, Leviton Metrology Solutions, Inc. (USA); Kevin H. Miller, Manuel A. Quijada, NASA Goddard Space Flight Ctr. (USA); Frank U. Grupp, Max-Planck-Institut für extraterrestrische Physik (Germany) ..... [9578-21]

### SESSION 6 ..... TUE 10:20 AM TO 11:40 AM

#### Solid State Lighting

Session Chair: Ching-Cherng Sun, National Central Univ. (Taiwan)

- Laser-activated remote phosphor light engine for projection applications**, Martin Daniels, OSRAM GmbH (Germany) ..... [9578-22]

- Complex visible scene projection technology**, Hong Yu, Beijing Simulation Ctr. (China) ..... [9578-23]

- LED collimation optics for large sources**, Ivan Moreno, Univ. Autónoma de Zacatecas (Mexico); Yasmin Berenice Alcántara-Pérez, Univ. de Guanajuato (Mexico) ..... [9578-24]

- High-performance LED luminaire for sports hall**, Xuan Hao Lee, Jin-Tsung Yang, National Central Univ. (Taiwan); Wei-Ting Chien, Jung-Hsuan Chang, National Central Univ. (Taiwan) and WitsLight Technology Group (Taiwan); Yi-Chien Lo, Che-Chu Lin, Ching-Cherng Sun, National Central Univ. (Taiwan) ..... [9578-25]

#### OPTICAL ENGINEERING

#### PLENARY SESSION ..... 4:00 PM TO 5:25 PM

Session Chair: Craig Olson, L-3 Communications (USA)

##### 4:00 pm: Welcome and Opening Remarks

- Democratization of next-generation imaging, sensing, and diagnostics tools through computational photonics (Plenary)**, Aydogan Ozcan, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA) ..... [9579-101]

- Restocking the optical designers' toolbox for next-generation wearable displays (Plenary)**, Bernard C. Kress, Google (USA) ..... [9579-102]

#### LENS DESIGN TECHNICAL EVENT ..... 8:00 PM TO 10:00 PM

Session Chair: Rich Pfisterer, Photon Engineering, LLC (USA)

##### "Let's Give 'Em Something to Talk About!"

Lens designers! Join us for our annual gathering to meet and discuss... lens design! Let's talk about what we're designing, how we're going about doing it (what materials, software, techniques, etc.), and which problems we're encountering. We'll also explore current technical and commercial trends in the marketplace. This year's invited speaker will be Dr. Michael Chriss from MIT Lincoln Laboratory, speaking on the use of NURBS surfaces in freeform optics design. Don't know what NURBS are, then come to the meeting and see the advantage these spline-based surfaces have for freeform optics. Michael will discuss his success with optimizing these surfaces and the resulting designs.

  
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# Novel Optical Systems Design and Optimization XVIII

Conference Chairs: **G. Groot Gregory**, Synopsys, Inc. (USA); **Arthur J. Davis**, ORAFOL Display Optics (USA); **Cornelius F. Hahlweg**, bbw Hochschule (Germany)

Program Committee: **Jost Adam**, Christian-Albrechts-Univ. zu Kiel (Germany), Univ. of California, Los Angeles (United States); **Wenrui Cai**, KLA-Tencor Corp. (USA); **Peter I. Goldstein**, Philips Color Kinetics (USA); **Richard C. Juergens**, Raytheon Missile Systems (USA); **R. John Koshel**, College of Optical Sciences, The Univ. of Arizona (USA); **Scott A. Lerner**, Carl Zeiss AG (Germany); **Paul K. Manhart**, Optikos Corp. (USA); **Joseph R. Mulley**, Melles Griot (USA); **Jorge Ojeda-Castañeda**, Univ. de Guanajuato (Mexico); **Craig Olson**, L-3 Communications (USA); **Jeffrey J. Perkins**, Alpha Photonics, Inc. (USA); **Kevin P. Thompson**, Synopsys, Inc. (USA), The Institute of Optics, Univ. of Rochester (United States); **José Sasián**, College of Optical Sciences, The Univ. of Arizona (USA); **David L. Shealy**, The Univ. of Alabama at Birmingham (USA); **Haiyin Sun**, ChemImage Corp. (USA)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

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**An optical filter with angular selectivity of the light transmission**, Rustam S. Zakirullin, Orenburg State Univ. (Russian Federation) ..... [9579-23]

**Analysis in the allocation of bandwidth applied to the concept of flexible optical networks**, William S. Puche, Univ. Pontificia Bolivariana (Colombia) and Politécnico Colombiano Jaime Isaza Cadavid (Colombia); Javier E. Sierra, Univ. Pontificia Bolivariana (Colombia) ..... [9579-24]

**Design and verifications of an eye model fitted with contact lenses for waveform measurement systems**, Yuan-Chieh Cheng, National Tsing Hua Univ. (Taiwan) and Instrument Technology Research Ctr. (Taiwan); Jia-Hong Chen, Rong-Jie Chang, Chung-Yen Wang, National Tsing Hua Univ. (Taiwan); Wei-Yao Hsu, Instrument Technology Research Ctr. (Taiwan); Pei-Jen Wang, National Tsing Hua Univ. (Taiwan) ..... [9579-25]

**Plenoptic camera based on a liquid crystal microlens array**, Yu Lei, Huazhong Univ. of Science and Technology (China) and Shijiazhuang Tiedao Univ. (China); Qing Tong, Xinyu Zhang, Changsheng Xie, Hongshi Sang, Huazhong Univ. of Science and Technology (China) ..... [9579-26]

**Performance analysis of NRZ, RZ, raised cosine and Gaussian modulation formats in 32x10 Gbps WDM system with different compensation techniques**, Hardeep Singh, Nivedita Mishra, Thapar Univ. (India) ..... [9579-27]

**Enhanced and heralded single-photon source models for quantum applications**, Attia Moez, Amor Gueddana, Rihab Chatta, SUP'COM (Tunisia) ..... [9579-28]

**Optical sensor for detection of tanks and filling level to liquid and liquefied gas without moving parts**, Cicero L. Omegna, Luiz C. Barbosa, Luxtec Sistemas Ópticos LTDA (Brazil) ..... [9579-29]

**Chemical resistance of plastics and glasses for level detectors**, Cicero L. Omegna, Luiz C. Barbosa, Luxtec Sistemas Ópticos LTDA (Brazil) ..... [9579-30]

**One-mirror and two-mirror laser scanners with variable focus lens**, Jiří Novák, Pavel Novák, Antonín Mikš, Petr Pokorný, Czech Technical Univ. in Prague (Czech Republic) ..... [9579-31]

**Parametric study on apodization profiles for improving sensitivity of fiber Bragg grating**, Ishac L. N. Kandas, Alexandria Univ. (Egypt); Nader Shehata, Alexandria Univ. (Egypt) and Virginia Polytechnic Institute and State Univ (USA); Mohamed Hagras, Effat Samir, Alexandria Univ. (Egypt) ..... [9579-32]

**An optofluidic grism**, Sergio Calixto-Carrera, Ctr. de Investigaciones en Óptica, A.C. (Mexico); Martha Rosete-Angular, Univ. Nacional Autónoma de México (Mexico); Guillermo Garnica, Ismael Torres-Gomez, Ctr. de Investigaciones en Óptica, A.C. (Mexico) ..... [9579-33]

**Analysis and compensation of moiré effects in fiber-coupled image sensors**, Salman Karbasi, Ashkan Arianpour, Nojan Motamed, Joseph Ford, Univ. of California, San Diego (USA) ..... [9579-34]

## ILLUMINATION TECHNICAL EVENT .... 8:00 PM TO 10:00 PM

Chair: **Jake Jacobsen**, Synopsys, Inc. (USA)

Please join us for an evening of stimulating discussion.

Since we last discussed this topic five years ago, solar energy production in the US has seen substantial growth. What is the state of solar technology and what is coming down the road? Join us for evening of discussion of the current state of solar energy production and a look into the future. At the end of the planned event, time permitting, any member of the audience may present information within the broad field of illumination. Light refreshments will be served.

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## TUESDAY 11 AUGUST

### SESSION 1 ..... TUE 1:30 PM TO 3:10 PM

#### Novel Instrumentation

Session Chair: **Joseph R. Mulley**, Melles Griot (USA)

**Nonlinear multi-photon laser wave-mixing optical detection in microarrays and microchips for ultrasensitive detection and separation of biomarkers for cancer and neurodegenerative diseases**, Manna Iwabuchi, Marcel Hetu, Eric Maxwell, Sébastien Pradel, Sashary Ramos, William G. Tong, San Diego State Univ. (USA) ..... [9579-1]

**A compact, efficient, and lightweight laser head for CARLO: integration, performance, and benefits**, Waldemar Deibel, Univ. of Basel (Switzerland); Adrian Schneider, Univ. Basel (Switzerland); Marcello Augello, Univ. Hospital Basel (Switzerland); Alfredo E. Bruno, AOT AG (Switzerland); Philipp Jürgens, Univ. Hospital Basel (Switzerland); Philippe C. Cattin, Univ. Basel (Switzerland) ..... [9579-2]

**Multispectral digital holographic microscopy with applications in water quality assessment**, Farnoud Kazemzadeh, Chao Jin, Iman Khodadad, Robert Amelard, Shahid A. Haider, Simarjeet S. Saini, Monica B. Emelko, Alexander Wong, Univ. of Waterloo (Canada) ..... [9579-3]

**Concurrent fluorescence macro-imaging across multiple spectral regions in the visible and the near infrared**, Farnoud Kazemzadeh, Shahid A. Haider, Chao Jin, David A. Clausi, Alexander Wong, Univ. of Waterloo (Canada) ..... [9579-4]

**Endoscopic system for automated high dynamic range inspection of moving periodic structures**, Cornelius F. Hahlweg, bbw Hochschule (Germany); Hendrik Rothe, Helmut-Schmidt Univ. (Germany) ..... [9579-5]

## OPTICAL ENGINEERING PLENARY SESSION..... 4:00 PM TO 5:25 PM

Session Chair: **Craig Olson**, L-3 Communications (USA)

4:00 pm: **Welcome and Opening Remarks**

**Democratization of next-generation imaging, sensing, and diagnostics tools through computational photonics (Plenary)**, Aydogan Ozcan, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA) ..... [9579-101]

**Restocking the optical designers' toolbox for next-generation wearable displays (Plenary)**, Bernard C. Kress, Google (USA) ..... [9579-102]

# CONFERENCE 9579

## LENS DESIGN TECHNICAL EVENT..... 8:00 PM TO 10:00 PM

Session Chair: **Rich Pfisterer**, Photon Engineering, LLC (USA)

### "Let's Give 'Em Something to Talk About!"

Lens designers! Join us for our annual gathering to meet and discuss... lens design! Let's talk about what we're designing, how we're going about doing it (what materials, software, techniques, etc.), and which problems we're encountering. We'll also explore current technical and commercial trends in the marketplace. This year's invited speaker will be Dr. Michael Chriss from MIT Lincoln Laboratory, speaking on the use of NURBS surfaces in freeform optics design. Don't know what NURBS are, then come to the meeting and see the advantage these spline-based surfaces have for freeform optics. Michael will discuss his success with optimizing these surfaces and the resulting designs.



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## WEDNESDAY 12 AUGUST

### SESSION 2..... WED 8:30 AM TO 10:10 AM

#### Novel Systems

Session Chair: **Jeffrey J. Perkins**, Alpha Photonics, Inc. (USA)

**Development features of nuclear CCTV systems for reactors' internal surfaces surveillance**, Sergei L. Pervov, Radda A. Iureva, Nadezhda K. Maltseva, Michael E. Fedosovsky, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation) ..... [9579-6]

**Dynamic noise corrected hyperspectral radiometric calibration in the SWIR 1000-2300 nm using a supercontinuum laser**, Janos C. Keresztes, Ben Aernouts, KU Leuven (Belgium); R. John Koshel, College of Optical Sciences, The Univ. of Arizona (USA); Wouter Saeys, KU Leuven (Belgium) ..... [9579-7]

**Risley prism universal pointing system**, John P. Dixon, James R. Engel, Robert Vaillancourt, Craig Schwarze, Kevin Potter, OPTRA, Inc. (USA). ..... [9579-8]

**Further development of imaging near-field scatterometer**, Denise Uebeler, Florian Dannenberg, Cornelius F. Hahlweg, bbw Hochschule (Germany) .. [9579-9]

**Object silhouettes and surface directions through stereo matching image processing**, Akira Akiyama, Kanazawa Technical College (Japan); Hideo Kumagai, Tamagawa Seiki Co., Ltd. (Japan). ..... [9579-10]

### SESSION 3..... WED 10:40 AM TO 11:50 PM

#### Novel Design and Simulation Methods

Session Chair: **Kevin P. Thompson**, Synopsys, Inc. (USA), The Institute of Optics, Univ. of Rochester (United States)

**Advancements in transformation optics-enabled gradient-index lens design**, Sawyer D. Campbell, Donovan E. Brocker, Jogender Nagar, Pingjuan L. Werner, Douglas H. Werner, The Pennsylvania State Univ. (USA) ..... [9579-11]

**Simulating optical system performance with three-dimensional scenes**, William J. Duncan, Jim Schwiegerling, The Univ. of Arizona (USA) ..... [9579-12]

**Curved fiber bundles for monocentric lens imaging (Invited Paper)**, Salman Karbasi, Igor Stamenov, Nojan Motamed, Ashkan Arianpour, Univ. of California, San Diego (USA); Adam Johnson, Ron Stack, Rick Morrison, Distant Focus Corp. (USA); Ilya Agurok, Distant Focus Corp. (USA) and Univ. of California, San Diego (USA); Joseph Ford, Univ. of California, San Diego (USA) ..... [9579-13]

Lunch/Exhibition Break ..... Wed 11:50 am to 1:30 pm

### SESSION 4..... WED 1:30 PM TO 3:10 PM

#### Optimization

Session Chair: **R. John Koshel**, The Univ. of Arizona (USA)

**Optical transfer function optimization based on linear expansions**, Jim Schwiegerling, Univ. of Arizona (USA) ..... [9579-14]

**Illumination design using computer experiments**, Janos C. Keresztes, Bart De Ketelaere, Jan Audenaert, KU Leuven (Belgium); R. John Koshel, College of Optical Sciences, The Univ. of Arizona (USA); Wouter Saeys, KU Leuven (Belgium) ..... [9579-15]

**Comparative analysis of optimization with freeform orthogonal polynomials for rectangular apertures**, Milena I. Nikolic, Univ. Politecnica de Madrid (Spain); Pablo Benitez, Juan Carlos Miñano, Univ. Politécnica de Madrid (Spain) and Light Prescriptions Innovators, LLC (USA); Jiayao Liu, Dejan Grabovickic, Bharathwaj Narasimhan, Marina Buljan, Univ. Politécnica de Madrid (Spain) ..... [9579-16]

**Design of three freeform mirror aplanats**, Bharathwaj Narasimhan, Pablo Benitez, Dejan Grabovickic, Juan Carlos Miñano, Milena Nikolic, Jose Infante, Univ. Politécnica de Madrid (Spain) ..... [9579-17]

**A method to improve the image reconstruction quality in a coded aperture compressive imaging system**, Ouyang Yao, Jing Chen, Beijing Institute of Technology (China) ..... [9579-18]

### SESSION 5..... WED 3:40 PM TO 5:00 PM

#### Novel Display Systems

Session Chair: **Haiyin Sun**, ChemImage Corp. (USA)

**120-view autostereoscopic display**, Junejei Huang, Yuchang Wang, Delta Electronics, Inc. (Taiwan) ..... [9579-19]

**Color and brightness uniformity compensation of a multi-projection 3D display**, Jin-Ho Lee, Juyong Park, Dongkyung Nam, Du-Sik Park, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) ..... [9579-20]

**Miniature projection system design**, Zhisheng Yun, Andrew Onderkirk, Stephen J. Willett, 3M Co. (USA) ..... [9579-21]

**Convertible 2D-3D display using an edge-lit light guide plate based on integral imaging**, Zi Wang, An-Ting Wang, Chun Gu, Lixin Xu, Hai Ming, Univ. of Science and Technology of China (China) ..... [9579-22]

# CONFERENCE 9580

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Monday-Thursday 10-13 August 2015 • Proceedings of SPIE Vol. 9580

## Zoom Lenses V

Conference Chairs: **Ellis Betensky**, Consultant (USA); **Takanori Yamanashi**, Theta Optical LLC (USA)

Program Committee: **Akira Yabe**, Consultant (Japan); **Akira Fukushima**, Konica Minolta Technology Ctr. (Japan); **Irina L. Livshits**, ITMO Univ. (Russian Federation); **Wilhelm Ulrich**, Carl Zeiss AG (Germany); **Robert M. Bates**, FiveFocal LLC (USA); **Richard N. Youngworth**, Riyo-LLC (USA); **Rung-Ywan Tsai**, Industrial Technology Research Institute (Taiwan); **Iain A. Neil**, ScotOptix (Switzerland)

### MONDAY 10 AUGUST

#### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**A liquid lens actuated using dielectric polymer**, Boya Jin, Jihyeon Lee, Zuowei Zhou, Sangwoo Park, Changwoon Nah, Hongwen Ren, Chonbuk National Univ. (Korea, Republic of).....[9580-23]

### TUESDAY 11 AUGUST

#### OPTICAL ENGINEERING

#### PLENARY SESSION..... 4:00 PM TO 5:25 PM

Session Chair: **Craig Olson**, L-3 Communications (USA)

4:00 pm: **Welcome and Opening Remarks**

**Democratization of next-generation imaging, sensing, and diagnostics tools through computational photonics** (*Plenary*), Aydogan Ozcan, Univ. of California, Los Angeles (USA) and California NanoSystems Institute (USA) .....

[9579-101]

**Restocking the optical designers' toolbox for next-generation wearable displays** (*Plenary*), Bernard C. Kress, Google (USA) .....

[9579-102]

#### LENS DESIGN TECHNICAL EVENT..... 8:00 PM TO 10:00 PM

Session Chair: **Rich Pfisterer**, Photon Engineering, LLC (USA)

**"Let's Give 'Em Something to Talk About!"**

Lens designers! Join us for our annual gathering to meet and discuss... lens design! Let's talk about what we're designing, how we're going about doing it (what materials, software, techniques, etc.), and which problems we're encountering. We'll also explore current technical and commercial trends in the marketplace. This year's invited speaker will be Dr. Michael Chriss from MIT Lincoln Laboratory, speaking on the use of NURBS surfaces in freeform optics design. Don't know what NURBS are? Then come to the meeting and see the advantage these spline-based surfaces have for freeform optics. Michael will discuss his success with optimizing these surfaces and the resulting designs.



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### WEDNESDAY 12 AUGUST

#### SESSION 1 ..... WED 1:30 PM TO 3:00 PM

##### Special Session

Session Chairs: **Ellis Betensky**, Consultant (USA); **Takanori Yamanashi**, Theta Optical LLC (USA)

**Challenges of designing a zoom lens for planetarium projection** (*Invited Paper*), Marco Hanft, Dirk Döring, Carl Zeiss AG (Germany) .....

[9580-1]

**"Perfect Zoom System" which enables both a zoom ratio of 25:1 and a high-resolution in stereo microscope** (*Invited Paper*), Norio Miyake, Masahiro Mizuta, Nobuhiro Shinada, Hiroaki Nakayama, Yumiko Ohuchi, Nikon Corp. (Japan) [9580-2]

**Understanding how entrance and exit pupils have determined the evolution of the modern zoom lens design** (*Invited Paper*), Ellis Betensky, Consultant (Canada) .....

[9580-3]

#### SESSION 2 ..... WED 3:30 PM TO 5:40 PM

##### Theory and Analysis

Session Chairs: **Richard N. Youngworth**, Riyo LLC (USA); **Ellis Betensky**, Consultant (USA)

**Toward a paraxial pre-design of zoom lenses** (*Invited Paper*), Thomas Milde, Carl Zeiss AG (Germany) .....

[9580-4]

**New tools for finding first-order zoom lens solutions and the analysis of zoom lenses during the design process**, Anthony J. Yee, Gustavo A. Gandara-Montano, Daniel J. L. Williams, Peter McCarthy, Julie Bentley, Duncan T. Moore, Univ. of Rochester (USA) .....

[9580-5]

**Modular optical design for flexible beam expansion**, Ulrike Fuchs, Sven Wickenhagen, asphericon GmbH (Germany) .....

[9580-6]

**Zoom lens design for tilted objects**, Robert M. Malone, Daniel K. Frayer, Morris I. Kaufman, Heather R. Leffler, Alfred Meidinger, National Security Technologies, LLC (USA) .....

[9580-7]

**Compensator selection considerations for a zoom lens**, John R. Rogers, Synopsys, Inc. (USA) .....

[9580-8]

**To zoom or not to zoom: do we have enough pixels?**, Richard N. Youngworth, Riyo LLC (USA) .....

[9580-9]

### THURSDAY 13 AUGUST

#### SESSION 3 ..... THU 8:30 AM TO 10:00 AM

##### Applications I: Infrared

Session Chair: **Akira Yabe**, Consultant (Japan)

**Increasing dual band infrared zoom ranges** (*Invited Paper*), Jay N. Vizgaitis, Arthur Hastings Jr., optX imaging system (USA) .....

[9580-10]

**Optical design study and prototyping of a dual-field zoom lens imaging in the 1-5 micron infrared waveband**, Dmitry Reshidko, The Univ. of Arizona (USA); Pavel Reshidko, Ran Carmeli, RP Optical Lab. Ltd. (Israel); Jose Sasian, The Univ. of Arizona (USA) .....

[9580-11]

**Optical design study of a VIS-SWIR 3X zoom lens**, Rebecca E. Berman, James A. Corsetti, Keija Fang, Eryn Fennig, Peter McCarthy, Greg R. Schmidt, Anthony J. Visconti, Daniel J. L. Williams, Anthony J. Yee, Yang Zhao, Julie Bentley, Duncan T. Moore, Univ. of Rochester (USA) .....

[9580-12]

**Chromatic correction for a VIS-SWIR zoom lens using optical glasses**, Yang Zhao, Daniel J. L. Williams, Peter McCarthy, Anthony J. Visconti, Julie L. Bentley, Duncan T. Moore, Univ. of Rochester (USA) .....

[9580-13]

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SESSION 4.....THU 10:30 AM TO 12:10 PM

## Applications II: Camera Lens

Session Chair: **Ellis Betensky**, Consultant (USA)

**Cine-servo lens technology for 4K broadcast and cinematography (Invited Paper)**, Ryuji Nurishi, Tsuyoshi Wakazono, Fumiaki Usui, Canon Inc. (Japan).....[9580-14]

**Extreme retrofocus zoom lens for single-shot single-lens HDR photography and video**, Anthony Vella, Julie L. Bentley, Univ. of Rochester (USA) .... [9580-15]

**All-reflective optical power zoom objectives (Invited Paper)**, Jens Knobbe, Heinrich Grueger, Fraunhofer-Institut für Photonische Mikrosysteme (Germany); Kristof Seidl, Fraunhofer-Institut für Photonische Mikrosysteme (Germany)[9580-16]

**Design of a zoom lens with a large field-of-view and better solutions with asphere**, Takanori Yamanashi, Theta Optical LLC (USA).....[9580-17]

Lunch/Exhibition Break..... Thu 12:10 pm to 1:30 pm

SESSION 5.....THU 1:30 PM TO 3:20 PM

## Applications III: Camera Lens

Session Chair: **Takanori Yamanashi**, Theta Optical LLC (USA)

**Change of optical design thought of zoom lens with evolution of single-lens camera system (Invited Paper)**, Hitoshi Hagimori, Panasonic Corp. (Japan)..... [9580-18]

**Multi-channel compact optical zoom module by using microlenses**, Wei-Hsiang Liao, Guo-Dung Su, National Taiwan Univ. (Taiwan) ..... [9580-19]

**Design study for a 16x zoom lens system for visible surveillance camera**, Anthony Vella, Heng Li, Yang Zhao, Isaac Trumper, Gustavo A. Gandara-Montano, Di Xu, Daniel K. Nikolov, Changchen Chen, Nicolas S. Brown, Andres Guevara-Torres, Hae Won Jung, Jacob Reimers, Julie L. Bentley, Univ. of Rochester (USA).....[9580-20]

**Novel optical system for very thin zoom lenses**, Akira Yabe, Consultant (Japan)..... [9580-21]

**Optical design of optical zoom optics with intermediate image**, Yi-Chin Fang, National Kaohsiung First Univ. of Science and Technology (Taiwan).... [9580-22]

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## Laser Beam Shaping XVI

Conference Chairs: **Andrew Forbes**, Univ. of the Witwatersrand (South Africa), CSIR National Laser Ctr. (South Africa); **Todd E. Lizotte**, Hitachi Via Mechanics (USA), Inc. (USA)

Program Committee: **Daniel M. Brown**, Optosensors Technology, Inc. (USA); **Fred M. Dickey**, FMD Consulting LLC (USA); **Angela Dudley**, CSIR National Laser Ctr. (South Africa); **Michael Duparré**, Friedrich-Schiller-Univ. Jena (Germany); **Julio Cesar Gutiérrez-Vega**, Tecnológico de Monterrey (Mexico); **Marc D. Himel**, JENOPTIK Optical Systems GmbH (Germany); **Alexander V. Laskin**, AdlOptica Optical Systems GmbH (Germany); **Alexis V. Kudryashov**, Active Optics Night N Ltd. (Russian Federation); **Carlos López-Mariscal**, U.S. Naval Research Lab. (USA); **David L. Shealy**, The Univ. of Alabama at Birmingham (USA); **Yakov G. Soskind**, DHPC Technologies (USA)

### MONDAY 10 AUGUST

#### SESSION 1 ..... MON 8:30 AM TO 10:20 AM

##### Laser Beams

Session Chair: **Fred M. Dickey**, FMD Consulting LLC (USA)

**Self-healing of light beams: a wave-optics approach (Invited Paper)**, Andrea Aiello, Max-Planck-Institut für die Physik des Lichts (Germany); Girish S. Agarwal, Oklahoma State Univ. (USA) ..... [9581-1]

**Angular accelerating white light**, Angela Dudley, CSIR National Laser Ctr. (South Africa); Christian Vetter, Alexander Szameit, Friedrich-Schiller-Univ. Jena (Germany); Andrew Forbes, Univ. of the Witwatersrand (South Africa) ..... [9581-2]

**Self-healing of Hermite-Gauss and Ince-Gauss beams**, Dilia Aguirre-Olivas, Gabriel Mellado-Villaseñor, Victor Arrizón, Sabino Chávez-Cerda, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [9581-3]

**Classical entanglement of vector vortex beams**, Melanie McLaren, Univ. of the Witwatersrand (South Africa); Thomas Konrad, Univ. of KwaZulu-Natal (South Africa); Andrew Forbes, Univ. of the Witwatersrand (South Africa) and CSIR National Laser Ctr. (South Africa) ..... [9581-4]

**Generating non-diffraction beams using DMD**, Yongdong Wang, Nanyang Technological Univ. (Singapore); Yilei Zhang, Nanyang Technological Univ. (Singapore) ..... [9581-5]

#### SESSION 2 ..... MON 10:50 AM TO 12:20 PM

##### Lasers and Resonators

Session Chair: **Yakov G. Soskind**, DHPC Technologies (USA)

**2 μm intra- and extra-cavity beam shaping (Invited Paper)**, Igor A. Litvin, Council for Scientific and Industrial Research (South Africa); Hencharl Strauss, Gary King, CSIR National Laser Ctr. (South Africa) ..... [9581-6]

**High-brightness fiber-coupled laser-diode beam-shaping design based on right-angle prism array**, Junhong Yu, Haitian (China) ..... [9581-7]

**Intracavity beam shaping using an SLM**, Liesl Burger, Council for Scientific and Industrial Research (South Africa) and Stellenbosch Univ. (South Africa); Igor Litvin, Sandile Ngcobo, Council for Scientific and Industrial Research (South Africa); Andrew Forbes, CSIR National Laser Ctr. (South Africa) ..... [9581-8]

**Selective excitation and detection of higher-order doughnut laser modes as an incoherent superposition of two petals modes in a digital laser resonator**, Sandile S. Ngcobo, Igor Litvin, Council for Scientific and Industrial Research (South Africa); Darryl Naidoo, CSIR National Laser Ctr. (South Africa); Kamel Ait-Ameur, Ecole Nationale Supérieure d'Ingénieurs de Caen et Ctr. de Recherche (France); Andrew Forbes, CSIR National Laser Ctr. (South Africa) ..... [9581-9]

Lunch Break ..... Mon 12:20 pm to 1:40 pm

#### SESSION 3 ..... MON 1:40 PM TO 3:00 PM

##### Techniques I

Session Chair: **Alexander V. Laskin**, AdlOptica Optical Systems GmbH (Germany)

**C-shaped structured electron beams: design and experimental production**, Michael Mousley, Jun Yuan, Mohamed Babiker, Gnanavel Thirunavukkarasu, The Univ. of York (United Kingdom) ..... [9581-10]

**Shaping sinusoidal phase contrast holograms (SPCH) for highly-efficient electron vortex beams**, Gnanavel Thirunavukkarasu, Michael Mousley, Mohamed Babiker, Jun Yuan, The Univ. of York (United Kingdom) ..... [9581-11]

**Electrically-controlled optical tweezing using space-time-wavelength mapping**, Shah Rahman, Rasul Torun, Qiancheng Zhao, Tuva Atasever, Ozdal Boyraz, University of California, Irvine (USA) ..... [9581-12]

**Encoding information using Laguerre Gaussian modes**, Abderrahmen Trichili, SUP'COM (Tunisia); Angela Dudley, CSIR National Laser Ctr. (South Africa); Mourad Zghal, SUP'COM (Tunisia); Andrew Forbes, CSIR National Laser Ctr. (South Africa) ..... [9581-13]

#### SESSION 4 ..... MON 3:30 PM TO 5:30 PM

##### Techniques II

Session Chair: **Angela Dudley**, CSIR National Laser Ctr. (South Africa)

**Experimental generation of Hermite-Gauss and Ince-Gauss beams through kinoform phase holograms**, Gabriel Mellado-Villaseñor, Dilia Aguirre-Olivas, David Sánchez-de-la-Llave, Victor Arrizón, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [9581-14]

**New approach for laser beam formation by means of deformable mirrors**, Alexis V. Kudryashov, Julia Sheldakova, Anna Lylova, Vadim Samarkin, Active Optics Night N Ltd. (Russian Federation) ..... [9581-15]

**Polarization design of high-efficiency diffractive optics**, Michael A. Golub, Tel Aviv Univ. (Israel) ..... [9581-16]

**Closed-loop adaptive optics system for laser beam shaping**, Javier Garces, Pedro Escarate, Mario Castro, Sebastian Zuniga, Univ. Técnica Federico Santa María (Chile); Andres Guesalaga, Pontificia Univ. Católica de Chile (Chile) [9581-17]

**Square shaped flat-top beam in refractive beam shapers**, Alexander V. Laskin, Vadim V. Laskin, AdlOptica Optical Systems GmbH (Germany); Aleksei B. Ostrun, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation) ..... [9581-18]

**Beam shaping concepts with aspheric surfaces**, Ulrike Fuchs, asphericon GmbH (Germany) ..... [9581-19]

# CONFERENCE 9581

## POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

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**A new error compensation strategy on laser displacement sensor in freeform surface measurement**, Bin Sun, Bin Li, Lei Chen, Xi'an Jiaotong Univ. (China) ..... [9581-20]

**Scanning in the optical vortex microscope**, Agnieszka Popi艂ek-Masajada, Łukasz Płocienniczak, Jan Masajada, Sławomir Drobczyński, Wrocław Univ. of Technology (Poland) ..... [9581-21]

**Orbital angular momentum mode coupling in fibers**, Bienvenu I. Ndagano, Melanie McLaren, Univ. of the Witwatersrand (South Africa); Andrew Forbes, Univ. of the Witwatersrand (South Africa) and CSIR National Laser Ctr. (South Africa) ..... [9581-22]

**Practical implementation of propagation-invariant laser beams**, Michael G. Soskind, Rose Soskind, Rutgers, The State Univ. of New Jersey (USA); Yakov Soskind, DHPC Technologies (USA) ..... [9581-23]

**Fabrication and characterization of a non-zero dispersion-shifted mechanically-induced long-period grating for optical fiber sensing**, Eloisa Gallegos-Arellano, Ruth I. Mata-Chavez, Eduardo H. Huerta-Mascotte, Julian M. Estudillo-Ayala, Ana D. Guzman-Chavez, Everardo Vargas-Rodriguez, Juan M. Sierra-Hernandez, Roberto Rojas-Laguna, Igor Guryev, Univ. de Guanajuato (Mexico) ..... [9581-24]

**Closed-Loop control for tip-tilt compensation**, Mario A. Castro R., Pedro Escárate, Javier Garcés, Sebastián Zuñiga, Univ. Técnica Federico Santa María (Chile); Andrés Guesalaga, Pontificia Univ. Católica de Chile (Chile) ..... [9581-25]

**Low-loss selective excitation of higher-order modes in a diode-pumped solid-state digital laser**, Sandile Ngcobo, Teboho J. Bell, CSIR National Laser Ctr. (South Africa); Kamel Ait-Ameur, Ecole Nationale Supérieure d'Ingenieurs de Caen et Ctr. de Recherche (France); Andrew Forbes, CSIR National Laser Ctr. (South Africa) ..... [9581-26]

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# Optical System Alignment, Tolerancing, and Verification IX

**Conference Chairs:** **José Sasián**, College of Optical Sciences, The Univ. of Arizona (USA); **Richard N. Youngworth**, Ryo LLC (USA)**Program Committee:** **Matthew B. Dubin**, College of Optical Sciences, The Univ. of Arizona (USA); **Jonathan D. Ellis**, Univ. of Rochester (USA); **Sen Han**, Univ. of Shanghai for Science and Technology (China); **Marco Hanft**, Carl Zeiss AG (Germany); **Chao-Wen Liang**, National Central Univ. (Taiwan); **Norbert Lindlein**, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); **Robert M. Malone**, National Security Technologies, LLC (USA); **Raymond G. Ohl IV**, NASA Goddard Space Flight Ctr. (USA); **Robert E. Parks**, Optical Perspectives Group, LLC (USA); **Martha Rosete-Aguilar**, Univ. Nacional Autónoma de México (Mexico); **Peng Su**, College of Optical Sciences, The Univ. of Arizona (USA); **Yana Z. Williams**, Atlas Material Testing Technology (USA)

## SUNDAY 9 AUGUST

**SESSION 1.....SUN 9:00 AM TO 10:20 AM**

### Alignment and Tolerancing for Aspheres and Freeforms

Session Chair: **Sen Han**, Univ. of Shanghai for Science and Technology (China)**New freeform standard in ISO 10110**, Sven R. Kiontke, asphericon GmbH (Germany) [9582-1]**Scanning pupil approach to aspheric surface slope error tolerancing in head-up display optics**, Viktor P. Sivokon, Raytheon ELCAN Optical Technologies (Canada) [9582-2]**The need for fiducials on freeform optical surfaces**, Kate Medicus, Jessica D. Nelson, Matthew Brunelle, Optimax Systems, Inc. (USA) [9582-3]**Tolerancing aspheric surfaces in optical design**, Ulrike Fuchs, asphericon GmbH (Germany) [9582-4]**SESSION 2..... SUN 10:50 AM TO 12:00 PM**

### Tolerance Analysis

Session Chair: **Richard N. Youngworth**, Ryo LLC (USA)**Slope sensitivities for optical surfaces**, John R. Rogers, Synopsys, Inc. (USA) [9582-5]**Tolerance analysis of optical systems using the Nijboer-Zernike approach (Invited Paper)**, Marco Hanft, Carl Zeiss AG (Germany) [9582-6]**Design and tolerance analysis of a transmission sphere by interferometer model**, Wei-Jei Peng, Cheng-Fong Ho, Wen-Lung Lin, Zong-Ru Yu, Chien-Yao Huang, Wei-Yao Hsu, Instrument Technology Research Ctr. (Taiwan) [9582-7]

Lunch Break ..... Sun 12:00 pm to 1:40 pm

**SESSION 3..... SUN 1:40 PM TO 3:30 PM**

### Alignment Analysis, Hardware, and Metrology

Session Chair: **José Sasián**, College of Optical Sciences, The Univ. of Arizona (USA)**Characterization of cryo-vacuum chamber windows for NIRCam instrument alignment and testing**, Paul F. Schweiger, Torben B. Andersen, Lockheed Martin Space Systems Co. (USA) [9582-8]**Measuring NIRCam's position and orientation in 6 DOF using one reference mirror surface inside an environmental chamber**, Paul F. Schweiger, Torben B. Andersen, Lockheed Martin Space Systems Co. (USA) [9582-9]**Dynamic alignment, tolerances, and metrology fundamentals at the nano and micro scales (Invited Paper)**, Donn M. Silberman, PI (Physik Instrumente) L.P. (USA) [9582-10]**1µm adjustment-tolerance for high-precision helical laser drilling**, Frank Zibner, Christian Fornaroli, Arnold Gillner, Jens Holtkamp, Fraunhofer-Institut für Lasertechnik (Germany) [9582-11]**Disruptive advancement in precision lens mounting**, Frédéric Lamontagne, Nichola Desnoyers, Michel Doucet, Patrice Côté, Jonny Gauvin, Geneviève Antil, INO (Canada) [9582-20]**SESSION 4..... SUN 4:00 PM TO 5:20 PM**

### State Estimation in Optical Alignment

Session Chair: **Marco Hanft**, Carl Zeiss AG (Germany)**Capabilities and accuracy of the Laser Alignment and Assembly StationTM (LASTM) with combined visible-infrared single-mode sources and digital detectors**, Thomas C. Hutchens, Dzmitry Sazonau, Michael W. Tompkins, Guy Pearlman, Opto-Alignment Technology, Inc. (USA); Charles Gaugh, Optic Systems Group (USA) and Opto-Alignment Technology, Inc. (USA); Brian Weinberg, Opto-Alignment Technology, Inc. (USA); Honggang Gao, OPTurn Co., Ltd. (China); Sasha Pearlman, Opto-Alignment Technology, Inc. (USA) [9582-12]**State estimation in optical system alignment using monochromatic beam imaging**, Joyce Fang, Dmitry Savransky, Cornell Univ. (USA) [9582-13]**Alignment estimation performance analysis of new MDCO algorithm for a TMA optical system**, Hyukmo Kang, Yonsei Univ. (Korea, Republic of); Eunsong Oh, Korea Institute of Ocean Science & Technology (Korea, Republic of); Sug-Whan Kim, Yonsei Univ. (Korea, Republic of) [9582-14]**Alignment state estimation performance of Merit Function Regression(MFR) method under mirror fabrication error**, Dongok Ryu, Sug-Whan Kim, Yonsei Univ. (Korea, Republic of) [9582-15]**SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM****Welcome and Opening Remarks****Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

**POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM**

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**Analysis of alignment tolerance of focal plane assembly of a telescope**, Sheng-Tsung Chang, Yu-Chuan Lin, Ming-Ying Hsu, Ting-Ming Huang, Fong-Zhi Chen, Instrument Technology Research Ctr. (Taiwan) [9582-16]**An optomechanical tolerance simulation for a four-group zoom lens**, Chen-Chin Cheng, Industrial Technology Research Institute (Taiwan); John D. Griffith, Moondog Optics, Inc. (USA) [9582-17]**Development of a FSMP mirror assembly**, Jihun Kim, Young-Soo Kim, Je Heon Song, Korea Astronomy and Space Science Institute (Korea, Republic of); Myung Cho, National Optical Astronomy Observatory (USA); Ho-Soon Yang, Joohyung Lee, Korea Research Institute of Standards and Science (Korea, Republic of); Ho-Sang Kim, Kyoung-Don Lee, Institute for Advanced Engineering (Korea, Republic of); Won Hyun Park, National Optical Astronomy Observatory (USA) and The Univ. of Arizona (USA); Byeong-Gon Park, Korea Astronomy and Space Science Institute (Korea, Republic of) [9582-18]**Multiple sensor fusion into a single optical instrument**, Oren Aharon, Duma Optronics Ltd. (Israel); Itai Vishnia, PLX Inc. (USA) [9582-19]

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# An Optical Believe It or Not: Key Lessons Learned IV

Conference Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

Program Committee: **George Z. Angeli**, LSST (USA); **Paul Atcheson**, Ball Aerospace & Technologies Corp. (USA); **Steven J. Battel**, Battel Engineering, Inc. (USA); **Robert P. Breault**, Breault Research Organization, Inc. (USA); **James T. Carnevale**, Raytheon Co. (USA); **William J. Cassarly**, Synopsys, Inc. (USA); **Daniel R. Coulter**, Jet Propulsion Lab. (USA); **Charles D. Cox**, UTC Aerospace Systems (USA); **Marc T. Daigle**, Optical Alchemy Inc. (USA); **Alan E. DeCew Jr.**, MIT Lincoln Lab. (USA); **Ronald G. Driggers**, U.S. Naval Research Lab. (USA); **Mark A. Ealey**, Univ. of Kansas (USA); **David F. Everett**, NASA Goddard Space Flight Ctr. (USA); **James L. Fanson**, Jet Propulsion Lab. (USA); **G. Groot Gregory**, Synopsys, Inc. (USA); **Alson E. Hatheway**, Alson E. Hatheway Inc. (USA); **Joseph B. Houston Jr.**, Houston Research Associates (USA); **Tony Hull**, The Univ. of New Mexico (USA); **Gary W. Matthews**, Exelis Inc. (USA); **Duncan T. Moore**, Univ. of Rochester (USA); **Harold Schall**, The Boeing Co. (USA); **Robert R. Shannon**, College of Optical Sciences, The Univ. of Arizona (USA); **Michael J.. Sholl**, Univ. of California, Berkeley (USA); **H. Philip Stahl**, NASA Marshall Space Flight Ctr. (USA); **David A. Thomas**, David Thomas Consulting (USA); **Linda C. Usher**, Executive Search Group (USA); **James C. Wyant**, College of Optical Sciences, The Univ. of Arizona (USA)

## MONDAY 10 AUGUST

### SESSION 1 ..... MON 8:00 AM TO 10:00 AM

#### Lessons Learned From Failures in Strategic Planning, Execution, and Communication

Session Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

**Why most strategic plans don't work**, Robert W. Bradford, Ctr. for Simplified Strategic Planning, Inc. (USA) ..... [9583-1]

**How do you bridge the gaps in your strategy?**, Denise A. Harrison, Spex, Inc. (USA) ..... [9583-2]

**Everyone knows execution is important: so why do we fail to execute?**, Robert W. Bradford, Ctr. for Simplified Strategic Planning, Inc. (USA); Denise A. Harrison, Spex, Inc. (USA) ..... [9583-3]

**Lessons learned in aligning an organization: two-way communication is key**, Denise A. Harrison, Spex, Inc. (USA) ..... [9583-4]

### SESSION 2 ..... MON 10:30 AM TO 11:50 AM

#### Keeping Things On Track and Debugging the Failures

Session Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

**They never said anything about this in school: lessons from the engineering front line**, Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (USA) ..... [9583-5]

**Root cause analysis: shutting down the alligator farm**, Anthony J. DeMarinis, Consultant (USA) ..... [9583-6]

Lunch Break ..... Mon 11:50 am to 1:00 pm

### SESSION 3 ..... MON 1:00 PM TO 3:20 PM

#### System Level Take-Aways

Session Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

**Lessons learned over the last thirty years**, Richard C. Juergens, Raytheon Missile Systems (USA) ..... [9583-7]

**Lessons not to make light of (when designing optical systems for space)**, Stephen E. Kendrick, Consultant (USA) ..... [9583-8]

**Requirements management lessons learned: fuzzy "most likely" versus clean shaven "not to exceed"**, Paul A. Lightsey, Ball Aerospace & Technologies Corp. (USA) ..... [9583-9]

**The art of planning for optical systems integration and alignment**, Joseph F. Sullivan, Ball Aerospace & Technologies Corp. (USA) ..... [9583-10]

**How to raise a teenage instrument: building and flying the Orbiting Carbon Observatory-2 (OCO-2)**, David Crisp, Jet Propulsion Lab. (USA) ..... [9583-11]

**The beam rotation that almost was in the National Ignition Facility**, R. Edward English Jr., L-3/Cincinnati Electronics (USA) and REE Optical Systems, LLC (USA) ..... [9583-12]

**Four big mistakes in developing photonics-enabled medical devices**, David Hill, Krista McEuen, Zygo Corporation (USA) ..... [9583-13]

### SESSION 4 ..... MON 3:50 PM TO 5:10 PM

#### Design, Tolerancing, Fabrication, and Assembly: Engineering Lessons Learned

Session Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

**Trials and tribulations of optical manufacturing: asphere edition (Invited Paper)**, Gregory Frisch, Kate Medicus, Mark E. Schickler, Brandon B. Light, Jessica DeGroote Nelson, Optimax Systems, Inc. (USA) ..... [9583-15]

**Polarimeter calibration error gets far out of control**, Russell A. Chipman, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9583-16]

**A quintuple of painful lessons from surface inspection to high-speed imaging**, Cornelius F. Hahlweg, bbw Hochschule (Germany); Cornelia Weyer, G&S Gesundheit für Betriebe GmbH (Germany) ..... [9583-17]

**From SDI to tactical battlefield lasers: myths, legends, and facts. Reflections of a "Star Warrior"**, James A. Horkovich, Schafer Corp. (USA) ..... [9583-18]

### SESSION 5 ..... MON 5:10 PM TO 5:30 PM

#### Lessons in Staffing and Training

Session Chair: **Mark A. Kahan**, Synopsys, Inc. (USA)

**The sage on the stage - and the audience is texting**, Judith F. Donnelly, Three Rivers Community College (USA) ..... [9583-19]

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# Ultrafast Nonlinear Imaging and Spectroscopy III

Conference Chair: **Zhiwen Liu**, The Pennsylvania State Univ. (USA)

Conference Co-Chairs: **Iam Choon Khoo**, The Pennsylvania State Univ. (USA); **Demetri Psaltis**, Ecole Polytechnique Fédérale de Lausanne (Switzerland); **Kebin Shi**, Peking Univ. (China)

Program Committee: **George Barbastathis**, Massachusetts Institute of Technology (USA); **Randy A. Bartels**, Colorado State Univ. (USA); **Martin Centurion**, Univ. of Nebraska-Lincoln (USA); **Yujie J. Ding**, Lehigh Univ. (USA); **Jason M. Eichenholz**, Open Photonics, Inc. (USA); **Kenan Gundogdu**, North Carolina State Univ. (USA); **Hans D. Hallen**, North Carolina State Univ. (USA); **Zhenyu Li**, The George Washington Univ. (USA); **Fiorenzo Gabriele Omenetto**, Tufts Univ. (USA); **Yong Xu**, Virginia Polytechnic Institute and State Univ. (USA)

## SUNDAY 9 AUGUST

**SESSION 1 . . . . . SUN 8:00 AM TO 10:20 AM**

### Ultrafast Electron Diffraction and Imaging

Session Chair: **Kebin Shi**, Peking Univ. (China)

**A beamline for attosecond pump-probe experiments: Mapping ultrafast electron dynamics in atoms and molecules** (*Invited Paper*), Emma R. Simpson, Imperial College London (United Kingdom); Simon E. E. Hutchinson, Imperial College London (United Kingdom) and Fibercore Ltd. (United Kingdom); Thomas Siegel, Imperial College London (United Kingdom) and ASE Optics Europe (Spain); Zsolt Diveki, Alvaro Sanchez-Gonzalez, Christian S. Struber, Lukas Miseikis, Dane R. Austin, Jon P. Marangos, Imperial College London (United Kingdom) . . . . . [9584-1]

**Ultrafast electron diffraction from laser-aligned carbon disulfide molecules** (*Invited Paper*), Jie Yang, Martin Centurion, Univ. of Nebraska-Lincoln (USA) . . . . . [9584-2]

**Imaging molecules with sub-angstrom resolution using femtosecond electron pulses** (*Invited Paper*), Omid Zandi, Univ. of Nebraska-Lincoln (USA); Alice DeSimone, Kyle Wilkin, Jie Yang, Martin Centurion, Univ. of Nebraska-Lincoln (USA) . . . . . [9584-3]

**Transient chromatic aberrations at discrete energies in ultrafast electron microscopy** (*Invited Paper*), David J. Flannigan, Dayne A. Plemons, Univ. of Minnesota, Twin Cities (USA) . . . . . [9584-4]

**Ultrafast probe using femtosecond electron pulses** (*Invited Paper*), Jianming Cao, Florida State Univ. (USA) . . . . . [9584-5]

**MeV ultrafast electron diffraction and imaging at SLAC** (*Invited Paper*), Xijie Wang, SLAC National Accelerator Lab. (USA) . . . . . [9584-6]

**SESSION 2 . . . . . SUN 10:45 AM TO 12:00 PM**

### SFG/SHG Spectroscopy and Imaging

Session Chair: **Martin Centurion**, Univ. of Nebraska-Lincoln (USA)

**True surface spectra from sum-frequency vibrational spectroscopy of nonpolar media** (*Invited Paper*), Chuanshan Tian, Fudan Univ. (China) . . . . . [9584-7]

**Chiral sum frequency generation microscopy by using polarization manipulation** (*Invited Paper*), Ziheng Ji, Peking Univ. (China); Kebin Shi, Peking Univ. (China) and State Key Lab. for Mesoscopic Physics (China) and Collaborative Innovation Ctr. of Quantum Matter (China) . . . . . [9584-8]

**Bond models of linear and nonlinear optics** (*Invited Paper*), David E. Aspnes, North Carolina State Univ. (USA) . . . . . [9584-9]

Lunch Break . . . . . Sun 12:00 pm to 1:30 pm

**SESSION 3 . . . . . SUN 1:30 PM TO 3:35 PM**

### Biological Imaging and Sensing Applications

Session Chair: **Yong Xu**, Virginia Polytechnic Institute and State Univ. (USA)

**Leveraging higher-order nonlinearities in optical transient absorption for microscopic imaging contrast** (*Invited Paper*), Jesse W. Wilson, Jong Kang Park, Miguel Anderson, Martin C. Fischer, Warren S. Warren, Duke Univ. (USA) [9584-10]

**Optimization of mid-IR photothermal imaging for tissue analysis** (*Invited Paper*), Atcha Totachawattana, Shyamsunder Erramilli, Michelle Y. Sander, Boston Univ. (USA) . . . . . [9584-11]

**Multifunctional diagnostic, nanothermometer, and photothermal nano-devices** (*Invited Paper*), Shuang Fang Lim, Kory Green, Janina Wirth M.D., North Carolina State Univ. (USA) . . . . . [9584-12]

**Multiscale diffusion of single molecules in crowded environments** (*Invited Paper*), Ahmed A. Heikal, Univ. of Minnesota, Duluth (USA) . . . . . [9584-13]

**Optical imaging for digital biosensing** (*Invited Paper*), Zhenyu Li, The George Washington Univ. (USA) . . . . . [9584-14]

**SESSION 4 . . . . . SUN 4:00 PM TO 5:15 PM**

### Imaging through Multi-mode Fibers

Session Chair: **Zhenyu Li**, The George Washington Univ. (USA)

**Adaptive control of waveguide modes in a few-mode fiber network** (*Invited Paper*), Yong Xu, Peng Lu, Matthew Shipton, Brennan Thews, Anbo Wang, Virginia Polytechnic Institute and State Univ. (USA) . . . . . [9584-15]

**Transmission of femtosecond pulses through multimode fibers** (*Invited Paper*), Demetri Psaltis, Ecole Polytechnique Fédérale de Lausanne (Switzerland) [9584-16]

**Delivery of ultrashort spatially focused pulses through a multimode fiber** (*Invited Paper*), Christophe Moser, Edgar E. Morales, Demetri Psaltis, Salma Farahi, Ecole Polytechnique Fédérale de Lausanne (Switzerland) . . . . . [9584-17]

## SYMPOSIUM-WIDE PLENARY SESSION . . . SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

**SESSION 5 . . . . . MON 8:00 AM TO 10:05 AM**

### Novel Nanoscale Techniques and Devices

Session Chair: **Hans D. Hallen**, North Carolina State Univ. (USA)

**Effects of quantum confinement and environment on exciton dynamics of monolayer and few-layers molybdenum disulfide** (*Invited Paper*), Hongyan Shi, Harbin Institute of Technology (China) and Key Lab. of Micro-Optics and Photonic Technology (China); Xuan Li, Ruihuan Tian, Yan Ling, Harbin Institute of Technology (China); Xiudong Sun, Harbin Institute of Technology (China) and Key Lab. of Micro-Optics and Photonic Technology (China) . . . . . [9584-18]

**Lithography-free super absorbing metasurfaces for surface enhanced nonlinear optics** (*Invited Paper*), Kai Liu, Tianmu Zhang, Dengxin Ji, Joseph Murphy, Haomin Song, Tim Thomay, Univ. at Buffalo (USA); Kebin Shi, Peking Univ. (China); Qiaoliang Gan, Alexander Cartwright, Univ. at Buffalo (USA) . . . . . [9584-19]

**Ultrafast pump-probe spectroscopy with force detection** (*Invited Paper*), Eric O. Potma, Univ. of California, Irvine (USA) . . . . . [9584-20]

**An exciton's transformation in a semiconducting polymer: How absorption and emission relate in an anisotropic solid** (*Invited Paper*), Kenan Gundogdu, Bhoj Gautham, Harald W. Ade, North Carolina State Univ. (USA); Natalie Stigelin, Imperial College London (United Kingdom); Robert Younts, North Carolina State Univ. (USA); Christoph Hellmann, Imperial College London (United Kingdom) . . . . . [9584-21]

**Nano-imaging and spectroscopy with optical antennas** (*Invited Paper*), Joanna M. Atkin, Univ. of Colorado at Boulder (USA) and The Univ. of North Carolina at Chapel Hill (USA) . . . . . [9584-22]

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SESSION 6.....MON 10:30 AM TO 11:50 AM

## Raman and Novel Spectroscopic Techniques

Session Chair: **Kenan Gundogdu**, North Carolina State Univ. (USA)

**Raman sensing in microresonators**, Corey Janisch, Alexander Cocking, The Pennsylvania State Univ. (USA); Lan Yang, Washington Univ. in St. Louis (USA); Zhiwen Liu, The Pennsylvania State Univ. (USA) ..... [9584-23]

**UV resonance Raman signatures of phonon-allowed absorptions and phonon-driven bubble formation (Invited Paper)**, Hans D. Hallen, North Carolina State Univ. (USA); Adam H. Willitsford, Johns Hopkins Univ. Applied Physics Lab., LLC (USA); Reagan Weeks, C. Russell Philbrick, North Carolina State Univ. (USA) ..... [9584-24]

**G-Fresnel cellphone spectrometer**, Chenji Zhang, The Pennsylvania State Univ. (USA); Perry S. Edwards, Atoptix, LLC (USA); Zhiwen Liu, The Pennsylvania State Univ. (USA) ..... [9584-25]

**Smartphone spectroscopy for non-invasive point-of-care diagnostics (Invited Paper)**, Perry S. Edwards, Atoptix, LLC (USA); Zhiwen Liu, The Pennsylvania State Univ. (USA) ..... [9584-26]

Lunch Break ..... Mon 11:50 am to 1:15 pm

SESSION 7.....MON 1:15 PM TO 4:15 PM

## Novel Imaging Techniques

Session Chair: **Perry S. Edwards**, Atoptix, LLC (USA)

**Axial slice light sheet microscopy with micro mirror array**, Yizhu Chen, Mingda Zhou, Yiqiu Xia, Ding Ma, Siyang Zheng, Zhiwen Liu, The Pennsylvania State Univ. (USA) ..... [9584-27]

**Compressive sensing in CARS holography**, Alexander Cocking, Nikhil Mehta, Zhiwen Liu, The Pennsylvania State Univ. (USA) ..... [9584-28]

**Fast acquisition for wide field of view high-resolution phase microscopy (Invited Paper)**, Laura Waller, Lei Tian, Ziji Liu, Univ. of California, Berkeley (USA); Chenguang Ma, Tsinghua Univ. (China); Simon Li, Kannan Ramchandran, Univ. of California, Berkeley (USA) ..... [9584-29]

**Watching photons on the fly by compressed ultrafast photography (Invited Paper)**, Liang S. Gao, Washington Univ. in St. Louis (USA) ..... [9584-30]

**Advances in the optical delivery architecture for femtosecond micromachining systems that employ simultaneous spatial and temporal focusing (Invited Paper)**, Jeffrey A. Squier, Colorado School of Mines (USA) ..... [9584-31]

**Three-color two-photon three-axis digital scanned light-sheet microscopy (3c2p3a-DSLM) (Invited Paper)**, Liangyi Chen, Weijian Zong, Aimin Wang, Peking Univ. (China) ..... [9584-32]

**Nonlinear tomographic spatial frequency modulated imaging (Invited Paper)**, Randy A. Bartels, Colorado State Univ. (USA) ..... [9584-33]

SESSION 8.....MON 4:15 PM TO 5:30 PM

## Ultrafast Laser and THz Sources

Session Chair: **Zhiwen Liu**, The Pennsylvania State Univ. (USA)

**Photonic-crystal-fiber platform for high-power multi-wavelength ultrashort-pulse sources and its applications (Invited Paper)**, Minglie Hu, Tianjin Univ. (China) ..... [9584-34]

**Ultrafast nonlinear THz emission and electrodynamics in low dimensions (Invited Paper)**, Jigang Wang, Iowa State Univ. (USA) and Ames Lab. (USA) ..... [9584-35]

**Ultrafast THz and mid-IR studies of nanoscale charge dynamics and electronic correlations (Invited Paper)**, Giacomo Coslovich, Ryan P. Smith, Jan H. Buss, Sascha Behl, Bernhard Huber, Lawrence Berkeley National Lab. (USA); Takao Sasagawa, Tokyo Institute of Technology (Japan); Hans A. Bechtel, Michael C. Martin, Robert A. Kaindl, Lawrence Berkeley National Lab. (USA) .... [9584-36]

POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Optical parametric oscillation in synchronously pumped MgO-doped periodically poled lithium niobate**, Ieva Pipinyte, Agne Marcinkeviciute, Rimantas Grigonis, Valdas Sirutkaitis, Vilnius Univ. (Lithuania) ..... [9584-37]

**Wavelet analysis of polarization maps of the myocardium tissue microscopic images in the diagnosis of the causes of death**, Alexander Ushenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine) ..... [9584-38]

**System of polarization correlometry of polycrystalline layers of urine in the differentiation stage of diabetes**, Alexander V. Dubolazov, Yuriy Ushenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine) ..... [9584-39]

**Confocal fluorescence microscopy for diagnostic of the bone grafts**, Pavel E. Timchenko, Elena V. Timchenko, Larisa A. Zherdeva (Taskina), Samara State Aerospace Univ. (Russian Federation); Larisa T. Volova, Samara State Medical Univ. (Russian Federation); Nikolay V. Belousov, Samara State Aerospace Univ. (Russian Federation) ..... [9584-40]

**Optical methods for the demineralization control of bone tissues**, Elena V. Timchenko, Larisa A. Zherdeva (Taskina), Pavel E. Timchenko, Samara State Aerospace Univ. (Russian Federation); Larisa T. Volova, Samara State Medical Univ. (Russian Federation); Julia V. Ponomareva, Samara Medicine Univ. (Russian Federation) ..... [9584-41]

**Spectrally tunable femto-second Erbium fiber laser based on an all-normal-dispersion cavity**, Zhiqiang Lv, Zibo Gong, Xing Lu, Peking Univ. (China); Kebin Shi, Peking Univ. (China) and Collaborative Innovation Ctr. of Quantum Matter (China) .....

**Ultrafast lattice dynamics in L10 phase FePt nanoparticles measured by MeV electron diffraction**, Xiaozhe Shen, SLAC National Accelerator Lab. (USA) ..... [9584-43]

**Optimization of concrete hardness by determination of radionuclides concentrations in raw materials using LIBS technique**, Mohamed M. Elfaham, Banha Univ. (Egypt); Osama M. Khalil, MIT Univ. (Egypt); Asmaa Elhassan, Tenth of Ramadan Institute (Egypt) ..... [9584-44]

# CONFERENCE 9585

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# Terahertz Emitters, Receivers, and Applications VI

Conference Chairs: **Manijeh Razeghi**, Northwestern Univ. (USA); **Alexei N. Baranov**, Univ. Montpellier 2 (France); **John M. Zavada**, Polytechnic Institute of New York Univ. (USA); **Dimitris Pavlidis**, National Science Foundation (USA)

Program Committee: **Joshua Abell**, U.S. Naval Research Lab. (USA); **Maria Amanti**, Univ. Paris 7-Denis Diderot (France); **Stefano Barbieri**, Univ. Paris 7-Denis Diderot (France); **Henry O. Everitt**, U.S. Army Research, Development and Engineering Command (USA); **Jérôme Faist**, ETH Zürich (Switzerland); **Mauro F. Pereira**, Sheffield Hallam Univ. (United Kingdom); **Sven Höfling**, Univ. of St. Andrews (United Kingdom); **Hiroshi Ito**, Kitasato Univ. (Japan); **Mona Jarrahi**, Univ. of Michigan (USA); **Wojciech Knap**, Univ. Montpellier 2 (France); **Stephen A. Lynch**, Cardiff Univ. (United Kingdom); **Juliette Mangeney**, Ecole Normale Supérieure (France); **Tariq Manzur**, Naval Undersea Warfare Ctr. (USA); **Oleg Mitrofanov**, Univ. College London (United Kingdom); **Gaël Mouret**, Univ. du Littoral Côte d'Opale (France); **Naoki Oda**, NEC Corp. (Japan); **Aleksandar D. Rakic**, The Univ. of Queensland (Australia); **Pascale Roy**, Synchrotron SOLEIL (France); **Carlo Sirtori**, Univ. Paris 7-Denis Diderot (France); **Zachary D. Taylor**, Univ. of California, Los Angeles (USA); **Roland Teissier**, Univ. Montpellier 2 (France); **Gintaras Valušis**, Ctr. for Physical Sciences and Technology (Lithuania); **Miriam S. Vitiello**, Consiglio Nazionale delle Ricerche (Italy); **Benjamin S. Williams**, Univ. of California, Los Angeles (USA)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 8:30 AM TO 10:00 AM

#### THz Emitters Based on Quantum Cascade Lasers

Session Chairs: **John M. Zavada**, Polytechnic Institute of New York Univ. (USA); **Oleg Mitrofanov**, Univ. College London (United Kingdom)

To be announced (*Invited Paper*), Manijeh Razeghi, Northwestern Univ. (USA) ..... [9585-1]

**Merging THz with optical waveguides for stabilization and modulation of quantum cascade lasers** (*Invited Paper*), Maria Amanti, Margaux Renaudat St-Jean, Univ. Paris 7-Denis Diderot (France); Alfredo Bismuto, ETH Zurich (Switzerland); Matthias Beck, Jérôme Faist, ETH Zürich (Switzerland); Carlo Sirtori, Univ. Paris 7-Denis Diderot (France) ..... [9585-2]

**Recent progress of THz-quantum cascade lasers using nitride-based materials** (*Invited Paper*), Hideki Hirayama, Wataru Terashima, RIKEN (Japan) ..... [9585-3]

### SESSION 2 ..... SUN 10:30 AM TO 11:40 AM

#### THz Emitters I

Session Chairs: **Wojciech Knap**, Univ. Montpellier 2 (France); **Gintaras Valušis**, Ctr. for Physical Sciences and Technology (Lithuania)

**Electrically pumped semiconductor lasers with monolithic control of circular polarization** (*Invited Paper*), Federico Capasso, Harvard School of Engineering and Applied Sciences (USA) ..... [9585-4]

**Broadband and enhanced-output-power terahertz-wave emitter based on slot-antenna-integrated uni-traveling-carrier photodiode**, Hiroshi Ito, Kitasato Univ. (Japan); Toshihide Yoshimatsu, Nippon Telegraph and Telephone Corp. (Japan); Hiroshi Yamamoto, Kitasato Univ. (Japan); Tadao Ishibashi, NTT Electronics Corp. (Japan) ..... [9585-5]

**TeraFermi: The THz beamline at the FERMI Free Electron Laser**, Cristian Svetina, Elettra-Sincrotrone Trieste S.C.p.A. (Italy) ..... [9585-6]

Lunch Break ..... Sun 11:40 am to 1:30 pm

### SESSION 3 ..... SUN 1:30 PM TO 3:20 PM

#### THz Emitters II

Session Chairs: **Hiroshi Ito**, Kitasato Univ. (Japan); **Maria Amanti**, Univ. Paris 7-Denis Diderot (France)

**Negative differential resistance devices for generation of terahertz radiation** (*Invited Paper*), Heribert Eisele, Univ. of Leeds (United Kingdom) ..... [9585-7]

**The study of gas species on THz generation from laser-induced air plasma**, Ji Zhao, Yuejin Zhao, Beijing Institute of Technology (China) ..... [9585-8]

**TE and TM THz intervalence band polaritons and antipolaritons**, Mauro F. Pereira, Inuwa A. Faragai, Sheffield Hallam Univ. (United Kingdom) ..... [9585-9]

**Research on Output Characteristics of optically pumped THz gas laser**, Xiaoyang Guo, Sichuan Univ. (China) ..... [9585-10]

**Terahertz generation via asymmetric Cherenkov radiation in LiNbO<sub>3</sub>**, Elena V. Svinikina, N.I. Lobachevsky State Univ. of Nizhni Novgorod (Russian Federation) ..... [9585-11]

### SESSION 4 ..... SUN 3:50 PM TO 5:30 PM

#### Fundamentals of THz Technology

Session Chairs: **Vladimir L. Vaks**, Institute for Physics of Microstructures (Russian Federation); **Zachary D. Taylor**, Univ. of California, Los Angeles (USA)

**Microscopic view on carrier dynamics in Landau-quantized graphene** (*Invited Paper*), Ermin Malic, Chalmers Univ. of Technology (Sweden); Florian Wendler, Andreas Knorr, Technische Univ. Berlin (Germany); Martin Mittendorff, Stephan F. Winnerl, Manfred Helm, Helmholtz-Zentrum Dresden-Rossendorf e. V. (Germany) ..... [9585-12]

**Microscopic theory for the optical properties of dilute semiconductors**, Mauro F. Pereira, Chijioke I. Oriaku, Sheffield Hallam Univ. (United Kingdom) ..... [9585-13]

**Development of low dielectric loss Nb-SiO<sub>2</sub>-Nb superconducting microstrips for the SPT-3G experiment**, Chrystian M. Posada, Argonne National Lab. (USA); Brad A. Benson, The Univ. of Chicago (USA); Jason E. Austermann, Univ. of Colorado at Boulder (USA); Amy Bender, Argonne National Lab. (USA); John E. Carlstrom, The Univ. of Chicago (USA); Clarence L. Chang, Argonne National Lab. (USA); Thomas M. Crawford, The Univ. of Chicago (USA); Ari Cukierman, Univ. of California, Berkeley (USA); Junjia Ding, Argonne National Lab. (USA); Tijmen de Haan, Matthew Adam Dobbs, McGill Univ. (Canada); Daniel Dutcher, The Univ. of Chicago (USA); Wenderline Everett, Nils W. Halverson, Univ. of Colorado at Boulder (USA); Nicholas L. Harrington, Kaori Hattori, Univ. of California, Berkeley (USA); Jason W. Henning, The Univ. of Chicago (USA); Gene C. Hilton, National Institute of Standards and Technology (USA); William L. Holzapfel, Univ. of California, Berkeley (USA); Johannes Hubmayr, National Institute of Standards and Technology (USA); Donna Kubik, Fermi National Accelerator Lab. (USA); Chao-Lin Kuo, Stanford Univ. (USA); Adrian T. Lee, Michael J. Myers, Univ. of California, Berkeley (USA); Tyler J. Natoli, The Univ. of Chicago (USA); Hogan Nguyen, Fermi National Accelerator Lab. (USA); Valentine Novosad, Argonne National Lab. (USA); Zhaodi Pan, The Univ. of Chicago (USA); John E. Pearson, Argonne National Lab. (USA); John E. Ruhe, Benjamin Saliwanchik, Case Western Reserve Univ. (USA); Erik D. Shirokoff, The Univ. of Chicago (USA); Aritoki Suzuki, Univ. of California, Berkeley (USA); Keith L. Thompson, Stanford Univ. (USA); Keith Vanderlinde, Univ. of Toronto (Canada); Joaquin D. Vieira, Univ. of Illinois at Urbana-Champaign (USA); Gensheng Wang, Volodymyr Yefremenko, Argonne National Lab. (USA); Ki Won Yoon, Stanford Univ. (USA) ..... [9585-14]

**Relativistic Doppler frequency up-conversion of terahertz pulses via reflection from photo-induced plasma fronts in solid-state media** (*Invited Paper*), Mark D. Thomson, Fanqi Meng, Hartmut G. Roskos, Johann Wolfgang Goethe-Universität Frankfurt am Main (Germany) ..... [9585-15]

### SYMPOSIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

# CONFERENCE 9585

MONDAY 10 AUGUST

SESSION 5..... MON 8:00 AM TO 10:00 AM

## Applications of THz Devices

Session Chairs: **Heribert Eisele**, Univ. of Leeds (United Kingdom); **Mark D. Thomson**, Johann Wolfgang Goethe-Univ. Frankfurt am Main (Germany)

**TERA-MIR radiation: Materials, generation, detection, and applications (Invited Paper)**, Mauro F. Pereira, Sheffield Hallam Univ. (United Kingdom) [9585-16]

**High effective algorithm of the detection and identification of substance using the noisy reflected THz pulse**, Vyacheslav A. Trofimov, Svetlana A. Varentsova, Vladislav V. Trofimov, Lomonosov Moscow State Univ. (Russian Federation) [9585-17]

**Development of ultra-broadband terahertz time domain ellipsometry (Invited Paper)**, Masatsugu Yamashita, Chiko Otani, RIKEN (Japan) [9585-18]

**Numerical analysis of a terahertz transmission line resonator for heterodyne photomixing**, Lars Juul, Inverto Digital Labs (Luxembourg); Martin Mikulčík, Forschungszentrum Jülich GmbH (Germany); Michel Marso, Univ. du Luxembourg (Luxembourg); Mauro F. Pereira, Sheffield Hallam Univ. (United Kingdom) [9585-19]

**High transmittance silicon terahertz polarizer using wafer bonding technology**, Ting-Yang Yu, Hsin-Cheng Tsai, National Chiao Tung Univ. (Taiwan); Shiang-Yu Wang, Academia Sinica (Taiwan); Chih-Wei Luo, Kuan-Neng Chen, National Chiao Tung Univ. (Taiwan) [9585-20]

SESSION 6..... MON 10:30 AM TO 12:00 PM

## THz Detectors

Session Chairs: **Mauro Fernandes Pereira**, Sheffield Hallam Univ. (United Kingdom); **Tyler L. Cocker**, Univ. Regensburg (Germany)

**Terahertz detector arrays based on nanometer field effect transistors (Invited Paper)**, Wojciech Knap, Univ. Montpellier 2 (France); J. Marczewski, Institute of Electron Technology (Poland); Dmytro B. But, Univ. Montpellier 2 (France); Nina V. Dyakonova-Cywinski, Institute of High Pressure Physics (Poland); Maciej Sypek, Warsaw Univ. of Technology (Poland) [9585-21]

**On-chip integration solutions of compact optics and detectors in room-temperature terahertz imaging systems**, Gintaras Valušis, Linas Minkevičius, Vincas Tamošiūnas, Irmantas Kašalynas, Rimvydas Venckevičius, Karolis Madeikis, Bogdan Voisiat, Dalius Seliuta, Gediminas Račiukaitis, Ctr. for Physical Sciences and Technology (Lithuania) [9585-22]

**Plasmonic enhancement of sensitivity in terahertz (THz) photo-conductive detectors**, Oleg Mitrofanov, Univ. College London (United Kingdom), Sandia National Labs. (USA); Ting Shan Luk, Igal Brener, John Reno, Sandia National Labs. (USA) [9585-23]

**Theoretical and experimental study on the response of Golay detector to the pulsed light**, Weitao Wang, Zhenhua Cong, Xiaohan Chen, Xingyu Zhang, Zengguang Qin, Guanqi Tang, Ning Li, Qiang Fu, Shiqi Jiang, Shandong Univ. (China) [9585-24]

Lunch Break ..... Mon 12:00 pm to 1:10 pm

SESSION 7..... MON 1:10 PM TO 3:30 PM

## THz Spectroscopy and Imaging

Session Chairs: **Richard D. Averitt**, Univ. of California, San Diego (USA); **James Lloyd-Hughes**, The Univ. of Warwick (United Kingdom)

**Multifrequency high precise subTHz-THz\_IR spectroscopy for exhaled breath research (Invited Paper)**, Vladimir L. Vaks, Institute for Physics of Microstructures (Russian Federation) and N.I. Lobachevsky State Univ. of Nizhni Novgorod (Russian Federation) [9585-25]

**Toward THz imaging of human eye: Direct mapping of corneal tissue water content with THz imaging**, Shijun Sung, Somporn Chantra, Neha Bajwa, Ryan McCurdy, Gintare Kerezyte, James Garritano, Jean-Pierre Hubschman, Univ. of California, Los Angeles (USA); Sohpie X. Deng, Univ. California, Los Angeles (USA); Warren Grundfest, Zachary Taylor, Univ. of California, Los Angeles (USA) [9585-26]

**New way for both quality enhancement of THz images and detection of concealed objects**, Vyacheslav A. Trofimov, Vladislav V. Trofimov, Lomonosov Moscow State Univ. (Russian Federation) [9585-27]

**Ultrafast field-resolved multi-THz spectroscopy on the sub-nanoparticle scale (Invited Paper)**, Tyler L. Cocker, Max Eisele, Markus A. Huber, Markus Plankl, Univ. Regensburg (Germany); Leonardo Viti, Daniele Ercolani, Lucia Sorba, Miriam S. Vitiello, Scuola Normale Superiore (Italy); Rupert Huber, Univ. Regensburg (Germany) [9585-28]

**Exploration of burn wound induction parameters on wound edema**, Neha Bajwa, Ctr. for Advanced Surgical and Interventional Technology (USA); Shijun Sung, James Garritano, Ctr. for Advanced Surgical & Interventional Technology (USA); Michael Fishbein, Univ. of California, Los Angeles (USA); Warren Grundfest, Zachary Taylor, Ctr. for Advanced Surgical & Interventional Technology (USA) [9585-29]

**Investigation of pharmaceutical drugs and caffeine-containing foods using Fourier and terahertz time-domain spectroscopy**, Gintaras Valušis, Mindaugas Karaliūnas, Rimvydas Venckevičius, Irmantas Kašalynas, Ctr. for Physical Sciences and Technology (Lithuania); Uroš Puc, Andreja Abina, Anton Jeglič, Aleksander Zidanšek, Jožef Stefan Institute (Slovenia) [9585-30]

SESSION 8..... MON 4:00 PM TO 5:20 PM

## Novel Concepts and Materials for THz Technology

Session Chairs: **Manijeh Razeghi**, Northwestern Univ. (USA); **Alexei N. Baranov**, Univ. Montpellier 2 (France)

**Quantum spin dynamics at terahertz frequencies in 2D hole gases and improper ferroelectrics (Invited Paper)**, James Lloyd-Hughes, The Univ. of Warwick (United Kingdom) [9585-31]

**THz polarization difference imaging of aqueous targets**, Shijun Sung, Neha Bajwa, Ryan McCurdy, Gintare Kerezyte, James Garritano, Warren Grundfest, Zachary Taylor, Univ. of California, Los Angeles (USA) [9585-32]

**Nonlinear dynamics in THz metamaterials: From impact ionization to field emission (Invited Paper)**, Richard D. Averitt, Univ. of California, San Diego (USA) [9585-33]

POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Coherent detection for continuous terahertz wave**, Hui Yuan, Tielin Lu, Yuejin Zhao, Beijing Institute of Technology (China); LiangLiang Zhang, Cunlin Zhang, Capital Normal Univ. (China) [9585-34]

**Silicon based active terahertz metamaterial devices**, Hyun-Woong Kim, Jeong Min Woo, Sung-Min Hong, Jae-Hyung Jang, Gwangju Institute of Science and Technology (Korea, Republic of) [9585-35]

**Development of magnetic system with high-anisotropy localized magnetic field for terahertz time-domain spectroscopy**, Solveiga E. Azbite, Mikhail K. Khodzitsky, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation) [9585-36]

Sunday-Monday 9-10 August 2015 • Proceedings of SPIE Vol. 9586

# Photonic Fiber and Crystal Devices: Advances in Materials and Innovations in Device Applications IX

*Conference Chairs:* Shizhuo Yin, The Pennsylvania State Univ. (USA); Ruyan Guo, The Univ. of Texas at San Antonio (USA)*Program Committee:* Partha P. Banerjee, Univ. of Dayton (USA); Liliana Braescu, Institut National de la Recherche Scientifique (Canada); Ken-Yuh Hsu, National Chiao Tung Univ. (Taiwan); Rongqing Hui, The Univ. of Kansas (USA); Suganda Jutamulia, Univ. of Northern California (USA); Nickolai V. Kukhtarev, Alabama A&M Univ. (USA); Ravindra B. Lal, Alabama A&M Univ. (USA); Byoungho Lee, Seoul National Univ. (Korea, Republic of); Liangcai Cao, Tsinghua Univ. (China); Sergei F. Lyuksyutov, The Univ. of Akron (USA); Manmohan D. Aggarwal, Alabama A&M Univ. (USA); Paul B. Ruffin, U.S. Army Research, Development and Engineering Command (USA); Nars Singh B. Singh, Univ. of Maryland, Baltimore County (USA); Wei-Hung Su, National Sun Yat-Sen Univ. (Taiwan); Ching-Cherng Sun, National Central Univ. (Taiwan); Xiang Zhang, Univ. of California, Berkeley (USA)*Founding Chair:* Francis T.S. Yu, The Pennsylvania State Univ. (USA)

## SUNDAY 9 AUGUST

**SESSION 1 ..... SUN 8:20 AM TO 11:50 AM****Advances in Photonic Crystals and Materials I**

Session Chairs: Abdalla M. Darwish, Dillard Univ. (USA); Ruyan Guo, The Univ. of Texas at San Antonio (USA)

**Polymer-inorganic nanocomposite thin film emitters, optoelectronic chemical sensors, and energy harvesters produced by multiple-beam pulsed laser deposition**, Abdalla M. Darwish, Dillard Univ. (USA); Sergey Sarkisov, SSS Optical Technologies, LLC (USA); Darayas Patel, Oakwood Univ. (USA); Allan Burkett, Simeon Wilson, Ashley Blackwell, Dillard Univ. (USA); Brent Koplitz, Tulane Univ. (USA) ..... [9586-1]**Negative differential resistance behaviors in SnO<sub>2</sub> thin film**, Chih-Yi Hsieh, National Central Univ. (Taiwan) ..... [9586-2]**Orientation dependence of dispersion and band gap of PIMNT single crystal**, Chongjun He, Nanjing Univ. of Aeronautics and Astronautics (China); Hongbing Chen, Ningbo Univ. (China); Jiming Wang, Xiaorong Gu, Tong Wu, Youwen Liu, Nanjing Univ. of Aeronautics and Astronautics (China) ..... [9586-3]**Significant near-IR light transmission asymmetry demonstrated in an all-dielectric (1-2)-dimensional photonic crystals**, Lukasz Zirkiewicz, Univ. of Warsaw (Poland); Jakub Haberko, AGH Univ. of Science and Technology (Poland); Piotr Wasylczyk, Univ. of Warsaw (Poland) ..... [9586-4]**Polarization holograms in gold nanoparticle-doped PQ/PMMA photopolymer**, Liangcai Cao, Chengmingyu Li, Zheng Wang, Guofan Jin, Tsinghua Univ. (China) ..... [9586-5]**Terahertz electrical and optical properties of LiNbO<sub>3</sub> single crystal thin films**, Moumita Dutta, Xomalin G. Peralta, Carol Ellis, Amar S. Bhalla, Ruyan Guo, The Univ. of Texas at San Antonio (USA) ..... [9586-6]**Magneto-acoustic-electroporation (MAEP): In-vitro visualization and numerical characterization**, Soutik Betal, Binita Shrestha, The Univ. of Texas at San Antonio (USA); Luiz F. Cotica, Univ. Estadual do Maringá (Brazil); Liang Tang, Kelly L. Nash, Amar S. Bhalla, Ruyan Guo, The Univ. of Texas at San Antonio (USA) ..... [9586-7]**Design and development of a high sensitive low cost fiber optic refractometer**, Vayunandana Kishore Pabbisetty, National Institute of Technology, Warangal (India) ..... [9586-8]**Study of P-type TiO<sub>2</sub> thin film and transparent p-n junction device**, Chia-Hua Lin, National Central Univ. (Taiwan) ..... [9586-9]

Lunch Break ..... Sun 11:50 am to 1:50 pm

**SESSION 2..... SUN 1:50 PM TO 5:20 PM****Advances in Photonic Crystals and Materials II**

Session Chairs: Partha P. Banerjee, Univ. of Dayton (USA); Ruyan Guo, The Univ. of Texas at San Antonio (USA)

**Formation of ultrashort parabolic pulses via passive nonlinear reshaping in normal dispersive optical fibers at 1550 nm**, Igor A. Sukhoivanov, Univ. de Guanajuato (Mexico); Sergii O. Iakushev, Kharkiv National Univ. of Radio Electronics (Ukraine); Oleksiy V. Shulika, Erick R. Baca Montero, Alejandro Barrientos García, Luis A. Herrera Piad, Igor V. Guryev, José A. Andrade Lucio, Univ. de Guanajuato (Mexico) ..... [9586-10]**A novel As<sub>2</sub>S<sub>5</sub>-tellurite hybrid photonic crystal fiber for long mid-IR supercontinuum fiber lasers**, Mbaye Diouf, Univ. Cheikh Anta Diop (Senegal); Amine Ben Salem, Rim Cherif, National Engineering School of Communication of Tunis (Tunisia); Ahmadou Wague, Univ. Cheikh Anta Diop (Senegal); Mourad Zghal, National Engineering School of Communication of Tunis (Tunisia) ..... [9586-11]**The changes of energy propagation due to radiation load on optical fiber couplers**, Frantisek Perecar, Lukas Bednarek, VSB-Technical Univ. of Ostrava (Czech Republic); Michal Lucki, Czech Technical Univ. in Prague (Czech Republic); Andrej Liner, VSB-Technical Univ. of Ostrava (Czech Republic); Lukas Hajek, Czech Technical Univ. in Prague (Czech Republic) and VSB-Technical Univ. of Ostrava (Czech Republic); Martin Papes, Jakub Jaros, Vladimir Vasinek, VSB-Technical Univ. of Ostrava (Czech Republic) ..... [9586-12]**Improve the light power of InP based 100nm tunable AMQW lasers using forced electrical confinement method**, Hesham M. Enshasy, King Faisal Univ. (Saudi Arabia) ..... [9586-13]**Design and analysis of rectangular photonic crystal fiber for supercontinuum generation**, Than Singh Saini, Ajeet Kumar, Ravindra K. Sinha, Delhi Technological Univ. (India) ..... [9586-14]**Design of single mode single polarization large mode area photonic crystal fiber**, Kishor D. Naik, Than Singh Saini, Ajeet Kumar, Ravindra K. Sinha, Delhi Technological Univ. (India) ..... [9586-15]**Design and development of high-temperature sensor using FBG**, Venkata Reddy Mamidi, Venkatappa Rao Thumu, National Institute of Technology, Warangal (India) ..... [9586-16]**Investigation of electrical, optical and structural properties of sputtered indium tin oxide thin film**, Md. Tanvir Hasan, Amar S. Bhalla, Ruyan Guo, The Univ. of Texas at San Antonio (USA) ..... [9586-17]**Developing of 2D helical waves in semiconductor under the action of femtosecond laser pulse and external electric field**, Vyacheslav A. Trofimov, Vladimir A. Egorenkov, Mariya M. Loginova, Lomonosov Moscow State Univ. (Russian Federation) ..... [9586-18]**SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM****Welcome and Opening Remarks****Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

# CONFERENCE 9586

MONDAY 10 AUGUST

SESSION 3.....MON 8:40 AM TO 12:10 PM

## Innovations in Devices and Applications I

Session Chair: Wei-Hung Su, National Sun Yat-Sen Univ. (Taiwan)

**Integrated Ti:lithium niobate digital optical switch (DOS) for quantum information processing**, Richard S. Kim, Eunsung Shin, Attila Szep, Michael Fanto, Paul M. Alsing, Air Force Research Lab. (USA); Antao Chen, Beckman Coulter, Inc. (USA).....[9586-19]

**Massive orbital angular momentum channels for high capacity optical communication using Dammann gratings**, Ting Lei, Shenzhen Univ. (China); Meng Zhang, Nankai Univ. (China); Yuru Li, Zhaojun Li, Jinan Univ. (China); Xiacong Yuan, Shenzhen Univ. (China).....[9586-20]

**Global sensitivity analysis for fine-tuning the dispersion properties of photonic crystal fibers**, Igor V. Guryev, Igor A. Sukhoivanov, Jose A. Andrade Lucio, Everardo Vargas Rodrigues, Oleksiy V. Shulika, Univ. de Guanajuato (Mexico).....[9586-21]

**Break-through of the spatial bandwidth product limit of digital holographic image detection by a light pipe**, Yeh-Wei Yu, Ting-Wei Lin, Ching-Cheng Sun, National Central Univ. (Taiwan).....[9586-22]

**Numerical investigation of silicon nitride trench waveguide**, Qiancheng Zhao, Yuwang Huang, Rasul Torun, Shah Rahman, Tuva C. Atasever, Ozdal Boyraz, Univ. of California, Irvine (USA).....[9586-23]

**Slow light generated via Brillouin scattering in small core chalcogenide photonic crystal fiber**, Amira Bailli, Rim Cherif, Mourad Zghal, SUP'COM (Tunisia).....[9586-24]

**Angular interrogation of evanescent wave absorption spectroscopy based sensors for harsh environment sensing applications**, Paul R. Ohodnicki Jr., Michael P. Buric, Zsolt L. Poole, National Energy Technology Lab. (USA) [9586-25]

**Simultaneous multi-parametric sensing in phase-shifted waveguide gratings**, Renikumar Mudachathi, Takuji Tanaka, RIKEN (Japan); Manoj M. Varma, Indian Institute of Science (India).....[9586-26]

**Digital holographic interferometer with a self-pumped phase conjugating mirror**, Prathan Buranasiri, King Mongkut's Institute of Technology Ladkrabang (Thailand).....[9586-27]

Lunch Break ..... Mon 12:10 pm to 2:10 pm

SESSION 4.....MON 2:10 PM TO 4:40 PM

## Innovations in Devices and Applications II

Session Chairs: Paul B. Ruffin, U.S. Army Research, Development and Engineering Command (USA); Shizhuo Yin, The Pennsylvania State Univ. (USA)

**Nanosecond speed KTN beam deflector**, Shizhuo Yin, Juhung Chao, Wenbin Zhu, Chao Wang, The Pennsylvania State Univ. (USA); Robert Hoffman, U.S. Army Research Lab. (USA).....[9586-28]

**Fibre optic sensors for load-displacement measurements and its comparisons to piezo sensor based electromechanical admittance signatures**, Muneesh Maheshwari, Venu Gopal M. Annadhas, John H. L. Pang, Swee Chuan Tjin, Anand K. Asundi, Nanyang Technological Univ. (Singapore).....[9586-29]

**Supersymmetric mode converters**, Matthias Heinrich, Friedrich-Schiller-Univ. Jena (Germany); Mohammad-Ali Miri, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); Simon Stützer, Stefan Nolte, Alexander Szameit, Friedrich-Schiller-Univ. Jena (Germany); Demetrios N. Christodoulides, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA).....[9586-30]

**Design and implementation of super broadband high speed waveguide switches**, Shizhuo Yin, Pennsylvania State Univ (USA); Wenbin Zhu, Penn State Univ. (USA); Juhung Chao, Chao Wang, Jimmy Yao, Penn State Univ (USA).....[9586-31]

**Slow light effect in pinch waveguide in photonic crystal**, Ravindra K. Sinha, Preeti Rani, Yogita Kalra, Delhi Technological Univ. (India) .....

[9586-32]  
**Investigation the effects of dispersion and intensity on supercontinuum spectrum**, Abolfazl Safaei, Mohammad Agha Bolorizadeh, Aliashgar Zakerifar, Graduate Univ. of Advanced Technology - Kerman (Iran, Islamic Republic of) .....

[9586-33]

POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

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**Post-shaping optical fiber taper filters**, Alejandro Martínez-Rios, Ctr. de Investigaciones en Óptica, A.C. (Mexico); Gilberto Anzueto-Sánchez, Univ. Autónoma del Estado de Morelos (Mexico); Romeo Selvas-Aguilar, Daniel Toral-Acosta, Univ. Autónoma de Nuevo León (Mexico); Victor Manuel Duran-Ramirez, Univ. de Guadalajara (Mexico); Guillermo Salceda-Delgado, Ctr. de Investigaciones en Óptica, A.C. (Mexico).....[9586-34]

**3 x 3 free-space optical router based on crossbar network and its control algorithm**, Peipei Hou, Jianfeng Sun, Zhou Yu, Wei Lu, Lijuan Wang, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) .....

[9586-35]  
**According to difference by poly styrene-block-poly-2-vinyl pyridine of molecular weight and swelling solution change, color difference in particle of photonic crystal**, Jin Youb Lim, Hongik Univ. (Korea, Republic of) .....

[9586-36]  
**According to diblock copolymer photonic film of various molecular weight, difference of wavelength change**, Sang Wook Lee, Hongik Univ. (Korea, Republic of) .....

[9586-37]  
**The ageing process of optical couplers by gamma irradiation**, Lukas Bednarek, Frantisek Perecar, Martin Papes, Lukas Hajek, Jan Nedoma, Vladimir Vasinek, VŠB-Technical Univ. of Ostrava (Czech Republic) .....

[9586-38]  
**DLC and AlN thin films influence the thermal conduction of HPLED light**, Ming Seng Hsu, Chinese Military Academy (Taiwan); Ching Yao Hsu, Cantwell-Sacred Heart of Mary High School (USA); Jen Wei Huang, Feng Lin Shyu, Chinese Military Academy (Taiwan) .....

[9586-39]  
**S-band multi-wavelength Brillouin Raman fiber laser utilizing FBG and Raman amplifier in the ring cavity**, Nor Azura Malini B. Ahmad Hamblin, Nur Elina B. Anwar, Muhammad Halim B. Abdul Wahid, Mukhzeer B. Mohamad Shahimin, Mohd Azarulsani B. Md. Azidin, Amira Zakiah B. Malek, Roshidah B. Yusof, Univ. Malaysia Perlis (Malaysia) .....

[9586-40]  
**Two-center recording in LiNbO<sub>3</sub>:Fe:Ru and LiNbO<sub>3</sub>:Ce:Ru crystals**, Zhifang Chai, East China Normal Univ. (China) .....

[9586-41]  
**Photon management assisted by surface modes on a photonic crystal platform**, Angelo Angelini, Politecnico di Torino (Italy); Luca Boarino, Istituto Nazionale di Ricerca Metrologica (Italy); Peter Munzert, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); Natascia De Leo, Istituto Nazionale di Ricerca Metrologica (Italy); Emiliano Descrovi, Politecnico di Torino (Italy) .....

[9586-42]  
**A tunable wavelength erbium doped fiber ring laser based on mechanically induced long-period fiber gratings**, Miguel Perez Maciel, Yanelis López Dieguez, Roberto Rojas Laguna, Eduardo H. Huerta Masscote, Daniel Jauregui Vazquez, Juan M. Sierra Hernández, Ruth I. Mata Chávez, Julián Móises Estudillo Ayala, Univ. de Guanajuato (Mexico) .....

[9586-43]  
**A cylindrical structure fiber-optic amplifier with broad-side pump coupling**, Steven R. Laxton, Tyler Bravo, Christi K. Madsen, Texas A&M Univ. (USA) [9586-44]

[9586-45]  
**Investigation of the laser energy parameters for laser initiation**, Natalia Korobova, Veniamin A. Vodopyanov, Evgeny Paderin, Evgeny Sholokhov, Sergey P. Timoshenkov, Valeri Timoshenkov, National Research Univ. of Electronic Technology (Russian Federation) .....

[9586-46]  
**Sputtered germanium/silicon devices for photonics applications**, Naga Korivi, Melvin DeBerry, Nabila Nujhat, Jean-Pierre Papouloute, Li Jiang, Tuskegee Univ. (USA) .....

[9586-47]  
**Memristor memory element based on ZnO thin film structures**, Armen R. Poghosyan, Elbak Y. Elbakyani, Institute for Physical Research (Armenia); Ruyan Guo, The Univ. of Texas at San Antonio (USA); Ruben K. Hovsepyan, Institute for Physical Research (Armenia) .....

[9586-48]  
**80 channels HDTV signal transmission using optical carrier suppression scheme and injection-locked FPLDs**, Ardhendu S. Patra, Sidho-Kanho-Birsha Univ. (India) .....

[9586-49]  
**Bidirectional and simultaneous FTTH/Ethernet services using RSOA based remodulation and polarization multiplexing technique**, Ardhendu S. Patra, Anindya Sundar Das, Sidho-Kanho-Birsha Univ. (India) .....

[9586-50]  
**Gray-level encoded fringe projection for profile measurements**, Wei-Hung Su, Bo-Chin Huang, National Sun Yat-Sen Univ. (Taiwan) .....

[9586-51]  
**Projected fringe profilometry for metal surfaces**, Wei-Hung Su, Bo-Chin Huang, National Sun Yat-Sen Univ. (Taiwan) .....

[9586-52]  
**Three-dimensional shape measurements using endoscopes**, Wei-Hung Su, Tzu-Chien Hsu, Cho-Yo Kuo, National Sun Yat-Sen Univ. (Taiwan) .....

[9586-53]  
**A reliable image processing algorithm using the scanning fringe projection for 3D profile measurements**, Wei-Hung Su, National Sun Yat-Sen Univ. (Taiwan); Nai-Jen Cheng, National Kaohsiung Univ. of Applied Sciences (Taiwan) .....

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# Optical Data Storage 2015

Conference Chairs: Ryuichi Katayama, Fukuoka Institute of Technology (Japan); Thomas D. Milster, College of Optical Sciences, The Univ. of Arizona (USA)

Program Committee: Mark R. Ayres, Akonia Holographics, LLC (USA); Min Gu, Swinburne Univ. of Technology (Australia); Luping Shi, Tsinghua Univ. (China); Kenichi Shimada, Hitachi, Ltd. (Japan); Yuzuru Takashima, College of Optical Sciences, The Univ. of Arizona (USA); Din Ping Tsai, National Taiwan Univ. (Taiwan)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 8:45 AM TO 10:00 AM

#### Holographic Data Storage I

Session Chair: Kenichi Shimada, Hitachi, Ltd. (Japan)

**Multi-terabit/in<sup>2</sup> holographic data storage demonstration (Invited Paper)**, Mark R. Ayres, Ken E. Anderson, Fred Askham, Brad Sissom, Adam C. Urness, Akonia Holographics, LLC (USA) ..... [9587-1]

**Numerical evaluation of multilayer holographic data storage with a varifocal lens generated with a spatial light modulator**, Teruyoshi Nobukawa, Takanori Nomura, Wakayama Univ. (Japan) ..... [9587-2]

**Design of binary data page with a phase mask for high-density holographic recording**, Daisuke Barada, Shigeo Kawata, Toyohiko Yatagai, Utsunomiya Univ. (Japan) ..... [9587-3]

**Optimization of holographic data storage system based on Seidel aberrations reduction**, Ren-Chung Liu, National Chiao Tung Univ. (Taiwan) ..... [9587-4]

### SESSION 2 ..... SUN 10:30 AM TO 12:00 PM

#### Holographic Data Storage II

Session Chair: Mark R. Ayres, Akonia Holographics, LLC (USA)

**Recent progress towards practical holographic digital data storage system (Invited Paper)**, Yuzuru Takashima, The Univ. of Arizona (USA) ..... [9587-5]

**Quantitative roadmap of holographic media performance (Invited Paper)**, Benjamin A. Kowalski, Robert R. McLeod, Univ. of Colorado at Boulder (USA) ..... [9587-6]

**High dynamic range holographic data storage media**, Mark R. Ayres, Fred Askham, Adam C. Urness, Akonia Holographics, LLC (USA) ..... [9587-7]

**Proposal for one-beam microholographic recording using radially polarized light beam**, Ryuichi Katayama, Fukuoka Institute of Technology (Japan) .. [9587-8]

Lunch Break ..... Sun 12:00 pm to 1:30 pm

### SESSION 3 ..... SUN 1:30 PM TO 3:30 PM

#### Emerging and Elemental Technologies

Session Chair: Ryuichi Katayama, Fukuoka Institute of Technology (Japan)

**Metasurface: Where meta, microfluidic, and tunable meet? (Invited Paper)**, Wei Zhang, Nanyang Technological Univ. (Singapore); D. T. Tsai, National Taiwan Univ. (Taiwan); Zhen Chuan Yang, Xing Zhu, Peking Univ. (China); Federico Capasso, Harvard School of Engineering and Applied Sciences (USA); Al Qun Liu, Nanyang Technological Univ. (Singapore) ..... [9587-9]

**Potential of multi-photon reading and writing for optical data storage systems (Invited Paper)**, Thomas D. Milster, Phat Lu, Khanh Kieu, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9587-10]

**Roll-to-roll fabrication of multilayer polymer films for high capacity optical data storage (Invited Paper)**, Kenneth D. Singer, Cory W. Christenson, Anuj Saini, Case Western Reserve Univ. (USA); Christopher J. Ryan, Heather Mirletz, Irina Shyanovskaya, Folio Photonics LLC (USA); Kezhen Yin, Eric Baer, Case Western Reserve Univ. (USA) ..... [9587-11]

**Air gap control and residual aberration compensation in a Hyper Blu-Ray Disc (NA=1.4) objective**, Victor E. Densmore, Young-Sik Kim, Thomas D. Milster, College of Optical Sciences, The Univ. of Arizona (USA); Matthew C. Watson, Dolaphine Kwok, The Univ. of Arizona (USA) ..... [9587-12]

**Optimized six-dimensional optical storage: A practicable way to large capacity and fast throughputs**, Shangqing Liu, Willow Optics Corp. (Canada) ... [9587-13]

### SESSION 4 ..... SUN 4:00 PM TO 5:15 PM

#### Holographic Data Storage III

Session Chair: Yuzuru Takashima, The Univ. of Arizona (USA)

**Modeling and measures against the effect of mechanical instabilities on holographic data storage system (Invited Paper)**, Kenichi Shimada, Toshiki Ishii, Taku Hoshizawa, Hitachi, Ltd. (Japan); Yuzuru Takashima, The Univ. of Arizona (USA) ..... [9587-14]

**Enhancement of data rates by single and double cavity holographic recording**, Bo E. Miller, Yuzuru Takashima, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9587-15]

**Optimized aperture for collinear holographic data storage system**, Jinqiu Liu, Yan Zhao, Liangcai Cao, Hao Zhang, Guofan Jin, Tsinghua Univ. (China). [9587-16]

**Volume holography with Bessel-like reference beams**, Raphael A. Guerrero, Jonathan P. Manigo, Ateneo de Manila Univ. (Philippines) ..... [9587-17]

### SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

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# Advances in X-Ray/EUV Optics and Components X

**Conference Chairs:** **Shunji Goto**, Japan Synchrotron Radiation Research Institute (Japan); **Christian Morawe**, European Synchrotron Radiation Facility (France); **Ali M. Khounsary**, X-ray Optics, Inc. (USA), Illinois Institute of Technology (United States)

**Program Committee:** **Lucia Alianelli**, Diamond Light Source Ltd. (United Kingdom); **Lahsen Assoufid**, Argonne National Lab. (USA); **Stefan Braun**, Fraunhofer IWS Dresden (Germany); **Shih-Lin Chang**, National Tsing Hua Univ. (Taiwan); **Raymond Conley Jr.**, Argonne National Lab. (USA); **Sultan B. Dabagov**, Istituto Nazionale di Fisica Nucleare (Italy); **Christian David**, Paul Scherrer Institut (Switzerland); **Hans M. Hertz**, KTH Royal Institute of Technology (Sweden); **Werner H. Jark**, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); **George A. Kyrala**, Los Alamos National Lab. (USA); **Eric Louis**, Univ. Twente (Netherlands); **Carolyn A. MacDonald**, Univ. at Albany (USA); **Howard A. Padmore**, Lawrence Berkeley National Lab. (USA); **Ladislav Pina**, Czech Technical Univ. in Prague (Czech Republic); **Yuriy Ya Platonov**, Rigaku Innovative Technologies, Inc. (USA); **Seungyu Rah**, Pohang Univ. of Science and Technology (Korea, Republic of); **Peter Revesz**, Cornell Univ. (USA); **Horst Schulte-Schrepping**, Deutsches Elektronen-Synchrotron (Germany); **Regina Soufli**, Lawrence Livermore National Lab. (USA); **Stanislav Stoupin**, Argonne National Lab. (USA); **Akihiko Ueda**, JTEC Corp. (Japan); **Joerg Wiesmann**, Incoatec GmbH (Germany); **Makina Yabashi**, RIKEN (Japan), Japan Synchrotron Radiation Research Institute (Japan); **Kazuto Yamauchi**, Osaka Univ. (Japan); **Brian W. Yates**, Canadian Light Source Inc. (Canada)

## TUESDAY 11 AUGUST

### SESSION 1 ..... TUE 8:50 AM TO 10:10 AM

#### Multilayers

Session Chairs: **Shunji Goto**, Japan Synchrotron Radiation Research Institute (Japan); **Raymond Conley Jr.**, Argonne National Lab. (USA)

**Multilayer coatings for free-electron laser sources**, Alain J. Corso, Paola Zuppella, Davide Bacco, Enrico Tessaro, Marco Nardello, Francesca Gerlin, Univ. degli Studi di Padova (Italy); Emiliano Principi, Erika Giangrisostomi, Filippo Bencivenga, Alessandro Gessini, Claudio Masciovecchio, Angelo Giglia, Stefano Nannarone, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); Maria G. Pelizzo, Univ. degli Studi di Padova (Italy) ..... [9588-1]

**Graded multilayers for figured Kirkpatrick-Baez mirrors on the new ESRF end station ID16A**, Christian Morawe, Raymond Barrett, Peter Cloetens, Benjamin Lantelme, Jean-Christophe Peffen, Amparo Vivo, ESRF - The European Synchrotron (France) ..... [9588-2]

**In-situ GISAXS monitoring of ultrashort period W/B4C multilayer x-ray mirror growth**, Martin Hodas, Peter Šiffalovič, Yurii Halahovets, Marco Pelletta, Karol Vegso, Matej Jergel, Eva Majkova, Institute of Physics SAS (Slovakia) ..... [9588-3]

**Multilayer optics for monochromatic high-resolution x-ray imaging**, Philippe P. Troussel, Berenice Loupias, Vincent dervieux, Ludovic Lecherbourg, Dominique Gontier, Commissariat à l'Énergie Atomique (France); Alexandre DO, Sophie D. Baton, Frédéric Perez, Ecole Polytechnique (France) and Ctr. National de la Recherche Scientifique (France); David Dennett, Synchrotron SOLEIL (France) ..... [9588-4]

### SESSION 2 ..... TUE 10:40 AM TO 12:00 PM

#### Focusing

Session Chairs: **Ali M. Khounsary**, X-ray Optics, Inc. (USA), Illinois Institute of Technology (United States); **Kazuto Yamauchi**, Osaka Univ. (Japan)

**Development of an adaptive K-B mirror for hard x-ray nanofocusing using piezoelectric deformable mirrors**, Takumi Goto, Satoshi Matsuyama, Osaka Univ (Japan); Hiroki Nakamori, JTEC Corporation (Japan); Takashi Kimura, Hokkaido University (Japan); Yasuhisa Sano, Osaka Univ (Japan); Yoshiaki Kohmura, Makina Yabashi, Tetsuya Ishikawa, RIKEN/SPring-8 (Japan); Kazuto Yamauchi, Osaka Univ (Japan) ..... [9588-5]

**MZP design and fabrication for efficient hard x-ray nano-focusing and imaging**, Christian Eberl, Florian Döring, Hans-Ulrich Krebs, Markus Osterhoff, Georg-August-Univ. Göttingen (Germany) ..... [9588-6]

**Adaptive optics at the angstrom scale: from discrete to continuous surface manipulation**, Benjamin J. Wylie-van Erd, Univ. Twente (Netherlands); Bram Krijnen, DEMCON (Netherlands); Fred Bijkerk, Guus J. H. M. Rijnders, Eric Louis, Univ. Twente (Netherlands) ..... [9588-7]

**Evaluation of surface figure error profile of ultra-precise ellipsoidal mirror for soft x-ray focusing**, Yoko Takeo, Takahiro Saito, Hidekazu Mimura, The Univ. of Tokyo (Japan) ..... [9588-8]

Lunch/Exhibition Break ..... Tue 12:00 pm to 1:30 pm

### SESSION 3 ..... TUE 1:30 PM TO 3:10 PM

#### Optics Development and Fabrication

Session Chairs: **Christian Morawe**, ESRF - The European Synchrotron (France); **Hidekazu Mimura**, The Univ. of Tokyo (Japan)

**Profile-coating of x-ray optics using the new magnetron sputtering deposition system**, Bing Shi, Jun Qian, Raymond Conley, Argonne National Lab. (USA) ..... [9588-9]

**Recent advances in multilayer Laue lens fabrication techniques**, Raymond Conley Jr., Argonne National Lab. (USA) and Brookhaven National Lab. (USA); Nathalie Bouet, Juan Zhou, Hanfei Yan, Xiaojing Huang, Kenneth Lauer, Evgeny Nazaretski, Matthew Vescovi, Brookhaven National Lab. (USA); Adam Kubec, Fraunhofer IWS Dresden (Germany); Albert T. Macrander, Jörg Maser, Bing Shi, Argonne National Lab. (USA); Yong S. Chu, Brookhaven National Lab. (USA) ..... [9588-10]

**Development of polycapillary x-ray optics for synchrotron spectroscopy**, Daniel Bennis, Incom Inc. (USA) ..... [9588-11]

**RXR: a new experimental station for 2D and 3D micro-XRF based on polycapillary optics**, Claudia Polese, Istituto Nazionale di Fisica Nucleare (Italy) and Sapienza Univ. di Roma (Italy); Andrea Liedl, Dariush Hampai, Istituto Nazionale di Fisica Nucleare (Italy); Sultan B. Dabagov, Istituto Nazionale di Fisica Nucleare (Italy) and Russian Academy of Sciences (Russian Federation) and National Research Nuclear Univ. MEPhI (Russian Federation); Francesco Taccetti, Istituto Nazionale di Fisica Nucleare (Italy) ..... [9588-12]

**Large-area kapton x-ray windows**, Mikhail A. Antimonov, Univ. of Illinois at Chicago (USA); Ali M. Khounsary, X-ray Optics, Inc. (USA), Illinois Institute of Technology (USA); Steven J. Weigand, Jack Rix, Denis T. Keane, Jim Grudzinski, W. Jansma, Argonne National Lab. (USA); Zhenwen Zhou, Univ. of Illinois at Chicago (USA); A. Johnson, Bowling Green State Univ. (USA) ..... [9588-13]

### SESSION 4 ..... TUE 3:40 PM TO 5:00 PM

#### Instruments and Imaging

Session Chairs: **Ladislav Pina**, Czech Technical Univ. in Prague (Czech Republic); **Shunji Goto**, Japan Synchrotron Radiation Research Institute (Japan)

**Effect of beamline optics vibration on the source size and divergence for synchrotron radiation**, Shunji Goto, Japan Synchrotron Radiation Research Institute (Japan) ..... [9588-14]

**Development of split-delay optics with wide range of photon energy for XFEL pump/XFEL probe experiments**, Takashi Hirano, Taito Osaka, Osaka Univ. (Japan); Yuichi Inubushi, Japan Synchrotron Radiation Research Institute (Japan); Yasuhisa Sano, Satoshi Matsuyama, Osaka Univ. (Japan); Kensuke Tono, Tetsuo Katayama, Japan Synchrotron Radiation Research Institute (Japan); Tetsuya Ishikawa, RIKEN SPring-8 Ctr. (Japan); Kazuto Yamauchi, Osaka Univ. (Japan); Makina Yabashi, RIKEN SPring-8 Ctr. (Japan) ..... [9588-15]

**0.1-meV-resolution broadband imaging spectrographs for inelastic x-ray scattering**, Yuri V. Shvyd'ko, Argonne National Lab. (USA) ..... [9588-16]

**Virtual x-ray differential phase contrast imaging system simulator**, Young-Sik Kim, Chris Summitt, Sunglin Wang, The Univ. of Arizona (USA); Yin Yuen, Charles Qi, Lambertus Hesselink, Stanford Univ. (USA); Yuzuru Takashima, The Univ. of Arizona (USA) ..... [9588-17]

# CONFERENCE 9588

## WORKSHOP ON X-RAY OPTICS ..... 8:00 PM TO 10:00 PM

Chair: **Ali M. Khounsary**, X-ray Optics, Inc. (USA) and Illinois Institute of Technology (USA)

The X-Ray Optics Working Group provides an informal setting for the interested engineers and scientists to meet and discuss issues related to the design, analysis, cooling, fabrication, and metrology of x-ray optics. Topics for discussion can be e-mailed to the organizer, Dr. Ali Khounsary (amk@iit.edu), prior to the meeting.

## WEDNESDAY 12 AUGUST

### SESSION 5 ..... WED 10:30 AM TO 12:10 PM

#### **Optics for Coherent Sources: Joint Session with Conferences 9588 and 9589**

Session Chairs: **Carmen S. Menoni**, Colorado State Univ. (USA); **Ali M. Khounsary**, X-ray Optics, Inc. (USA), Illinois Institute of Technology (USA)

**Multilayer optics for coherent EUV/X-ray laser sources (Invited Paper)**, Franck Delmotte, Charles Bourassin-Bouchet, Sébastien de Rossi, Evgeni Melchakov, Maël Dehlinger, Lab. Charles Fabry (France) ..... [9589-6]

**X-ray diffractive optics (Invited Paper)**, Anne E. Sakdinawat, Sharon Oh, Chieh Chang, Jeongwon Park, SLAC National Accelerator Lab. (USA); Michael J. Rooks, Yale Univ. (USA); Richard C. Tiberio, Stanford Univ. (USA) ..... [9589-7]

**Waveguiding, mode filtering, and polarization control at extreme-ultraviolet frequencies**, Sergey Zayko, Georg-August-Univ. Göttingen (Germany) .. [9588-18]

**Development of ellipsoidal focusing mirror for soft x-ray and EUV**, Hidekazu Mimura, Yoshinori Takei, Takahiro Saito, Takehiro Kume, Hiroto Motoyama, Satoru Egawa, Yoko Takeo, Takahiro Higashi, The Univ. of Tokyo (Japan). .... [9588-19]

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# X-Ray Lasers and Coherent X-Ray Sources: Development and Applications XI

Conference Chairs: **Annie Klisnick**, CNRS, Univ. Paris-Sud 11 (France); **Carmen S. Menoni**, Colorado State Univ. (USA)

**Program Committee:** **Jens Biegert**, ICFO - Institut de Ciències Fotòniques (Spain); **Hiroyuki Daido**, Japan Atomic Energy Agency (Japan); **Yasin Ekinci**, Paul Scherrer Institut (Switzerland); **Sylvie Jacquemot**, Ecole Polytechnique (France); **Do-Kyeong Ko**, Gwangju Institute of Science and Technology (Korea, Republic of); **Michaela Kozlova**, Institute of Physics of the ASCR, v.v.i. (Czech Republic); **Ciaran L. S. Lewis**, Queen's Univ. Belfast (United Kingdom); **Stefan P. Moeller**, SLAC National Accelerator Lab. (USA); **Peter Viktor Nickles**, Gwangju Institute of Science and Technology (Korea, Republic of); **Joseph Nilsen**, Lawrence Livermore National Lab. (USA); **Jorge J. Rocca**, Colorado State Univ. (USA); **Regina Soufli**, Lawrence Livermore National Lab. (USA); **Szymon Suckewer**, Princeton Univ. (USA); **Gregory J. Tallents**, The Univ. of York (United Kingdom); **Alexander Vladimirovich Vinogradov**, P.N. Lebedev Physical Institute (Russian Federation); **Marco Zangrandi**, Sincrotrone Trieste S.C.p.A. (Italy)

## WEDNESDAY 12 AUGUST

### SESSION 1 ..... WED 8:00 AM TO 10:00 AM

#### X-Ray Interaction with Solids

Session Chairs: **Annie Klisnick**, Univ. Paris-Sud 11 (France); **Joseph Nilsen**, Lawrence Livermore National Lab. (USA)

**Observation of dynamics and modification of solid surface using a picosecond soft x-ray laser** (*Invited Paper*), Masaharu Nishikino, Tetsuya Kawachi, Noboru Hasegawa, Masahiko Ishino, Japan Atomic Energy Agency (Japan); Takuro Tomita, Univ. of Tokushima (Japan); Naofumi Ohnishi, Tohoku Univ. (Japan); Atsushi M. Ito, National Institute for Fusion Science (Japan); Takashi Eyma, Naoya Kakimoto, Rui Idutsu, Univ. of Tokushima (Japan); Yasuo Minami, Yokohama National Univ. (Japan); Tohru Suemoto, The Univ. of Tokyo (Japan); Anatoly Y. Faenov, Osaka Univ. (Japan); Nail A. Inogamov, Russian Academy of Sciences (Russian Federation); Mitsuru Yamagiwa, Japan Atomic Energy Agency (Japan) ... [9589-1]

**An overview of the application of extreme ultra-violet lasers in plasma heating and diagnosis**, Gregory J. Tallents, Valentin Aslanyan, Andrew K. Rossall, Sarah Wilson, The Univ. of York (United Kingdom) ... [9589-2]

**Low electron temperature in ablating materials formed by picosecond soft x-ray laser pulses**, Masahiko Ishino, Noboru Hasegawa, Masaharu Nishikino, Japan Atomic Energy Agency (Japan); Tatiana A. Pikuz, Russian Academy of Sciences (Russian Federation) and Osaka Univ. (Japan); Igor Y. Skobelev, Russian Academy of Sciences (Russian Federation) and National Research Nuclear Univ. MEPhI (Russian Federation); Anatoly Y. Faenov, Russian Academy of Sciences (Russian Federation) and Osaka Univ. (Japan); Nail A. Inogamov, Russian Academy of Sciences (Russian Federation); Tetsuya Kawachi, Mitsuru Yamagiwa, Japan Atomic Energy Agency (Japan) ... [9589-3]

**Advances in nanoscale 3D molecular imaging by soft x-ray laser ablation mass spectrometry**, Ilya Kuznetsov, Jorge Filevich, Mark R. Woolston, Tyler Green, Colorado State Univ. (USA); David Carlton, Weilun Chao, Eric Anderson, Lawrence Berkeley National Lab. (USA); Elliot Bernstein, Dean Crick, Debbie Crans, Colorado State Univ. (USA); Valentin Aslanyan, Andrew Rossall, Greg Tallents, The Univ. of York (United Kingdom); Tomas Burian, Libor Juha, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Jorge Rocca, Carmen Menoni, Colorado State Univ. (USA) ... [9589-4]

**XUV/x-ray laser-induced irreversible changes in solids** (*Invited Paper*), Libor Juha, Institute of Physics of the ASCR, v.v.i. (Czech Republic) ... [9589-5]

### SESSION 2 ..... WED 10:30 AM TO 12:10 PM

#### Optics for Coherent Sources: Joint Session with Conferences 9588 and 9589

Session Chairs: **Carmen S. Menoni**, Colorado State Univ. (USA); **Ali M. Khounsary**, X-ray Optics, Inc. (USA), Illinois Institute of Technology (United States)

**Multilayer optics for coherent EUV/X-ray laser sources** (*Invited Paper*), Franck Delmotte, Charles Bourassin-Bouchet, Sébastien de Rossi, Evgeni Melchakov, Maël Dehlinger, Lab. Charles Fabry (France) ... [9589-6]

**X-ray diffractive optics** (*Invited Paper*), Anne E. Sakdinawat, Sharon Oh, Chieh Chang, Jeongwon Park, SLAC National Accelerator Lab. (USA); Michael J. Rooks, Yale Univ. (USA); Richard C. Tiberio, Stanford Univ. (USA) ... [9589-7]

**Waveguiding, mode filtering, and polarization control at extreme-ultraviolet frequencies**, Sergey Zayko, Georg-August-Univ. Göttingen (Germany) ... [9588-18]

**Development of ellipsoidal focusing mirror for soft x-ray and EUV**, Hidekazu Mimura, Yoshinori Takei, Takahiro Saito, Takehiro Kume, Hiroto Motoyama, Satoru Egawa, Yoko Takeo, Takahiro Higashi, The Univ. of Tokyo (Japan) ... [9588-19]

Lunch/Exhibition Break ..... Wed 12:10 pm to 1:40 pm

### SESSION 3 ..... WED 1:40 PM TO 3:20 PM

#### X-Ray Interaction with Solids and Clusters

Session Chairs: **Regina Soufli**, Lawrence Livermore National Lab. (USA); **Hiroyuki Daido**, Japan Atomic Energy Agency (Japan)

**EUV laser photoelectron spectroscopy of mass selected neutral clusters** (*Invited Paper*), Elliot R. Bernstein, Shi Yin, Colorado State Univ. (USA) ... [9589-8]

**The observation of a transient surface morphology in the femtosecond laser ablation process by using the soft x-ray laser probe**, Noboru Hasegawa, Masaharu Nishikino, Masahiko Ishino, Japan Atomic Energy Agency (Japan); Takuro Tomita, The Univ. of Tokushima (Japan); Naofumi Ohnishi, Tohoku Univ. (Japan); Atsushi M. Ito, National Institute for Fusion Science (Japan); Takashi Eyma, Naoya Kakimoto, Rui Idutsu, The Univ. of Tokushima (Japan); Yasuo Minami, The Univ. of Tokyo (Japan); Motoyoshi Baba, Tohru Suemoto, The Univ. of Tokyo (Japan); Anatoly Y. Faenov, Osaka Univ. (Japan); Nail A. Inogamov, Russian Academy of Sciences (Russian Federation); Tetsuya Kawachi, Mitsuru Yamagiwa, Japan Atomic Energy Agency (Japan) ... [9589-9]

**Overview of warm dense matter experiments at SLAC** (*Invited Paper*), Eric C. Galtier, SLAC National Accelerator Lab. (USA) ... [9589-10]

**Generation of strongly-coupled plasma using Argon-based capillary discharge lasers**, Andrew K. Rossall, Valentin Aslanyan, Sarah Wilson, Gregory J. Tallents, The Univ. of York (United Kingdom) ... [9589-11]

# CONFERENCE 9589

SESSION 4 ..... WED 3:50 PM TO 5:50 PM

## Seeded X-Ray Lasers

Session Chairs: **Jorge J. Rocca**, Colorado State Univ. (USA); **Olga Kocharovskaya**, Texas A&M Univ. (USA)

**Development of an ultrashort plasma-based soft x-ray laser (Invited Paper)**, Adrien Depresseux, Lab. d'Optique Appliquée (France); Eduardo Oliva, Lab. de Physique des Gaz et des Plasmas (France); Julien Gautier, Fabien Tissandier, Lab. d'Optique Appliquée (France); Jaroslav Nejdl, Michaela Kozlova, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Gilles Maynard, Lab. de Physique des Gaz et des Plasmas (France); Jean-Philippe Goddet, Amar Tafzi, Agustin Lifschitz, Lab. d'Optique Appliquée (France); Hyung Taek Kim, Gwangju Institute of Science and Technology (Korea, Republic of) and Institute for Basic Science (Korea, Republic of); Sylvie Jacquemot, Lab. pour l'Utilisation des Lasers Intenses (France) and Commissariat à l'Energie Atomique et aux Energies Alternatives (France); Victor Malka, Kim Ta Phuoc, Cédric Thaury, Pascal Rousseau, Thierry Lefrou, Gregory Iaquaniello, Alessandro Flacco, Boris Vodungbo, Guillaume Lambert, Antoine Rousse, Philippe Zeitoun, Stéphane Sebbar, Lab. d'Optique Appliquée (France) ..... [9589-12]

**Modeling of dense injection-seeded Ni-like Krypton plasma amplifiers**, Eduardo Oliva, Univ. Politécnica de Madrid (Spain); Adrien Depresseux, Fabien Tissandier, Julien Gautier, Stéphane Sebbar, Lab. d'Optique Appliquée (France); Gilles Maynard, Lab. de Physique des Gaz et des Plasmas (France) ..... [9589-13]

**FEL seeding at FERMI: a root to table-top laser-like FEL performance (Invited Paper)**, Miltcho B. Danailov, Paolo Cinquegrana, Alexander A. Demidovich, Gabor Kurdi, Ivaylo P. Nikolov, Paolo Sigalotti, Elettra-Sincrotrone Trieste S.C.p.A. (Italy) ..... [9589-14]

**Chirped-pulse amplification in x-ray free-electron lasers**, Benoît Mahieu, Hugo Dacasa, Lab. d'Optique Appliquée (France); Marta Fajardo, Instituto Superior Técnico (Portugal); Thuy T. T. Le, Lab. d'Optique Appliquée (France); Lu Li, Queen's Univ. Belfast (Ireland); Eduardo Oliva, Univ. Politécnica de Madrid (Spain); Philippe Zeitoun, Lab. d'Optique Appliquée (France) ..... [9589-15]

**EIS-TIMER, mini-TIMER, and nano-TIMER: present and future experimental facilities for VUV/soft x-ray transient grating experiments**, Cristian Svetina, Elettra-Sincrotrone Trieste S.C.p.A. (Italy) ..... [9589-16]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Design challenges to photon diagnostics and beam line components under high-repetition-rate x-ray FEL operation**, Yiping Feng, SLAC National Accelerator Lab. (USA) ..... [9589-35]

**Soft x-ray source based on the high-current capillary-discharge system**, Jiri Schmidt, Karel Kolacek, Oleksandr Frolov, Jaroslav Straus, Institute of Plasma Physics of the ASCR, v.v.i. (Czech Republic) ..... [9589-36]

**Ultra-broadband ptychography with self-consistent coherence estimation from a high harmonic source**, Michal Odstrčil, Univ. of Southampton (United Kingdom) and RWTH Aachen Univ. (Germany); Peter Baksh, William S. Brocklesby, Jeremy G. Frey, Univ. of Southampton (United Kingdom) ..... [9589-37]

## THURSDAY 13 AUGUST

SESSION 5 ..... THU 8:00 AM TO 9:50 AM

## High-Repetition-Rate X-Ray Lasers and Applications

Session Chairs: **Chang Hee Nam**, Gwangju Institute of Science and Technology (Korea, Republic of); **Sylvie Jacquemot**, Lab. pour l'Utilisation des Lasers Intenses (France)

**Towards milliwatt average power table-top soft x-ray lasers (Invited Paper)**, Jorge J. Rocca, Brendan Reagan, Cory Baumgarten, Yong Wang, Shoujun Wang, Alex Rockwood, Liang Yin, Mario Marconi, Vyacheslav Shlyaptsev, Carmen Menoni, Colorado State Univ. (USA) ..... [9589-17]

**Single-shot phase-controlled diffraction imaging using an Ag x-ray laser at 13.9 nm**, Kyoung Hwan Lee, Hyeok Yun, Institute for Basic Science (Korea, Republic of); Jae Hee Sung, Seong Ku Lee, Institute for Basic Science (Korea, Republic of) and Advanced Photonics Research Institute (Korea, Republic of); Hwang Woon Lee, Institute for Basic Science (Korea, Republic of); Hyung Taek Kim, Institute for Basic Science (Korea, Republic of) and Advanced Photonics Research Institute (Korea, Republic of); Chang Hee Nam, Institute for Basic Science (Korea, Republic of) and Gwangju Institute of Science & Technology (Korea, Republic of) ..... [9589-18]

**X-ray characterization of short-pulse laser illuminated hydrogen storage alloys having very high performance**, Hiroyuki Daido, Japan Atomic Energy Agency (Japan) ..... [9589-19]

**Coherent diffractive imaging employing a laboratory-scale, spatially partially-coherent discharge plasma EUV light source**, Jan Bussmann, Forschungszentrum Jülich GmbH (Germany) and RWTH Aachen Univ. (Germany) and JARA-Fundamentals of Future Information Technology (Germany); Michal Odstrčil, Univ. of Southampton (United Kingdom) and RWTH Aachen Univ. (Germany); Raoul Bresenitz, Forschungszentrum Jülich GmbH (Germany) and JARA-Fundamentals of Future Information Technology (Germany) and RWTH Aachen Univ. (Germany); Denis Rudolf, Forschungszentrum Jülich GmbH (Germany); William S. Brocklesby, Univ. of Southampton (United Kingdom); Jianwei Miao, Univ. of California, Los Angeles (USA) and California Nano Systems Institute (USA); Detlev Grützmacher, Forschungszentrum Jülich GmbH (Germany); Larissa Juschkin, RWTH Aachen Univ. (Germany) and Forschungszentrum Jülich GmbH (Germany) ..... [9589-20]

**3D nanoscale imaging of biological samples with laboratory-based soft x-ray sources**, Aurélie Dehlinger, Berlin Lab. for Innovative X-ray Technologies (Germany) and Technische Univ. Berlin (Germany) and Max-Born-Institut (Germany); Anne Blechschmidt, Technische Univ. Berlin (Germany); Birgit Kanngießer, Technische Univ. Berlin (Germany) and Berlin Lab. for Innovative X-ray Technologies (Germany); Martina C. Meinke, Fiorenza Rancan, Charité Universitätsmedizin Berlin (Germany); Kai Reineke, Leibniz-Institut für Agrartechnik Potsdam-Bornim e.V. (Germany); Christian Seim, Berlin Lab. for Innovative X-ray Technologies (Germany) and Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie (Germany); Holger Stiel, Berlin Lab. for Innovative X-ray Technologies (Germany); Stephan Werner, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany) ..... [9589-21]

SESSION 6 ..... THU 10:20 AM TO 12:10 PM

## Beam Properties and Diagnostics

Session Chairs: **Larissa Juschkin**, RWTH Aachen Univ. (Germany); **Cristian Svetina**, Elettra-Sincrotrone Trieste S.C.p.A. (Italy)

**Output beam polarisation of x-ray lasers with transient inversion (Invited Paper)**, Karol A. Janulewicz, Gwangju Institute of Science and Technology (Korea, Republic of); Chul Min Kim, Gwangju Institute of Science and Technology (Korea, Republic of) and Institute of Basic Science (Korea, Republic of); Holger Stiel, Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie (Germany); Tetsuya Kawachi, Masaharu Nishikino, Noboru Hasegawa, Japan Atomic Energy Agency (Japan) ..... [9589-22]

**Spectral interferometric methods for the complete characterization of femtosecond extreme-ultraviolet pulses**, Benoît Mahieu, Hugo Dacasa, Lab. d'Optique Appliquée (France); Lu Li, Queen's Univ. Belfast (Ireland); Eduardo Oliva, Univ. Politécnica de Madrid (France); Philippe Zeitoun, Lab. d'Optique Appliquée (France) ..... [9589-23]

**Influence of the partial temporal coherence of XUV laser pulses on the measurement of their spectral properties**, Andréa Le Marec, Institut des Sciences Moléculaires d'Orsay (France) and Ctr. National de la Recherche Scientifique (France); Olivier A. Guillaud, Univ. Paris-Sud 11 (France) and Ctr. National de la Recherche Scientifique (France); Pierre Chavel, Ctr. National de la Recherche Scientifique (France) and Univ. Paris-Sud II (France); Olivier Larroche, Commissariat à l'Energie Atomique (France); Annie Klisnick, Univ. Paris-Sud 11 (France) ..... [9589-24]

**Wigner distribution measurement of the spatial coherence properties of FELs**, Tobias Mey, Bernd Schäfer, Klaus Mann, Laser-Lab. Göttingen e.V. (Germany); Barbara Keitel, Elke Plönnies, Marion Kuhlmann, Deutsches Elektronen-Synchrotron (Germany) ..... [9589-25]

**Cross-correlation measurement of femtosecond hard x-ray pulses from a laser plasma source: approaching 100 fs benchmark**, Mazhar Iqbal, Muhammad Ijaz, Gwangju Institute of Science and Technology (Korea, Republic of); Holger Stiel, Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie (Germany); Do Young Noh, Karol A. Janulewicz, Gwangju Institute of Science and Technology (Korea, Republic of) ..... [9589-26]

Lunch/Exhibition Break ..... Thu 12:10 pm to 1:40 pm

# CONFERENCE 9589

## SESSION 7 ..... THU 1:40 PM TO 3:20 PM

### High-Harmonics and Applications

Session Chairs: **Gregory J. Tallents**, The Univ. of York (United Kingdom);  
**Eduardo Oliva**, Univ. Politècnica de Madrid (Spain)

**Applications of EUV high-harmonics for probing molecular structure and ultrafast dynamics (Invited Paper)**, Chang Hee Nam, Institute for Basic Science (Korea, Republic of) and Gwangju Institute of Science and Technology (Korea, Republic of); Hyek Yun, Institute for Basic Science (Korea, Republic of); Hyung Taek Kim, Kyung Taec Kim, Institute for Basic Science (Korea, Republic of) and Gwangju Institute of Science and Technology (Korea, Republic of) . . . . . [9589-27]

**The MEL-X project at the Lawrence Livermore National Laboratory: a multilayer delay line for x-rays**, Tommaso Pardini, Randolph M. Hill, Jennifer B. Alameda, Regina Soufli, Lawrence Livermore National Lab. (USA); Andy Aquila, Sébastien Boutet, SLAC National Accelerator Lab. (USA); Stefan P. Hau-Riege, Lawrence Livermore National Lab. (USA) . . . . . [9589-28]

**High-harmonics generation and applications (Invited Paper)**, Jens Biegert, Seth L. Cousin, Stephan Teichmann, Michael Hemmer, Barbara Buades, Noslen Suarez, Francisco Silva, Nicola Di Palo, ICFO - Institut de Ciències Fotòniques (Spain) . . . . . [9589-29]

**Scalings of high-order harmonics from relativistic electron cusps**, Alexander S. Pirozhkov, Masaki Kando, Timur Z. Esirkepov, Japan Atomic Energy Agency (Japan); Tatiana A. Pikuz, Photon Pioneers Ctr. in Osaka Univ. (Japan) and Joint Institute for High Temperatures of the Russian Academy of Sciences (JIHT RAS) (Russian Federation); Anatoly Ya. Faenov, Osaka Univ. (Japan); Koichi Ogura, Yukio Hayashi, Hideyuki Kotaki, Japan Atomic Energy Agency (Japan); Eugene N Ragozin, P.N. Lebedev Physical Institute (Russian Federation) and Moscow Institute of Physics and Technology (Russian Federation); David Neely, STFC Rutherford Appleton Lab. (United Kingdom) and Univ. of Strathclyde (United Kingdom); Hiromitsu Kuriyama, James K. Koga, Yuji Fukuda, Akito Sagisaka, Masaharu Nishikino, Takashi Imazono, Noboru Hasegawa, Tetsuya Kawachi, Hiroyuki Daido, Japan Atomic Energy Agency (Japan); Yoshiaki Kato, The Graduate School for the Creation of New Photonics Industries (Japan); Paul R. Bolton, Sergei V. Bulanov, Kiminori Kondo, Japan Atomic Energy Agency (Japan) . . . . . [9589-30]

## SESSION 8 ..... THU 3:50 PM TO 5:30 PM

### New X-Ray Sources

Session Chairs: **Annie Klisnick**, Univ. Paris-Sud 11 (France); **Carmen S. Menoni**, Colorado State Univ. (USA)

**Attosecond pulses formation via switching of resonant interaction by tunnel ionization (Invited Paper)**, Timur R. Akhmedzhanov, Texas A&M Univ. (USA); Vladimir A. Antonov, Institute of Applied Physics (Russian Federation); Yevgeny V. Radeonychev, Institute of Applied Physics (Russian Federation) and Russian Academy of Sciences (Russian Federation); Olga Kocharovskaya, Texas A&M Univ. (USA) . . . . . [9589-31]

**Using the XFEL to drive the gain of inner-shell x-ray lasers using photo-ionization and photo-excitation processes**, Joseph Nilsen, Lawrence Livermore National Lab. (USA) . . . . . [9589-32]

**Enhancement of laser-driven betatron radiation (Invited Paper)**, Liming Chen, The Institute of Physics (China) . . . . . [9589-33]

**Multi-stage Auger pumping of atomic EUV lasers in Xe and Kr by a soft x-ray free-electron laser**, Laurent Mercadier, Clemens Weninger, Ctr. for Free-Electron Laser Science (Germany) and Max-Planck-Institut für Physik komplexer Systeme (Germany); Sven Bernitt, Michael Blessenohl, Hendrick Bekker, Stepan Dobrodey, Max-Planck-Institut für Kernphysik (Germany); Alvaro Sanchez-Gonzalez, Imperial College London (United Kingdom); Cedric Bomme, Deutsches Elektronen-Synchrotron (Germany); Benjamin Erk, Deutsches Elektronen-Synchrotron (Germany); Philipp Schmidt, Martin Wilke, Andre Knie, Univ. Kassel (Germany); Wen Te Liao, Ctr. for Free-Electron Laser Science (Germany) and Max-Planck-Institut für Physik komplexer Systeme (Germany); Artem Rudenko, Kansas State Univ. (USA); Zhong Yin, Deutsches Elektronen-Synchrotron (Germany); Jan P. Müller, Technische Univ. Berlin (Germany); Rebecca Boll, Evgeny Savelyev, Rolf Treusch, Andrey Sorokin, Deutsches Elektronen-Synchrotron (Germany); Daniel Rolles, Deutsches Elektronen-Synchrotron (Germany); Arno Ehresmann, Univ. Kassel (Germany); Jose R. Crespo Lopez-Urrutia, Max-Planck-Institut für Kernphysik (Germany); Nina Rohringer, Ctr. for Free-Electron Laser Science (Germany) and Max-Planck-Institut für Physik komplexer Systeme (Germany) . . . . . [9589-34]

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# Advances in Laboratory-based X-Ray Sources, Optics, and Applications IV

Conference Chairs: **Ali M. Khounsary**, X-ray Optics, Inc. (USA), Illinois Institute of Technology (United States); **Carolyn A. MacDonald**, Univ. at Albany (USA)

Program Committee: **Mark A. Anastasio**, Washington Univ. in St. Louis (USA); **Sandra G. Biedron**, Colorado State Univ. (USA); **Jovan G. Brankov**, Illinois Institute of Technology (USA); **Björn Hansson**, Exciilum AB (Sweden); **Hans M. Hertz**, KTH Royal Institute of Technology (Sweden); **George A. Kyrala**, Los Alamos National Lab. (USA); **Derrick C. Mancini**, Illinois Institute of Technology (USA); **Ladislav Pina**, Czech Technical Univ. in Prague (Czech Republic); **J. Scott Price**, GE Global Research (USA); **Gert E. van Dorssen**, PANalytical B.V. (Netherlands)

## MONDAY 10 AUGUST

### WELCOME AND OPENING REMARKS ..... 8:30 AM TO 8:40 AM

**Ali M. Khounsary**, X-ray Optics, Inc. (USA) and Illinois Institute of Technology (USA)

### SESSION 1 ..... MON 8:40 AM TO 10:20 AM

#### Novel X-Ray Sources I

Session Chairs: **J. Scott Price**, GE Global Research (USA); **Sandra G. Biedron**, Colorado State Univ. (USA)

**Hard x-rays from a table-top all-laser-driven synchrotron light source** (*Invited Paper*), Donald P Umstadter, Univ. of Nebraska-Lincoln (USA) ..... [9590-1]

**The compact light source: A miniature synchrotron producing x-rays via inverse Compton scattering** (*Invited Paper*), Ronald D. Ruth, SLAC National Accelerator Lab. (USA) and Lyncean Technologies, Inc. (USA); Rod Loewen, Lyncean Technologies, Inc. (USA) ..... [9590-2]

**Liquid-metal-jet and ultra-high resolution x-ray tube technology including microscopy applications** (*Invited Paper*), Emil Espes, Björn A. M. Hansson, Oscar Hemberg, Mikael Otendal, Per Takman, Tomi Tuohimaa, Exciilum AB (Sweden) ..... [9590-3]

**A novel technique to produce x-rays for XRF, medical, and scientific purposes** (*Invited Paper*), Carlos Camara, Tribogenics (USA) ..... [9590-4]

### SESSION 2 ..... MON 10:50 AM TO 12:15 PM

#### Novel X-Ray Sources II

Session Chairs: **Ali M. Khounsary**, X-ray Optics, Inc. (USA), Illinois Institute of Technology (United States); **George A. Kyrala**, Los Alamos National Lab. (USA)

**From incoherent to coherent x-rays with ICS sources** (*Invited Paper*), Emilio Alessandro Nanni, Massachusetts Institute of Technology (USA) ..... [9590-5]

**Current challenges in diagnostic x-ray source and how they can be met**, J. Scott Price, GE Global Research (USA) ..... [9590-6]

**Development of an adaptable shield wall design for the CSU Linac**, Joel Williams, Tejas Doshi, Madhuri Ravikumar, Jeff Ngyn, Sandra G. Biedron, Stephen V. Milton, Josh Einstein, Colorado State Univ. (USA) ..... [9590-7]

**Liquid jet target x-ray tube with field emission cathode**, Gennadiy Karpinskiy, Siemens Russia (Russian Federation) and National Research Nuclear Univ. MEPhI (Russian Federation); Taras Bondarenko, Stepan Polikarov, Siemens Russia (Russian Federation); Alexandra Botyachkova, Siemens Russia (Russian Federation) and National Research Nuclear Univ. MEPhI (Russian Federation); Sergey Frolov, Vyacheslav Ivanov, N.N. Semenov Institute of Chemical Physics (Russian Federation); Andreas Geisler, Siemens AG (Germany) ..... [9590-8]

Lunch Break ..... Mon 12:15 pm to 1:45 pm

### SESSION 3 ..... MON 1:45 PM TO 3:30 PM

#### Optics and Applications

Session Chairs: **Björn Hansson**, Exciilum AB (Sweden); **Carlos Camara**, Tribogenics (USA)

**A review of formed optics for lab-based x-ray systems** (*Invited Paper*), Ladislav Pina, Czech Technical Univ. in Prague (Czech Republic) ..... [9590-9]

**Beam conditioning multilayer optics for laboratory x-ray sources**, Yuriy Ya. Platonov, Boris Verman, Lica Jiang, Bonglea Kim, Rigaku Innovative Technologies, Inc. (USA) ..... [9590-10]

**NanoCT imaging with a prototype nanofocus source**, Mark Müller, Simone Ferstl, Sebastian Allner, Martin Dierolf, Technische Univ. München (Germany); Björn Hansson, Tomi Tuohimaa, Per Takman, Exciilum AB (Sweden); Franz Pfeiffer, Technische Univ. München (Germany) ..... [9590-11]

**The best of both worlds: automated CMP polishing of channel-cut monochromators**, Elina Kasman, Argonne National Lab. (USA) ..... [9590-12]

**Possibility for new PolyCO imaging: stroboscopic imaging based on vibrating capillary optics**, Andrea Liedl, Univ. degli Studi di Roma Tre (Italy) and Infn-LNF (Italy); Dariush Hampai, Istituto Nazionale di Fisica Nucleare (Italy); Sultan B. Dabagov, Istituto Nazionale di Fisica Nucleare (Italy) and P.N. Lebedev Physical Institute (Russian Federation) and National Research Nuclear Univ. MEPhI (Russian Federation); Claudia Polese, Istituto Nazionale di Fisica Nucleare (Italy) and Univ. degli Studi di Roma La Sapienza (Italy) ..... [9590-13]

### SESSION 4 ..... MON 4:00 PM TO 5:40 PM

#### Applications and Techniques

Session Chairs: **Ladislav Pina**, Czech Technical Univ. in Prague (Czech Republic); **J. Scott Price**, GE Global Research (USA)

**A triboelectric closed loop band system for the generation of x-rays**, Eli Van Cleve, Zach Ganlieli, Ben Lucas, Dan Cudra, Eric W. Wong, Mark Valentine, Pedro Cortes Jr., David Kamkar, Gilberto Jimenez, Andreas Magnusson, Rebecka Jacobsson, Timothy Baxendale, Nikhil Mehta, Jon Fong, Steve Hansen, Andy Kotowski, Dale Fox, Carlos Camara, Justen Harper, Tribogenics (USA) ..... [9590-14]

**Thermal analysis of high-power microfocus x-ray target-scaling effect**, Xi Zhang, Vance Robinson, Mark Frontera, GE Global Research (USA) ..... [9590-15]

**X-ray tube thermal management**, Ali M. Khounsary, Illinois Institute of Technology (USA) ..... [9590-16]

**Table-top-analyzer-based phase contrast imaging system optimization**, Jovan G. Brankov, Illinois Institute of Technology (USA) ..... [9590-17]

**Low-dose high-contrast x-ray radiography with tunable narrow-bandwidth x-rays**, Shouyuan Chen, Univ. of Nebraska-Lincoln (USA) ..... [9590-18]

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# Target Diagnostics Physics and Engineering for Inertial Confinement Fusion IV

Conference Chairs: **Jeffrey A. Koch**, National Security Technologies, LLC (USA); **Gary P. Grim**, Lawrence Livermore National Lab. (USA)

Program Committee: **W. Jack Armstrong**, Univ. of Rochester (USA); **Perry M. Bell**, Lawrence Livermore National Lab. (USA); **David K. Bradley**, Lawrence Livermore National Lab. (USA); **Frank E. Merrill**, Los Alamos National Lab. (USA); **T. Craig Sangster**, Univ. of Rochester (USA)

## WEDNESDAY 12 AUGUST

### SESSION 1 ..... WED 1:30 PM TO 3:20 PM

#### Target Diagnostics: Joint Session with Conferences 9591 and 9595

Session Chair: **Gary P. Grim**, Lawrence Livermore National Lab. (USA)

**Co-linear neutron and x-ray imaging at the National Ignition Facility (Invited Paper)**, Frank E. Merrill, Los Alamos National Lab. (USA); Kim Christensen, Lawrence Livermore National Lab. (USA); Christopher R. Danly, Valerie Fatherley, Los Alamos National Lab. (USA); David N. Fittinghoff, Lawrence Livermore National Lab. (USA); Jeffrey R. Griego, Los Alamos National Lab. (USA); Gary P. Grim, Nobuhiko Izumi, Lawrence Livermore National Lab. (USA); Donald R. Jedlovec, Lawrence Livermore National Lab. (USA) and Los Alamos National Lab (USA); Raspberry Simpson, Los Alamos National Lab. (USA); Kenneth M. Skulina, Lawrence Livermore National Lab. (USA); Petr L. Volegov, Carl H. Wilde, Los Alamos National Lab. (USA) ..... [9595-11]

**Testing of the gamma-ray imaging system with a mono-energetic gamma source at HIGS**, Daniel A Lemieux, College of Optical Sciences The Univ of Arizona (USA) ..... [9595-12]

**Fundamental performance differences of CMOS and CCD imagers: part VI (Invited Paper)**, James R. Janesick, Tom Elliott, James Andrews, John Tower, SRI International Sarnoff (USA) ..... [9591-1]

**Complete time-resolved polarimetry of scattered light on the NIF (Invited Paper)**, David Turnbull, Joseph E. Ralph, Robert Chow, Pierre A. Michel, Gene Frieders, Robin L. Hibbard, Kenn M. Knittel, Joel R. Stanley, James L. Vickers, Ziad M. Zeid, John D. Moody, Lawrence Livermore National Lab. (USA). .... [9591-2]

### SESSION 2 ..... WED 3:50 PM TO 5:30 PM

#### X-Ray and Optical Systems I

Session Chair: **Jeffrey A. Koch**, National Security Technologies, LLC (USA)

**Upgrades to the VISAR-streaked optical pyrometer (SOP) system on NIF**, Anastacia M. Manuel, Marius Millot, Peter M. Celliers, Eugene O. Vergel de Dios, Glen James, Philip Datte, Lynn G. Seppala, Lawrence Livermore National Lab. (USA) ..... [9591-3]

**Radiation test results for a megapixel CMOS charge dump and read camera at the National Ignition Facility**, Joseph R. Kimbrough, Perry M. Bell, Alexander A. Lombard, Mai S. Thao, Lawrence Livermore National Lab. (USA) ..... [9591-4]

**Design and implementation of a gated-laser entrance hole imaging diagnostic (G-LEH-1) at NIF**, Nathan E. Palmer, Hui Chen, Jarom Nelson, Joe Kimbrough, Marilyn B. Schneider, Perry M. Bell, Lawrence Livermore National Lab. (USA); Eric Huffman, National Security Technologies, LLC (USA); John L. Porter, Marcos O. Sanchez, Liam D. Claus, Mark W. Kimmel, Sandia National Labs. (USA); John W. Stahoviak, Sandia Staffing Alliance, LLC (USA); Terance J. Hilsabeck, Joseph D. Kilkenny, General Atomics (USA) ..... [9591-5]

**Gated x-ray camera microchannel plate gain droop investigation**, Bart Beeman, Jorge Carrera, John M. Chesser, John B. Lugten, Fred V. Allen, Alex A. Lombard, Charles G. Brown Jr., Joe P. Holder, Joseph R. Kimbrough, Lawrence Livermore National Lab. (USA) ..... [9591-6]

**Mirrored low-energy channel for the MiniXRD**, Eric C. Dutra, Lawrence P. MacNeil, National Security Technologies, LLC (USA); Steven M. Compton, Barry A. Jacoby, Lawrence Livermore National Lab. (USA); Mark L. Raphaelian, National Security Technologies, LLC (USA) ..... [9591-7]

## THURSDAY 13 AUGUST

### SESSION 3 ..... THU 8:30 AM TO 10:20 AM

#### Optical Systems

Session Chair: **Joseph R. Kimbrough**, Lawrence Livermore National Lab. (USA)

**Disposable blast shields for use on NIF imaging diagnostics**, Cal A. Smith, Lawrence Livermore National Lab. (USA); Karen M. Wang, Lawrence Livermore National Lab. (USA) and Stanford Univ. (USA); Marion J. Ayers, Robbin L. Hibbard, Kim Christensen, Nathan D. Masters, Lawrence Livermore National Lab. (USA) ..... [9591-8]

**3ω beam timing diagnostic for the OMEGA laser facility**, Joseph D. Katz, Univ. of Rochester (USA) ..... [9591-9]

**Digitizer architecture analysis for target diagnostics on the National Ignition Facility**, Arthur Carpenter, Todd J. Clancy, Bart Beeman, Perry Bell, Lawrence Livermore National Lab. (USA) ..... [9591-10]

**Materials characterization of irradiated spectralon from the NIF target chamber**, Robert Chow, Gene Frieders, Wayne Jensen, Mark Pearson, Phil Datte, Lawrence Livermore National Lab. (USA) ..... [9591-11]

**Gated photocathode design for the P510 electron tube used in the National Ignition Facility (NIF) optical streak cameras (Invited Paper)**, Philip S Datte, Glen James, Daniel Kalantar, Gene Vergel de Dios, Lawrence Livermore National Lab. (USA) ..... [9591-12]

### SESSION 4 ..... THU 10:50 AM TO 12:20 PM

#### Nuclear Systems

Session Chair: **Philip S. Datte**, Lawrence Livermore National Lab. (USA)

**Multi-axis neutron imaging at the National Ignition Facility (Invited Paper)**, David N. Fittinghoff, Gary P. Grim, Robin L. Hibbard, Donald R. Jedlovec, Lawrence Livermore National Lab. (USA); Frank E. Merrill, Petr L. Volegov, Carl H. Wilde, Los Alamos National Lab. (USA) ..... [9591-13]

**Upgrades to the Radiochemistry Analysis of Gas Samples (RAGS) diagnostic at the National Ignition Facility**, Donald R. Jedlovec, Kim Christensen, Lawrence Livermore National Security, LLC (USA); Carol Velsko, William Cassata, Wolfgang Stoeffl, Dawn Shaughnessy, Lawrence Livermore National Security, LLC (USA) ..... [9591-14]

**Vast Area Detection for Experimental Radiochemistry (VADER) at the National Ignition Facility**, Justin D. Galbraith, Ron Bettencourt, Dawn Shaughnessy, Bahram Talison, Kevin Morris, Lawrence Livermore National Lab. (USA) ..... [9591-15]

**Implementation of an enhanced permanently-installed neutron activation diagnostic hardware in NIF**, Donald R. Jedlovec, Lawrence Livermore National Security, LLC (USA); Charles B. Yeamans, Ellen R. Edwards, Jorge A. Carrera, Lawrence Livermore National Security, LLC (USA) ..... [9591-16]

Lunch/Exhibition Break ..... Thu 12:20 pm to 1:50 pm

# CONFERENCE 9591

SESSION 5.....THU 1:50 PM TO 3:20 PM

## X-Ray Systems

Session Chair: **Arthur Carpenter**, Lawrence Livermore National Lab. (USA)

**Design of a spectrometer for opacity experiments at the National Ignition Facility** (*Invited Paper*), Patrick W. Ross, Jeffrey A. Koch, Michael J. Haugh, Wayne C. Stolte, National Security Technologies, LLC (USA); Robert F. Heeter, Marilyn B. Schneider, Duane A. Liedahl, Theodore S. Perry, Lawrence Livermore National Lab. (USA); Greg S. Dunham, Sandia National Labs. (USA) ..... [9591-17]

**Calibration results for first NIF Kirkpatrick-Baez diagnostic**, Nicolai F. Breinholt, Louisa A. Pickworth, Jay J. Ayers, David K. Bradley, Todd A. Decker, Stefan P. Hau-Riege, Randolph M. Hill, Thomas J. McCarville, Tommaso Pardini, Julia K. Vogel, Chris C. Walton, Lawrence Livermore National Lab. (USA) ..... [9591-18]

**Determining the diffraction properties of a cylindrically-bent KAP crystal from 1 to 4.5 keV**, Michael J. Haugh, National Security Technologies, LLC (USA); Ming Wu, Sandia National Labs. (USA); Kenneth D. Jacoby, Cindy Christensen, National Security Technologies, LLC (USA); Joshua J. Lee, National Security Technologies, LLC (USA) and Sandia National Labs. (USA) ..... [9591-19]

**Optimizing the input and output transmission lines that gate the microchannel plate in a high-speed x-ray framing camera**, John B. Lugten, Charles G. Brown Jr., Bart V. Beeman, Alex A. Lombard, Fred V. Allen, Douglas R. Kittle, Lawrence Livermore National Lab. (USA) ..... [9591-20]

SESSION 6..... THU 3:50 PM TO 5:20 PM

## X-Ray and Optical Systems II

Session Chair: **Donald R. Jedlovec**, Lawrence Livermore National Lab. (USA)

**Exploration of high Miller index Ge crystals in flat and bent geometries for imaging high-energy x-rays** (*Invited Paper*), Joshua J. Lee, Michael J. Haugh, Jeffery A. Koch, National Security Technologies, LLC (USA) ..... [9591-21]

**Shot-time photography at the National Ignition Facility**, Donald R. Jedlovec, Kim Christensen, Lawrence Livermore National Lab. (USA) ..... [9591-22]

**Precision fabrication of large-area silicon-based geometrically-enhanced x-ray photocathodes using plasma etching**, Yekaterina P. Opachich, National Security Technologies, LLC (USA); Ning Chen, Ashwini Gopal, Salah Uddin, Nanoshift, LLC (USA); Eric Huffman, Jeffrey A. Koch, National Security Technologies, LLC (USA); Andrew MacPhee, Lawrence Livermore National Lab. (USA); Terance J. Hilsabeck, General Atomics (USA); Sabrina R. Nagel, Perry M. Bell, David K. Bradley, Otto L. Landen, Lawrence Livermore National Lab. (USA) ..... [9591-23]

**An overview of the Ultrafast X-ray Imager (UXI) program at Sandia Labs**, Liam Claus, Lu Fang, Mark W. Kimmel, Joel Long, John L. Porter, Gideon Robertson, Marcos Sanchez, Sandia National Labs. (USA); Douglas Trotter, Douglas Trotter Consulting (USA); Randolph R. Kay, Sandia National Labs. (USA) ..... [9591-24]

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# X-Ray Nanoimaging: Instruments and Methods II

Conference Chair: **Barry Lai**, Argonne National Lab. (USA)

Program Committee: **Michael Feser**, Carl Zeiss X-ray Microscopy, Inc. (USA); **Hans M. Hertz**, Royal Institute of Technology (Sweden); **Ian McNulty**, Argonne National Lab. (USA); **David Paterson**, Australian Synchrotron (Australia); **Christian G. Schroer**, DESY, Univ. of Hamburg (Germany); **Andrea Somogyi**, Synchrotron SOLEIL (France); **Kazuto Yamauchi**, Osaka Univ. (Japan)

## WEDNESDAY 12 AUGUST

### WELCOME AND OPENING REMARKS ..... 8:30 AM TO 8:40 AM

Barry Lai, Argonne National Lab. (USA)

### SESSION 1 ..... WED 8:40 AM TO 10:30 AM

#### Scanning Probe I

Session Chair: **Barry Lai**, Argonne National Lab. (USA)

**Science capabilities of the Hard X-ray Nanoprobe (HXN) at NSLS-II (Invited Paper)**, Yong S. Chu, Hanfei Yan, Xiaojing Huang, Sebastian Kalbfleisch, Evgeny Nazaretski, Nathalie Bouet, Juan Zhou, Li Li, Weihe Xu, Hui Yan, Kenneth Lauer, Kazimierz J. Gofron, Brian Mullany, Dennis Kuhne, James Biancarosa, Michael Maklary, Nikolaos Simos, Brookhaven National Lab. (USA) ..... [9592-1]

**Fast scanning multi-technique imaging and tomography at Nanoscopium (Synchrotron Soleil)**, Andrea Somogyi, Kadda Medjoubi, Gil Baranton, François A. Polack, Jean-Pierre Samama, Synchrotron SOLEIL (France) ..... [9592-2]

**Hard x-ray nanoprobe by Montel KB mirrors at Taiwan Photon Source**, Gung-Chian Yin, Shi-Hung Chang, Bo-Yi Chen, Huang-Yeh Chen, Bi-Hsuan Lin, Shao-Chin Tseng, Chien-Yu Lee, Jian-Xing Wu, National Synchrotron Radiation Research Ctr. (Taiwan); Shao-Yun Wu, National Tsing Hua Univ. (Taiwan); Mau-Tsu Tang, National Synchrotron Radiation Research Ctr. (Taiwan) ..... [9592-3]

**A next-generation in-situ nanoprobe beamline at the APS MBA lattice**, Jörg Maser, Barry Lai, Argonne National Lab. (USA); Mariana Bertoni, Arizona State Univ. (USA); Tonio Buonassisi, Massachusetts Institute of Technology (USA); Si Chen, Lydia Finney, Sophie-Charlotte Gleber, Ross Harder, Curt Preissner, Ruben Reininger, Chris Roehrig, Xianbo Shi, Volker Rose, Deming Shu, David Vine, Stefan Vogt, Argonne National Lab. (USA) ..... [9592-4]

**High-speed x-ray mapping using the FalconX4 at extremely-high count rates**, Peter Grudberg, XIA LLC (USA); Paul A. Scouller, Southern Innovation (Australia) ..... [9592-5]

### SESSION 2 ..... WED 11:00 AM TO 12:00 PM

#### Full-Field Microscope I

Session Chair: **David J. Paterson**, Australian Synchrotron (Australia)

**Resolution limits of projection x-ray microscopy and tomography**, Michael Feser, Carl Zeiss X-ray Microscopy, Inc. (USA) ..... [9592-6]

**Development of achromatic full-field hard x-ray microscopy with two monolithic imaging mirrors**, Satoshi Matsuyama, Hidetoshi Kino, Shuhei Yasuda, Osaka Univ. (Japan); Yoshiki Kohmura, RIKEN SPring-8 Ctr. (Japan); Hiromi Okada, JTEC Corp. (Japan); Tetsuya Ishikawa, RIKEN SPring-8 Ctr. (Japan); Kazuto Yamauchi, Osaka Univ. (Japan) ..... [9592-7]

**FXI: a full-field x-ray imaging beamline at NSLS-II**, Wah-Keat Lee, William Loo, Yong S. Chu, Jun Wang, Richard Gambella, Zhong Zhong, Brookhaven National Lab. (USA); Ruben Reininger, Argonne National Lab. (USA) ..... [9592-8]

Lunch/Exhibition Break ..... Wed 12:00 pm to 1:30 pm

### SESSION 3 ..... WED 1:30 PM TO 3:00 PM

#### Ptychography

Session Chair: **Ian McNulty**, Argonne National Lab. (USA)

**Ptychographic x-ray nanotomography at the Swiss Light Source (Invited Paper)**, Manuel Guizar-Sicairos, Ana Diaz, Mirko Holler, Julio C. da Silva, Oliver Bunk, Andreas Menzel, Paul Scherrer Institut (Switzerland) ..... [9592-9]

**Development of a soft x-ray ptychography beamline at SSRL and its application in the study of energy storage materials**, Anna M. Wise, Hendrik Ohldag, SLAC National Accelerator Lab. (USA); William Chueh, Stanford Univ. (USA); Joshua J. Turner, Michael F. Toney, Johanna L. Nelson Weker, SLAC National Accelerator Lab. (USA) ..... [9592-10]

**Imaging strain in SiGe thin films at the nanoscale by x-ray Bragg ptychography**, Wen Hu, Xiaojing Huang, Brookhaven National Lab. (USA); Conal E. Murray, IBM Thomas J. Watson Research Ctr. (USA); Zhonghou Cai, Argonne National Lab. (USA); Evgeny Nazaretski, Yong S. Chu, Brookhaven National Lab. (USA); Hanfei Yan, National Synchrotron Light Source II, Brookhaven National Laboratory (USA) ..... [9592-11]

**3D Bragg projection ptychography: a new approach dedicated to probe structures in crystalline materials**, Marc Allain, Institut Fresnel (France); Stephan O. Hruszkewycz, Argonne National Lab. (USA); Virginie Chamard, Institut Fresnel (France) ..... [9592-12]

### SESSION 4 ..... WED 3:30 PM TO 5:00 PM

#### Nanofocusing Optics

Session Chair: **Kazuto Yamauchi**, Osaka Univ. (Japan)

**Progress on multi-order hard x-ray imaging with multilayer zone plates (Invited Paper)**, Markus Osterhoff, Christian Eberl, Robin Wilke, Jesper Wallentin, Florian Döring, Hans-Ulrich Krebs, Georg-August-Univ. Göttingen (Germany); Michael Sprung, Deutsches Elektronen-Synchrotron (Germany); Tim Salditt, Georg-August-Univ. Göttingen (Germany) ..... [9592-13]

**High-resolution high-efficiency multilayer Fresnel zone plates for soft and hard x-rays**, Umut T. Sanlı, Kahraman Keskinbora, Corinne Grévent, Max-Planck-Institut für Intelligente Systeme (Germany); Keith Gregorczyk, CIC nanoGUNE Consolider (Spain); Mato Knez, CIC nanoGUNE Consolider (Spain) and IKERBASQUE, Basque Foundation for Science (Spain); Gisela Schütz, Max-Planck-Institut für Intelligente Systeme (Germany) ..... [9592-14]

**Stacking multiple zone plates for efficient hard x-ray focusing at the Advanced Photon Source**, Michael Wojcik, Sophie-Charlotte Gleber, Deming Shu, Christian Roehrig, Barry Lai, David J. Vine, Stefan Vogt, Argonne National Lab. (USA) ..... [9592-15]

**Fabrication and x-ray testing of true kinoform lenses with high efficiency**, Kahraman Keskinbora, Umut T. Sanlı, Corinne Grévent, Gisela Schütz, Max-Planck-Institut für Intelligente Systeme (Germany) ..... [9592-16]

# CONFERENCE 9592

## POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Extending x-ray imaging with current nanofabrication techniques for fabrication of high-yield Fresnel zone plate optics,** Robert Peters, Mirwais Aktary, Luis Gutierrez-Rivera, Cameron Horvath, Applied NanoTools Inc. (Canada) ..... [9592-26]

**High-resolution strain mapping of single nanowires with x-ray Bragg ptychography,** Dmitry Dzhigaev, Deutsches Elektronen-Synchrotron (Germany); Tomas Stankevic, Univ. of Copenhagen (Denmark); Zhaoxia Bi, Lund Univ. (Sweden); Max Rose, Anatoly Shabalin, Julianne Reinhardt, Deutsches Elektronen-Synchrotron (Germany); Anders Mikkelsen, Lund Univ. (Sweden); Ulf Lorenz, Univ. Potsdam (Germany); Ruslan Kurta, European XFEL GmbH (Germany); Andrei Singer, Univ. of California, San Diego (USA); Frank Seiboth, Technische Univ. Dresden (Germany); Lars Samuelson, Lund Univ. (Sweden); Christian G. Schroer, Deutsches Elektronen-Synchrotron (Germany); Robert Fedenhans'l, Univ. of Copenhagen (Denmark); Ivan A. Vartanyants, Deutsches Elektronen-Synchrotron (Germany) ..... [9592-27]

**Transmission x-ray microscopy at Diamond Light Source I13 Beamline,** Joan Vila Comamala, Diamond Light Source Ltd. (United Kingdom); Jeroen Borggra, Paul Scherrer Institut (Switzerland); David S. Eastwood, The Univ. of Manchester (United Kingdom) and Research Complex at Harwell (United Kingdom); Ulrich H. Wagner, Andrew J. Bodey, Miryam Garcia-Fernandez, Diamond Light Source Ltd. (United Kingdom); Christian David, Paul Scherrer Institut (Switzerland); Christoph Rau, Diamond Light Source Ltd. (United Kingdom) ..... [9592-28]

**Fast strain mapping of nanoLED devices using nano-focused x-ray beams,** Tomas Stankevic, Univ. of Copenhagen (Denmark); Dmitry Dzhigaev, Max Rose, Anatoly Shabalin, Deutsches Elektronen-Synchrotron (Germany); Zhaoxia Bi, Lund Univ. (Sweden); Julianne Reinhardt, Deutsches Elektronen-Synchrotron (Germany); Anders Mikkelsen, Lars Samuelson, Lund Univ. (Sweden); Gerald Falkenberg, Ivan A. Vartanyants, Deutsches Elektronen-Synchrotron (Germany); Robert K. Feidenhans'l, Univ. of Copenhagen (Denmark). ..... [9592-29]

**Fly-scan ptychography,** Junjing Deng, Northwestern Univ. (USA); Youssef S. G. Nashed, Si Chen, Argonne National Lab. (USA); Nicholas W. Phillips, La Trobe Univ. (Australia); Tom Peterka, Rob Ross, Stefan Vogt, Argonne National Lab. (USA); Chris J. Jacobsen, Northwestern Univ. (USA); David J. Vine, Argonne National Lab. (USA) ..... [9592-30]

**Layer tilt analyses of MLLs using diffraction efficiency versus rocking angle for defect mapping,** Adam Kubec, Fraunhofer IWS Dresden (Germany) and Argonne National Lab. (USA); Raymond Conley, Argonne National Lab. (USA) and Brookhaven National Lab. (USA); Nathalie Bouet, Hanfei Yan, Juan Zhou, Brookhaven National Lab. (USA); Albert T. Macrander, Jörg Maser, Argonne National Lab. (USA) ..... [9592-31]

**MAPStoTomoPy: a workflow for synchrotron-based fluorescence tomography,** Young Pyo Hong, Northwestern University (USA); Si Chen, X-ray Science Division, Advanced Photon Source, Argonne National Laboratory (USA); Chris Jacobsen, Department of Physics & Astronomy, Northwestern University (USA) and X-ray Science Division, Advanced Photon Source, Argonne National Laboratory (USA) ..... [9592-32]

**Refractive lens-based full-field x-ray imaging at 50 keV with sub-micron resolution,** Sarvit D. Shastri, Peter Kenesei, Argonne National Lab. (USA); Robert M. Suter, Carnegie Mellon Univ. (USA) ..... [9592-33]

## THURSDAY 13 AUGUST

### SESSION 5.....THU 8:30 AM TO 10:20 AM

#### Scanning Probe II

Session Chair: **Andrea Somogyi**, Synchrotron SOLEIL (France)

**Simultaneous x-ray nano-ptychographic and fluorescence microscopy at the bionanoprobe (Invited Paper),** Si Chen, Argonne National Lab. (USA); Junjing Deng, Northwestern Univ. (USA); David J. Vine, Youssef Nashed, Argonne National Lab. (USA); Qiaoling Jin, Northwestern Univ. (USA); Stefan Vogt, Argonne National Lab. (USA); Chris J. Jacobsen, Argonne National Lab. (USA) and Northwestern Univ. (USA) ..... [9592-17]

**The hard x-ray nanoprobe beamline and electron microscopy facility at Diamond,** Paul Quinn, Julia Parker, Fernando Cacho-Neri, Andrew Peach, Guy Wilkin, Diamond Light Source Ltd. (United Kingdom) ..... [9592-18]

**Nano Investigator: a versatile tool for nm-scale spatial resolution x-ray imaging with MLL nanofocusing optics,** Evgeny Nazaretski, Brookhaven National Lab. (USA) ..... [9592-25]

**Development of differential analysis techniques for multivariate imaging data analysis,** Zhonghou Cai, Argonne National Lab. (USA) ..... [9592-19]

**Chemical speciation imaging at environmentally-relevant concentrations using x-ray fluorescence microscopy,** David J Paterson, Daryl L Howard, Martin D de Jonge, Kathryn M Spiers, Australian Synchrotron (Australia); Chris G Ryan, Robin Kirkham, CSIRO (Australia); Barbara E. Etschmann, Monash Univ. (Australia); Enzo Lombi, Erica Donner, Univ. of South Australia (Australia); Peter M. Kopittke, The Univ. of Queensland (Australia) ..... [9592-20]

### SESSION 6.....THU 10:50 AM TO 12:20 PM

#### Full-Field Microscope II

Session Chair: **Michael Feser**, Carl Zeiss X-ray Microscopy, Inc. (USA)

**Chemical and tomographic microscopy of energy materials in action (Invited Paper),** Johanna L. Nelson Weker, Yijin Liu, Joy C. Andrews, SLAC National Accelerator Lab. (USA) ..... [9592-21]

**Synchrotron-based transmission x-ray microscopy for improved extraction in shale during hydraulic fracturing,** Andrew M. Kiss, Adam D. Jew, Stanford Synchrotron Radiation Lightsource (USA); Claresta Joe-Wong, Stanford Univ. (USA); Kate M. Maher, Yijin Liu, Gordon E. Brown, John Bargar, Stanford Synchrotron Radiation Lightsource (USA) ..... [9592-22]

**Magnetic contrast nanotomography,** Robert P. Winarski, Argonne National Lab. (USA) ..... [9592-23]

**X-ray microscopy for in situ characterization of 3D microstructure evolution in the laboratory,** Benjamin Hornberger, Hrishikesh Bale, Arno Merkle, Michael Feser, William Harris, Carl Zeiss X-ray Microscopy, Inc. (USA) ..... [9592-24]

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# Hard X-Ray, Gamma-Ray, and Neutron Detector Physics XVII

Conference Chairs: **Larry Franks**, Consultant (USA); **Ralph B. James**, Brookhaven National Lab. (USA); **Michael Fiederle**, Freiburger Materialforschungszentrum (Germany); **Arnold Burger**, Fisk Univ. (USA)

Program Committee: **Toru Aoki**, Shizuoka Univ. (Japan); **Fikri Aqariden**, EPIR Technologies, Inc. (USA); **Jim E. Baciak Jr.**, Univ. of Florida (USA); **David B. Beach**, National Nuclear Security Administration (USA); **Zane W. Bell**, Oak Ridge National Lab. (USA); **Koushik Biswas**, Arkansas State Univ. (USA); **Lynn A. Boatner**, Oak Ridge National Lab. (USA); **Aleksey E. Bolotnikov**, Brookhaven National Lab. (USA); **Edith Bourret Courchesne**, Lawrence Berkeley National Lab. (USA); **Giuseppe S. Camarda**, Brookhaven National Lab. (USA); **Bill Cardoso**, Creative Electron (USA); **Henry Chen**, Brimrose Corp. of America (USA); **Nerine J. Cherepy**, Lawrence Livermore National Lab. (USA); **Jeffrey J. Derby**, Univ. of Minnesota (USA); **Kim F. Ferris**, Pacific Northwest National Lab. (USA); **Petro M. Fochuk**, Yuri Fedkovych Chernivtsi National Univ. (Ukraine); **Jan Franc**, Charles Univ. in Prague (Czech Republic); **Fei Gao**, Pacific Northwest National Lab. (USA); **Zhong He**, Univ. of Michigan (USA); **Keitaro Hitomi**, Tohoku Univ. (Japan); **Alan Janos**, U.S. Dept. of Homeland Security (USA); **Mercouri Kanatzidis**, Northwestern Univ. (USA); **Warnick J. Kieran**, Pacific Northwest National Lab. (USA); **KiHyun Kim**, Korea Univ. College of Health Sciences (Korea, Republic of); **Henrik Krawczynski**, Washington Univ. in St. Louis (USA); **Kelvin G. Lynn**, Washington State Univ. (USA); **Krishna C. Mandal**, Univ. of South Carolina (USA); **Robert D. McLaren**, Consultant (USA); **Shariar Motakef**, CapeSym, Inc. (USA); **Sanjoy Mukhopadhyay**, National Security Technologies, LLC (USA); **Utpal N. Roy**, Brookhaven National Lab. (USA); **Arie Ruzin**, Tel Aviv Univ. (Israel); **David J. Singh**, Oak Ridge National Lab. (USA); **Narsingh B. Singh**, Univ. of Maryland, Baltimore County (USA); **Michael R. Squillante**, Radiation Monitoring Devices, Inc. (USA); **Ashley C. Stowe**, Y-12 National Security Complex (USA); **Csaba Szeles**, El Detection & Imaging Systems (USA); **Sergey E. Ulin**, National Research Nuclear Univ. MEPhI (Russian Federation); **Edgar V. van Loef**, Radiation Monitoring Devices, Inc. (USA); **Aaron L. Washington II**, Savannah River National Lab. (USA); **Richard T. Williams**, Wake Forest Univ. (USA)

## MONDAY 10 AUGUST

### WELCOME AND OPENING REMARKS ..... 8:15 AM TO 8:20 AM

Ralph B. James, Brookhaven National Lab. (USA)

### SESSION 1 ..... MON 8:20 AM TO 10:00 AM

#### Scintillators I

Session Chair: **Nerine J. Cherepy**, Lawrence Livermore National Lab. (USA)

**Physics of spectral resolution in gamma-ray scintillator detectors (Invited Paper)**, Stephen A. Payne, Nerine J. Cherepy, Steven L. Hunter, Erik L. Swanberg, Patrick R. Beck, Zachary M. Seeley, Lawrence Livermore National Lab. (USA) ..... [9593-1]

**Co-doping effects in halide scintillators: density-functional calculations**, Koushik Biswas, Arkansas State Univ. (USA); Richard T. Williams, Wake Forest Univ. (USA) ..... [9593-2]

**Linearity response of Ca<sup>2+</sup>-doped CeBr<sub>3</sub> as a function of gamma-ray energy**, Paul P. Guss, National Security Technologies, LLC (USA); Michael E. Foster, Sandia National Labs. (USA); Bryan M. Wong, Univ. of California, Riverside (USA); F. P. Doty, Sandia National Labs. (USA); Kanai S. Shah, Michael R. Squillante, Urmila Shirwadkar, Rastgo Hawrami, Joshua P. Tower, Radiation Monitoring Devices, Inc. (USA); Thomas G. Stampahar, Sanjoy Mukhopadhyay, National Security Technologies, LLC (USA) ..... [9593-3]

**Versatile rate equation and transport model for proportionality of light yield in electron tracks: undoped and Tl-doped CsI at 295 K, undoped CsI at 100 K, and YAP:Ce vs [Ce] (Invited Paper)**, Richard T. Williams, Xinfu Lu, James L. Drewwy, Wake Forest Univ. (USA); Gregory A. Bizarri, Lawrence Berkeley National Lab. (USA); Samuel Donald, The Univ. of Tennessee (USA) and Agile Technologies (USA); Jason Hayward, Merry Koschan, Charles L. Melcher, The Univ. of Tennessee Knoxville (USA); Kan Yang, Saint-Gobain Crystals (USA); Michael Mayhugh, Saint-Gobain Crystals (USA) and Faceted Development, LLC (USA); Peter R. Menge, Saint-Gobain Crystals (USA) ..... [9593-4]

### SESSION 2 ..... MON 10:30 AM TO 12:20 PM

#### CZT I

Session Chair: **Robert D. McLaren**, Consultant (USA)

**Crystallographic defects in detector-grade CZT crystals: exploring their properties using synchrotron facilities (Invited Paper)**, Anwar Hossain, Aleksey Bolotnikov, Giuseppe Camarda, Yonggang Cui, Rubi Gul, Utpal Roy, Ge Yang, Ralph James, Brookhaven National Lab. (USA) ..... [9593-5]

**Control of electric field in CdZnTe radiation detectors by above-bandgap light**, Jan Franc, Václav Dedic, Martin Rejhon, Charles Univ. in Prague (Czech Republic) ..... [9593-6]

**Study of point defects in As-grown and annealed bridgman grown CZT crystals and their effects on  $\gamma$ -product and resistivity**, Rubi Gul, Brookhaven National Lab. (USA) and Alabama A&M Univ. (USA); Stephen Egarievwe, Alabama A&M Univ. (USA); Georgios Prekas, Uri El-Hanany, Redlen Technologies (Canada); Aleksey E. Bolotnikov, Giuseppe Camarda, Yonggang Cui, Anwar Hossain, Utpal Roy, Ge Yang, Brookhaven National Lab. (USA); Adam Densmore, Redlen Technologies (Canada); Ralph B. James, Brookhaven National Lab. (USA). [9593-7]

**Correcting response inhomogeneity of CdZnTe detectors**, Aleksey E. Bolotnikov, Giuseppe S. Camarda, Yonggang Cui, Gianluigi De Geronimo, Jack Fried, Anwar Hossain, Utpal N. Roy, Emerson Vernon, Ge Yang, Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-8]

**Towards a post-growth annealing approach to mitigate material defects: case analysis of CdZnTe, CdMnTe, and CdTeSe**, Ge Yang, Aleksey E. Bolotnikov, Yonggang Cui, Giuseppe S. Camarda, Anwar Hossain, Utpal N. Roy, Rubi Gul, Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-9]

Lunch Break ..... Mon 12:20 pm to 1:50 pm

### SESSION 3 ..... MON 1:50 PM TO 3:20 PM

#### Neutron Detection

Session Chair: **Paul P. Guss**, National Security Technologies, LLC (USA)

**Investigations of 6LiIn<sub>1-x</sub>Ga<sub>x</sub>Se<sub>2</sub> semi-insulating crystals for neutron detection**, Brenden Wiggins, Vanderbilt Univ. (USA); Arnold Burger, Fisk Univ. (USA); Keivan G. Stassun, Vanderbilt Univ. (USA); Ashley C. Stowe, Y-12 National Security Complex (USA) ..... [9593-10]

**Recent progress on uranium oxide-based semiconductor neutron detectors**, Craig Kruschwitz, Sanjoy Mukhopadhyay, David Schwellenbach, National Security Technologies, LLC (USA); Thomas T. Meek, Christopher B. Shaver, The Univ. of Tennessee Knoxville (USA) ..... [9593-11]

**Thermal neutron detectors based on hexagonal boron nitride epilayers**, Hongxing Jiang, Jingyu Lin, Texas Tech Univ. (USA) ..... [9593-12]

**Neutron detection with LiInSe<sub>2</sub> (Invited Paper)**, Zane W. Bell, Oak Ridge National Lab. (USA); Arnold Burger, Fisk Univ. (USA); Ashley C. Stowe, Y-12 National Security Complex (USA); Joshua P. Tower, Radiation Monitoring Devices, Inc. (USA); Liviu Matei, Michael Groza, Fisk Univ. (USA); Alireza Kargar, Huicong Hong, Radiation Monitoring Devices, Inc. (USA) ..... [9593-13]

# CONFERENCE 9593

SESSION 4.....MON 3:50 PM TO 5:50 PM

## Alternate Materials I

Session Chair: **Arnold Burger**, Fisk Univ. (USA)

**Towards stable thallium bromide devices for long-term use (Invited Paper)**, Amlan Datta, CapeSym, Inc. (USA); Piotr Becla, CapeSym, Inc. (USA) and Massachusetts Institute of Technology (USA); Shariar Motakef, CapeSym, Inc. (USA) ..... [9593-14]

**Impact of heat treatment on the electrical characteristics and charge collection efficiency of metal-GaAs:Cr-metal x-ray sensors**, Anton V. Tyazhev, Andrei N. Zarubin, Vladimir A. Novikov, Oleg P. Tolbanov, Anastasiya D. Lozinskaya, David L. Budnitsky, Maxim S. Skakunov, National Research Tomsk State Univ. (Russian Federation) ..... [9593-15]

**Novel semiconductor radiation detector based on mercurous halides (Invited Paper)**, Henry Chen, Joo-Soo Kim, Proyanthi Amarasinghe, Feng Jin, Sudhir B. Trivedi, Brimrose Technology Corp. (USA); Arnold Burger, Fisk Univ. (USA); Jarrod Marsh, Marc S. Litz, U.S. Army Research Lab. (USA); James O. Jensen, U.S. Army Edgewood Chemical Biological Ctr. (USA) ..... [9593-16]

**Low-energy neutron detection via noble gas scintillation using thin film and foam converters**, Christopher M. Lavelle, Johns Hopkins Univ. Applied Physics Lab., LLC (USA); Michael Coplan, Univ. of Maryland, College Park (USA); Eric C. Miller, Johns Hopkins Univ. Applied Physics Lab., LLC (USA); Alan K. Thompson, National Institute of Standards and Technology (USA); Alex Kowler, Univ. of Maryland, College Park (USA); Rob Vest, Andrew Yue, National Institute of Standards and Technology (USA); Tim Koeth, Johns Hopkins Univ. Applied Physics Lab., LLC (USA) and Univ. of Maryland, College Park (USA); Mohammad Al-Sheikhly, Univ. of Maryland, College Park (USA); Charles Clark, National Institute of Standards and Technology (USA) ..... [9593-17]

**High-barrier Schottky contact on n-type 4H-SiC epitaxial layer and investigation of defect levels by deep level transient spectroscopy (DLTS)**, Khai V. Nguyen, Rahmi O. Pak, Cihan Oner, Mohammad A. Mannan, Krishna C. Mandal, Univ. of South Carolina (USA) ..... [9593-58]

## TUESDAY 11 AUGUST

SESSION 5.....TUE 8:30 AM TO 10:00 AM

## Alternate Materials II

Session Chair: **Aleksey E. Bolotnikov**, Brookhaven National Lab. (USA)

**Novel highly-stable and rugged contact on CdTe-based materials for radiation detector applications (Invited Paper)**, Utpal N. Roy, Aleksey E. Bolotnikov, Giuseppe S. Camarda, Yonggang Cui, Rubi Gul, Anwar Hossain, Ge Yang, Ralph B. James, Brookhaven National Lab. (USA); Aswini K. Pradhan, Rajeh Mundie, Norfolk State Univ. (USA) ..... [9593-18]

**Growth characterization of CdTeSe-based materials and fabrication of devices for radiation detector applications**, Utpal N. Roy, Aleksey E. Bolotnikov, Giuseppe S. Camarda, Yonggang Cui, Rubi Gul, Anwar Hossain, Ryan Tappero, Ge Yang, Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-19]

**Xenon gamma-ray spectrometer in the experiment Signal on board the spacecraft Interhelioprobe**, Alexander S. Novikov, Sergey E. Ulin, Valery V. Dmitrenko, Victor M. Grachev, Viktor N. Stekhanov, Konstantin F. Vlasik, Ziyaetdin M. Uteshev, Irina V. Chernysheva, Alexander E. Shustov, Denis V. Petrenko, National Research Nuclear Univ. MEPhI (Russia Federation) ..... [9593-20]

**First principles studies of the stability and Shottky barriers of metal/CdTe(111) interfaces**, Zhen Liu, Dorj Odkhuu, Maosheng Miao, Nicholas Kioussis, California State Univ., Northridge (USA); Suleyman Tari, Fikri Aqariden, Yong Chang, Sivananthan Labs., Inc. (USA); Christoph H. Grein, Univ. of Illinois at Chicago (USA) ..... [9593-21]

SESSION 6.....TUE 10:30 AM TO 12:10 PM

## Scintillators II

Session Chair: **Stephen A. Payne**, Lawrence Livermore National Lab. (USA)

**Potassium-based halide scintillators with high-energy resolution (Invited Paper)**, Mariya Zhuravleva, Luis Stand, Eric D. Lukosi, Charles L. Melcher, The Univ. of Tennessee Knoxville (USA) ..... [9593-22]

**Organic-inorganic scintillator detectors for radiation detection**, Nathan T. Shewmon, Paul M. Johns, Weiran Cao, Daken Starkenburg, Shinyoung Yeo, James E. Baciak Jr., Juan C. Nino, Jiangeng Xue, Univ. of Florida (USA) ..... [9593-23]

**Transparent ceramic scintillators (Invited Paper)**, Nerine J. Cherepy, Zachary M. Seeley, Stephen A. Payne, Patrick R. Beck, Erik L. Swanberg, Brian Whil, Steven Hunter, Scott E. Fisher, Peter A. Thelin, Daniel J. Schneberk, Gary F. Stone, Randall Thompson, Lawrence Livermore National Lab. (USA); Todd Stefanik, Nanocerox, Inc. (USA); Joel Kindem, Cokiya, Inc. (USA) ..... [9593-24]

**Degradation of deliquescent halide scintillators**, Mariya Zhuravleva, Luis Stand, Hua Wei, The Univ. of Tennessee Knoxville (USA); Lynn A. Boatner, Oak Ridge National Lab. (USA); Kanai Shah, Radiation Monitoring Devices, Inc. (USA); Arnold Burger, Fisk Univ. (USA); Charles L. Melcher, The Univ. of Tennessee Knoxville (USA) ..... [9593-25]

Lunch/Exhibition Break ..... Tue 12:10 pm to 1:40 pm

SESSION 7.....TUE 1:40 PM TO 3:30 PM

## Novel Materials and Methods

Session Chair: **Jan Franc**, Charles Univ. in Prague (Czech Republic)

**Challenges and future directions for planetary gamma ray and neutron spectroscopy (Invited Paper)**, Thomas H Prettyman, Planetary Science Institute (USA); Arnold Burger, Fisk Univ. (USA); James L. Lambert, Julie Castillo-Rogez, Jet Propulsion Lab. (USA); Naoyuki Yamashita, Planetary Science Institute (USA) ..... [9593-26]

**Radiation anomaly detection algorithms for field acquired gamma energy spectra**, Sanjoy Mukhopadhyay, Richard J. Maurer, Ronald S. Wolff, Paul P. Guss, Stephen E. Mitchell, National Security Technologies, LLC (USA) ..... [9593-27]

**The next generation of crystal detectors for future HEP experiments**, Ren-Yuan Zhu, California Institute of Technology (USA) ..... [9593-28]

**Measurements on scintillators and semiconductor detectors at the Advanced Light Source (ALS)**, Giuseppe S. Camarda, Aleksey E. Bolotnikov, Yonggang Cui, Rubi Gul, Anwar Hossain, Utpal Roy, Ge Yang, Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-29]

**Development of NEUANCE: the neutron detector array at DANCE**, Marian Jandel, Bayar Baramsai, Aaron Couture, Shea M. Mosby, Gencho Y. Rusev, John L. Ullmann, Carrie L. Walker, Los Alamos National Lab. (USA) ..... [9593-30]

SESSION 8.....TUE 4:00 PM TO 5:40 PM

## Devices

Session Chair: **Sanjoy Mukhopadhyay**, National Security Technologies, LLC (USA)

**Hard X-ray Camera (HXC) for the FFAST Mission**, Hiroshi Tsunemi, Kiyoshi Hayashida, Hiroshi Nakajima, Naohisa Anabuki, Ryo Nagino, Osaka Univ. (Japan); Masanobu Ozaki, Japan Aerospace Exploration Agency (Japan) ..... [9593-31]

**A low-noise wide-dynamic-range event-driven detector using SOI pixel technology for high-energy particle imaging**, Sumeet Shrestha, Hiroki Kamehama, Keita Yasutomi, Keiichiro Kagawa, Shizuoka Univ. (Japan); Ayaki Takeda, Takeshi G. Tsuru, Kyoto Univ. (Japan); Yasuo Arai, High Energy Accelerator Research Organization, KEK (Japan); Shoji Kawahito, Shizuoka Univ. (Japan) ..... [9593-32]

**X-CELIV: X-ray-excited charge extraction by linearly increasing voltage: a new method for the electrical charge transport characterization of x-ray detectors**, Moses Richter, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Patric Büchele, Siemens AG (Germany); Gebhard J. Matt, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Sandro F. Tedde, Oliver Schmidt, Siemens AG (Germany); Christoph J. Brabec, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany) ..... [9593-33]

**Photon counting 3D x-ray CT as a input device for 3D-printers**, Toru Aoki, Univ. of Shizuoka (Japan); Akifumi Koike, ANSeeN, Inc. (Japan) and Univ. of Shizuoka (Japan); Kiryu Sugiyama, Univ. of Shizuoka (Japan) ..... [9593-34]

**Spectral x-ray imaging performance of a hybrid pixel detector working in data driven read out mode**, Erik Fröjd, Rafael Ballabriga Sune, Jerome Alozy, Michael Campbell, Erik H. M. Heijne, Xavier Llopart, Tuomas Poikela, Lukas Tlustos, Winnie S. Wong, CERN (Switzerland) ..... [9593-35]

# CONFERENCE 9593

## PENETRATING RADIATION

TECHNICAL EVENT..... 8:00 PM TO 10:00 PM

Chair: James E. Baciak, Univ. of Florida (USA)

This event brings together technologists and scientists with interests in neutron, x- and gamma-ray detection, spectroscopy, and imaging for all applications. This year's speaker is soon to be announced.

## WEDNESDAY 12 AUGUST

SESSION 9..... WED 8:30 AM TO 10:10 AM

### Scintillators III

Session Chair: Henry Chen, Brimrose Corp. of America (USA)

**Growth and characterization of self-activated scintillator for dual gamma- and neutron- detector applications**, Utpal N. Roy, Aleksey E. Bolotnikov, Giuseppe S. Camarda, Yonggang Cui, Rubi Gul, Brookhaven National Lab. (USA) ..... [9593-36]

**Synthesis of transparent nanocomposite monoliths for gamma scintillation**, Yunxia Jin, Chao Liu, Tibor J. Hajagos, David Kishpaugh, Yi Chen, Qibing Pei, Univ. of California, Los Angeles (USA) ..... [9593-37]

**Characterization and testing of EJ309 liquid scintillator detector**, Bayarbadrakh Baramsai, Marian Jandel, Todd A. Bredeweg, Aaron Couture, Shea Mosby, Gencho Rusev, John L. Ullmann, Carrie L. Walker, Los Alamos National Lab. (USA) [9593-38]

**Development of a thin scintillation film fission-fragment detector and a novel neutron source**, Gencho Y. Rusev, Marian Jandel, Evelyn M. Bond, Audrey R. Roman, Jaimie K. Daum, Rebecca K. Springs, Los Alamos National Lab. (USA) ..... [9593-39]

**Electronic properties of ternary alkali-alkaline earth halide scintillators**, Koushik Biswas, Changming Fang, Arkansas State Univ. (USA); Sanjoy Mukhopadhyay, National Security Technologies, LLC (USA) ..... [9593-40]

POSTERS-WEDNESDAY..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Networked gamma radiation detection system for tactical deployment**, Sanjoy Mukhopadhyay, Richard J. Maurer, Ronald S. Wolff, Paul P. Guss, Ethan X. Smith, Stephen E. Mitchell, National Security Technologies, LLC (USA) ..... [9593-41]

**Possibility of gated silicon drift detector detecting hard x-ray**, Hideharu Matsura, Shinya Fukushima, Shungo Sakurai, Shohei Ishikawa, Akinobu Takeshita, Atsuki Hidaka, Osaka Electro-Communication Univ. (Japan) .. [9593-42]

**Response function of planar Cd(Zn)Te detectors to beta-radiation**, Alexandr A. Zakharchenko, Aleksandr V. Rybka, Leonid N. Davydov, Vladimir E. Kutny, Manap A. Khazhmuradov, National Science Ctr. Kharkov Institute of Physics and Technology (Ukraine); Petro M. Fochuk, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Aleksey E. Bolotnikov, Ralph B. James, Brookhaven National Lab. (USA) [9593-43]

**The effect/influence of crystal thickness on the electrical characteristics of Cd(Zn)Te detectors**, Valerii M. Sklyarchuk, Petro M. Fochuk, Ilarii Rarenko, Zinajida Zakharuk, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Aleksey E. Bolotnikov, Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-44]

**Temperature-dependent electrical properties of high-resistivity CdTe**, Petro M. Fochuk, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Yevhen Nykoniuk, National Univ. of Water Management and Natural Resources Application (Ukraine); Valerii M. Sklyarchuk, Zinajida Zakharuk, Serhii Dremlyuzhenko, Ilarii Rarenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Aleksey E. Bolotnikov, Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-45]

**Regularities of melting and crystallization in CdTe-Al alloys**, Andriy I. Kanak, Oleh Kopach, Petro M. Fochuk, Larysa P. Shcherbak, Igor Nakonechnyj, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Aleksey E. Bolotnikov, Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-46]

**Development of wide-band-gap AlGaAs photodiodes for scintillation-based radiation detection applications**, Xiao Jie Chen, Erik B. Johnson, Chad M. Whitney, Radiation Monitoring Devices, Inc. (USA); Taehoon Kang, Michigan State Univ. (USA); Mark D. Hammig, Univ. of Michigan (USA); James F. Christian, Radiation Monitoring Devices, Inc. (USA) ..... [9593-47]

**Gamma radiation sensor by using Si implanted SONOS device**, Wen-Ching Hsieh, Minghsin Univ. of Science and Technology (Taiwan); Fuh-Cheng Jong, Southern Taiwan Univ. of Science & Technology (Taiwan); Shich-Chuan Wu, National Nano Device Labs. (Taiwan) ..... [9593-48]

**Bismuth- and lithium-loaded plastic scintillators for gamma and neutron detection**, H. Paul Martinez, Nerine J. Cherepy, Robert D. Sanner, Thomas T. Tillotson, Patrick R. Beck, Erik L. Swanberg, Stephen A. Payne, Lawrence Livermore National Lab. (USA) ..... [9593-49]

**Comparative study of CdMnTe crystals grown by three different methods**, Anwar Hossain, Aleksey Bolotnikov, Giuseppe Camarda, Yonggang Cui, Rubi Gul, Brookhaven National Lab. (USA); KiHyun Kim, Korea Univ. College of Health Sciences (Korea, Republic of); Utpal Roy, Ge Yang, Ralph James, Brookhaven National Lab. (USA) ..... [9593-50]

**Ionizing radiation detection by Yb-doped silica optical fibers**, Cristina De Mattia, Ivan Veronese, Univ. degli Studi di Milano (Italy); Mauro Fasoli, Norberto Chiodini, Univ. degli Studi di Milano-Bicocca (Italy); Eleonora Mones, Azienda Ospedaliera Maggiore della Carità (Italy); Marie Claire Cantone, Simone Cialdi, Marco Gargano, Nicola Ludwig, Letizia Bonizzoni, Univ. degli Studi di Milano (Italy); Anna Vedda, Univ. degli Studi di Milano-Bicocca (Italy) ..... [9593-51]

**Study on the single crystal InI for radiation detector applications**, ShinHaeng Cho, PilSu Kim, ChanSun Park, KiHyun Kim, Korea Univ. (Korea, Republic of) ..... [9593-52]

**Compact lightweight search instruments: a toolbox approach**, Scott A. Watson, Los Alamos National Lab. (USA) ..... [9593-53]

**In-situ monitoring of electrical properties during the CZT annealing**, Chansun Park, Ki-Hyun Kim, PilSu Kim, Shinhaeng Cho, Korea Univ. (Korea, Republic of); Ralph B. James, Anwar Hossain, Giuseppe S. Camarda, Aleksey E. Bolotnikov, Brookhaven National Lab. (USA) ..... [9593-54]

**Isochronal annealing and passivation studies on 50 μm 4H-SiC epitaxial layers**, Mohammad A. Mannan, Khai V. Nguyen, Rahmi O. Pak, Cihan Oner, Krishna C. Mandal, Univ. of South Carolina (USA) ..... [9593-55]

**Investigation of metal contacts on high-resistivity amorphous selenium alloy films**, Krishna C. Mandal, Rahmi O. Pak, Mohammad A. Mannan, Khai V. Nguyen, Cihan Oner, Univ. of South Carolina (USA) ..... [9593-56]

**Defect characterization of nuclear detector grade Cd<sub>0.9</sub>Zn<sub>0.1</sub>Te crystals using electron beam induced current (EBIC) imaging, thermally stimulated current (TSC), and deep level transient spectroscopy (DLTS)**, Rahmi O. Pak, Khai V. Nguyen, Cihan Oner, Mohammad A. Mannan, Krishna C. Mandal, Univ. of South Carolina (USA) ..... [9593-57]

**Feasibility studies of icosahedral boron arsenide (B<sub>12</sub>As<sub>2</sub>) for thermal neutron detection**, Yonggang Cui, Aleksey E. Bolotnikov, Giuseppe S. Camarda, Rubi Gul, Anwar Hossain, Utpal N. Roy, Ge Yang, Brookhaven National Lab. (USA); James H. Edgar, Ugochukwu Nwagwu, Kansas State Univ. (USA); Ralph B. James, Brookhaven National Lab. (USA) ..... [9593-59]

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# Medical Applications of Radiation Detectors V

Conference Chairs: **H. Bradford Barber**, The Univ. of Arizona (USA); **Lars R. Furenlid**, The Univ. of Arizona (USA); **Hans N. Roehrig**, The Univ. of Arizona (USA)

Program Committee: **Yonggang Cui**, Brookhaven National Lab. (USA); **F. Patrick Doty**, Sandia National Labs., California (USA); **Geoffrey Harding**, Morpho Detection (Germany); **Ralph B. James**, Brookhaven National Lab. (USA); **Edward S. Jimenez Jr.**, Sandia National Labs. (USA); **Denny L. Lee**, Direct X Ray Digital Imaging Technology LLC (USA); **Rex A. Moats**, Children's Hospital Los Angeles (USA), The Univ. of Southern California (United States); **Vivek V. Nagarkar**, Radiation Monitoring Devices, Inc. (USA); **Eiichi Sato**, Iwate Medical Univ. (Japan); **Michael R. Squillante**, Radiation Monitoring Devices, Inc. (USA)

## WEDNESDAY 12 AUGUST

### POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Low-level laser therapy on fibroblasts submitted to ionizing radiation**, Camila R. Silva, Débora P. Aureliano, Martha S. Ribeiro, Instituto de Pesquisas Energéticas e Nucleares (Brazil) ..... [9594-20]

## THURSDAY 13 AUGUST

### SESSION 1 ..... THU 8:00 AM TO 9:50 AM

#### Digital Radiography and CT

Session Chair: **H. Bradford Barber**, The Univ. of Arizona (USA)

**Dual-energy x-ray computed tomography system using a cadmium telluride detector and its application to gadolinium imaging**, Yasuhiro Miura, Eiichi Sato, Yasuyuki Oda, Satoshi Yamaguchi, Iwate Medical Univ. (Japan); Osahiko Hagiwara, Hiroshi Matsukyo, Manabu Watanabe, Shinya Kusachi, Toho Univ. (Japan) [9594-1]

**Exploring the feasibility of traditional image querying tasks for industrial radiographs**, Edward S. Jimenez Jr., Sandia National Labs. (USA) ..... [9594-2]

**X-ray imaging with scintillator-sensitized hybrid organic photodetectors**, Patric Büchele, Siemens AG (Germany) and Karlsruhe Institute of Technology (Germany); Genesis N. Ankah, Leibniz-Institut für Neue Materialien GmbH (Germany); Moses Richter, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Sandro F. Tedde, Rene Fischer, Barbara Wegler, Wilhelm Metzger, Markus Biele, Siemens AG (Germany); Gebhard J. Matt, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Samuele Lilliu, Masdar Institute of Science & Technology (United Arab Emirates); Christoph J. Brabec, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Tobias Kraus, Leibniz-Institut für Neue Materialien GmbH (Germany); Oliver Schmidt, Siemens AG (Germany) ..... [9594-3]

**Monochromatic x-ray photon counting using a microcomputer and its application to iodine imaging**, Yasuyuki Oda, Eiichi Sato, Satoshi Yamaguchi, Iwate Medical Univ. (Japan); Osahiko Hagiwara, Hiroshi Matsukyo, Manabu Watanabe, Shinya Kusachi, Toho Univ. (Japan) ..... [9594-4]

**Si-strip photon counting detectors for contrast-enhanced spectral mammography** (*Invited Paper*), Buxin Chen, Ingrid Reiser, The Univ. of Chicago (USA); Jan C Wessel, DxRay Inc. (USA) and Interon AS (Norway); Nail Malakhov, Grigor Wawrzyniak, Interon AS (Norway); Neal E Hartsough, Thulasidharan Gandhi, DxRay Inc. (USA); Chin-Tu Chen, The Univ. of Chicago (USA); Einar Nygård, Interon AS (Norway); Jan S. Iwanczyk, DxRay, Inc. (USA); William C. Barber, DxRay, Inc. (USA) and Interon AS (Norway) ..... [9594-5]

### SESSION 2 ..... THU 10:10 AM TO 12:10 PM

#### SPECT, PET, and Preclinical Imaging

Session Chair: **Edward S. Jimenez Jr.**, Sandia National Labs. (USA)

**Advances in molecular breast imaging** (*Invited Paper*), Haris Kudrolli, Timothy R. Garcia, Aleksandr Kivenson, Gamma Medica, Inc. (USA) ..... [9594-6]

**Integration of hardware and estimation methods in the design process for solid-state detectors**, Esen Salcin, College of Optical Sciences, The Univ. of Arizona (USA); Lars R Furenlid, The Univ. of Arizona (USA) ..... [9594-7]

**Where have we been and where are we going: a look into the past and future of preclinical imaging** (*Invited Paper*), Kevin B. Parnham, Hein P. Haas, JoAnn Zhang, James M. Masciotti, TriFoil Imaging (USA) ..... [9594-8]

**Optimization of an adaptive SPECT system with the scanning linear estimator**, Nasrin Ghanbari, Eric Clarkson, Matthew A. Kupinski, The Univ. of Arizona (USA) ..... [9594-9]

**Fisher information analysis of digital pulse timing**, Maria D. Ruiz-Gonzalez, Lars R. Furenlid, The Univ. of Arizona (USA) ..... [9594-10]

Lunch/Exhibition Break ..... Thu 12:10 pm to 1:40 pm

### SESSION 3 ..... THU 1:40 PM TO 3:20 PM

#### New Detectors for Medical Imaging

Session Chair: **Lars R. Furenlid**, The Univ. of Arizona (USA)

**Properties of transparent  $(\text{Gd},\text{Lu})_3(\text{Al},\text{Ga})\text{S}\text{O}_{12}:\text{Ce}$  ceramic with Ca and Mg co-dopants** (*Invited Paper*), Yimin Wang, Gary Baldoni, William H. Rhodes, Urmila Shirwadkar, Charles Brecher, Chuncheng Ji, Jarek Glodo, Kanai S. Shah, Radiation Monitoring Devices, Inc. (USA) ..... [9594-11]

**Biomimetic-integrated surface nanostructures for medical imaging scintillation radiation**, Ya Sha Yi, Univ. of Michigan (USA) ..... [9594-12]

**Efficient high-resolution hard x-ray imaging with transparent  $\text{Lu}_2\text{O}_3:\text{Eu}$  scintillator thin films** (*Invited Paper*), Zsolt Marton, Stuart R. Miller, Charles Brecher, Radiation Monitoring Devices, Inc. (USA); Peter Kenesei, Matthew D. Moore, Russell Woods, Jonathon D. Almer, Antonino Miceli, Argonne National Lab. (USA); Vivek V. Nagarkar, Radiation Monitoring Devices, Inc. (USA) ..... [9594-13]

**Development of an LSO-MPPC x-ray spectrometer and its application to high-count-rate energy-dispersive computed tomography using a high-speed linear scanner**, Eiichi Sato, Yasuyuki Oda, Satoshi Yamaguchi, Iwate Medical Univ. (Japan); Osahiko Hagiwara, Hiroshi Matsukyo, Toho Univ. (Japan); Manabu Watanabe, Iwate Medical Univ. (Japan) and Toho University (Japan); Shinya Kusachi, Toho Univ. (Japan) ..... [9594-14]

### SESSION 4 ..... THU 3:50 PM TO 5:40 PM

#### Phase Contrast Imaging and Other

Session Chair: **Esen Salcin**, College of Optical Sciences, The Univ. of Arizona (USA)

**GPU programming for biomedical imaging** (*Invited Paper*), Luca Caucci, Lars R. Furenlid, The Univ. of Arizona (USA) ..... [9594-15]

**Design of photonic-channelled x-ray detector array for single-grating x-ray differential phase contrast imaging system**, Yuzuru Takashima, Young-Sik Kim, Chris Summitt, Sunglin Wang, The Univ. of Arizona (USA) ..... [9594-16]

**A grating-based x-ray phase-contrast imaging simulation**, Edward S. Jimenez Jr., Amber L. Young, Sandia National Labs. (USA) ..... [9594-17]

**Portable LED-induced autofluorescence imager with a probe of L shape for oral cancer diagnosis**, Ting-Wei Huang, Nai-Lun Cheng, Yung-Jhe Yan, Hou-Chi Chiang, Jin-Chern Chiou, Ou-Yang Mang, National Chiao Tung Univ. (Taiwan) ..... [9594-18]

**Natural radioactivity in scintillators**, H. Bradford Barber, Univ of Arizona (USA) ..... [9594-19]

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# Radiation Detectors: Systems and Applications XVI

Conference Chairs: **Gary P. Grim**, Lawrence Livermore National Lab. (USA); **H. Bradford Barber**, The Univ. of Arizona (USA)

Program Committee: **Stuart A. Baker**, National Security Technologies, LLC (USA); **Patrick Feng**, Sandia National Labs., California (USA); **Paul P. Guss**, National Security Technologies, LLC (USA); **Khalid M. Hattar**, Sandia National Labs. (USA); **Ralph B. James**, Brookhaven National Lab. (USA); **Edward Steven Jimenez Jr.**, Sandia National Labs. (USA); **Will E. Johns**, Vanderbilt Univ. (USA); **Michael J. King**, Rapiscan Systems Labs. (USA); **Edward A. McKigney**, Los Alamos National Lab. (USA); **Wondwosen Mengesha**, Physical Optics Corp. (USA); **Frank E. Merrill**, Los Alamos National Lab. (USA); **Michael R. Squillante**, Radiation Monitoring Devices, Inc. (USA)

## WEDNESDAY 12 AUGUST

### SESSION 1 ..... WED 8:00 AM TO 10:00 AM

#### X-Ray and Gamma-Ray Systems I

Session Chair: **Daniel A. Lemieux**, The Univ. of Arizona (USA)

**Maximum likelihood source localization using elpasolite crystals as a dual gamma neutron directional detector**, Paul P. Guss, Thomas G. Stampahar, Sanjoy Mukhopadhyay, National Security Technologies, LLC (USA); Alexander Barzilov, Amber Guckles, Univ. of Nevada, Las Vegas (USA) ..... [9595-1]

**Imaging system for dynamic x-ray diffraction and radiographic diagnostics from 17 to 25 keV**, Dane V. Morgan, National Security Technologies, LLC (USA) ..... [9595-2]

**Microsystem for remote sensing of high-energy radiation with associated extremely-low photon flux densities**, Vijay K. Jain, Alex Otten, Univ. of South Florida (USA) ..... [9595-3]

**Measuring x-ray spectra of flash radiographic sources**, Amanda E. Gehring, Michelle A. Espy, Todd J. Haines, Robert Sedillo, Los Alamos National Lab. (USA) ..... [9595-4]

**Auger compositional depth profiling of the metal contact-TIBr interface**, Art J. Nelson, Erik L. Swanberg, Lars F. Voss, Robert T. Graff, Adam M. Conway, Stephen A. Payne, Lawrence Livermore National Lab. (USA); Hadong Kim, Leonard J. Cirignano, Kanai S. Shah, Radiation Monitoring Devices, Inc. (USA) ..... [9595-5]

**Design and optimization of a radiation detector for ground- and spaced-based exposure**, Dileon Saint-Jean, Louisiana Tech Univ. (USA); Kazim R. Abbot, Darnel D. Williams, Grambling State Univ. (USA); Pedro Derosa, Lee Sawyer, Dilip K. Jana, Louisiana Tech Univ. (USA) ..... [9595-6]

### SESSION 2 ..... WED 10:20 AM TO 11:50 AM

#### X-Ray and Gamma-Ray Systems II

Session Chair: **Frank E. Merrill**, Los Alamos National Lab. (USA)

**Detector blur associated with MeV radiographic imaging systems** (*Invited Paper*), Stuart A. Baker, Kristina K Brown, Duane D Smalley, Russell A Howe, Stephen E. Mitchell, National Security Technologies, LLC (USA); Stephen S Lutz, Keystone International, Inc. (USA); Rachel M Posner, National Security Technologies, LLC (USA); Timothy J. Webb, Sandia National Labs. (USA); Jeremy Danielson, Todd J. Haines, Los Alamos National Lab. (USA) ..... [9595-7]

**Quantitative criteria for assessment of gamma-ray imager performance**, Hans Malik, Stephen R. Gottesman, Kristi Keller, Northrop Grumman Electronic Systems (USA) ..... [9595-8]

**Physical basis for signal separation for remote sensing of multiple high-energy radiation sources**, Vijay K. Jain, John Richards, Univ. of South Florida (USA) ..... [9595-9]

**Design of x-ray differential phase contrast imaging system for high energy and incoherent x-ray sources**, Yuzuru Takashima, Young-Sik Kim, Jihun Kim, The Univ. of Arizona (USA) ..... [9595-10]

Lunch/Exhibition Break ..... Wed 11:50 am to 1:30 pm

### SESSION 3 ..... WED 1:30 PM TO 3:20 PM

#### Target Diagnostics: Joint Session with Conferences 9591 and 9595

Session Chair: **Gary P. Grim**, Lawrence Livermore National Lab. (USA)

**Co-linear neutron and x-ray imaging at the National Ignition Facility** (*Invited Paper*), Frank E. Merrill, Los Alamos National Lab. (USA); Kim Christensen, Lawrence Livermore National Lab. (USA); Christopher R. Danly, Valerie Fatherley, Los Alamos National Lab. (USA); David N. Fittinghoff, Lawrence Livermore National Lab. (USA); Jeffrey R. Griego, Los Alamos National Lab. (USA); Gary P. Grim, Nobuhiko Izumi, Lawrence Livermore National Lab. (USA); Donald R. Jedlovec, Lawrence Livermore National Lab. (USA) and Los Alamos National Lab (USA); Raspberry Simpson, Los Alamos National Lab. (USA); Kenneth M. Skulina, Lawrence Livermore National Lab. (USA); Petr L. Volegov, Carl H. Wilde, Los Alamos National Lab. (USA) ..... [9595-11]

**Testing of the gamma-ray imaging system with a mono-energetic gamma source at HIGS**, Daniel A Lemieux, College of Optical Sciences The Univ of Arizona (USA) ..... [9595-12]

**Fundamental performance differences of CMOS and CCD imagers: part VI** (*Invited Paper*), James R. Janesick, Tom Elliott, James Andrews, John Tower, SRI International Sarnoff (USA) ..... [9591-1]

**Complete time-resolved polarimetry of scattered light on the NIF** (*Invited Paper*), David Turnbull, Joseph E. Ralph, Robert Chow, Pierre A. Michel, Gene Frieders, Robin L. Hibbard, Kenn M. Knittel, Joel R. Stanley, James L. Vickers, Ziad M. Zeid, John D. Moody, Lawrence Livermore National Lab. (USA) ..... [9591-2]

### SESSION 4 ..... WED 3:40 PM TO 5:30 PM

#### Particle Systems

Session Chair: **H. Bradford Barber**, The Univ. of Arizona (USA)

**The challenge of building large-area high-precision tracking detectors for upgrading the ATLAS Muon Spectrometer for the LHC high-luminosity phase** (*Invited Paper*), Oliver Stelzer-Chilton, TRIUMF (Canada) ..... [9595-13]

**Spatial response characterization of He-4 scintillation detectors**, Ryan P. Kelley, Noah Steinberg, Univ. of Florida (USA); David Murer, Arktis Radiation Detectors Ltd. (Switzerland); Heather Ray, Kelly A. Jordan, Univ. of Florida (USA) ..... [9595-14]

**ENGA: a novel large area neutron detector**, Marian Jandel, Gencho Y. Rusev, Terry N. Taddeucci, Los Alamos National Lab. (USA) ..... [9595-15]

**Operational performance of a high-speed neutron detector using CLYC**, Erik B. Johnson, Chad M. Whitney, Sam Vogel, Radiation Monitoring Devices, Inc. (USA); Keith E. Holbert, Premkumar Chandran, Arizona State Univ. (USA); Joshua P. Tower, Patrick J. O'Dougherty, Craig Hines, James F. Christian, Radiation Monitoring Devices, Inc. (USA) ..... [9595-16]

**Time-gating for energy selection and scatter rejection: high-energy pulsed neutron imaging at LANSCE**, Alicia L. Swift, Los Alamos National Lab. (USA) and The Univ. of Tennessee (USA); Richard C. Schirato, Edward A. McKigney, James F. Hunter, Brian Temple, Los Alamos National Lab. (USA) ..... [9595-17]

# CONFERENCE 9595

## POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Evaluation of a gamma camera system for the RITS-6 accelerator using the self-magnetic pinch diode**, Timothy J. Webb, Mark L. Kiefer, Sandia National Labs. (USA); Raymond Gignac, Stuart A. Baker, National Security Technologies, LLC (USA) ..... [9595-18]

**Influence of tailed-current on UXO prospecting**, Linlin Zhang, Shuang Zhang, Shudong Chen, Haoyang Fu, Jilin Univ. (China) ..... [9595-19]

**An improved RF circuit for overhauser magnetometer excitation**, Di Zheng, Shuang Zhang, Xin Guo, Haoyang Fu, Jilin Univ. (China) ..... [9595-20]

**Stacked filtered multi-channel x-ray diode array**, Lawrence P. MacNeil, Eric C. Dutra, National Security Technologies, LLC (USA); Steven M. Compton, Barry A. Jacoby, Lawrence Livermore National Lab. (USA); Mark L. Raphaelian, National Security Technologies, LLC (USA) ..... [9595-21]

**The short line of sight neutron imaging diagnostic at the National Ignition Facility**, Raspberry Simpson, Frank E. Merrill, Christopher R. Danly, Petr L. Volegov, Carl H. Wilde, Los Alamos National Lab. (USA); David N. Fittinghoff, Nobuhiko Izumi, Kim Christensen, Kenneth M. Skulina, Donald R. Jedlovec, Lawrence Livermore National Lab. (USA) ..... [9595-22]

Wednesday-Thursday 12-13 August 2015 • Proceedings of SPIE Vol. 9596

# Signal and Data Processing of Small Targets 2015

Conference Chair: Oliver E. Drummond, Consulting Engineer (USA)

Conference Co-Chair: Richard D. Teichgraeber, Consulting Engineer (USA)

Program Committee: Liyi Dai, U.S. Army Research Office (USA); Darren K. Emge, U.S. Army Edgewood Chemical Biological Ctr. (USA); Denise E. Jones, U.S. Army Space and Missile Defense Command (USA); Karla K. Spriestersbach, Missile Defense Agency (USA); Steven W. Waugh, Defense Threat Reduction Agency (USA)

## TUESDAY 11 AUGUST

### SIGNAL, IMAGE, AND DATA PROCESSING

#### PLENARY SESSION.....TUE 1:30 PM TO 2:30 PM

Session Chair: Khan M. Iftekharuddin, Old Dominion Univ. (USA)

Welcome and Introductions: 1:30 to 1:35 pm

Visual Signal Analysis: Focus on Texture Similarity (*Plenary*), Thrasivoulos N. Pappas, Northwestern Univ. (USA) ..... [9596-500]

## WEDNESDAY 12 AUGUST

#### SESSION 1.....WED 1:30 PM TO 5:00 PM

### Signal Processing

Infrared small target detection algorithm based on multiscale codebook model, Lei Liu, Yayun Zhou, Nanjing Univ. of Science and Technology (China) ..... [9596-1]

Enhanced accuracy of heart-rate measurement using the green light diode laser and infrared reflection model from Taipei, Taiwan, Yen-Hsing Lin, National Taipei Univ. of Technology (Taiwan); Guan-Jhong Lin, National Taiwan Univ. (Taiwan); Chung-Ping Chen, National Taipei Univ. of Technology (Taiwan). [9596-2]

Small and dim target detection by background modeling, Jing Hu, Yi Yu, Fan Liu, Huazhong Univ. of Science and Technology (China) ..... [9596-3]

Raman laser spectrometer adaptive processing for Mars exploration, Carlos Diaz Cano, Andoni G. Moral Inza, Carlos Pérez Canora, INTA Instituto Nacional de Técnica Aeroespacial (Spain); Guillermo López Reyes, Univ. de Valladolid (Spain); Eva Diaz Catalá, INTA Instituto Nacional de Técnica Aeroespacial (Spain) and INTA (Spain); Fernando Rull, Universidad de Valladolid (Spain); Gonzalo Ramos, María Colombo, INTA (Spain); Jose Antonio Rodríguez, ISDEF (Spain) ..... [9596-4]

Numerical study of the statistical characteristics of range-resolved sea clutter, Jianing Wang, Xiaojian Xu, BeiHang Univ. (China) ..... [9596-5]

Research on the algorithm of small infrared target detection based on the three frame difference and background subtraction method, Yun Liu, Yuejin Zhao, Ming Liu, Liqian Dong, Mei Hui, Xiaohua Liu, Ling-Qin Kong, Beijing Institute of Technology (China) ..... [9596-6]

Contour detect of objects in the image by shearlet transform, Luis Cadena, Nikolai D. Espinosa, Escuela Politecnica del Ejercito (Ecuador); Grigory Okhotnikov, Siberian Federal Univ. (Russian Federation); Franklin Cadena, Colegio Nacional Eloy Alfaro (Ecuador); Jesus Vila, Univ. Pais Vasco (Spain) ..... [9596-7]

#### POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

Detection of bone fragment embedded in de-boned chicken meat using near-infrared hyperspectral reflectance imaging technique, Jongguk Lim, Giyoung Kim, Changyeun Mo, Rural Development Administration (Korea, Republic of) ..... [9596-20]

A survey of maneuvering target tracking: Part VI: sampling-based nonlinear filters, Xiao-Rong Li, Vesselin P. Jilkov, Univ. of New Orleans (USA) .... [9596-21]

Detecting ground moving objects using panoramic system, Fu-yuan Xu, Guohua Gu, Nanjing Univ of Science and Technology (China); Jing Wang, LiShui MinFeng Town Bank (China) ..... [9596-22]

Motion object detection by three-view constraint using moving camera, Wei Yang, Guohua Gu, Nanjing Univ of Science and Technology (China); Wenjuan Wang, Nanjing Panda Handa Technology Company Limited (China) ..... [9596-23]

Motion object tracking algorithm using multi-cameras, Xiao-fang Kong, Nanjing University of Science and Technology (China) ..... [9596-24]

## THURSDAY 13 AUGUST

#### SESSION 2.....THU 8:30 AM TO 12:00 PM

### Tracking: Association and Filtering

Track-to-track association for object matching in an inter-vehicle communication system, Ting Yuan, Qi Chen, Tobias Roth, Mercedes-Benz Research & Development North America, Inc. (USA) ..... [9596-8]

Relationship between fractional calculus and fractional Fourier transform, Yan-Shan Zhang, Feng Zhang, Mingfeng Lu, Beijing Institute of Technology (China) ..... [9596-9]

Error bounds for particle flow nonlinear filters, Frederick E. Daum, Raytheon Co. (USA) ..... [9596-10]

Hybrid particle-parameter flow for Bayesian nonlinear filters, decisions, learning, and transport, Frederick E. Daum, Raytheon Co. (USA) ..... [9596-11]

A correlation filter for small target/signal detection, acquisition, estimation and tracking in clutter, low signal-to-noise clutter, and background noise processing, Gee-In Goo, MicroTechnologies, Inc. (USA) ..... [9596-12]

Evidence-based contact tracking: a different approach to bearings-only TMA, Ernest T. Northhardt, Steven C. Nardone, Joseph W. Burke, Brian W. Guimond, Mikel, Inc. (USA) ..... [9596-13]

Implementation and performance comparison of FPGA-accelerated particle flow and particle filters, Jiande Wu, Vesselin P. Jilkov, Dimitrios Charalampidis, Univ. of New Orleans (USA) ..... [9596-14]

Lunch/Exhibition Break ..... Thu 12:00 pm to 2:10 pm

#### SESSION 3.....THU 2:10 PM TO 3:00 PM

### Signal and Data Processing Issues

The optimization of the lognormal distribution into the counting channel for the airborne particle counter, Juan Yang, Jinling Institute of Technology (China) ..... [9596-15]

Dim target trajectory-associated detection in bright earth limb background, Penghui Chen, Xiaojian Xu, Xiaoyu He, Yuesong Jiang, BeiHang Univ. (China) ..... [9596-16]

#### SESSION 4.....THU 3:30 PM TO 4:45 PM

### Workshop: Signal and Data Processing

Action windows with resource limits, David D Swarder, Univ of California San Diego (USA); John Boyd, Cubic Defense Applications, Inc. (USA) ..... [9596-17]

Implementation and evaluation of a detector of clutter embedded resolved targets in optical and infrared maritime video, Martin Jaszewski, Eric Hallenborg, Space and Naval Warfare Systems Ctr. Pacific (USA) ..... [9596-18]

Title to be determined, Oliver Drummond, CyberRnD, Inc. (USA) ..... [9596-19]

# CONFERENCE 9597

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Monday-Wednesday 10-12 August 2015 • Proceedings of SPIE Vol. 9597

## Wavelets and Sparsity XVI

Conference Chairs: **Manos Papadakis**, Univ. of Houston (USA); **Vivek K. Goyal**, Boston Univ. (USA); **Dimitri Van De Ville**, Ecole Polytechnique Fédérale de Lausanne (Switzerland), Univ. of Geneva (Switzerland)

Program Committee: **Sophie Achard**, Gipsa-lab (France); **Radu V. Balan**, Univ. of Maryland, College Park (USA); **Bernhard G. Bodmann**, Univ. of Houston (USA); **Peter G. Casazza**, Univ. of Missouri-Columbia (USA); **Fabrizio De Vico Fallani**, Institut National de Recherche en Informatique et en Automatique (France); **Bin Dong**, Peking Univ. (China); **Jalal M. Fadili**, ENSICAEN (France); **Matthew Fickus**, Air Force Institute of Technology (USA); **Mathews Jacob**, The Univ. of Iowa (USA); **Gitta Kutyniok**, Technische Univ. Berlin (Germany); **Demetrio Labate**, Univ. of Houston (USA); **Fernanda Laezza**, The Univ. of Texas Medical Branch (USA); **Michael Liebling**, Univ. of California, Santa Barbara (USA); **Yue M. Lu**, Harvard Univ. (USA); **Mauro Maggioni**, Duke Univ. (USA); **Jean-Christophe Olivo-Marin**, Institut Pasteur (France); **Naoki Saito**, Univ. of California, Davis (USA); **Joshua D. Trzasko**, Mayo Clinic (USA); **Michael Unser**, Ecole Polytechnique Fédérale de Lausanne (Switzerland); **Yves Wiaux**, Ecole Polytechnique Fédérale de Lausanne (Switzerland); **Rebecca M. Willett**, Univ. of Wisconsin-Madison (USA)

### MONDAY 10 AUGUST

SESSION 1 ..... MON 8:30 AM TO 9:50 AM

#### Sparse Representations in MRI

Session Chairs: **Mathews Jacob**, The Univ. of Iowa (USA); **Joshua D. Trzasko**, Mayo Clinic (USA)

Off-the-grid recovery of piecewise constant MR images, Mathews Jacob, The Univ. of Iowa (USA) ..... [9597-1]

Learning sparsifying filter banks, Luke Pfister, Yoram Bresler, Univ. of Illinois at Urbana-Champaign (USA) ..... [9597-2]

Advanced image reconstruction strategies for 4D prostate DCE-MRI: steps toward clinical practicality, Eric G. Stinson, Eric A. Borisch, Adam T. Froemming M.D., Akira Kawashima M.D., Brent A. Warndahl, Roger C. Grimm, Stephen J. Riederer, Joshua D. Trzasko, Mayo Clinic (USA) ..... [9597-3]

Imaging industry expectations for compressed sensing in MRI, Kevin F. King, GE Healthcare (USA) ..... [9597-4]

SESSION 2 ..... MON 9:50 AM TO 12:00 PM

#### Variational Techniques and Optimization for Compressed Sensing

Session Chair: **Bin Dong**, Peking Univ. (China)

PDE-free variational imaging methods based on sparse representations, Julia Dobrosotskaya, Case Western Reserve Univ. (USA) ..... [9597-5]

Dictionary learning for compressive parameter mapping in magnetic resonance imaging, Benjamin P. Berman, Mahesh B. Keerthivasan, Zhitao Li, The Univ. of Arizona (USA); Diego R. Martin, The Univ. of Arizona College of Medicine (USA); Maria I. Altbach, Ali Bilgin, The Univ. of Arizona (USA) ..... [9597-6]

Semi-supervised high dimensional clustering by tight wavelet frames, Bin Dong, Peking Univ. (China); Ning Hao, The Univ. of Arizona (USA) ..... [9597-7]

Smooth affine shear tight frames: digitization and applications, Xiaosheng Zhuang, City Univ. of Hong Kong (Hong Kong, China) ..... [9597-8]

A fast algorithm for reconstruction of spectrally sparse signals in super-resolution, Jian-Feng Cai, Suhui Liu, Weiyu Xu, The Univ. of Iowa (USA) .. [9597-9]

Lunch Break ..... Mon 12:00 pm to 1:30 pm

SESSION 3 ..... MON 1:30 PM TO 3:30 PM

#### Frame Theory and Applications

Session Chairs: **Peter G. Casazza**, Univ. of Missouri (USA); **Matthew Fickus**, Air Force Institute of Technology (USA)

Algebraic and geometric spread in finite frames, Emily J. King, Univ. Bremen (Germany) ..... [9597-10]

Compressive classification and the rare eclipse problem, Dustin G. Mixon, Air Force Institute of Technology (USA) ..... [9597-11]

Gabor fusion frames generated by difference sets, Irena Bojarovska, Technische Univ. Berlin (Germany); Victoria Paternostro, Univ. de Buenos Aires (Argentina) ..... [9597-12]

The null space property of compressed sensing, Xuemei Chen, Univ. of Missouri (USA); Rongrong Wang, The Univ. of British Columbia (Canada) ..... [9597-13]

Generalized Steiner equiangular tight frames, John D. Jasper, Univ. of Oregon (USA); Matthew Fickus, Dustin G. Mixon, Jesse D. Peterson, Air Force Institute of Technology (USA) ..... [9597-14]

Sparse frame representation in DOA estimations under severe noise, Cao Xing, Xidian Univ. (China); Shidong Li, San Francisco State Univ. (USA); Guisheng Liao, Xidian Univ. (China) ..... [9597-15]

SESSION 4 ..... MON 4:00 PM TO 6:00 PM

#### Sparse and Directional Representations in Neuroimaging

Session Chairs: **Demetrio Labate**, Univ. of Houston (USA); **Fernanda Laezza**, The Univ. of Texas Medical Branch (USA)

Registration using the shearlet transform, Glenn R. Easley, The MITRE Corp. (USA); Demetrio Labate, Univ. of Houston (USA) ..... [9597-16]

Shearlet-domain task-driven post-processing and filtering of CT noise, Bart Goossens, Jan Aelterman, Hiêp Q. Luong, Aleksandra Piżurica, Wilfried Philips, Univ. Gent (Belgium) ..... [9597-17]

Geometry and dimensionality reduction of feature spaces in primary visual cortex, Davide Barbieri, Univ. Autónoma de Madrid (Spain) ..... [9597-18]

Shearlets-based regularization in fan-beam ROI-CT problems, Tatiana A. Bubba, Univ. of Ferrara (Italy); Silvia Bonettini, Univ. degli Studi di Ferrara (Italy); Demetrio Labate, Univ. of Houston (USA); Gaetano Zanghirati, Univ. degli Studi di Ferrara (Italy) ..... [9597-19]

Directional ratio based on parabolic molecules and its applications to tubular structure detection, Manos Papadakis, Burcin Ozcan, Univ. of Houston (USA); Fernanda Laezza, The Univ. of Texas Medical Branch (USA); Demetrio Labate, Univ. of Houston (USA) ..... [9597-20]

Investigating the impact of blood pressure increase to the brain using high resolution serial histology and image processing, Frédéric Lesage, Baoqiang Li, Alexandre Castonguay, Pramod Avti, Joel Lefebvre, Ecole Polytechnique de Montréal (Canada) ..... [9597-21]

### TUESDAY 11 AUGUST

SESSION 5 ..... TUE 8:00 AM TO 10:00 AM

#### Frame Theory and Sparse Approximations

Session Chairs: **Radu V. Balan**, Univ. of Maryland, College Park (USA); **Bernhard G. Bodmann**, Univ. of Houston (USA); **Gitta Kutyniok**, Technische Univ. Berlin (Germany)

Phase retrieval by projections, Peter G. Casazza, Univ. of Missouri-Columbia (USA) ..... [9597-22]

Frame and compressed sensing quantization with exponential accuracy, Ozgur Yilmaz, The Univ. of British Columbia (Canada) ..... [9597-23]

Scalable filter banks, Kasso A. Okoudjou, Univ. of Maryland, College Park (USA); Youngmi Hur, Yonsei Univ. (Korea, Republic of) ..... [9597-24]

Self-calibration and biconvex compressive sensing, Thomas Strohmer, Shuyang Ling, Univ. of California, Davis (USA) ..... [9597-25]

Perturbations of frame sequences and the effect on their duals, Friedrich Philipp, Technische Univ. Berlin (Germany); Victoria Paternostro, Univ. de Buenos Aires (Argentina) ..... [9597-26]

Performance bounds in the phase retrieval problem, Radu V. Balan, Univ. of Maryland, College Park (USA) ..... [9597-27]

# CONFERENCE 9597

SESSION 6 ..... TUE 10:30 AM TO 12:10 PM

## Computational Bioimaging

Session Chairs: Jean-Christophe Olivo-Marin, Institut Pasteur (France); Michael Liebling, Univ. of California, Santa Barbara (USA)

**Mesoscopic and macroscopic fluorescence molecular optical tomography enhanced by sparsity**, Xavier Intes, Rensselaer Polytechnic Institute (USA) ..... [9597-28]

**Fast live cell imaging at nanometer scale using sparse recovery**, Junhong Min, KAIST (Korea, Republic of); Michael Unser, Suliana Manley, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Jong Chul Ye, KAIST (Korea, Republic of) ..... [9597-29]

**Light propagation via B-spline discretized-convolutions: examples of use**, Nikhil Chacko, Univ. of California, Santa Barbara (USA); Michael Liebling, Idiap Research Institute (Switzerland) and The Univ. of California, Santa Barbara (USA) ..... [9597-30]

**Biological image denoising via compressed sensing**, Jean-Christophe Olivo-Marin, William Meinhardt, Institut Pasteur (France); Elsa D. Angelini, Columbia Univ. (USA) ..... [9597-31]

**PSF super-resolution using sparsity and low rank matrices constraint**, Fred Ngole, Jean-Luc Starck, Commissariat à l'Énergie Atomique (France) ... [9597-32]

Lunch/Exhibition Break ..... Tue 12:10 pm to 1:30 pm

## SIGNAL, IMAGE, AND DATA PROCESSING

### PLENARY SESSION ..... TUE 1:30 PM TO 2:30 PM

Session Chair: Khan M. Iftekharuddin, Old Dominion Univ. (USA)

Welcome and Introductions: 1:30 to 1:35 pm

**Visual Signal Analysis: Focus on Texture Similarity (Plenary)**, Thrasivoulou N. Pappas, Northwestern Univ. (USA) ..... [9598-500]

### KEYNOTE SESSION ..... TUE 2:30 PM TO 3:10 PM

## Keynote Session I

Session Chair: Vivek K. Goyal, Boston Univ. (USA)

**The dark side of imaging: emerging methods in photon-limited image reconstruction (Invited Paper)**, Rebecca M. Willett, Univ. of Wisconsin-Madison (USA) ..... [9597-33]

SESSION 7 ..... TUE 3:40 PM TO 5:40 PM

## Sparse Representations in MRI

Session Chairs: Mathews Jacob, The Univ. of Iowa (USA); Joshua D. Trzasko, Mayo Clinic (USA)

**Low-rank modeling of local k-space neighborhoods: from phase and support constraints to structured sparsity**, Justin P. Haldar, The Univ. of Southern California (USA) ..... [9597-34]

**Sparse methods for quantitative susceptibility mapping (QSM)**, Berkin Bilgic, Athinoula A. Martinos Ctr. for Biomedical Imaging (USA) ..... [9597-35]

**Real-time MRI of speech in multiple planes using a novel custom upper airway coil, golden angle spirals, and temporal regularization**, Sajan Goud Lingala, Krishna S. Nayak, The Univ. of Southern California (USA) ..... [9597-36]

**Better and faster imaging and reconstruction by transform-based blind compressed sensing**, Saiprasad Ravishankar, Yoram Bresler, Univ. of Illinois at Urbana-Champaign (USA) ..... [9597-37]

**Diffusion tensor MR imaging denoising with image and eigen-value sparsity constraint**, Xi Peng, Dong Liang, Shenzhen Institutes of Advanced Technology (China) ..... [9597-38]

**Magnetic resonance fingerprinting**, Mark Griswold, Case Western Reserve Univ. (USA) ..... [9597-39]

WEDNESDAY 12 AUGUST

SESSION 8 ..... WED 8:20 AM TO 9:20 AM

## Frame Theory and Applications

Session Chairs: Peter G. Casazza, Univ. of Missouri (USA); Matthew Fickus, Air Force Institute of Technology (USA)

**Weaving Hilbert space frames**, Richard G. Lynch, Peter G. Casazza, Univ. of Missouri (USA) ..... [9597-40]

**Bayesian wavelet change point detection**, Darrin Speegle, Saint Louis Univ. (USA); Robert Steward, Saint Louis Univ. (USA) and National Geospatial-Intelligence Agency (USA) ..... [9597-41]

**Block-circulant constructions for robust and efficient phase retrieval**, Mark Iwen, Aditya Viswanathan, Michigan State Univ. (USA); Yang Wang, Hong Kong Univ. of Science and Technology (Hong Kong, China) ..... [9597-42]

SESSION 9 ..... WED 9:20 AM TO 10:20 AM

## Frame Theory and Sparse Approximations

Session Chairs: Radu V. Balan, Univ. of Maryland, College Park (USA); Bernhard G. Bodmann, Univ. of Houston (USA); Gitta Kutyniok, Technische Univ. Berlin (Germany)

**A new approach for constructing equiangular tight frames**, Matthew Fickus, Air Force Institute of Technology (USA); John D. Jasper, Univ. of Missouri (USA); Dustin G. Mixon, Jesse D. Peterson, Air Force Institute of Technology (USA) ... [9597-43]

**Connectivity of spaces of finite unit-norm tight frames**, Nathaniel Strawn, Jameson Cahill, Duke Univ. (USA); Dustin G. Mixon, Air Force Institute of Technology (USA) ..... [9597-44]

**The generalized lasso with non-linear measurements**, Yaniv Plan, The Univ. of British Columbia (Canada); Roman Vershynin, Univ. of Michigan (USA) .. [9597-45]

SESSION 10 ..... WED 10:50 AM TO 11:50 AM

## Multiscale and Randomized Algorithms for Large Data I

Session Chairs: Yue M. Lu, Harvard Univ. (USA); Mauro Maggioni, Duke Univ. (USA)

**Geometric multi-resolution analysis for dictionary learning**, Nathaniel Strawn, Mauro Maggioni, Duke Univ. (USA); Stanislav Minsker, Wells Fargo (USA) [9597-46]

**Geometric multi-resolution analysis and data-driven convolutions**, Nathaniel Strawn, Duke Univ. (USA) ..... [9597-47]

**Higher-order graph wavelets and sparsity on circulant graphs**, Madeleine S. Kotzagiannidis, Pier Luigi Dragotti, Imperial College London (United Kingdom) ..... [9597-48]

Lunch/Exhibition Break ..... Wed 11:50 am to 1:20 pm

KEYNOTE SESSION ..... WED 1:20 PM TO 2:00 PM

## Keynote Session II

Session Chair: Dimitri Van De Ville, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

**Applied and computational harmonic analysis on graphs and networks (Keynote Presentation)**, Naoki Saito, Univ. of California, Davis (USA) .. [9597-49]

SESSION 11 ..... WED 2:00 PM TO 2:40 PM

## Multiscale and Randomized Algorithms for Large Data II

Session Chairs: Yue M. Lu, Harvard Univ. (USA); Mauro Maggioni, Duke Univ. (USA)

**Multiresolution matrix factorization**, Risi Kondor, The Univ. of Chicago (USA) ..... [9597-50]

**Randomized Kaczmarz algorithms: dynamics in the large system limit**, Yue M. Lu, Chuang Wang, Ameya Agaskar, Harvard Univ. (USA) ..... [9597-51]

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SESSION 12 ..... WED 2:40 PM TO 5:10 PM

## Sparse Analysis and Graph Models in Neuroimaging

Session Chairs: **Sophie Achard**, Univ. Grenoble Alps (France); **Fabrizio De Vico Fallani**, Institut National de Recherche en Informatique et en Automatique (France)

**Granger-causality brain networks**, Fabrizio De Vico Fallani, Institut National de Recherche en Informatique et en Automatique (France) ..... [9597-52]

**Directed brain graphs from autoregressive models**, Fabrizio De Vico Fallani, Institut National de Recherche en Informatique et en Automatique (France) and L'Institut du Cerveau et de la Moelle épinière (France) ..... [9597-53]

**Graph spectroscopy**, Paul Expert, King's College London (United Kingdom); Renaud Lambiotte, Sarah de Nigris, Univ. of Namur (Belgium); Taro Takaguchi, National Institute of Informatics (Japan) ..... [9597-54]

**Classification of fMRI data using Gaussian graphical models**, Aude Costard, Sophie Achard, Olivier Michel, GIPSA-lab (France); Pierre Borgnat, Patrice Abry, Lab. de Physique (France) and Ecole Normale Supérieure de Lyon (France) ..... [9597-55]

**Statistical methods for comparing brain connectomes at different scales**, Djalel-Eddine Meskaldji, Univ. of Genéva (Switzerland); Stephan Morgenthaler, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Dimitri Van De Ville, Ecole Polytechnique Fédérale de Lausanne (Switzerland) and Univ. of Genéva (Switzerland) ..... [9597-56]

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# Optics and Photonics for Information Processing IX

Conference Chairs: **Abdul A. S. Awwal**, Lawrence Livermore National Lab. (USA); **Khan M. Iftekharuddin**, Old Dominion Univ. (USA); **Mohammad A. Matin**, Univ. of Denver (USA); **Mireya García Vázquez**, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico)

Conference Co-Chair: **Andrés Márquez**, Univ. de Alicante (Spain)

Program Committee: **George Barbastathis**, Massachusetts Institute of Technology (USA); **Juan Campos**, Univ. Autònoma de Barcelona (Spain); **Liangcai Cao**, Tsinghua Univ. (China); **David Casasent**, Carnegie Mellon Univ. (USA); **Xinbin Cheng**, Tongji Univ. (China); **Víctor H. Diaz-Ramirez**, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); **Laurence G. Hassebrook**, Univ. of Kentucky (USA); **Kazuyoshi Itoh**, Osaka Univ. (Japan); **Mohammad Ataul Karim**, Univ. of Massachusetts Dartmouth (USA); **Byoung-ho Lee**, Seoul National Univ. (Korea, Republic of); **Abhijit Mahalanobis**, Lockheed Martin Missiles and Fire Control (USA); **Osamu Matoba**, Kobe Univ. (Japan); **Alastair D. McAulay**, Lehigh Univ. (USA); **Nasser M. Nasrabadi**, U.S. Army Research Lab. (USA); **Mark A. Neifeld**, The Univ. of Arizona (USA); **Takanori Nomura**, Wakayama Univ. (Japan); **Ting-Chung Poon**, Virginia Polytechnic Institute and State Univ. (USA); **Philippe Réfrégier**, Institut Fresnel (France); **Joseph Rosen**, Ben-Gurion Univ. of the Negev (Israel); **John T. Sheridan**, Univ. College Dublin (Ireland); **Jun Tanida**, Osaka Univ. (Japan); **Juan J. Tapia-Armenta**, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); **Leonardo Trujillo**, Instituto Tecnológico de Tijuana (Mexico); **Cardinal Warde**, Massachusetts Institute of Technology (USA); **Eriko Watanabe**, The Univ. of Electro-Communications (Japan); **Toyohiko Yatagai**, Utsunomiya Univ. (Japan); **María J. Yzuel**, Univ. Autònoma de Barcelona (Spain)

## MONDAY 10 AUGUST

### SESSION 1 ..... MON 8:40 AM TO 10:00 AM

#### Optical Imaging

**3D imaging of amplitude objects embedded in phase objects using transport of intensity**, Mahmudunnabi Basunia, Univ. of Dayton (USA); Partha Banerjee, University of Dayton (USA) ..... [9598-1]

**Linear fitting interpolation based on FOV division for correcting wide angle fish-eye lens distortion**, An Li, Yisi Wu, Chi Chen, Zhenrong Zheng, Zhejiang Univ. (China) ..... [9598-2]

**Real-time sine transform of images based on volume holographic optical correlator**, Fanglin Liu, Liangcai Cao, Dezhao Kong, Guofan Jin, Tsinghua Univ. (China) ..... [9598-3]

**Modeling for space-based visible imaging characteristics of space object**, Cheng-Ming Sun, Academy of Opto-Electronics (China); Yan Yuan, BeiHang Univ. (China); Zhiliang Zhou, Academy of Opto-Electronics (China) ..... [9598-4]

### SESSION 2 ..... MON 10:30 AM TO 12:10 PM

#### Holography and Systems

**Image quality improvement of digital holography by use of various rectangle apertures**, Takanori Nomura, Takahiko Fukuoka, Yutaka Mori, Wakayama Univ. (Japan) ..... [9598-5]

**Static and dynamic effects of flicker in phase multilevel elements on LCoS devices**, Andrés Márquez, Francisco J. Martínez-Guardiola, Sergi Gallego, Manuel Ortúño, Jorge Francés, Augusto Beléndez, Inmaculada Pascual, Univ. de Alicante (Spain) ..... [9598-6]

**Incoherent holography to obtain depth information by a rotational shearing interferometer**, Kaho Watanabe, Takanori Nomura, Wakayama Univ. (Japan) ..... [9598-7]

**Spectral characterization and tuning with liquid-crystal retarders**, María del Mar Sánchez-López, Ignacio Moreno, Univ. Miguel Hernández de Elche (Spain); Asticio V. Vargas, Univ. de la Frontera (Chile); Pascuala García-Martínez, Univ. de València (Spain) ..... [9598-8]

**Z-domain modeling and analysis of vertically coupled triple asymmetric optical micro ring resonator (VCTAOMRR)**, Sanjoy Mandal, Suchita Lakra, Indian School of Mines (India) ..... [9598-9]

Lunch Break ..... Mon 12:10 pm to 1:40 pm

### SESSION 3 ..... MON 1:40 PM TO 3:00 PM

#### Digital Optical Processing I

**Measurement of repetitive surface displacement modulation induced by illuminating femto-second laser pulses**, Ryoma Tozawa, Daisuke Barada, Shigeo Kawata, Utsunomiya Univ. (Japan) ..... [9598-10]

**Least-squares algorithm for statistical generalized phase-shifting digital holography using continuous fringe scanning scheme**, Nobukazu Yoshikawa, Kazuki Kajihara, Saitama Univ. (Japan) ..... [9598-11]

**A hybrid MEMS-planar waveguide optical signal processor**, Dwayne Macik, Russell J. Howe, Christi K. Madsen, Texas A&M Univ. (USA) ..... [9598-12]

**The solution spectroellipsometry objectives for environmental monitoring**, Ferenfant A. Mkrtchyan, Institute of Radio Engineering and Electronics (Russian Federation) ..... [9598-13]

### SESSION 4 ..... MON 3:30 PM TO 5:10 PM

#### Digital Optical Processing II

**The determination of species composition for flow field's temperature reconstruction by optical computerized tomography**, Yun-Yun Chen, Nanjing Univ. of Information Science and Technology (China); Fang Gu, Nanjing Univ. of Information Science & Technology (China); Xia Zhong, Nanjing Univ. of Information Science and Technology (China); Yingying Zhang, Nanjing Xiaozhuang Univ. (China) ..... [9598-14]

**Measuring refractive index of glass by using two captures under speckle field illumination**, Changliang Guo, Univ. College Dublin (Ireland); Dayan Li, Institut Langevin (France) and Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris (France); Damien P. Kelly, Technische Univ. Ilmenau (Germany); John T. Sheridan, Univ. College Dublin (Ireland) ..... [9598-15]

**Compressive sensing based ptychography image encryption**, Nitin Rawat, Gwangju Institute of Science and Technology (Korea, Republic of) and Analog and Mixed Signal Integrated Circuit Design Lab. (Korea, Republic of) ..... [9598-16]

**Research on signal-to-noise ratio characteristics and image restoration for waveform coding**, Yijian Wu, Yuejin Zhao, Liqian Dong, Xiaohu Guo, Wei Jia, Ji Zhao, Beijing Institute of Technology (China) ..... [9598-17]

**Fractional Fourier transform of non-integer vortex beams**, Yaqin Zhao, Xin Zhong, Guanghui Ren, Zhilu Wu, Harbin Institute of Technology (China) .. [9598-18]

# CONFERENCE 9598

TUESDAY 11 AUGUST

SESSION 5..... TUE 8:20 AM TO 10:00 AM

## Algorithms and Detection

**Characterization of dynamic speckle sequences using principal component analysis and image descriptors**, José Manuel López-Alonso, Univ. Complutense de Madrid (Spain); Eduardo Grumel, Hector J. Rabal, Marcelo Trivi, Ctr. de Investigaciones Ópticas (Argentina); Javier Alda, Univ. Complutense de Madrid (Spain) ..... [9598-19]

**Edge extraction of optical subaperture based on fractal dimension method**, Yunqi Wang, Mei Hui, Ming Liu, Liqian Dong, Xiaohua Liu, Yuejin Zhao, Beijing Institute of Technology (China) ..... [9598-20]

**Low crosstalk optical hierarchical authentication with a fixed random phase lock based on two beams interference**, Dajiang Lu, Wenqi He, Xiang Peng, Shenzhen Univ. (China) ..... [9598-21]

**Variants of light modulation for MINACE filter implementation in 4-F correlators**, Dmitry V. Shaulskiy, Nikolay N. Evtikhiev, Evgenie Y. Zlokazov, Sergey N. Starikov, Rostislav S. Starikov, Elizaveta K. Petrova, National Research Nuclear Univ. MEPhI (Russian Federation) ..... [9598-22]

**A fast decoding of Reed-Solomon code with p-polynomial and look-up table method**, Yan-Haw Chen, Chong-Dao Lee, Trieu-Kien Truong, I-Shou Univ. (Taiwan) ..... [9598-23]

SESSION 6..... TUE 10:30 AM TO 12:10 PM

## Intelligent Systems in Mexico and Other Countries

**Video annotations of Mexican nature in a collaborative environment**, Lester Arturo Oropesa Morales, Abraham Montoya Obeso, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Gabriel Nicolas Martínez, Luis Fernando Vázquez Álvarez, Rosaura Hernández García, Escuela Superior en Cómputo (Mexico); Sara Ivonne Cocolán Almeda, Ezra Palomo Romero, MIRAL R&D&I (USA); Luis Miguel Zamudio Fuentes, Mireya Sará García Vázquez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Jesús A. Martínez Nuño, Escuela Superior de Cómputo (Mexico); Alejandro Alvaro Ramírez Acosta, MIRAL R&D&I (USA) ..... [9598-24]

**Detecting fiducials affected by Trombone delay in ARC and the main laser alignment at the National Ignition Facility**, Abdul A. S. Awwal, Richard R. Leach Jr., Randy S. Roberts, Karl Wilhelmsen, Victoria J. Miller-Kamm, Roger R. Lowe-Webb, Lawrence Livermore National Lab. (USA) ..... [9598-25]

**Robust estimators for speech enhancement in real environments**, Yuma Sandoval Ibarra, Víctor H. Díaz-Ramírez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9598-26]

**Automatic alignment of the Advanced Radiographic Capability at the National Ignition Facility**, Randy S. Roberts, Abdul A. S. Awwal, Erlan S. Bliss, Richard R. Leach Jr., Charles D. Orth, Michael C. Rushford, Roger R. Lowe-Webb, Karl Wilhelmsen, Lawrence Livermore National Lab. (USA) ..... [9598-27]

**Annotations of Mexican bullfighting videos for semantic index**, Abraham Montoya Obeso, Lester Arturo Oropesa Morales, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Juan Manuel Torres Martínez, Alan Misael Sánchez Escalona, Escuela Superior en Cómputo (Mexico); Sara Ivonne Cocolán Almeda, MIRAL R&D&I (USA); Luis Miguel Zamudio Fuentes, Mireya Sará García Vázquez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Jesús Yalzá Montiel Pérez, Saúl A. de La O Torres, Instituto Politécnico Nacional (Mexico) and Escuela Superior en Cómputo (Mexico); Alejandro Álvaro Ramírez Acosta, MIRAL R&D&I (USA) ..... [9598-28]

Lunch/Exhibition Break ..... Tue 12:10 pm to 1:30 pm

SESSION 7..... TUE 2:40 PM TO 5:10 PM

## Research on Signal Processing in Mexico and Other Countries

**Mathematical model for classification of EEG signals**, Victor Hugo Ortiz Flores, Instituto Politécnico Nacional (Mexico) and Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Juan Jose Tapia Armenta, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico) and Instituto Politécnico Nacional (Mexico) ..... [9598-29]

**Luminance and contrast ideal balancing based tone mapping algorithm**, Amine Besrour, SUP'COM (Tunisia) and Univ. de Technologie Troyes (France); Mohamed Siala, Fatma Abdelkefi, SUP'COM (Tunisia); Hichem Snoussi, Univ. de Technologie Troyes (France) ..... [9598-30]

**A 3D approach for object recognition in illuminated scenes with adaptive correlation filters**, Kenia Picos, Víctor H. Díaz-Ramírez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico) ..... [9598-31]

**Robust modulation formats recognition technique using wavelet transform for high speed optical networks**, Latifa Guesmi, Abir Hraghi, Mourad Menif, SUP'COM (Tunisia) ..... [9598-32]

**Real-time image dehazing using local adaptive neighborhoods and dark-channel-prior**, Jesus A. Valderrama, Víctor H. Díaz-Ramírez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9598-33]

**Comparison analysis of surfaces detected through polarimetric imaging and by fringe projection profilometry**, Alejandra Serrano Trujillo, Univ Autónoma de Baja California (Mexico); Adriana Nava, Univ. Autónoma de Baja California (Mexico); Victor Ruiz-Cortes, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9598-34]

WEDNESDAY 12 AUGUST

POSTERS-WEDNESDAY..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**High dynamic range imaging for shiny surface with single-shot raw data of the color camera**, Yongkai Yin, Shenzhen Univ. (China); Jiangtao Xi, Univ. of Wollongong (Australia); Zewei Cai, Shenzhen Univ. (China); Yanguang Yu, Univ. of Wollongong (Australia); Xiang Peng, Shenzhen Univ. (China) ..... [9598-35]

**Automated counting of morphologically normal red blood cells by using digital holographic microscopy and statistical methods**, Inkyu Moon, Faliu Yi, Chosun Univ. (Korea, Republic of) ..... [9598-36]

**3D face recognition based on matching of facial surfaces**, Beatriz A. Echeagaray Patrón, Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9598-37]

**Illumination-invariant hand gesture recognition**, América I. Mendoza-Morales, CICESE (Mexico); Daniel Miramontes-Jaramillo, Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9598-38]

**Research on the high-precision non-contact optical detection technology for banknotes**, Xiaofeng Jin, Shanghai Institute of Optics and Fine Mechanics (China); Tiancai Liang, Pengfeng Luo, GRG Banking Equipment Co., Ltd. (China); Jianfeng Sun, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9598-39]

**The research of measurements mode of optical spectra by spectral device based on acousto-optic tunable filter**, Georgy Korol, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation) ..... [9598-40]

**Objects tracking with adaptive correlation filters and Kalman filtering**, Sergio E. Ontiveros Gallardo, Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9598-41]

**Optical image encryption based on phase-truncated Fresnel diffraction**, Chenggong Zhang, Wenqi He, Xiang Peng, Dajiang Lu, Shenzhen Univ. (China) ..... [9598-42]

**Optical identification authentication based on the phase modulation of moiré effect in the phase-space optics**, Meihua Liao, Wenqi He, Dajiang Lu, Jiachen Wu, Xiang Peng, Shenzhen Univ. (China) ..... [9598-43]

**Evolution of optical pulses in the optical fiber as basis of spectral devices**, Ilya A. Osmakov, Oleg D. Moskaletz, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation) ..... [9598-44]

**Influence of lens system aperture on optical information processing**, Sergey N. Mosentsov, Vasily Kazakov, Oleg D. Moskaletz, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation) ..... [9598-45]

# CONFERENCE 9598

- Correlation measurements in optical range**, Aleksey Orlov, Oleg D. Moskaletz, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation); Dmitry O. Moskaletz, Saint Petersburg Electrotechnical Univ. "LETI" (Russian Federation) ..... [9598-46]
- Power spectrum estimation of optical radiation by multichannel resonant spectral device**, Artur Paraskun, Oleg D. Moskaletz, Saint-Petersburg State Univ. of Aerospace Instrumentation (Russian Federation) ..... [9598-47]
- The conception and implementation of a local HDR fusion algorithm depending on contrast and luminosity parameters**, Amine Besrour, SUP'COM (Tunisia) and Univ. de Technologie Troyes (France); Fatma Abdelkefi, Mohamed Siala, SUP'COM (Tunisia); Hichem Snoussi, Univ. de Technologie Troyes (France) ..... [9598-48]
- Study of the index matching for different photopolymers**, Sergi Gallego, Univ. de Alicante (Spain); Andrés Márquez, Univ de Alicante (Spain); Roberto Fernández, Stephan Marini, manuel Ortúñoz, Augusto Beléndez, Inmaculada Pascual, Univ. de Alicante (Spain) ..... [9598-49]
- Correlations filters used for object recognition and tracking in UAV's applications**, Francisco Javier Ramírez-Arias, Univ. Autónoma de Baja California (Mexico); Víctor H. Díaz-Ramírez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico); Antonio Gomez Roa, Univ. Autónoma de Baja California (Mexico) ..... [9598-50]
- Numerical analysis of holographic tomography with different reconstruction algorithms in the presence of noise**, Andrey V. Belashov, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation) and Ioffe Physical-Technical Institute (Russian Federation); Nikolay V. Petrov, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation); Irina V. Semenova, Ioffe Physical-Technical Institute (Russian Federation); Igor A. Shevkunov, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation) ..... [9598-51]
- Alignment mask design and image processing for the Advanced Radiographic Capability (ARC) at the National Ignition Facility**, Richard R. Leach Jr., Abdul A. S. Awwal, Simon J. Cohen, Roger R. Lowe-Webb, Randy S. Roberts, Joseph T. Salmon, David A. Smauley, Karl Wilhelmsen, Lawrence Livermore National Lab. (USA) ..... [9598-52]
- Object recognition via MINACE filter trained on synthetic 3D model**, Dmitry V. Shaulskiy, Maxim V. Konstantinov, Rostislav S. Starikov, National Research Nuclear Univ. MEPhI (Russian Federation) ..... [9598-53]
- High-speed and large accepted incidence area for a self-pumped phase conjugate mirror**, Che-Chu Lin, Yeh-Wei Yu, Ching-Cherng Sun, National Central Univ. (Taiwan) ..... [9598-54]
- Simultaneous transmission of accurate time and stable frequency through bidirectional channel over telecommunication infrastructure with excessive spans**, Josef Vojtěch, Vladimir Smotlacha, CESNET z.s.p.o. (Czech Republic) ..... [9598-55]

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# Applications of Digital Image Processing XXXVIII

Conference Chair: Andrew G. Tescher, AGT Associates (USA)

Program Committee: Anne Margot Aaron, Netflix, Inc. (USA); Vasudev Bhaskaran, Qualcomm Inc. (USA); Frederic Dufaux, Télécom ParisTech (France); Touradj Ebrahimi, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Arianne T. Hinds, CableLabs (USA); C.-C. Jay Kuo, The Univ. of Southern California (USA); Ajay Luthra, ARRIS Group, Inc. (USA); Ofer Hadar, Ben-Gurion Univ. of the Negev (Israel); Andre J. Oosterlinck, Kuleuven R & D (Belgium); Sethuraman Panchanathan, Arizona State Univ. (USA); Yurii A. Reznik, InterDigital, Inc. (USA); Thomas Richter, Univ. Stuttgart (Germany); John A. Saghir, California Polytechnic State Univ., San Luis Obispo (USA); Peter Schelkens, Vrije Univ. Brussel (Belgium); Gary J. Sullivan, Microsoft Corp. (USA); Mihaela van der Schaar, Univ. of California, Los Angeles (USA); Anthony Vetro, Mitsubishi Electric Research Labs. (USA)

## MONDAY 10 AUGUST

### SESSION 1 ..... MON 8:30 AM TO 12:00 PM

#### Applications

Session Chair: Andrew G. Tescher, AGT Associates (USA)

**Sparse reconstruction of compressed sensing multispectral data using a cross-spectral multilayered conditional random field model**, Edward Li, Mohammad Javad Shafiee, Farnoud Kazemzadeh, Alexander Wong, Univ. of Waterloo (Canada) ..... [9599-1]

**Optical character recognition of camera-captured images based on phase features**, Julia Diaz, Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9599-2]

**Performance evaluation of correlation filters for target tracking**, Leopoldo N. Gaxiola, Víctor H. Díaz-Ramírez, Juan Jose Tapia Armenta, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico) ..... [9599-3]

**Shearlet-based edge detection: flame fronts and tidal flats**, Emily J. King, Rafael Reisenhofer, Univ. Bremen (Germany) ..... [9599-4]

**The impact of privacy protection filters on deep learning-based gender recognition by machines and crowdsourced evaluation by humans**, Pavel Korshunov, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Natacha Rachaud, EURECOM (France); Anne-Flore Perrin, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Grigory Antipov, Jean-Luc Dugelay, EURECOM (France); Touradj Ebrahimi, Ecole Polytechnique Fédérale de Lausanne (Switzerland) [9599-5]

**Early forest fire detection via spectral and temporal clustering analysis of visible and infrared video data**, John A. Saghir, California Polytechnic State Univ., San Luis Obispo (USA); John T. Jacobs, Timothy M. Davenport, Raytheon Space and Airborne Systems (USA); David Garges, California Polytechnic State Univ., San Luis Obispo (USA) ..... [9599-6]

**Localization of tumors using edge detectors**, Felipe Lopez-Velez, Univ. EAFIT (Colombia) ..... [9599-7]

**Inpainting using Airy diffusion**, Sara Lourduy-Hernandez, Univ. EAFIT (Colombia) ..... [9599-8]

**Color grading process in restoration of archive films: technical aid for colorists**, Karel Fliegel, Petr Páta, Czech Technical Univ. in Prague (Czech Republic); Jiri Myslik, Josef Pecák, Marek Jicha, FAMU International (Czech Republic) ..... [9599-9]

Lunch/Exhibition Break ..... Mon 12:00 pm to 1:10 pm

### SESSION 2 ..... MON 1:10 PM TO 3:30 PM

#### HDR I

Session Chair: Ajay Luthra, ARRIS Group, Inc. (USA)

**Performance and complexity of color gamut scalable coding**, Yuwen He, Yan Ye, Xiaoyu Xiu, InterDigital, Inc. (USA) ..... [9599-10]

**Implication of high dynamic range and wide color gamut content distribution**, Taoran Lu, Fangjun Pu, Peng Yin, Tao Chen, Walter J. Husak, Dolby Labs., Inc. (USA) ..... [9599-11]

**HEVC for high dynamic range services**, Kiran M. Misra, Seung-Hwan Kim, Jie Zhao, Andrew Segall, Sharp Labs. of America, Inc. (USA) ..... [9599-12]

**Chroma sampling and modulation techniques in high dynamic range video coding**, Pankaj Topiwala, Wei Dai, Madhu Krishnan, FastVDO Inc. (USA) [9599-13]

**High dynamic range and wide color gamut in HEVC Main10**, Chad Fogg, MovieLabs (USA); Bill Mandel, Universal Pictures (USA); James L. Helman, MovieLabs (USA) ..... [9599-14]

**On metrics for objective and subjective evaluation of high dynamic range video**, Koohyar Minoo, David Baylon, Zhouye Gu, Ajay Luthra, ARRIS Group, Inc. (USA) ..... [9599-15]

**Towards high dynamic range extensions of HEVC: subjective evaluation of potential coding technologies**, Philippe Hanhart, Touradj Ebrahimi, Martin Rabebek, Anne-Flore Perrin, Ecole Polytechnique Federale de Lausanne (Switzerland) ..... [9599-16]

### SESSION 3 ..... MON 4:00 PM TO 5:30 PM

#### Digital Holography

Session Chair: Peter Schelkens, Vrije Univ. Brussel (Belgium)

**Digital signal processing of light in holographic 3D imaging (Invited Paper)**, Kyoji Matsushima, Kansai Univ. (Japan) ..... [9599-17]

**Compression of digital holographic data: an overview**, Frederic Dufaux, Yafei Xing, Beatrice Pesquet-Popescu, Télécom ParisTech (France); Peter Schelkens, Vrije Univ. Brussel (Belgium) and iMinds (Belgium) ..... [9599-18]

**Fast generation of complex modulation video holograms using temporal redundancy compression and hybrid point-source/wave-field approaches**, Antonin Gilles, Institut de recherche technologique B-Com (France); Patrick Gioia, Institut de recherche technologique B-Com (France) and Orange SA (France); Rémi Cozot, Institut de recherche technologique B-Com (France) and Univ. de Rennes 1 (France); Luce Morin, Institut de recherche technologique B-Com (France) and Institut National des Sciences Appliquées de Rennes (France) ..... [9599-19]

**Evaluation inter- and intra-channel correlations of representations for the compression of holograms**, Ayyoub Ahar, David Blinder, Tim Brulyants, Colas Schretter, Adrian Munteanu, Peter Schelkens, Vrije Univ. Brussel (Belgium) ..... [9599-20]

# CONFERENCE 9599

TUESDAY 11 AUGUST

SESSION 4 ..... TUE 9:20 AM TO 12:10 PM

## Algorithms

Session Chair: **Touradj Ebrahimi**, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

**A comparison of variants of the generalized autoencoder (GAE) method for dimensionality reduction applied to general image classification**, David C. Smith, National Security Agency (USA) ..... [9599-21]

**The image registration of multi-band images by geometrical optics**, Yung-Jhe Yan, Hou-Chi Chiang, National Chiao Tung Univ. (Taiwan); Yu-Hsiang Tsai, Industrial Technology Research Institute (Taiwan); Ting-Wei Huang, Ou-Yang Mang, National Chiao Tung Univ. (Taiwan) ..... [9599-22]

**Restoration of remotely sensed images through bilevel multiobjectives programming**, Soo Mee Wong, National Space Agency (ANGKASA) (Malaysia); Chee Seng Chan, Univ. of Malaya (Malaysia) ..... [9599-23]

**Quick matching of binary images**, Adnan A. Mustafa, Kuwait Univ. (Kuwait) ..... [9599-24]

**Airy-Kaup-Kupershmidt filters applied to image processing**, Laura Hoyos, Univ. EAFIT (Colombia) ..... [9599-25]

**Compression and denoising in image processing via SVD on the Fourier domain using computer algebra**, Ana M. Ospina-Duque, Univ. EAFIT (Colombia) ..... [9599-26]

**An adaptive spatio-temporal bilateral filter for video denoising**, Ehsan Nadernejad, Apical (United Kingdom); Sara Saravi, Eran A. Edrizinghe, Loughborough Univ. (United Kingdom) ..... [9599-27]

Lunch/Exhibition Break ..... Tue 12:10 pm to 1:30 pm

## SIGNAL, IMAGE, AND DATA PROCESSING

PLENARY SESSION ..... TUE 1:30 PM TO 2:30 PM

Session Chair: **Khan M. Iftekharuddin**, Old Dominion Univ. (USA)

Welcome and Introductions: 1:30 to 1:35 pm

**Visual Signal Analysis: Focus on Texture Similarity (Plenary)**, Thrasivoulos N. Pappas, Northwestern Univ. (USA) ..... [9598-500]

SESSION 5 ..... TUE 2:40 PM TO 5:30 PM

## HDR II

Session Chair: **Frederic Dufaux**, Télécom ParisTech (France)

**A dynamic range complexity measure for high dynamic range content**, Giuseppe Valenzise, Télécom ParisTech (France); Francesco Banerle, Consiglio Nazionale delle Ricerche (Italy); Francesca De Simone, Frederic Dufaux, Télécom ParisTech (France) ..... [9599-28]

**Color transfer between high-dynamic-range images**, Hristina Hristova, Remi Cozot, Olivier Le Meur, Kadi Bouatouch, Univ. de Rennes 1 (France) ..... [9599-29]

**The JPEG XT suite of standards: status and future plans**, Thomas Richter, Univ. Stuttgart (Germany); Tim Bruylants, Peter Schelkens, Vrije Univ. Brussel (Belgium) and iMinds (Belgium); Touradj Ebrahimi, Ecole Polytechnique Fédérale de Lausanne (Switzerland) ..... [9599-30]

**Live HDR video streaming on commodity hardware**, Alan Chalmers, Joshua McNamee, Jon Hatchett, Kurt Debattista, The Univ. of Warwick (United Kingdom) ..... [9599-31]

**Study of high dynamic range video quality assessment**, Manish Narwaria, Matthieu Perreira Da Silva, Patrick Le Callet, Institut de Recherche en Communications et en Cybernétique de Nantes (France) ..... [9599-32]

**Automatic HDR merging algorithm based on GPU-assisted optimization for technical vision applications**, Igor V. Guryev, Cesar Alejandro Martinez Hernandez, Natalia Gurieva, Carlos Rodriguez Doñate, Eduardo Cabal Yepez, Univ. de Guanajuato (Mexico) ..... [9599-33]

**Rendering of HDR content on LDR displays: an objective approach**, Lukáš Krasila, Czech Technical Univ. in Prague (Czech Republic) and Institut de Recherche en Communications et en Cybernétique de Nantes (France); Manish Narwaria, Institut de Recherche en Communications et en Cybernétique de Nantes (France); Karel Fliegel, Czech Technical Univ. in Prague (Czech Republic); Patrick Le Callet, Institut de Recherche en Communications et en Cybernétique de Nantes (France) ..... [9599-34]

WEDNESDAY 12 AUGUST

SESSION 6 ..... WED 8:40 AM TO 11:50 AM

## Video Quality Assessment

Session Chairs: **Anne Margot Aaron**, Netflix, Inc. (USA); **C.-C. Jay Kuo**, The Univ. of Southern California (USA)

**Objective video presentation QoE predictor for smart adaptive video streaming**, Zhou Wang, Kai Zeng, Abdul Rehman, Hojjatollah Yeganeh, Shiqi Wang, Univ. of Waterloo (Canada) ..... [9599-35]

**Experimental design and analysis of video JND test**, YuChieh Lin, The Univ. of Southern California (USA); Zhi Li, Anne M. Aaron, Netflix, Inc. (USA); C.-C. Jay Kuo, The Univ. of Southern California (USA) ..... [9599-36]

**Predicting the visibility of dynamic DCT distortion in natural videos**, Jeremy P. Evert, Md Mushfiqul Alam, Damon M. Chandler, Oklahoma State Univ. (USA) ..... [9599-37]

**A time-varying subjective quality model for mobile streaming videos with stalling events**, Deepki Ghadiyaram, Janice Pan, Alan C. Bovik, The Univ. of Texas at Austin (USA) ..... [9599-38]

**The effect of texture granularity on texture synthesis quality**, S. Alireza Golestaneh, Mahesh M. Subedar, Lina J. Karam, Arizona State Univ. (USA) ..... [9599-39]

**Objective video quality for video on mobile devices**, Louis J. Kerofsky, InterDigital, Inc. (USA) ..... [9599-40]

**Neurophysiological assessment of perceived image quality using steady-state visual evoked potentials**, Thomas Wiegand, Fraunhofer-Institut für Nachrichtentechnik Heinrich-Hertz-Institut (Germany) ..... [9599-41]

**Optimal sequence duration for subjective video quality assessment**, Felix J. Mercer Moss, Fan Zhang, Ke Wang, Roland Baddeley, David Bull, Univ. of Bristol (United Kingdom) ..... [9599-42]

Lunch/Exhibition Break ..... Wed 11:50 am to 1:20 pm

SESSION 7 ..... WED 1:20 PM TO 3:40 PM

## Applications and Extensions for High Efficiency Video Coding (HEVC)

Session Chair: **Gary J. Sullivan**, Microsoft Corp. (USA)

**Video streaming with SHVC to HEVC transcoding**, Srinivas Gudumusu, Aricent, Inc. (India); Yuwen He, Yan Ye, Xiaoyu Xiu, InterDigital, Inc. (USA) ..... [9599-43]

**A perceptual quantization strategy for HEVC based on a convolutional neural network trained on natural videos**, Md Mushfiqul Alam, Tuan Nguyen, Damon M. Chandler, Oklahoma State Univ. (USA) ..... [9599-44]

**Performance analysis of HEVC and its format range and screen content coding extensions**, Bin Li, Microsoft Corp. (USA); Jizheng Xu, Microsoft Research Asia (China); Gary J. Sullivan, Microsoft Corp. (USA) ..... [9599-45]

**Smart pattern-based full-pel search strategies in the context of HEVC**, Georg Maier, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany); Benjamin Bross, Dan Grois, Detlev Marpe, Heiko Schwarz, Fraunhofer-Institut für Nachrichtentechnik Heinrich-Hertz-Institut (Germany); R.C. Veltkamp, Utrecht Univ. (Netherlands) ..... [9599-46]

**Coding tools investigation for next generation video coding based on HEVC**, Jianle Chen, Ying Chen, Marta Karczewicz, Hongbin Liu, Li Zhang, Xin Zhao, Qualcomm Inc. (USA) ..... [9599-47]

**Coding efficiency improvements beyond HEVC with known tools**, Alexander Alshin, Elena A. Alshina, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Madhukar Budagavi, SAMSUNG Telecommunications America Inc. (USA); SeungSoo Jeong, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Junghye Min, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Ankur Saxena, SAMSUNG Electronics Co., Ltd. (Korea, Republic of) ..... [9599-48]

**Improved motion search methods for HEVC screen content coding**, Krishna Rapaka, Qualcomm Inc. (USA); Bin Li, Microsoft Corp. (USA); Jizheng Xu, Microsoft Research Asia (China) ..... [9599-49]

# CONFERENCE 9599

## POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Medical image classification for skin cancer based on quantitative image features with optical coherence tomography**, Wei Gao, Valery P. Zakharov, Oleg O. Myakinin, Ivan A. Bratchenko, Dmitry N. Artemyev, Dmitry V. Kornilin, Samara State Aerospace Univ. (Russian Federation) ..... [9599-58]

**A novel teaching-learning-based optimization for image enhancement**, Xiaojun Bi, Harbin Engineering Univ. (China) ..... [9599-59]

**Registration of point cloud data for HDD stamped base inspection**, Sungho Suh, Hansang Cho, SAMSUNG Electro-Mechanics (Korea, Republic of) ..... [9599-60]

**Robust illumination-invariant tracking algorithm based on HOGs**, Daniel Miramontes-Jaramillo, Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico); Víctor H. Díaz-Ramírez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico) ..... [9599-61]

**Adaptive codebook selection schemes for image classification in correlated channels**, Chia-Chang Hu, Xiang-Lian Liu, Kuan-Fu Liu, National Chung Cheng Univ. (Taiwan) ..... [9599-62]

**Research of improved sparse grid non-uniformity correction technologies for infrared resistor array**, Huijie Du, Beijing Simulation Ctr. (China) ..... [9599-63]

**Digital image database processing to simulate image formation in ideal lightning conditions of the human eye**, Jessica Castañeda Santos, Univ. Tecnológica de la Mixteca (Mexico); Agustín Santiago-Alvarado, Angel S. Cruz-Félix, Arturo Hernández Méndez, Univ. Tecnológica de la Mixteca (Mexico) ..... [9599-64]

**Inverse ill-posed problems in sensing with terahertz pulsed spectroscopy: from non-destructive evaluation of materials to non-invasive diagnosis of dysplastic skin nevi**, Egor Yakovlev, Kirill I. Zaytsev, Nikita V. Chernomyrdin, Arsenii A. Gavdush, Irina N. Dolganova, Stanislav O. Yurchenko, Bauman Moscow State Technical Univ. (Russian Federation) ..... [9599-65]

**Position, rotation, and scale invariant image descriptor based on ray and circle 1D signatures**, Selene Solorza, Univ. Autónoma de Baja California (Mexico) ..... [9599-66]

**ROI-preserving 3D video compression method utilizing depth information analysis**, Chunli Ti, Guodong Xu, Yudong Guan, Yidan Teng, Harbin Institute of Technology (China) ..... [9599-67]

**New visual sensitivity based error concealment algorithm in wireless stereo video communication**, Yue Sun, Mei Yu, Keseng Yan, Gangyi Jiang, Ningbo Univ. (China) ..... [9599-68]

**Kuramoto-Sivashinsky-Korteweg-de Vries filters for image processing**, Sebastian C. Castaño, Univ. EAFIT (Colombia) ..... [9599-69]

**System of scale-selective tomography of myocardium birefringence**, Alexander G. Ushenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine) ..... [9599-70]

**Mueller-matrix invariants of optical anisotropy of the bile polycrystalline films in the diagnosis of human liver pathologies**, Alexander V. Dubolazov, Vladimir A. Ushenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine) ..... [9599-71]

**Autofluorescent polarimetry of bile films in the liver pathology differentiation**, Olexander V. Dubolazov, Yuriy A. Ushenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine) ..... [9599-72]

**Polarization-correlation microscopy of human liquid polycrystalline films in infertility diagnosis**, Alexander V. Dubolazov, Artem O. Karachevtsev, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine) ..... [9599-73]

**Difference of Gaussian statistical features based blind image quality assessment: a deep learning approach**, Yaqi Lu, Gangyi Jiang, Mei Yu, Haiyong Xu, Ningbo Univ. (China) ..... [9599-74]

**Volumetric liquid flow measurement through thermography to simulate blood flow in an artery**, Carlos Villaseñor-Mora, Adela Rabell-Montiel, Arturo González-Vega, Gerardo Gutierrez-Juarez, Univ. de Guanajuato (Mexico) ..... [9599-75]

**Multifunctional polarization tomography of optical anisotropy biological layers in diagnosis of endometriosis**, Alexander V. Dubolazov, Yuriy A. Ushenko, Artem O. Karachevtsev, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine) ..... [9599-76]

**Spectrometry techniques of differential diagnosis of benign and malignant prostate tumor**, Sergey B. Yermolenko, Yuriy Fedkovych Chernivtsi National Univ. (Ukraine); Alexander Fedoruk, Dmytro Voloshynskyi, Bukovinian State Medical Univ. (Ukraine) ..... [9599-77]

**Explicit solutions of one-dimensional total variation problem**, Artyom Makovetskii, Sergei Voronin, Chelyabinsk State Univ. (Russian Federation); Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9599-78]

**Performance evaluation of image deconvolution techniques in space-variant astronomical imaging systems with nonlinearities**, Karel Fliegel, Petr Janout, Jan Bednář, Elena Anisimova, Petr Páta, Czech Technical Univ. in Prague (Czech Republic) ..... [9599-79]

**Implementation of cost-effective diffuse light source mechanism to reduce specular reflection and halo effects for resistor-image processing**, Yung-Sheng Chen, Jeng-Yau Wang, Yuan Ze Univ. (Taiwan) ..... [9599-80]

**A fusion algorithm for building three-dimensional maps**, Aleksandr Vokhmintsev, Artyom Makovetskii, Chelyabinsk State Univ. (Russian Federation); Vitaly Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) ..... [9599-81]

**Mueller imaging of white blood cells**, Shirsendu Sarkar, Ajay Ghosh, Univ. of Calcutta (India) ..... [9599-82]

**Dermoscopy analysis of RGB-images based on comparative features**, Oleg O. Myakinin, Valery P. Zakharov, Ivan A. Bratchenko, Dmitry N. Artemyev, Samara State Aerospace Univ. (Russian Federation); Evgeny Y. Neretin, Sergey V. Kozlov, Samara State Medical Univ. (Russian Federation) ..... [9599-83]

**Meteor localization via statistical analysis of spatially: temporal fluctuations in image sequences**, Jaromír Kukal, Institute of Chemical Technology (Czech Republic); Martin Klím, Czech Technical Univ. in Prague (Czech Republic); Jan Švihlík, Institute of Chemical Technology (Czech Republic); Karel Fliegel, Czech Technical Univ. in Prague (Czech Republic) ..... [9599-84]

**Virtual spectral multiplexing for applications in in-situ imaging microscopy of transient phenomena**, Farnoud Kazemzadeh, Mohammad Javad Shafee, Jason Deglin, Edward Li, Iman Khodadad, Simarjeet S. Saini, Alexander Wong, David A. Clausi, Univ. of Waterloo (Canada) ..... [9599-85]

**Additive discrete 1D linear canonical transform**, Liang T. Zhao, John J. Healy, John T. Sheridan, Univ. College Dublin (Ireland) ..... [9599-86]

**Color normalization for robust evaluation of microscopy images**, Jan Švihlík, Czech Technical Univ. in Prague (Czech Republic) ..... [9599-87]

**Inference of dense spectral reflectance images from sparse reflectance measurement using non-linear regression modeling**, Jason Deglin, Farnoud Kazemzadeh, Alexander Wong, David A. Clausi, Univ. of Waterloo (Canada) ..... [9599-88]

**A digital architecture for striping noise compensation in push-broom hyperspectral cameras**, Wladimir Valenzuela, Miguel Figueroa, Jorge E. Pezoa Nunez, Univ. de Concepción (Chile) ..... [9599-89]

**Blind identification of linear degradation operators in the Fourier domain**, Victor N. Karnaukhov, Vitaly Kober, Institute for Information Transmission Problems (Russian Federation) ..... [9599-90]

**Support plane method applied to ground objects recognition using modelled SAR images**, Denis A. Zherdev, Vladimir A. Fursov, Samara State Aerospace Univ. (Russian Federation) and Image Processing Systems Institute (Russian Federation) ..... [9599-92]

**Video compression technique impact on efficiency of person identification in CCTV systems**, Stanislav Vitek, Czech Technical Univ. in Prague (Czech Republic) ..... [9599-93]

**A custom hardware classifier for bruised apple detection in hyperspectral images**, Javier Cárdenas, Miguel Figueroa, Jorge E. Pezoa Nunez, Univ. de Concepción (Chile) ..... [9599-94]

**GPU accelerated processing of astronomical high frame-rate videosequences**, Stanislav Vitek, Czech Technical Univ. in Prague (Czech Republic) ..... [9599-95]

# CONFERENCE 9599

- Pattern recognition descriptor using the Z-Fisher transform**, Carolina Barajas-Garcia, Selene Solorza-Calderón, Univ. Autónoma de Baja California (Mexico); Josué Álvarez-Borrego, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico) . . . . . [9599-96]
- Fourier based detection of microcalcifications in mammograms**, Elizabeth López Meléndez, Luis David Lara-Rodríguez, Gonzalo Urcid, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) . . . . . [9599-97]
- A dendritic lattice neural network for color image segmentation**, Gonzalo Urcid, Luis David Lara-Rodríguez, Elizabeth López Meléndez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) . . . . . [9599-98]
- True-color image encoding technique for segmented RF transmission using limited bandwidth**, Yuriy Kotsarenko, Gustavo Urquiza, Svetlana V. Koshevaya, Univ. Autónoma del Estado de Morelos (Mexico) . . . . . [9599-99]
- Analysis of the palm vein distribution for people recognition**, Raúl Castro-Ortega, Carina Toxqui-Quitl, Univ. Politécnica de Tulancingo (Mexico); Gabriel Cristóbal Pérez, Instituto de Óptica "Daza de Valdés" (Spain) and Consejo Superior de Investigaciones Científicas (Spain); José Victor Marcos-Martín, Instituto de Óptica "Daza de Valdés" (Spain); Alfonso Padilla-Vivanco, Univ. Politécnica de Tulancingo (Mexico) . . . . . [9599-100]
- Correlation peak analysis applied to a sequence of images using two different filters**, Verónica Patron, Univ. de Sonora (Mexico); Josué Álvarez-Borrego, Ctr. de Investigación Científica y de Educación Superior de Ensenada B.C. (Mexico); Ángel Coronel Beltrán, Univ. de Sonora (Mexico) . . . . . [9599-101]
- Robust template matching using run-length encoding**, Hunsue Lee, Sungho Suh, Hansang Cho, SAMSUNG Electro-Mechanics (Korea, Republic of) [9599-102]
- Discrete Wigner distribution function of a circular aperture displaced of the origin of space coordinates using coherent light**, Sergio Mejía-Romero, Luis Raúl Berriel-Valdos, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) . . . . . [9599-103]
- Reconstruction of digital holograms from three intensity measurements**, Liang T. Zhao, Univ. College Dublin (Ireland); Yang Wu, Damien P. Kelly, Technische Univ. Ilmenau (Germany); John T. Sheridan, Univ. College Dublin (Ireland) . . . . . [9599-104]
- Non-destructively reading out information embedded inside real objects by using far-infrared light**, Kazutake Uehira, Kanagawa Institute of Technology (Japan) . . . . . [9599-105]
- Information embedding in real object image using temporally brightness-modulated light**, Kazutake Uehira, Hiroshi Unno, Kanagawa Institute of Technology (Japan) . . . . . [9599-106]
- Tutte polynomial applied to processing of functional magnetic resonance images**, Marly García-Castillón, Univ. EAFIT (Colombia) . . . . . [9599-107]
- Detecting curvatures in digital images using filters derived from differential geometry**, Juanita Toro-Giraldo, Univ. EAFIT (Colombia) . . . . . [9599-108]
- An image registration technique based on BWB mask**, Ihtsham U. Haq, Pakistan Council of Scientific & Industrial Research (Pakistan) and Pakistan Institute of Engineering and Applied Sciences (Pakistan); Asloob A. Mudassar, Pakistan Institute of Engineering and Applied Sciences (Pakistan) . . . . . [9599-109]
- Face recognition using the most representative sift images**, Issam J. Dagher, Univ. of Balamand (Lebanon) . . . . . [9599-110]
- Improvements for hot pixels in digital imagers using lossless approximation techniques**, Ofer Hadar, Ariel Shleifer, Ben-Gurion Univ. of the Negev (Israel) . . . . . [9599-111]

## THURSDAY 13 AUGUST

SESSION 8 . . . . . THU 9:00 AM TO 12:10 PM

### Compression and Processing Issues

Session Chairs: **Vasudev Bhaskaran**, Qualcomm Inc. (USA); **Ofer Hadar**, Ben-Gurion Univ. of the Negev (Israel)

**An overview of new video coding tools under consideration for VP10: the successor to VP9**, Debargha Mukherjee, Google (USA) . . . . . [9599-50]

**Cyber attack/defense algorithms based on data hiding in compressed video stream**, Ofer Hadar, Y. Amsalem, Ben-Gurion Univ. of the Negev (Israel) . . . . . [9599-51]

**Vision-based driver assistance systems using looking-in and looking-out framework**, Ravi Kumar Satzoda, Univ. of California, San Diego (USA) . . . . . [9599-52]

**Overview of MPEG internet video coding**, Ronggang Wang, Sang-hyo Park, Peking Univ. (China); Jae-Gon Kim, Korea Aerospace Univ. (Korea, Republic of); Tie-jun Huang, Peking Univ. (China); Euee S. Jang, Hanyang Univ. (Korea, Republic of); Wen Gao, Peking Univ. (China) . . . . . [9599-53]

**Privacy protection by transmorphing JPEG images**, Touradj Ebrahimi, Lin Yuan, Ecole Polytechnique Fédérale de Lausanne (Switzerland) . . . . . [9599-54]

**Frequency Domain methods for demosaicking images sampled using arbitrary color filter array patterns**, Hasib A. Siddiqui, Kalin Attanassov, Qualcomm Inc. (USA) . . . . . [9599-55]

**3D LUT circuit design for color transformation**, Vladimir Lachine, Qualcomm Inc. (Canada) . . . . . [9599-56]

**Compressed data organization for high throughput parallel entropy coding**, Amir Said, Qualcomm Inc. (USA); Abo-Talib Mahfoodh, Michigan State Univ. (USA); Sehoon Yea, LG Electronics Inc. (Korea, Republic of) . . . . . [9599-57]

Tuesday-Wednesday 11-12 August 2015 • Proceedings of SPIE Vol. 9600

# Image Reconstruction from Incomplete Data VIII

Conference Chairs: **Philip J. Bones**, Univ. of Canterbury (New Zealand); **Michael A. Fiddy**, The Univ. of North Carolina at Charlotte (USA); **Rick P. Millane**, Univ. of Canterbury (New Zealand)

Program Committee: **Mark A. Anastasio**, Washington Univ. in St. Louis (USA); **David J. Brady**, Duke Univ. (USA); **Emmanuel J. Candes**, Stanford Univ. (USA); **Joe Chen**, Arizona State Univ. (USA); **Julian C. Christou**, Large Binocular Telescope Observatory (USA); **Timothy J. Cornwell**, SKA Organisation (United Kingdom); **Peter C. Doerschuk**, Cornell Univ. (USA); **Veit Elser**, Cornell Univ. (USA); **James Fienup**, Univ. of Rochester (USA); **Andrew J. Lambert**, The Univ. of New South Wales (Australia); **Julian Maclaren**, Stanford Univ. (USA); **Charles L. Matson**, Air Force Research Lab. (USA); **Sudhakar Prasad**, The Univ. of New Mexico (USA); **Markus E. Testorf**, Dartmouth College (USA); **Kevin J. Webb**, Purdue Univ. (USA); **Jong Chul Ye**, KAIST (Korea, Republic of); **Chunhong Yoon**, European XFEL GmbH (Germany)

## TUESDAY 11 AUGUST

**OPENING REMARKS** ..... 8:30 AM TO 8:40 AM

**SESSION 1** ..... TUE 8:40 AM TO 10:30 AM

### Image Recovery

**Image reconstruction in serial femtosecond nanocrystallography using x-ray free-electron lasers (Invited Paper)**, Rick P. Millane, Romain Arnal, Joe Chen, David Wojtas, Philip J. Bones, Univ. of Canterbury (New Zealand); Rick Kirian, Arizona State Univ. (USA); Ken Beyerlein, Richard Bean, Henry N. Chapman, Ctr. for Free-Electron Laser Science (Germany); John C. H. Spence, Arizona State Univ. (USA) ..... [9600-1]

**Dynamic optically multiplexed imaging**, Yaron Rachlin, Vinay Shah, R. Hamilton Shepard, Tina Shih, MIT Lincoln Lab. (USA) ..... [9600-2]

**Restoration of defocused images using quasi-point sources which are detected with coherent light**, Rosalinda Ortiz Sosa, Luis Raúl Berriel-Valdos, J. Félix Aguilar, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [9600-3]

**United estimation of blur distribution for space-variant rotation motion deblurring**, Ziyi Shen, Tingfa Xu, Ziwei Liu, Hongqing Wang, Guokai Shi, Beijing Institute of Technology (China) ..... [9600-4]

**Geometric superresolution using double rect mask**, Ihtsham U. Haq, National Physical and Standard Lab. (Pakistan) and Pakistan Institute of Engineering and Applied Sciences (Pakistan) and Pakistan Council of Scientific and Industrial Research (Pakistan); Asloob A. Mudassar, Pakistan Institute of Engineering and Applied Sciences (Pakistan); Ihtram U. Haq, Univ. of Karachi (Pakistan); Asma A. Mirza, Federal Urdu Univ. of Arts, Sciences and Technology (Pakistan); Shakeel A. Khan, Government College Jaranwala, Faisalabad (Pakistan) ..... [9600-5]

**SESSION 2** ..... TUE 11:00 AM TO 12:20 PM

### Phase Retrieval

**Phase estimation for magnetic resonance imaging near metal prostheses**, Philip J. Bones, Laura J. King, Rick P. Millane, Univ. of Canterbury (New Zealand) ..... [9600-6]

**Phase retrieval for multiple objects and undersampled intensity data**, Rick P. Millane, Romain Arnal, Joe Chen, Univ. of Canterbury (New Zealand) ..... [9600-7]

**A phase-space approach to imaging from limited data**, Markus E. Testorf, Dartmouth College (USA) ..... [9600-8]

**Combination of genetic algorithms and FSD applied to fringe pattern demodulation**, Ulises H. Rodríguez-Marmolejo, Univ. de Guadalajara (Mexico) and Instituto Tecnológico de Aguascalientes (Mexico); Tania A. Ramírez del Real, Jesús Muñoz-Macié, Miguel Mora-González, Univ. de Guadalajara (Mexico) ..... [9600-9]

Lunch/Exhibition Break ..... Tue 12:20 pm to 1:30 pm

## SIGNAL, IMAGE, AND DATA PROCESSING

**PLENARY SESSION** ..... TUE 1:30 PM TO 2:30 PM

Session Chair: **Khan M. Iftekharuddin**, Old Dominion Univ. (USA)

Welcome and Introductions: 1:30 to 1:35 pm

**Visual Signal Analysis: Focus on Texture Similarity (Plenary)**, Thrasivoulos N. Pappas, Northwestern Univ. (USA) ..... [9598-500]

**SESSION 3** ..... TUE 2:40 PM TO 3:40 PM

### Inverse Scattering

**Exploiting reciprocity for imaging**, Morteza Karami, Michael A. Fiddy, The Univ. of North Carolina at Charlotte (USA) ..... [9600-10]

**Joint sparse recovery in inverse scattering**, Ok Kyun Lee, Jong Chul Ye, KAIST (Korea, Republic of) ..... [9600-11]

**Superresolution imaging from nonlinear inverse scattering**, Richard S. Ritter, Olivet Nazarene Univ. (USA); Michael A. Fiddy, The Univ. of North Carolina at Charlotte (USA) ..... [9600-12]

**SESSION 4** ..... TUE 4:00 PM TO 5:30 PM

### Tomography

**Feature extraction for 3D object detection from integral imaging data (Invited Paper)**, Doron Aloni, Yitzhak Yitzhaky, Ben-Gurion Univ. of the Negev (Israel) ..... [9600-13]

**Title to be determined**, Peter C. Doerschuk, Cornell Univ. (USA) ..... [9600-14]

**Alternative techniques for high-resolution spectral estimation of spectrally encoded endoscopy**, Mahta Mousavi, Univ. of California, San Diego (USA); Lian Duan, Stanford Univ. (USA); Tara Javidi, Univ. of California, San Diego (USA); Audrey K. Ellerbee, Stanford Univ. (USA) ..... [9600-15]

**FPGA acceleration by asynchronous parallelization for simultaneous image reconstruction and segmentation based on the Mumford-Shah regularization**, Wentai Zhang, Li Shen, Peking Univ. (China); Thomas Page, Univ. Bremen (Germany); Guojie Luo, Peking Univ. (China); Peng Li, Univ. of California, Los Angeles (USA); Ming Jiang, Peking Univ. (China); Peter Maass, Univ. Bremen (Germany); Jason Cong, Univ. of California, Los Angeles (USA) ..... [9600-16]

## WEDNESDAY 12 AUGUST

**SESSION 5** ..... WED 9:20 AM TO 10:30 AM

### Imaging in Scattering Media

**Imaging fields through heavily scattering random media with speckle correlations over source position (Invited Paper)**, Jason A. Newman, Kevin J. Webb, Purdue Univ. (USA) ..... [9600-17]

**Imaging through scattering media via Hadamard illumination and single-pixel detection**, Vicente Durán, Chalmers Univ. of Technology (Sweden); Fernando Soldevila Torres, Esther Irles, Pedro J. Clemente Pesudo, Enrique Tajahuerce, Univ. Jaume I (Spain); Pedro Andrés Bou, Univ. de València (Spain); Jesús S. Lancis, Univ. Jaume I (Spain) ..... [9600-19]

**A laminar optical tomographic system for the detection of early cervical cancer**, Huijuan Zhao, Shuang Wang, Mengyu Jia, Xueying Chen, Shanshan Cui, Feng Gao, Tianjin Univ. (China) ..... [9600-20]

**SESSION 6** ..... WED 11:00 AM TO 12:00 PM

### Signal Recovery

**Inter-trial alignment of EEG data and high-frequency phase-locking**, Markus E. Testorf, Peter Horak, Andy Connolly, Dartmouth College (USA); Gregory L. Holmes M.D., The Univ. of Vermont (USA); Barbara C. Jobst, Dartmouth College (USA) ..... [9600-21]

**Precoding design of compressive sensing data based on singular value decomposition criterion**, Chia-Chang Hu, Kang-Tsao Tang, Bo-Hung Chen, National Chung Cheng Univ. (Taiwan) ..... [9600-22]

**Implementation of an adaptive ictal spike detection algorithm**, Stephen Meisenhelter, Peter C. Horak, Andrew Connolly, Barbara C. Jobst, Dartmouth Hitchcock Medical Ctr. (USA) ..... [9600-23]

**CLOSING REMARKS** ..... 12:00 PM TO 12:10 PM

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Sunday-Monday 9–10 August 2015 • Proceedings of SPIE Vol. 9601

# UV, X-Ray, and Gamma-Ray Space Instrumentation for Astronomy XIX

Conference Chair: **Oswald H. Siegmund**, Univ. of California, Berkeley (USA)

Program Committee: **Stephan R. McCandliss**, Johns Hopkins Univ. (USA); **Camden Ertley**, Univ. of California, Berkeley (USA); **Brian T. Fleming**, Univ. of Colorado at Boulder (USA); **James C. Green**, Univ. of Colorado at Boulder (USA); **Anton Tremsin**, Univ. of California, Berkeley (USA)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 8:20 AM TO 10:00 AM

#### X-Ray Technologies and Missions I

Session Chair: **Camden D. Ertley**, Univ. of California, Berkeley (USA)

**Generation of response matrix for multi-pixel CZT detectors**, Tanmoy Chattopadhyay, Santosh V. Vadawale, Physical Research Lab. (India); A. R. Rao, Tata Institute of Fundamental Research (India) ..... [9601-3]

**CdTe focal plane detector for hard x-ray focusing optics**, Paul Seller, Matthew D. Wilson, Matthew C. Veale, Andreas Schneider, STFC Rutherford Appleton Lab. (United Kingdom); Jessica A. Gaskin, Colleen Wilson-Hodge, NASA Marshall Space Flight Ctr. (USA); Steven D. Christe, Albert Y. Shih, NASA Goddard Space Flight Ctr. (USA) ..... [9601-2]

**First results from the OGRESS sounding rocket payload**, Thomas D. Rogers, Univ. of Colorado at Boulder (USA); Ted B. Schultz, James H. Tutt, Jake McCoy, Drew M. Miles, Randall L. McEntaffer, The Univ. of Iowa (USA) ..... [9601-3]

**Technological developments with the OGRE focal plane array**, James H. Tutt, Randall L. McEntaffer, Casey T. DeRoo, Ted B. Schultz, The Univ. of Iowa (USA); Andrew D. Holland, Neil J. Murray, The Open Univ. (United Kingdom); Karen Holland, David Colebrook, David Farn, XCAM Ltd. (United Kingdom); Daniel P. Weatherill, The Open Univ. (United Kingdom); Anthony M. Evagora, XCAM Ltd. (United Kingdom); Drew M. Miles, The Univ. of Iowa (USA); William W. Zhang, NASA Goddard Space Flight Ctr. (USA) ..... [9601-4]

**A primer for telemetry interfacing in accordance with NASA standards using low cost FPGAs**, Jake A. McCoy, Ted B. Schultz, The Univ. of Iowa (USA); Thomas D. Rogers, Univ. of Colorado at Boulder (USA); James H. Tutt, Drew M. Miles, Thomas J. Peterson, Randall L. McEntaffer, The Univ. of Iowa (USA) ..... [9601-5]

### SESSION 2 ..... SUN 10:30 AM TO 11:50 AM

#### X-Ray Technologies and Missions II

Session Chair: **Brian T. Fleming**, Univ. of Colorado at Boulder (USA)

**Modeling contamination migration on the Chandra X-ray Observatory: III**, Stephen L. O'Dell, Douglas A. Swartz, NASA Marshall Space Flight Ctr. (USA); Neil W. Tice, Massachusetts Institute of Technology (USA); Paul P. Plucinsky, Smithsonian Astrophysical Observatory (USA); Catherine E. Grant, Herman L. Marshall, Massachusetts Institute of Technology (USA); Alexey A. Vikhlinin, Smithsonian Astrophysical Observatory (USA); Allyn F. Tenant, NASA Marshall Space Flight Ctr. (USA) ..... [9601-6]

**Soft x-ray, UV, and optical transmission of the contamination blocking filer for the soft x-ray imager (SXI) on board ASTRO-H**, Takayoshi Kohmura, Yuta Sato, Koki Tamasawa, Shoma Tanno, Yuma Yoshino, Shintaro Kuwano, Masato Ando, Kenta Kaneko, Tokyo Univ. of Science (Japan); Tadayasu Dotani, Masanobu Ozaki, Hiroshi Tomida, Masashi Kimura, Keisuke Kondo, Japan Aerospace Exploration Agency (Japan); Hiroshi Tsunemi, Kiyoshi Hayashida, Naohisa Anabuki, Hiroshi Nakajima, Ryo Nagino, Juyong Kim, Ritsuko Imatani, Hiroyuki Kurubi, Osaka Univ. (Japan) ..... [9601-7]

**The optical blocking filter for the ATHENA wide field imager: baselign design and preliminary performance evaluation**, Marco Barbera, Univ. degli Studi di Palermo (Italy) and INAF - Osservatorio Astronomico di Palermo Giuseppe S. Vaiana (Italy); Graziella Branduardi-Raymont, Univ. College London (United Kingdom); Alfonso Collura, INAF - Osservatorio Astronomico di Palermo Giuseppe S. Vaiana (Italy); Andrea Comastri, INAF - Osservatorio Astronomico di Bologna (Italy); Tadeusz Kamisiński, AGH Univ. of Science and Technology (Poland); Ugo Lo Cicero, INAF - Osservatorio Astronomico di Palermo Giuseppe S. Vaiana (Italy); Norbert Meidinger, Max-Planck-Institut für extraterrestrische Physik (Germany); Teresa Mineo, INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica di Palermo (Italy); Silvano Molendi, INAF - IASF Milano (Italy); Adam Pilch, AGH Univ. of Science and Technology (Poland); Luigi Piro, INAF - IASF Roma (Italy); Miroslaw Rataj, Space Research Ctr. (Poland); Gregor Rauw, Univ. de Liège (Belgium); Luisa Sciotino, Univ. degli studi di Palermo (Italy); Salvatore Sciotino, INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica di Palermo (Italy); Piotr Wawer, Space Research Ctr. (Poland) ..... [9601-8]

**Development of the strontium iodide coded aperture (SICA) instrument**, Lee Mitchell, Bernard F. Philips, U.S. Naval Research Lab. (USA) ..... [9601-9]  
Lunch Break ..... Sun 11:50 am to 1:20 pm

### SESSION 3 ..... SUN 1:20 PM TO 3:00 PM

#### Solid State Detectors

Session Chair: **Oswald H. W. Siegmund**, Univ. of California, Berkeley (USA)

**The speedster-EXD: a new event-triggered hybrid CMOS x-ray detector**, Christopher V. Griffith, Abe D. Falcone, Zachary R. Prieskorn, David N. Burrows, The Pennsylvania State Univ. (USA) ..... [9601-10]

**Soft x-ray quantum efficiency and other characteristics of x-ray sensitive Si hybrid CMOS detectors**, Zachary R. Prieskorn, The Pennsylvania State Univ. (USA); Stephen D. Bongiorno, Johns Hopkins Univ. (USA); David N. Burrows, Abraham D. Falcone, Christopher V. Griffith, The Pennsylvania State Univ. (USA); Jonathan A. Nikoleyeczik, Univ. of Maryland, College Park (USA) ..... [9601-11]

**Recent progress in the development of Kyoto's x-ray astronomical SOI pixel sensor**, Takeshi G. Tsuru, Hideaki Matsumura, Ayaki Takeda, Takaaki Tanaka, Kyoto Univ. (Japan); Shinya Nakashima, Institute of Space and Astronautical Science (Japan); Yasuo Arai, High Energy Accelerator Research Organization, KEK (Japan); Koji Mori, Ryota Takenaka, Yusuke Nishioka, Univ. of Miyazaki (Japan); Takayoshi Kohmura, Tokyo Univ. of Science (Japan); Takaki Hatsui, Yoshiaki Kohmura, RIKEN SPRing-8 Ctr. (Japan); Takashi Kameshima, Japan Synchrotron Radiation Research Institute (Japan); Dai Takei, RIKEN SPRing-8 Ctr. (Japan); Shoji Kawahito, Keiichiro Kagawa, Keita Yasutomi, Hiroki Kamehama, Sumeet Shrestha, Shizuoka Univ. (Japan) ..... [9601-12]

**The soft x-ray imager (SXI) for the ASTRO-H Mission**, Takaaki Tanaka, Kyoto Univ. (Japan); Hiroshi Tsunemi, Kiyoshi Hayashida, Osaka Univ. (Japan); Takeshi G. Tsuru, Kyoto Univ. (Japan); Tadayasu Dotani, Institute of Space and Astronautical Science (Japan); Hiroshi Nakajima, Naohisa Anabuki, Ryo Nagino, Shutaro Ueda, Osaka Univ. (Japan); Hiroyuki Uchida, Masayoshi Nobukawa, Kyoto Univ. (Japan); Masanobu Ozaki, Japan Aerospace Exploration Agency (Japan); Chikara Natsukari, Institute of Space and Astronautical Science (Japan); Hiroshi Tomida, Masashi Kimura, Japan Aerospace Exploration Agency (Japan); Junko S. Hiraga, The Univ. of Tokyo (Japan); Takayoshi Kohmura, Tokyo Univ. of Science (Japan); Hiroshi Murakami, Tohoku Gakuin Univ. (Japan); Koji Mori, Makoto Yamauchi, Isamu Hatukade, Yusuke Nishioka, Univ. of Miyazaki (Japan); Aya Bamba, Aoyama Gakuin Univ. (Japan); John P. Doty, Noqsi Aerospace, Ltd. (USA) ..... [9601-13]

**Initial results from a cryogenic proton irradiation of a p-channel CCD**, Jason P. D. Gow, David J. Hall, Ben J. Dryer, Simeon Barber, Andrew D. Holland, Neil J. Murray, The Open Univ. (United Kingdom) ..... [9601-14]

# CONFERENCE 9601

SESSION 4.....SUN 3:30 PM TO 5:10 PM

## Spaceborne X-Ray Experiments

Session Chair: **Camden D. Ertley**, Univ. of California, Berkeley (USA)

**Hard x-ray polarimetry with Astrosat-CZTI**, Tanmoy Chattopadhyay, Santosh V. Vadawale, Physical Research Lab. (India); A. R. Rao, Tata Institute of Fundamental Research (India).....[9601-15]

**Development of the wide field imager for Athena**, Norbert Meidinger, Kirpal Nandra, Arne Rau, Markus Plattner, Max-Planck-Institut für extraterrestrische Physik (Germany); Joern Wilms, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); Marco Barbera, Univ. degli Studi di Palermo (Italy).....[9601-16]

**LAMP: a micro-satellite based soft x-ray polarimeter for astrophysics**, Rui She, Hua Feng, Tsinghua Univ. (China); Paolo Soffitta, Fabio Muleri, INAF - IASF Roma (Italy); Renxin Xu, Peking Univ. (China); Hong Li, Tsinghua Univ. (China); Ronaldo Bellazzini, Istituto Nazionale di Fisica Nucleare (Italy); Zhanshan Wang, Tongji Univ. (China); Daniele Spiga, Giovanni Pareschi, Gianpiero Tagliaferri, Kashmira Tayabaly, Bianca Salmaso, INAF - Osservatorio Astronomico di Brera (Italy); Yafeng Zhan, Jianhua Lu, Tsinghua Univ. (China).....[9601-17]

**NASA x-ray surveyor mission: a concept study**, Jessica A. Gaskin, NASA Marshall Space Flight Ctr. (USA); Alexey Vikhlinin, Harvard-Smithsonian Ctr. for Astrophysics (USA); Martin Weisskopf, NASA Marshall Space Flight Ctr. (USA); Harvey Tananbaum, Harvard-Smithsonian Ctr. for Astrophysics (USA)....[9601-18]

**The eROSITA X-ray Observatory**, Vadim Burwitz, Peter Predehl, Max-Planck-Institut für extraterrestrische Physik (Germany).....[9601-19]

## SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

SESSION 5.....MON 8:20 AM TO 10:00 AM

## UV Technologies and Missions I

Session Chair: **Stephan R. McCandliss**, Johns Hopkins Univ. (USA)

**Fireball-2: a UV multi-object spectrograph for detecting the low z circumgalactic medium**, D. Christopher Martin, Erika T. Hamden, California Institute of Technology (USA); David Schiminovich, Columbia Univ. (USA); Bruno Milliard, Robert Grange, Lab. d'Astrophysique de Marseille (France); Shouleh Nikzad, Jet Propulsion Lab. (USA); Lauren Corlies, Columbia Univ. (USA); Robert Crabil, California Institute of Technology (USA); Didier Ferrand, Lab. d'Astrophysique de Marseille (France); Albert Gomes, Ctr. National d'Études Spatiales (France); Anne-Sophie Hutter, Marc Jaquet, Lab. d'Astrophysique de Marseille (France); April Jewell, Jet Propulsion Lab. (USA); Gillian Kyne, California Institute of Technology (USA); Vincent Lamande, Gerard Lemaitre, Lab. d'Astrophysique de Marseille (France); Michele Limon, Columbia Univ. (USA); Nicole Lingner, California Institute of Technology (USA); Marc Llored, Lab. d'Astrophysique de Marseille (France); Mateusz Matuszewski, California Institute of Technology (USA); Pierre Mege, Lab. d'Astrophysique de Marseille (France); Frederi Mirc, Ctr. National d'Études Spatiales (France); Patrick Morrissey, California Institute of Technology (USA); Hwei Ru Ong, Columbia Univ. (USA); Alain Origne, Sandrine Pascal, Celine Peroux, Samuel Quiret, Didier Vibert, Lab. d'Astrophysique de Marseille (France); Jose M. Zorrilla, Columbia Univ. (USA).....[9601-20]

**Detector performance for FIREBall's UV experiment**, April D. Jewell, Jet Propulsion Lab. (USA); Erika T. Hamden, California Institute of Technology (USA); Timothy M. Goodall, Charles A. Shapiro, Samuel R. Cheng, Todd J. Jones, Alexander G. Carver, Michael E. Hoenk, Jet Propulsion Lab. (USA); David Schiminovich, Columbia Univ. (USA); D. Christopher Martin, California Institute of Technology (USA); Shouleh Nikzad, Jet Propulsion Lab. (USA).....[9601-21]

**Noise and dark performance for FIREBall-2 EMCCD delta-doped CCD detector**, Erika T. Hamden, Nicole Lingner, Gillian Kyne, Patrick Morrissey, D. Christopher Martin, California Institute of Technology (USA).....[9601-22]

**Solar glint suppression in compact planetary ultraviolet spectrographs**, Michael W. Davis, G. Randall Gladstone, Cesare Grava, Thomas K. Greathouse, Kurt D. Retherford, Southwest Research Institute (USA).....[9601-23]

**Characterizing, managing, and correcting distortions in the HST/COS FUV detector**, David J. Sahnow, George Dana Becker, John H. Debes, Justin Ely, Sean A. Lockwood, Derck Massa, Cristina M. Oliveira, Steven V. Penton, Charles Proffitt, Julia Roman-Duval, Hugues Sana, Paule Sonnentrucker, Joanna Taylor, Space Telescope Science Institute (USA).....[9601-24]

SESSION 6.....MON 10:30 AM TO 11:50 AM

## UV Technologies and Missions II

Session Chair: **Brian T. Fleming**, Univ. of Colorado at Boulder (USA)

**New UV instrumentation enabled by enhanced broadband lithium fluoride coatings**, Brian T. Fleming, Univ. of Colorado at Boulder (USA); Manuel A. Quijada, NASA Goddard Space Flight Ctr. (USA); Kevin France, Univ. of Colorado at Boulder (USA).....[9601-25]

**Characterization of borosilicate microchannel plates functionalized by atomic layer deposition**, Camden D. Ertley, Oswald H. W. Siegmund, Jason McPhate, Anton Tremsin, John V. Vallerga, Space Sciences Lab. (USA); Henry J. Frisch, The Univ. of Chicago (USA); Jeffrey W. Elam, Anil U. Mane, Robert G. Wagner, Argonne National Lab. (USA); Michael J. Minot, Aileen O'Mahony, Christopher A. Craven, Mark Popecki, Incom Inc. (USA).....[9601-26]

**Performance and characteristics of the FUV microchannel plate detector for icon**, Oswald H. W. Siegmund, Jason McPhate, Nate Darling, Travis Curtis, Sharon R. Jelinsky, Univ. of California, Berkeley (USA).....[9601-27]

**Design and characterization of the ICON FUV CCD cameras**, Erik Syrstad, Brian C. Thompson, Robert Burt, Mitch Whiteley, Space Dynamics Lab. (USA).....[9601-28]

**POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM**

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**A transmissive x-ray polarimeter conception for hard x-ray focusing telescopes**, Hong Li, Hua Feng, Jianfeng Ji, Zhi Deng, Li He, Ming Zeng, Tenglin Li, Yinong Liu, Peiyi Heng, Qiong Wu, Dong Han, Tsinghua Univ. (China); Yongwei Dong, Fangjun Lu, Shuangnan Zhang, Institute of High Energy Physics (China).....[9601-29]

**Characterization of single photon operation of Al0.8Ga0.2As Geiger photodiodes**, Xiao Jie Chen, Erik B. Johnson, Chad M. Whitney, Radiation Monitoring Devices, Inc. (USA); Min Ren, Yaojia Chen, Joe C. Campbell, Univ. of Virginia (USA); James F. Christian, Radiation Monitoring Devices, Inc. (USA).....[9601-30]

**Current progress in the characterization of atomic layer deposited metal fluorides for future astronomical ultraviolet mirror coatings**, Christopher S. Moore, Univ. of Colorado at Boulder (USA); John Hennessy, April D. Jewell, Shouleh Nikzad, Jet Propulsion Lab. (USA); Kevin France, Univ. of Colorado at Boulder (USA).....[9601-31]

**Silicon photomultipliers for next generation high-energy space telescopes**, Karine Lacombe, Jürgen Knöldlseder, Simon Delaigue, Maël Galliano, Baptiste Houret, Pascale Ramon, Gilbert Rouaix, Institut de Recherche en Astrophysique et Planétologie (France); Cédric Virmontois, Ctr. National d'Études Spatiales (France).....[9601-32]

**VUV testing of science cameras at MSFC: QE measurement of the clasp flight cameras**, Patrick R. Champey, The Univ. of Alabama in Huntsville (USA); Ken Kobayashi, Amy R. Winebarger, Jonathan W. Cirtain, David W. Hyde, Bryan A. Robertson, Brent L. Beabout, Dyana L. Beabout, NASA Marshall Space Flight Ctr. (USA); Mike Stewart, The Univ. of Alabama in Huntsville (USA).....[9601-33]

Sunday-Monday 9-10 August 2015 • Proceedings of SPIE Vol. 9602

# UV/Optical/IR Space Telescopes and Instruments: Innovative Technologies and Concepts VII

Conference Chairs: **Howard A. MacEwen**, Reviresco LLC (USA); **James B. Breckinridge**, College of Optical Sciences, The Univ. of Arizona (USA), California Institute of Technology (United States)

Program Committee: **Suzanne Casement**, Northrop Grumman Aerospace Systems (USA); **Colin R. Cunningham**, UK Astronomy Technology Ctr. (United Kingdom); **Lee D. Feinberg**, NASA Goddard Space Flight Ctr. (USA); **Matthew J. Griffin**, Cardiff Univ. (United Kingdom); **David Leisawitz**, NASA Goddard Space Flight Ctr. (USA); **Charles F. Lillie**, Lillie Consulting LLC (USA); **Jean-Pierre Maillard**, Institut d'Astrophysique de Paris (France); **Gary W. Matthews**, Exelis Geospatial Systems (USA); **Mark J. McCaughrean**, European Space Research and Technology Ctr. (Netherlands); **Jacobus M. Oschmann Jr.**, Ball Aerospace & Technologies Corp. (USA); **Marc Postman**, Space Telescope Science Institute (USA); **David C. Redding**, Jet Propulsion Lab. (USA); **Bernard D. Seery**, NASA Goddard Space Flight Ctr. (USA); **H. Philip Stahl**, NASA Marshall Space Flight Ctr. (USA)

## SUNDAY 9 AUGUST

**SESSION 1 . . . . . SUN 8:00 AM TO 10:00 AM**

### ATLAST I

Session Chair: **Bernard D. Seery**, NASA Goddard Space Flight Ctr. (USA)

**Status of the James Webb Space Telescope science instrument payload**,  
Matthew A. Greenhouse, NASA Goddard Space Flight Ctr. (USA) . . . . . [9602-1]

**Beyond JWST: a technology path to the next great UVOIR space telescope**,  
David C. Redding, Jet Propulsion Lab. (USA); David Schiminovich, Columbia Univ. (USA); Sara Seager, Massachusetts Institute of Technology (USA); Julianne Dalcanton, Univ. of Washington (USA); Suzanne Aigrain, Oxford Univ. (United Kingdom); Steven J. Battel, Battel Engineering, Inc. (USA); Niel Brandt, The Pennsylvania State Univ. (USA); Charles Conroy, Univ. of California, Santa Cruz (USA); Lee D. Feinberg, NASA Goddard Space Flight Ctr. (USA); Suvi Gezari, Univ. of Maryland, College Park (USA); Olivier Guyon, Subaru Telescope, National Astronomical Observatory of Japan (USA); Walter Harris, The Univ. of Arizona (USA); Christopher M. Hirata, The Ohio State Univ. (USA); John C. Mather, NASA Goddard Space Flight Ctr. (USA); Marc Postman, Space Telescope Science Institute (USA); H. Philip Stahl, NASA Marshall Space Flight Ctr. (USA); Jason Tumlinson, Space Telescope Science Institute (USA) . . . . . [9602-2]

**TECHBREAK: a technology foresight activity for the European Space Agency points the way to future space telescopes**, Colin Cunningham, UK Astronomy Technology Ctr. (United Kingdom); Martin J. Cullum, European Southern Observatory (Germany); Paul Kamoun, Thales Alenia Space (Belgium); Jean-Claude Worms, European Science Foundation (France); Jean-Pierre Swings, Univ. de Liège (Belgium); Emmanuil Detris, European Science Foundation (France); Jean-Jacques Tortora, Eurospace (France) . . . . . [9602-3]

**A future large-aperture UVOIR space observatory: reference designs**, Norman Rioux, Lee D. Feinberg, NASA Goddard Space Flight Ctr. (USA); David C. Redding, Jet Propulsion Lab. (USA); H. Philip Stahl, NASA Marshall Space Flight Ctr. (USA) . . . . . [9602-4]

**SLS launched missions concept studies for LUVOIR Mission**, H. Philip Stahl, Randall Hopkins, NASA Marshall Space Flight Ctr. (USA) . . . . . [9602-5]

**An evolvable space telescope for future astronomical missions: 2015 update**, Ronald S. Polidan, Northrop Grumman Aerospace Systems (USA); James B. Breckinridge, Breckinridge Associates, LLC (USA); Charles F. Lillie, Lillie Consulting, LLC (USA); Howard A. MacEwen, Reviresco LLC (USA); Martin R. Flannery, Dean R. Dailey, Northrop Grumman Aerospace Systems (USA) . . . . . [9602-6]

**SESSION 2 . . . . . SUN 10:30 AM TO 12:30 PM**

### ATLAST II

Session Chair: **Marc Postman**, Space Telescope Science Institute (USA)  
**Overview and accomplishments of advanced mirror technology development phase 2 (AMTD-2) project**, H. Philip Stahl, NASA Marshall Space Flight Ctr. (USA) . . . . . [9602-7]

**Technology development for the Advanced Technology Large Aperture Space Telescope (ATLAST) as a candidate large UV-Optical-Infrared (LUVOIR) surveyor**, Matthew R. Bolcar, NASA Goddard Space Flight Ctr. (USA); Kunji Balasubramanian, Jet Propulsion Lab. (USA); Mark Clampin, Julie A. Crooke, Lee D. Feinberg, NASA Goddard Space Flight Ctr. (USA); Marc Postman, Space Telescope Science Institute (USA); Manuel A. Quijada, Bernard J. Rauscher, NASA Goddard Space Flight Ctr. (USA); David C. Redding, Jet Propulsion Lab. (USA); Norman Rioux, NASA Goddard Space Flight Ctr. (USA); Stuart B. Shaklan, Jet Propulsion Lab. (USA); H. Philip Stahl, NASA Marshall Space Flight Ctr. (USA); Carl M. Stahle, Harley A. Thronson Jr., NASA Goddard Space Flight Ctr. (USA) . . . . . [9602-8]

**ATLAST ULE mirror segment performance analytical predictions based on thermally induced distortions**, Michael J. Eisenhower, Lester M. Cohen, Smithsonian Astrophysical Observatory (USA); Lee D. Feinberg, NASA Goddard Space Flight Ctr. (USA); Gary W. Matthews, Exelis Inc. (USA); Joel A. Nissen, Jet Propulsion Lab. (USA); Sang C. Park, Smithsonian Astrophysical Observatory (USA); Hume L. Peabody, NASA Goddard Space Flight Ctr. (USA) . . . . . [9602-9]

**Correction of large aperture active space telescope mirror using a gradient approach and a secondary deformable mirror**, Matthew R. Allen, Jae Jun Kim, Brij N. Agrawal, Naval Postgraduate School (USA) . . . . . [9602-10]

**Optical design of camera for transiting exoplanet survey satellite (TESS)**, Michael Chrisp, Kristin E. Clark, Brian C. Primeau, Michael Dalpiaz, Joseph Lennon, MIT Lincoln Lab. (USA) . . . . . [9602-11]

**Detector requirements for coronagraphic biosignature characterization**, Bernard J. Rauscher, NASA Goddard Space Flight Ctr. (USA) . . . . . [9602-12]

Lunch Break . . . . . Sun 12:30 pm to 2:00 pm

**SESSION 3 . . . . . SUN 2:00 PM TO 3:00 PM**

### Unconventional

Session Chair: **David C. Redding**, Jet Propulsion Lab. (USA)

**Orbiting rainbows: NIAC phase II progress**, Scott A. Basinger, Marco B. Quadrelli, Jet Propulsion Lab. (USA); Grover A. Swartzlander Jr., Xiaopeng Peng, Rochester Institute of Technology (USA); Alexandra Artusio, Rochester State Rocks (USA); Darmin D. Arumugam, Jet Propulsion Lab. (USA) . . . . . [9602-13]

**Of elephants and whales**, Thomas D. Ditto, 3DeWitt, LLC (USA) . . . . . [9602-14]

**Design and test of the new generation solar imaging telescope**, Olha V. Asmolova, Geoff Andersen, U.S. Air Force Academy (USA) . . . . . [9602-15]

# CONFERENCE 9602

SESSION 4..... SUN 3:30 PM TO 4:30 PM

## EUCLID

Session Chair: **Lee D. Feinberg**, NASA Goddard Space Flight Ctr. (USA)

**Demonstrator model: a first demonstration of the NISP detection system**, Jean Claude Clémens, Aurélia Secroun, Benoît Serra, Anne Ealet, Ctr. de Physique des Particules de Marseille (France); Rémi Barbier, Institut de Physique Nucléaire de Lyon (France); Florent Beaumont, Lab. d'Astrophysique de Marseille (France); Eric Chabanat, Institut de Physique Nucléaire de Lyon (France); Christophe Fabron, José Garcia, Emmanuel Grassi, Lab. d'Astrophysique de Marseille (France); Bogna Kubik, Institut de Physique Nucléaire de Lyon (France); Thierry Maciaszek, Eric Prieto, Lab. d'Astrophysique de Marseille (France); Gérard Smadja, Institut de Physique Nucléaire de Lyon (France) ..... [9602-16]

**Characterization of Euclid-like H2RG IR detectors for the NISP instrument**, Benoît Serra, Aurélia Secroun, Anne Ealet, Jean Claude Clémens, Philippe Lagier, Mathieu Niclas, Ctr. de Physique des Particules de Marseille (France); remi Barbier, Institut de Physique Nucléaire de Lyon (France); Michael I. Andersen, Niels Bohr Institute (Denmark); Eric Chabanat, Bogna Kubik, Institut de Physique Nucléaire de Lyon (France); Thierry Maciaszek, Lab. d'Astrophysique de Marseille (France); Anton Norup Sørensen, Niels Bohr Institute (Denmark); Eric Prieto, Lab. d'Astrophysique de Marseille (France); Gérard Smadja, Institut de Physique Nucléaire de Lyon (France) ..... [9602-17]

**Preliminary results on the EUCLID NISP stray-light and ghost analysis**, Frank U. Grupp, Univ.-Sternwarte München (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); Norbert Geis, Ralf Bender, Max-Planck-Institut für extraterrestrische Physik (Germany) ..... [9602-18]

**SYMPORIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM**

Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

SESSION 5..... MON 8:00 AM TO 10:00 AM

## Tel Tech

Session Chair: **Gary W. Matthews**, Exelis Inc. (USA)

**Coatings for UVOIR telescope mirrors**, Kunjithapatham Balasubramanian, John Hennessy, Shouleh Nikzad, Nasrat A. Raouf, Michael E. Ayala, Jet Propulsion Lab. (USA); Javier G. Del Hoyo, Manuel A. Quijada, NASA Goddard Space Flight Ctr. (USA) ..... [9602-19]

**Carbon nanotube optical mirrors**, Peter C. Chen, NASA Goddard Space Flight Ctr. (USA) and The Catholic Univ. of America (USA); Douglas M. Rabin, NASA Goddard Space Flight Ctr. (USA) ..... [9602-20]

**A global shutter CMOS image sensor with in-pixel CDS for hyperspectral imaging**, Ben J. Dryer, Konstantin D. Stefanov, David J. Hall, The Open Univ. (United Kingdom); Jérôme Pratlong, Martin Fryer, Andrew Pike, e2v technologies plc (United Kingdom) ..... [9602-21]

**Testing simple models for dynamic correlated charge collection effects in thick CCDs**, Daniel P. Weatherill, Konstantin D. Stefanov, Andrew D. Holland, The Open Univ. (United Kingdom); Douglas Jordan, e2v technologies plc (United Kingdom); Ivan V. Kotov, Brookhaven National Lab. (USA) ..... [9602-22]

**Proton-induced random telegraph signal in the CMOS imaging sensor for JANUS, the visible imaging telescope on JUICE**, George P. Winstone, Matthew R. Soman, Andrew D. Holland, Jason P. D. Gow, Konstantin D. Stefanov, Mark Leese, The Open Univ. (United Kingdom) ..... [9602-23]

**Radiation qualification of the CIS115 for the JUICE mission**, Matthew Soman, Andrew D. Holland, George P. Winstone, Jason P. D. Gow, Konstantin D. Stefanov, Mark Leese, The Open Univ. (United Kingdom) ..... [9602-24]

SESSION 6..... MON 10:30 AM TO 11:50 AM

## SmallSats and Sub-Orbital

Session Chair: **Suzanne Casement**, Northrop Grumman Aerospace Systems (USA)

**Optical design and tolerance analysis of a reflecting telescope for CubeSat**, Ching-Wei Chen, Chia-Ray Chen, National Space Organization (Taiwan) ..... [9602-25]

**Analysis of an optical relay system and integration into a satellite imager**, Louhab Noui, Surrey Satellite Technology Ltd. (United Kingdom) ..... [9602-26]

**Focal plane actuation for the development of a high resolution suborbital telescope**, Alexander D. Miller, Paul A. Scowen, Arizona State Univ. (USA); Todd J. Veach, NASA Goddard Space Flight Ctr. (USA) ..... [9602-27]

**Low cost visible imaging and IR spectroscopy from stratospheric telescopes**, Eliot F. Young, Southwest Research Institute (USA); Charles A. Hibbitts, Andrew F. Cheng, Johns Hopkins Univ. Applied Physics Lab., LLC (USA); Robert A. Woodruff, Lockheed Martin Corp. (USA) ..... [9602-28]

SESSION 7..... MON 11:50 AM TO 12:10 PM

## X-ray

Session Chair: **David T. Leisawitz**, NASA Goddard Space Flight Ctr. (USA)

**ATHENA: system design and implementation for a next generation x-ray telescope**, Mark R. Ayre, Marcos Bvdaz, Ivo Ferreira, Martin Linder, Eric Wille, David H. Lumb, European Space Agency (Netherlands) ..... [9602-29]

Lunch Break ..... Mon 12:10 pm to 1:40 pm

SESSION 8..... MON 1:40 PM TO 3:20 PM

## WFIRST / AFTA

Session Chair: **David T. Leisawitz**, NASA Goddard Space Flight Ctr. (USA)

**Thermal shield with high soft x-ray transparency**, Bruce M. Lairson, Heidi Lopez, David Grove, Travis Ayers, Luxel Corp. (USA) ..... [9602-30]

**Challenges in photon-starved space astronomy in a harsh radiation environment using CCDs**, David J. Hall, Nathan L. Bush, Neil J. Murray, Jason P. D. Gow, Andrew S. Clarke, Ross Burgon, Andrew D. Holland, The Open Univ. (United Kingdom) ..... [9602-31]

**Optical tolerancing and predicted performance of the Wide-Field InfraRed Survey Telescope / Astrophysics Focused Telescope Assets (WFIRST/AFTA) wide-field instrument**, Bert A. Pasquale, Catherine T. Marx, David A. Content, Jeffrey W. Kruk, Qian Gong, Joseph M. Howard, Alden S. Jurling, J. Eric Mentzell, NASA Goddard Space Flight Ctr. (USA); Neresa V. Armani, Arthur L. Whipple, Martina S. Atanassova, Clifton E. Jackson, SGT, Inc. (USA); Thomas M. Casey, Sigma Space Corp. (USA); Carl A. Blaurock, Nightsky Systems, Inc. (USA) [9602-32]

**Wide-Field InfraRed Survey Telescope/Astrophysics Focused Telescope Assets (WFIRST/AFTA) grism spectrometer**, Qian Gong, NASA Goddard Space Flight Ctr. (USA); Thomas Casey, Sigma Space Corp. (USA); David A. Content, Margaret Z. Dominguez, Jeffrey W. Kruk, Catherine Marx, Bert A. Pasquale, Thomas E. Wallace, Arthur O. Whipple, NASA Goddard Space Flight Ctr. (USA) ..... [9602-33]

**Specral performance of WFIRST/AFTA bandpass filter prototypes**, Manuel A. Quijada, David A. Content, Jeffrey W. Kruk, Kevin H. Miller, NASA Goddard Space Flight Ctr. (USA) ..... [9602-34]

POSTERS-MONDAY..... MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**ACCESS: integration and pre-launch performance**, Mary E. Kaiser, Matthew J. Morris, Johns Hopkins Univ. (USA); Jeffrey W. Kruk, Bernard J. Rauscher, Randy A. Kimble, NASA Goddard Space Flight Ctr. (USA); Edward L. Wright, Univ. of California, Los Angeles (USA); Stephan R. McCandliss, Russell Peitton, Lauren N. Aldoroty, Grant O. Peacock, Paul D. Feldman, Henry W. Moos, Johns Hopkins Univ. (USA); Adam G. Riess, Johns Hopkins Univ. (USA) and Space Telescope Science Institute (USA); Dominic J. Benford, Jonathan P. Gardner, NASA Goddard Space Flight Ctr. (USA); Ralph C. Bohlin, Susana E. Deustua, William V. Dixon, David J. Sahn, Space Telescope Science Institute (USA); Robert Kurucz, Harvard-Smithsonian Ctr. for Astrophysics (USA); Michael Lampton, Space Sciences Lab. (USA); Saul Perlmutter, Lawrence Berkeley National Lab. (USA) ..... [9602-35]

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# Optics for EUV, X-Ray, and Gamma-Ray Astronomy VII

Conference Chairs: **Stephen L. O'Dell**, NASA Marshall Space Flight Ctr. (USA); **Giovanni Pareschi**, INAF - Osservatorio Astronomico di Brera (Italy)

Program Committee: **Nicolas M. Barrière**, cosine Science & Computing B.V. (Netherlands); **Marcos Bvdaz**, European Space Research and Technology Ctr. (Netherlands); **Vadim Burwitz**, Max-Planck-Institut für extraterrestrische Physik (Germany); **Finn E. Christensen**, DTU Space (Denmark); **Peter Friedrich**, Max-Planck-Institut für extraterrestrische Physik (Germany); **Filippo Frontera**, Univ. degli Studi di Ferrara (Italy); **Fiona A. Harrison**, California Institute of Technology (USA); **René Hudec**, Astronomical Institute of the ASCR, v.v.i. (Czech Republic); **Hideyo Kunieda**, Nagoya Univ. (Japan); **Randall L. McEntaffer**, The Univ. of Iowa (USA); **Noriyuki Narukage**, National Astronomical Observatory of Japan (Japan); **Rene A. Ong**, Univ. of California, Los Angeles (USA); **Mikhail N. Pavlinsky**, Space Research Institute (Russian Federation); **Robert Petre**, NASA Goddard Space Flight Ctr. (USA); **Brian D. Ramsey**, NASA Marshall Space Flight Ctr. (USA); **Paul B. Reid**, Harvard-Smithsonian Ctr. for Astrophysics (USA); **Suzanne E. Romaine**, Harvard-Smithsonian Ctr. for Astrophysics (USA); **Mark L. Schattenburg**, Massachusetts Institute of Technology (USA); **Daniele Spiga**, INAF - Osservatorio Astronomico di Brera (Italy); **Yuzuru Tawara**, Nagoya Univ. (Japan); **Peter von Ballmoos**, Institut de Recherche en Astrophysique et Planétologie (France); **Richard Willingale**, Univ. of Leicester (United Kingdom); **David L. Windt**, Reflective X-Ray Optics LLC (USA); **William W. Zhang**, NASA Goddard Space Flight Ctr. (USA)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Off-plane grating alignment approach for Arcus**, Benjamin D. Donovan, The Univ. of Iowa (USA); Ryan Allured, Edward Hertz, Peter N. Cheimets, Harvard-Smithsonian Ctr. for Astrophysics (USA); Randall L. McEntaffer, The Univ. of Iowa (USA); Randall K. Smith, Harvard-Smithsonian Ctr. for Astrophysics [9603-59]

**Addressing the problem of glass thickness variation in the indirect slumping technology**, Laura Proserpio, Elias Breunig, Peter Friedrich, Anita Winter, Max-Planck-Institut für extraterrestrische Physik (Germany); Christoph Wellnhofer, Max-Planck Institut für extraterrestrische Physik (Germany) and Institut für Werkstoffwissenschaft und Werkstoffmechanik (Germany) ..... [9603-60]

**Off-plane x-ray diffraction grating fabrication**, Thomas J. Peterson, Casey T. DeRoo, Randall L. McEntaffer, The Univ. of Iowa (USA) ..... [9603-61]

**Design and implementation of an x-ray reflectometer system for testing x-ray optics coatings**, Danielle Gurgev, The Univ. of Alabama in Huntsville (USA) and NASA Marshall Space Flight Ctr. (USA); Brian D. Ramsey, Mikhail V. Gubarev, David Broadway, NASA Marshall Space Flight Ctr. (USA) ..... [9603-62]

**The development of a deflectometer for accurate surface figure metrology**, Mikhail V. Gubarev, Brian Ramsey, NASA Marshall Space Flight Ctr. (USA); Carolyn Atkins, The Univ. of Alabama in Huntsville (USA) ..... [9603-63]

**Development of an x-ray telescope with a large effective area for the iron K line band**, Hironori Matsumoto, Sasagu Tachibana, Shun Yoshikawa, Keisuke Tamura, Hideyuki Mori, Kojun Yamashita, Ikuuyuki Mitsuishi, Yuzuru Tawara, Hideyo Kunieda, Nagoya Univ. (Japan) ..... [9603-64]

**Development of an x-ray telescope using the carbon fiber reinforced plastic**, Hironori Matsumoto, Toshihiro Iwase, Masato Maejima, Nagoya Univ. (Japan); Hisamitsu Awaki, Ehime Univ. (Japan); Hideyo Kunieda, Nagoya Univ. (Japan); Naoki Ishida, Tamagawa Engineering Co., Ltd. (Japan); Satoshi Sugita, Ehime Univ. (Japan); Takuya Miyazawa, Naoki Shima, Ikuuyuki Mitsuishi, Yuzuru Tawara, Nagoya Univ. (Japan) ..... [9603-65]

## TUESDAY 11 AUGUST

### INTRODUCTORY REMARKS.....8:00 AM TO 8:10 AM

Conference Chair: **Stephen L. O'Dell**, NASA Marshall Space Flight Ctr. (USA)

### SESSION 1.....TUE 8:10 AM TO 10:10 AM

#### Cherenkov Telescopes

Session Chair: **Stephen L. O'Dell**, NASA Marshall Space Flight Ctr. (USA)

**An overview on mirrors for Cherenkov telescopes manufactured by glass cold-shaping technology**, Rodolfo Canestrari, INAF - Osservatorio Astronomico di Brera (Italy); Enrico Giro, INAF - Osservatorio Astronomico di Padova (Italy); Giacomo Bonnoli, Giuseppe Crimi, INAF - Osservatorio Astronomico di Brera (Italy); Mauro Fiorini, INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica di Palermo (Italy); Giovanni Pareschi, INAF - Osservatorio Astronomico di Brera (Italy); Gabriele Rodeghiero, INAF - Osservatorio Astronomico di Padova (Italy); Giorgia Sironi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-1]

**The ASTRI SST-2M prototype for the Cherenkov Telescope Array: opto-mechanical test results**, Rodolfo Canestrari, INAF - Osservatorio Astronomico di Brera (Italy); Enrico Giro, Gabriele Rodeghiero, INAF - Osservatorio Astronomico di Padova (Italy); Giorgia Sironi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-2]

**ASTRI primary mirrors characterization by deflectometry**, Giorgia Sironi, Rodolfo Canestrari, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-3]

**Towards the construction of a medium size prototype Schwarzschild-Couder telescope for CTA**, Julien Rousselle, Univ. of California, Los Angeles (USA) [9603-4]

**Results and developments from the 12m Davies-Cotton MST prototype for CTA**, Louise Oakes, Humboldt-Univ. zu Berlin (Germany); Markus Garnczarczyk, Stefan Schlenstedt, DESY Zeuthen (Germany); Ullrich Schwaneke, Humboldt-Univ. zu Berlin (Germany) ..... [9603-5]

**Roughness tolerances for Cherenkov telescope mirrors**, Kashmira Tayabaly, INAF - Osservatorio Astronomico di Brera (Italy) and Politecnico di Milano (Italy); Daniele Spiga, Giacomo Bonnoli, Rodolfo Canestrari, Giorgia Sironi, Giovanni Pareschi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-6]

# CONFERENCE 9603

SESSION 2 ..... TUE 10:40 AM TO 12:00 PM

## Laue Lenses

Session Chair: **Nicolas M. Barrière**, cosine Science & Computing B.V.  
(Netherlands)

**Hard x-rays broad band Laue lenses (80 - 600 keV): building methods and performances**, Enrico Virgili, Filippo Frontera, Piero Rosati, Vittore Carassiti, Univ. degli Studi di Ferrara (Italy); Stefano Squerzanti, Istituto Nazionale di Fisica Nucleare (Italy); Ezio Caroli, John Stephen, Natalia Auricchio, Angelo Basilii, Stefano Silvestri, INAF - IASF Bologna (Italy); Ferdinando Cassese, Luca Recanatesi, DTM Srl (Italy) ..... [9603-7]

**Rapid and accurate assembly method for a new Laue lens prototype**, Colin Wade, Univ. College Dublin (Ireland); Nicolas M. Barrière, cosine Research B.V. (Netherlands); Lorraine Hanlon, Univ. College Dublin (Ireland); Steven E. Boggs, Space Sciences Lab. (USA); Nicolai F. Brejnholt, Lawrence Livermore National Lab. (USA); Sonny Massahi, Univ. of California, Berkeley (USA); John A. Tomnick, Space Sciences Lab. (USA); Peter von Ballmoos, Institut de Recherche en Astrophysique et Planétologie (France) ..... [9603-8]

**Bending of crystals using carbon fiber films**, Vincenzo Guidi, Riccardo Camattari, Valerio Bellucci, Gianfranco Paternò, Andrea Mazzolari, Enrico Virgili, Univ. degli Studi di Ferrara (Italy) ..... [9603-9]

**Development of self-focusing Si Laue components (SiLCs) for high performance Laue lenses**, Nicolas M. Barrière, cosine Research B.V. (Netherlands) and Univ. of California, Berkeley (USA); Abdelhakim Chatbi, Maximilien Collon, Ramses Günther, cosine Research B.V. (Netherlands); Lorraine Hanlon, Univ. College Dublin (Ireland); Giuseppe Vacanti, Mark Vervest, cosine Research B.V. (Netherlands); Peter von Ballmoos, Institut de Recherche en Astrophysique et Planétologie (France); Colin Wade, Univ. College Dublin (Ireland); Alexei Yanson, cosine Research B.V. (Netherlands) ..... [9603-10]

Lunch Break ..... Tue 12:00 pm to 1:30 pm

SESSION 3 ..... TUE 1:30 PM TO 2:30 PM

## X-ray Telescopes

Session Chair: **Paul B. Reid**, Harvard-Smithsonian Ctr. for Astrophysics (USA)

**Status of ART-XC / SRG instrument**, Mikhail N. Pavlinsky, Valeriy Akimov, Vasiliy Levin, Igor Lapshov, Alexey Tkachenko, Nikolay Semena, Mikhail Buntov, Alexander Glushenko, Vadim Arefiev, Alexander Yaskovich, Space Research Institute (Russian Federation); Rashid Sunyaev, Eugene Churazov, Marat Gilfanov, Space Research Institute (Russian Federation) and Max-Planck-Institut für Astrophysik (Germany); Sergei Grebenev, Sergey Sazonov, Mikhail Revnivtsev, Alexander Lutovinov, Sergey Molkov, Mikhail Kudelin, Tatjana Drozdova, Space Research Institute (Russian Federation); Sergey Garanin, Sergey Grigorovich, Dmitriy Litvin, Valeriy Lazarchuk, Igor Roiz, Mikhail Garin, Russian Federal Nuclear Ctr. - All-Russian Research Institute of Experimental Physics (Russian Federation); Vladimir Babyshkin, Ilya Lomakin, Alexander Menderov, NPO Lavochkin (Russian Federation); Mikhail Gubarev, Brian Ramsey, Kiranmayee Kilaru, Stephen O'Dell, Jeffery Kolodziejczak, Ronald Elsner, NASA Marshall Space Flight Ctr. (USA) ..... [9603-11]

**Ultra high throughput four-reflection x-ray telescope for high resolution spectroscopy**, Yuzuru Tawara, Ikuyuki Mitsuishi, Yasunori Babasaki, Ren Nakamichi, Ayako Bandai, Nagoya Univ. (Japan) ..... [9603-12]

**Development of the four-stage x-ray telescope (FXT) for the DIOS mission (2)**, Ikuyuki Mitsuishi, Yasunori Babasaki, Ren Nakamichi, Ayako Bandai, Yuzuru Tawara, Ikuya Sakurai, Tatsuharu Torii, Kenji Tachibana, Takefumi Onishi, Nagoya Univ. (Japan); Satoshi Sugita, Ehime Univ. (Japan); Naomichi Kikuchi, Toshiki Sato, Tokyo Metropolitan Univ. (Japan); Takayuki Hayashi, Japan Aerospace Exploration Agency (Japan); Ryo Izuka, Yoshitomo Maeda, Institute of Space and Astronautical Science (Japan) and Japan Aerospace Exploration Agency (Japan) ..... [9603-13]

SESSION 4 ..... TUE 2:30 PM TO 3:30 PM

## Design & Analyses

Session Chair: **Yuzuru Tawara**, Nagoya Univ. (Japan)

**New ray-tracing capabilities for the development of silicon pore optics**, Giuseppe Vacanti, Nicols Barrière, Abdelhakim Chatbi, cosine Science & Computing B.V. (Netherlands); Maximilien Collon, cosine Research B.V. (Netherlands); Ramses Günther, Alexei Yanson, Mark Vervest, cosine Science & Computing B.V. (Netherlands); Marcos Bvdaz, Eric Wille, European Space Agency (Netherlands) ..... [9603-14]

**Surface reconstruction and x-ray scattering computation from power- and phase-spectral densities**, Daniele Spiga, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-15]

**On the statistical error of the half energy width**, Giuseppe Vacanti, cosine Science & Computing B.V. (Netherlands) ..... [9603-16]

SESSION 5 ..... TUE 4:00 PM TO 5:20 PM

## Silicon-pore Optics

Session Chair: **William W. Zhang**, NASA Goddard Space Flight Ctr. (USA)

**The Athena optics**, Marcos Bvdaz, Eric Wille, Brian Shortt, Sebastiaan Fransen, European Space Agency (Netherlands); Maximilien Collon, cosine Research B.V. (Netherlands); Giuseppe Vacanti, Ramses Guenther, Alexei Yanson, Mark Vervest, cosine Science & Computing B.V. (Netherlands); Jeroen Haneveld, Micronit Microfluidics B.V. (Netherlands); Coen van Baren, SRON Netherlands Institute for Space Research (Netherlands); Karl-Heinz Zuknik, OHB-System AG (Germany); Finn E. Christensen, DTU Space (Denmark); Michael Krumrey, Physikalisch-Technische Bundesanstalt (Germany); Vadim Burwitz, Max-Planck-Institut für extraterrestrische Physik (Germany); Giovanni Pareschi, INAF - Osservatorio Astronomico di Brera (Italy); Giuseppe Valsecchi, Media Lario Technologies S.r.l. (Italy) ..... [9603-17]

**Silicon pore optics development for ATHENA**, Maximilien Collon, cosine Research B.V. (Netherlands); Ramses Günther, Alexei Yanson, Abdelhakim Chatbi, Giuseppe Vacanti, Mark Vervest, Nicolas M. Barrière, cosine Science & Computing B.V. (Netherlands); Marco W. Beijersbergen, cosine Research B.V. (Netherlands); Marcos Bvdaz, Eric Wille, European Space Agency (Netherlands); Jeroen Haneveld, Arenda Koelewijn, Micronit Microfluidics B.V. (Netherlands); Coen van Baren, SRON Netherlands Institute for Space Research (Netherlands); Peter Müller, Michael Krumrey, Physikalisch-Technische Bundesanstalt (Germany); Vadim Burwitz, Max-Planck-Institut für extraterrestrische Physik (Germany); Finn E. Christensen, DTU Space (Denmark); Giovanni Pareschi, Paolo Conconi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-18]

**Silicon pore optics mirror modules for inner and outer radii**, Eric Wille, Marcos Bvdaz, Tim Oosterbroek, European Space Research and Technology Ctr. (Netherlands); Maximilien Collon, Marcelo D. Ackermann, cosine Research B.V. (Netherlands); Ramses Guenther, Giuseppe Vacanti, Mark Vervest, Alexei Yanson, cosine Science & Computing B.V. (Netherlands); Coen van Baren, SRON Netherlands Institute for Space Research (Netherlands); Jeroen Haneveld, Arenda Koelewijn, Anne Leenstra, Micronit Microfluidics B.V. (Netherlands); Giovanni Pareschi, Marta Civitani, Paolo Conconi, Daniele Spiga, INAF - Osservatorio Astronomico di Brera (Italy); Giuseppe Valsecchi, Fabio Marioni, Media Lario Technologies S.r.l. (Italy); Mario Schweitzer, Karl-Heinz Zuknik, OHB-System AG (Germany) ..... [9603-19]

**Multilayer coated SPO stack: Production and test**, Sonny Massahi, Anders C. Jakobsen, David Girou, Finn E. Christensen, DTU Space (Denmark); Brian Shortt, European Space Research and Technology Ctr. (Netherlands); Maximilien Collon, cosine Research B.V. (Netherlands); Michael Krumrey, Levent Cibik, Stefanie Langner, Physikalisch-Technische Bundesanstalt (Germany) ..... [9603-20]

# CONFERENCE 9603

WEDNESDAY 12 AUGUST

SESSION 6..... WED 8:10 AM TO 10:10 AM

## Slumped-glass Optics

Session Chair: **Marcos Bvdaz**, European Space Research and Technology Ctr. (Netherlands)

**An alternative solution for ATHENA mission: preliminary design of the mirror modules and mirror assembly based on the slumped glass**, Stefano Bassi, Marta M. Civitani, Giovanni Pareschi, Enrico Buratti, INAF - Osservatorio Astronomico di Brera (Italy); Josef Eder, Peter Friedrich, Maria Fürmetz, Max-Planck-Institut für extraterrestrische Physik (Germany) ..... [9603-21]

**Slumped glass optics for x-ray telescopes: advances in the hot slumping assisted by pressure**, Bianca Salmaso, Claudio Brizzolari, Stefano Bassi, Marta Civitani, Mauro Ghigo, Giovanni Pareschi, Daniele Spiga, Gianpiero Tagliaferri, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-22]

**Slumped glass optics based on thin hot formed glass segments and interfacing ribs for high angular resolution x-ray astronomy: performances and development status**, Marta M. Civitani, Stefano Bassi, Mauro Ghigo, Bianca Salmaso, Daniele Spiga, Gianpiero Tagliaferri, Gabriele Vecchi, INAF - Osservatorio Astronomico di Brera (Italy); Gisela D. Hartner, Benedikt Menz, Vadim Burwitz, Max-Planck-Institut Röntgen Testanlage PANTER (Germany); Giovanni Pareschi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-23]

**Lightweight and high-resolution x-ray optics for astronomy**, William W. Zhang, NASA Goddard Space Flight Ctr. (USA) ..... [9603-24]

**Progress report on air bearing slumping of thin glass mirrors for x-ray telescopes**, Mark L. Schattenburg, MIT Kavli Institute for Astrophysics and Space Research (USA); Brandon Chalifoux, Massachusetts Institute of Technology (USA); Michael D. DeTienne, Ralf Heilmann, Heng Zuo, MIT Kavli Institute for Astrophysics and Space Research (USA) ..... [9603-25]

**Indirect glass slumping for future x-ray missions: overview, status and progress**, Anita Winter, Elias Breunig, Peter Friedrich, Laura Proserpio, Max-Planck-Institut für extraterrestrische Physik (Germany); Thorsten Döhring, Hochschule Aschaffenburg (Germany) ..... [9603-26]

SESSION 7..... WED 10:40 AM TO 12:00 PM

## Other Mirror Technologies

Session Chair: **Daniele Spiga**, INAF - Osservatorio Astronomico di Brera (Italy)

**Development of precision Wolter mirrors for future solar x-ray observations**, Taro Sakao, Japan Aerospace Exploration Agency (Japan) and The Graduate Univ. for Advanced Studies (Japan); Satoshi Matsuyama, Ayumi Kime, Takumi Goto, Akihiko Nishihara, Hiroki Nakamori, Kazuto Yamauchi, Osaka Univ. (Japan); Yoshiaki Kohmura, RIKEN SPring-8 Ctr. (Japan); Yoshinori Suematsu, Noriyuki Narukage, National Astronomical Observatory of Japan (Japan) ..... [9603-27]

**Direct fabrication of full-shell x-ray optics**, Mikhail V. Gubarev, NASA Marshall Space Flight Ctr. (USA); Brian Ramsey, NASA Marshall Space Flight Ctr (USA); W. Scott Smith, Jeffery Kolodziejczak, Jacqueline Roche, William Jones, William Arnold, NASA Marshall Space Flight Ctr. (USA); Carolyn Atkins, The Univ. of Alabama in Huntsville (USA) ..... [9603-28]

**Fabrication of high resolution and lightweight monocrystalline silicon x-ray mirrors**, Raul E. Riveros, Univ. of Maryland, Baltimore County (USA); Linette D. Kolos, NASA Goddard Space Flight Ctr. (USA); James R. Mazzarella, Kevin P. McKeon, SGT, Inc. (USA); William W. Zhang, NASA Goddard Space Flight Ctr. (USA) ..... [9603-29]

**Development of light weight replicated x-ray optics**, Suzanne E. Romaine, Ricardo Bruni, Harvard-Smithsonian Ctr. for Astrophysics (USA); Brian Choi, Christopher Jensen, ReliaCoat Technologies, LLC (USA); Brian D. Ramsey, National Space Science and Technology Ctr. (USA); Sanjay Sampath, ReliaCoat Technologies, LLC (USA) ..... [9603-30]

Lunch Break ..... Wed 12:00 pm to 1:40 pm

SESSION 8..... WED 1:40 PM TO 3:00 PM

## Alignment & Assembly

Session Chair: **Mikhail N. Pavlinsky**, Space Research Institute (Russian Federation)

**Alignment, bonding, and testing of lightweight x-ray mirrors**, Kai-Wing Chan, Michael P. Biskach, Joseph Bonafe, Linette D. Kolos, James R. Mazzarella, NASA Goddard Space Flight Ctr. (USA); Ryan S. McClelland, Kevin P. McKeon, SGT, Inc. (USA); Jason Niemeyer, Raul E. Riveros, Timo T. Saha, NASA Goddard Space Flight Ctr. (USA); Mark J. Schofield, SGT, Inc. (USA); Marton V. Sharpe, William W. Zhang, NASA Goddard Space Flight Ctr. (USA) ..... [9603-31]

**Cold shaping of thin glass foils: a fast and cost-effective solution for making light-weight astronomical x-ray optics**, Marta M. Civitani, Stefano Bassi, Oberto Citterio, Mauro Ghigo, Bianca Salmaso, Gianpiero Tagliaferri, Giovanni Pareschi, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-32]

**JIM: a joint integrated module of glass x-ray optics for astronomical telescopes**, Laura Proserpio, Max-Planck-Institut für extraterrestrische Physik (Germany); Stefano Bassi, INAF - Osservatorio Astronomico di Brera (Italy); Elias Breunig, Max-Planck-Institut für extraterrestrische Physik (Germany); Enrico Buratti, INAF - Osservatorio Astronomico di Brera (Italy); Vadim Burwitz, Max-Planck-Institut für extraterrestrische Physik (Germany); Marta Civitani, INAF - Osservatorio Astronomico di Brera (Italy); Josef Eder, Peter Friedrich, Gisela D. Hartner, Benedikt Menz, Christian Rohé, Anita Winter, Max-Planck-Institut für extraterrestrische Physik (Germany) ..... [9603-33]

**Liquid metal actuators: correctable mounting and assembly of thin-shell x-ray telescope mirrors**, Martin L. Klingensmith, Alexander R. Brucolieri, Brandon D. Chalifoux, Ralf K. Heilmann, Mark L. Schattenburg, Massachusetts Institute of Technology (USA) ..... [9603-34]

SESSION 9..... WED 3:30 PM TO 4:30 PM

## Dispersion Gratings

Session Chair: **Randall L. McEntaffer**, The Univ. of Iowa (USA)

**High-efficiency blazed transmission gratings for high-resolution soft x-ray spectroscopy**, Ralf K. Heilmann, MIT Kavli Institute for Astrophysics and Space Research (USA); Alexander R. Brucolieri, Izentis, LLC (USA); Mark L. Schattenburg, MIT Kavli Institute for Astrophysics and Space Research (USA) ..... [9603-35]

**X-ray and optical alignment approaches to off-plane reflection gratings**, Ryan Allured, Harvard-Smithsonian Ctr. for Astrophysics (USA); Benjamin D. Donovan, The Univ. of Iowa (USA); Vadim Burwitz, Max-Planck-Institut für Astrophysik (Germany); Peter N. Cheimets, Harvard-Smithsonian Ctr. for Astrophysics (USA); Casey T. DeRoo, The Univ. of Iowa (USA); Gisela Hartner, Max-Planck-Institut für Astrophysik (Germany); Hannah R. Marlowe, Randall L. McEntaffer, The Univ. of Iowa (USA); Edward Hertz, Harvard-Smithsonian Ctr. for Astrophysics (USA); Benedikt Menz, Max-Planck-Institut für Astrophysik (Germany); Randall K. Smith, Harvard-Smithsonian Ctr. for Astrophysics (USA); James H. Tutt, The Univ. of Iowa (USA) ..... [9603-36]

**Diffraction efficiency measurements of radially-profiled off-plane gratings**, Drew M. Miles, Hannah R. Marlowe, Jake A. McCoy, Randall L. McEntaffer, Thomas J. Peterson, Ted B. Schultz, James H. Tutt, The Univ. of Iowa (USA); Thomas D. Rogers, Univ. of Colorado at Boulder (USA); Christian Laubis, Frank Scholze, Physikalisch-Technische Bundesanstalt (Germany) ..... [9603-37]

SESSION 10..... WED 4:30 PM TO 5:50 PM

## Polarimetric Optical Elements

Session Chair: **Mark L. Schattenburg**, Massachusetts Institute of Technology (USA)

**Polarization sensitivity of blazed, off-plane reflection gratings in the soft x-ray regime**, Hannah R. Marlowe, James H. Tutt, Casey T. DeRoo, Drew M. Miles, Randal L. McEntaffer, The Univ. of Iowa (USA); Frank Scholze, Christian Laubis, Physikalisch-Technische Bundesanstalt (Germany) ..... [9603-38]

**New laterally graded multilayer mirrors for soft x-ray polarimetry**, Herman L. Marshall, Norbert S. Schulz, Massachusetts Institute of Technology (USA); David L. Windt, Reflective X-Ray Optics LLC (USA); Eric M. Gullikson, Lawrence Berkeley National Lab. (USA); Eric Blake, Univ. of Massachusetts Lowell (USA); Dan Getty, Massachusetts Institute of Technology (USA); Zane McInturff, Univ. of Wisconsin-Madison (USA); John A. Clarke, Massachusetts Institute of Technology (USA) ..... [9603-39]

**High efficiency carbon-based multilayers for LAMP at 250 eV**, Mingwu Wen, Qiushi Huang, Tongji Univ. (China); Rui She, Tsinghua Univ. (China); Li Jiang, Zhong Zhang, Zhanshan Wang, Tongji Univ. (China); Hua Feng, Tsinghua Univ. (China); Daniele Spiga, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-40]

# CONFERENCE 9603

**Testing multilayer-coated nickel mirrors for the LAMP x-ray polarimetric telescope**, Daniele Spiga, INAF - Osservatorio Astronomico di Brera (Italy); Zhanshan Wang, Tongji Univ. (China); Robert Banham, Media Lario Technologies S.r.l. (Italy); Enrico Costa, INAF - Istituto di Astrofisica e Planetologia Spaziali (Italy); Hua Feng, Tsinghua Univ. (China); Angelo Giglia, Elettra-Sincrotrone Trieste S.C.p.A. (Italy); Qilushi Huang, Tongji Univ. (China); Fabio Muleri, INAF - Istituto di Astrofisica e Planetologia Spaziali (Italy); Giovanni Pareschi, Bianca Salmaso, INAF - Osservatorio Astronomico di Brera (Italy); Rui She, Tsinghua Univ. (China); Paolo Soffitta, INAF - Istituto di Astrofisica e Planetologia Spaziali (Italy); Gianpiero Tagliaferri, INAF - Osservatorio Astronomico di Brera (Italy); Kashmira Tayabaly, Politecnico di Milano (Italy) and INAF - Osservatorio Astronomico di Brera (Italy); Giuseppe Valsecchi, Media Lario Technologies S.r.l. (Italy); Mingwu Wen, Tongji Univ. (China) ..... [9603-41]

## THURSDAY 13 AUGUST

### SESSION 11 ..... THU 8:10 AM TO 9:10 AM

#### Multilayer Coatings

Session Chair: Suzanne E. Romaine, Harvard-Smithsonian Ctr. for Astrophysics (USA)

**Advancements in hard x-ray multilayers for x-ray astronomy**, David L. Windt, Reflective X-Ray Optics LLC (USA) ..... [9603-42]

**Development of Ni-based multilayers for future focusing soft gamma ray telescopes**, David Girou, Erlend Sleire, Sonny Massahi, Finn E. Christensen, Anders C. Jakobsen, DTU Space (Denmark) ..... [9603-43]

**A soft gamma-ray concentrator using thin-film multilayer structures**, Peter F. Bloser, Paul Aliotta, Olof Echt, James Krzanowski, Jason S. Legere, Mark L. McConnell, Farzane Shirazi, John Tsavalas, Emily Wong, The Univ. of New Hampshire (USA) ..... [9603-44]

### SESSION 12 ..... THU 9:10 AM TO 10:10 AM

#### Differential Deposition

Session Chair: Finn E. Christensen, DTU Space (Denmark)

**Progress in differential deposition for improving the figures of full-shell astronomical grazing incidence x-ray optics**, Kiranmayee Kilaru, NASA Marshall Space Flight Ctr. (USA); Carolyn Atkins, The Univ. of Alabama in Huntsville (USA); Brian D. Ramsey, Mikhail V. Gubarev, David M. Broadway, NASA Marshall Space Flight Ctr. (USA) ..... [9603-45]

**Differential deposition correction of segmented glass x-ray optics**, Carolyn Atkins, The Univ. of Alabama in Huntsville (USA); Kiranmayee Kilaru, Brian D. Ramsey, David M. Broadway, Jessica A. Gaskin, Mikhail V. Gubarev, Stephen L. O'Dell, NASA Marshall Space Flight Ctr. (USA); William W. Zhang, NASA Goddard Space Flight Ctr. (USA) ..... [9603-46]

**Two-dimensional differential deposition for figure correction of thin-shell mirror substrates for x-ray astronomy**, David L. Windt, Reflective X-Ray Optics LLC (USA); Raymond Conley Jr., Argonne National Lab. (USA) ..... [9603-47]

### SESSION 13 ..... THU 10:40 AM TO 12:00 PM

#### Coating Stress Control

Session Chair: David L. Windt, Reflective X-Ray Optics LLC (USA)

**Stress compensation for adjustable grazing incidence x-ray optics**, David M. Broadway, NASA Marshall Space Flight Ctr. (USA); Jeffrey Weimer, Danielle Gurgew, Tomasz Lis, The Univ. of Alabama in Huntsville (USA); Stephen L. O'Dell, Brian D. Ramsey, NASA Marshall Space Flight Ctr. (USA) ..... [9603-48]

**Compensating for piezo-electric materials processing stresses in adjustable x-ray optics**, Katie Ames, Ricardo Bruni, Paul B. Reid, Suzanne E. Romaine, Harvard-Smithsonian Ctr. for Astrophysics (USA) ..... [9603-49]

**Stress manipulated coating: a new surface correction method for light weight x-ray optics**, Youwei Yao, Xiaoli Wang, Jian Cao, Michael E. Graham, Semyon Vaynman, Shannon E. Grogans, Yifang Cao, Melville P. Ulmer, Northwestern Univ. (USA) ..... [9603-50]

**Ion implantation for figure correction of segmented x-ray telescope mirror substrates**, Brandon D. Chalifoux, Graham Wright, Ralf K. Heilmann, Mark L. Schattenburg, Massachusetts Institute of Technology (USA) ..... [9603-51]

Lunch Break ..... Thu 12:00 pm to 1:40 pm

### SESSION 14 ..... THU 1:40 PM TO 3:00 PM

#### Active Optics

Session Chair: Vadim Burwitz, Max-Planck-Institut für extraterrestrische Physik (Germany)

**Development of adjustable x-ray optics with 0.5 arcsec resolution: a status update**, Paul B. Reid, Ryan Allured, Sagi Ben-Ami, Vincenzo Cotroneo, Harvard-Smithsonian Ctr. for Astrophysics (USA); Edward Hertz, Smithsonian Astrophysical Observatory (USA); Raegan L. Johnson-Wilke, Sandia National Labs. (USA); Vanessa Marquez, Smithsonian Astrophysical Observatory (USA); Stuart McMurdoch, Daniel A. Schwartz, Harvey D. Tananbaum, Harvard-Smithsonian Ctr. for Astrophysics (USA); Susan Trolier-McKinstry, The Pennsylvania State Univ. (USA); Alexey A. Vikhlinin, Harvard-Smithsonian Ctr. for Astrophysics (USA); Margeaux L. Wallace, The Pennsylvania State Univ. (USA); Rudeger H. T. Wilke, Sandia National Labs. (USA) ..... [9603-52]

**Improved control and characterization of adjustable x-ray optics**, Ryan Allured, Sagi Ben-Ami, Vincenzo Cotroneo, Vanessa Marquez, Stuart McMurdoch, Paul B. Reid, Daniel A. Schwartz, Harvard-Smithsonian Ctr. for Astrophysics (USA); Susan Trolier-McKinstry, The Pennsylvania State Univ. (USA); Alexey A. Vikhlinin, Harvard-Smithsonian Ctr. for Astrophysics (USA); Margeaux L. Wallace, The Pennsylvania State Univ. (USA) ..... [9603-53]

**Manufacturing and testing a thin glass mirror shell with piezoelectric active control**, Daniele Spiga, INAF - Osservatorio Astronomico di Brera (Italy); Marco Barbera, Univ. degli Studi di Palermo (Italy); Stefano Basso, Marta Civitani, INAF - Osservatorio Astronomico di Brera (Italy); Alfonso Collura, Ugo Lo Cicero, INAF - Osservatorio Astronomico di Palermo Giuseppe S. Vaiana (Italy); Giuseppe Lullo, Univ. degli Studi di Palermo (Italy); Carlo Pelliciari, Marco Riva, Bianca Salmaso, INAF - Osservatorio Astronomico di Brera (Italy); Luisa Scirtino, Univ. degli Studi di Palermo (Italy) ..... [9603-54]

**Investigation of magnetically smart films applied to correct the surface profile of light weight x-ray optics in two directions**, Xiaoli Wang, Youwei Yao, Jian Cao, Michael E. Graham, Semyon Vaynman, Tianchen Liu, Melville P. Ulmer, Northwestern Univ. (USA) ..... [9603-55]

### SESSION 15 ..... THU 3:00 PM TO 4:00 PM

#### Testing and Metrology

Session Chair: Giovanni Pareschi, INAF - Osservatorio Astronomico di Brera (Italy)

**BEATRIx: an expanded soft x-ray beam facility for test of focusing optics, an update**, Carlo Pelliciari, Daniele Spiga, Giovanni Pareschi, Giampiero Tagliaferri, INAF - Osservatorio Astronomico di Brera (Italy) ..... [9603-56]

**A Fresnel zone plate collimator: potential and aberrations**, Benedikt Menz, Heinrich Brauner, Vadim Burwitz, Gisela D. Hartner, Peter Predehl, Max-Planck-Institut für extraterrestrische Physik (Germany) ..... [9603-57]

**The characterization of mirror module for the qualification model of the ART-XC/SRG instrument**, Alexey Tkachenko, Mikhail N. Pavlinsky, Alexander Yaskovich, Igor Y. Lapshov, Vladimir A. Oleynikov, Space Research Institute (Russian Federation); Sergey V. Grigorovich, Dmitriy Litvin, Valeriy P. Lazarchuk, Igor Roiz, Mikhail Garin, Russian Federal Nuclear Ctr. - All-Russian Research Institute of Experimental Physics (Russian Federation) ..... [9603-58]

### DISCUSSION AND CLOSING REMARKS ..... 4:00 PM TO 5:00 PM

Conference Chair: Giovanni Pareschi, INAF - Osservatorio Astronomico di Brera (Italy)

Sunday - Monday 9 -10 August 2015 • Proceedings of SPIE Vol. 9604

# Solar Physics and Space Weather Instrumentation VI

Conference Chairs: **Silvano Fineschi**, INAF - Osservatorio Astronomico di Torino (Italy); **Judy Fennelly**, Air Force Research Lab. (USA)

Program Committee: **Frédéric Auchère**, Institut d'Astrophysique Spatiale (France); **Dominic B. Doyle**, European Space Research and Technology Ctr. (Netherlands); **John D. Moses**, U.S. Naval Research Lab. (USA); **Daniel Ober**, Air Force Research Lab. (USA); **Toshifumi Shimizu**, Japan Aerospace Exploration Agency (Japan); **David Voss**, Air Force Research Lab. (USA)

## SUNDAY 9 AUGUST

SESSION 1 ..... SUN 1:30 PM TO 3:40 PM

### Space Weather

Session Chair: **Judy A. Fennelly**, Air Force Research Lab. (USA)

**SSUSI-Lite : a far-ultraviolet hyper-spectral imager for space weather remote sensing (Invited Paper)**, Bernard S. Ogorzalek, Steve N. Osterman, John E. Hicks, Larry J. Paxton, Matthew P. Grey, Johns Hopkins Univ. Applied Physics Lab., LLC (USA) ..... [9604-1]

**Stellar calibration of the special sensor ultraviolet limb imager (SSULI) on the DMSP spacecraft**, Peter Walker, Computational Physics, Inc. (USA); Andrew C. Nicholas, Scott A. Budzien, Kenneth F. Dymond, Andrew W. Stephan, U.S. Naval Research Lab. (USA) ..... [9604-2]

**WINCS on-orbit performance results**, Andrew C. Nicholas, U.S. Naval Research Lab. (USA); Fred Herrero, Space Systems Research Corp. (USA); Andrew W. Stephan, Theodore Finne, U.S. Naval Research Lab. (USA) ..... [9604-3]

**Miniaturization of legacy space weather instrumentation: engineering challenges of meeting mission requirements on today's shrinking satellite platforms**, Joseph M. Coombs, Patrick A. Roddy, John O. Ballenthin, Air Force Research Lab. (USA) ..... [9604-4]

**Proton-electron discrimination detector (PEDD) for space weather monitoring**, Chad M. Whitney, Erik B. Johnson, Xiao J. Chen, Christopher Stapels, Sam Vogel, James F. Christian, Radiation Monitoring Devices, Inc. (USA) ..... [9604-5]

**South Atlantic anomaly and CubeSat design considerations**, Judy A. Fennelly, William R. Johnston, Daniel M. Ober, Gordon R. Wilson, Air Force Research Lab. (USA); T. Paul O'Brien, The Aerospace Corp. (USA); Stuart L. Huston, Atmospheric and Environmental Research, Inc. (USA) ..... [9604-6]

SESSION 2 ..... SUN 4:10 PM TO 5:10 PM

### Advanced Solar Optics

Session Chair: **Silvano Fineschi**, INAF - Osservatorio Astronomico di Torino (Italy)

**Fabrication and testing of the Daniel K. Inouye Solar Telescope polarization optics**, Erika K. Petrak, Meadowlark Optics Inc (USA); Stacey R. Sueoka, College of Optical Sciences, The University of Arizona (USA); Thomas G. Baur, Meadowlark Optics, Inc. (USA) ..... [9604-23]

**Study of solar wind ions implantation effects in optical coatings in view of solar orbiter space mission operation**, Davide Bacco, Alain Jody Corso, Univ. degli Studi di Padova (Italy); Enrico Tessarolo, IFN-CNR LUXOR Lab. (Italy); Enrico Napolitani, Univ. degli Studi di Padova (Italy); Paola Zuppella, IFN-CNR LUXOR Lab. (Italy); Francesca Gerlin, Marco Nardello, Univ. degli Studi di Padova (Italy); Silvano Fineschi, Ester Antonucci, INAF - Osservatorio Astronomico di Torino (Italy); Maria Guglielmina Pelizzo, IFN-CNR LUXOR Lab. (Italy) ..... [9604-17]

**Investigation of contamination of thin-film aluminum filters by MMH-NTO plumes exposed to UV radiation**, Vaibhav Gupta, Seth Wieman, Leonid Didkovsky, Space Sciences Ctr. (USA); Ralf Haiges, Wei Wu, Yuhua Yao, Mike Gruntman, Dan Erwin, The Univ. of Southern California (USA) ..... [9604-25]

## SYMPOSIUM-WIDE PLENARY SESSION.. SUN 6:00 TO 7:30 PM

### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

SESSION 3 ..... MON 8:00 AM TO 10:00 AM

### PROBA-3 Formation Flying

Session Chair: **Frédéric Auchère**, Institut d'Astrophysique Spatiale (France)

**Design status of ASPIICS, an externally occulted coronagraph for PROBA-3**, Etienne Renotte, Univ. de Liège (Belgium) ..... [9604-8]

**Design and modelisation of ASPIICS optics**, Yvan G. Stockman, Camille Galy, Cedric Thizy, Etienne Renotte, Jean-Sébastien Servaye, Univ. de Liège (Belgium) ..... [9604-7]

**The shadow positioning sensors (SPS) for formation flying metrology onboard the ESA-PROBA3 mission**, Alessandro Bemporad, INAF - Osservatorio Astronomico di Torino (Italy); Gerardo Capobianco, INAF - Osservatorio Astrofisico di Torino (Italy); Silvano Fineschi, INAF - Osservatorio Astronomico di Torino (Italy); Mauro Focardi, Univ. of Florence (Italy) and INAF - Osservatorio Astrofisico di Arcetri (Italy); Federico Landini, INAF - Osservatorio Astrofisico di Arcetri (Italy); Davide Loreggia, Giuseppe Massone, INAF - Osservatorio Astronomico di Torino (Italy); Gianalfredo Nicolini, INAF - Osservatorio Astrofisico di Torino (Italy); Vladimiro Noce, INAF - Osservatorio Astrofisico di Arcetri (Italy); Maurizio Pancrazi, Univ. of Florence (Italy); Marco Romoli, INAF - Osservatorio Astrofisico di Arcetri (Italy); Steve Buckley, Kevin O'Neill, SensL (Ireland) ..... [9604-9]

**Formation flying metrology for the ESA-PROBA3 Mission: the shadow positioning sensors (SPS) silicon photomultipliers (SiPMs) readout electronics**, Mauro Focardi, INAF - Osservatorio Astrofisico di Arcetri (Italy); Alessandro Bemporad, INAF - Osservatorio Astronomico di Torino (Italy); Steve Buckley, Kevin O'Neill, SensL (Ireland); Silvano Fineschi, INAF - Osservatorio Astronomico di Torino (Italy); Maurizio Pancrazi, Federico Landini, Vladimiro Noce, Gerardo Capobianco, INAF - Osservatorio Astrofisico di Arcetri (Italy); Marco Romoli, Univ. degli Studi di Firenze (Italy); Davide Loreggia, Giuseppe Massone, INAF - Osservatorio Astronomico di Torino (Italy); Gianalfredo Nicolini, INAF - Osservatorio Astrofisico di Torino (Italy); Cedric Thizy, Etienne Renotte, Univ. de Liège (Belgium) ..... [9604-10]

**Significance of the occulter diffraction for the PROBA3/ASPIICS formation flight metrology**, Federico Landini, INAF - Osservatorio Astrofisico di Arcetri (Italy); Alessandro Bemporad, INAF - Osservatorio Astronomico di Torino (Italy); Mauro Focardi, INAF - Osservatorio Astrofisico di Arcetri (Italy); Silvano Fineschi, INAF - Osservatorio Astrofisico di Torino (Italy); Marco Romoli, Univ. degli Studi di Firenze (Italy); Maurizio Pancrazi, INAF - Osservatorio Astrofisico di Arcetri (Italy); Gerardo Capobianco, Davide Loreggia, Gianalfredo Nicolini, INAF - Osservatorio Astrofisico di Torino (Italy); Giuseppe Massone, INAF - Osservatorio Astronomico di Torino (Italy); Vladimiro Noce, INAF - Osservatorio Astrofisico di Arcetri (Italy); Cédric Thizy, Etienne Renotte, Univ. de Liège (Belgium) ..... [9604-11]

**OPSE metrology system onboard of the PROBA3 mission of ESA**, Davide Loreggia, Alessandro Bemporad, INAF - Osservatorio Astronomico di Torino (Italy); Gerardo Capobianco, Silvano Fineschi, INAF - Osservatorio Astrofisico di Torino (Italy); Mauro Focardi, Federico Landini, INAF - Osservatorio Astrofisico di Arcetri (Italy); Giuseppe Massone, Gianalfredo Nicolini, INAF - Osservatorio Astrofisico di Torino (Italy); Maurizio Pancrazi, INAF - Osservatorio Astrofisico di Arcetri (Italy); Marco Romoli, INAF - Osservatorio Astronomico di Arcetri (Italy); Ileana Cernica, Munizer G. Purica, Elena Budianu, National Institute for Research and Development in Microtechnologies (Romania); Cedric Thizy, Etienne Renotte, Jean-Sébastien Servaye, CSL - Centre Spatial de Liège (Belgium) ..... [9604-12]

# CONFERENCE 9604

SESSION 4 ..... MON 10:30 AM TO 12:10 PM

## Solar Orbiter Mission

Session Chair: **Federico Landini**, INAF - Osservatorio Astrofisico di Arcetri (Italy)

**The extreme UV imager telescope on-board the solar orbiter mission: phase C development summary**, Jean-Philippe A. Halain, Pierre L. Rochus, Etienne Renotte, Aline Hermans, Lionel Jacques, Univ. de Liège (Belgium); Frédéric Auchère, Institut d'Astrophysique Spatiale (France); David Berghmans, Royal Observatory of Belgium (Belgium); Louise K. Harra, Mullard Space Science Lab. (United Kingdom); Udo H. Schühle, Max-Planck-Institut für Sonnensystemforschung (Germany); Werner K. Schmutz, Physikalisch-Meteorologisches Observatorium Davos (Switzerland); Andrei N. Zhukov, Royal Observatory of Belgium (Belgium); Regina Aznar Cuadrado, Max-Planck-Institut für Sonnensystemforschung (Germany); Franck Delmotte, Institut d'Optique Graduate School (France); Cydalise Dumesnil, Institut d'Astrophysique Spatiale (France); Manfred Gyo, Physikalisch-Meteorologisches Observatorium Davos (Switzerland); Thomas E. Kennedy, Philip J. Smith, Jason A. Tandy, Mullard Space Science Lab. (United Kingdom); Raymond F. Mercier, Institut d'Optique Graduate School (France); Francis Verbeeck, Royal Observatory of Belgium (Belgium) .... [9604-13]

**The extreme ultraviolet imager of solar orbiter: optical design and alignment scheme**, Jean-Philippe A. Halain, Alexandra Mazzoli, Univ. de Liège (Belgium); Stefan Meining, Max-Planck-Institut für Sonnensystemforschung (Germany); Pierre L. Rochus, Etienne Renotte, Univ. de Liège (Belgium); Frédéric Auchère, Institut d'Astrophysique Spatiale (France); Udo H. Schühle, Max-Planck-Institut für Sonnensystemforschung (Germany); Franck Delmotte, Institut d'Optique Graduate School (France); Anne Philippon, Institut d'Astrophysique Spatiale (France); Raymond F. Mercier, Institut d'Optique Graduate School (France); Aline Hermans, Univ. de Liège (Belgium) .... [9604-14]

**Polarimetric visible-light imaging with the METIS coronagraph on solar orbiter**, Silvano Fineschi, INAF - Osservatorio Astronomico di Torino (Italy); Gerardo Capobianco, INAF - Osservatorio Astrofisico di Torino (Italy); Matteo Marmonti, Optec S.p.A. (Italy); Paolo Sandri, CGS S.p.A. (Italy); Ester Antonucci, INAF - Osservatorio Astronomico di Torino (Italy); Marco Romoli, Univ. degli Studi di Firenze (Italy); Giampiero Naletto, Univ. degli Studi di Padova (Italy); Daniele Spadaro, INAF - Osservatorio Astrofisico di Catania (Italy) .... [9604-27]

**Dependence of the polarimetric efficiencies of a polarization modulator based on liquid crystal variable retarder on angle of incidence for the solar orbiter mission**, Pilar García Parejo, Alberto Alvarez-Herrero, INTA Instituto Nacional de Técnica Aeroespacial (Spain) .... [9604-16]

**Off-pointing stray light effects analysis on solar orbiter/METIS coronagraph**, Marco Romoli, Univ. degli Studi di Firenze (Italy); Federico Landini, INAF - Osservatorio Astrofisico di Arcetri (Italy); Silvano Fineschi, Ester Antonucci, INAF - Osservatorio Astronomico di Torino (Italy); John D. Moses, U.S. Naval Research Lab. (USA); Mauro Focardi, Maurizio Pancrazzi, INAF - Osservatorio Astrofisico di Arcetri (Italy); Giampiero Naletto, Univ. degli Studi di Padova (Italy); Gianalfredo Nicolini, INAF - Osservatorio Astrofisico di Torino (Italy); Daniele Spadaro, INAF - Osservatorio Astrofisico di Catania (Italy); Vincenzo Andretta, INAF - Osservatorio Astronomico di Capodimonte (Italy) .... [9604-15]

Lunch Break ..... Mon 12:10 pm to 2:00 pm

SESSION 5 ..... MON 2:00 PM TO 5:10 PM

## Future Solar Missions

Session Chair: **Silvano Fineschi**, INAF - Osservatorio Astronomico di Torino (Italy)

**New scheme of international task shares of the Solar-C Mission**, Tetsuya Watanabe, National Astronomical Observatory of Japan (Japan); Kiyoshi Ichimoto, Kyoto Univ. Hida Observatory (Japan); Kanya Kusano, Nagoya Univ. (Japan); Toshifumi Shimizu, Japan Aerospace Exploration Agency (Japan); Hirohisa Hara, National Astronomical Observatory of Japan (Japan); Taro Sakao, Japan Aerospace Exploration Agency (Japan); Yoshihori Suematsu, Yukio Katsukawa, National Astronomical Observatory of Japan (Japan); Keisuke Yoshihara, Japan Aerospace Exploration Agency (Japan) .... [9604-18]

**Magnetic activity of the solar corona (MASC)**, Frédéric Auchère, Institut d'Astrophysique Spatiale (France); Hui Li, Purple Mountain Observatory (China) .... [9604-19]

**Hydrogen Lyman- $\alpha$  polarimeter for SCORE**, Silvano Fineschi, INAF - Osservatorio Astronomico di Torino (Italy); John D. Moses, U.S. Naval Research Lab. (USA); Juan Ignacio Larruquert, Instituto de Óptica "Daza de Valdés" (Spain) .... [9604-26]

**EUV multilayer coatings for solar imaging and spectroscopy**, David L. Windt, Reflective X-Ray Optics LLC (USA) .... [9604-24]

**Waves and magnetism in the solar atmosphere (WAMIS)**, John D. Moses, Yuan-Kuen Ko, J. Martin Laming, Leonard Strachan, U.S. Naval Research Lab. (USA); Steven Tomczyk, National Ctr. for Atmospheric Research (USA); Frédéric Auchère, Institut d'Astrophysique Spatiale (France); Roberto Casini, National Ctr. for Atmospheric Research (USA); Silvano Fineschi, INAF - Osservatorio Astronomico di Torino (Italy); Sarah E. Gibson, Michael Knoelker, National Ctr. for Atmospheric Research (USA); Clarence M. Korendyke, U.S. Naval Research Lab. (USA); Scott McIntosh, National Ctr. for Atmospheric Research (USA); Marco Romoli, Univ. degli Studi di Firenze (Italy); Jan Rybak, Astronomical Institute (Slovakia); Dennis George Socker, U.S. Naval Research Lab. (USA); Angelos Vourlidas, Johns Hopkins Univ. (USA); Qian Wu, National Ctr. for Atmospheric Research (USA) .... [9604-28]

**Coronal and heliospheric imagers for solar wind phenomena**, Kevin F. Middleton, Jackie A. Davies, Chris J. Eyles, Doug K. Griffin, Richard A. Harrison, S. James Tappin, Ian A. J. Tosh, Nick R. Waltham, STFC Rutherford Appleton Lab. (United Kingdom) .... [9604-20]

**The Bragg solar x-ray spectrometer Solpex**, Daniel Ścisłowski, Janusz Sylwester, Stefan Płocieniak, Jarosław Bąkala, Zaneta Szaforz, Marek Stęślicki, Mirosław Kowaliński, Piotr Podgóński, Jose Hernandez, Witold Trzebiński, Space Research Ctr. (Poland); Sergey V. Kuzin, P.N. Lebedev Physical Institute of the Russian Academy of Sciences (Russian Federation); Sergey V. Shestov, P.N. Lebedev Physical Institute (Russian Federation) .... [9604-22]

**ASO-S: advanced space-based solar observatory**, Weiqun Gan, Purple Mountain Observatory (China) .... [9604-21]

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# Techniques and Instrumentation for Detection of Exoplanets VII

Conference Chair: Stuart Shaklan, Jet Propulsion Lab. (USA)

Program Committee: Olivier Guyon, Subaru Telescope, National Astronomical Observatory of Japan (USA), Research Corp. of Univ. of Hawaii (United States), The Univ. of Arizona (United States); Lucas Labadie, Univ. of Cologne (Germany); Bruce A. Macintosh, Lawrence Livermore National Lab. (USA); Dimitri P. Mawet, California Institute of Technology (USA); M. Charley Noecker, Jet Propulsion Lab. (USA); Rémi Soummer, Space Telescope Science Institute (USA)

## MONDAY 10 AUGUST

### POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Fluoride fiber thermal emission study for SPIRou @ CFHT**, Yoan Micheau, Marc Bouyé, Observatoire Midi-Pyrénées (France); Jérôme Parisot, Observatoire de Paris à Meudon (France); Driss Kouach, Observatoire Midi-Pyrénées (France) . [9605-60]

**A new fiber slit assembly for the foces spectrograph**, Hanna Kellermann, Univ.-Sternwarte München (Germany); Frank U. Grupp, Univ.-Sternwarte München (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); Christian Franik, Univ.-Sternwarte München (Germany); Anna Brucalassi, Max-Planck-Institut für extraterrestrische Physik (Germany); Florian Lang-Bardl, Ulrich Hopp, Univ.-Sternwarte München (Germany); Ralf Bender, Max-Planck-Institut für extraterrestrische Physik (Germany) . [9605-61]

**The replicable high-resolution exoplanet and asteroseismology (RHEA) spectrograph**, Tobias Feger, Macquarie Univ. (Australia); Alexander Arriola Martíarena, Macquarie Univ. (Australia) and Ctr. for Ultrahigh Bandwidth Devices for Optical Systems (Australia); Izabela Spaleniak, Heriot-Watt Univ. (United Kingdom); Simon Gross, Macquarie Univ. (Australia) and Ctr. for Ultrahigh Bandwidth Devices for Optical Systems (Australia); Michael Ireland, The Australian National Univ. (Australia); David W. Coutts, Macquarie Univ. (Australia); Christian Schwab, Macquarie Univ. (Australia) and Australian Astronomical Observatory (Australia); Joao Bento, Macquarie Univ. (Australia) . [9605-62]

**A white super-stable source for the metrology of astronomical photometers**, François Wildi, Adrien Deline, Bruno Chazelas, Observatoire de Genève (Switzerland) . [9605-63]

**Design of the iLocater acquisition camera for the LBT**, Andrew Bechter, Jonathan Crass, Ryan Ketterer, Justin R. Crepp, Univ. of Notre Dame (USA); David M. P. King, Univ. of Cambridge (United Kingdom); Robert O. Reynolds, Phil M. Hintz, The Univ. of Arizona (USA); Jack Brooks, Eric Bechter, Univ. of Notre Dame (USA); Bo Zhao, Univ. of Florida (USA); Christopher Matthews, Univ. of Notre Dame (USA) . [9605-64]

**Numerically designed phase-mask for stellar coronagraph**, Naoshi Baba, Naoshi Murakami, Hokkaido Univ. (Japan); Noriaki Miura, Kitami Institute of Technology (Japan); Motohide Tamura, The Univ. of Tokyo (Japan) . [9605-65]

**Sparse aperture mask for low order wavefront sensing**, Hari Subedi, Neil T. Zimmerman, N. Jeremy Kasdin, A. J. E. Riggs, Princeton Univ. (USA); Kathleen Cavanagh, SciTec, Inc. (USA) . [9605-66]

**Coronagraphic image analysis for tip-tilt retrieval applied to the vector vortex phase mask**, Elsa Huby, Univ. de Liège (Belgium); Pierre Baudoz, Observatoire de Paris (France); Olivier Absil, Univ. de Liège (Belgium); Dimitri Mawet, California Institute of Technology (USA) and European Southern Observatory (Chile); Aïssa Jolivet, Univ. de Liège (Belgium); Garrett J. Ruane, Rochester Institute of Technology (USA); Brunella Carlomagno, Pierre Piron, Jean Surdej, Univ. de Liège (Belgium) . [9605-67]

**High-contrast coronagraph performance in the presence of DM actuator defects**, Erkin Sidick, Stuart B. Shaklan, Eric Cady, Jet Propulsion Lab. (USA) . [9605-68]

**Development of focal plane phase masks for PIAACMC**, Kevin E. Newman, Olivier Guyon, The Univ. of Arizona (USA); James W. Conway, Stanford Univ. (USA); Ruslan Belikov, NASA Ames Research Ctr. (USA) . [9605-69]

**High performance PIAACMC-type coronagraph designs for centrally obscured and segmented apertures**, Olivier Guyon, The Univ. of Arizona (USA); Brian D. Kern, Jet Propulsion Lab. (USA); Ruslan Belikov, Kevin E. Newman, Eugene A. Pluzhnik, NASA Ames Research Ctr. (USA) . [9605-70]

**In-lab performance of the latest AGPMs (angular groove phase mask) and recent development of VODCA (vortex optical demonstrator for coronagraphic applications)**, Aissa Jolivet, Elsa Huby, Olivier Absil, Univ. de Liège (Belgium); Christian Delacroix, Ctr. de Recherche Astrophysique de Lyon (France); Serge Habraken, Univ. de Liège (Belgium); Dimitri Mawet, European Southern Observatory (Chile); Pierre Piron, Jean Surdej, Univ. de Liège (Belgium) . [9605-71]

**Design of off-axis PIAACMC mirrors**, Eugene A. Pluzhnik, NASA Ames Research Ctr. (USA); Olivier Guyon, The Univ. of Arizona (USA) and Subaru Telescope, National Astronomical Observatory of Japan (USA); Ruslan Belikov, NASA Ames Research Ctr. (USA); Brian D. Kern, Jet Propulsion Lab. (USA) . [9605-72]

**Design and performance simulations of mid-IR AGPMs for ELT/METIS applications**, Brunella Carlomagno, Univ. de Liège (Belgium); Christian Delacroix, Ctr. de Recherche Astrophysique de Lyon (France); Elsa Huby, Olivier Absil, Univ. de Liège (Belgium); Dimitri Mawet, European Southern Observatory (Chile); Aissa Jolivet, Univ. de Liège (Belgium); Mikael Karlsson, Pontus Forsberg, Ernesto Vargas, Uppsala Univ. (Sweden); Serge Habraken, Jean Surdej, Univ. de Liège (Belgium) . [9605-73]

**PISCES: high contrast integral field spectrograph simulations and data reduction pipeline**, Jorge Domingo Llop Sayson, The Catholic Univ. of America (USA); Nargess Memarsadeghi, Michael McElwain, NASA Goddard Space Flight Ctr. (USA); Marshall Perrin, Space Telescope Science Institute (USA); Qian Gong, NASA Goddard Space Flight Ctr. (USA); Bryan Grammer, SGT, Inc. (USA) and NASA Goddard Space Flight Ctr. (USA); Bradford W. Greeley, NASA Goddard Space Flight Ctr. (USA); George M. Hilton, Universities Space Research Association (USA) and NASA Goddard Space Flight Ctr. (USA); Catherine T. Marx, NASA Goddard Space Flight Ctr. (USA) . [9605-74]

**Maturing CCD photon counting technology for space flight**, Udayan Mallik, Richard G. Lyon, Michael McElwain, Dominic J. Benford, Mark Clampin, Brian A. Hlicks, NASA Goddard Space Flight Ctr. (USA) . [9605-75]

**Technological progress of a ferrofluid deformable mirror with tunable nominal optical power for high-contrast imaging**, Aaron J. Lemmer, Tyler D. Groff, N. Jeremy Kasdin, Princeton Univ. (USA) . [9605-76]

**Wavefront sensing with pupil diversity using science hardware**, Anand Sivaramakrishnan, Space Telescope Science Institute (USA); Alexandra Z. Greenbaum, Johns Hopkins Univ. (USA) . [9605-77]

**Two DM probe test for high-contrast wavefront estimation**, Christopher C. Veto, A. J. Eldorado Riggs, Neil T. Zimmerman, Tyler D. Groff, N. Jeremy Kasdin, Princeton Univ. (USA) . [9605-78]

**Zernike wavefront sensor (ZWFS) modeling development for low order wavefront sensing (LOWFS) on wide-field IR space telescope (WFIRST) / astrophysics focused telescope assets (AFTA)**, Xu Wang, J.Kent Wallace, Fang Shi, Jet Propulsion Lab. (USA) . [9605-79]

**Deconvolution of differential OTF (dTOf) to measure high-resolution wavefront structure**, Justin M. Knight, Kelsey L. Miller, Alexander T. Rodack, Johanan L. Codona, Olivier Guyon, The Univ. of Arizona (USA) . [9605-80]

**UA wavefront control lab: design overview and implementation of new wavefront sensing techniques**, Kelsey L. Miller, Justin M. Knight, Alexander T. Rodack, Johanan L. Codona, Olivier Guyon, The Univ. of Arizona, Steward Observatory (USA) . [9605-81]

**Adaptive optics self-calibration using differential OTF (dTOf)**, Alexander T. Rodack, Justin M. Knight, Kelsey L. Miller, Johanan L. Codona, The Univ. of Arizona (USA); Olivier Guyon, Subaru Telescope, National Astronomical Observatory of Japan (USA) . [9605-82]

**Control design for momentum-compensated fast steering mirror for WFIRST/AFTA coronagraph instrument**, Brent E. Tweddle, Keith Patterson, Joel F. Shields, Xu Wang, Paul B. Brugarolas, Fang Shi, Jet Propulsion Lab. (USA) . [9605-83]

**Design of a laboratory tesbed for external occulters at flight Fresnel numbers**, Yunjong Kim, Michael Galvin, N. Jeremy Kasdin, Robert J. Vanderbei, Princeton Univ. (USA); Dongok Ryu, Sug-Whan Kim, Yonsei Univ. (Korea, Republic of); Dan Sirbu, NASA Ames Research Ctr. (USA) . [9605-84]

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**External occulter edge scattering control using metamaterials for exoplanet detection**, Eduardo A. Bendek, Dan Sirbu, NASA Ames Research Ctr. (USA); Zhaowei Liu, Univ. of California, San Diego (USA); Stefan R. Martin, Jet Propulsion Lab. (USA) . . . . . [9605-85]

**Scaling relation for occulter manufacturing errors**, Dan Sirbu, NASA Ames Research Ctr. (USA); N. Jeremy Kasdin, Robert J. Vanderbei, Princeton Univ. (USA) . . . . . [9605-86]

**Astrometry with JWST-NIRISS AMI cryovac data**, Deepashri Thatte, Space Telescope Science Institute (USA); Alexandra Z. Greenbaum, Johns Hopkins Univ. (USA); André R. Martel, Space Telescope Science Institute (USA); Étienne Artigau, Univ. de Montréal (Canada); Anand Sivaramakrishnan, Space Telescope Science Institute (USA) . . . . . [9605-87]

**A method to directly image exoplanets in multi-star systems such as Alpha-Centauri**, Sandrine J. Thomas, Ruslan Belikov, Eduardo A. Bendek, NASA Ames Research Ctr. (USA) . . . . . [9605-88]

**Modeling of planetary signal detection through ray-tracing based beam propagation**, Dongok Ryu, Sug-Whan Kim, Yonsei Univ. (Korea, Republic of) . . . . . [9605-89]

**Initial look at the technology gap for direct imaging of exoEarths**, Rhonda M. Morgan, Nicholas Siegler, Jet Propulsion Lab. (USA) . . . . . [9605-90]

## TUESDAY 11 AUGUST

### SESSION 1 . . . . . TUE 8:00 AM TO 10:00 AM

#### WFIRST/AFTA I

Session Chair: **M. Charley Noecker**, Jet Propulsion Lab. (USA)

**Requirements and design reference mission for the WFIRST-AFTA coronagraph instrument**, Richard Demers, Frank G. Dekens, Robert J. Calvet, Zenshue Chang, Robert T. Effinger, Eric M. Ek, Laura Jones, Anthony Loc, Bijan Nemati, Martin Charley Noecker, Timothy Neville, Hung Pham, Hong Tang, Jet Propulsion Lab. (USA); Juan Villalvazo, Applied Sciences Lab. Inc. (USA) . . . . . [9605-1]

**WFIRST/AFTA coronagraph technology development: component maturation and testbed validation**, Ilya Poberezhsky, Jet Propulsion Lab. (USA) . . . . . [9605-2]

**The WFIRST/AFTA coronagraph instrument optical design**, Hong Tang, Jet Propulsion Lab. (USA) . . . . . [9605-3]

**An overview of WFIRST/AFTA coronagraph optical modeling**, John Krist, Gary Gutt, Jeffrey Jewell, Brian Kern, Bijan Nemati, David C. Palacios, Jet Propulsion Lab. (USA); A. J. Eldorado Riggs, Princeton Univ. (USA); Erkin Sidick, Hanying Zhou, Jet Propulsion Lab. (USA) . . . . . [9605-4]

**Effect of DM actuator gain errors on the WFIRST/AFTA coronagraph contrast performance**, Erkin Sidick, Fang Shi, Jet Propulsion Lab. (USA) . . . . . [9605-5]

**Wavefront correction with Kalman filtering for the WFIRST/AFTA coronagraph instrument**, A. J. Eldorado Riggs, N. Jeremy Kasdin, Tyler D. Groff, Princeton Univ. (USA) . . . . . [9605-6]

### SESSION 2 . . . . . TUE 10:30 AM TO 12:00 PM

#### WFIRST/AFTA II

Session Chair: **M. Charley Noecker**, Jet Propulsion Lab. (USA)

**Current best estimates of planet populations (Invited Paper)**, Leslie A. Rogers, California Institute of Technology (USA) . . . . . [9605-7]

**Low order wavefront sensing and control for WFIRST/AFTA coronagraph**, Fang Shi, Kunjithapatham Balasubramanian, Randall D. Bartos, Randall C. Hein, Brian D. Kern, John Krist, Raymond K. Lam, James Moore, Keith Patterson, Joel F. Shields, Ilya Poberezhsky, Erkin Sidick, Hong Tang, Tuan Truong, Brent Tweddle, J. Kent Wallace, Xu Wang, Jet Propulsion Lab. (USA) . . . . . [9605-8]

**Shaped pupil Lyot coronagraph designs for WFIRST/AFTA**, Neil T. Zimmerman, A. J. E. Riggs, N. Jeremy Kasdin, Princeton Univ. (USA); Alexis Carlotti, Institut de Planétologie et d'Astrophysique de Grenoble (France); Robert J. Vanderbei, Princeton Univ. (USA) . . . . . [9605-9]

**Laboratory performance of the shaped pupil coronagraphic architecture for the WFIRST/AFTA coronagraph**, Eric Cady, Camilo A. Mejia Prada, Xin An, Kunjithapatham Balasubramanian, Rosemary T. Diaz, Jeffrey Jewell, Jet Propulsion Lab. (USA) and California Institute of Technology (USA); N. Jeremy Kasdin, Princeton Univ. (USA); Brian D. Kern, Andreas Kuhnert, Bijan Nemati, Keith Patterson, Ilya Poberezhsky, Jet Propulsion Lab. (USA) and California Institute of Technology (USA); A. J. Eldorado Riggs, Princeton Univ. (USA); Daniel J. Ryan, Hanying Zhou, Robert P. Zimmer, Jet Propulsion Lab. (USA) and California Institute of Technology (USA); Neil T. Zimmerman, Princeton Univ. (USA) . . . . . [9605-10]

Lunch Break . . . . . Tue 12:00 pm to 1:30 pm

### SESSION 3 . . . . . TUE 1:30 PM TO 3:10 PM

#### WFIRST/AFTA III

Session Chair: **Lucas Labadie**, Univ. of Cologne (Germany)

**PIAACMC coronagraphic occulting mask fabrication, characterization, and modeling**, Brian D. Kern, Daniel W. Wilson, Jet Propulsion Lab. (USA); Olivier Guyon, Subaru Telescope, National Astronomical Observatory of Japan (USA); Richard E. Muller, Kunjithapatham Balasubramanian, Erkin Sidick, Ilya Poberezhsky, Jet Propulsion Lab. (USA); Ruslan Belikov, NASA Ames Research Ctr. (USA) . . . . . [9605-11]

**AFTA coronagraph performance: feedback from post-processing studies to overall design**, Bertrand Mennesson, Jet Propulsion Lab. (USA) . . . . . [9605-12]

**The impact of radiation damage on photon counting with an EM-CCD for the WFIRST-AFTA coronagraph**, Nathan L. Bush, David J. Hall, Andrew D. Holland, Ross Burgon, Neil J. Murray, Jason P. D. Gow, Matthew R. Soman, The Open Univ. (United Kingdom); Douglas Jordan, e2v technologies (UK) Ltd. (United Kingdom); Richard Demers, Leon K. Harding, Michael E. Hoenk, Darren Michaels, Bijan Nemati, Pavani Peddada, Jet Propulsion Lab. (USA) . . . . . [9605-13]

**Electron multiplication CCD detector technology advancement for the WFIRST-AFTA coronagraph integral field spectrograph**, Leon K. Harding, Michael Cherng, Richard Demers, Michael E. Hoenk, Darren Michaels, Bijan Nemati, Pavani Peddada, Jet Propulsion Lab. (USA) . . . . . [9605-14]

**Prototype imaging spectrograph for coronagraphic exoplanet studies (PISCES) for WFIRST/AFTA**, Qian Gong, Michael McElwain, Bradford Greeley, Bryan Grammer, Catherine Marx, Nargess Memarsadeghi, George Hilton, NASA Goddard Space Flight Ctr. (USA); Marshall Perrin, Space Telescope Science Institute (USA); Jorge Domingo Llop Sayson, Karl Stapelfeldt, NASA Goddard Space Flight Ctr. (USA); Richard Demers, Hong Tang, Brian Kern, Janaan Ferdosi, Jet Propulsion Lab. (USA) . . . . . [9605-15]

### SESSION 4 . . . . . TUE 3:40 PM TO 5:20 PM

#### High Contrast Laboratory Results

Session Chair: **Stuart B. Shaklan**, Jet Propulsion Lab. (USA)

**Studies of the effects of control bandwidth and dark-hole size on the HCIT contrast performance**, Erkin Sidick, Stuart B. Shaklan, Kunjithapatham Balasubramanian, Eric Cady, Jet Propulsion Lab. (USA) . . . . . [9605-16]

**High-contrast imager for complex aperture telescopes (HiCAT): 3. First laboratory results including wavefront control**, Mamadou N'Diaye, Élodie Choquet, Johan Mazoyer, Space Telescope Science Institute (USA); Alexis Carlotti, Institut de Planétologie et d'Astrophysique de Grenoble (France); Laurent A. Pueyo, Space Telescope Science Institute (USA); Sylvain Egron, Lucie Leboulleux, Olivier Levecq, Institut d'Optique Graduate School (France); Marshall D. Perrin, Space Telescope Science Institute (USA); J. Kent Wallace, Jet Propulsion Lab. (USA); Chris A. Long, Rachel Lajoie, Charles-Philippe Lajoie, Space Telescope Science Institute (USA); A. J. Eldorado Riggs, Neil T. Zimmerman, Robert J. Vanderbei, Tyler D. Groff, N. Jeremy Kasdin, Princeton Univ. (USA); Dimitri Mawet, California Institute of Technology (USA); Bruce A. Macintosh, Stanford Univ. (USA); Stuart B. Shaklan, Jet Propulsion Lab. (USA); Rémi Soummer, Space Telescope Science Institute (USA) . . . . . [9605-17]

**EXCEDE technology development III: demonstration of polychromatic contrast in vacuum at 1.2 L/D**, Dan Sirbu, Sandrine J. Thomas, Ruslan Belikov, NASA Ames Research Ctr. (USA); Julien Lozi, National Astronomical Observatory of Japan (USA); Eduardo A. Bendek, Eugene A. Pluzhnik, Dana Lynch, NASA Ames Research Ctr. (USA); Troy T. Hix, Lockheed Martin Space Systems Co. (USA); Peter T. Zell, NASA Ames Research Ctr. (USA); Glenn H. Schneider, The Univ. of Arizona (USA); Olivier Guyon, National Astronomical Observatory of Japan (USA) . . . . . [9605-18]

**Broadband results with the visible nulling coronograph**, Brian A. Hicks, Richard G. Lyon, NASA Goddard Space Flight Ctr. (USA); Peter Petrone III, Sigma Space Corp. (USA); Ian J. Miller, LightMachinery Inc. (Canada); Matthew R. Bolcar, Mark Clampin, Udayan Mallik, NASA Goddard Space Flight Ctr. (USA) . . . . . [9605-19]

**Fabrication and characterization of exoplanet coronagraph shaped pupil masks and laboratory scale star-shade masks**, Kunjithapatham Balasubramanian, Victor E. White, Karl Y. Yee, Pierre M. Echternach, Richard Muller, Matthew R. Dickie, Eric Cady, Daniel J. Ryan, Jet Propulsion Lab. (USA); A. J. Eldorado Riggs, Neil T. Zimmerman, N. Jeremy Kasdin, Princeton Univ. (USA) . . . . . [9605-20]

# CONFERENCE 9605

## WEDNESDAY 12 AUGUST

### SESSION 5 ..... WED 8:00 AM TO 10:20 AM

#### Wavefront Control and Signal Extraction

Session Chair: **Dimitri Mawet**, California Institute of Technology (USA)

**Active correction of aperture discontinuities for high contrast imaging: parametrical analysis**, Johan Mazoyer, Laurent A. Pueyo, Space Telescope Science Institute (USA); Colin A. Norman, Johns Hopkins Univ. (USA); Marshall D. Perrin, Rémi Soummer, Mamadou N'Diaye, Élodie Choquet, Space Telescope Science Institute (USA); Alexis Carlotti, Institut de Planétologie et d'Astrophysique de Grenoble (France); Dimitri Mawet, European Southern Observatory (Chile) ..... [9605-21]

**Managing the optical wavefront for exoplanet imaging with a space coronagraph**, John T. Trauger, Dwight C. Moody, John Krist, Jet Propulsion Lab. (USA) ..... [9605-22]

**Estimation of chromatic errors from broadband images for high contrast imaging**, Dan Sirbu, Ruslan Belikov, NASA Ames Research Ctr. (USA) .. [9605-23]

**Preliminary analysis of effect of random segment errors on coronagraph performance**, Mark T. Stahl, H. Philip Stahl, NASA Marshall Space Flight Ctr. (USA); Stuart B. Shaklan, Jet Propulsion Lab. (USA) ..... [9605-24]

**Linearized dark field control (LDFC) and self-calibration for high contrast imaging**, Olivier Guyon, Johanan L. Codona, The Univ. of Arizona (USA); Brian D. Kern, Jet Propulsion Lab. (USA); Ruslan Belikov, NASA Ames Research Ctr. (USA) ..... [9605-25]

**Blind source separation approaches for exoplanet signal extraction**, Dmitry Savransky, Cornell Univ. (USA) ..... [9605-26]

**Point spread function subtraction methods for high-contrast imaging in the context of future space-based coronagraph instruments**, Marie Ygouf, Rémi Soummer, Marshall D. Perrin, Laurent A. Pueyo, Space Telescope Science Institute (USA); Bruce A. Macintosh, Stanford Univ. (USA) ..... [9605-27]

### SESSION 6 ..... WED 10:50 AM TO 12:00 PM

#### Exo-C Probe Study

Session Chair: **Olivier Guyon**, Subaru Telescope, National Astronomical Observatory of Japan (USA), Research Corp. of Univ. of Hawaii (United States), The Univ. of Arizona (United States)

**Exo-C: a probe-scale space observatory for direct imaging and spectroscopy of extrasolar planetary systems (Invited Paper)**, Karl Stapelfeldt, NASA Goddard Space Flight Ctr. (USA); Frank G. Dekens, Michael P. Brenner, Keith R. Warfield, Jet Propulsion Lab. (USA) and California Institute of Technology (USA); Ruslan Belikov, NASA Ames Research Ctr. (USA); Paul B. Brugarolas, Geoffrey Bryden, Jet Propulsion Lab. (USA) and California Institute of Technology (USA); Kerri L. Cahoy, Massachusetts Institute of Technology (USA); Supriya Chakrabarti, Univ. of Massachusetts Lowell (USA); Serge Dubovitsky, Robert T. Effinger, Casey Heeg, Brian Hirsch, Andrew Kissil, John Krist, Jared J. Lang, Jet Propulsion Lab. (USA) and California Institute of Technology (USA); Mark S. Marley, NASA Ames Research Ctr. (USA); Michael McElwain, NASA Goddard Space Flight Ctr. (USA); Victoria Meadows, Univ. of Washington (USA); Joel A. Nissen, Jeffrey M. Oseas, Christopher Pong, Eugene Serabyn, Eric T. Sunada, John T. Trauger, Jet Propulsion Lab. (USA) and California Institute of Technology (USA) ..... [9605-28]

**Ultra-stable thermal-optical performance from the Exo-C design study**, Joel A. Nissen, Robert T. Effinger, Andrew Kissil, Jet Propulsion Lab. (USA) .... [9605-29]

**PIAA coronagraph design for the Exo-C Mission concept**, Ruslan Belikov, NASA Ames Research Ctr. (USA); John Krist, Jet Propulsion Lab. (USA); Karl Stapelfeldt, NASA Goddard Space Flight Ctr. (USA) ..... [9605-30]

Lunch Break ..... Wed 12:00 pm to 1:30 pm

### SESSION 7 ..... WED 1:30 PM TO 3:20 PM

#### Exo-S Probe Study

Session Chair: **Olivier Guyon**, Subaru Telescope, National Astronomical Observatory of Japan (USA), Research Corp. of Univ. of Hawaii (United States), The Univ. of Arizona (United States)

**The Exo-S Probe Class Starshade Mission (Invited Paper)**, Sara Seager, Massachusetts Institute of Technology (USA); Margaret C. Turnbull, Global Science Institute (USA); William B. Sparks, Space Telescope Science Institute (USA); Mark Thomson, Stuart B. Shaklan, Jet Propulsion Lab. (USA); Aki Roberge, Marc J. Kuchner, NASA Goddard Space Flight Ctr. (USA); N. Jeremy Kasdin, Princeton Univ. (USA); Shawn Domagal-Goldman, NASA Goddard Space Flight Ctr. (USA); Webster Cash, Univ. of Colorado at Boulder (USA); Keith R. Warfield, Douglas Lisman, Daniel P. Scharf, David R. Webb, Rachel Trabert, Stefan R. Martin, Eric Cady, Cate Heneghan, Jet Propulsion Lab. (USA) ..... [9605-31]

**Optical instrumentation for science and formation flying with a starshade observatory**, Stefan R. Martin, Eric Cady, Stuart B. Shaklan, Daniel P. Scharf, Hong Tang, Jet Propulsion Lab. (USA) ..... [9605-32]

**Design reference missions for the Exoplanet Starshade (Exo-S) Probe-Class study**, Rachel Trabert, Stuart B. Shaklan, Douglas Lisman, Jet Propulsion Lab. (USA); Aki Roberge, NASA Goddard Space Flight Ctr. (USA); Margaret C. Turnbull, Global Science Institute (USA); Shawn Domagal-Goldman, Christopher C. Stark, NASA Goddard Space Flight Ctr. (USA) ..... [9605-33]

**Error budgets for the Exoplanet Starshade (Exo-S) Probe-Class Mission study**, Stuart B. Shaklan, Luis Marchen, Eric Cady, Douglas Lisman, Stefan R. Martin, Mark Thomson, Jet Propulsion Lab. (USA) ..... [9605-34]

**The Exo-S Starshade mechanical design**, Mark Thomson, David R. Webb, Brian Hirsch, Brian P. Trease, Vinh M. Bach, Brian Y. Lim, Jet Propulsion Lab. (USA) ..... [9605-35]

### SESSION 8 ..... WED 3:50 PM TO 5:10 PM

#### Mission Concepts and Technologies

Session Chair: **Dimitri Mawet**, California Institute of Technology (USA)

**ADEPT: apparatus for detection of exoplanets by diffraction pupil telescopy**, Thomas D. Ditto, 3DeWitt, LLC (USA) ..... [9605-36]

**Fully achromatic nulling interferometer (FANI) for high SNR exoplanet characterization**, François B. Hénault, Institut de Planétologie et d'Astrophysique de Grenoble (France) ..... [9605-37]

**A 4-telescope linear nullder based on an integrated optics beam combiner**, Ronny Errmann, Romina Diener, Stefano Minardi, Friedrich-Schiller-Univ. Jena (Germany); Lucas Labadie, Univ. zu Köln (Germany); Felix Dreisow, Stefan Nolte, Thomas Pertsch, Matthias Heinrich, Friedrich-Schiller-Univ. Jena (Germany) ..... [9605-38]

**A pareto-optimal characterization of small-scale distributed occulter/telescope systems**, Adam W. Koenig, Simone D'Amico, Stanford Univ. (USA); Bruce A. Macintosh, Kavli Institute for Particle Astrophysics and Cosmology, Stanford Univ. (USA) ..... [9605-39]

## THURSDAY 13 AUGUST

### SESSION 9 ..... THU 8:00 AM TO 10:00 AM

#### Space-Based Imaging and Transit

Session Chair: **Lucas Labadie**, Univ. of Cologne (Germany)

**Space telescope design to directly image the habitable zone of Alpha Centauri**, Eduardo A. Bendek, Ruslan Belikov, Sandrine J. Thomas, NASA Ames Research Ctr. (USA); Julien Lozi, Subaru Telescope, National Astronomical Observatory of Japan (USA); Jared R. Males, The Univ. of Arizona (USA) . [9605-40]

**How to directly image a habitable planet around Alpha Centauri with a ~30-45cm space telescope**, Ruslan Belikov, Eduardo A. Bendek, Sandrine J. Thomas, NASA Ames Research Ctr. (USA); Jared R. Males, The Univ. of Arizona (USA); Julien Lozi, Subaru Telescope, National Astronomical Observatory of Japan (USA) ..... [9605-41]

**Orbital difference imaging: a new high-contrast post-processing technique for direct imaging of exoplanets**, Jared R. Males, The Univ. of Arizona (USA); Ruslan Belikov, Eduardo A. Bendek, NASA Ames Research Ctr. (USA) ..... [9605-42]

**The low-order wavefront sensor for the PICTURE-C exoplanetary imaging balloon mission**, Christopher B. Mendillo, Glenn A. Howe, Timothy A. Cook, Univ. of Massachusetts Lowell (USA); Ewan S. Douglas, Boston Univ. (USA); Susanna C. Finn, Kuravi Hewasawam, Jason Martel, Supriya Chakrabarti, Univ. of Massachusetts Lowell (USA) ..... [9605-43]

**End-to-end simulation of high-contrast imaging systems: methods and results for the PICTURE Mission family**, Ewan S. Douglas, Boston Univ. (USA); Kuravi Hewasawam, Christopher B. Mendillo, Univ. of Massachusetts Lowell (USA); Kerri L. Cahoy, Massachusetts Institute of Technology (USA); Timothy A. Cook, Susanna C. Finn, Glenn A. Howe, Univ. of Massachusetts Lowell (USA); Marc J. Kuchner, NASA Goddard Space Flight Ctr. (USA); Nikole K. Lewis, Space Telescope Science Institute (USA); Anne D. Marinan, Massachusetts Institute of Technology (USA); Dimitri Mawet, Jet Propulsion Lab. (USA) and European Southern Observatory (Chile); Supriya Chakrabarti, Univ. of Massachusetts Lowell (USA) ..... [9605-44]

**On-ground calibration of the CHEOPS payload**, François Wildi, Bruno Chazelas, Adrien Deline, Mirsad Sarajlic, Michael Sordet, Observatoire de Genève (Switzerland) ..... [9605-45]

# CONFERENCE 9605

SESSION 10 ..... THU 10:30 AM TO 11:50 AM

## Ground-Based Instruments and Processing

Session Chair: **Bruce A. Macintosh**, Lawrence Livermore National Lab. (USA)

**The CHARIS IFS for high contrast imaging at Subaru**, Tyler D. Groff, N. Jeremy Kasdin, Mary Anne Peters-Limbach, Michael Galvin, Michael A. Carr, Gillian R. Knapp, Princeton Univ. (USA); Timothy D. Brandt, Institute for Advanced Study (USA); Craig Loomis, Norman Jarosik, Princeton Univ. (USA); Kyle Mede, The Univ. of Tokyo (Japan); Michael McElwain, NASA Goddard Space Flight Ctr. (USA); Douglas B. Leviton, Leviton Metrology Solutions (USA); Kevin H. Miller, NASA Goddard Space Flight Ctr. (USA); Manuel A. Quijada, NASA Goddard Space Flight Ctr. (USA); Olivier Guyon, Subaru Telescope, National Astronomical Observatory of Japan (USA); Nemanja Jovanovic, Naruhisa Takato, Subaru Telescope, National Astronomical Observatory of Japan (USA); Masahiko Hayashi, Subaru Telescope, National Astronomical Observatory of Japan (Japan) ..... [9605-46]

**Arizona lenslet for exoplanet spectroscopy (ALES): an AO-fed 3-5 micron optimized integral field spectrograph for the LBT**, Andrew J. Skemer, Phil M. Hinz, Manny Montoya, The Univ. of Arizona (USA); Olivier Durney, Univ. of Arizona (USA); Michael F. Skrutskie, John C. Wilson, Matt J. Nelson, Univ. of Virginia (USA); Jarron M. Leisenring, The Univ. of Arizona (USA); Charles E. Woodward, Univ. of Minnesota (USA); Denis Defrère, Vanessa P. Bailey, The Univ. of Arizona (USA) ..... [9605-47]

**High contrast imaging from the ground with combined visible light extreme-AO and fast near-IR speckle control**, Olivier Guyon, Nemanja Jovanovic, Julien Lozi, Subaru Telescope, National Astronomical Observatory of Japan (USA); Jared R. Males, The Univ. of Arizona (USA); Garima Singh, Subaru Telescope, National Astronomical Observatory of Japan (USA); Benjamin A. Mazin, Univ. of California, Santa Barbara (USA); Frantz Martinache, Observatoire de la Côte d'Azur (France); Tomoyuki Kudo, Prashant Pathak, Subaru Telescope, National Astronomical Observatory of Japan (USA); Sean Goebel, Univ. of Hawai'i (USA) and Subaru Telescope, National Astronomical Observatory of Japan (USA) ..... [9605-48]

**An update on the VORTEX project**, Olivier Absil, Univ. de Liège (Belgium); Dimitri Mawet, California Institute of Technology (USA); Mikael Karlsson, Uppsala Univ. (Sweden); Serge Habraken, Jean Surdej, Univ. de Liège (Belgium); Pierre-Antoine Absil, Univ. Catholique de Louvain (Belgium); Brunella Carlonmagno, Univ. de Liège (Belgium); Valentin Christiaens, Univ. de Chile (Chile) and Univ. de Liège (Belgium); Denis Defrère, The Univ. of Arizona (USA); Pontus Forsberg, Uppsala Univ. (Sweden); Julien H. V. Girard, European Southern Observatory (Chile); Carlos A. Gomez Gonzalez, Univ. de Liège (Belgium); Philip M. Hinz, The Univ. of Arizona (USA); Elsa Huby, Aïssa Jolivet, Univ. de Liège (Belgium); Julien Milli, European Southern Observatory (Chile); Eric J. Pantin, CEA-Ctr. de SACLAY (France); Garrett J. Ruane, Rochester Institute of Technology (USA); Eugene Serabyn, Jet Propulsion Lab. (USA); Marc Van Droogenbroeck, Univ. de Liège (Belgium); Ernesto Vargas Catalan, Uppsala Univ. (Sweden); Olivier Wertz, Univ. de Liège (Belgium) [9605-49]

Lunch Break ..... Thu 11:50 am to 1:20 pm

SESSION 11 ..... THU 1:20 PM TO 3:20 PM

## Ground-Based Instruments and Processing II

Session Chair: **Bruce A. Macintosh**, Stanford Univ. (USA)

**Exoplanet science with the LBTI: instrument status and plans**, Denis Defrère, Philip M. Hinz, Andrew J. Skemer, Vanessa P. Bailey, Elwood C. Downey, Olivier Durney, John M. Hill, William F. Hoffmann, Jarron M. Leisenring, The Univ. of Arizona (USA); Bertrand Mennesson, Jet Propulsion Lab. (USA); Rafael Millan-Gabet, Infrared Processing and Analysis Ctr. (USA); Manny Montoya, The Univ. of Arizona (USA); Michael F. Skrutskie, Univ. of Virginia (USA); Eckhart Spalding, Amali Vaz, The Univ. of Arizona (USA) ..... [9605-50]

**Post processing for direct imaging: characterizing noise properties and astrophysical sources in modern ground based coronagraphs**, Laurent A. Pueyo, Space Telescope Science Institute (USA) ..... [9605-51]

**Optimized pupil and focal plane phase elements for vortex coronagraphs on telescopes with obstructed apertures**, Garrett J. Ruane, Rochester Institute of Technology (USA); Elsa Huby, Univ. de Liège (Belgium); Christian Delacroix, Ctr. de Recherche Astrophysique de Lyon (France); Dimitri Mawet, Jet Propulsion Lab. (USA); Olivier Absil, Univ. de Liège (Belgium); Grover A. Swartzlander Jr., Rochester Institute of Technology (USA) ..... [9605-52]

**A Mach-Zehnder interferometer based on orbital angular momentum for improved vortex coronagraph efficiency**, Pierre Piron, Univ. de Liège (Belgium); Christian Delacroix, Ctr. de Recherche Astrophysique de Lyon (France); Elsa Huby, Univ. de Liège (Belgium); Dimitri Mawet, Jet Propulsion Lab. (USA); Aïssa Jolivet, Brunella Carlonmagno, Serge Habraken, Olivier Absil, Jean Surdej, Univ. de Liège (Belgium) ..... [9605-53]

**A family of subwavelength grating vortex coronagraphs (SGVCs) with higher topological charge**, Christian Delacroix, Ctr. de Recherche Astrophysique de Lyon (France); Pontus Forsberg, Uppsala Univ. (Sweden); Pierre Piron, Univ. de Liège (Belgium); Gareth J. Ruane, Rochester Institute of Technology (USA); Elsa Huby, Brunella Carlonmagno, Aïssa Jolivet, Univ. de Liège (Belgium); Ernesto Vargas, Uppsala Univ. (Sweden); Olivier Absil, Univ. de Liège (Belgium); Dimitri Mawet, European Southern Observatory (Chile); Mikael Karlsson, Uppsala Univ. (Sweden); Jean Surdej, Serge Habraken, Univ. de Liège (Belgium) ..... [9605-54]

**ExTrA**, Jose Manuel Almenara, Xavier Bonfils, Laurent Jocou, Institut de Planétologie et d'Astrophysique de Grenoble (France); Anael Wünsche, Institut d'Informatique et Mathématiques Appliquées de Grenoble (France); Pierre Kern, Alain Delboulbé, Philippe Feautrier, Laurence Gluck, Sylvain Lafrasse, Yves Magnard, Didier Maurel, Thibaut Moulin, Felipe Murgas, Patrick Rabou, Sylvain Rochat, Alain Roux, Eric Stadler, Institut de Planétologie et d'Astrophysique de Grenoble (France) ..... [9605-55]

SESSION 12 ..... THU 3:50 PM TO 4:50 PM

## Ground-Based Instruments and Processing III

Session Chair: **Stuart B. Shaklan**, Jet Propulsion Lab. (USA)

**iLocater: a high-resolution, near-infrared Doppler spectrometer for the large binocular telescope**, Justin R. Crepp, Eric Bechter, Erica Gonzales, Edward Kielb, Andrew Bechter, Jonathan Crass, Jay Carroll, Ryan Ketterer, John Brooks, Univ. of Notre Dame (USA); Robert O. Reynolds, Large Binocular Telescope Observatory (USA); Phil M. Hinz, The Univ. of Arizona (USA); Michael F. Skrutskie, Univ. of Virginia (USA); Joshua Eisner, The Univ. of Arizona (USA); Louis G. Fantano, NASA Goddard Space Flight Ctr. (USA); B. Scott Gaudi, The Ohio State Univ. (USA); David Go, John Kearns, Univ. of Notre Dame (USA); David M. P. King, Univ. of Cambridge (USA); Corina Koca, NASA Goddard Space Flight Ctr. (USA); Kaitlin Kratter, The Univ. of Arizona (USA); Christopher Matthews, Univ. of Notre Dame (USA); Giuseppina Micela, INAF - Osservatorio Astronomico di Palermo Giuseppe S. Vaiana (Italy); Andreas Quirrenbach, Landessternwarte Heidelberg (Germany); Alessandro Sozzetti, INAF - Osservatorio Astronomico di Torino (Italy); Karl Stapelfeldt, NASA Goddard Space Flight Ctr. (USA); Darren Williams, The Pennsylvania State Univ. (USA); Charles E. Woodward, Univ. of Minnesota, Twin Cities (USA); Bo Zhao, Univ. of Florida (USA); Isabella Pagano, INAF - Osservatorio Astrofisico di Catania (Italy) ..... [9605-56]

**First results of instrumental stability using an astro frequency comb at the focea spectrograph**, Frank U. Grupp, Univ.-Sternwarte München (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); Anna Brucalassi, Max-Planck-Institut für extraterrestrische Physik (Germany); Hanna Kellermann, Univ.-Sternwarte München (Germany); Ronald Holzwarth, Tilo Steinmetz, Menlo Systems GmbH (Germany); Ulrich Hopp, Univ.-Sternwarte München (Germany); Ralf Bender, Max-Planck-Institut für extraterrestrische Physik (Germany) ..... [9605-57]

**Effects of fiber manipulation methods on optical fiber properties**, Robert O. Reynolds, Large Binocular Telescope Observatory (USA) ..... [9605-58]

SESSION 13 ..... THU 4:50 PM TO 5:10 PM

## Archival NICMOS Data

Session Chair: **Bruce A. Macintosh**, Lawrence Livermore National Lab. (USA)

**Archival legacy investigation of circumstellar environments (ALICE): statistical analysis of high-contrast images of 400 stars with HST-NICMOS**, Élodie Choquet, Rémi Soummer, Laurent A. Pueyo, J. Brendan Hagan, Elena Gofas-Salas, Marshall D. Perrin, Christine Chen, John H. Debes, David A. Golimowski, Dean C. Hines, Space Telescope Science Institute (USA); Glenn H. Schneider, The Univ. of Arizona (USA); Amaya Moro-Martín, Space Telescope Science Institute (USA); Christian Marois, NRC-Dominion Astrophysical Observatory (Canada); Dimitri Mawet, European Southern Observatory (Chile); Mamadou N'Diaye, Space Telescope Science Institute (USA); Abhijith Rajan, Arizona State Univ. (USA); Schuyler G. Wolff, Jonathan Aguilar, Alexandra Z. Greenbaum, Johns Hopkins Univ. (USA); Tushar Mittal, Univ. of California, Berkeley (USA); Bin Ren, Johns Hopkins Univ. (USA) ..... [9605-59]

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# Instruments, Methods, and Missions for Astrobiology XVII

Conference Chairs: **Richard B. Hoover**, Athens State Univ. (USA), Buckingham Ctr. for Astrobiology (United Kingdom); **Gilbert V. Levin**, Arizona State Univ. (USA); **Alexei Yu. Rozanov**, Joint Institute for Nuclear Research (Russian Federation); **Nalin C. Wickramasinghe**, Buckingham Ctr. for Astrobiology (United Kingdom)

Program Committee: **Stanley M. Awramik**, Univ. of California, Santa Barbara (USA); **Steven A. Benner**, The Foundation For Applied Molecular Evolution (USA); **Stuart Bowyer**, Univ. of California, Berkeley (USA); **Nathalie A. Cabrol**, SETI Institute (USA), NASA Ames Research Ctr. (United States); **Bin Chen**, NASA Ames Research Ctr. (USA); **Paul C. W. Davies**, Arizona State Univ. (USA); **Michael H. Engel**, The Univ. of Oklahoma (USA); **George E. Fox**, Univ. of Houston (USA); **Carl H. Gibson**, Univ. of California, San Diego (USA); **Brig Klyce**, Astrobiology Research Trust (USA); **Vera M. Kolb**, Univ. of Wisconsin-Parkside (USA); **Eric J. Korpela**, Univ. of California, Berkeley (USA); **Rosalyn Lopes**, Jet Propulsion Lab. (USA); **Joseph Seckbach**, The Hebrew Univ. of Jerusalem (Israel); **George Tremberger Jr.**, Queensborough Community College (USA); **Luis Villarreal**, Univ. of California, Irvine (USA); **Daryl H. Wallis**, Buckingham Ctr. for Astrobiology (United Kingdom); **Jamie H. Wallis**, Cardiff Univ. (United Kingdom)

## SUNDAY 9 AUGUST

### WELCOME AND INTRODUCTORY REMARKS .1:00 PM TO 1:15 PM

**Richard B. Hoover**, Athens State Univ. (USA), Buckingham Ctr. for Astrobiology (United Kingdom); **Gilbert V. Levin**, Arizona State Univ. (USA); **Alexei Yu. Rozanov**, Joint Institute for Nuclear Research (Russian Federation); **Nalin C. Wickramasinghe**, Buckingham Ctr. for Astrobiology (United Kingdom)

### SESSION 1 ..... SUN 1:15 PM TO 1:45 PM

#### Sir Fred Hoyle Centenary Tribute

Session Chairs: **Richard B. Hoover**, Athens State Univ. (USA), Buckingham Ctr. for Astrobiology (United Kingdom); **Gilbert V. Levin**, Arizona State Univ. (USA); **Alexei Yu. Rozanov**, Joint Institute for Nuclear Research (Russian Federation); **Chandra N. Wickramasinghe**, The Univ. of Buckingham (United Kingdom)

**The centenary of the birth of Fred Hoyle, a landmark event in astrobiology**, Chandra N. Wickramasinghe, The Univ. of Buckingham (United Kingdom) and Institute for the Study of Panspermia and Astroecomics (Japan) and Univ. of Peradeniya (Sri Lanka); G. Tokoro, Institute for the Study of Panspermia and Astroecomics (Japan); Brig Klyce, Astrobiology Research Trust (USA) . . [9606-1]

### SESSION 2 ..... SUN 1:45 PM TO 3:15 PM

#### Philosophical Considerations of Astrobiology

Session Chair: **Richard B. Hoover**, Athens State Univ. (USA), Buckingham Ctr. for Astrobiology (United Kingdom)

**Is life supernatural?** (*Invited Paper*), Gilbert V. Levin, Arizona State Univ. (USA) . . . . . [9606-2]

**Oparin's coacervates as an important milestone in chemical evolution** (*Invited Paper*), Vera M. Kolb, Univ. of Wisconsin-Parkside (USA) . . . . . [9606-3]

**Philosophy of astrobiology: Some recent developments**, Vera M. Kolb, Univ. of Wisconsin-Parkside (USA) . . . . . [9606-4]

**How to survive a late heavy bombardment**, Gregory A. Konesky, National Nanotech Inc. (USA) . . . . . [9606-5]

### SESSION 3 ..... SUN 4:00 PM TO 4:50 PM

#### Exoplanets, Exomoons and Astrobiology

Session Chair: **Gilbert V. Levin**, Arizona State Univ. (USA)

**Bioluminescent bacteria grown under modelled gravity of different astronomical bodies in the solar system** (*Invited Paper*), Santosh Bhakshan, Vivekanand Education Society College of Arts, Science and Commerce (India) and Savitribai Phule Pune Univ. (India); Rohan D. Dudhale, P.E.S. Modern College of Arts, Science and Commerce (India) and Haffkine Institute (India); Jyotsana P. Dixit, P.E.S. Modern College of Arts, Science and Commerce (India) and Savitribai Phule Pune Univ. (India); Ajit N. Sahasrabuddhe, P.E.S. Modern College of Arts, Science and Commerce (India) and Serum Institute of India (India); Pandit B. Vidyasagar, Savitribai Phule Pune Univ. (India) and Swami Ramanand Teerth Marathwada Univ. (India) . . . . . [9606-6]

**Exomoon habitability**, Gregory A. Konesky, National Nanotech Inc. (USA) [9606-7]

### SESSION 4 ..... SUN 4:50 PM TO 5:40 PM

#### SETI

Session Chair: **Vera M. Kolb**, Univ. of Wisconsin-Parkside (USA)

**The search for extra-terrestrial intelligence: current status and future prospects** (*Invited Paper*), Stuart Bowyer, Univ. of California, Berkeley (USA) . . . . . [9606-8]

**The next phases of SETI@home**, Eric J. Korpela, Andrew P. V. Siemion, Dan Werthimer, Univ. of California, Berkeley (USA); Matt Lebofsky, Space Sciences Lab. (USA); Jeff Cobb, Univ. of California, Berkeley (USA) . . . . . [9606-9]

### SYMPORIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

### SESSION 5 ..... MON 8:00 AM TO 10:00 AM

#### Chemical Evolution and the Origin of Life I

Session Chair: **George E. Fox**, Univ. of Houston (USA)

**The universal alien and the case for our Martian origins** (*Invited Paper*), Steven Albert Benner, The Foundation For Applied Molecular Evolution (USA) . . . [9606-10]

**Prebiotic reactions in superheated water**, Vera M. Kolb, Univ. of Wisconsin-Parkside (USA) . . . . . [9606-11]

**The bioinformatics of nucleotide sequence coding for proteins requiring metal coenzymes and proteins embedded with metals** (*Invited Paper*), George Tremberger Jr., Sunil Dehipawala, Andrew Nguyen, Todd Holden, David Lieberman, Tak D. Cheung, Queensborough Community College (USA) . . . . . [9606-12]

**The advantage of dynamic, covalent bonds in the formation and evolution of proto-RNA** (*Invited Paper*), Nicholas V. Hud, Georgia Institute of Technology (USA) . . . . . [9606-13]

# CONFERENCE 9606

SESSION 6 ..... MON 10:30 AM TO 11:50 AM

## Chemical Evolution and the Origin of Life II

Session Chair: N. C. Wickramasinghe, The Univ. of Buckingham (United Kingdom)

Ribosome dynamics and the evolutionary history of ribosomes (*Invited Paper*), George E. Fox, Maxim Paci, Quyen Tran, Univ. of Houston (USA) ..... [9606-14]

The complexity of genetic sequences modified by horizontal gene transfer, George Tremberger Jr., Sunil Dehipawala, Andrew Nguyen, Todd Holden, David Lieberman, Tak D. Cheung, Queensborough Community College (USA) ..... [9606-15]

Mutation, but not random, Brig Klyce, Astrobiology Research Trust (USA) ..... [9606-16]

Lunch Break ..... Mon 11:50 am to 1:30 pm

SESSION 7 ..... MON 1:30 PM TO 3:10 PM

## Biomolecules and Microfossils in Meteorites

Session Chair: Robert B. Sheldon, NASA Marshall Space Flight Ctr. (USA)

Possible effects of diagenesis on the stable isotope composition of amino acids in carbonaceous meteorites (*Invited Paper*), Michael H. Engel, The Univ. of Oklahoma (USA) ..... [9606-17]

Carbonaceous structures in the Tissint Martian Meteorite: evidence of a biogenetic origin (*Invited Paper*), Jamie H. Wallis, Cardiff Univ. (United Kingdom); Nalin Chandra Wickramasinghe, Daryl H. Wallis, The Univ. of Buckingham (United Kingdom); Norimune Miyake, Chiba Institute of Technology (Japan); Max K. Wallis, The Univ. of Buckingham (United Kingdom); Richard B. Hoover, The Univ. of Buckingham (United Kingdom) and Athens State Univ. (USA) ..... [9606-18]

Chemical and structural composition of organic carbonaceous structures in Tissint: evidence for a biogenetic origin, Jamie H. Wallis, Cardiff Univ. (United Kingdom); N. C. Wickramasinghe, Daryl H. Wallis, The Univ. of Buckingham (United Kingdom); Norimune Miyake, Chiba Institute of Technology (Japan); Max K. Wallis, The Univ. of Buckingham (United Kingdom); Richard Hoover, The Univ. of Buckingham (United Kingdom) and Athens State Univ. (USA) ..... [9606-19]

Microbiological investigation of two chondrite meteorites: Murchison and Polonaruwa, Elena V. Pikuta, Athens State Univ. (USA); Paul A. Lawson, Nisha Patel, The Univ. of Oklahoma (USA); William B. Whitman, The Univ. of Georgia (USA); Jacob Hagel, Daniel Easters, Genevieve LaBrake, Athens State Univ. (USA); Chandra N. Wickramasinghe, The Univ. of Buckingham (United Kingdom); Richard B. Hoover, Athens State Univ. (USA) and The Univ. of Buckingham (United Kingdom) ..... [9606-20]

SESSION 8 ..... MON 3:40 PM TO 5:20 PM

## Instruments and Methods to Search for Extraterrestrial Life

Session Chair: Prasanta K. Mukhopadhyay, Global Geoenergy Research Ltd. (Canada)

Instruments and methods to search for viable extraterrestrial microorganisms, Richard B. Hoover, The Univ. of Buckingham (United Kingdom) and Athens State Univ. (USA) ..... [9606-21]

Sensitivity of flight-representative Raman spectrometers to reduced carbon in preparation for the ExoMars rover mission, Liam V. Harris, Ian B. Hutchinson, Richard Ingle, Univ. of Leicester (United Kingdom) ..... [9606-22]

Raman laser spectrometer for ExoMars 2018 (*Invited Paper*), Andoni G. Moral, Carlos Pérez Canora, INTA Instituto Nacional de Técnica Aeroespacial (Spain) ..... [9606-23]

CRIRES+: the ESO/VLT planet hunter in the NIR, Ulf Seemann, Georg-August-Univ. Göttingen (Germany) ..... [9606-24]

## TUESDAY 11 AUGUST

SESSION 9 ..... TUE 8:00 AM TO 10:10 AM

## Astrobiology of Icy Moons, Comets and Mars I

Session Chair: Joseph Seckbach, The Hebrew Univ. of Jerusalem (Israel)

Exploring the lakes and seas of Titan (*Invited Paper*), Nathalie A. Cabrol, NASA Ames Research Ctr. (USA) ..... [9606-25]

Terrain and biology of Comet 67P/Churyumov-Gerasimenko (*Invited Paper*), Chandra N. Wickramasinghe, The Univ. of Buckingham (United Kingdom) and Institute for the Study of Panspermia and Astroeconomics (Japan) and Univ. of Peradeniya (Sri Lanka); Max K. Wallis, The Univ. of Buckingham (United Kingdom); Milton Wainwright, The Univ. of Sheffield (United Kingdom); G. Tokoro, Institute for the Study of Panspermia and Astroeconomics (Japan) ..... [9606-26]

Big bang nucleosynthesis, comets and life, Robert B. Sheldon, NASA Marshall Space Flight Ctr. (USA) ..... [9606-27]

Arrhenius reconsidered: astrophysical jets and the spread of spores, Malkah I. Sheldon, Covenant Christian Academy (USA); Robert B. Sheldon, NASA Marshall Space Flight Ctr. (USA) ..... [9606-28]

Hydro-gravitational-dynamics cosmology is crucial to astrobiology and the biological big bang at two million years, Carl H. Gibson, Univ. of California, San Diego (USA) ..... [9606-29]

SESSION 10 ..... TUE 10:40 AM TO 11:50 AM

## Astrobiology of Icy Moons, Comets and Mars II

Session Chair: Carl H. Gibson, Univ. of California, San Diego (USA)

Link between organic life and hydrocarbons on comets and asteroids (eg. CCs): evolution of biogenic hydrocarbon source rocks and oil & gas on Mars, Earth, and other solar system planets (and their respective moons) (*Invited Paper*), Prasanta K. Mukhopadhyay, Global Geoenergy Research Ltd. (Canada) ..... [9606-30]

Rock varnish on Earth and Mars: what is the difference?, Barry E. DiGregorio, The Univ. of Buckingham (United Kingdom) ..... [9606-31]

Evidence of ancient microbial activity on Mars, Jamie H. Wallis, Cardiff Univ. (United Kingdom); N. C. Wickramasinghe, The Univ. of Buckingham (United Kingdom); Daryl Wallis, Cardiff Univ. (United Kingdom) and The Univ. of Buckingham (United Kingdom); Norimune Miyake, Chiba Institute of Technology (Japan); Max K. Wallis, The Univ. of Buckingham (United Kingdom); Richard B. Hoover, The Univ. of Buckingham (United Kingdom) and Athens State Univ. (USA) ..... [9606-32]

Lunch and Exhibition Break ..... Tue 11:50 am to 1:50 pm

SESSION 11 ..... TUE 1:50 PM TO 3:10 PM

## Microbial Extremophiles

Session Chair: Luis Villarreal, Univ. of California, Irvine (USA)

Microorganisms in extreme environments with a view to astrobiology (*Invited Paper*), Joseph Seckbach, The Hebrew Univ. of Jerusalem (Israel) ..... [9606-33]

Molecular study of anaerobic strains from Antarctica and their taxonomic identifications, Zhe Lyu, William B. Whitman, The Univ. of Georgia (USA); Jacob Hagel, Daniel Easters, Genevieve LaBrake, Elena V. Pikuta, Athens State Univ. (USA) ..... [9606-34]

Searching for the algorithm of genes distribution during the process of microbial evolution (*Invited Paper*), Elena V. Pikuta, Athens State Univ. (USA) ..... [9606-35]

SESSION 12 ..... TUE 3:40 PM TO 5:50 PM

## Extremophiles, Viruses, and the Origin of Life

Session Chair: Elena V. Pikuta, Athens State Univ. (USA)

How can parasites promote life? Group behaviors and the 'Gangen' hypothesis (*Invited Paper*), Luis Villarreal, Univ. of California, Irvine (USA) [9606-36]

Bioinformatics comparison of sulfate-reducing metabolism nucleotide sequences, George Tremberger Jr., Sunil Dehipawala, Andrew Nguyen, Todd Holden, David Lieberman, Tak D. Cheung, Queensborough Community College (USA) ..... [9606-37]

Biological entities isolated from the stratosphere-evidence for a space origin, Milton Wainwright, Chandra N. Wickramasinghe, The Univ. of Buckingham (United Kingdom) ..... [9606-38]

Eukaryotes in oldest rocks of Earth and meteorites, Alexei Yu. Rozanov, Paleontological Institute (Russian Federation); Richard B. Hoover, Athens State Univ. (USA) ..... [9606-39]

Phytoplankton and the Archean Earth system (*Invited Paper*), Stanley M. Awramik, David J. Chapman, Univ. of California, Santa Barbara (USA) ... [9606-40]

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## Earth Observing Systems XX

Conference Chairs: **James J. Butler**, NASA Goddard Space Flight Ctr. (USA); **Xiaoxiong (Jack) Xiong**, NASA Goddard Space Flight Ctr. (USA); **Xingfa Gu**, Institute of Remote Sensing Applications (China)

Program Committee: **Philip E. Ardanuy**, Raytheon Intelligence & Information Systems (USA); **Hal J. Bloom**, Science & Technology Corp. (USA); **Jeffrey S. Czapla-Myers**, College of Optical Sciences, The Univ. of Arizona (USA); **Armin Doerry**, Sandia National Labs. (USA); **Christopher N. Durell**, Labsphere, Inc. (USA); **Bertrand Fougne**, Ctr. National d'Études Spatiales (France); **Mitchell D. Goldberg**, National Environmental Satellite, Data, and Information Service (USA); **Joel McCorkel**, NASA Goddard Space Flight Ctr. (USA); **Thomas S. Pagano**, Jet Propulsion Lab. (USA); **Jeffery J. Puschell**, Raytheon Space & Airborne Systems (USA); **Carl F. Schueler**, Schueler Consulting-Santa Barbara (USA)

### MONDAY 10 AUGUST

#### SESSION 1 ..... MON 8:00 AM TO 10:20 AM

##### On-orbit Instrument Performance and Data Products

Session Chair: **Joel McCorkel**, NASA Goddard Space Flight Ctr. (USA)

**Measuring atmospheric carbon dioxide from space with the Orbiting Carbon Observatory-2 (OCO-2)**, David Crisp, Jet Propulsion Lab. (USA) ..... [9607-1]

**Toward consistent radiometric calibration of the NOAA AVHRR visible and near-infrared data record**, Rajendra Bhatt, Science Systems and Applications, Inc. (USA); David R. Doelling, NASA Langley Research Ctr. (USA); Benjamin R. Scarino, Arun Gopalan, Conor O. Haney, Science Systems and Applications, Inc. (USA) ..... [9607-2]

**Geometric effects in SeaWiFS lunar observations**, Robert E. Eplee Jr., Frederick S. Patt, Gerhard Meister, NASA Goddard Space Flight Ctr. (USA) ..... [9607-3]

**Cross radiometric calibration for GF-1 WFs**, Yong Xie, Institute of Remote Sensing and Digital Earth (China) ..... [9607-4]

**Preliminary evaluation of AHI L1b products**, Xiangqian Wu, National Oceanic and Atmospheric Administration (USA); Hidehiko Murata, Japan Meteorological Agency (Japan); Fangfang Yu, ERT, Inc. (USA); Arata Okuyama, Japan Meteorological Agency (Japan); Michael Grotenhuis, ERT, Inc. (USA); Kotaro Bessho, Japan Meteorological Agency (Japan); Aaron Pearlman, Michael Chu, ERT, Inc. (USA) ..... [9607-5]

**Building vectorization inside a favela utilizing LIDAR spot elevation**, Plinio Temba, Univ. Federal de Minas Gerais (Brazil) ..... [9607-6]

**Optimizing urban growth modeling based on land use/cover changes and road network by using agent-based cellular automata**, Yousef Khajavigodellou, Salahaddin Univ.-Hawler (Iraq); Ali A. Alesheikh, K.N. Toosi Univ. of Technology (Iran, Islamic Republic of); Kamran Chapi, Univ. of Kurdistan (Iran, Islamic Republic of); Farshad Hakimpour, Univ. of Tehran (Iran, Islamic Republic of) ..... [9607-7]

#### SESSION 2 ..... MON 10:50 AM TO 12:10 PM

##### Instrument Intercomparisons and Vicarious Calibration I

Session Chair: **Xiaoxiong J. Xiong**, NASA Goddard Space Flight Ctr. (USA)

**Design of an ultra-portable field transfer radiometer supporting automated vicarious calibration**, Nikolaus J. Anderson, The Univ. of Arizona (USA); Kurtis Thome, NASA Goddard Space Flight Ctr. (USA); Jeffrey Czapla-Myers, Stuart Biggar, The Univ. of Arizona (USA) ..... [9607-8]

**Atmospheric measurement analysis for the radiometric calibration test site (RadCaTS)**, Jeffrey S. Czapla-Myers, The Univ. of Arizona (USA) ..... [9607-9]

**Requirements for online resource for earth-observing satellite sensor calibration**, Joel McCorkel, NASA Goddard Space Flight Ctr. (USA); Jeffrey S. Czapla-Myers, College of Optical Sciences, The Univ. of Arizona (USA); Brian Wenny, Science Systems and Applications, Inc. (USA); Kurtis J. Thome, NASA Goddard Space Flight Ctr. (USA) ..... [9607-10]

**Radiometric calibration of GLiHT's imaging spectrometer using GLAMR for satellite sensor intercalibration**, Amit Angal, Science Systems and Applications, Inc. (USA); Joel McCorkel, NASA Goddard Space Flight Ctr. (USA) ..... [9607-11]

Lunch Break ..... Mon 12:10 pm to 1:40 pm

#### SESSION 3 ..... MON 1:40 PM TO 3:20 PM

##### Instrument Intercomparisons and Vicarious Calibration II

Session Chair: **Philip E. Ardanuy**, Raytheon Intelligence & Information Systems (USA)

**Preliminary study for improving the VIIRS DNB low light calibration accuracy with ground based active light source**, Changyong Cao, NOAA National Environmental Satellite, Data, and Information Service (USA); Yuqing Zong, National Institute of Standards and Technology (USA); Xi Shao, Yan Bai, Univ. of Maryland, College Park (USA) ..... [9607-12]

**On-orbit calibration of S-NPP VIIRS day-night band and M bands using ground reference targets of Libya 4 and dome C sites**, Xuexia Chen, Aisheng Wu, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-13]

**Multiimage matching for lunar surface reconstruction from orbital images**, Ahmed Elaksher, New Mexico State Univ. (USA) ..... [9607-14]

**Remote sensing of 'APEC blue' skies in China**, Xingfa Gu, Ying Wang, Tianhai Cheng, Hao Chen, Hong Guo, Xiangqin Wei, Bin Li, Chinese Academy of Sciences (China) ..... [9607-15]

**Cross calibration of GF-1 satellite PMS sensor using Landsat 8 OLI**, Hailiang Gao, Institute of Remote Sensing and Digital Earth (China) and Chinese Academy of Sciences (China) ..... [9607-16]

#### SESSION 4 ..... MON 3:50 PM TO 5:30 PM

##### Infrared Sounding Instruments

Session Chair: **Mitchell Goldberg**, National Environmental Satellite, Data, and Information Service (USA)

**Results from CrIS/ATMS obtained using an "AIRS version-6 like" retrieval algorithm**, Joel Susskind, NASA Goddard Space Flight Ctr. (USA) ..... [9607-17]

**Comparison of AIRS and CrIS using synthetic principle component analysis**, Hartmut H. Aumann, Evan M. Manning, Jet Propulsion Lab. (USA) ..... [9607-18]

**Improving AIRS radiance spectra in cloudy scenes using MODIS**, Thomas S. Pagano, Hartmut H. Aumann, Denis A. Elliott, Evan M. Manning, Jet Propulsion Lab. (USA) ..... [9607-19]

**Enhanced simultaneous Nadir observations for IR sounder evaluation and comparison**, Evan M. Manning, Hartmut H. Aumann, Jet Propulsion Lab. (USA) ..... [9607-20]

**Usability, calibration, and data analysis issues in modern infrared spectrometers using large detector arrays**, Denis A. Elliott, Hartmut H. Aumann, Jet Propulsion Lab. (USA) ..... [9607-21]

# CONFERENCE 9607

## POSTERS-MONDAY.....MON 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Monday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Intercomparison calibration study of Terra ASTER and MODIS**, Karen Y. Yuan, Kurtis J. Thome, Joel McCorkel, NASA Goddard Space Flight Ctr. (USA) [9607-74]

**Implementation of electronic crosstalk correction for terra MODIS PV LWIR bands**, Xu Geng, Sriharsha Madhavan, Na Chen, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA) [9607-75]

**Precise pre-launch radiometric calibration of VIIRS**, Leonid A. Mikheenko, Volodymyr N. Borovitsky, Andrii V. Fesenko, National Technical Univ. of Ukraine (Ukraine) [9607-76]

**Assessment of scan-angle dependent bias of Suomi-NPP VIIRS day/night band from bridge light observations**, Yan Bai, Univ. of Maryland, College Park (USA); Changyong Cao, National Oceanic and Atmospheric Administration (USA); Xi Shao, Univ. of Maryland, College Park (USA) [9607-77]

**Noise characteristics research of Overhauser magnetometer sensor**, Tala Liu, Lingjia Gu, Shuang Zhang, Haoyang Fu, Jilin Univ. (China) [9607-78]

**An improved proton magnetometer for Earth's magnetic field observation**, Chengyu Xiao, Shuang Zhang, Xin Guo, Haoyang Fu, Jilin Univ. (China) [9607-79]

**Improvements in the characterization of MODIS reflective solar band detector differences**, Amit Angal, Yonghong Li, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA); Xu Geng, Hongda Chen, Daniel Link, Aisheng Wu, Science Systems and Applications, Inc. (USA) [9607-80]

**GOCI in-orbit radiometric calibration status after four-year operation**, Seongick Cho, Kibeom Ahn, Eunsong Oh, Korea Institute of Ocean Science & Technology (Korea, Republic of) and Yonsei Univ. (Korea, Republic of); YoungJe Park, Korea Institute of Ocean Science & Technology (Korea, Republic of); Sug-Whan Kim, Yonsei Univ. (Korea, Republic of) [9607-81]

**Assessment of the collection 6 Terra and Aqua MODIS bands 1 and 2 calibration performance**, Aisheng Wu, Xuexia Chen, Amit Angal, Yonghong Li, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) [9607-82]

**Radiometric performance assessment of Suomi NPP VIIRS SWIR band (2.25 μm)**, Sirish Upadhyay, Colorado State Univ. (USA); Changyong Cao, NOAA National Environmental Satellite, Data, and Information Service (USA) [9607-83]

**Measured polarized transmittance of JPSS J1 VIIRS using the NIST T-SIRCUS**, Jeffrey McIntire, Science Systems and Applications, Inc. (USA); James B. Young, Stellar Solutions Inc. (USA); David I. Moyer, The Aerospace Corp. (USA); Eugene Waluschka, Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA) [9607-84]

**Preliminary validation of Himawari-8/AHI navigation and calibration**, Arata Okuyama, Akiyoshi Andou, Masaya Takahashi, Kenji Date, Tasuku Tabata, Keita Hosaka, Hidehiko Murata, Nobutaka Mori, Japan Meteorological Agency (Japan); Ryoko Yoshino, Japan Aerospace Exploration Agency (Japan); Kotaro Bessho, Japan Meteorological Agency (Japan) [9607-85]

**Comparison of JPSS-1 VIIRS VisNIR responsivities measured with monochromatic and broadband sources**, Thomas Schwarting, Qiang Ji, Jeffrey McIntire, Hassan Oudrari, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA) [9607-86]

**Extracting information on urban impervious surface from GF-1 data in Tianjin City of China**, Li Bin, Institute of Remote Sensing and Digital Earth (China); Jun Wu, Qingyan Meng, Xingfa Gu, Chinese Academy of Sciences (China) [9607-87]

**Vicarious validation of straylight correction for VIIRS day/night band using Dome-C**, Shi Qiu, Xi Shao, Univ. of Maryland, College Park (USA); Changyong Cao, Wenhui Wang, NOAA National Environmental Satellite, Data, and Information Service (USA) [9607-88]

**Ray tracing based ISRD (inter-slot radiometric discrepancy) simulation tool for GOCI**, Ki-Beom Ahn, Seongick Cho, Eunsong Oh, Korea Institute of Ocean Science & Technology (Korea, Republic of) and Yonsei Univ. (Korea, Republic of); Young Je Park, Korea Institute of Ocean Science & Technology (Korea, Republic of); Sug-Whan Kim, Yonsei Univ. (Korea, Republic of) [9607-89]

**How much particles outburst is responsible to Geomagnetism rise during SME of certain solar activity?**, Umesh Prasad Verma, Patna Science College (India) [9607-90]

## TUESDAY 11 AUGUST

### SESSION 5.....TUE 8:30 AM TO 10:30 AM

#### Landsat

Session Chair: **Armin W. Doerry**, Sandia National Labs. (USA)

**Radiometric calibration and stability of the Landsat-8 operational land imager (OLI)**, Brian L. Markham, NASA Goddard Space Flight Ctr. (USA); Julia A. Barsi, Edward Kaita, Lawrence Ong, Science Systems and Applications, Inc. (USA); Ron A. Moritt, U.S. Geological Survey (USA); Md. Obaidul Haque, SGT, Inc. (USA); Jeffrey S. Czapla-Myers, College of Optical Sciences, The Univ. of Arizona (USA); Dennis L. Helder, Nischal Mishra, South Dakota State Univ. (USA) [9607-22]

**OLI relative radiometric calibration**, Julia A. Barsi, Brian L. Markham, NASA Goddard Space Flight Ctr. (USA) [9607-23]

**Assessing OLI stray light and contamination changes with lunar observations**, Raviv Levy, NASA Goddard Space Flight Ctr. (USA) and Science Systems and Applications, Inc. (USA); Philip W. Dabney, Brian L. Markham, NASA Goddard Space Flight Ctr. (USA) [9607-24]

**TIRS stray light correction: algorithms and performance**, Aaron D. Gerace, Matthew Montanaro, Rochester Institute of Technology (USA); Julia A. Barsi, NASA Goddard Space Flight Ctr. (USA); Tim Beckmann, U.S. Geological Survey (USA); Victoria Scholl, Jiang Fu, Rochester Institute of Technology (USA) [9607-25]

**Atmospheric correction for Landsat 8 over case 2 waters**, Javier A. Concha, John R. Schott, Rochester Institute of Technology (USA) [9607-26]

**Requirement sensitivity studies for a future Landsat sensor**, Matthew Montanaro, Aaron D. Gerace, John R. Schott, Rochester Institute of Technology (USA); Brian L. Markham, NASA Goddard Space Flight Ctr. (USA) [9607-27]

### SESSION 6.....TUE 11:00 AM TO 12:20 PM

#### CERES and MODIS Instruments

Session Chair: **Jeffrey S. Czapla-Myers**, College of Optical Sciences, The Univ. of Arizona (USA)

**Assessment of the clouds and the Earth's radiant energy system (CERES) instrument performance and stability on the Aqua, Terra, and S-NPP spacecraft**, Nathaniel P. Smith, Susan Thomas, Mohan Shankar, Phillip C. Hess, Natividad M. Smith, Dale R. Walkainen, Robert S. Wilson, Science Systems and Applications, Inc. (USA); Kory J. Priestley, NASA Langley Research Ctr. (USA) [9607-28]

**Evaluating the impact of cold focal plane temperature on Aqua MODIS thermal emissive photoconductive band calibration**, Yonghong Li, Aisheng Wu, Brian Wenny, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA) [9607-29]

**Electronic crosstalk in Terra MODIS thermal emissive bands**, Junqiang Sun, National Oceanic and Atmospheric Administration (USA) and Global Science & Technology, Inc. (USA); Sriharsha Madhavan, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA); Menghua Wang, NOAA National Environmental Satellite, Data, and Information Service (USA) [9607-30]

**Electronic crosstalk characterization of Terra MODIS long wave infrared channels**, Sriharsha Madhavan, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA); Junqiang Sun, Global Science & Technology, Inc. (USA) and National Oceanic and Atmospheric Administration (USA); Aisheng Wu, Science Systems and Applications, Inc. (USA) [9607-31]

Lunch Break ..... Tue 12:20 pm to 1:50 pm

# CONFERENCE 9607

SESSION 7 ..... TUE 1:50 PM TO 3:30 PM

## Pre-launch Instrument Calibration I

Session Chair: **Bertrand Fougne**, Ctr. National d'Études Spatiales (France)

**Solar diffusers in earth observation instruments with an illumination angle of up to 70°: design and verification of performance in BSDF**, Bilgehan Gür, Hans Bol, TNO Science and Industry (Netherlands) ..... [9607-32]

**Characterization and application of a LED-driven integrating sphere source**, Leibo Ding, Science Systems and Applications, Inc. (USA); Elena M. Georgieva, NASA Langley Research Ctr. (USA); James J. Butler, NASA Goddard Space Flight Ctr. (USA); Georgi T. Georgiev, John W. Cooper, Gilbert R. Smith, Science Systems and Applications, Inc. (USA) ..... [9607-33]

**Improved thermal-vacuum compatible flat plate radiometric source for system-level testing of optical sensors**, Mark A. Schwarz, Craig J. Kent, Stellar Solutions Inc. (USA); Steven W. Brown, National Institute of Standards and Technology (USA); Robert Bousquet, Genesis Engineering Solutions, Inc. (USA) ..... [9607-34]

**Preliminary assessment of JPSS-1 VIIRS pre-launch radiometric performance**, Hassan Oudrari, Jeff McIntire, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, James Butler, NASA Goddard Space Flight Ctr. (USA); Boryana Efremova, Qiang Ji, Science Systems and Applications, Inc. (USA); Shihyan Lee, Contractor (USA); Tom Schwarting, Science Systems and Applications, Inc. (USA) ..... [9607-35]

**JPSS-1 VIIRS pre-launch spectral characterization and performance**, Christopher Moeller, Univ. of Wisconsin-Madison (USA); Thomas Schwarting, Jeffrey McIntire, Science Systems and Applications, Inc. (USA); Dave I. Moyer, The Aerospace Corp. (USA) ..... [9607-36]

SESSION 8 ..... TUE 4:00 PM TO 5:20 PM

## Pre-launch Instrument Calibration II

Session Chair: **Jeffery J. Puschell**, Raytheon Space and Airborne Systems (USA)

**VIIRS polarization narrative**, Eugene Waluschka, NASA Goddard Space Flight Ctr. (USA); Steven W. Brown, National Institute of Standards and Technology (USA); James J. Butler, NASA Goddard Space Flight Ctr. (USA); Eric C. Fest, Raytheon Missile Systems (USA); Keith R. Lykke, National Institute of Standards and Technology (USA); Brendan McAndrew, Joel McCorkel, NASA Goddard Space Flight Ctr. (USA); Jeffrey McIntire, Sigma Space Corp. (USA); Gerhard Meister, NASA Goddard Space Flight Ctr. (USA); Eslim O. Monroe, Raytheon Space and Airborne Systems (USA); David I. Moyer, The Aerospace Corp. (USA); Kevin Terpie, Kurtis J. Thome, NASA Goddard Space Flight Ctr. (USA); Tung R. Wang, Raytheon Space and Airborne Systems (USA); James B. Young, Stellar Solutions Inc. (USA) ..... [9607-37]

**Analysis of JPSS J1 VIIRS polarization sensitivity using the NIST T-SIRCUS**, Jeffrey McIntire, Science Systems and Applications, Inc. (USA); James B. Young, Stellar Solutions Inc. (USA); David I. Moyer, The Aerospace Corp. (USA); Eugene Waluschka, NASA Goddard Space Flight Ctr. (USA); Hassan Oudrari, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-38]

**Impacts of VIIRS polarization sensitivity on non-ocean scenes**, Timothy S. Wilkinson, The Aerospace Corp. (USA) ..... [9607-39]

**JPSS solar diffuser stability monitor response to sun angle of incidence**, Vijay Murgai, Kristie Yu, Neil R. Nelson, Raytheon Space and Airborne Systems (USA); James K. McCarthy, Stellar Solutions Inc. (USA) ..... [9607-40]

WEDNESDAY 12 AUGUST

SESSION 9 ..... WED 8:00 AM TO 10:00 AM

## Pre-launch Instrument Calibration III

Session Chair: **Hal J. Bloom**, Science & Technology Corp. (USA)

**JPSS-1 VIIRS pre-launch day/night band radiometric calibration**, Thomas Schwarting, Science Systems and Applications, Inc. (USA); ShihYan Lee, ERT, Inc. (USA); Jeffrey McIntire, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-41]

**JPSS-1 VIIRS DNB/SWIR non-linearity and its impact on SDR calibration**, ShihYan Lee, Wenhui Wang, ERT, Inc. (USA); Chengyong Cao, NOAA National Environmental Satellite, Data, and Information Service (USA) ..... [9607-42]

**Preliminary results of J1 VIIRS ground geometric testing**, Guoqing Lin, Science Systems and Applications, Inc. (USA); Robert E. Wolfe, NASA Goddard Space Flight Ctr. (USA); Masahiro Nishihama, Science Systems and Applications, Inc. (USA) ..... [9607-43]

**A robust method for determining VIIRS calibration coefficients in solar reflective bands**, Qiang Ji, Boryana V. Efremova, Thomas Schwarting, Jeffrey McIntire, Hassan Oudrari, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-44]

**Modeling spectrally varying resolution in broadband imaging systems**, Stephen A. Cota, Scott L. Schnee, Adam L. Loverro, The Aerospace Corp. (USA) ..... [9607-45]

**Simple techniques for modeling wavefront error in imaging systems**, Scott L. Schnee, Stephen A. Cota, The Aerospace Corp. (USA) ..... [9607-46]

SESSION 10 ..... WED 10:30 AM TO 11:50 AM

## New Missions, Instruments, and Technologies I

Session Chair: **Carl F. Schueler**, Schueler Consulting-Santa Barbara (USA)

**Demonstrating the error budget for the climate absolute radiance and refractivity observatory through solar irradiance measurements**, Kurtis J. Thome, Joel McCorkel, Brendan McAndrew, NASA Goddard Space Flight Ctr. (USA) ..... [9607-47]

**Development of the next geostationary ocean color imager, GOCI-II**, Seongick Cho, YoungJe Park, Kibeom Ahn, Eunsong Oh, Yu-Hwan Ahn, Korea Institute of Ocean Science & Technology (Korea, Republic of) ..... [9607-48]

**New polishable R-SiC layer on ultra lightweighted SiC substrates for space applications**, Eric Ruch, REOSC (France) ..... [9607-49]

**Novel compound parabolic concentrator for broadband radiometric measurement of ratio of reflected to incoming solar radiations around L1 halo orbit**, Sehyun Seong, Sug-Whan Kim, Yonsei Univ. (Korea, Republic of); Michael Lockwood, The Univ. of Reading (United Kingdom) ..... [9607-50]

Lunch Break ..... Wed 11:50 am to 1:20 pm

SESSION 11 ..... WED 1:20 PM TO 2:40 PM

## New Missions, Instruments, and Technologies II

Session Chair: **Thomas S. Pagano**, Jet Propulsion Lab. (USA)

**Development of low optical cross talk filters for VIIRS for JPSS**, Vijay Murgai, Derek Hendry, Raytheon Space and Airborne Systems (USA); Kevin R. Downing, Dave Carbone, Materion Barr Precision Optics & Thin Film Coatings (USA) [9607-51]

**An update on EUMETSAT programmes and plans**, K. Dieter Klaes, Kenneth Holmlund, EUMETSAT (Germany) ..... [9607-52]

**The convergence of earth science and applications from space: it's not your grandparents' R2O**, Philip E. Ardanuy, Raytheon Intelligence & Information Systems (USA); Molly K. Macauley, Resources for the Future (USA); William B. Gail, Global Weather Corp. (USA); William H. Hooke, American Meteorological Society (USA) ..... [9607-53]

**Collaboration tools for optimizing 'operational' climate monitoring from space**, Douglas B. Helmuth, Lockheed Martin Corp. (USA) ..... [9607-54]

# CONFERENCE 9607

## SESSION 12 ..... WED 2:40 PM TO 4:30 PM

### Suomi NPP VIIRS I

Session Chair: **James J. Butler**, NASA Goddard Space Flight Ctr. (USA)

**S-NPP VIIRS instrument telemetry and calibration data trend study**, ZiPing Sun, Frank J. De Luccia, Jason C. Cardema, The Aerospace Corp. (USA) ..... [9607-55]

**Trending of SNPP ephemeris and its implications on VIIRS geometric performance**, Guoqing Lin, Science Systems and Applications, Inc. (USA); Robert E. Wolfe, NASA Goddard Space Flight Ctr. (USA); Masahiro Nishihama, Science Systems and Applications, Inc. (USA) ..... [9607-56]

**Mission history of reflective solar band calibration performance of VIIRS**, Gabriel Moy, Kameron Rausch, Evan Haas, Timothy S. Wilkinson, Jason C. Cardema, Frank J. De Luccia, The Aerospace Corp. (USA) ..... [9607-57]

**VIIRS reflective solar bands calibration improvements with hybrid approach**, Junqiang Sun, National Oceanic and Atmospheric Administration (USA) and Global Science & Technology, Inc. (USA); Menghua Wang, NOAA National Environmental Satellite, Data, and Information Service (USA) ..... [9607-58]

## SESSION 13 ..... WED 4:30 PM TO 5:50 PM

### Suomi NPP VIIRS II

Session Chair: **Xingfa Gu**, Institute of Remote Sensing Applications (China)

**Progress in the on-orbit calibration of SNPP VIIRS for ocean data applications**, Robert E. Eplee Jr., Kevin R. Turpie, Gerhard Meister, Frederick S. Patt, Bryan A. Franz, NASA Goddard Space Flight Ctr. (USA) ..... [9607-59]

**Propagation of visible infrared imaging radiometer suite (VIIRS) calibration uncertainty trends to ocean color data**, Kevin R. Turpie, Univ. of Maryland, Baltimore County (USA); Robert E. Eplee Jr., SAIC (USA); Gerhard Meister, NASA Goddard Space Flight Ctr. (USA) ..... [9607-60]

**JPSS-1 VIIRS Prelaunch RSB RVS characterization and water vapor correction**, ShihYan Lee, ERT, Inc. (USA); Changyong Cao, NOAA National Environmental Satellite, Data, and Information Service (USA) ..... [9607-61]

**Stellar calibration of the Suomi-NPP VIIRS day-night band high gain**, Jon P. Fulbright, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-62]

## THURSDAY 13 AUGUST

## SESSION 14 ..... THU 8:00 AM TO 10:00 AM

### Suomi NPP VIIRS III

Session Chair: **Christopher N. Durell**, Labsphere, Inc. (USA)

**Assessment of MODIS and VIIRS solar diffuser on-orbit degradation**, Xiaoxiong J. Xiong, Jim Butler, NASA Goddard Space Flight Ctr. (USA); Amit Angal, Zhipeng Wang, Science Systems and Applications, Inc. (USA) ..... [9607-63]

**Out-of-band response and the Suomi-NPP solar diffuser stability monitor**, Jon P. Fulbright, Ning Lei, Zhipeng Wang, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-64]

**Estimation of the accuracy of the SNPP VIIRS solar diffuser BRDF degradation factor determined by the on-board solar diffuser stability monitor**, Ning Lei, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-65]

**Determination of the SNPP VIIRS solar diffuser BRDF degradation factor over wavelengths not covered by the SDSM detectors**, Ning Lei, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-66]

**Investigation of the solar diffuser degradation non-uniformity**, Junqiang Sun, National Oceanic and Atmospheric Administration (USA) and Global Science & Technology, Inc. (USA); Mike Chu, National Oceanic and Atmospheric Administration (USA) and ERT, Inc. (USA); Menghua Wang, NOAA National Environmental Satellite, Data, and Information Service (USA) ..... [9607-67]

**Impact of the angular dependence of the SNPP VIIRS solar diffuser BRDF degradation factor on the radiometric calibration of the reflective solar bands**, Ning Lei, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-68]

## SESSION 15 ..... THU 10:30 AM TO 12:10 PM

### Suomi NPP VIIRS IV

Session Chair: **James J. Butler**, NASA Goddard Space Flight Ctr. (USA)

**Calibration improvements for MODIS and VIIRS SWIR spectral bands**,

Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA); Amit Angal, Jon P. Fulbright, Ning Lei, Zhipeng Wang, Aisheng Wu, Science Systems and Applications, Inc. (USA) ..... [9607-69]

**Update on the performance of Suomi-NPP VIIRS lunar calibration**, Zhipeng Wang, Jon Fulbright, Science Systems and Applications, Inc. (USA); Xiaoxiong Xiong, NASA Goddard Space Flight Ctr. (USA) ..... [9607-70]

**Improved VIIRS offset correction during lunar intrusion into space view**, Peter J. Isaacson, Frank J. De Luccia, Gabriel Moy, Nicholas R. Vandermeiden, The Aerospace Corp. (USA) ..... [9607-71]

**An improved algorithm for VIIRS band-to-band registration characterization with lunar observation**, Zhipeng Wang, Science Systems and Applications, Inc. (USA); Xiaoxiong J. Xiong, NASA Goddard Space Flight Ctr. (USA); Yonghong Li, Science Systems and Applications, Inc. (USA) ..... [9607-72]

**S-NPP VIIRS TEB detector noise analysis using ICVS linear gain**, Taeyoung J. Choi, NOAA National Environmental Satellite, Data, and Information Service (USA) and ERT, Inc. (USA); Changyong Cao, Fuzhong Weng, NOAA National Environmental Satellite, Data, and Information Service (USA) ..... [9607-73]

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# Infrared Remote Sensing and Instrumentation XXIII

Conference Chairs: **Marija Strojnik Scholl**, Ctr. de Investigaciones en Óptica, A.C. (Mexico); **Gonzalo Páez**, Ctr. de Investigaciones en Óptica, A.C. (Mexico)

Program Committee: **Gabriele E. Arnold**, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); **Gerald T. Fraser**, National Institute of Standards and Technology (USA); **Sarith D. Gunapala**, Jet Propulsion Lab. (USA); **Neil R. Malone**, Raytheon Co. (USA); **Wellesley Pereira**, Air Force Research Lab. (USA); **Stanley J. Wellard**, Space Dynamics Lab. (USA)

## MONDAY 10 AUGUST

### WELCOME REMARKS ..... 8:00 AM TO 8:10 AM

Conference Chairs: **Marija Strojnik Scholl** and **Gonzalo Páez**, Ctr. de Investigaciones en Óptica, A.C. (Mexico)

### SESSION 1 ..... MON 8:10 AM TO 12:20 PM

#### Planetary and Comet Exploration

Session Chairs: **Gabriele E. Arnold**, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); **Marija Strojnik Scholl**, Ctr. de Investigaciones en Óptica, A.C. (Mexico)

**Rosetta and 67p/ Churyumov - Gerasimenko: a comet under observation** (Invited Paper), Gabriele E. Arnold, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany) ..... [9608-1]

**VIRTIS on Rosetta: a unique technique to observe comet 67p/Churyumov - Gerasimenko: first results and prospects**, Gabriele E. Arnold, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Fabrizio Capaccioni, INAF - IASF Roma (Italy); Gianrico Filacchione, INAF - Istituto di Astrofisica e Planetologia Spaziali (Italy); Stéphane Erard, Lab. d'Etudes Spatiales et d'Instrumentation en Astrophysique (France); Dominique Bockele-Morvan, Antonella Barucci, Observatoire de Paris à Meudon (France); Maria Cristina De Sanctis, Ernesto Palomba, Maria Teresa Capria, Priscilla Cerroni, INAF - IASF Roma (Italy); Pierre Drossart, Florence Henry, Cedric Leyrat, Observatoire de Paris à Meudon (France); Giuseppe Piccioni, INAF - IASF Roma (Italy); Bernard Schmitt, Lab. d'Astrophysique de l'Observatoire de Grenoble (France); Federico Tosi, INAF - IASF Roma (Italy); Gian Paolo Tozzi, INAF - Osservatorio Astrofisico di Arcetri (Italy) ..... [9608-2]

**MERTIS: geometrical calibration of thermal infrared optical system by applying diffractive optical elements**, Martin Bauer, Technische Univ. Berlin (Germany) and Technische Fachhochschule Wildau (Germany) ..... [9608-3]

**MERTIS FM: optical performance of the thermal infrared push-broom imaging spectrometer**, Martin Bauer, Technische Univ. Berlin (Germany) ..... [9608-4]

**VIRTIS on Venus Express: retrieval of real surface emissivity at global scales**, Gabriele E. Arnold, David Kappel, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Rainer Haus, Westfälische Wilhelms-Univ. Münster (Germany); Laura Tellez Pedroza, Univ. Potsdam (Germany); Giuseppe Piccioni, INAF - IASF Roma (Italy); Pierre Drossart, Observatoire de Paris à Meudon (France) ..... [9608-5]

**Development of a mast or robotic arm-mounted infrared AOTF spectrometer for surface moon and mars probes** (Invited Paper), Oleg Korabev, Andrei Y. Ivanov, Space Research Institute (Russian Federation); Yurii K. Kalinnikov, VNIIFTRI (Russian Federation); Alexei Sharpen, Space Research Institute (Russian Federation); Sergei N. Mantsevich, Lomonosov Moscow State Univ. (Russian Federation) and Space Research Institute (Russian Federation); Anna A. Fedorova, Alexander V. Kiselev, Space Research Institute (Russian Federation) ..... [9608-6]

**Middle-infrared echelle cross-dispersion spectrometer ACS-MIR for the ExoMars trace gas orbiter**, Alexander Y. Trokhimovsky, Oleg Korabev, Space Research Institute (Russian Federation); Yurii S. Ivanov, Ivan I. Sinyavsky, National Academy of Sciences (Ukraine); Alexander V. Stepanov, Lomonosov Moscow State Univ. (Russian Federation) and Space Research Institute (Russian Federation); Andrei Y. Titov, SKB IKI (Russian Federation); Tatiana O. Kozlova, Space Research Institute (Russian Federation); Andrei S. Patrakeev, Space Research Institute (Russian Federation) and Moscow Institute of Physics and Technology (Russian Federation); Pavel P. Moiseev, Astron Electronics (Russian Federation); Anna A. Fedorova, Space Research Institute (Russian Federation); Franck Montmessin, LATMOS (France) ..... [9608-7]

**Near-infrared echelle-AOTF spectrometer ACS-NIR for the ExoMars trace gas orbiter**, Alexander Y. Trokhimovsky, Oleg Korabev, Space Research Institute (Russian Federation); Yurii K. Kalinnikov, VNIIFTRI (Russian Federation); Anna A. Fedorova, Space Research Institute (Russian Federation); Alexander V. Stepanov, Lomonosov Moscow State Univ. (Russian Federation) and Space Research Institute (Russian Federation); Andrei Yu Titov, SKB IKI (Russian Federation); Andrei S. Patrakeev, Space Research Institute (Russian Federation) and Moscow Institute of Physics and Technology (Russian Federation); Ilya Dziuban, Space Research Institute (Russian Federation); Franck Montmessin, LATMOS (France) ..... [9608-8]

**Fourier-spectrometer ACS-TIRVIM for the ExoMars trace gas orbiter**, Alexei V. Grigoriev, Boris E. Moshkin, Alexei V. Shakun, Oleg Korabev, Alexander V. Zharkov, Dmitry V. Patsaev, Fedor G. Martynovich, Andrei S. Kungurov, Oleg M. Sazonov, Igor A. Maslov, Alexander Santos-Skripko, Sergei A. Nenashev, Igor A. Stupin, Nikolai I. Ignatiev, Space Research Institute (Russian Federation). . [9608-9]

**M-DLS laser and heterodyne IR spectrometer for studies of the martian atmosphere from ExoMars-2018 landing platform**, Alexander V. Rodin, Moscow Institute of Physics and Technology (Russian Federation) and Space Research Institute (Russian Federation); Imant I. Vinogradov, Space Research Institute (Russian Federation) and Moscow Institute of Physics and Technology (Russian Federation); V. V. Barke, Space Research Institute (Russian Federation); O. V. Benderov, D. V. Churbanov, Artem Klimchuk, Moscow Institute of Physics and Technology (Russian Federation); Yu. V. Lebedev, Space Research Institute (Russian Federation); A. A. Pereslavtseva, Z. B. Seilov, V. S. Semenov, Moscow Institute of Physics and Technology (Russian Federation); Maxim V. Spiridonov, Prokhorov General Physics Institute (Russian Federation) ..... [9608-10]

Lunch Break ..... Mon 12:20 pm to 1:50 pm

### SESSION 2 ..... MON 1:50 PM TO 3:30 PM

#### Probing Extra-terrestrial World: from Asteroids to Cosmos

Session Chairs: **Marija Strojnik Scholl**, Ctr. de Investigaciones en Óptica, A.C. (Mexico); **Gerald T. Fraser**, National Institute of Standards and Technology (USA)

**Infrared sensor system using robotics technology for inter-planetary mission**, Hiroki Hihara, NEC TOSHIBA Space Systems Ltd. (Japan) and The Univ. of Tokyo (Japan); Junpei Sano, Kaori Iwase, NEC TOSHIBA Space Systems Ltd. (Japan); Yousuke Takano, Jun Takada, Tetsuya Masuda, NEC Corp. (Japan); Hisashi Otake, Tatsuaki Okada, Japan Aerospace Exploration Agency (Japan); Ryu Funase, The Univ. of Tokyo (Japan) ..... [9608-11]

**Measurement of the speed of light from extraterrestrial sources** (Invited Paper), Jing-shown Wu, National Taiwan Univ. (Taiwan) ..... [9608-13]

**Stratospheric observatory for infrared astronomy (SOFIA): science, science instruments and observatory operations** (Invited Paper), Maureen L. Savage, SOFIA / USRA (USA) ..... [9608-14]

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## SESSION 3..... MON 4:00 PM TO 6:00 PM

### Advanced Techniques in Remote Sensing

Session Chairs: **Wellesley Pereira**, Air Force Research Lab. (USA); **John Kielkopf**, Univ. of Louisville (USA)

**Dim object detection in cluttered scenes**, Chris Agh, Matt Buoni, Toyon Research Corp. (USA) ..... [9608-15]

**Field results from investigating potential correlations between jet engine noise and plume dynamics in the hypertemporal infrared domain**, Philip M. Cunio, Reed A. Weber, Kimberly Knobel, Air Force Research Lab. (USA) ..... [9608-16]

**Fractional intensity modulation of diffusely scattered light**, John Kielkopf, Elijah Jensen, Univ. of Louisville (USA); Frank O. Clark, Spectral Sciences, Inc. (USA); Bradley Noyes, Wopeco Research (USA) ..... [9608-17]

**Remote optical interrogation of vibrations in materials inspection applications**, Jason A. Cline, Ryan W. Penny, Bridget Tannian, Spectral Sciences, Inc. (USA); John Kielkopf, Univ. of Louisville (USA) ..... [9608-18]

**Remote optical detection of ground vibrations**, Robert M. Shroll, Bridget Tannian, Spectral Sciences, Inc. (USA); Benjamin St. Peter, Univ. of Massachusetts Amherst (USA); Elijah Jensen, John Kielkopf, Univ. of Louisville (USA); Wellesley E. Pereira, Air Force Research Lab. (USA) ..... [9608-19]

**Comparative analysis of IR images degraded by lossy compression techniques**, Reed A. Weber, Air Force Research Lab. (USA); William A. Toussaint, Boston College (USA) ..... [9608-20]

## TUESDAY 11 AUGUST

## SESSION 4..... TUE 8:10 AM TO 10:00 AM

### Probing Earth with Remote Sensors

Session Chairs: **Gail E. Bingham**, Utah State Univ. Research Foundation (USA); **Stanley J. Wellard**, Space Dynamics Lab. (USA)

**GOSAT operation beyond the designed lifetime** (*Invited Paper*), Hiroshi Suto, Akihiko Kuze, Kei Shiomi, Masakatsu Nakajima, Japan Aerospace Exploration Agency (Japan) ..... [9608-21]

**High resolution near infrared imaging spectrometer in CO<sub>2</sub> detection**, Xueqian Zhu, Lei Ding, Xinhua Niu, Shanghai Institute of Technical Physics (China) [9608-22]

**Fast calculation of scattered radiance in multispectral imagery simulation**, Xiaojia He, Xiaojian Xu, BeiHang Univ. (China) ..... [9608-23]

**Radiometric calibration of the ECOSTRESS signal chain**, William R. Johnson, Andre Wong, Colin Donahue, Robert Smythe, Jet Propulsion Lab. (USA) ..... [9608-24]

**Remote sensing in extreme environment: considerations on visible and infrared instrumentation for magnetic fusion experiments**, Marc Ferlet, MFC (France) ..... [9608-25]

## SESSION 5..... TUE 10:30 AM TO 12:00 PM

### Calibration and Data Processing for IR Feature Extraction I

Session Chairs: **Gonzalo Páez**, Ctr. de Investigaciones en Óptica, A.C. (Mexico); **Jing-shown Wu**, National Taiwan Univ. (Taiwan)

**Verification of gallium as thermal calibration reference in space** (*Invited Paper*), Gail E. Bingham, Shane Topham, Harri Latvikoski, Utah State Univ. Research Foundation (USA); Igor Podolski, Institute of Biomedical Problems (Russian Federation) ..... [9608-26]

**Absolute spectroradiometric calibration of standard stars**, John T. Woodward, Keith R. Lykke, Claire E. Cramer, Gerald T. Fraser, National Institute of Standards and Technology (USA) ..... [9608-27]

**Optical gratings and grisms: developments on straylight and polarization sensitivity improved microstructures**, Peter Triebel, Torsten Diehl, Tobias Moeller, Carl Zeiss Microscopy GmbH (Germany); Alexandre Gatto, Alexander Pesch, Lars Erdmann, Matthias Burkhardt, Alexander Kalies, Carl Zeiss Jena GmbH (Germany) ..... [9608-28]

**Payload system design for reducing size weight and power of a thermal infrared Earth resource monitoring instrument**, Trent Newswander, Scott Hansen, Jed Hancock, Space Dynamics Lab (USA) ..... [9608-29]

Lunch Break ..... Tue 12:00 pm to 1:30 pm

## SESSION 6..... TUE 1:30 PM TO 2:10 PM

### Calibration and Data Processing for IR Feature Extraction II

Session Chairs: **Gonzalo Páez**, Ctr. de Investigaciones en Óptica, A.C. (Mexico); **Jing-shown Wu**, National Taiwan Univ. (Taiwan)

**Optimal assimilation of advanced infrared and microwave sounding data for numerical weather prediction**, Chian-Yi Liu, National Central Univ. (Taiwan); Chung-Chih Liu, Minghsin Univ. of Science and Technology (Taiwan); Tang-Huang Lin, National Central Univ. (Taiwan); Agnes H. N. Lim, Univ. of Wisconsin-Madison (USA) ..... [9608-30]

**Temperature resolution enhancing of commercially available IR camera using computer processing**, Vyacheslav A. Trofimov, Vladislav V. Trofimov, Lomonosov Moscow State Univ. (Russian Federation) ..... [9608-31]

## SESSION 7..... TUE 2:10 PM TO 4:20 PM

### Advanced VIS-IR Focal Plane Development

Session Chairs: **Sean P. Kilcoyne**, Raytheon Co. (USA); **Neil Malone**, Raytheon Co. (USA)

**Efficient visible through SWIR focal plane MTF measurement**, Neil R. Malone, Raytheon Co. (USA) ..... [9608-32]

**Modern multispectral, ground, airborne and space digital focal plane technology**, Neil R. Malone, Raytheon Co. (USA) ..... [9608-33]

**Advancements in large-format SiPIN hybrid focal plane technology at Raytheon**, Sean P. Kilcoyne, Neil Malone, Raytheon Co. (USA) ..... [9608-34]

**Lifetime evaluation of large format CMOS mixed signal infrared devices**, Albert W. Linder, Raytheon Co. (USA) ..... [9608-35]

**Focal plane precision alignment, metrology, accuracy, knowledge and capability**, Jay R. Neumann, Raytheon Co. (USA) ..... [9608-36]

## SESSION 8..... TUE 4:20 PM TO 6:00 PM

### Development of Novel IR-Responsive Materials

Session Chairs: **Peter Bermel**, Purdue Univ. (USA); **Gonzalo Páez**, Ctr. de Investigaciones en Óptica, A.C. (Mexico)

**Cavity-enhanced AlGaAs/GaAs resonant tunneling photodetectors for telecommunication wavelength light detection at 1.3 μm** (*Invited Paper*), Andreas Pfennig, Fabian Hartmann, Fabian Langer, Sven Höfling, Martin Kamp, Lukas Worschech, Julius-Maximilians-Univ. Würzburg (Germany) ..... [9608-37]

**Modulation transfer function of infrared focal plane arrays** (*Invited Paper*), Sarah D. Gunapala, Sir B. Rafol, David Z. Ting, Cory J. Hill, Linda Hoeglund, Arezou Khoshakhlagh, Sam A. Keo, John K. Liu, Edward M. Luong, Jason M. Mumolo, Jet Propulsion Lab. (USA) ..... [9608-38]

**Alternative infrared and plasmonic materials: metal germanides and conductive oxides**, Nima Nader, Air Force Research Lab. (USA) and College of Optical Sciences, The Univ. of Arizona (USA); Shivashankar Vangala, Joshua Hendrickson, Air Force Research Lab. (USA); William Streyer, Daniel Wasserman, Univ. of Illinois at Urbana-Champaign (USA); Kevin Leedy, David Look, Air Force Research Lab. (USA); Richard Soref, Univ. of Massachusetts Boston (USA); Justin Cleary, Air Force Research Lab. (USA) ..... [9608-39]

**Colloidal quantum dot materials for infrared optoelectronics**, Susanna M. Thon, Johns Hopkins Univ. (USA) ..... [9608-40]

# CONFERENCE 9608

WEDNESDAY 12 AUGUST

SESSION 9 ..... WED 8:30 AM TO 12:00 PM

## Radiation-to-Current Transducers: Engineering Materials to Increase Current Generation

Session Chairs: **Sarath D. Gunapala**, Jet Propulsion Lab. (USA); **Gonzalo Páez**, Ctr. de Investigaciones en Óptica, A.C. (Mexico)

**Quantum confined semiconductor nanocrystals for use in high efficiency: low cost solar energy conversion strategies (Invited Paper)**, Matthew C. Beard, National Renewable Energy Lab. (USA) ..... [9608-41]

**Limiting efficiencies of photo-detection and solar energy conversion via internal emission of hot electrons and hot holes (Invited Paper)**, Svetlana V. Boriskina, Jiawei Zhou, Wei-Chun Hsu, Bolin Liao, Gang Chen, Massachusetts Institute of Technology (USA) ..... [9608-42]

**Nanomembranes and soft fabrication methods for high performance, low cost energy technologies (Invited Paper)**, Ralph G. Nuzzo, Univ. of Illinois at Urbana-Champaign (USA) ..... [9608-43]

**New concept to break the intrinsic properties of organic semiconductors for optical sensing applications (Invited Paper)**, Wallace C. H. Choy, The Univ. of Hong Kong (Hong Kong, China) ..... [9608-44]

**Hot electron detectors and energy conversion in the UV and IR (Invited Paper)**, Jeremy N. Munday, Univ. of Maryland, College Park (USA) ..... [9608-45]

**2D materials for photon conversion and nanophotonics (Invited Paper)**, Volker J. Sorger, Mohammad H. Tahersima, The George Washington Univ. (USA) ..... [9608-46]

Lunch Break ..... Wed 12:00 pm to 1:30 pm

SESSION 10 ..... WED 1:30 PM TO 4:30 PM

## Radiation-to-Current Transducers: Engineering Surfaces To Increase Radiation Absorption

Session Chairs: **Ralph G. Nuzzo**, Univ. of Illinois at Urbana-Champaign (USA); **Marija Strojnik Scholl**, Ctr. de Investigaciones en Óptica, A.C. (Mexico)

**Photothermal effects, hot plasmonic electrons and plasmonic photochemistry in hybrid nanostructures for light harvesting in the visible and infrared intervals (Invited Paper)**, Alexander Govorov, Ohio Univ. (USA) ..... [9608-47]

**Refractory plasmonic metal nitrides for infrared spectral region (Invited Paper)**, Vladimir M. Shalaev, Purdue Univ. (USA); Urcan Guler, Nano-Meta Technologies, Inc. (USA); Alexander V. Kildishev, Alexandra Boltasseva, Purdue Univ. (USA) ..... [9608-48]

**Enhancing selectivity of infrared absorbers and emitters through quality-factor matching (Invited Paper)**, Peter Bermel, Purdue Univ. (USA) ..... [9608-49]

**Passive radiative cooling of terrestrial surfaces below ambient under direct sunlight (Invited Paper)**, Aaswath P. Raman, Linxiao Zhu, Shanhai Fan, Stanford Univ. (USA) ..... [9608-50]

**Nanophotonics for energy applications (Invited Paper)**, Marin Soljacic, Massachusetts Institute of Technology (USA) ..... [9608-51]

CONCLUDING REMARKS ..... 4:30 PM TO 4:40 PM

Conference Chairs: **Marija Strojnik Scholl** and **Gonzalo Páez**, Ctr. de Investigaciones en Óptica, A.C. (Mexico)

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# Infrared Sensors, Devices, and Applications V

Conference Chairs: **Paul D. LeVan**, Air Force Research Lab. (USA); **Ashok K. Sood**, Magnolia Optical Technologies, Inc. (USA); **Priyalal Wijewarnasuriya**, U.S. Army Research Lab. (USA); **Arvind I. D'Souza**, DRS Sensors & Targeting Systems, Inc. (USA)

Program Committee: **Sumith Bandara**, U.S. Army Night Vision & Electronic Sensors Directorate (USA); **Eric A. DeCuir Jr.**, U.S. Army Research Lab. (USA); **Eustace L. Dereniak**, College of Optical Sciences, The Univ. of Arizona (USA); **Nibir K. Dhar**, Defense Advanced Research Projects Agency (USA); **Barbara G. Grant**, Lines and Lights Technology (USA); **Sarath D. Gunapala**, Jet Propulsion Lab. (USA); **John E. Hubbs**, Ball Aerospace & Technologies Corp. (USA); **Sanjay Krishna**, Ctr. for High Technology Materials (USA); **Michael W. Kudenov**, North Carolina State Univ. (USA); **Hooman Mohseni**, Northwestern Univ. (USA); **Hiroshi Murakami**, Japan Aerospace Exploration Agency (Japan); **Jimmy Xu**, Brown Univ. (USA)

## WEDNESDAY 12 AUGUST

### SESSION 1 ..... WED 8:00 AM TO 12:30 PM

#### Novel Detectors & Materials

Session Chairs: **Paul D. LeVan**, Air Force Research Lab. (USA); **Arvind I. D'Souza**, DRS Sensors & Targeting Systems, Inc. (USA)

**Advanced EO/IR Technologies at DARPA-MTO (Invited Paper)**, Jay S. Lewis, DARPA/MTO (USA); Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (USA); Ravi Dat, Lee A. Elizondo, Booz Allen Hamilton Inc. (USA) ..... [9609-32]

**Semi-insulating GaAs and Au Schottky barrier photodetectors for near-infrared detection (1280 nm)**, Ahmad I. Nusir, Yahia Makableh, Omar Manasreh, Univ. of Arkansas (USA) ..... [9609-1]

**Dependence on the depth of the arsenic implant in planar P+-on-n SWIR HgCdTe infrared detectors**, Jonathan Schuster, U.S. Army Research Lab. (USA) and Boston Univ. (USA); Roger E. DeWames, Corbin Co. (USA); Enrico Bellotti, Boston Univ. (USA); Priyalal S. Wijewarnasuriya, U.S. Army Research Lab. (USA) ..... [9609-2]

**Imaging technology: What is on the horizon?**, Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (USA) ..... [9609-37]

**Control of antimony incorporation on strain free InAs InAsSb type II superlattice materials for infrared sensing**, Heather J. Haugan, Gail J. Brown, Krishnamurthy Mahalingam, Air Force Research Lab. (USA); Said Elhamri, Univ. of Dayton (USA); Frank Szmulowicz, Air Force Research Lab. (USA) ..... [9609-3]

**An InGaAs p-i-n photodiode focal plane array with 360 degree field of view and 100% external quantum efficiency**, Dejui Fan, Kyusang Lee, Stephen Forrest, Univ. of Michigan (USA) ..... [9609-4]

**High-speed and high-saturation-current Si/Ge uni-traveling-carrier photodetector**, Chong Li, Beijing Univ. of Technology (China) ..... [9609-5]

**Enhancement of electron-injection detector performance by their special three-dimensional-geometry**, Vala Fathipour, Hooman Mohseni, Northwestern Univ. (USA) ..... [9609-6]

**Sensitivity advantage of using electron-injection detectors in ultra high speed 1060nm swept-source optical coherence tomography**, Vala Fathipour, Hooman Mohseni, Northwestern Univ. (USA) ..... [9609-7]

**A 16.4μm InGaAs/InAlAs quantum cascade detector**, Shengqiang Zhai, Junqi Liu, Fengqi Liu, Zhanqiao Wang, Institute of Semiconductors (China) ..... [9609-8]

**Characterization on Geiger-mode operation of deep diffused silicon APDs**, Erik B. Johnson, Xiao J. Chen, Mickel McElroy, Richard Farrell, James F. Christian, Radiation Monitoring Devices, Inc. (USA) ..... [9609-9]

Lunch Break ..... Wed 12:30 pm to 2:00 pm

### SESSION 2 ..... WED 2:00 PM TO 3:20 PM

#### Models, Simulations, Theory

Session Chairs: **Priyalal S. Wijewarnasuriya**, U.S. Army Research Lab. (USA); **Ashok K. Sood**, Magnolia Optical Technologies, Inc. (USA)

**Determining the electrical mechanism of surface resistivity property of doped polyvinyl alcohol (pva) and pyroelectric properties of polyvinylidene difluoride (pvdf) films**, Matthew E. Edwards Sr., Jemelia Polius, Padmaja Guggilla, Afef Janen, Michael Curley, Alabama A&M Univ. (USA) ..... [9609-10]

**Analytical model of avalanche photodiode based on “low-high-low” type heterostructure with separate absorption and multiplication regions**, Viacheslav A. Khodolnov, Institute of Radio Engineering and Electronics (Russian Federation); Mikhail S. Nikitin, JSC “Shvabe-Photodevice” (Russian Federation); Igor D. Burlakov, Orion Research-and-Production Association (Russian Federation) ..... [9609-11]

**Band structure and semiconductor to semimetal transition in InAs/GaSb nanostructure mid-infrared detector superlattice**, Abderrazak Boutramine, Abdelhakim Nafidi, Driss Barkissi, Abdelkrim Hannour, Ahmed Saba, Thami El Gouti, Univ. Ibn Zohr (Morocco) ..... [9609-12]

**Indirect-direct gap transition and electronic bands properties of GaAs/AIAs nanostructure superlattice for near infrared detection at room temperature**, Driss Barkissi, Abdelhakim Nafidi, Abderrazak Boutramine, Hicham Charifi, Abdellatif Elanique, Ali Khalal, Univ. Ibn Zohr (Morocco) ..... [9609-13]

### SESSION 3 ..... WED 3:50 PM TO 5:30 PM

#### Focal Plane Arrays and Electro-Optical Components

Session Chairs: **Priyalal S. Wijewarnasuriya**, U.S. Army Research Lab. (USA); **Arvind I. D'Souza**, DRS Sensors & Targeting Systems, Inc. (USA)

**Fabrication of resonator-QWIP FPA by inductively coupled plasma etching and projection printing**, Jason N. Sun, Kwong Choi, Kimberley Olver, U.S. Army Research Lab. (USA) ..... [9609-14]

**High temperature operation In1-xAlxSb infrared focal plane**, Yanqiu Lv, Luoyang Institute of Electro-Optical Equipment (China); Junjie Si, Xiancun Cao, Liang Zhang, Zhengyu Peng, Jiaxin Ding, Xiaolei Zhang, Luoyang Optoelectro Technology Development Ctr. (China); Valeriy Reobrazhenskiy, Institute of Semiconductor Physics (Russian Federation) ..... [9609-15]

**All optical modulator based on silicon resonator**, Meir Danino, Moshe Sinvani, Zeev Zalevsky, Liron Bidani, Oded M. Baharav, Hadar Pinhas, Bar-Ilan Univ. (Israel) ..... [9609-16]

**Design of ultra-thin metallic grating based quarter-wave plate for near infrared**, Dejiao Hu, Pang Lin, Sichuan Univ. (China) ..... [9609-17]

**Comparison of a liquid crystal display and MEMS deformable mirror for adaptive optics compensation in a flood illuminating system**, José Luis Magaña-Chávez, Sandra E. Balderas-Mata, Univ. de Guadalajara (Mexico); Gustavo Ramírez-Zavaleta, Luis Gabriel Valdívieso-González, Eduardo Tepichín-Rodríguez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico) ..... [9609-18]

# CONFERENCE 9609

## POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Angle deviation correction for symmetric slant edges in linear imaging sensor MTF measurement**, Ho-Lin Tsay, Ting-Ming Huang, Instrument Technology Research Ctr. (Taiwan) ..... [9609-26]

**Study on electron escaping mechanism of multi-alkali photocathode in the Super Gen. II image intensifier**, Xiao Feng Li, North Night Vision Technology Group Co., Ltd. (China) ..... [9609-27]

**The fiber grating strain sensor using in high temperature environment**, Qing Shi, Zhoulu Sun, Dongli Wang, Jiachen Ning, Beijing Research Institute of Telemetry (China). ..... [9609-28]

**Welding pool measurement using thermal array sensor**, Chia Hung Cho, Yi Chen Hsieh, Hsin Yi Chen, Industrial Technology Research Institute (Taiwan) ..... [9609-29]

**Photothermal deflection of laser beam as means to characterize thermal properties of biological tissue: numerical study**, Enoch Gutierrez-Herrera, Univ. Nacional Autónoma de México (Mexico) and Ctr. de Ciencias Aplicadas y Desarrollo Tecnológico (Mexico); Celia A. Sánchez Pérez, Carlos A. García-Cadena, Ctr. de Ciencias Aplicadas y Desarrollo Tecnológico (Mexico) and Univ. Nacional Autónoma de México (Mexico) ..... [9609-30]

## THURSDAY 13 AUGUST

## SESSION 4.....THU 8:20 AM TO 10:00 AM

### Innovative EO Fiber Applications

Session Chairs: **Ashok K. Sood**, Magnolia Optical Technologies, Inc. (USA); **Paul D. LeVan**, Air Force Research Lab. (USA)

**Design and development of wafer-level short wave infrared micro-camera**, Ashok K. Sood, John W. Zeller, Yash R. Puri, Magnolia Optical Technologies, Inc. (USA); Harry Efstathiatis, Pradeep Haldar, Univ. at Albany (USA); Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (USA); Jay S. Lewis, DARPA/MTO (USA) ..... [9609-33]

**Mid-infrared GeTe4 waveguide on silicon with ZnSe isolation layer**, Vinita Mittal, James S. Wilkinson, Ganapathy S. Murugan, Univ. of Southampton (United Kingdom) ..... [9609-36]

**Remote road surface sensor using a single-wavelength light source**, Chi Ruan, Yuntao Wang, Xi'an Institute of Optics and Precision Mechanics (China) . [9609-19]

**Series-coupled fiber double-ring in Mach-Zehnder interferometer for temperature sensing**, Yundong Zhang, Yongfeng Wu, Xuenan Zhang, Hui Li, Ping Yuan, Harbin Institute of Technology (China) ..... [9609-20]

**Integrated multi-color illumination source for lab-on-a-chip fluorescence analysis**, Abdullah J. Zakariya, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); Bassam Alfeeli, Kuwait Foundation for Advancement of Science (Kuwait) ..... [9609-21]

**Mechanically induced long period fiber gratings on single mode tapered optical fiber for structure sensing applications**, María G. Pulido-Navarro, Sigifredo Marrujo-García, José A. Álvarez-Chávez, Jesús S. Velázquez-González, Fernando Martínez-Piñón, Ctr. de Investigación e Innovación Tecnológica (Mexico); Ponciano J. Escamilla-Ambrosio, Ctr. de Investigación en Computación (Mexico) ..... [9609-22]

**PET and PVC separation system based on optical sensors**, Grethell Georgina Pérez-Sánchez, Teresa Granados, Ricardo Rodríguez, José R. Pérez-Torres, Tecnológico de Estudios Superiores de Coacalco (Mexico); José A. Álvarez-Chávez, Ctr. de Investigación e Innovación Tecnológica (Mexico) . [9609-23]

## SESSION 5.....THU 10:30 AM TO 11:10 AM

### Components and Applications of EO/IR Technology

Session Chairs: **Arvind I. D'Souza**, DRS Sensors & Targeting Systems, Inc. (USA); **Paul D. LeVan**, Air Force Research Lab. (USA)

**Long-term infrared background compensation for faint objects and variable backgrounds: a feasibility study**, Paul D. LeVan, Air Force Research Lab. (USA); Mark Stegall, Greg Pierce, SE-IR Corp. (USA) ..... [9609-24]

**High-performance near-infrared spectrally encoded microscopy by using a balanced detector**, Jiluling Liao, Wanrong Gao, Nanjing Univ. of Science and Technology (China) ..... [9609-25]

**Metal bonding to enable contact to three-dimensional antenna-coupled intersubband detectors**, Robert L. Brown, Alan Selewa, Sung Jun Jang, Aireza Bonakdar, Mohsen Rezaei, Hooman Mohseni, Northwestern Univ. (USA). [9609-31]

**Development of high gain avalanche photodiodes for UV imaging applications**, Ashok K. Sood, John W. Zeller, Roger E. Welser, Yash R. Puri, Magnolia Optical Technologies, Inc. (USA); Mi-Hee Jee, Russell D. Dupuis, Georgia Institute of Technology (USA); Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (USA); Jay S. Lewis, DARPA/MTO (USA) ..... [9609-34]

**Large format MBE HgCdTe on silicon detector development for astronomy**, Brandon J. Hanold, Donald F. Figer, Joong Y. Lee, Kimberly E. Kolb, Ian Marcuson, Rochester Institute of Technology (USA); Elizabeth Corrales, Jonathan Getty, Lynn Mears, Raytheon Co. (USA) ..... [9609-35]

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# Remote Sensing and Modeling of Ecosystems for Sustainability XII

**Conference Chairs:** Wei Gao, Colorado State Univ. (USA); Ni-Bin Chang, Univ. of Central Florida (USA)**Conference Co-Chair:** Jinnian Wang, Institute of Remote Sensing Applications (China)**Program Committee:** E. Raymond Hunt Jr., Agricultural Research Service (USA); Brian Robert Johnson, Raytheon Co. (USA); Thomas U. Kampe, NEON, Inc. (USA); Xin-Zhong Liang, Univ. of Maryland, College Park (USA); Dennis Ojima, Colorado State Univ. (USA); John J. Qu, George Mason Univ. (USA); David Riaño, Univ. of California, Davis (USA); Jiong Shu, East China Normal Univ. (China); Zhibin Sun, Colorado State Univ. (USA); Qiao Wang, Ministry of Environmental Protection (China); Hongjie Xie, The Univ. of Texas at San Antonio (USA); Xiaobing Zhou, Montana Tech (USA)

## TUESDAY 11 AUGUST

**SESSION 1 ..... TUE 1:30 PM TO 5:30 PM**

### Environmental Remote Sensing and GIS

Session Chairs: Zhibin Sun, Colorado State Univ. (USA); Ali Abou-Elnour, Ajman Univ. of Science &amp; Technology (United Arab Emirates)

**Site suitability evaluation for ecotourism potential areas using remote sensing (RS) and geographic information system (GIS): a case study of Wadi Wurayah, Fujairah, United Arab Emirates** (*Invited Paper*), Ali Abou-Elnour, Ajman Univ. of Science & Technology (United Arab Emirates) ..... [9610-1]**Evaluations of cropland representations in CMIP5 simulations** (*Invited Paper*), Min Xu, Forrest Hoffman, Oak Ridge National Lab. (USA) ..... [9610-2]**UV irradiance products from combined TOMS-OMI satellite and UVMR ground measurements across the continental U.S.** (*Invited Paper*), Zhibin Sun, John Davis, Wei Gao, Colorado State Univ. (USA) ..... [9610-3]**Mapping the lawn in urban area using airborne LIDAR and aerial visible images**, Hongbo Su, Florida Atlantic Univ. (USA); Ni-Bin Chang, Univ. of Central Florida (USA) ..... [9610-4]**Continuous evaluation of land cover restoration of tsunami struck plains in Japan by using several kinds of optical satellite image in time series**, Hideki Hashiba, Nihon Univ. (Japan) ..... [9610-5]**In situ hyperspectral data analysis for chlorophyll content estimation of an invasive species spartina alterniflora based on PROSAIL canopy radiative transfer model**, Jinquan Ai, East China Normal Univ. (China); Wei Gao, Colorado State Univ. (USA); Runhe Shi, East China Normal Univ. (China); Zhibin Sun, Colorado State Univ. (USA); Wenhui Chen, Fujian Normal Univ. (China); Chao Zhang, Pudong Liu, Yuyan Zeng, East China Normal Univ. (China) ..... [9610-6]**Monitoring forest biodiversity using imaging spectroscopy based on leaf biochemical variations in subtropical forest**, YuJin Zhao, Yuan Zeng, Bingfang Wu, Qianjun Zhao, Dan Zhao, Institute of Remote Sensing and Digital Earth (China) ..... [9610-7]**Detecting response of rice phenology to cold and heat damages using time series analysis of MODIS images**, Shenbin Yang, Shuanghe Shen, Nanjing Univ. of Information Science & Technology (China); Chunlin Shi, Jiangsu Academy of Agricultural Sciences (China) ..... [9610-8]**The land use change characteristics and its driving force analysis of Shiyang River Basin in northwest China**, Tao Han, Lanzhou Institute of Arid Meteorology (China) ..... [9610-9]

## WEDNESDAY 12 AUGUST

**SESSION 2 ..... WED 8:10 AM TO 12:00 PM**

### Remote Sensing for Agriculture, Ecosystems, and Hydrology

Session Chairs: Ni-Bin Chang, Univ. of Central Florida (USA); Min Xu, Oak Ridge National Lab. (USA)

**Seasonal urban heat island effect in Tampa Bay under the varying hydrological patterns** (*Invited Paper*), Ni-Bin Chang, Univ. of Central Florida (USA); Kaixu Bai, Univ. of Central Florida (USA) and East China Normal Univ. (China); Wei Gao, Colorado State Univ. (China) ..... [9610-10]**Incorporation of crop growth models into climate weather research and forecasting model: biophysical feedbacks of maize growth to regional climate** (*Invited Paper*), Xin-Zhong Liang, Min Xu, Univ. of Maryland, College Park (USA); Xuesong Zhang, Univ. of Maryland at College Park (USA); Wei Gao, Colorado State Univ. (USA) ..... [9610-11]**Land cover fraction estimation with global endmembers using collaborative SUNSAL**, Uttam Kumar, Cristina Milesi, NASA Ames Research Ctr. (USA); S. Kumar Raja, EADS Innovation Works, Airbus Engineering Ctr. (India); Ramakrishna Nemani, NASA Ames Research Ctr. (USA); Sangram Ganguly, NASA Ames Research Ctr. (USA) and Bay Area Environmental Research Institute (BAERI) (USA); Weile Wang, California State Univ. (USA) and NASA Ames Research Ctr. (USA) ..... [9610-12]**Effects of errors in solar radiation inputs on ecosystem model performance**, Shinichi Asao, Zhibin Sun, Wei Gao, Colorado State Univ. (USA) ..... [9610-13]**Visualization of Remote Sensing Image Positioning Uncertainty**, Jiao Weili, Saiguang Ling, Yiqing Yu, Tengfei Long, Guojin He, Institute of Remote Sensing and Digital Earth (China) ..... [9610-14]**Using artificial neural network and satellite data to predict rice yield in Bangladesh**, Kawsar A. Akhand, The City Univ. of New York (USA); Mohammad Nizamuddin, Leonid Roitman, The City College of New York (USA); Felix Kogan, Mitch Goldberg, Ctr. for Satellite Applications and Research (USA) ..... [9610-15]**Sensitivity analysis of canopy model parameters by EFAST method**, Pudong Liu, Runhe Shi, Hong Wang, Wei Gao, East China Normal Univ. (China) .. [9610-16]**NPP estimation and seasonal change research of Gansu province in northwest China**, Tao Han, Lanzhou Institute of Arid Meteorology (China) ..... [9610-17]**A study on China's LUCC and carbon-sink response with remote sensing**, Zhiqiang Gao, Yantai Institute of Coastal Zone Research (China) ..... [9610-18]

# CONFERENCE 9610

SESSION 3 ..... WED 1:30 PM TO 5:20 PM

## Remote Sensing and Modeling Applications

Session Chairs: Xin-Zhong Liang, Univ. of Maryland, College Park (USA); John H. Prueger, Agricultural Research Service (USA)

**Long-term precipitation forecasting based on teleconnection signal propagation across North America (Invited Paper)**, Ni-Bin Chang, Sanaz Imen, Univ. of Central Florida (USA); Kaixu Bai, Univ. of Central Florida (USA) and East China Normal Univ. (China) ..... [9610-19]

**Climate change impacts on the U.S. agricultural economy (Invited Paper)**, Xin-Zhong Liang, You Wu, Robert G. Chambers, Univ. of Maryland (USA); Daniel L. Schmoldt, U.S. Dept. of Agriculture (USA); Chao Sun, Univ. of Maryland (USA) ..... [9610-20]

**Temporal variation (seasonal and interannual) of vegetation indices of corn and soybeans across multiple years in central Iowa**, John H. Prueger, Jerry L. Hatfield, Agricultural Research Service (USA) ..... [9610-21]

**The calibration of collocated UV and VIS multi-filter rotating shadowband radiometers by the reference channel method**, Maosi Chen, John Davis, Zhibin Sun, Wei Gao, Colorado State Univ. (USA) ..... [9610-22]

**Water stress detection of lilac leaves using a polarized laser**, Songxin Tan, A. S. M. K. Khan, South Dakota State Univ. (USA) ..... [9610-23]

**Raman spectroscopy for the control of the atmosphere bioindicator**, Elena V. Timchenko, Larisa A. Zherdeva Taskina, Nikolay V. Tregub, Pavel E. Timchenko, Ludmila A. Shamina, Samara State Aerospace Univ. (Russian Federation) [9610-24]

**Study of emissivity changes presented by inorganic and organic soil under drying at ambient temperature**, Carlos Villaseñor-Mora, Arturo Gonzalez-Vega, Univ. de Guanajuato (Mexico); Pablo Martinez-Torres, Univ. Michoacana de San Nicolás de Hidalgo (Mexico) ..... [9610-25]

**Accurate extracting of moso bamboo from Landsat TM based on a constrained linear least square method**, Yixiang Wang, Zhejiang Agriculture & Forestry Univ. (China) and Colorado State Univ. (USA); Zhibin Sun, Colorado State Univ. (USA); Shangbin Bai, Zhejiang Agriculture & Forestry Univ. (China) and Colorado State Univ. (USA) ..... [9610-26]

**Assessments of Chinese FY-3C MWHTS measurements and the stripping noise analysis**, Juan Li, China Meteorological Administration (China); ZhengKun Qin, Nanjing Univ. of Information Science & Technology (China) ..... [9610-27]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Rapid urban sprawl stimulated by increasing GDP and rising urban land price in east China coast from 2000 to 2009**, Qingshui Lu, Yantai Institute of Coastal Zone Research (China) ..... [9610-28]

**Evaluation of WRF physics and cumulus parameterization schemes in simulating convective precipitation over Yangtze River Delta**, Yu Kan, Chaoshun Liu, Yan-an Liu, East China Normal Univ. (China) ..... [9610-29]

**A soil heavy metal source apportionment method based on GIS**, Cheng C. Fu, Chinese Academy of Sciences (China); Zhiqiang Gao, Bo H. Zhang, Shui Q. Lu, Institute of Geographic Sciences and Natural Resources Research (China) [9610-30]

**A tool for NDVI time series extraction from wide-swath remotely sensed images**, Zhishan Li, Runhe Shi, Wei Gao, East China Normal Univ. (China) [9610-31]

**Implementation of coastal zone data integration and sharing platform based on web GIS**, Mingzhu Xu, Institute of Geographic Sciences and Natural Resources Research (China) and Univ. of Chinese Academy of Sciences (China); Zhiqiang Gao, Institute of Geographic Sciences and Natural Resources Research (China) [9610-32]

**Spatial-temporal variability of the continental coastline in Bohai Rim**, Ning Xu, Zhiqiang Gao, Yantai Institute of Coastal Zone Research (China) ..... [9610-33]

**Salinity and soil moisture retrieval algorithms in western Jilin province of China using passive microwave remote sensing data**, Haoyang Fu, Lingjia Gu, Ruizhi Ren, Jilin Univ. (China) ..... [9610-34]

**Analysis on changes in coastline and reclamation area and its causes based on 30-years satellite data in the highly effective ecological zone of the Yellow River Delta**, Xiangyu Zheng, Yantai Institute of Coastal Zone Research (China) ..... [9610-35]

**Snow depth retrieval algorithm of saline-alkali land in western Jilin province of China using passive microwave remote sensing data**, Mingbo Sun, Lingjia Gu, Ruizhi Ren, Haoyang Fu, Jilin Univ. (China) ..... [9610-36]

**The application of geo-information TuPu in coastline change study: taking coastland of Shandong province as an example**, Xiangyang Liu, Zhiqiang Gao, Jicai Ning, Qingshui Lu, Yantai Institute of Coastal Zone Research (China) [9610-37]

**Analysis of scaling effect on the estimation of chlorophyll content using narrow band NDVI based on radiative transfer models**, Hong Wang, Runhe Shi, Pudong Liu, East China Normal Univ. (China) ..... [9610-38]

**Retrieving aerosol optical depth over Beijing based on Landsat8 OLI data**, Lu Zhang, Runhe Shi, Long Li, East China Normal Univ. (China) ..... [9610-39]

**Comparative analysis of land surface emissivity (LSE) retrieval methods and the impact on the land surface temperature based on Landsat-8 thermal infrared data**, Kan Zenghui, Liu Chaoshun, Gao Wei, East China Normal Univ. (China) ..... [9610-40]

**Assessing the potential and actual productivity of winter wheat in the North China Plain by WOFOST model**, Jialin Yang, Chaoshun Liu, East China Normal Univ. (China); Wei Gao, East China Normal Univ. (China) and Colorado State Univ. (USA) ..... [9610-41]

**Total ozone columns comparisons between space-based and ground-based observations**, Ming-Liang Ma, Runhe Shi, Wei Gao, East China Normal Univ. (China) ..... [9610-42]

**Remote estimation of GPP in temperate grassland: implications of the uncertainty in GPP estimation in grassland using MODIS data**, Shishi Liu, Huazhong Agricultural Univ. (China); Yi Peng, Wuhan Univ. (China); Qingfeng Guan, China Univ. of Geosciences (China) ..... [9610-43]

**Analysis of temporal and spatial variation in Shandong province island shoreline and land cover based on remote sensing and GIS**, Ruqing Zhuo, Yantai Institute of Coastal Zone Research (China) ..... [9610-44]

**Sensitivity analysis of model parameters for retrieval of leaf area index based on PROSAIL model**, Yuyan Zeng, Runhe Shi, Pudong Liu, Jinquan Ai, Wei Gao, East China Normal Univ. (China) ..... [9610-45]

**Changes on albedo after a large forest fire in Mediterranean ecosystems**, Carmen Quintano, Univ. de Valladolid (Spain); Alfonso Fernández-Manso, Victor Fernández, Univ. de León (Spain); Leonor Calvo, Univ. de León (Spain) .. [9610-46]

**Linear fractional-based filter as a pre-classifier to map surface coal mining affected area**, Carmen Quintano, Univ. de Valladolid (Spain); Alfonso Fernández-Manso, Univ. de León (Spain); Eduardo Cuesta, Univ. de Valladolid (Spain) [9610-47]

**Data fusion of CO<sub>2</sub> retrieved from GOSAT and AIRS using regression analysis and fixed rank kriging**, Cong Zhou, Runhe Shi, East China Normal Univ. (China) ..... [9610-48]

**Study on relationship between concentration of air pollution and meteorological factor in Shanghai from 2013-2014**, Jing Wang, Runhe Shi, East China Normal Univ. (China) ..... [9610-49]

**Optical methods for control of aquatic plants under pollutant effect**, Elena V. Timchenko, Larisa A. Zherdeva Taskina, Pavel E. Timchenko, Anna A. Asadova, Samara State Aerospace Univ. (Russian Federation) ..... [9610-50]

**Retrieval of water and heat flux based on fusion of LANDSAT TM/ETM+ and MODIS data**, Jicai Ning, Yantai Institute of Coastal Zone Research (China) ..... [9610-51]

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## Imaging Spectrometry XX

Conference Chairs: **Thomas S. Pagano**, Jet Propulsion Lab. (USA); **John F. Silny**, Raytheon Space & Airborne Systems (USA)

Program Committee: **Christoph C. Borel**, Air Force Institute of Technology (USA); **Thomas Cooley**, Air Force Research Lab. (USA); **Eustace L. Dereniak**, College of Optical Sciences, The Univ. of Arizona (USA); **Robert O. Green**, Jet Propulsion Lab. (USA); **Emmett J. Lentilucci**, Rochester Institute of Technology (USA); **Steven A. Macenka**, Jet Propulsion Lab. (USA); **Mehrube Mehrubeoglu**, Texas A&M Univ. Corpus Christi (USA); **Joseph Meola**, Air Force Research Lab. (USA); **Jose F. Moreno**, Univ. de València (Spain); **Pantazis Mouroulis**, Jet Propulsion Lab. (USA); **Richard L. Wiggins**, Corning Specialty Materials, Inc. (USA)

### MONDAY 10 AUGUST

#### SESSION 1 ..... MON 8:00 AM TO 11:10 AM

##### Remote Sensing

Session Chairs: **Steven A. Macenka**, Jet Propulsion Lab. (USA); **Mehrube Mehrubeoglu**, Texas A&M Univ. Corpus Christi (USA)

**Compact wide swath imaging spectrometer (CWIS): alignment and laboratory calibration**, Byron E. Van Gorp, Pantazis Mouroulis, Robert O. Green, Daniel W. Wilson, Jose I. Rodriguez, Elliot Liggett, Jet Propulsion Lab. (USA) ..... [9611-1]

**Snow and water imaging spectrometer (SWIS): opto-mechanical and system design for a CubeSat-compatible instrument**, Holly A. Bender, Pantazis Mouroulis, Byron E. Van Gorp, Jet Propulsion Lab. (USA); Christopher D. Smith, ATK Aerospace Systems (USA); Michael Eastwood, Ernesto Diaz, Colin H. Smith, Jet Propulsion Lab. (USA) ..... [9611-2]

**Technical developments toward the pre-processing and quality assessment of the upcoming EnMAP space-based hyperspectral data**, André Hollstein, Karl Segl, Christian Rogass, Luis Guanter, Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ (Germany) ..... [9611-3]

**Effect of entangled PSF/ISRF of imaging spectrometers on the retrieval of low signals over spectrally contrasting features: a case study for remote sensing of chlorophyll fluorescence**, Luis Alonso, Univ. de València (Spain); Francisco Pinto, Uwe Rascher, Forschungszentrum Jülich GmbH (Germany); Jose Moreno, Univ. de València (Spain) ..... [9611-4]

**Mapping pigment distribution in mud samples through hyperspectral imaging**, Mehrube Mehrubeoglu, Cosmina Nicula, Shane W. Smith, Dustin K. Smith, Elizabeth S. Shanks, Paul V. Zimba, Texas A&M Univ. Corpus Christi (USA) [9611-5]

**Long-wavelength infrared hyperspectral data “mining” at Cuprite, NV**, Steven M. Adler-Golden, Patrick F. Conforti, Lawrence S. Bernstein, Robert Sundberg, Spectral Sciences, Inc. (USA) ..... [9611-6]

**Baffling for high performance thermal imaging spectroscopy**, William R. Johnson, Jonathan Mihaly, Simon J. Hook, Bjorn T. Eng, Jet Propulsion Lab. (USA) ..... [9611-7]

**Performance status of the AIRS instrument thirteen years after launch**, Denis A. Elliott, Thomas S. Pagano, Jet Propulsion Lab. (USA) ..... [9611-8]

#### SESSION 2 ..... MON 11:10 AM TO 11:50 AM

##### Instrument and Scene Simulation and Modeling I

Session Chairs: **Eustace L. Dereniak**, College of Optical Sciences, The Univ. of Arizona (USA); **Christoph C. Borel-Donohue**, Air Force Institute of Technology (USA)

**Retrieved products from simulated hyperspectral infrared observations of a hurricane**, Joel Susskind, NASA Goddard Space Flight Ctr. (USA) ..... [9611-9]

**Observing system simulation experiments to evaluate the potential impact of new remote sensing instruments on hurricane track and intensity forecasting**, Robert M. Atlas, National Oceanic and Atmospheric Administration (USA) [9611-10]

Lunch Break ..... Mon 11:50 am to 1:20 pm

#### SESSION 3 ..... MON 1:20 PM TO 2:20 PM

##### Instrument and Scene Simulation and Modeling II

Session Chairs: **Eustace L. Dereniak**, College of Optical Sciences, The Univ. of Arizona (USA); **Christoph C. Borel-Donohue**, Air Force Institute of Technology (USA)

**Design of a satellite end-to-end mission performance simulator for imaging spectrometers and its application to the ESA's FLEX/Sentinel-3 tandem mission**, Jorge Vicent, Neus Sabater, Carolina Tenjo, Univ. de València (Spain); Juan Acarreta, Elecnor Deimos Space S.L.U. (Spain); María Manzano, GMV Aerospace & Defence (Spain); Juan Pablo Rivera, Univ. de València (Spain); Raffaella Franco, European Space Research and Technology Ctr. (Netherlands); Jose Moreno, Univ. de València (Spain) ..... [9611-11]

**Best practices for performance modeling of imaging spectrometers**, Louis Zellinger, Raytheon Space and Airborne Systems (USA) ..... [9611-12]

**Analysis of a LWIR HSI design concept to mitigate the impact of optical distort**, Pierre V. Villeneuve, Exelis, Inc. (USA); Eric M. Moskun, Joseph G. Shanks, John F. Silny, Raytheon Space and Airborne Systems (USA); Alan D. Stocker, DRS Sensors & Targeting Systems, Inc. (USA) ..... [9611-13]

#### SESSION 4 ..... MON 2:20 PM TO 5:30 PM

##### Surface and Gas Imaging Spectrometry

Session Chairs: **Richard L. Wiggins**, Corning Specialty Materials, Inc. (USA); **Thomas W. Cooley**, Air Force Research Lab. (USA)

**Experimental measurement and analysis of wavelength-dependent properties of the BRDF**, Samuel D. Butler, Stephen E. Nauyoks, Michael A. Marciak, Air Force Institute of Technology (USA) ..... [9611-14]

**Comparative study of spectral diffuse-only and diffuse-specular radiative transfer models and field-collected data in the LWIR**, Dimitar M. Stoyanov, Michael A. Marciak, Air Force Institute of Technology (USA); Joseph Meola, Air Force Research Lab. (USA) ..... [9611-15]

**Snapshot spectral imaging for gas cloud sensing and quantification**, Nathan A. Hagen, Robert T. Kester, Ryan P. Mallory, Rebellion Photonics (USA) ..... [9611-16]

**Improved modeling of multiple scattering in hyperspectral BRDF of coastal sediments**, Charles M. Bachmann, Rochester Institute of Technology (USA) ..... [9611-17]

**Determining the bilirubin concentration in bruises of human skin using spectral imaging**, Marta Lange, Inga Saknate, Janis Spigulis, Univ. of Latvia (Latvia) ..... [9611-18]

**A comparative study of three vision systems for metal surface defect detection**, Mehrube Mehrubeoglu, Petru-Aurelian Simionescu, Shawn Robinson, Texas A&M Univ. Corpus Christi (USA); Lifford McLauchlan, Texas A&M Univ.-Kingsville (USA) ..... [9611-19]

**Relating water absorption features to soil moisture characteristics**, Jia Tian, William Philpot, Cornell Univ. (USA) ..... [9611-20]

**Application of imaging spectrometer in gas analysis by Raman scattering**, Duluo Zuo, Anlan Yu, Zhe Li, Xingbing Wang, Huazhong Univ. of Science and Technology (China); Youhui Xiong, Wuhan Cubic Optoelectronics Co., Ltd. (China) ..... [9611-21]

# CONFERENCE 9611

TUESDAY 11 AUGUST

SESSION 5.....TUE 8:00 AM TO 11:10 AM

## Novel Designs and Technologies

Session Chairs: Thomas S. Pagano, Jet Propulsion Lab. (USA); John F. Silny, Raytheon Space and Airborne Systems (USA)

**Predicted and measured properties of single-blaze and dual-blaze diamond-ruled Offner gratings for VIS-SWIR**, Mohammad A. Saleh, Patrick Woodman, Lovell E. Comstock, Richard L. Wiggins, Corning Incorporated (USA) . . . [9611-22]

**Standing wave integrated Fourier transform spectrometer for imaging spectrometry in the near infrared**, Gaël D. Osowiecki, Mohammadreza Madi, Ecole Polytechnique Fédérale de Lausanne (Switzerland); Edoardo Alberti, Micos Engineering GmbH (Switzerland); Toralf Scharf, Hans Peter Herzig, Ecole Polytechnique Fédérale de Lausanne (Switzerland) . . . [9611-23]

**Straylight analysis of a hyperspectral spectrometer using non sequential ray tracing**, Jinsuk Hong, Samsung Thales Co., Ltd. (Korea, Republic of) . . . [9611-24]

**Bae systems small form factor long wave infrared hyperspectral imager**, John MacEachin, Michael J. Russo, BAE Systems (USA) . . . [9611-25]

**Smart CMOS sensor for wideband laser threat detection**, Craig R. Schwarze, OPTRA, Inc. (USA); Sameer Sonkusale, Tufts Univ. (USA) . . . [9611-26]

**Propagation of spectral characterization errors of imaging spectrometers at level-1 and its correction within a level-2 recalibration scheme**, Jorge Vicent, Neus Sabater, Univ. de València (Spain); Christophe Miesch, Airbus Defence and Space (France); Stefan Kraft, European Space Operations Ctr. (Germany); Jose Moreno, Univ. de València (Spain) . . . [9611-27]

**The CHROMA focal plane array: a large-format, low-noise detector optimized for imaging spectroscopy**, Bradley Jones, Steven G. Bernd, Jason Herring, Jianmei Pan, Ryan S. Ries, Brian Starr, Donald L. Lee, James W. Beletic, Teledyne Imaging Sensors (USA); Elliott Liggett, Jet Propulsion Lab. (USA) . . . [9611-28]

**Advanced space Cryocoolers for imaging spectrometry**, Ted Conrad, Brian Schaefer, Lowell A. Bellis, Ryan Yates, Michael Barr, John F. Silny, Raytheon Space and Airborne Systems (USA) . . . [9611-29]

SESSION 6.....TUE 11:10 AM TO 11:50 AM

## Radiative Transfer, Detection, and Data Processing I

Session Chairs: Emmett J. lentiucci, Rochester Institute of Technology (USA); Joseph Meola, Air Force Research Lab. (USA)

**Measurement and modeling of longwave infrared directional downwelling spectral radiance**, Nathan P. Wurst, Joseph Meola, Air Force Research Lab. (USA); David L. Perry, General Dynamics Corp. (USA) . . . [9611-30]

**Nonnegative matrix factorization for efficient hyperspectral image projection**, Alexander S. Iacchetta, James R. Fienup, Univ. of Rochester (USA); David T. Leisawitz, Matthew R. Bolcar, NASA Goddard Space Flight Ctr. (USA) . . . [9611-31]

Lunch Break . . . . . Tue 11:50 am to 1:20 pm

SESSION 7.....TUE 1:20 PM TO 4:30 PM

## Radiative Transfer, Detection, and Data Processing II

Session Chairs: Emmett J. lentiucci, Rochester Institute of Technology (USA); Joseph Meola, Air Force Research Lab. (USA)

**Comparison of hyperspectral change detection algorithms**, Michael L. Pieper, Dimitris G. Manolakis, MIT Lincoln Lab. (USA); Thomas W. Cooley, Air Force Research Lab. (USA); Michael S. Brueggeman, Andrew J. Weisner, John Jacobson, National Air and Space Intelligence Ctr. (USA) . . . . . [9611-32]

**Ultrafast high accuracy radiative transfer modeling of cloudy atmosphere in solar spectral region**, Qiguang Yang, Xu Liu, NASA Langley Research Ctr. (USA); Wan Wu, Science Systems and Applications, Inc. (USA); Ping Yang, Chenxi Wang, Texas A&M Univ. (USA) . . . . . [9611-33]

**Phase correction algorithms for a snapshot hyperspectral imaging system**, Victoria C. Chan, The Univ. of Arizona (USA); Michael W. Kudenov, North Carolina State Univ. (USA); Eustace L. Derenik, The Univ. of Arizona (USA) . . . . . [9611-34]

**Characterizing intimate mixtures of materials in hyperspectral imagery with albedo-based and kernel-based least squares and approaches**, Robert S. Rand, Ronald G. Resmini, National Geospatial-Intelligence Agency (USA); David W. Allen, National Institute of Standards and Technology (USA) . . . . . [9611-35]

**Improved atmospheric retrievals of hyperspectral data using geometric constraints**, Kenneth Ewald, Ball Aerospace & Technologies Corp. (USA); Emmett J. lentiucci, Rochester Institute of Technology (USA); John Jacobson, National Air and Space Intelligence Ctr. (USA); Alan T. Buswell, Ball Aerospace & Technologies Corp. (USA) . . . . . [9611-36]

**Hyperspectral band selection using the total dependence metric**, Seyed Enayat Hosseini Aria, Massimo Menenti, Ben Gorte, Technische Univ. Delft (Netherlands) . . . . . [9611-37]

**A novel anomaly detection approach based on clustering and decision-level fusion**, Shengwei Zhong, Ye Zhang, Harbin Institute of Technology (China) . . . . . [9611-38]

**An improved full automated endmember extraction algorithm based on endmember independence**, Yiran Wang, Ye Zhang, Harbin Institute of Technology (China) . . . . . [9611-39]

WEDNESDAY 12 AUGUST

POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Random projection-based dimensionality reduction method for hyperspectral target detection**, Weiyi Feng, Nanjing Univ. of Science and Technology (China) . . . . . [9611-40]

**Analysis of active oxygen species kinetics**, Andrey Pershin, Samara State Aerospace Univ. (Russian Federation) . . . . . [9611-41]

**Development and testing of an image-guided FT-IR Instrument for field spectroscopy**, Xiaobing Dai, State Key Lab. for Multi-Spectral Information Processing Technologies (China) and Huazhong Univ. of Science and Technology (China); Xiangyan Liu, Huazhong Univ. of Science and Technology (China) [9611-42]

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# Lidar Remote Sensing for Environmental Monitoring XV

Conference Chair: Upendra N. Singh, NASA Langley Research Ctr. (USA)

Program Committee: Parminder Ghuman, NASA Goddard Space Flight Ctr. (USA); Floyd E. Hovis, Fibertek, Inc. (USA); Yongxiang Hu, NASA Langley Research Ctr. (USA); George J. Komar, NASA Headquarters (USA); Kohei Mizutani, National Institute of Information and Communications Technology (Japan); Jirong Yu, NASA Langley Research Ctr. (USA)

## WEDNESDAY 12 AUGUST

### POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

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**Parameterization of a geometrical reaction time model for two beam nacelle LIDARs.** Thorsten Beuth, Maik Fox, Wilhelm Stork, Karlsruher Institut für Technologie (Germany) ..... [9612-19]

## THURSDAY 13 AUGUST

### WELCOME COMMENTS ..... 8:00 AM TO 8:20 AM

Conference Chair: Upendra N. Singh, NASA Langley Research Ctr. (USA)

### SESSION 1 ..... THU 8:20 AM TO 8:50 AM

#### Keynote Session

Session Chair: Parminder Ghuman, NASA Goddard Space Flight Ctr. (USA)

**NASA's future earth science technology capabilities: challenges and opportunities (Keynote Presentation).** George J. Komar, NASA Headquarters (USA) ..... [9612-1]

### SESSION 2 ..... THU 8:50 AM TO 11:40 AM

#### Greenhouse Gases Technologies, Techniques, and Measurements

Session Chairs: George J. Komar, NASA Headquarters (USA); Upendra N. Singh, NASA Langley Research Ctr. (USA)

**Progress in developing the CO<sub>2</sub> sounder Lidar as a candidate for the ASCENDS Mission (Invited Paper).** James B. Abshire, Haris Riris, NASA Goddard Space Flight Ctr. (USA); Graham R. Allan, Sigma Space Corp. (USA); Jeffrey R. Chen, Anthony W. Yu, Xiaoli Sun, NASA Goddard Space Flight Ctr. (USA); Anand K. Ramanathan, Univ. of Maryland, College Park (USA) ..... [9612-2]

**Development of double and tripled-pulsed 2-micron IPDA Lidars for column CO<sub>2</sub> measurement.** Upendra N. Singh, Jirong Yu, Mulugeta Petros, Tamer F. Refaat, Ruben G. Remus, NASA Langley Research Ctr. (USA); Karl Reithmaier, Science Systems and Applications, Inc. (USA) ..... [9612-3]

**High power and frequency-agile optical parametric oscillators for H<sub>2</sub>O, cH<sub>4</sub>, and HSRL airborne Lidar observations (H3ALO).** Amin Nehrir, Johnathan W. Hair, Anthony Notari, Richard Ferrare, Chris A. Hostetler, NASA Langley Research Ctr. (USA); Ti Chuang, Timothy Shuman, Fibertek, Inc. (USA); Tamer F. Refaat, NASA Langley Research Ctr. (USA) ..... [9612-4]

**Optical parametric technology for methane measurements.** Martha W. Dawsey, NASA Goddard Space Flight Ctr. (USA); Kenji Numata, Univ. of Maryland, College Park (USA); Stewart T. Wu, Haris Riris, NASA Goddard Space Flight Ctr. (USA) ..... [9612-5]

**Single frequency pulsed and continuous wave fiber lasers near 2 micron wavelength (Invited Paper).** Shabin Jiang, AdValue Photonics, Inc. (USA) .. [9612-6]

**Monolithic high power semiconductor seed lasers near 2.05 μm.** Mahmood Bagheri, Clifford Frez, Ryan Briggs, Siamak Forouhar, Jet Propulsion Lab. (USA) ..... [9612-7]

Lunch Break ..... Thu 11:40 am to 1:10 pm

### SESSION 3 ..... THU 1:10 PM TO 2:50 PM

#### Space-based Laser/Lidar Development

Session Chairs: Parminder Ghuman, NASA Goddard Space Flight Ctr. (USA); Floyd E. Hovis, Fibertek, Inc. (USA)

**Laser transmitter development for NASA's Global Ecosystem Dynamics Investigation (GEDI) Lidar (Invited Paper).** Donald B. Coyle, Paul R. Stylianou, NASA Goddard Space Flight Ctr. (USA); Demetrios Poulios, Greg B. Clarke, Richard B. Kay, American Univ. (USA) ..... [9612-8]

**UV lifetime laser demonstrator for space-based applications.** Floyd E. Hovis, Michael Albert, Kent Puffenburger, Tom Schum, Fran Fitzpatrick, Slava Litvinovich, Joe Rudd, Fibertek, Inc. (USA) ..... [9612-9]

**The cloud-aerosol transport system (CATS): a technology demonstration from the International Space Station (Invited Paper).** Matthew McGill, John Yorks, Stan Scott, NASA Goddard Space Flight Ctr. (USA); Andrew Kupchock, Patrick Selmer, Science Systems and Applications, Inc. (USA) ..... [9612-10]

**Fiber-based, carbon dioxide, laser transmitter development for space application.** Mark A. Stephen, Anthony W. Yu, NASA Goddard Space Flight Ctr. (USA) ..... [9612-11]

### SESSION 4 ..... THU 3:20 PM TO 4:30 PM

#### Lidar Measurements

Session Chairs: Upendra N. Singh, NASA Langley Research Ctr. (USA); George J. Komar, NASA Headquarters (USA)

**Lidar investigations of atmospheric dynamics and structure (Invited Paper).** C. Russell Philbrick, Hans D. Hallen, North Carolina State Univ. (USA) ..... [9612-12]

**Two-component wind fields from single scanning aerosol lidar.** Shane D. Mayor, Pierre Derian, Christopher F. Mauzey, California State Univ., Chico (USA) ..... [9612-13]

**Optical autocovariance wind Lidar: aircraft test-flight history and current plans.** Sara C. Tucker, Ball Aerospace & Technologies Corp. (USA) ..... [9612-14]

### SESSION 5 ..... THU 4:30 PM TO 5:50 PM

#### Lidar Instrument and Component Technologies

Session Chairs: Floyd E. Hovis, Fibertek, Inc. (USA); Shabin Jiang, AdValue Photonics, Inc. (USA)

**1 micron wavelength single frequency pulsed fiber lasers with mJ pulse energy.** Shabin Jiang, AdValue Photonics, Inc. (USA) ..... [9612-15]

**Comparison of aerosol backscatter and wind field estimates from REAL and SAMPLE.** Shane D. Mayor, Christopher F. Mauzey, Paul Arpin, Shea Arceo, California State Univ., Chico (USA); Scott Higdon, Thomas Chyba, Darrell Ramsey, Spectral Sensor Solutions, LLC (USA) ..... [9612-16]

**Performance characterization of a pressure-tuned wide-angle Michelson interferometric spectral filter for high spectral resolution Lidar.** Shane T. Seaman, Anthony L. Cook, Salvatore J. Scola, Chris A. Hostetler, NASA Langley Research Ctr. (USA) ..... [9612-17]

**Multi-wavelength high efficiency laser system for Lidar applications.** Christina C. Willis, Charles Culpepper, Ralph L. Burnham, Fibertek, Inc. (USA) ..... [9612-18]

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# Polarization Science and Remote Sensing VII

**Conference Chairs:** Joseph A. Shaw, Montana State Univ. (USA); Daniel A. LeMaster, Air Force Research Lab. (USA)**Program Committee:** Bruce E. Bernacki, Pacific Northwest National Lab. (USA); David B. Chenault, Polaris Sensor Technologies, Inc. (USA); Russell A. Chipman, College of Optical Sciences, The Univ. of Arizona (USA); Julia M. Craven-Jones, Sandia National Labs. (USA); Aristide C. Dogariu, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); Dennis H. Goldstein, Polaris Sensor Technologies Inc. (USA); Michael Kudennov, North Carolina State Univ. (USA); Kazuhiko Oka, Hokkaido Univ. (Japan); Yoav Y. Schechner, Technion-Israel Institute of Technology (Israel); Frans Snik, Leiden Univ. (Netherlands); Jean-Marc Thériault, Defence Research and Development Canada, Valcartier (Canada); J. Scott Tyo, College of Optical Sciences, The Univ. of Arizona (USA)

## TUESDAY 11 AUGUST

**SESSION 1 . . . . . TUE 8:20 AM TO 10:00 AM**

### Imaging Polarimetry I

Session Chair: Joseph A. Shaw, Montana State Univ. (USA)

**Polarizer-free degree of polarization computational imaging from a single speckle image**, Julien Fade, Institut de Physique de Rennes (France); Muriel Roche, Institut Fresnel (France); Mehdi Alouini, Institut de Physique de Rennes (France) . . . . . [9613-1]**Single shot diattenuation imaging by circular polarization orthogonality breaking**, Noé Ortega-Quijano, Julien Fade, Institut de Physique de Rennes (France); Emmanuel Schaub, François Pernet, Univ. de Rennes 1 (France); Mehdi Alouini, Institut de Physique de Rennes (France) . . . . . [9613-2]**Adaptive filters for bad pixel replacement in microgrid modulated polarimeters**, Daniel A. LeMaster, Air Force Research Lab. (USA); Bradley M. Ratliff, Exelis Space Computer Corp. (USA) . . . . . [9613-3]**Bandwidth and crosstalk considerations in modulated polarimeters with finite integration time**, Israel J. Vaughn, Oscar G. Rodriguez-Herrera, College of Optical Sciences, The Univ. of Arizona (USA); Mohan Xu, The Univ. of Arizona (USA); J. Scott Tyo, College of Optical Sciences, The Univ. of Arizona (USA) . . . . . [9613-4]**On demand polarimetry using a movable microgrid polarizer**, Page King, Raytheon Co. (USA); Eric C. Fest, Raytheon Missile Systems (USA) . . . . . [9613-5]**SESSION 2 . . . . . TUE 10:30 AM TO 11:40 AM**

### Imaging Polarimetry II

Session Chair: Daniel A. LeMaster, Air Force Research Lab. (USA)

**The twisted universe: cosmic polarimetry at the few parts-per-billion level (Invited Paper)**, Brian G. Keating, Univ. of California, San Diego (USA) . . . . . [9613-6]**Complete intrinsic coincident polarimetry using stacked organic photovoltaics**, Subharup Gupta Roy, Omar M. Awartani, Pratik Sen, Brendan T. O'Connor, Michael W. Kudennov, North Carolina State Univ. (USA) . . . . . [9613-7]**Integrated computational imaging system for enhanced polarimetric measurements**, Shahid A. Haider, Farnoud Kazemzadeh, Alexander Wong, David A. Claudi, Univ. of Waterloo (Canada) . . . . . [9613-8]

Lunch Break . . . . . Tue 11:40 am to 1:10 pm

**SESSION 3 . . . . . TUE 1:10 PM TO 2:10 PM**

### Polarimetry Applications

Session Chair: Russell A. Chipman, College of Optical Sciences, The Univ. of Arizona (USA)

**Snapshot retinal imaging Mueller matrix polarimeter**, Yifan Wang, Michael Kudennov, North Carolina State Univ. (USA); Amir Kashani, Keck School of Medicine (USA); Jim Schwiegerling, College of Optical Sciences, The Univ. of Arizona (USA) . . . . . [9613-9]**A polarization system for persistent chemical detection**, Julia Craven-Jones, Leah Appelhans, Todd Embree, Patrick Finnegan, Sandia National Labs. (USA); Dennis Goldstein, Polaris Sensor Technologies, Inc. (USA); Charles LaCasse, Ting S. Luk, Sandia National Labs. (USA); Adoum Mahamat, College of Optical Sciences, The Univ. of Arizona (USA); Lee Massey, Anthony Tanbakuchi, Cody Washburn, Steven Vigil, Sandia National Labs. (USA) . . . . . [9613-10]**Full-field imaging for spectroscopic Stokes parameters in all directions and its application to flaw detection**, Hiroshi Hasegawa, Yukitoshi Otani, Utsunomiya Univ. (Japan) . . . . . [9613-11]**SESSION 4 . . . . . TUE 2:10 PM TO 3:30 PM**

### Polarization Metrology and Instrumentation

Session Chair: Julia Craven-Jones, Sandia National Labs. (USA)

**Innovative static spectropolarimeter concept for wide spectral ranges**, Martin Pertenais, Observatoire de Paris à Meudon (France) and Univ. de Toulouse (France); Coralie Neiner, Observatoire de Paris à Meudon (France); Laurent P. Parès, Observatoire Midi-Pyrénées (France) and Univ. de Toulouse (France); Pascal M. Petit, Univ. de Toulouse (France) and Institut de Recherche en Astrophysique et Planétologie (France) . . . . . [9613-12]**Snapshot Mueller-matrix spectropolarimeter using spectral and spatial carriers**, Kazuhiko Oka, Yujin Haga, Hiroshi Michida, Hokkaido Univ. (Japan) . . . . . [9613-13]**High precision stokes polarimeter for scattered light by intensity detection with high dynamic range**, Yukitoshi Otani, Shuhei Shibata, Tomohiro Kiire, Yoshiro Hayasaki, Toyohiko Yatagai, Utsunomiya Univ. (Japan) . . . . . [9613-14]**A multi-domain full-Stokes polarization modulator that is efficient for 300-2500nm spectropolarimetry**, Frans Snik, Gerard van Harten, Leiden Observatory (Netherlands); Andrey Alenin, J. Scott Tyo, College of Optical Sciences, The Univ. of Arizona (USA) . . . . . [9613-15]**SESSION 5 . . . . . TUE 4:00 PM TO 5:00 PM**

### Polarization Analysis of Optical Systems I

Session Chair: Frans Snik, Leiden Univ. (Netherlands)

**Polarization aberration in astronomical telescopes**, Russell A. Chipman, James B. Breckinridge, Wai Sze T. Lam, College of Optical Sciences, The Univ. of Arizona (USA) . . . . . [9613-16]**Polarization modulators based on liquid crystal variable retarders for the solar orbiter mission**, Alberto Alvarez-Herrero, INTA, Instituto Nacional de Técnica Aeroespacial (Spain); Pilar García Parejo, Hugo Laguna, Javier Villanueva, Javier Barandiarán, Laurent Bastide, Manuel Reina, Isabel Vera, Mayte Royo, INTA, Instituto Nacional de Técnica Aeroespacial (Spain) . . . . . [9613-17]**The Polaris-M ray tracing program**, Russell A. Chipman, Wai Sze T. Lam, College of Optical Sciences, The Univ. of Arizona (USA) . . . . . [9613-18]

## WEDNESDAY 12 AUGUST

**SESSION 6 . . . . . WED 8:40 AM TO 9:20 AM**

### Polarization Analysis of Optical Systems II

Session Chair: Frans Snik, Leiden Observatory (Netherlands)

**The geostationary operational environmental satellite R-series advanced baseline imager: polarization sensitivity and potential impacts**, Aaron J. Pearlman, ERT, Inc. (USA) and NOAA National Environmental Satellite, Data, and Information Service (USA); Changyong Cao, NOAA National Environmental Satellite, Data, and Information Service (USA); Xiangqian Wu, National Oceanic and Atmospheric Administration (USA) . . . . . [9613-19]**Why diffractive retarders are not in common use**, Russell A. Chipman, College of Optical Sciences, The Univ. of Arizona (USA) . . . . . [9613-20]

# CONFERENCE 9613

SESSION 7 ..... WED 9:20 AM TO 10:30 AM

## Mathematics of Coherence, Polarization, and Scattering

Session Chair: **Joseph A. Shaw**, Montana State Univ. (USA)

**Partial channeled Mueller matrix polarimetry**, Andrey S. Alenin, J. Scott Tyo, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9613-21]

**Ray tracing based path-length calculations for polarized light tomographic imaging**, Rakesh Manjappa, Rajan Kanhiroda, Indian Institute of Science (India) ..... [9613-22]

**Bandwidth and information in the design and analysis of polarimeters (Invited Paper)**, J. Scott Tyo, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9613-23]

SESSION 8 ..... WED 11:00 AM TO 12:00 PM

## Polarization in Remote Sensing I

Session Chair: **Daniel A. LeMaster**, Air Force Research Lab. (USA)

**The visible-to-SWIR spectrum of skylight polarization**, Laura M. Dahl, Joseph A. Shaw, Montana State Univ. (USA) ..... [9613-24]

**Light scattering by roughed spheroids: a database of dust aerosols for POLDER/PARASOL 490, 670 and 865nm channels**, Jianping Liu, Ping Yang, Texas A&M Univ. (USA); Ralph Kahn, NASA Goddard Space Flight Ctr. (USA) ..... [9613-25]

**Morphological operators for enhanced polarimetric imaging target detection**, Joao M. Romano, U.S. Army Armament Research, Development and Engineering Ctr. (USA); Dalton S. Rosario, U.S. Army Research Lab. (USA) ..... [9613-26]

Lunch Break ..... Wed 12:00 pm to 1:30 pm

SESSION 9 ..... WED 1:30 PM TO 3:10 PM

## Polarization in Remote Sensing II

Session Chair: **J. Scott Tyo**, College of Optical Sciences, The Univ. of Arizona (USA)

**Accurate spectrally modulating polarimeters for atmospheric aerosol characterization**, Jeroen H. H. Rietjens, Martijn Smit, SRON Netherlands Institute for Space Research (Netherlands); Gerard van Harten, Leiden Observatory (Netherlands); Antonio Di Noia, Otto P. Hasekamp, SRON Netherlands Institute for Space Research (Netherlands); Jos de Boer, Leiden Observatory (Netherlands); Hester Volten, Rijksinstituut voor Volksgezondheid en Milieu (Netherlands); Frans Snik, Christoph U. Keller, Leiden Observatory (Netherlands) ..... [9613-27]

**Applying a microfacet model to polarized light scattering measurements of the Earth's surface**, Meredith K. Kupinski, Christine L. Bradley, College of Optical Sciences, The Univ. of Arizona (USA); David Diner, Feng Xu, Jet Propulsion Lab. (USA); Russell Chipman, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9613-28]

**Spectral invariance hypothesis study of polarized reflectance with ground-based multiangle spectropolarimetric imager (GroundMSPI)**, Christine L. Bradley, Meredith Kupinski, College of Optical Sciences, The Univ. of Arizona (USA); David J. Diner, Jet Propulsion Lab. (USA); Russell A. Chipman, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9613-29]

**Optimal contrast enhancement in long distance snapshot polarimetric imaging through fog**, Swapnesh Panigrahi, Univ. de Rennes 1 (France); Julien Fadé, Mehdi Alouini, Institut de Physique de Rennes (France); Hema Ramachandran, Raman Research Institute (India) ..... [9613-30]

**Characterization of sun and sky glint from wind ruffled sea surfaces for improved estimation of polarized remote sensing reflectance**, Robert Foster, Amir Ibrahim, Alex Gilerson, Ahmed El-Habashi, Carlos Carrizo, Sam Ahmed, The City College of New York (USA) ..... [9613-31]

SESSION 10 ..... WED 3:40 PM TO 5:00 PM

## Polarization in Remote Sensing III

Session Chair: **Joao M. Romano**, U.S. Army Armament Research, Development and Engineering Ctr. (USA)

**Material identification using polarimetric hyperspectral imagery**, Jacob A. Martin, Kevin C. Gross, Air Force Institute of Technology (USA) and Oak Ridge Institute for Science and Education (USA) ..... [9613-32]

**Polarization-based complex index of refraction estimation with volumetric scattering consideration**, Hanyu Zhan, David G. Voelz, Xifeng Xiao, New Mexico State Univ. (USA) ..... [9613-33]

**Remotely sensing the photochemical reflectance index (pri)**, Vern C. Vanderbilt, NASA Ames Research Ctr. (USA); Craig S. T. Daughtry, U.S. Dept. of Agriculture (USA); Robert P. Dahlgren, NASA Ames Research Ctr. (USA) ..... [9613-34]

**The 3MI mission: multi-viewing -channel -polarisation imager of the EUMETSAT polar system - second generation (EPS-SG) dedicated to aerosol and cloud monitoring**, Thierry Marbach, European Organisation for the Exploitation of Meteorological Satellites (Germany); Jérôme Riedi, Univ. des Sciences et Technologies de Lille (France); Antoine Lacan, Peter Schluessel, European Organisation for the Exploitation of Meteorological Satellites (Germany) ..... [9613-35]

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**System of polarization phasometry of polycrystalline blood plasma networks in mammary gland pathology diagnostics**, Natalia I. Zabolotna, Vinnytsia National Technical Univ. (Ukraine); Bogdan P. Oliynychenko, Medivin (Ukraine); Kostiantyn O. Radchenko, Anastasiia K. Krasnoshchoka, Olga K. Shcherba, Vinnytsia National Technical Univ. (Ukraine) ..... [9613-36]

**A portable imaging Mueller matrix polarimeter based on a spatio-temporal modulation approach: theory and implementation**, Israel J. Vaughn, College of Optical Sciences, The Univ. of Arizona (USA); Oscar G. Rodriguez, Mohan Xu, The Univ. of Arizona (USA); J. Scott Tyo, College of Optical Sciences, The Univ. of Arizona (USA) ..... [9613-37]

**Polarization modulation for the Atacama Cosmology Telescope using continuously rotating half-wave plates**, Jonathan T. Ward, Univ. of Pennsylvania (USA) ..... [9613-38]

**Characterizing the kinetics of suspended cylindrical particles by polarization measurements**, Ran Liao, Nan Zeng, Honghui He, Hui Ma, Tsinghua Univ. (China) ..... [9613-39]

**Identification of soot particles in air using polarization scattering method**, Da Li, Nan Zeng, Maomao Zeng, Ran Liao, Hui Ma, Tsinghua Univ. (China) .. [9613-40]

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# Laser Communication and Propagation through the Atmosphere and Oceans IV

Conference Chairs: **Alexander M. J. van Eijk**, TNO Defence, Security and Safety (Netherlands); **Christopher C. Davis**, Univ. of Maryland, College Park (USA); **Stephen M. Hammel**, Space and Naval Warfare Systems Command (USA)

Program Committee: **Larry C. Andrews**, Univ. of Central Florida (USA); **Jaime Anguita**, Univ. de Los Andes (Chile); **Shlomi Arnon**, Ben-Gurion Univ. of the Negev (Israel); **Sukanta Basu**, North Carolina State Univ. (USA); **Matthew M. Bold**, Lockheed Martin Space Systems Co. (USA); **Jeremy P. Bos**, Air Force Research Lab. (USA); **Mikhail I. Charnotskii**, National Oceanic and Atmospheric Administration (USA); **Gang Chen**, Univ. of California, Riverside (USA); **Jony Jiang Liu**, U.S. Army Research Lab. (USA); **Arun K. Majumdar**, Naval Air Warfare Ctr. Weapons Div. (USA); **Vladimir B. Markov**, Advanced Systems & Technologies, Inc. (USA); **Dominic C. O'Brien**, Univ. of Oxford (United Kingdom); **Ronald L. Phillips**, Florida Space Institute (USA); **William S. Rabinovich**, U.S. Naval Research Lab. (USA); **Karin Stein**, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany); **Miranda van Iersel**, TNO Defence, Security and Safety (Netherlands); **Thomas Weyrauch**, Univ. of Dayton (USA); **Otakar Wilfert**, Brno Univ. of Technology (Czech Republic); **Heba Yuksel**, Bogaziçi Üniv. (Turkey)

## MONDAY 10 AUGUST

### SESSION 1 ..... MON 1:50 PM TO 3:20 PM

#### Turbulence and Imagery

Session Chairs: **Christopher C. Davis**, Univ. of Maryland, College Park (USA); **Jeremy P. Bos**, Air Force Research Lab. (USA)

**Estimation of turbulence strength, anisotropy, outer scale and spectral slope from an LED array (Invited Paper)**, Max Segel, Szymon Gladysz, Christian Eisele, Rui Barros, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany) ..... [9614-1]

**Blob identification algorithms applied to laser speckle to characterize optical turbulence**, Galen Cauble, David T. Wayne, Space and Naval Warfare Systems Ctr. Pacific (USA) ..... [9614-2]

**Stereo image motion monitor for atmospheric mitigation and estimation**, Kristofor Gibson, SPAWAR Systems Ctr. (USA) ..... [9614-3]

**Imaging through turbulence using a plenoptic sensor**, Chensheng Wu, Jonathan Ko, Christopher C. Davis, Univ. of Maryland, College Park (USA) ..... [9614-4]

### SESSION 2 ..... MON 3:50 PM TO 5:10 PM

#### Imaging in Turbulence

Session Chairs: **Alexander M. J. van Eijk**, TNO Defence, Security and Safety (Netherlands); **Chensheng Wu**, Univ. of Maryland, College Park (USA)

**Super-resolution in the scintillation imaging through turbulence**, Mikhail I. Charnotskii, National Oceanic and Atmospheric Administration (USA) ..... [9614-5]

**Using aperture partitioning to improve scene recovery in horizontal long-path speckle imaging**, Jeremy P. Bos, Air Force Research Lab. (USA); Brandoch Calef, Boeing LTS Inc. (USA) ..... [9614-6]

**Modeling and simulation of anisoplanatic (space-variant) imaging through the atmosphere**, Colin Reinhardt, Space and Naval Warfare Systems Ctr. Pacific (USA) ..... [9614-7]

**Propagation dynamics of optical vortices in turbulent atmosphere**, Haiyan Wang, Nanjing Univ. of Science and Technology (China) ..... [9614-8]

## TUESDAY 11 AUGUST

### SESSION 3 ..... TUE 8:30 AM TO 9:20 AM

#### Theory

Session Chairs: **Gang Chen**, Univ. of California, Riverside (USA); **Christopher C. Davis**, Univ. of Maryland, College Park (USA)

**A modern approach for tilt-removed beam propagation in the atmosphere (Invited Paper)**, Gary Baker, Lockheed Martin Space Systems Co. (USA) ..... [9614-9]

**Spread and wander of a laser beam propagating through anisotropic atmospheric turbulence**, Italo Toselli, Olga Korotkova, Univ. of Miami (USA) ..... [9614-10]

### SESSION 4 ..... TUE 9:20 AM TO 10:00 AM

#### Atmospheric Effects

Session Chairs: **Gang Chen**, Univ. of California, Riverside (USA); **Christopher C. Davis**, Univ. of Maryland, College Park (USA)

**Lunar laser ranging: atmospheric limitations and upgrading SLR stations**, Douglas G. Currie, Univ. of Maryland, College Park (USA) ..... [9614-11]

**Different atmospheric effects causing FSO link attenuation: experimental results and modelling in Czech Republic**, Ondřej Fiser, Institute of Atmospheric Physics of the ASCR, v.v.i. (Czech Republic) and Czech Technical Univ. in Prague (Czech Republic); Vladimír Brazda, Institute of Atmospheric Physics of the ASCR, v.v.i. (Czech Republic) ..... [9614-12]

### SESSION 5 ..... TUE 10:30 AM TO 12:10 PM

#### Turbulence Effects

Session Chairs: **Stephen M. Hammel**, Space and Naval Warfare Systems Command (USA); **Mikhail I. Charnotskii**, National Oceanic and Atmospheric Administration (USA)

**Determining beam properties at an inaccessible plane using the reciprocity of atmospheric turbulence**, William Nelson, Chensheng Wu, Christopher C. Davis, Univ. of Maryland, College Park (USA) ..... [9614-13]

**Entropy studies on beam distortion by atmospheric turbulence**, Chensheng Wu, Jonathan Ko, Christopher C. Davis, Univ. of Maryland, College Park (USA) ..... [9614-14]

**Analogue holographic wavefront sensor: a performance analysis**, Andreas Zepp, Szymon Gladysz, Rui Almeida de Sa Barros, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany); Wolfgang Osten, Univ. Stuttgart (Germany) and Institut für Technische Optik (Germany); Karin U. Stein, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany) ..... [9614-15]

**Atmospheric turbulence induced by hot metal objects**, Miranda van Iersel, TNO (Netherlands); Henny E. T. Veerman, Alexander M. van Eijk, TNO (Netherlands) ..... [9614-16]

**An adaptive optics approach for laser beam correction in turbulence utilizing a modified plenoptic camera**, Jonathan Ko, Chensheng Wu, Christopher C. Davis, Univ. of Maryland, College Park (USA) ..... [9614-17]

Lunch Break ..... Tue 12:10 pm to 1:40 pm

# CONFERENCE 9614

SESSION 6 ..... TUE 1:40 PM TO 3:10 PM

## Numerical Weather Prediction and Atmospheric Models

Session Chairs: **Szymon Gladysz**, Fraunhofer-Institut für Optik, Systemtechnik und Bildauswertung (Germany); **Miranda van Iersel**, TNO Defence, Security and Safety (Netherlands)

**Estimating refractive index structure parameter (Cn2) profiles in the atmosphere: a framework based on fractal interpolation (Invited Paper)**, Sukanta Basu, Ping He, North Carolina State Univ. (USA) ..... [9614-18]

**Mesoscale modeling of optical turbulence utilizing novel Cn2 parameterizations**, Ping He, Sukanta Basu, North Carolina State Univ. (USA) ..... [9614-19]

**The Havemann-Taylor fast radiative transfer code (HT-FRTC) and its applications**, Jean-Claude Thelan, Stephan Havemann, Damian R. Wilson, Warren J. Lewis, Met Office (United Kingdom) ..... [9614-20]

**A parameterization of littoral fog**, Joshua J. Rudiger, SPAWARSYSCEN Pacific: San Diego (USA); John S. deGrassie, Space and Naval Warfare Systems Ctr. Pacific (USA) ..... [9614-21]

SESSION 7 ..... TUE 3:40 PM TO 5:40 PM

## FSO Systems

Session Chairs: **John S. deGrassie**, Space and Naval Warfare Systems Ctr. Pacific (USA); **Stephen M. Hammel**, Space and Naval Warfare Systems Command (USA)

**The study of full link duplexing of UV NLOS scattering channel**, Gang Chen, Linchao Liao, Univ. of California, Riverside (USA) ..... [9614-22]

**Massive MIMO visible light communication system via hemispherical lens on hemispherical beehive structure receiver**, Gang Chen, Tian lang, Univ. of California, Riverside (USA) ..... [9614-23]

**Optical design of communication simulator for orbital angular momentum based free-space link with an adaptive optics receiver**, Alonso J. Espinoza, Garrett Odom, Wenbo Gao, Milorad Cvjetic, Yuzuru Takashima, The Univ. of Arizona (USA) ..... [9614-24]

**The turbulence effects analysis in vehicular optical communication**, Gang Chen, Zening Li, Univ. of California, Riverside (USA) ..... [9614-25]

**Terrestrial FSO links: channel model classification using neural networks and a case study on the effect of rain**, Geetha Prakash, PES Institute of Technology (India); Sripathi U. Acharya, Muralidhar Kulkarni, National Institute of Technology, Karnataka (India) ..... [9614-26]

**Improving method for fitting random wavefront using Zernike polynomials**, Xiaochuan Hu, Sichuan Univ. (China) ..... [9614-27]

WEDNESDAY 12 AUGUST

POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

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**Testing resistance modulation formats for FSO communication in turbulent environment, with used simulation box**, Aleš Vanderka, Jan Látl, Lukas Hajek, Jan Vitasek, Petr Koudeleka, Stanislav Hejduk, Vladimir Vašinek, VSB-Technical Univ. of Ostrava (Czech Republic) ..... [9614-28]

**The performance of coherent receiver controlled by the phase lock base in dual rate free-space laser communication**, Xiaoping Ma, Jianfeng Sun, Peipei Hou, Wei Lu, Qian Xu, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9614-29]

**Evaluation of FSO link throughput in Qatar under harsh environment**, Syed Jawad Hussain, Abir Touati II, Mohammed Elamri III, Farid Touati IV, Qatar Univ. (Qatar) ..... [9614-30]

**Statistical prediction of the atmospheric behavior for free space optical link**, Lukas Hajek, Jan Látl, Aleš Vanderka, Andrej Liner, Stanislav Hejduk, Petr Koudeleka, Vladimír Vašinek, Jan Vitasek, VŠB-Technical Univ. of Ostrava (Czech Republic) ..... [9614-31]

**Modulation of radio signal using laser beam**, Mohammad M. Anwar, Asiatic Society of Bangladesh (Bangladesh) ..... [9614-32]

**Performance analysis of OOK receiver with a GSM laser source in space to ground optical communication link**, Mengnan Li, Liying Tan, Jing Ma, Siyuan Yu, Chao Zhai, Harbin Institute of Technology (China) ..... [9614-33]

**Orthogonal phase modulation with self homodyne detect laser communication method for the satellite-to-ground link**, Jianfeng Sun, Peipei Hou, Xiaoping Ma, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9614-34]

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# Quantum Communications and Quantum Imaging XIII

Conference Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Yanhua Shih**, Univ. of Maryland, Baltimore County (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

Program Committee: **Stefania A. Castelletto**, RMIT Univ. (Australia); **Milena D'Angelo**, Univ. degli Studi di Bari (Italy); **Mark T. Gruneisen**, Air Force Research Lab. (USA); **Richard J. Hughes**, Los Alamos National Lab. (USA); **Yoon-Ho Kim**, Pohang Univ. of Science and Technology (Korea, Republic of); **Todd B. Pittman**, Univ. of Maryland, Baltimore County (USA); **Barry C. Sanders**, Univ. of Calgary (Canada); **Alexander V. Sergienko**, Boston Univ. (USA); **Dmitry V. Strekalov**, Jet Propulsion Lab. (USA); **Shigeki Takeuchi**, Hokkaido Univ. (Japan); **Xiao Tang**, National Institute of Standards and Technology (USA); **Arnold Tunick**, U.S. Army Research Lab. (USA)

## SUNDAY 9 AUGUST

### SESSION 1 ..... SUN 9:00 AM TO 10:10 AM

#### Quantum Imaging

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**Recent progresses in quantum imaging real applications** (*Invited Paper*), Marco Genovese, Istituto Nazionale di Ricerca Metrologica (Italy) ..... [9615-1]

**Two-mode squeezed light source for quantum illumination and quantum imaging**, Genta Masada, Tamagawa Univ. (Japan) ..... [9615-2]

**Quantum imaging at ARL** (*Invited Paper*), Ronald E. Meyers, U.S. Army Research Lab. (USA) ..... [9615-3]

### SESSION 2 ..... SUN 10:40 AM TO 11:55 AM

#### Quantum Networks

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**Quantum repeaters for long distance quantum communication** (*Invited Paper*), Liang Jiang, Sreraman Muralidharan, Linshu Li, Yale Univ. (USA); Norbert Lutkenhaus, Univ. of Waterloo (Canada); Jungsang Kim, Duke Univ. (USA); Mikhail D. Lukin, Harvard Univ. (USA) ..... [9615-4]

**An ion-cavity interface for quantum networks** (*Invited Paper*), Tracy E. Northup, Bernardo Casabone, Konstantin Friebe, Clemens Schüppert, Florian Ong, Moonjoo Lee, Dario Fioretto, Univ. of Innsbruck (Austria); Rainer Blatt, Leopold-Franzens-Univ. Innsbruck (Austria) and Institut für Quantenoptik und Quanteninformation (Austria) ..... [9615-5]

**Narrowband correlated single photon source for quantum communications and quantum memory applications from a cavity referenced to cesium atoms** (*Invited Paper*), Oliver Slattery, Lijun Ma, Paulina Kuo, Xiao Tang, National Institute of Standards and Technology (USA) ..... [9615-6]

Lunch Break ..... Sun 11:55 am to 1:30 pm

### SESSION 3 ..... SUN 1:30 PM TO 3:00 PM

#### Quantum Communications I

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**Enabling transmitter and receiver technology for free-space quantum key distribution** (*Invited Paper*), David Woolf, Joel M. Hensley, Physical Sciences Inc. (USA) ..... [9615-7]

**Secure satellite communication using multi-photon tolerant quantum communication protocol**, Bhagyashri A. Darunkar, Nikhil V. Punekar, Pramode K. Verma, The Univ. of Oklahoma - Tulsa (USA) ..... [9615-8]

**Channel models for QKD at higher photon flux levels based on spatial entanglement of twin beams in PDC**, Marina Mondin, Politecnico di Torino (Italy); Fred Daneshgaran, California State Univ., Los Angeles (USA); Ivo P. Degiovanni, Marco Genovese, Ivano Ruo Berchera, Istituto Nazionale di Ricerca Metrologica (Italy) ..... [9615-9]

**A modified quantum secret sharing algorithm for distributing two-party secret keys** (*Invited Paper*), Warren P. Grice, Phil Evans, Benjamin Lawrie, Oak Ridge National Lab. (USA); Matthieu Legre, Id Quantique SA (Switzerland); Pavel Lougovski, William Ray, Brian Williams, Bing Qi, A. Matthew Smith IV, Oak Ridge National Lab. (USA) ..... [9615-10]

### SESSION 4 ..... SUN 3:30 PM TO 4:35 PM

#### Quantum Information Processing and Technology

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**Twin photon source: spatio-temporal properties**, Joyee Ghosh, Indian Institute of Technology, Delhi (India) and ICFO-The Institute of Photonic Sciences (Spain); Gabriel Molina-Terriza, ICFO-The Institute of Photonic Sciences (Spain) and Macquarie Univ. (Australia); N. Piro, ICFO-The Institute of Photonic Sciences (Spain) and École Polytechnique Fédérale de Lausanne (Switzerland); L. Dubreuil, Juan P. Torres, ICFO-The Institute of Photonic Sciences (Spain); Juergen Eschner, ICFO-The Institute of Photonic Sciences (Spain) and Univ. des Saarlandes (Germany) ..... [9615-11]

**EIT quantum memory based on Cs Atom** (*Invited Paper*), Lijun Ma, Oliver Slattery, Paulina Kuo, Xiao Tang, National Institute of Standards and Technology (USA) ..... [9615-12]

**Hybrid quantum photonic applications of nanodiamond**, Brant C. Gibson, RMIT Univ. (Australia) ..... [9615-13]

### SYMPOSIUM-WIDE PLENARY SESSION .. SUN 6:00 TO 7:30 PM

#### Welcome and Opening Remarks

**Rosetta: Comet-Chaser, Comet-Lander, and Comet-Hopper all in One Mission!**, Artur B. Chmielewski, U.S. Rosetta Project Manager, NASA JPL (USA)

**Sculpting Waves**, Nader Engheta, Univ. of Pennsylvania (USA)

## MONDAY 10 AUGUST

### SESSION 5 ..... MON 8:00 AM TO 10:15 AM

#### Quantum Technology

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**New opportunities for quantum storage in diamond** (*Invited Paper*), Philip R. Hemmer, Texas A&M Univ. (USA) ..... [9615-14]

**Quantum vacuum emission from a moving refractive index front** (*Invited Paper*), Maxime Jacquet, Friedrich Koenig, Univ. of St. Andrews (United Kingdom) [9615-15]

**A solid state spin-wave optical quantum memory**, Margherita Mazzera, Mustafa Gündoğan, Patrick M. Ledingham, Kutlu Kutluer, ICFO - Institut de Ciències Fotòniques (Spain); Hugues de Riedmatten, ICFO - Institut de Ciències Fotòniques (Spain) and Institució Catalana de Recerca i Estudis Avançats (Spain) ..... [9615-16]

**Quantum nonlinear optics with optical nanofibers**, Daniel E. Jones, James D. Franson, Todd B. Pittman, Univ. of Maryland, Baltimore County (USA) ... [9615-17]

**Single “atom-like” defects in silicon carbide for future quantum photonics** (*Invited Paper*), Stefania Castelletto, RMIT Univ. (Australia) ..... [9615-18]

**Boson sampling with integrated photonics**, Fabio Sciarrino, Univ. degli Studi di Roma La Sapienza (Italy) ..... [9615-19]

# CONFERENCE 9615

SESSION 6.....MON 10:45 AM TO 12:20 PM

## Entanglement & Metrology

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**Experimental demonstration of delayed-choice decoherence suppression (Invited Paper)**, Jong-Chan Lee, Hyang-Tag Lim, Kang-Hee Hong, Youn-Chang Jeong, Pohang Univ. of Science and Technology (Korea, Republic of); Myungshik Kim, Imperial College London (United Kingdom); Yoon-Ho Kim, Pohang Univ. of Science and Technology (Korea, Republic of) ..... [9615-20]

**Hong-Ou-Mandel interference for the orbital angular momentum Bell States: a high dimensional analysis**, Yingwen Zhang, Filippus S. Roux, CSIR National Laser Ctr. (South Africa); Thomas Konrad, Univ. of KwaZulu-Natal (South Africa); Megan Agnew, Jonathan Leach, Heriot-Watt Univ. (United Kingdom); Andrew Forbes, CSIR National Laser Ctr. (South Africa) ..... [9615-21]

**Accurate and precise characterization of linear optical devices (Invited Paper)**, Ish Dhand, Abdullah Khalid, Univ. of Calgary (Canada) and Institute for Quantum Science and Technology (Canada); He Lu, Univ. of Science and Technology of China (China); Barry Sanders, Univ. of Calgary (Canada) and Univ. of Science and Technology of China (China) and Canadian Institute for Advanced Research (Canada) ..... [9615-22]

**Quasi-Bell entangled coherent states and its quantum discrimination problem in the presence of thermal noise (Invited Paper)**, Kentaro Kato, Tamagawa Univ. (Japan) ..... [9615-23]

Lunch Break ..... Mon 12:20 pm to 1:50 pm

SESSION 7.....MON 1:50 PM TO 3:30 PM

## Quantum Communications II

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**Low-power optical communication: approaching the quantum limit (Invited Paper)**, Konrad Banaszek, Univ. of Warsaw (Poland) ..... [9615-24]

**Security loopholes in a free-space quantum communication receiver (Invited Paper)**, Vadim Makarov, Shihan Saeed, Poompong Chaiwongkhot, Jean-Philippe Bourgois, Univ. of Waterloo (Canada); Thomas D. Jennewein, Univ. of Waterloo (Canada) and Canadian Institute for Advanced Research (Canada); Norbert Lütkenhaus, Univ. of Waterloo (Canada) ..... [9615-25]

**Hybrid quantum systems and entanglement (Invited Paper)**, ..... [9615-26]

**Experimental investigation on local environment effects on the quantum teleportation fidelity (Invited Paper)**, Laura T. Knoll, Instituto de Investigaciones Científicas y Técnicas para la Defensa (Argentina); Christian T. Schmiegelow, UNIDEF (CITEDEF-CONICET) (Argentina); Miguel A. Larotonda, Instituto de Investigaciones Científicas y Técnicas para la Defensa (Argentina) ..... [9615-27]

SESSION 8.....MON 4:00 PM TO 5:00 PM

## Quantum Technology & Entanglement

Session Chairs: **Ronald E. Meyers**, U.S. Army Research Lab. (USA); **Keith S. Deacon**, U.S. Army Research Lab. (USA)

**Deploying quantum light sources on nanosatellites: lessons and perspectives**, ..... [9615-28]

**To be Announced**, ..... [9615-29]

**Novel fiber based entangled photon sources and protocols**, Ronald E. Meyers, U.S. Army Research Lab. (USA) ..... [9615-30]

WEDNESDAY 12 AUGUST

POSTERS-WEDNESDAY.....WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Twin photons: spatial and temporal properties by coincidence detection**, Joyee Ghosh, Indian Institute of Technology, Delhi (India) ..... [9615-31]

**Quantum repeater research at NIST**, Xiao Tang, Oliver Slattery, Lijun Ma, Paulina Kuo, Alan Mink, National Institute of Standards and Technology (USA) .. [9615-32]

**Preparation and characterization of optically transparent and photoluminescent electrospun nanofiber composed of carbon quantum dots and poly(acrylonitrile) blend with poly(acrylic acid)**, Hak Yong Kim, Chonbuk National Univ. (Korea, Republic of) ..... [9615-33]

**Characterization of teleportation experiments**, Ronald E. Meyers, U.S. Army Research Lab. (USA) ..... [9615-34]

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# Nanophotonics and Macrophotonics for Space Environments IX

Conference Chairs: **Edward W. Taylor**, International Photonics Consultants, Inc. (USA); **David A. Cardimona**, Air Force Research Lab. (USA)

Conference Co-Chair: **Ronald G. Pirich**, Northrop Grumman Aerospace Systems (Retired) (USA)

Program Committee: **Francis Berghmans**, Vrije Univ. Brussel (Belgium); **Yiqiao Chen**, SVT Associates, Inc. (USA); **Koen Clays**, Katholieke Univ. Leuven (Belgium); **Jason Cline**, Spectral Sciences, Inc. (USA); **Vincent M. Cowan**, Air Force Research Lab. (USA); **Nathan J. Dawson**, Youngstown State Univ. (USA); **Jihong Geng**, AdValue Photonics, Inc. (USA); **Michael J. Hayduk**, Air Force Research Lab. (USA); **F. Kenneth Hopkins**, Air Force Research Lab. (USA); **Gary B. Hughes**, California Polytechnic State Univ., San Luis Obispo (USA); **Kenneth J. Jerkatis**, Boeing Directed Energy Systems (USA); **Serge Oktyabrsky**, Univ. at Albany (USA); **Javier Pérez-Moreno**, Skidmore College (USA); **Sam-Shajing Sun**, Norfolk State Univ. (USA); **Michael D. Watson**, NASA Marshall Space Flight Ctr. (USA)

## MONDAY 10 AUGUST

### WELCOME AND INTRODUCTION ..... 8:00 AM TO 8:10 AM

Conference Chair: Edward W. Taylor, International Photonics Consultants, Inc. (USA)

### SESSION 1 ..... MON 8:10 AM TO 10:00 AM

#### Technology for Planetary Defense I

Session Chair: **Gary B. Hughes**, California Polytechnic State Univ., San Luis Obispo (USA)

**Stand-off molecular composition analysis** (*Invited Paper*), Gary B. Hughes, California Polytechnic State Univ., San Luis Obispo (USA); Philip M. Lubin, Peter Meinholt, Univ. of California, Santa Barbara (USA); Hugh O'Neill, Ventura College (USA); Travis Brashears, Qicheng Zhang, Janelle A. Griswold, Jordan C. Riley, Caio Motta, Univ. of California, Santa Barbara (USA) ..... [9616-1]

**Orbital simulations on the deflection of near earth asteroids by directed energy** (*Invited Paper*), Qicheng Zhang, Univ. of California, Santa Barbara (USA); Kevin J. Walsh, Southwest Research Institute (USA); Carl Melis, Univ. of California, San Diego (USA); Gary B. Hughes, California Polytechnic State Univ., San Luis Obispo (USA); Philip M. Lubin, Univ. of California, Santa Barbara (USA) ..... [9616-2]

**Directed energy deflection laboratory measurements** (*Invited Paper*), Travis R. Brashears, Phillip M. Lubin, Univ. of California, Santa Barbara (USA); Gary B. Hughes, California Polytechnic State Univ., San Luis Obispo (USA); Jonathan Y. Suen, Peter Meinholt, Caio A. Motta, Janelle A. Griswold, Qicheng Zhang, Miikka Kangas, Payton Battliner, Alexander A. Lang, Jordan C. Riley, Alex McDaniel, Univ. of California, Santa Barbara (USA) ..... [9616-3]

**Simulations of directed energy thrust on rotating asteroids**, Janelle A. Griswold, Isabella Johansson, Philip M. Lubin, Univ. of California, Santa Barbara (USA); Gary B. Hughes, California Polytechnic State Univ., San Luis Obispo (USA); Hugh O'Neill, Ventura College (USA); Peter Meinholt, Jonathan Y. Suen, Jordan C. Riley, Caio A. Motta, Qicheng Zhang, Travis R. Brashears, Univ. of California, Santa Barbara (USA) ..... [9616-4]

### SESSION 2 ..... MON 10:30 AM TO 12:00 PM

#### Technology for Planetary Defense II

Session Chair: **Gary B. Hughes**, California Polytechnic State Univ., San Luis Obispo (USA)

**Local phase control for a planar array of fiber laser amplifiers** (*Invited Paper*), Patrick Steffanic, Benjamin T. Johannes, Gary B. Hughes, California Polytechnic State Univ., San Luis Obispo (USA); Philip M. Lubin, Peter Meinholt, Jonathan Y. Suen, Univ. of California, Santa Barbara (USA); Hugh O'Neill, Ventura College (USA); Miikka Kangas, Travis R. Brashears, Qicheng Zhang, Janelle A. Griswold, Jordan C. Riley, Caio A. Motta, Univ. of California, Santa Barbara (USA) ..... [9616-5]

**Orbital simulations of laser-propelled spacecraft**, Qicheng Zhang, Univ. of California, Santa Barbara (USA); Kevin J. Walsh, Southwest Research Institute (USA); Carl Melis, Univ. of California, San Diego (USA); Gary B. Hughes, California Polytechnic State Univ., San Luis Obispo (USA); Philip M. Lubin, Univ. of California, Santa Barbara (USA) ..... [9616-6]

**Directed energy propulsion of wafer scale spacecraft for interstellar missions**, Travis R. Brashears, Philip M. Lubin, Univ. of California, Santa Barbara (USA); Gary B. Hughes, California Polytechnic State Univ., San Luis Obispo (USA); Caio A. Motta, Kyle McDonough, Sebastian Roland, Alexander A. Lang, Qicheng Zhang, Univ. of California, Santa Barbara (USA) ..... [9616-7]

**Solar lens mission concept with directed energy propulsion**, Travis R. Brashears, Philip M. Lubin, Univ. of California, Santa Barbara (USA) ..... [9616-8]

Lunch Break ..... Mon 12:00 pm to 1:00 pm

### SESSION 3 ..... MON 1:00 PM TO 2:00 PM

#### Keynote Session

Session Chair: **Edward W. Taylor**, International Photonics Consultants, Inc. (USA)

**Fiber Bragg gratings in microstructured optical fibers: fabrication challenges and applications** (*Invited Paper*), Francis Berghmans, Thomas Geernaert, Tigran Baghdasaryan, Hugo Thienpont, Vrije Univ. Brussel (Belgium) ..... [9616-9]

### SESSION 4 ..... MON 2:00 PM TO 3:20 PM

#### Radiation Testing and Modeling of Organic Materials

Session Chair: **Nathan J. Dawson**, Case Western Reserve Univ. (USA)

**Effects of degradation on the performance of a triphenylene based liquid crystal organic semiconductor** (*Invited Paper*), Nathan J. Dawson, Michael S. Patrick, Kyle Peters, Kenneth D. Singer, Case Western Reserve Univ. (USA); Sanjoy Paul, Brett Ellman, Kent State Univ. (USA); Rachael Matthews, Emily Pentzer, Case Western Reserve Univ. (USA); Robert J. Twieg, Kent State Univ. (USA) ..... [9616-10]

**Impact of ionizing radiation on organic photovoltaic cells**, Camron G. Kouhestani, Team Technologies, Inc. (USA); Kenneth E. Kambour, Leidos (USA); Duc D. Nguyen, COSMIAC (USA); Roderick A. B. Devine, Think Strategically (USA); Johnny Chen, Gang Li, Yang Yang, Univ. of California, Los Angeles (USA); Yue Wu, Solarmer Energy, Inc. (USA) ..... [9616-11]

**Using complementary tools to characterize the effects of radiation in electro-optic polymeric materials** (*Invited Paper*), Javier Perez-Moreno, Skidmore College (USA) ..... [9616-12]

# CONFERENCE 9616

SESSION 5.....MON 3:50 PM TO 5:30 PM

## Effects of Proton Irradiation on Semiconductor Photodetectors

Session Chair: **Vincent M. Cowan**, Air Force Research Lab. (USA)

**Proton irradiation of MWIR HgCdTe/CdZnTe**, Stephen Fahey, Silviu Velicu, Ramana Bommena, Jun Zhao, EPIR Technologies, Inc. (USA); Vincent M. Cowan, Christian P. Morath, Air Force Research Lab. (USA); Sivalingam Sivananthan, EPIR Technologies, Inc. (USA) ..... [9616-13]

**MWIR unipolar barrier photodetectors based on strained layer superlattices**, David A. Ramirez, Stephen A. Myers, Elena Plis, SKINfrared LLC (USA); Christian P. Morath, Vincent M. Cowan, Air Force Research Lab. (USA); Sanjay Krishna, The Univ. of New Mexico (USA) ..... [9616-14]

**Empirical trends of minority carrier recombination lifetime vs proton radiation for rad-hard IR detector materials**, Geoffrey Jenkins, Air Force Research Lab. (USA) ..... [9616-15]

**Low-frequency, noise spectrum measurements of mid-wave infrared nBn detectors with superlattice absorbers**, Eli Garduno, Christian P. Morath, Vicent M. Cowan, Air Force Research Lab. (USA) ..... [9616-16]

**InAs/GaSb type II strained-layer superlattice (T2SLS) vertical transport and radiation tolerance**, Mitch C. Malone, The Univ. of New Mexico (USA) and Air Force Research Lab. (USA); Christian P. Morath, Air Force Research Lab. (USA); Sanjay Krishna, The Univ. of New Mexico (USA) ..... [9616-17]

## TUESDAY 11 AUGUST

WELCOME AND INTRODUCTION..... 8:00 AM TO 8:10 AM

Conference Chair: Edward W. Taylor, International Photonics Consultants, Inc. (USA)

SESSION 6..... TUE 8:10 AM TO 10:30 AM

## Advances in Radiation Hard Atomic Clocks, Gyros and Lasers

Session Chair: **Edward W. Taylor**, International Photonics Consultants, Inc. (USA)

**High power VCSEL devices for atomic clock applications (Invited Paper)**, Laurence S. Watkins, Jean-Francois Seurin, Chuni Ghosh, Delai Zhou, Guoyang Xu, Bing Xu, Alexander Miglo, Princeton Optronics, Inc. (USA) ..... [9616-18]

**A multi-channel tunable source for atomic sensors (Invited Paper)**, Matthew S. Bigelow, Tony D. Roberts, Shirley McNeil, Todd Hawthorne, Philip R. Battle, AdvR, Inc. (USA) ..... [9616-19]

**Miniature atomic clock for space applications (Invited Paper)**, Lute Maleki, OEWaves, Inc. (USA) ..... [9616-20]

**Radiation studies on silicon photonic ring resonators**, Sharon M. Weiss, Shweta Bhandaru, Shuren Hu, Daniel M. Fleetwood, Vanderbilt Univ. (USA) ..... [9616-21]

**Compact, highly sensitive optical gyros and sensors with fast-light (Invited Paper)**, Caleb A. Christensen, Anton Zavriyev, Malcolm Cummings, A. Craig Beal, Mark Lucas, Michael J. Lagasse, MagiQ Technologies, Inc. (USA) ..... [9616-22]

SESSION 7..... TUE 11:00 AM TO 12:00 PM

## Light Harvesting and Image Sensors for Space Environment I

Session Chairs: **Sam-Shajing Sun**, Norfolk State Univ. (USA); **Ronald G. Pirich**, Northrop Grumman Aerospace Systems (Retired) (USA)

**Polymer light harvesting composites for optoelectronic applications (Invited Paper)**, Sam-Shajing Sun, Dan Wang, Norfolk State Univ. (USA) ..... [9616-23]

**MEMS based solutions for an integrated and miniaturized multi-spectrum energy harvesting and conservation system (Invited Paper)**, Heath A. Berry, Eric G. Borquist, Mitchell Belser, Radiance Technologies, Inc. (USA); Sandra Zivanovic, Leland Weiss, Louisiana Tech Univ. (USA) ..... [9616-24]

Lunch Break ..... Tue 12:00 pm to 1:00 pm

SESSION 8..... TUE 1:00 PM TO 1:40 PM

## Light Harvesting and Image Sensors for Space Environment II

Session Chairs: **Sam-Shajing Sun**, Norfolk State Univ. (USA); **Ronald G. Pirich**, Northrop Grumman Aerospace Systems (Retired) (USA)

**Towards ultra-lightweight photonics using atomically thin semiconductors**, Vinod M. Menon, The City College of New York (USA) ..... [9616-25]

**Radiation damage effects in a CMOS TDI image sensor**, Joseph E. Rushton, Konstantin D. Stefanov, Andrew D. Holland, The Open Univ. (United Kingdom) ..... [9616-26]

SESSION 9..... TUE 1:40 PM TO 3:40 PM

## Performance Degradation in Photonic Devices for Space Applications: Modeling and Experiment

Session Chair: **David A. Cardimona**, Air Force Research Lab. (USA)

**Microscopic model for studying radiation degradation of electron transport and photodetection devices (Invited Paper)**, Danhong Huang, Air Force Research Lab. (USA); Fei Gao, Univ. of Michigan (USA); David A. Cardimona, Christian P. Morath, Vicent M. Cowan, Air Force Research Lab. (USA) ..... [9616-27]

**Atomistic- and meso-scale simulations of radiation effects in photodetection devices (Invited Paper)**, Fei Gao, Efrain Hernandez-Rivera, Univ. of Michigan (USA); Danhong Huang, Air Force Research Lab. (USA) ..... [9616-28]

**Surface conduction in InAs and GaSb**, Daniel E. Sidor, Gregory R. Savich, Gary W. Wicks, Univ. of Rochester (USA) ..... [9616-29]

**Radiation effects on Yb:YLF crystals used in cryogenic optical refrigerators**, Kyle W. Martin, Applied Technology Associates (USA); Tom Fraser, John E. Hubbs, Vicent M. Cowan, Air Force Research Lab. (USA); Seth D. Melgaard, Mansoor Sheik-Bahae, The Univ. of New Mexico (USA) ..... [9616-30]

**Potential of CdSiP2 for enabling mid-infrared laser sources**, F. Kenneth Hopkins, Air Force Research Lab. (USA); Peter G. Schunemann, Kevin T. Zawilski, BAE Systems (USA); Nancy C. Giles, Air Force Institute of Technology (USA); Larry E. Halliburton, West Virginia Univ. (USA) ..... [9616-31]

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# Unconventional Imaging and Wavefront Sensing XI

Conference Chairs: **Jean J. Dolne**, The Boeing Co. (USA); **Thomas J. Karr**, Defense Advanced Research Projects Agency (USA); **Victor L. Gamiz**, Air Force Research Lab. (USA)

Conference Co-Chair: **David C. Dayton**, Applied Technology Associates (USA)

Program Committee: **Stephen C. Cain**, Air Force Institute of Technology (USA); **James Fienup**, Univ. of Rochester (USA); **Wes D. Freiwald**, Pacific Defense Solutions, LLC (USA); **Richard B. Holmes**, Boeing LTS Inc. (USA); **Liren Liu**, Shanghai Institute of Optics and Fine Mechanics (China); **Zhaowei Liu**, Univ. of California, San Diego (USA); **Sergio R. Restaino**, U.S. Naval Research Lab. (USA); **Michael C. Roggemann**, Michigan Technological Univ. (USA); **Robert K. Tyson**, The Univ. of North Carolina at Charlotte (USA); **David G. Voelz**, New Mexico State Univ. (USA)

## WEDNESDAY 12 AUGUST

### POSTERS-WEDNESDAY ..... WED 5:30 PM TO 7:30 PM

Conference attendees are invited to attend the poster session on Wednesday evening. Come view the posters, enjoy light refreshments, ask questions, and network with colleagues in your field. Authors of poster papers will be present to answer questions concerning their papers. Attendees are required to wear their conference registration badges to the poster sessions. Poster authors, view poster presentation guidelines at <http://spie.org/x30293.xml>.

**Single wave-front sensor control deformable mirrors: theory and experiment**, Ye Hongwei, Shen Feng, Zhou Rui, Institute of Optics and Electronics (China) ..... [9617-16]

**Direct detection of phase coded signal for ranging in synthetic aperture LADAR**, Guangyu Cai, Jianfeng Sun, Yu Zhou, Xiaoping Ma, Peipei Hou, FuChuan Liu, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) .. [9617-17]

**Imaging signal-to-noise ratio of synthetic aperture LADAR**, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China). ..... [9617-18]

**Improvement of the signal-to-noise ratio in static-mode down-looking synthetic aperture imaging LADAR**, Zhiyong Lu, Jianfeng Sun, Ning Zhang, Yu Zhou, Guangyu Cai, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9617-19]

**A compact optical processor for synthetic aperture imaging LADAR based on low-pass filtering**, Zhiwei Sun, Jianfeng Sun, Yu Zhou, Ning Zhang, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9617-20]

**Measurement of polarization parameters of the targets in synthetic aperture imaging LADAR**, Qian Xu, Jianfeng Sun, Wei Lu, Peipei Hou, Zhiwei Sun, Zhiyong Lu, Xiaoping Ma, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9617-21]

**A balanced APD photodetection technology for large field of view coherent receiver**, Guo Zhang, Zhou Yu, Jianfeng Sun, Baoliang Li, Liren Liu, Guang-Yu Cai, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9617-22]

**Resampling technique in the orthogonal direction for down-looking SAIL**, Guangyuan Li, Jianfeng Sun, Zhiyong Lu, Ning Zhang, Guang-Yu Cai, Zhiwei Sun, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China). .... [9617-23]

**A demonstrator of all-optronic multifunctional down-looking synthetic aperture LADAR**, Wei Lu, Zhiyong Lu, Zhiwei Sun, Ning Zhang, Jianfeng Sun, Lijuan Wang, Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China) ..... [9617-24]

**Dual-mode photosensitive arrays based on integration of liquid crystal microlenses and CMOS sensors for obtaining intensity images and wavefronts**, Qing Tong, Yu Lei, Huazhong Univ. of Science and Technology (China) ..... [9617-25]

**Some characteristics of the E-ELT's "sodium LGSSs"**, Nourredine N. Moussaoui, Univ. des Sciences et de la Technologie Houari Boumediene (Algeria) . . [9617-26]

## THURSDAY 13 AUGUST

### SESSION 1 ..... THU 8:00 AM TO 10:00 AM

#### Wavefront Sensing and Imaging

Session Chair: **David C. Dayton**, Applied Technology Associates (USA)

**Multi-conjugate adaptive optics (MCAO): analysis and assessment**, Katharine J. Jones, WBAO Consultant Group (USA) ..... [9617-1]

**Wavefront-sensor tomography for measuring spatial coherence**, Bohumil Stoklasa, Libor Motka, Jaroslav Rehacek, Zdenek Hradil, Palacký Univ. Olomouc (Czech Republic); Luis Lorenzo Sánchez-Soto, Univ. Complutense de Madrid (Spain) .. [9617-2]

**Broad comparison of existing and novel adaptive optics techniques to the strong turbulence problem**, Michael J. Steinbock, Air Force Institute of Technology (USA); Mark F. Spencer, Air Force Research Lab. (USA); Jack E. McCrae Jr., Milo W. Hyde IV, Air Force Institute of Technology (USA). .... [9617-3]

**Development of an extreme adaptive optics testbench using a self-referenced Mach-Zehnder wavefront sensor**, Christian Delacroix, Magali Loupias, Maud P. Langlois, Michel Tallon, Éric M. Thiébaut, Ctr. de Recherche Astrophysique de Lyon (France) .. [9617-4]

**Digital holography wave-front sensing in the presence of strong atmospheric turbulence and thermal blooming**, Mark F. Spencer, Air Force Research Lab. (USA); Michael J. Steinbock, Air Force Institute of Technology (USA) .... [9617-5]

**Artificial turbulence generation by means of different types of piezoceramic deformable mirrors**, Alexis V. Kudryashov, Anna Lyllova, Julia Sheldakova, Vadim Samarkin, Active Optics Night N Ltd. (Russian Federation) ..... [9617-6]

### SESSION 2 ..... THU 10:30 AM TO 11:30 AM

#### Computational and Interferometric Imaging

Session Chair: **Jean J. Dolne**, The Boeing Co. (USA)

**Geometric superresolution by scanning two rect masks - with relative path difference**, Ihtsham U. Haq, National Physical and Standard Lab. (Pakistan) and Pakistan Institute of Engineering and Applied Sciences (Pakistan) and Pakistan Council of Scientific and Industrial Research (Pakistan); Asloob A. Mudassar, Pakistan Institute of Engineering and Applied Sciences (Pakistan); Ihtram U. Haq, Univ. of Karachi (Pakistan) .. [9617-7]

**Laboratory validation of a sparse aperture image quality model**, Philip S. Salvaggio, Rochester Institute of Technology (USA) ..... [9617-8]

**Multiple-baseline detection of a geostationary satellite with the Navy precision optical interferometer**, J. Tom Armstrong, Ellyn K. Baines, Henrique R. Schmitt, Sergio R. Restaino, James H. Clark, U.S. Naval Research Lab. (USA); James A. Benson, Donald J. Hutter, Bob T. Zavala, U.S. Naval Observatory (USA) .. [9617-9]

Lunch Break ..... Thu 11:30 am to 1:00 pm

# CONFERENCE 9617

SESSION 3..... THU 1:00 PM TO 2:20 PM

## Active Imaging and Beam Shaping

Session Chair: **Victor L. Gamiz**, Air Force Research Lab. (USA)

**Spectrum engineering for ultrafast imaging**, Eric Huang, Qian Ma, Zhaowei Liu, Univ. of California, San Diego (USA) ..... [9617-10]

**Remote sensing solution using 3-D flash LADAR for automated control of aircraft**, Brian J. Neff, U.S. Air Force (USA) ..... [9617-11]

**Experimental method of generating electromagnetic Gaussian Schell-model beams**, Matthew J. Gridley, Milo W. Hyde IV, Air Force Institute of Technology (USA); Mark F. Spencer, Air Force Research Lab. (USA); Santasri Basu, Air Force Institute of Technology (USA) ..... [9617-12]

**Laser beam propagation and wavefront correction in turbid media**, Alexis V. Kudryashov, Ilya Galaktionov, Julia Sheldakova, Active Optics Night N Ltd. (Russian Federation) ..... [9617-13]

SESSION 4..... THU 2:20 PM TO 3:00 PM

## Spectral and Ghost Imaging

Session Chair: **Thomas J. Karr**, Defense Advanced Research Projects Agency (USA)

**Transparent-conductor/oxide/silicon plasmonic photocapacitor for spectral imaging**, Farnood Khalilzadeh-Rezaie, Christian W. Smith, Michael S. Lodge, Janardan Nath, Univ. of Central Florida (USA); Justin W. Cleary, Air Force Research Lab. (USA); Masahiro Ishigami, Robert E. Peale, Univ. of Central Florida (USA) ..... [9617-14]

**Light field modulation of computational ghost imaging with defocus blur**, Weiliang Zhang, Wenwen Zhang, Qian Chen, Guohua Gu, Nanjing Univ. of Science and Technology (China). ..... [9617-15]



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- Probability for Systems Engineers
- Physical Optics Designs (with Examples)
- Gradient Index (GRIN) Optical Design
- Specifying and Mitigating Laser Damage
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# COURSES

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
<h2>Optical Design and Systems Engineering</h2>				
SC690 <b>Optical System Design: Layout Principles and Practice</b> ( <i>Greivenkamp</i> ) 8:30 am to 5:30 pm, \$560 / \$670, p. 218	SC835 <b>Infrared Systems - Technology &amp; Design</b> ( <i>Daniels</i> ) 8:30 am to 5:30 pm, \$1,155 / \$1,410, p. 220		SC912 <b>Intermediate Lens Design</b> ( <i>Bentley</i> ) 8:30 am to 5:30 pm, \$560 / \$670, p. 218	
SC1164 <b>Wavefront Data Analysis</b> ( <i>Mahajan</i> ) <span style="color:red">NEW</span> 1:30 pm to 5:30 pm, \$375 / \$430, p. 224	SC003 <b>Practical Optical System Design</b> ( <i>Youngworth</i> ) 8:30 am to 5:30 pm, \$615 / \$725, p. 219	SC017 <b>Principles of Fourier Optics and Diffraction</b> ( <i>Gaskill</i> ) 8:30 am to 5:30 pm, \$660 / \$770, p. 219	SC1086 <b>Optical Materials, Fabrication and Testing for the Optical Engineer</b> ( <i>DeGroote Nelson</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 221	
	SC1112 <b>Introduction to Electro-Optical Systems Design</b> ( <i>Stotts</i> ) 8:30 am to 5:30 pm, \$590 / \$700, p. 220	SC454 <b>Fabrication Technologies for Micro- and Nano-Optics</b> ( <i>Suleski</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 223	SC1166 <b>Physical Optics Design (with Examples)</b> ( <i>Soskind</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 217	
	SC1003 <b>Optical Scatter Metrology for Industry</b> ( <i>Stover</i> ) 8:30 am to 12:30 pm, \$370 / \$425, p. 222		SC1165 <b>Probability for Systems Engineers</b> ( <i>Arenberg</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 217	
	SC915 <b>Radiometry Revealed</b> ( <i>Shaw</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 221		SC1167 <b>Gradient Index (GRIN) Optical Design</b> ( <i>Moore</i> ) 1:30 pm to 5:30 pm, \$300 / \$355, p. 217	
	SC567 <b>Introduction to Optical Remote Sensing Systems</b> ( <i>Shaw</i> ) 1:30 pm to 5:30 pm, \$300 / \$355, p. 223			
	SC492 <b>Predicting, Modeling, and Interpreting Light Scattered by Surfaces</b> ( <i>Germer</i> ) 1:30 pm to 5:30 pm, \$300 / \$355, p. 222			
	SC1114 <b>The Proper Care of Optics: Cleaning, Handling, Storage and Shipping</b> ( <i>Schalck</i> ) 1:30 pm to 5:30 pm, \$345 / \$400, p. 224			

SUNDAY

MONDAY

TUESDAY

WEDNESDAY

THURSDAY

## Optomechanics and Optical Manufacturing

SC014 <b>Introduction to Optomechanical Design</b> <i>(Vukobratovich)</i> 8:30 am to 5:30 pm, \$1,000 / \$1,255, p. 225	SC454 <b>Fabrication Technologies for Micro- and Nano-Optics</b> <i>(Suleski)</i> 8:30 am to 12:30 pm, \$300 / \$355, p. 229	SC1086 <b>Optical Materials, Fabrication and Testing for the Optical Engineer</b> <i>(DeGroote Nelson)</i> 8:30 am to 12:30 pm, \$300 / \$355, p. 228	SC1120 <b>Finite Element Analysis of Optics</b> <i>(Doyle, Genberg)</i> 8:30 am to 5:30 pm, \$595 / \$705, p. 226
SC1164 <b>Wavefront Data Analysis</b> <i>(Mahajan)</i> <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">NEW</span> 1:30 pm to 5:30 pm, \$375 / \$430, p. 230	SC015 <b>Structural Adhesives for Optical Bonding</b> <i>(Daly)</i> 8:30 am to 12:30 pm, \$300 / \$355, p. 227	SC010 <b>Introduction to Optical Alignment Techniques</b> <i>(Castle)</i> 8:30 am to 5:30 pm, \$525 / \$635, p. 225	SC1166 <b>Physical Optics Design (with Examples)</b> <i>(Soskind)</i> <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">NEW</span> 8:30 am to 12:30 pm, \$300 / \$355, p. 231
SC492 <b>Predicting, Modeling, and Interpreting Light Scattered by Surfaces</b> <i>(Germer)</i> 1:30 pm to 5:30 pm, \$300 / \$355, p. 230	SC1019 <b>Mounting of Optical Components</b> <i>(Kasunic)</i> 8:30 am to 5:30 pm, \$605 / \$715, p. 227	SC796 <b>Strength Properties of Glass and Ceramics</b> <i>(Pepi)</i> 8:30 am to 12:30 pm, \$340 / \$395, p. 226	SC1085 <b>Optomechanical Systems Engineering</b> <i>(Kasunic)</i> 8:30 am to 5:30 pm, \$595 / \$705, p. 227
SC1114 <b>The Proper Care of Optics: Cleaning, Handling, Storage and Shipping</b> <i>(Schalck)</i> 1:30 pm to 5:30 pm, \$345 / \$400, p. 228	SC1168 <b>Specifying And Mitigating Laser Damage</b> <i>(McGuire)</i> <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">NEW</span> 1:30 pm to 5:30 pm, \$300 / \$355, p. 225	SC011 <b>Design of Efficient Illumination Systems</b> <i>(Cassarly)</i> 1:30 pm to 5:30 pm, \$300 / \$355, p. 232	SC1167 <b>Gradient Index (GRIN) Optical Design</b> <i>(Moore)</i> <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">NEW</span> 1:30 pm to 5:30 pm, \$300 / \$355, p. 231
		SC213 <b>Introduction to Interferometric Optical Testing</b> <i>(Wyant)</i> 8:30 am to 12:30 pm, \$335 / \$390, p. 229	

## Detectors and Imaging

SC157 <b>MTF in Optical and Electro-Optical Systems</b> <i>(Boreman)</i> 8:30 am to 5:30 pm, \$565 / \$675, p. 234	SC504 <b>Introduction to CCD and CMOS Imaging Sensors and Applications</b> <i>(Janesick)</i> 8:30 am to 5:30 pm, \$665 / \$775, p. 233	SC916 <b>Digital Camera and Sensor Evaluation Using Photon Transfer</b> <i>(Janesick)</i> 8:30 am to 5:30 pm, \$580 / \$690, p. 233	SC1167 <b>Gradient Index (GRIN) Optical Design</b> <i>(Moore)</i> 1:30 pm to 5:30 pm, \$300 / \$355, p. 235
	SC915 <b>Radiometry Revealed</b> <i>(Shaw)</i> 8:30 am to 12:30 pm, \$300 / \$355, p. 234		SC194 <b>Multispectral and Hyperspectral Image Sensors</b> <i>(Lomheim)</i> 1:30 pm to 5:30 pm, \$380 / \$435, p. 232

# COURSES

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
<b>Remote Sensing</b>				
	<b>SC835 Infrared Systems - Technology &amp; Design (Daniels)</b> 8:30 am to 5:30 pm, \$1,155 / \$1,410, p. 236		<b>SC1165 Probability for Systems Engineers</b> <span style="color:red; font-size: small;">NEW</span> (Arenberg) 8:30 am to 12:30 pm, \$300 / \$355, p. 239	
<b>SC157 MTF in Optical and Electro-Optical Systems (Boreman)</b> 8:30 am to 5:30 pm, \$565 / \$675, p. 237	<b>SC504 Introduction to CCD and CMOS Imaging Sensors and Applications (Janesick)</b> 8:30 am to 5:30 pm, \$665 / \$775, p. 238	<b>SC916 Digital Camera and Sensor Evaluation Using Photon Transfer (Janesick)</b> 8:30 am to 5:30 pm, \$580 / \$690, p. 239	<b>SC194 Multispectral and Hyperspectral Image Sensors (Lomheim)</b> 1:30 pm to 5:30 pm, \$380 / \$435, p. 237	
	<b>SC1112 Introduction to Electro-Optical Systems Design (Stotts)</b> 8:30 am to 5:30 pm, \$590 / \$700, p. 236			
	<b>SC915 Radiometry Revealed (Shaw)</b> 8:30 am to 12:30 pm, \$300 / \$355, p. 238			
	<b>SC567 Introduction to Optical Remote Sensing Systems (Shaw)</b> 1:30 pm to 5:30 pm, \$300 / \$355, p. 235			
<b>Astronomical Optics and Instrumentation</b>				
	<b>SC835 Infrared Systems - Technology &amp; Design (Daniels)</b> 8:30 am to 5:30 pm, \$1,155 / \$1,410, p. 242		<b>SC1086 Optical Materials, Fabrication and Testing for the Optical Engineer (DeGroote Nelson)</b> 8:30 am to 12:30 pm, \$300 / \$355, p. 247	<b>SC1120 Finite Element Analysis of Optics (Doyle, Genberg)</b> 8:30 am to 5:30 pm, \$595 / \$705, p. 241
	<b>SC1112 Introduction to Electro-Optical Systems Design (Stotts)</b> 8:30 am to 5:30 pm, \$590 / \$700, p. 245	<b>SC010 Introduction to Optical Alignment Techniques (Castle)</b> 8:30 am to 5:30 pm, \$525 / \$635, p. 243		
	<b>SC1003 Optical Scatter Metrology for Industry (Stover)</b> 8:30 am to 12:30 pm, \$370 / \$425, p. 246	<b>SC1019 Mounting of Optical Components (Kasunic)</b> 8:30 am to 5:30 pm, \$605 / \$715, p. 244	<b>SC1165 Probability for Systems Engineers</b> <span style="color:red; font-size: small;">NEW</span> (Arenberg) 8:30 am to 12:30 pm, \$300 / \$355, p. 241	<b>SC1085 Optomechanical Systems Engineering (Kasunic)</b> 8:30 am to 5:30 pm, \$595 / \$705, p. 241
<b>SC014 Introduction to Optomechanical Design (Vukobratovich)</b> 8:30 am to 5:30 pm, \$1,000 / \$1,255, p. 243			<b>SC796 Strength Properties of Glass and Ceramics (Pepi)</b> 8:30 am to 12:30 pm, \$340 / \$395, p. 241	
<b>SC157 MTF in Optical and Electro-Optical Systems (Boreman)</b> 8:30 am to 5:30 pm, \$565 / \$675, p. 246	<b>SC915 Radiometry Revealed (Shaw)</b> 8:30 am to 12:30 pm, \$300 / \$355, p. 240		<b>SC213 Introduction to Interferometric Optical Testing (Wyant)</b> 8:30 am to 12:30 pm, \$335 / \$390, p. 247	
<b>SC1164 Wavefront Data Analysis (Mahajan)</b> <span style="color:red; font-size: small;">NEW</span> 1:30 pm to 5:30 pm, \$375 / \$430, p. 248	<b>SC015 Structural Adhesives for Optical Bonding (Daly)</b> 8:30 am to 12:30 pm, \$300 / \$355, p. 245			
	<b>SC567 Introduction to Optical Remote Sensing Systems (Shaw)</b> 1:30 pm to 5:30 pm, \$300 / \$355, p. 243			
	<b>SC492 Predicting, Modeling, and Interpreting Light Scattered by Surfaces (Germer)</b> 1:30 pm to 5:30 pm, \$300 / \$355, p. 247			
	<b>SC1114 The Proper Care of Optics: Cleaning, Handling, Storage and Shipping (Schalck)</b> 1:30 pm to 5:30 pm, \$345 / \$400, p. 240			

SUNDAY

MONDAY

TUESDAY

WEDNESDAY

THURSDAY

## Nanoscience

SC454 <b>Fabrication Technologies for Micro- and Nano-Optics</b> ( <i>Suleski</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 249
SC1082 <b>Nanophotonics and Metaphotonics</b> ( <i>Prasad, Baev</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 248

## Optics + Photonics for Sustainable Energy

SC1003 <b>Optical Scatter Metrology for Industry</b> ( <i>Stover</i> ) 8:30 am to 12:30 pm, \$370 / \$425, p. 250
SC915 <b>Radiometry Revealed</b> ( <i>Shaw</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 251
SC492 <b>Predicting, Modeling, and Interpreting Light Scattered by Surfaces</b> ( <i>Germer</i> ) 1:30 pm to 5:30 pm, \$300 / \$355, p. 250

## Illumination Engineering

SC157 <b>MTF in Optical and Electro-Optical Systems</b> ( <i>Boreman</i> ) 8:30 am to 5:30 pm, \$565 / \$675, p. 251	SC915 <b>Radiometry Revealed</b> ( <i>Shaw</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 252	SC011 <b>Design of Efficient Illumination Systems</b> ( <i>Cassarly</i> ) 1:30 pm to 5:30 pm, \$300 / \$355, p. 251
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## Metrology

SC1164 <b>Wavefront Data Analysis</b> ( <i>Mahajan</i> ) <span style="color:red;">NEW</span> 1:30 pm to 5:30 pm, \$375 / \$430, p. 252	SC1003 <b>Optical Scatter Metrology for Industry</b> ( <i>Stover</i> ) 8:30 am to 12:30 pm, \$370 / \$425, p. 253	SC017 <b>Principles of Fourier Optics and Diffraction</b> ( <i>Gaskill</i> ) 8:30 am to 5:30 pm, \$660 / \$770, p. 254	SC213 <b>Introduction to Interferometric Optical Testing</b> ( <i>Wyant</i> ) 8:30 am to 12:30 pm, \$335 / \$390, p. 253
	SC492 <b>Predicting, Modeling, and Interpreting Light Scattered by Surfaces</b> ( <i>Germer</i> ) 1:30 pm to 5:30 pm, \$300 / \$355, p. 254		

## Nanoengineering

SC1003 <b>Optical Scatter Metrology for Industry</b> ( <i>Stover</i> ) 8:30 am to 12:30 pm, \$370 / \$425, p. 256	SC454 <b>Fabrication Technologies for Micro- and Nano-Optics</b> ( <i>Suleski</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 255
	SC1082 <b>Nanophotonics and Metaphotonics</b> ( <i>Prasad, Baev</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 255

# COURSES

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY
<h2>Signal, Image, and Data Processing</h2>				
SC157 <b>MTF in Optical and Electro-Optical Systems</b> <i>(Boreman)</i> 8:30 am to 5:30 pm, \$565 / \$675, p. 256	SC1112 <b>Introduction to Electro-Optical Systems Design</b> ( <i>Stotts</i> ) 8:30 am to 5:30 pm, \$590 / \$700, p. 257	SC916 <b>Digital Camera and Sensor Evaluation Using Photon Transfer</b> ( <i>Janesick</i> ) 8:30 am to 5:30 pm, \$580 / \$690, p. 257		
		SC017 <b>Principles of Fourier Optics and Diffraction</b> <i>(Gaskill)</i> 8:30 am to 5:30 pm, \$660 / \$770, p. 258		
<h2>Atmospheric and Space Optical Systems</h2>				
SC157 <b>MTF in Optical and Electro-Optical Systems</b> <i>(Boreman)</i> 8:30 am to 5:30 pm, \$565 / \$675, p. 259	SC1112 <b>Introduction to Electro-Optical Systems Design</b> ( <i>Stotts</i> ) 8:30 am to 5:30 pm, \$590 / \$700, p. 261	SC916 <b>Digital Camera and Sensor Evaluation Using Photon Transfer</b> ( <i>Janesick</i> ) 8:30 am to 5:30 pm, \$580 / \$690, p. 260	SC1165 <b>Probability for Systems Engineers</b> <span style="color:red">NEW</span> <i>(Arenberg)</i> 8:30 am to 12:30 pm, \$300 / \$355, p. 259	
	SC915 <b>Radiometry Revealed</b> ( <i>Shaw</i> ) 8:30 am to 12:30 pm, \$300 / \$355, p. 260			
	SC567 <b>Introduction to Optical Remote Sensing Systems</b> ( <i>Shaw</i> ) 1:30 pm to 5:30 pm, \$300 / \$355, p. 259			
	SC1114 <b>The Proper Care of Optics: Cleaning, Handling, Storage and Shipping</b> ( <i>Schalck</i> ) 1:30 pm to 5:30 pm, \$345 / \$400, p. 259			
<h2>Professional Development</h2>				
	WS897 <b>Effective Technical Presentations</b> ( <i>Doumont</i> ) 8:30 am to 12:30 pm, \$75 / \$125, p. 262		WS1058 <b>Critical Skills for Compelling Research Proposals</b> ( <i>Diehl</i> ) 8:30 am to 12:30 pm, \$50 / \$100, p. 261	
	WS908 <b>Effective Scientific Papers</b> ( <i>Doumont</i> ) 1:30 pm to 5:30 pm, \$75 / \$125, p. 262		WS1059 <b>Resumes to Interviews: Strategies for a Successful Job Search</b> ( <i>Lawson, Krinsky</i> ) 1:30 pm to 5:30 pm, \$50 / \$100, p. 261	
<h2>Workshops for Optics Educators</h2>				
		WS1142 <b>It's Elementary -- Light and Optics for Kids</b> ( <i>DeHarporte</i> ) 8:30 am to 10:30 am, \$25 / \$50, p. 263		
		WS1156 <b>Dumpster Optics: Real optical science with free stuff</b> ( <i>Donnelly, Magnani</i> ) 10:30 am to 12:30 pm, \$10 / \$15, p. 263	<span style="color:red">NEW</span>	

# OPTICAL DESIGN AND SYSTEMS ENGINEERING

## Probability for Systems Engineers New

**SC1165**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course explains basic principles for the use of probability analysis as applied to systems engineering. A primary goal of the course is explaining the logic, construction and application of performance and error budgeting. This probabilistic methodology should be a tool in every engineer's tool kit and is key to understanding the probability of a successful system. Examples are taken from various problems in systems engineering of astronomical and laser systems. This course will be of benefit to anyone who wants to answer the question, "what are the chances of success of my project?"

### LEARNING OUTCOMES

This course will enable you to:

- compose a performance or error budget
- calculate the distribution of likely outcomes of a design process
- calculate the most likely value for the performance of a component or system
- identify the sensitivity of performance to all parameters in the system
- explain the probability of the success of design project

### INTENDED AUDIENCE

Scientists, engineers, technicians, or managers who wish to learn more about how to apply probability to engineering problems. Undergraduate training in engineering or science is assumed.

### INSTRUCTOR

**Jonathan Arenberg** has been working as an optical and systems engineer for over 30 years. His work experience has included tactical and high-power laser components and systems and major space astronomical projects such as Chandra and the James Webb Space Telescope. He holds degrees in physics and engineering from the University of California, Los Angeles and currently the Chief Engineer for Northrop Grumman Aerospace Systems on the James Webb Space Telescope. Dr. Arenberg is an SPIE Fellow.

## Physical Optics Design New

**SC1166**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course introduces the audience to design principles and simulation techniques employed in physical optics design. The course covers the fundamental principles of physical optics that are governed by the wave phenomenon of light and need to be accounted for during the design process. Attendees will learn how to apply physical optics simulations to control light distributions in photonics instruments.

The instructor will illustrate physical optics design principles based on several practical design examples that demonstrate the application of physical optics design techniques to successful photonics instrumentation development. The design examples include the following topics: point-spread function engineering and optical superresolution; light coupling in integrated photonics and fiber optics devices; optical systems employing diffractive components; laser beam shaping, beam combining, and propagation; propagation-invariant laser beams and self-healing phenomenon; design of components employing sub-wavelength structures.

### LEARNING OUTCOMES

This course will enable you to:

- apply the principles of physical optics design to their respective areas of work and field of study
- explain the differences between simulation techniques based on physical optics (wave phenomena) and geometrical optics (ray-tracing)
- describe the practical considerations and limitations associated with physical optics design
- explain the influence of optical components on the performance of optical systems and photonics instruments
- apply physical optics design principles for controlling optical field distributions in photonics instruments

### INTENDED AUDIENCE

This material is intended for engineers, scientists, photonics professionals and college students who would like to expand their knowledge into the area of physical optics design, understand the theoretical and practical considerations behind physical optics simulations, and become familiar with the fundamentals and important developments in physical optics and photonics instruments.

### INSTRUCTOR

**Yakov Soskind** is Photonics Instrumentation Development Manager with DHPC Technologies, Inc., leading the development of unique laser-based and electro-optical instrumentation. He has more than 30 years of successful contributions to the field of optical engineering, developing laser systems, fiber-optics and photonics instrumentation, diffractive and micro-optics, imaging and illumination devices. Dr. Soskind is a founding chair of the Photonic Instrumentation Engineering conference at Photonics West. He is the author of "Field Guide to Diffractive Optics", SPIE Press, 2011, and has been awarded more than 20 domestic and international patents in the field of photonics.

## Gradient Index (GRIN) Optical Design New

**SC1167**

**Course Level: Intermediate**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 1:30 pm to 5:30 pm**

Gradient index (GRIN) lenses are more common than you may know. The human lens is a gradient index optic, and the last time you scanned a document the scanner probably used a gradient index lens array. In a homogeneous lens, light refracts at the surfaces, only bending when it enters and exits the material. In a GRIN lens, light refracts at the surfaces and also bends inside the lens. The ability of GRIN optics to bend light gives an optical designer more variables to work with and opens up new design spaces. This course is designed to introduce optical designers and engineers to existing and emerging GRIN materials and to teach them the essentials necessary to use GRIN materials in optical designs.

# COURSES

This course begins with an introduction to gradient index phenomenon and the basic principles of GRIN optics. The properties of axial, radial and spherical optical systems will be presented as well as a review of aberration theory. A variety of GRIN materials that cover wavelength bands from the visible to the long wave infrared will be discussed. GRIN chromatic properties will be reviewed, and the GRIN Abbe number will be introduced. The course will review software tools written to help optical designers use GRIN materials in their systems along with easy-to-understand examples.

## LEARNING OUTCOMES

This course will enable you to:

- describe how light propagates in gradient index materials
- list gradient index optical materials
- classify axial, radial, and spherical GRIN lenses
- describe the chromatic properties of GRIN materials
- design a color corrected radial GRIN singlet

## INTENDED AUDIENCE

This course is intended for optical designers, engineers, and students who are interested in learning how to specify, design, and analyze GRIN materials in an optical system and to have a better understanding of the subject. Previous knowledge of geometrical optics, and optical design, is strongly recommended.

## INSTRUCTOR

**Duncan Moore** received his PhD in Optics in 1974 and his master's degree in Optics from the University of Rochester. He previously earned his bachelor's degree in Physics from the University of Maine. Currently he is the Vice Provost of Entrepreneurship and the Kingslake Professor of Optical Engineering as well as a Professor of Business Administration at the University of Rochester. Dr. Moore has extensive experience in the academic, research, business and governmental arenas of science and technology. He is an expert in gradient-index optics, solar cell design, computer-aided design, and the manufacture of optical systems.

## Intermediate Lens Design

### SC912

#### Course Level: Intermediate

**CEU: 0.65 \$560 Members | \$670 Non-Members USD**

**Wednesday 8:30 am to 5:30 pm**

Have you ever wondered why refractive, reflective, and zoomed optical systems look the way that they do? This course begins with a brief review of paraxial optics, third-order aberration theory, and computer aided optimization. A survey of refractive optical design forms from the landscape lens to the double gauss lens is given. Telephoto and retrofocus lenses, Petzval and microscope objectives, and wide angle lenses are discussed. Zoom lens principles and first order layout are presented in detail with easy to understand examples. Visible band color correction techniques and UV and IR design constraints are discussed.

This full day course also examines the basics of reflective optical system design including refractive design analogies, advantages and disadvantages of reflective systems, obscured vs. unobscured design forms. Reflective systems ranging from the Cassegrain to the reflective triplet to three and four mirror anastigmats are presented.

## LEARNING OUTCOMES

This course will enable you to:

- determine which lens types are suitable for various applications
- create a new system design from scratch
- layout a zoom lens from first principles
- describe reflective system designs and constraints

## INTENDED AUDIENCE

This course is intended for optical engineers and scientists who have some previous knowledge of geometrical optics, aberration theory, and lens design and who want to increase their optical design proficiency through a better understanding of the subject.

## INSTRUCTOR

**Julie Bentley** is an Associate Professor at The Institute of Optics, University of Rochester and has been teaching two graduate level courses in optical design for more than 10 years. She received her B.S., M.S., and PhD in Optics from the The Institute of Optics, University of Rochester. After graduating she spent two years at Hughes Aircraft Co. in California designing optical systems for the defense industry and then twelve years at Corning Tropel Corporation in Fairport, New York designing and manufacturing precision optical assemblies such as microlithographic inspection systems.

COURSE PRICE INCLUDES the text *Field Guide to Lens Design* (SPIE Press, 2012) by Julie Bentley and Craig Olson.

This course is an analogue to Warren Smith's long-running course SC006, Modern Lens Design.

## Optical System Design: Layout Principles and Practice

### SC690

#### Course Level: Introductory

**CEU: 0.65 \$560 Members | \$670 Non-Members USD**

**Sunday 8:30 am to 5:30 pm**

This course provides the background and principles necessary to understand how optical imaging systems function, allowing you to produce a system layout which will satisfy the performance requirements of your application.

This course teaches the methods and techniques of arriving at the first-order layout of an optical system by a process which determines the required components and their locations. This process will produce an image of the right size and in the right location. A special emphasis is placed on understanding the practical aspects of the design of optical systems.

Optical system imagery can readily be calculated using the Gaussian cardinal points or by paraxial ray tracing. These principles are extended to the layout and analysis of multi-component systems. This course includes topics such as imaging with thin lenses and systems of thin lenses, stops and pupils, and afocal systems. The course starts by providing the necessary background and theory of first-order optical design followed by numerous examples of optical systems illustrating the design process.

## LEARNING OUTCOMES

This course will enable you to:

- specify the requirements of an optical system for your application including magnification, object-to-image distance, and focal length
- diagram ray paths and do simple ray tracing
- describe the performance limits imposed on optical systems by diffraction and the human eye
- predict the imaging characteristics of multi-component systems
- determine the required element diameters
- apply the layout principles to a variety of optical instruments including telescopes, microscopes, magnifiers, field and relay lenses, zoom lenses, and afocal systems
- adapt a known configuration to suit your application
- grasp the process of the design and layout of an optical system

## INTENDED AUDIENCE

This course is intended for engineers, scientists, managers, technicians and students who need to use or design optical systems and want to understand the principles of image formation by optical systems. No previous knowledge of optics is assumed in the material development, and only basic math is used (algebra, geometry and trigonometry). By the end of the course, these techniques will allow the design and analysis of relatively sophisticated optical systems.

## INSTRUCTOR

**John Greivenkamp** is a professor at the College of Optical Sciences of The University of Arizona where he teaches geometrical optics and optical system design to undergraduate and graduate students. John is the editor of the SPIE Field Guides and is the author of the *Field Guide to Geometrical Optics* (SPIE Press, 2004).

COURSE PRICE INCLUDES the *Field Guide to Geometrical Optics* (SPIE Press, 2004) by John E. Greivenkamp.

SPECIAL NOTE: This course is a continuation of Warren Smith's long-standing SPIE course SC001, Optical System Design: Layout Principles and Practice and incorporates many of the same approaches and material used for that course.

## Practical Optical System Design

### SC003

#### Course Level: Intermediate

CEU: 0.65 \$615 Members | \$725 Non-Members USD

Monday 8:30 am to 5:30 pm

This course will provide attendees with a basic working knowledge of optical design and associated engineering. The information in this course will help novice and experienced designers, as well as people who interact with optical designers and engineers, sufficiently understand these problems and solutions to minimize cost and risk. The course includes background information for optical design and an array of pragmatic considerations such as optical system specification, analysis of optical systems, material selection, use of catalog systems and components, ultraviolet through infrared system considerations, environmental factors and solutions, Gaussian beam optics, and production considerations such as optical testing and alignment. The course includes many practical and useful examples emphasizing rigorous optical design and engineering with an emphasis on designing for manufacture. Even if you have never used an optical design program before, you will become fluent with how to estimate, assess, execute, and manage the design of optical systems for many varied applications.

This course is a continuation of the long-running Practical Optical Systems Design course established and taught by Robert E. Fischer.

## LEARNING OUTCOMES

This course will enable you to:

- develop a complete optical system design specification
- review fundamental physics and engineering related to optical design
- assess and analyze optical systems using computer-aided methods
- properly take into account system considerations such as environmental factors
- design for manufacture, alignment, and testing
- describe all aspects of optical design and associated engineering

## INTENDED AUDIENCE

This course is intended for anyone who needs to learn how to design optical systems. It will be of value to those who either design their own optics or those who work directly or indirectly with optical designers, as you will now understand what is really going on and how to ask the right questions of your designers.

## INSTRUCTOR

**Richard Youngworth** is Founder and Chief Engineer of Ryo LLC, an optical design and engineering firm providing engineering and product development services. His industrial experience spans diverse topics including optical metrology, design, manufacturing, and analysis. Dr. Youngworth has spent significant time working on optical systems in the challenging transition from ideal design to successful volume manufacturing. He is widely considered an expert, due to his research, lectures, publications, and industrial work on the design, producibility, and tolerance analysis of optical components and systems. Dr. Youngworth teaches "Practical Optical System Design" and "Cost-Conscious Tolerancing of Optical Systems" for SPIE. He has a B.S. in electrical engineering from the University of Colorado at Boulder and earned his Ph.D. in optics at the University of Rochester by researching tolerance analysis of optical systems.

COURSE PRICE INCLUDES the text *Optical System Design, 2nd Edition* (SPIE Press, 2008) by Robert E. Fischer, Biljana Tadic-Galeb, and Paul R. Yoder, Jr.

**This course is also available in online format.**

## Principles of Fourier Optics and Diffraction

### SC017

#### Course Level: Intermediate

CEU: 0.65 \$660 Members | \$770 Non-Members USD

Tuesday 8:30 am to 5:30 pm

This course introduces the application of Fourier theory in diffraction and image formation. The first part of the course provides a review of a number of mathematical topics, including convolution and the Fourier transform. Next, the phenomenon of diffraction is introduced, the effects of lenses on diffraction are discussed, and the propagation of Gaussian beams is treated. Finally, the effects of diffraction on the performance of image-forming systems and other optical devices are discussed.

## LEARNING OUTCOMES

This course will enable you to:

- understand convolution and Fourier transform operations
- describe the general effects of diffraction in the Fresnel and Fraunhofer regions
- understand the effects of lenses on diffraction
- predict the Fraunhofer diffraction patterns associated with specific apertures
- describe the propagation of Gaussian beams
- understand the effects of diffraction on image formation and image resolution
- calculate the Point-Spread Functions (PSF) and Optical Transfer Functions (OTF) for various imaging systems

## INTENDED AUDIENCE

This course is intended for scientists and engineers who need to understand the diffraction of optical wavefields and the effects of diffraction on the performance of image-forming systems and other optical devices.

## INSTRUCTOR

**Jack Gaskill** is Professor Emeritus of Optical Sciences at the University of Arizona where, for more than 30 years, his teaching activities were devoted primarily to the applications of Fourier theory in optics. He has taught more than 40 off-campus short courses in Fourier optics and related subjects. Gaskill is author of the textbook, *Linear Systems, Fourier Transforms, and Optics* (Wiley, 1978), and is a Past President of SPIE.

COURSE PRICE INCLUDES the text *Linear Systems, Fourier Transforms, and Optics* (Wiley, 1978) by Jack D. Gaskill.

# COURSES

## Introduction to Electro-Optical Systems Design

**SC1112**

**Course Level: Intermediate**

**CEU: 0.65 \$590 Members | \$700 Non-Members USD**

**Monday 8:30 am to 5:30 pm**

Using communication theory, this full-day course explains the universal principles underlying a diverse range of electro-optical systems. From visible / infra-red imaging, to free space optical communications and laser remote sensing, the course relates key concepts in science and systems engineering to practical systems issues. To provide realistic understanding of the concepts presented, many real-world examples are included.

This course summarizes laser propagation fundamentals, coherent and incoherent optical system characterization, the effects of optical turbulence and particulate scattering on propagating laser beams, atmospheric and submarine laser communication systems concepts, and laser radar and optical imaging basics. Also included are discussions of adaptive optics, adaptive image processing, and statistical hypothesis testing and its effect on system performance.

### LEARNING OUTCOMES

This course will enable you to:

- perform Fourier and Geometric Optics Analyses of electro-optical systems
- estimate detector noise statistics, detector performance, and signal-to-noise ratio
- perform first order image processing, including statistical image enhancements of incoherent images
- calculate contrast, irradiance and radiance created by the propagation of light in particulate environments
- calculate the system link budgets for laser systems
- perform statistical hypothesis testing, which includes how to calculate logarithmic likelihood ratio tests, test statistics, and probabilities of false alarm and detection
- assess and understand real-world Adaptive Optical system performance

### INTENDED AUDIENCE

This course is intended for scientists, technical managers and design engineers who are interested in understanding first-order electro-optical system design and the effects that limit system performance.

### INSTRUCTOR

**Larry Stotts** is a consultant and was the Deputy Office Director in the Strategic Technology Office of the Defense Advanced Research Projects Agency. He earned his Ph.D. in Electrical Engineering (Communications Systems) at the University of California at San Diego. He has published over 102 technical reports and journal articles and 2 co-authored books. Recognition of his work includes a Department of Defense Medal for Distinguished Civilian Service; two Secretary of Defense Medal for Meritorious Civilian Service Awards; two DARPA Technical Achievement Awards; The Technical Cooperation Program Technical Achievement Award, and the Naval Ocean Systems Center Technical Director's Award. Dr. Stotts is a Life Fellow of the SPIE, Fellow of the IEEE and a Senior Member and Fellow of OSA.

**COURSE PRICE INCLUDES** the text *Fundamentals of Electro-Optic Systems Design: Communications, Lidar and Imaging* by S. Karp and L. B. Stotts (Cambridge Press, 2013).

## Infrared Systems - Technology & Design

**SC835**

**Course Level: Advanced**

**CEU: 1.3 \$1,155 Members | \$1,410 Non-Members USD**

**Monday–Tuesday 8:30 am to 5:30 pm**

This course covers the range of topics necessary to understand the theoretical principles of modern infrared-technology. It combines numerous engineering disciplines necessary for the development of infrared systems. Practical engineering calculations are highlighted, with examples of trade studies illustrating the interrelationships among the various hardware characteristics.

This course is comprised of four sections:

Section 1 introduces the geometrical optics concepts including image formation, stops and pupils, thick lenses and lens combinations, image quality, and the properties of infrared materials.

Section 2 covers the essentials of radiometry necessary for the quantitative understanding of infrared signatures and flux transfer. These concepts are then developed and applied to flux-transfer calculations for blackbody, graybody, and selective radiator sources. Remote temperature calibrations and measurements are then used as an illustration of these radiometric principles.

Section 3 is devoted to fundamental background issues for optical detection-processes. It compares the characteristics of cooled and uncooled detectors with an emphasis on spectral and blackbody responsivity, detectivity ( $D^*$ ), as well as the noise mechanisms related to optical detection. The detector parameters and capabilities of single detectors and third generation focal plane arrays (FPAs) are analyzed.

With this acquired background, Section 4 considers the systems-design aspects of infrared imagers. The impact of scan format on signal-to-noise ratio is described, and the engineering tradeoffs inherent in the development of infrared search and track (IRST) systems are explained. Figures of merit such as MTF, NETD, and MRTD of staring arrays are examined for the performance metrics of thermal sensitivity and spatial resolution of thermal imaging systems (TIS). Contrast threshold functions based on Johnson and visible cycles (often denoted as N- and V-cycles) are specified. The interrelationships among the design parameters are identified through trade-study examples.

### LEARNING OUTCOMES

This course will enable you to:

- learn the principles and fundamentals of infrared optical design
- choose the proper infrared materials suite for your applications
- quickly execute flux-transfer calculations
- calibrate infrared sources and target signatures
- recognize the importance of background in thermal signatures
- have an appreciation for the capacity of infrared systems and learn the interaction of its critical components (optics, detectors, and electronics) in the production of a final infrared image
- assess the influence of noise mechanisms related to optical detection
- comprehend the fundamental response mechanisms and differences between cooled and uncooled single detectors as well as focal plane arrays (FPAs)
- comprehend the central theory behind third generation infrared imagers
- define and use common descriptors for detector and system performance (R,  $D^*$ , NEP, NEI, MTF, NETD, and MRTD)
- estimate system performance given subsystem and component specifications
- apply design tradeoffs in both infrared search and track systems (IRST) and thermal-imaging systems (TIS)
- carry out the preliminary design of infrared systems for different thermal applications

## INTENDED AUDIENCE

This course is directed to the practicing engineers and/or scientists who require both theoretical and effective practical technical information to design, build, and/or test infrared systems in a wide variety of thermal applications. A background at the bachelor's level in engineering is highly recommended. The participant should also have ample understanding of Fourier analysis and random processes.

## INSTRUCTOR

**Arnold Daniels** is a senior lead engineer with extensive experience in the conceptual definition of advance infrared, optical, and electro-optical systems. His background consists of technical contributions to applications for infrared search & track, thermal imaging, and ISR systems. Other technical expertise include infrared radiometry (testing and measurements), infrared test systems (i.e., MTF, NETD, and MRTD), thermographic nondestructive testing (TNNDT), optical design, precision optical alignment, stray light analysis, adaptive optics, Fourier analysis, image processing, and data acquisition systems. He earned an M.S. in Electrical Engineering from the University of Tel-Aviv and a doctorate in Electro-Optics from the School of Optics (CREOL) at the University of Central Florida. In 1995 he received the Rudolf Kingslake medal and prize for the most noteworthy original paper to appear in SPIE's Journal of Optical Engineering. He is presently developing direct energy laser weapon systems for defense applications.

COURSE PRICE INCLUDES the *Field Guide to Infrared Systems, Detectors, and FPAs, 2nd Edition* by Arnold Daniels (SPIE, 2010) and *Infrared Detectors and Systems* (Wiley, 1996) by Eustace L. Dereniak and Glenn D. Boreman.

## Radiometry Revealed

### SC915

#### Course Level: Introductory

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

This course explains basic principles and applications of radiometry and photometry. A primary goal of the course is to reveal the logic, systematic order, and methodology behind what sometimes appears to be a confusing branch of optical science and engineering. Examples are taken from the ultraviolet through the long-wave infrared portions of the electromagnetic spectrum. Anyone who wants to answer questions such as, "how many watts or photons do I have?" or "how much optical energy or radiation do I need?" will benefit from taking this course.

## LEARNING OUTCOMES

This course will enable you to:

- describe the fundamental units and quantities used to quantify electromagnetic radiation at wavelengths from the ultraviolet through the visible and infrared
- use, understand, and convert between radiometric and photometric quantities
- apply radiometry to typical applications, such as calibrating an imaging system, determining human-perceived brightness of a display, or calculating electricity produced by a solar cell
- calculate areas and solid angles to determine the energy, energy density, or brightness in an optical system
- explain the role of rays, stops, and pupils in defining the field of view and light-gathering capability of an optical system
- determine the throughput of an optical system and use it in radiometric calculations
- quantify the radiant energy in optical images from point and extended sources
- transfer radiant energy into and throughout optical systems
- identify radiometric standards and calibration methods
- be familiar with radiometers and photometers

## INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who wish to learn more about how to quantify radiant energy in optical systems and measurements. Undergraduate training in engineering or science is assumed.

## INSTRUCTOR

**Joseph Shaw** is Director of the Optical Technology Center and Professor of Electrical Engineering and Physics at Montana State University in Bozeman, Montana. He previously worked at the NOAA research labs in Boulder, Colorado. He is a widely recognized expert in the development, calibration, and analysis of optical systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona and is a Fellow of both the OSA and SPIE.

**This course is also available in online format.**

## Optical Materials, Fabrication and Testing for the Optical Engineer

### SC1086

#### Course Level: Introductory

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course is designed to give the optical engineer or lens designer an introduction to the technologies and techniques of optical materials, fabrication and testing. This knowledge will help the optical engineer understand how the choice of optical specifications and tolerances can either lead to more cost effective optical components, or can excessively drive the price up. Topics covered include optical materials, traditional, CNC and novel optical fabrication technologies, surface testing and fabrication tolerances.

## LEARNING OUTCOMES

This course will enable you to:

- identify key mechanical, chemical and thermal properties of optical materials (glass, crystals and ceramics) and how they affect the optical system performance and cost of optical components
- describe the basic processes of optical fabrication
- define meaningful surface and dimensional tolerances
- communicate effectively with optical fabricators
- design optical components that are able to be manufactured and measured using state of the art optical fabrication technologies
- choose the optimum specifications and tolerances for your next project

## INTENDED AUDIENCE

Optical engineers, lens designers, or managers who wish to learn more about how optical materials, fabrication and testing affect the optical designer. Undergraduate training in engineering or science is assumed.

## INSTRUCTOR

**Jessica DeGroote Nelson** is the Director of Engineering at Optimax Systems, Inc, where she oversees Optimax engineering, quality and research and development departments. She is an adjunct faculty member at The Institute of Optics at the University of Rochester teaching an undergraduate course on Optical Fabrication and Testing, and has given several guest lectures on optical metrology methods. She earned a Ph.D. in Optics at The Institute of Optics at the University of Rochester. Dr. Nelson is a member of both OSA and SPIE.

# COURSES

## Optical Scatter Metrology for Industry

### SC1003

#### Course Level: Intermediate

CEU: 0.35 \$370 Members | \$425 Non-Members USD

Monday 8:30 am to 12:30 pm

Optical scatter, originally used almost exclusively to characterize the stray light generated by optically smooth surfaces, is now being used as a sensitive, economical way to monitor the surface texture requirements in a variety of industries. For example, the photo-voltaic industry uses specific types of texture on surfaces to increase absorption and system efficiency. Texture is often an important requirement for the metal producing industry and it changes with roll wear. The appearance of every day appliances (from door hinges to computer cases) varies dramatically with texture. The quality of flat panel displays depends on the scatter characteristics of the screen and components behind it. SEMI and ASTM are responding to the new applications with "scatter standards" to help communication between manufacturers, vendors and customers.

The low signal (hard to measure) optical applications were solved first because the math was easy. Rougher surface scatter relationships are more complicated, but the signals are much larger - making instrumentation easier. The course starts with the optical applications and then explores the transition to rougher industry surfaces. Between a good optical mirror and a concrete sidewalk there are thousands of industry surfaces that can be monitored with scatter metrology. There are two key points for these "in-between" surfaces: (1) If the texture changes - the scatter changes and (2) these changes (and product function) cannot be adequately monitored by a single variable - such as RMS Roughness, Haze or Gloss. The course emphasizes quantifying, measuring and understanding scatter. The modeling of scatter is mentioned, but is not emphasized here.

#### LEARNING OUTCOMES

This course will enable you to:

- quantify and analyze scatter in terms of BRDF, TIS, Haze and DSC units
- explain the instrumentation for obtaining scatter data and evaluate system calibration
- describe and overcome the various difficulties in comparing roughness statistics found from profilometers and scatterometers for both one- and two-dimensional samples
- convert scatter to roughness statistics when possible and understand when it is not possible
- evaluate the use of scatter measurement for specific applications such as: stray system radiation, surface micro-roughness, particulate sizing, background sensor noise
- explain the use of polystyrene latex sphere depositions as an optical scattering standard
- review scattering standards for the semiconductor and photovoltaic industries

#### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of scatter metrology to laboratory research and industrial process control. Some knowledge of calculus is helpful, but the course does not require that the student follow mathematical derivations. The instructor has worked with Thomas Germer (SC492 instructor) to avoid overlap between the two courses.

#### INSTRUCTOR

**John Stover** is President of The Scatter Works, Inc., a Tucson firm concentrating on scatter based metrology standards, consulting, and measurement as they apply to diverse industries. He has researched light scatter related problems for over 30 years and led teams of engineers who developed state-of-the-art scatterometers, verified theoretical relationship between surface roughness and scatter and characterized surface defects to improve wafer metrology. He has been involved with international standards organizations for over 20 years, is an SPIE Fellow, and has been active as an author, conference chairman, and editor, and has over one hundred publications.

COURSE PRICE INCLUDES the text *Optical Scattering: Measurement and Analysis, 3rd Edition* (SPIE Press, 2012) by John Stover.

## Predicting, Modeling, and Interpreting Light Scattered by Surfaces

### SC492

#### Course Level: Intermediate

CEU: 0.35 \$300 Members | \$355 Non-Members USD

Monday 1:30 pm to 5:30 pm

The measurement of light scattered by surfaces can be used to locate and identify roughness, particulates, and defects on a wide variety of materials. Applications include the inspection of silicon wafers, optics, and storage media, characterization of thin film roughness, identification of objects in remote sensing, and prediction of optical system performance. The aim of this course is to provide tools to engineers and scientists to enable them to predict scattering for different sources, differentiate amongst different scattering sources, and to design instrumentation that maximizes sensitivity or differentiation amongst scattering sources for their specific application. Emphasis will be placed on the use of the SCATMECH library of scattering codes and the Modeled Integrated Scatter Tool (MIST) in order to minimize the mathematics that can often be a barrier to those who would otherwise be interested in using optical scatter. The measurement of scatter is emphasized in SC1003 taught by John Stover.

#### LEARNING OUTCOMES

This course will enable you to:

- quantify scatter in terms of intensity and polarization properties
- identify likely sources of scatter from a material or thin film
- predict scatter from specific scatter sources: roughness, particles, and subsurface defects
- design experiments that differentiate among scattering sources
- use MIST to evaluate or visualize optical scatter in a variety of applications.
- define the limitations of light scattering

#### INTENDED AUDIENCE

This course is intended for scientists and engineers who are interested in modeling, predicting, and interpreting light scatter from surfaces for material inspection, optical design, or remote sensing applications.

The instructor has designed the course to complement SC1003, working in conjunction with SC1003's instructor John Stover to coordinate the material.

#### INSTRUCTOR

**Thomas Germer** is a physicist specializing in measurements and modeling of the optical properties of materials at the National Institute of Standards and Technology in Gaithersburg, Maryland. He has published over one hundred technical papers, covering topics of electron and ultrafast time-resolved surface spectroscopy, diffuse optical scattering from particles, roughness, and defects near surfaces and thin films, polarimetry, critical dimension metrology by grating scatterometry, and biomedical optics. He is the developer of the SCATMECH library of light scattering codes and the associated MIST program. Dr. Germer received a B.A. from the University of California, Berkeley, and a M.S. and Ph.D. from Cornell University, and is a Fellow of SPIE.

Following the course, attendees will be provided with an electronic copy of the public domain SCATMECH library, the MIST program, and all of the example programs discussed in the class.

## Fabrication Technologies for Micro- and Nano-Optics

**SC454**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Tuesday 8:30 am to 12:30 pm**

Applications of micro and nano-scale optics are widespread in essentially every industry that uses light in some way. A short list of sample application areas includes communications, solar power, biomedical sensors, laser-assisted manufacturing, and a wide range of consumer electronics. Understanding both the possibilities and limitations for manufacturing micro- and nano-optics is useful to anyone interested in these areas. To this end, this course provides an introduction to fabrication technologies for micro- and nano-optics, ranging from refractive microlenses to diffractive optics to sub-wavelength optical nanostructures.

After a short overview of key applications and theoretical background for these devices, the principles of photolithography are introduced. With this backdrop, a wide variety of lithographic and non-lithographic fabrication methods for micro- and nano-optics are discussed in detail, followed by a survey of testing methods. Relative advantages and disadvantages of different techniques are discussed in terms of both technical capabilities and scalability for manufacturing. Issues and trends in micro- and nano-optics fabrication are also considered, focusing on both technical challenges and manufacturing infrastructure.

### LEARNING OUTCOMES

This course will enable you to:

- describe example applications and key ‘rules of thumb’ for micro- and nano-optics
- explain basic principles of photolithography and how they apply to the fabrication of micro- and nano-optics
- identify and explain multiple techniques for micro- and nano-optics fabrication
- compare the advantages and disadvantages of different manufacturing methods
- describe and compare performance and metrological testing methods for micro- and nano-optics
- evaluate fabrication trends and supporting process technologies for volume manufacturing

### INTENDED AUDIENCE

Engineers, scientists, and managers who are interested in the design, manufacture, or application of micro/nano-optics, or systems that integrate these devices. A background in basic optics is helpful but not assumed.

### INSTRUCTOR

**Thomas Suleski** has been actively involved in research and development of micro- and nano-optics since 1991 at Georgia Tech, Digital Optics Corporation, and since 2003, as a member of the faculty at the University of North Carolina at Charlotte. He holds 12 patents and more than 110 technical publications on the design, fabrication, and testing of micro- and nano-optical components and systems. Dr. Suleski is a Fellow of SPIE, the International Society for Optical Engineering, and currently serves as Senior Editor for JM3, the Journal of Micro/Nanolithography, MEMS and MOEMS.

## Introduction to Optical Remote Sensing Systems

**SC567**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

This course provides a broad introduction to optical remote sensing systems, including both passive sensors (e.g., radiometers and spectral imagers) and active sensors (e.g., laser radars or LIDARs). A brief review of basic principles of radiometry and atmospheric propagation (absorption, emission, and scattering) is followed by a system-level discussion of a variety of ground-, air-, and space-based remote sensing systems. Key equations are presented for predicting the optical resolution and signal-to-noise performance of passive and active sensing systems. Sensor system examples discussed in the class include solar radiometers, passive spectrometers and hyperspectral imagers, airborne imaging spectrometers, thermal infrared imagers, polarization imagers, and active laser radars (LIDARs and LADARs). The course material is directly relevant to sensing in environmental, civilian, military, astronomical, and solar energy applications.

### LEARNING OUTCOMES

This course will enable you to:

- review the principles of optical radiometry used to describe and calculate the flow of optical energy in an optical sensor system or solar energy system
- describe how the atmosphere affects the propagation of optical radiation
- explain how optical atmospheric effects influence remote sensing measurements or solar energy
- use system parameters in basic radiometric calculations to predict the signal received by passive and active sensors
- compare systems at the block-diagram level remote sensing measurements
- explain the difference between passive imaging based on reflection and emission
- acquire the operating principles of laser radar (lidar/ladar) systems for distributed and solid target sensing

### INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who find themselves working on (or curious about) optical remote sensing systems or data. Undergraduate training in engineering or science is assumed.

### INSTRUCTOR

**Joseph Shaw** is a professor of electrical engineering and physics at Montana State University and previously worked at the NOAA research labs. He is a recognized expert in development, calibration, and analysis of optical remote sensing systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization’s Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona. Dr. Shaw is a Fellow of both the OSA and SPIE.

# COURSES

## The Proper Care of Optics: Cleaning, Handling, Storage and Shipping

**SC1114**

**Course Level: Introductory**

**CEU: 0.35 \$345 Members | \$400 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

There are many ways to clean optics; some are learned from experience and/or failure. This course explains the proper cleaning methods for optics that are used by professional optical technicians and engineers.

How to clean optics has always been a challenging and controversial subject. Searching the Internet will yield hundreds of articles and videos that claim to know the best methods. This course will explain the simple steps used in cleaning optics. It will also describe the proper handling, storage and shipping of optical components. The course is designed for a diverse audience, from a first-time optical cleaner to an engineer searching for methods of handling and packaging optics. An in-class demonstration on inspecting and cleaning optics will be presented.

### LEARNING OUTCOMES

This course will enable you to:

- identify proper cleaning tools and their use
- explain safety guidelines, personal protection equipment and basic worktable layout
- compare lighting types required for inspection and cleaning
- identify solvents and cleaning liquids used for removing contaminants
- describe hand techniques used for applicators, wipes, and how to fold wipes
- explain inspection methods for optical surfaces
- list the types of contaminants and describe a short history of scratch and dig
- describe visual methods used: unaided eye, eye loupe, microscope (light and digital)
- describe types of optical coatings
- explain proper cleaning of small, large and infrared optics
- describe special cleaning techniques
- explain techniques used for instrument inspection, disassembly, assembly, and cleaning
- describe various instrument types
- describe the tricks of the trade: edge cleaning, protection, black paint and removing glue
- describe handling of optics using tweezers, cups, trays, storage and protection methods
- summarize shipping containment methods
- explain outdoor field cleaning

### INTENDED AUDIENCE

Technicians, engineers, scientists and managers who wish to learn the methods of cleaning, handling, storage and shipping of optics. High school to graduate degree.

### INSTRUCTOR

**Robert Schalck** is an Optical Engineer with over 40 years experience in the optical industry, and author of the text "The Proper Care of Optics" (SPIE Press, 2013) as well as an SPIE Online Course of the same title. He presented his first paper on cleaning optics at the OSA OF&T workshop in 1975. In 1989, he delivered a paper on Classical Optical Cleaning at the OSA "How to Conference." Over several decades, he has given presentations on how to clean optics to groups and organizations. He is a Senior Member of OSA and SPIE.

COURSE PRICE INCLUDES the text *The Proper Care of Optics: Cleaning, Handling, Storage and Shipping* (SPIE Press, 2013), by Robert Schalck.

**This course is also available in online format.**

## Wavefront Data Analysis



**SC1164**

**Course Level: Intermediate**

**CEU: 0.35 \$375 Members | \$430 Non-Members USD**

**Sunday 1:30 pm to 5:30 pm**

The course begins with an overview of basic aberrations and tolerance analysis in optical imaging systems. Zernike circle polynomials and their use in wavefront data analysis are presented as are analytical methods for cases involving non-circular pupils such as annular, square, hexagonal and elliptical pupils. The calculation of orthonormal aberration coefficients from the wavefront error data obtained by phase-shifting interferometry or wavefront slope error data obtained with a Shack-Hartmann sensor is explained, and numerical analyses of both types of data are demonstrated.

### LEARNING OUTCOMES

This course will enable you to:

- acquire a working knowledge of basic aberrations
- specify aberration/fabrication tolerance based on Strehl ratio and Rayleigh's quarter wave rule
- explain what Zernike polynomials are and why they are used in wavefront data analysis
- determine Zernike coefficients from optical design or testing wavefront data.
- determine Zernike coefficients from wavefront slope data
- relate Zernike coefficients to Seidel coefficients
- interpret data generated by wavefront or wavefront slope sensors
- develop effective communication between system engineers or engineering managers and optical designers, fabricators, and testers.

### INTENDED AUDIENCE

Scientists, engineers, and managers involved in lens and optical system design, fabrication, or optical testing. Some knowledge of aberrations and or experience with optical design, fabrication, or testing is helpful but not necessary.

### INSTRUCTOR

**Virendra Mahajan** is a graduate of the College of Optical Sciences, University of Arizona, where he is an adjunct professor. He has 40 years of experience working on space optical systems, the last 31 with The Aerospace Corporation. He is a Fellow of SPIE, OSA, and the Optical Society of India, and recipient of SPIE's 2006 Conrady award, and 2015 Educator award. Dr. Mahajan is the author of *Aberration Theory Made Simple*, 2nd ed. (2011), the editor of *Selected Papers on Effects of Aberrations in Optical Imaging* (1993), and the author of *Optical Imaging and Aberrations, Part I: Ray Geometrical Optics* (1998), *Part II: Wave Diffraction Optics*, 2nd ed. (2011), *Part III: Wavefront Analysis* (2013), *Fundamentals of Geometrical Optics* (2014), all published by SPIE Press. He is also an Associate Editor of OSA's *Handbook of Optics*, 3rd ed.

COURSE PRICE INCLUDES the text *Optical Imaging and Aberrations, Part III: Wavefront Analysis* (SPIE Press 2013) by Virendra N. Mahajan.

# OPTOMECHANICS AND OPTICAL MANUFACTURING

## Specifying And Mitigating Laser Damage



SC1168

**Course Level: Introductory****CEU: 0.35 \$300 Members | \$355 Non-Members USD****Tuesday 1:30 pm to 5:30 pm**

In today's environment of shrinking systems and a focus on making lasers affordable, the oldest problem in building reliable lasers - laser induced optical damage - is at the forefront of every laser designer's mind. From specifying and verifying the laser damage threshold of specialty coatings, to imparting appropriate cleaning procedures on the production line, no aspect of the design and build process can be neglected in order to achieve success reliably. This course will provide an overview of the history of laser damage, the scientific community's understanding of critical mechanisms at play, a review of the current standards of use, and good practices for testing and mitigating laser damage mechanisms. Completion of the course will bring a broad understanding of laser damage, and provide a strong base on which to build solutions for a variety of laser damage problems.

### LEARNING OUTCOMES

This course will enable you to:

### INTENDED AUDIENCE

Intended for engineers (laser, systems, optical, and quality), scientists, technicians, and managers who are developing, specifying, or purchasing laser systems.

### INSTRUCTOR

**Jon McGuire** has designed, built and tested laser systems for applications in military, space, and biomedical with high quality and reliability demands. Throughout his career he has worked with teams of laser, reliability, quality, and systems engineers to identify laser damage potential before it occurs, and to identify and eliminate laser damage related failures after they occur. He has experience in development and high rate production of laser diodes, fiber lasers, Q-switched lasers and multi-stage non-linear optical components and has witnessed, induced, and mitigated laser damage in a variety of environments. He received a BSE in Optical Engineering from the Department of Applied Science at the University of California at Davis, and an MS in Optics from CREOL at the University of Central Florida. Jon joined the Optics and Electro-Optics Standards Council (OEOSC) in 2007 to develop and implement practical standards for the specification and inspection of optical surface appearance imperfections, and is currently a member of ASC OP/TF7, Laser damage standards.

## Introduction to Optical Alignment Techniques

SC010

**Course Level: Introductory****CEU: 0.65 \$525 Members | \$635 Non-Members USD****Tuesday 8:30 am to 5:30 pm**

This course discusses the equipment, techniques, tricks, and skills necessary to align optical systems and devices. You learn to identify errors in an optical system, and how to align lens systems.

### LEARNING OUTCOMES

This course will enable you to:

- determine if errors in the optical system are due to misalignment errors or other factors such as fabrication, design, or mounting problems
- recognize and understand the fundamental imaging errors associated with optical systems
- diagnose (qualitatively and quantitatively) what is wrong with an optical system by simply observing these fundamental imaging errors
- use the variety of tools available for aligning optical systems, and more importantly, how to "tweak" logically the adjustments on these devices so that the alignment proceeds quickly and efficiently
- align basic lens systems and telescopes
- align more complex optical systems such as those containing off-axis aspheric surfaces, and maintain alignment using automatic mounting techniques

### INTENDED AUDIENCE

This course is directed toward engineers and technicians needing basic practical information and techniques to achieve alignment of simple optical systems, as well as seemingly more complicated off-axis aspheric mirrors. To benefit most from this course you will need a basic knowledge of the elementary properties of lenses and optical systems (i.e. focal lengths, f/numbers, magnification, and other imaging properties) and a working knowledge of simple interferometry. Some familiarity with the basic aberrations such as spherical aberration, coma, and astigmatism will be helpful.

### INSTRUCTOR

**Kenneth Castle** Ph.D. is president of Ruda-Cardinal, Inc., an optical engineering consulting firm located in Tucson, Arizona. Ken has worked with Mitch Ruda, the originator of this course, for 28 years. Mitch passed away August 31, 2013, and Ruda-Cardinal is continuing the tradition of this course in his memory.

## Introduction to Optomechanical Design

SC014

**Course Level: Introductory****CEU: 1.3 \$1,000 Members | \$1,255 Non-Members USD****Sunday - Monday 8:30 am to 5:30 pm**

This course will provide the training needed for the optical engineer to work with the mechanical features of optical systems. The emphasis is on providing techniques for rapid estimation of optical system performance. Subject matter includes material properties for optomechanical design, kinematic design, athermalization techniques, window design, lens and mirror mounting.

### LEARNING OUTCOMES

This course will enable you to:

- select materials for use in optomechanical systems
- determine the effects of temperature changes on optical systems, and develop design solutions for those effects
- design high performance optical windows
- design low stress mounts for lenses
- select appropriate mounting techniques for mirrors and prisms
- describe different approaches to large and lightweight mirror design

### INTENDED AUDIENCE

Engineers who need to solve optomechanical design problems. Optical designers will find that the course will give insight into the mechanical aspects of optical systems. The course will also interest those managing projects involving optomechanics. Short course SC690, Optical System Design: Layout Principles and Practice, or a firm understanding of its content, is required as background to this course.

# COURSES

## INSTRUCTOR

**Daniel Vukobratovich** is a senior principal engineer at Raytheon. He has over 30 years of experience in optomechanics, is a founding member of the SPIE working group in optomechanics, and is fellow of SPIE. He has taught optomechanics in 11 countries, consulted with over 50 companies and written over 50 publications in optomechanics.

This course is also available in online format.

## Strength Properties of Glass and Ceramics

### SC796

#### Course Level: Intermediate

CEU: 0.35 \$340 Members | \$395 Non-Members USD

Wednesday 8:30 am to 12:30 pm

This course provides attendees with a basic understanding of the terminology and analyses used in a fracture mechanics approach to determine the strength of glass, crystals, and ceramics. The course focuses on the determination of inert strength based on surface flaws, and reduction of such strength of these materials in the presence of time and moisture. Included are the effects of residual stress on lifetime, and basic reliability predictions. Examples from the literature are presented to bear out the theoretical design principles.

#### LEARNING OUTCOMES

This course will enable you to:

- review the strength of unflawed, perfect surfaces
- identify the processes that reduce glass strength
- name and define the critical fracture mechanics terms
- estimate the strength of glass, crystals, and ceramics in the presence of flaws and moist environments
- compose strength vs. time diagrams
- understand the effects of residual stress and design limitations
- list and compare alternative methods of crack propagation strength analyses

#### INTENDED AUDIENCE

This material is intended for structural, mechanical and optical engineers who wish to obtain an understanding of the principles of strength determination for optical components. Those who work with ground, air, or space-based systems will leave with a keen understanding of fracture mechanics applications without the need for complex and unwieldy computation.

#### INSTRUCTOR

**John Pepi** is a senior principal mechanical engineer with L-3 Communications SSG in Wilmington, MA. He holds a Master's degree in Structural Engineering, and has over 35 years' experience in the structural design of lightweight optical systems. He is an internationally recognized authority on mirror design principles, has authored a score of papers on opto-structural design principles, and has been a previous instructor for SPIE at its annual meetings. He has recently published a tutorial text through SPIE Press on this topic, which is available as a companion to this course.

COURSE PRICE INCLUDES the text *Strength Properties of Glass and Ceramics* (SPIE Press, 2014) by John W. Pepi.

## Finite Element Analysis of Optics

### SC1120

#### Course Level: Intermediate

CEU: 0.65 \$595 Members | \$705 Non-Members USD

Thursday 8:30 am to 5:30 pm

This course presents the use of finite element methods to model and predict the behavior of optical elements and support structures including lenses, mirrors, windows, and optical mounts in the presence of mechanical and environmental loads. Students will learn general FEA modeling strategies and guidelines specific to optical systems including how to develop low-fidelity models to quickly perform optomechanical design tradeoffs as well as the creation of high-fidelity models to support detailed design.

Emphasized will be the application of FEA techniques to meet optical system error budget allocations including mounting tolerances, alignment errors, optical surface distortions, image stability, and wavefront error. In addition, use of FEA to ensure structural integrity requirements including yield, buckling, and fracture will be discussed.

#### LEARNING OUTCOMES

This course will enable you to:

- develop optical component and system level finite element models
- model conventional and lightweight mirrors including evaluating the impact of optical coatings
- analyze optical mounts including kinematic, flexure, and optical bond designs
- predict optical alignment errors due to mechanical, assembly, and environmental loads
- perform optical surface error analyses using Zernike polynomials
- predict optical system image motion due to thermal and dynamic environments
- evaluate the effects of temperature and stress on optical performance

#### INTENDED AUDIENCE

This course is intended for mechanical engineers interested in learning about the application of finite element analysis in the mechanical design of optical systems. An interest in optomechanical engineering and/or familiarity with finite element software is recommended.

#### INSTRUCTOR

**Keith Doyle** has over 25-years experience in the field of optomechanical engineering, specializing in the multidisciplinary modeling of optical systems. He is a co-author of the book titled *Integrated Optomechanical Analysis*, has authored or co-authored over 40-publications in the field, and is a Fellow of SPIE. He is currently employed at MIT Lincoln Laboratory as a Group Leader in the Engineering Division. Previously he served as Vice President of Sigmadyne Inc. and as a Senior Systems Engineer at Optical Research Associates. He received his Ph.D. in engineering mechanics with a minor in optical sciences from the University of Arizona.

**Victor Genberg** has over 40-years experience in the application of finite element methods to high-performance optical structures and is a recognized expert in opto-mechanics. He is currently President of Sigmadyne, Inc. and a Professor of Mechanical Engineering at the University of Rochester where he teaches courses in optomechanics, finite element analysis, and design optimization. He is the co-author of the book titled *Integrated Optomechanical Analysis* has over 40 publications in this field including two chapters in the CRC Handbook of Optomechanical Engineering. Prior to founding Sigmadyne, Dr. Genberg spent 28-years at Eastman Kodak serving as a technical specialist for military and commercial optical systems.

COURSE PRICE INCLUDES the text *Integrated Optomechanical Analysis, 2nd Edition* (SPIE Press, 2012) by Keith Doyle, Victor Genberg, and Gregory Michels.

## Structural Adhesives for Optical Bonding

### SC015

**Course Level: Intermediate**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

Optomechanical systems require secure mounting of optical elements. Adhesives are commonly used, but rarely addressed in the literature. This course has compiled an overview of these adhesives, their properties, and how to test them. How to use them is addressed in detail with guidelines and examples provided. A summary of common adhesives is presented with justification for their use. Consideration and analysis of adhesive strength, reliability, and stability are included. Different design approaches to optimize the application are presented and discussed. Many examples are described as well as lessons learned from past experience. Discussions are encouraged to address current problems of course attendees.

#### LEARNING OUTCOMES

This course will enable you to:

- describe and classify adhesives and how they work (epoxy, urethane, silicone, acrylic, RTV, VU-cure, etc.)
- obtain guidance in: adhesive selection, surface preparation, application, and curing
- develop a basis for analysis of stress and thermal effects
- recognize contamination/outgassing and how to avoid it
- review design options
- create and use an adhesive check list

#### INTENDED AUDIENCE

This course is for engineers, managers, and technicians. This course provides a foundation for the correct design for successful optical mounting; an understanding of the best options to employ for each application, and the selection and approach conducive to production. A bound course outline (that is a good reference text) is provided, including summaries of popular adhesives and their properties.

#### INSTRUCTOR

**John Daly** has 35 years of experience in lasers and optomechanics. Over this period, he has worked optical bonding problems since his thesis projects, as an employee of several major corporations, and now as a consultant. His academic background in mechanical engineering and applied physics complements this discipline. His work experience has been diverse covering areas such as: military lasers, medical lasers, spectroscopy, point and standoff detection, and E-O systems. His roles over these years have included analysis, design, development, and production. He is a SPIE member, with numerous publications, and is a committee member of the SPIE Optomechanical Engineering Program.

## Mounting of Optical Components

### SC1019

**Course Level: Introductory**

**CEU: 0.65 \$605 Members | \$715 Non-Members USD**

**Tuesday 8:30 am to 5:30 pm**

This course introduces the optomechanical engineering principles for the mounting of optical components such as lenses, mirrors, windows, prisms, and filters. Oriented towards practicing engineers and managers, case studies are used to show how mount design is driven by a combination of environmental, performance, and cost requirements. Standard industry practices and common mounting techniques are reviewed, including:

- Mounting of lenses into barrels using adhesives or retaining rings
- Mounting of prisms and small mirrors using adhesives or clamps
- Mounting of assemblies using flexures
- Mounting and sealing of windows

Without using finite-element analysis (FEA), first-order engineering estimates are used to predict the performance of various mount types.

#### LEARNING OUTCOMES

This course will enable you to:

- isolate the effects of the environment on optics
- identify critical aspects of the optic-to-mount interface
- compare alternate low-strain mounting techniques for common types of elements
- estimate survivability for vibration and thermal loading
- design mounts that balance performance, survivability, and cost
- estimate optomechanical tolerances for optical assemblies using standard designs

#### INTENDED AUDIENCE

Intended for engineers (mechanical, optical, electrical, and systems), scientists, technicians, and managers who are developing, specifying, or purchasing optical, electro-optical, infrared, or laser systems. The material is at an introductory level, but a basic familiarity with optomechanical engineering principles is useful.

#### INSTRUCTOR

**Keith Kasunic** has more than 25 years of experience developing optical, electro-optical, infrared, and laser systems. He holds a Ph.D. in Optical Sciences from the University of Arizona, an MS in Mechanical Engineering from Stanford University, and a BS in Mechanical Engineering from MIT. He has worked for or been a consultant to a number of organizations, including Lockheed Martin, Ball Aerospace, Sandia National Labs, Nortel Networks, and Bookham. He is currently the Technical Director of Optical Systems Group, LLC. He is also an Adjunct Professor at Univ. of Central Florida's CREOL - The College of Optics and Photonics, as well as an Affiliate Instructor with Georgia Tech's SENSAC, and an Instructor for the Optical Engineering Certificate Program at Univ. of California Irvine.

COURSE PRICE INCLUDES the text *Mounting Optics in Optical Instruments, 2nd edition* (SPIE Press, 2008), by Paul R. Yoder, Jr.

**This course is also available in online format.**

## Optomechanical Systems Engineering

### SC1085

**Course Level: Introductory**

**CEU: 0.65 \$595 Members | \$705 Non-Members USD**

**Thursday 8:30 am to 5:30 pm**

This course emphasizes a systems-level overview of optomechanical engineering. Starting with the fundamentals of imaging, it reviews how optical system concepts flow down into optomechanical requirements on optical fabrication, alignment, structural design, mechanics of materials (metals, composites, and glasses), structural vibrations, thermal management, and kinematic mounts. The focus is on real-world design problems, as well as the commercial off-the-shelf (COTS) components used to solve them.

#### LEARNING OUTCOMES

This course will enable you to:

- utilize the basic concepts and terminology of optical engineering required for the development of optomechanical components
- read conventional and ISO-10110 drawings used for the fabrication of lenses
- develop an alignment plan with an emphasis on critical tolerances, alignment mechanisms, and "go-no go" decisions for adjusting tilt, decenter, despace, and defocus
- quantify the ability of a structural design to maintain alignment using efficient architectures and lightweight materials; compare low-strain lens and mirror mounts for reducing wavefront error (WFE)
- utilize the results of STOP (structural-thermal-optical) analysis for the deflection and distortion of optical components under static loads; estimate the impact of stress concentrations and contact stresses; select optical materials with appropriate structural properties

# COURSES

- estimate the effects of vibration environments on the alignment of optomechanical systems; select COTS components for vibration isolation
- predict the effects of conductive, convective, and radiative thermal environments on the performance of optical systems; select materials and off-the-shelf hardware to manage the effects of heat loads and temperature changes
- compare kinematic and semi-kinematic mounts and the limitations of COTS hardware

## INTENDED AUDIENCE

Intended for engineers (systems, optical, mechanical, and electrical), scientists, technicians, and managers who are developing, specifying, or purchasing optical, electro-optical, infrared, or laser systems.

## INSTRUCTOR

**Keith Kasunic** has more than 25 years of experience developing optical, electro-optical, infrared, and laser systems. He holds a Ph.D. in Optical Sciences from the University of Arizona, an MS in Mechanical Engineering from Stanford University, and a BS in Mechanical Engineering from MIT. He has worked for or been a consultant to a number of organizations, including Lockheed Martin, Ball Aerospace, Sandia National Labs, Nortel Networks, and Bookham. He is currently the Technical Director of Optical Systems Group, LLC. He is also an Adjunct Professor at Univ. of Central Florida's CREOL - The College of Optics and Photonics, as well as an Affiliate Instructor with Georgia Tech's SENSAC, and an Instructor for the Optical Engineering Certificate Program at Univ. of California Irvine. This course is based on courses he teaches at CREOL and Georgia Tech's SENSAC.

COURSE PRICE INCLUDES the text *Optomechanical Systems Engineering* (Wiley, 2015) by Keith Kasunic.

## Optical Materials, Fabrication and Testing for the Optical Engineer

### SC1086

#### Course Level: Introductory

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course is designed to give the optical engineer or lens designer an introduction to the technologies and techniques of optical materials, fabrication and testing. This knowledge will help the optical engineer understand how the choice of optical specifications and tolerances can either lead to more cost effective optical components, or can excessively drive the price up. Topics covered include optical materials, traditional, CNC and novel optical fabrication technologies, surface testing and fabrication tolerances.

## LEARNING OUTCOMES

This course will enable you to:

- identify key mechanical, chemical and thermal properties of optical materials (glass, crystals and ceramics) and how they affect the optical system performance and cost of optical components
- describe the basic processes of optical fabrication
- define meaningful surface and dimensional tolerances
- communicate effectively with optical fabricators
- design optical components that are able to be manufactured and measured using state of the art optical fabrication technologies
- choose the optimum specifications and tolerances for your next project

## INTENDED AUDIENCE

Optical engineers, lens designers, or managers who wish to learn more about how optical materials, fabrication and testing affect the optical designer. Undergraduate training in engineering or science is assumed.

## INSTRUCTOR

**Jessica DeGroote Nelson** is the Director of Engineering at Optimax Systems, Inc, where she oversees Optimax engineering, quality and research and development departments. She is an adjunct faculty member at The Institute of Optics at the University of Rochester teaching an undergraduate course on Optical Fabrication and Testing, and has given several guest lectures on optical metrology methods. She earned a Ph.D. in Optics at The Institute of Optics at the University of Rochester. Dr. Nelson is a member of both OSA and SPIE.

## The Proper Care of Optics: Cleaning, Handling, Storage and Shipping

### SC1114

#### Course Level: Introductory

**CEU: 0.35 \$345 Members | \$400 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

There are many ways to clean optics; some are learned from experience and/or failure. This course explains the proper cleaning methods for optics that are used by professional optical technicians and engineers.

How to clean optics has always been a challenging and controversial subject. Searching the Internet will yield hundreds of articles and videos that claim to know the best methods. This course will explain the simple steps used in cleaning optics. It will also describe the proper handling, storage and shipping of optical components. The course is designed for a diverse audience, from a first-time optical cleaner to an engineer searching for methods of handling and packaging optics. An in-class demonstration on inspecting and cleaning optics will be presented.

## LEARNING OUTCOMES

This course will enable you to:

- identify proper cleaning tools and their use
- explain safety guidelines, personal protection equipment and basic worktable layout
- compare lighting types required for inspection and cleaning
- identify solvents and cleaning liquids used for removing contaminants
- describe hand techniques used for applicators, wipes, and how to fold wipes
- explain inspection methods for optical surfaces
- list the types of contaminants and describe a short history of scratch and dig
- describe visual methods used: unaided eye, eye loupe, microscope (light and digital)
- describe types of optical coatings
- explain proper cleaning of small, large and infrared optics
- describe special cleaning techniques
- explain techniques used for instrument inspection, disassembly, assembly, and cleaning
- describe various instrument types
- describe the tricks of the trade: edge cleaning, protection, black paint and removing glue
- describe handling of optics using tweezers, cups, trays, storage and protection methods
- summarize shipping containment methods
- explain outdoor field cleaning

## INTENDED AUDIENCE

Technicians, engineers, scientists and managers who wish to learn the methods of cleaning, handling, storage and shipping of optics. High school to graduate degree.

**INSTRUCTOR**

**Robert Schalck** is an Optical Engineer with over 40 years experience in the optical industry, and author of the text "The Proper Care of Optics" (SPIE Press, 2013) as well as an SPIE Online Course of the same title. He presented his first paper on cleaning optics at the OSA OF&T workshop in 1975. In 1989, he delivered a paper on Classical Optical Cleaning at the OSA "How to Conference." Over several decades, he has given presentations on how to clean optics to groups and organizations. He is a Senior Member of OSA and SPIE.

COURSE PRICE INCLUDES the text *The Proper Care of Optics: Cleaning, Handling, Storage and Shipping* (SPIE Press, 2013), by Robert Schalck.

This course is also available in online format.

## Fabrication Technologies for Micro- and Nano-Optics

**SC454**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Tuesday 8:30 am to 12:30 pm**

Applications of micro and nano-scale optics are widespread in essentially every industry that uses light in some way. A short list of sample application areas includes communications, solar power, biomedical sensors, laser-assisted manufacturing, and a wide range of consumer electronics. Understanding both the possibilities and limitations for manufacturing micro- and nano-optics is useful to anyone interested in these areas. To this end, this course provides an introduction to fabrication technologies for micro- and nano-optics, ranging from refractive microlenses to diffractive optics to sub-wavelength optical nanostructures.

After a short overview of key applications and theoretical background for these devices, the principles of photolithography are introduced. With this backdrop, a wide variety of lithographic and non-lithographic fabrication methods for micro- and nano-optics are discussed in detail, followed by a survey of testing methods. Relative advantages and disadvantages of different techniques are discussed in terms of both technical capabilities and scalability for manufacturing. Issues and trends in micro- and nano-optics fabrication are also considered, focusing on both technical challenges and manufacturing infrastructure.

### LEARNING OUTCOMES

This course will enable you to:

- describe example applications and key 'rules of thumb' for micro- and nano-optics
- explain basic principles of photolithography and how they apply to the fabrication of micro- and nano-optics
- identify and explain multiple techniques for micro- and nano-optics fabrication
- compare the advantages and disadvantages of different manufacturing methods
- describe and compare performance and metrological testing methods for micro- and nano-optics
- evaluate fabrication trends and supporting process technologies for volume manufacturing

### INTENDED AUDIENCE

Engineers, scientists, and managers who are interested in the design, manufacture, or application of micro/nano-optics, or systems that integrate these devices. A background in basic optics is helpful but not assumed.

**INSTRUCTOR**

**Thomas Suleski** has been actively involved in research and development of micro- and nano-optics since 1991 at Georgia Tech, Digital Optics Corporation, and since 2003, as a member of the faculty at the University of North Carolina at Charlotte. He holds 12 patents and more than 110 technical publications on the design, fabrication, and testing of micro- and nano-optical components and systems. Dr. Suleski is a Fellow of SPIE, the International Society for Optical Engineering, and currently serves as Senior Editor for JM3, the Journal of Micro/Nanolithography, MEMS and MOEMS.

## Introduction to Interferometric Optical Testing

**SC213**

**Course Level: Introductory**

**CEU: 0.35 \$335 Members | \$390 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This short course introduces the field of interferometric optical testing. Topics covered include basic interferometers for optical testing, and concepts of phase-shifting interferometry including error analysis. Long wavelength interferometry, testing of aspheric surfaces, measurement of surface microstructure, and the state-of-the-art of direct phase measurement interferometers are also discussed.

### LEARNING OUTCOMES

This course will enable you to:

- explain the basic concepts of interferometric optical testing
- describe the power, capabilities, and limitations of phase-shifting interferometry
- describe techniques, advantages, and disadvantages of long-wavelength interferometry
- compare different aspheric testing techniques
- list capabilities and techniques for measuring surface microstructure
- describe the current state-of-the-art of direct phase measurement interferometers

### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand the basic concepts of interferometric optical testing.

**INSTRUCTOR**

**James Wyant** is Professor of Optical Sciences at the University of Arizona. He is currently Chairman of the Board of 4D Technology. He was a founder of the WYKO Corporation and served as its president from 1984 to 1997. Dr. Wyant was the 1986 President of SPIE.

COURSE PRICE INCLUDES the text *Field Guide to Interferometric Optical Testing* (SPIE Press, 2006) by Eric P. Goodman and James C. Wyant.

# COURSES

## Predicting, Modeling, and Interpreting Light Scattered by Surfaces

**SC492**

**Course Level: Intermediate**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

The measurement of light scattered by surfaces can be used to locate and identify roughness, particulates, and defects on a wide variety of materials. Applications include the inspection of silicon wafers, optics, and storage media, characterization of thin film roughness, identification of objects in remote sensing, and prediction of optical system performance. The aim of this course is to provide tools to engineers and scientists to enable them to predict scattering for different sources, differentiate amongst different scattering sources, and to design instrumentation that maximizes sensitivity or differentiation amongst scattering sources for their specific application. Emphasis will be placed on the use of the SCATMECH library of scattering codes and the Modeled Integrated Scatter Tool (MIST) in order to minimize the mathematics that can often be a barrier to those who would otherwise be interested in using optical scatter. The measurement of scatter is emphasized in SC1003 taught by John Stover.

### LEARNING OUTCOMES

This course will enable you to:

- quantify scatter in terms of intensity and polarization properties
- identify likely sources of scatter from a material or thin film
- predict scatter from specific scatter sources: roughness, particles, and subsurface defects
- design experiments that differentiate among scattering sources
- use MIST to evaluate or visualize optical scatter in a variety of applications.
- define the limitations of light scattering

### INTENDED AUDIENCE

This course is intended for scientists and engineers who are interested in modeling, predicting, and interpreting light scatter from surfaces for material inspection, optical design, or remote sensing applications.

The instructor has designed the course to complement SC1003, working in conjunction with SC1003's instructor John Stover to coordinate the material.

### INSTRUCTOR

**Thomas Germer** is a physicist specializing in measurements and modeling of the optical properties of materials at the National Institute of Standards and Technology in Gaithersburg, Maryland. He has published over one hundred technical papers, covering topics of electron and ultrafast time-resolved surface spectroscopy, diffuse optical scattering from particles, roughness, and defects near surfaces and thin films, polarimetry, critical dimension metrology by grating scatterometry, and biomedical optics. He is the developer of the SCATMECH library of light scattering codes and the associated MIST program. Dr. Germer received a B.A. from the University of California, Berkeley, and a M.S. and Ph.D. from Cornell University, and is a Fellow of SPIE.

Following the course, attendees will be provided with an electronic copy of the public domain SCATMECH library, the MIST program, and all of the example programs discussed in the class.

## Wavefront Data Analysis



**SC1164**

**Course Level: Intermediate**

**CEU: 0.35 \$375 Members | \$430 Non-Members USD**

**Sunday 1:30 pm to 5:30 pm**

The course begins with an overview of basic aberrations and tolerance analysis in optical imaging systems. Zernike circle polynomials and their use in wavefront data analysis are presented as are analytical methods for cases involving non-circular pupils such as annular, square, hexagonal and elliptical pupils. The calculation of orthonormal aberration coefficients from the wavefront error data obtained by phase-shifting interferometry or wavefront slope error data obtained with a Shack-Hartmann sensor is explained, and numerical analyses of both types of data are demonstrated.

### LEARNING OUTCOMES

This course will enable you to:

- acquire a working knowledge of basic aberrations
- specify aberration/fabrication tolerance based on Strehl ratio and Rayleigh's quarter wave rule
- explain what Zernike polynomials are and why they are used in wavefront data analysis
- determine Zernike coefficients from optical design or testing wavefront data.
- determine Zernike coefficients from wavefront slope data
- relate Zernike coefficients to Seidel coefficients
- interpret data generated by wavefront or wavefront slope sensors
- develop effective communication between system engineers or engineering managers and optical designers, fabricators, and testers.

### INTENDED AUDIENCE

Scientists, engineers, and managers involved in lens and optical system design, fabrication, or optical testing. Some knowledge of aberrations and/or experience with optical design, fabrication, or testing is helpful but not necessary.

### INSTRUCTOR

**Virendra Mahajan** is a graduate of the College of Optical Sciences, University of Arizona, where he is an adjunct professor. He has 40 years of experience working on space optical systems, the last 31 with The Aerospace Corporation. He is a Fellow of SPIE, OSA, and the Optical Society of India, and recipient of SPIE's 2006 Condray award, and 2015 Educator award. Dr. Mahajan is the author of Aberration Theory Made Simple, 2nd ed. (2011), the editor of Selected Papers on Effects of Aberrations in Optical Imaging (1993), and the author of Optical Imaging and Aberrations, Part I: Ray Geometrical Optics (1998), Part II: Wave Diffraction Optics, 2nd ed. (2011), Part III: Wavefront Analysis (2013), Fundamentals of Geometrical Optics (2014), all published by SPIE Press. He is also an Associate Editor of OSA's Handbook of Optics, 3rd ed.

COURSE PRICE INCLUDES the text *Optical Imaging and Aberrations, Part III: Wavefront Analysis* (SPIE Press 2013) by Virendra N. Mahajan.

## Physical Optics Design (with Examples)

SC1166

**Course Level: Introductory****CEU: 0.35 \$300 Members | \$355 Non-Members USD****Wednesday 8:30 am to 12:30 pm**

This course introduces the audience to design principles and simulation techniques employed in physical optics design. The course covers the fundamental principles of physical optics that are governed by the wave phenomenon of light and need to be accounted for during the design process. Attendees will learn how to apply physical optics simulations to control light distributions in photonics instruments.

The instructor will illustrate physical optics design principles based on several practical design examples that demonstrate the application of physical optics design techniques to successful photonics instrumentation development. The design examples include the following topics: point-spread function engineering and optical superresolution; light coupling in integrated photonics and fiber optics devices; optical systems employing diffractive components; laser beam shaping, beam combining, and propagation; propagation-invariant laser beams and self-healing phenomenon; design of components employing sub-wavelength structures.

**LEARNING OUTCOMES**

This course will enable you to:

- apply the principles of physical optics design to their respective areas of work and field of study
- explain the differences between simulation techniques based on physical optics (wave phenomena) and geometrical optics (ray-tracing)
- describe the practical considerations and limitations associated with physical optics design
- explain the influence of optical components on the performance of optical systems and photonics instruments
- apply physical optics design principles for controlling optical field distributions in photonics instruments

**INTENDED AUDIENCE**

This material is intended for engineers, scientists, photonics professionals and college students who would like to expand their knowledge into the area of physical optics design, understand the theoretical and practical considerations behind physical optics simulations, and become familiar with the fundamentals and important developments in physical optics and photonics instruments.

**INSTRUCTOR**

**Yakov Soskind** is Photonics Instrumentation Development Manager with DHPC Technologies, Inc., leading the development of unique laser-based and electro-optical instrumentation. He has more than 30 years of successful contributions to the field of optical engineering, developing laser systems, fiber-optics and photonics instrumentation, diffractive and micro-optics, imaging and illumination devices. Dr. Soskind is a founding chair of the Photonic Instrumentation Engineering conference at Photonics West. He is the author of "Field Guide to Diffractive Optics", SPIE Press, 2011, and has been awarded more than 20 domestic and international patents in the field of photonics.



## Gradient Index (GRIN) Optical Design

SC1167

**Course Level: Intermediate****CEU: 0.35 \$300 Members | \$355 Non-Members USD****Wednesday 1:30 pm to 5:30 pm**

Gradient index (GRIN) lenses are more common than you may know. The human lens is a gradient index optic, and the last time you scanned a document the scanner probably used a gradient index lens array. In a homogeneous lens, light refracts at the surfaces, only bending when it enters and exits the material. In a GRIN lens, light refracts at the surfaces and also bends inside the lens. The ability of GRIN optics to bend light gives an optical designer more variables to work with and opens up new design spaces. This course is designed to introduce optical designers and engineers to existing and emerging GRIN materials and to teach them the essentials necessary to use GRIN materials in optical designs.

This course begins with an introduction to gradient index phenomenon and the basic principles of GRIN optics. The properties of axial, radial and spherical optical systems will be presented as well a review of aberration theory. A variety of GRIN materials that cover wavelength bands from the visible to the long wave infrared will be discussed. GRIN chromatic properties will be reviewed, and the GRIN Abbe number will be introduced. The course will review software tools written to help optical designers use GRIN materials in their systems along with easy-to-understand examples.

**LEARNING OUTCOMES**

This course will enable you to:

- describe how light propagates in gradient index materials
- list gradient index optical materials
- classify axial, radial, and spherical GRIN lenses
- describe the chromatic properties of GRIN materials
- design a color corrected radial GRIN singlet

**INTENDED AUDIENCE**

This course is intended for optical designers, engineers, and students who are interested in learning how to specify, design, and analyze GRIN materials in an optical system and to have a better understanding of the subject. Previous knowledge of geometrical optics, and optical design, is strongly recommended.

**INSTRUCTOR**

**Duncan Moore** received his PhD in Optics in 1974 and his master's degree in Optics from the University of Rochester. He previously earned his bachelor's degree in Physics from the University of Maine. Currently he is the Vice Provost of Entrepreneurship and the Kingslake Professor of Optical Engineering as well as a Professor of Business Administration at the University of Rochester. Dr. Moore has extensive experience in the academic, research, business and governmental arenas of science and technology. He is an expert in gradient-index optics, solar cell design, computer-aided design, and the manufacture of optical systems.



# COURSES

## Design of Efficient Illumination Systems

### SC011

Course Level: Intermediate

CEU: 0.35 \$300 Members | \$355 Non-Members USD

Wednesday 1:30 pm to 5:30 pm

Illumination systems are included in fiber illuminators, projectors, and lithography systems. The design of an illumination system requires balancing uniformity, maximizing the collection efficiency from the source, and minimizing the size of the optical package. These choices are examined for systems using lightpipes, lens arrays, faceted optics, tailored edge rays designs, and integrating spheres through a combination of computer simulations, hardware demonstrations and discussions.

### LEARNING OUTCOMES

This course will enable you to:

- describe the differences between illuminance, intensity and luminance
- compute the required source luminance given typical illumination system specifications
- compute the change in luminance introduced by an integrating sphere
- distinguish between a Kohler illuminator and an Abbe illuminator
- explain the difference in uniformity performance between a tailored edge ray reflector and a standard conic reflector
- design a lightpipe system to provide uniform illuminance
- design a lens array system to create a uniform illuminance distribution
- design a reflector with facets to create a uniform illuminance distribution

### INTENDED AUDIENCE

Individuals who design illumination systems or need to interface with those designers will find this course appropriate. Previous exposure to Optical Fundamentals (Reflection, Refraction, Lenses, Reflectors) is expected.

### INSTRUCTOR

William Cassarly is a Senior Scientist with Synopsys (formerly Optical Research Associates). Before joining ORA 18 years ago, Cassarly worked at GE for 13 years, holds 47 US patents, and has worked extensively in the areas of illumination system design, sources, photometry, light pipes, and non-imaging optics. Bill was awarded the GE Corporate 'D. R. Mack Advanced Course Supervisor Award' for his efforts in the training of GE Engineers and is an SPIE Fellow.

## DETECTORS AND IMAGING

### Multispectral and Hyperspectral Image Sensors

### SC194

Course Level: Advanced

CEU: 0.35 \$380 Members | \$435 Non-Members USD

Wednesday 1:30 pm to 5:30 pm

This course will describe the imaging capabilities and applications of the principal types of multispectral (MS) and hyperspectral (HS) sensors. The focus will be on sensors that work in the visible, near-infrared and shortwave-infrared spectral regimes, but the course will touch on longwave-infrared applications. A summary of the salient features of classical color imaging (human observation) will also be provided in an appendix.

### LEARNING OUTCOMES

This course will enable you to:

- understand many of the applications and advantages of multispectral (MS) and hyperspectral (HS) imaging
- describe and categorize the properties of the principal MS / HS design types (multi-band scanner, starers with filter wheels, dispersive, wedge, and Fourier transform imagers with 2D arrays, etc.)
- list and define the relevant radiometric radiometric quantities, concepts and phenomenology
- understand the process of translating system requirements into sensor hardware constraints and specifications
- analyze signal-to-noise ratio, modulation-transfer-function, and spatial / spectral sampling for MS and HS sensors
- define, understand and apply the relevant noise-equivalent figures-of-merit (Noise-equivalent reflectance difference, Noise-equivalent temperature difference, Noise-equivalent spectral radiance, Noise-equivalent irradiance, etc.)
- describe the elements of the image chain from photons-in to bits-out (photon detection, video signal manipulation, analog processing, and digitization)
- list and review key imager subsystem technology elements (optical, focal plane, video electronics, and thermal)
- formulate a detailed end-to-end design example of a satellite imaging scanning HS sensor
- provide an appendix that summarizes color imaging principles and sensor associated elements for human observation applications (e.g. color television, still cameras, etc.)

### INTENDED AUDIENCE

Engineers, scientists, and technical managers who are interested in understanding and applying multispectral and hyperspectral sensors in advanced military, civil, scientific and commercial applications.

### INSTRUCTOR

**Terrence Lomheim** holds the position of Distinguished Engineer at The Aerospace Corp. He has 34 years of hardware and analysis experience in visible and infrared electro-optical systems, focal plane technology, and applied optics, and has authored and co-authored 63 publications in these technical areas. He is a Fellow of the SPIE.

COURSE PRICE INCLUDES the text *CMOS/CCD Sensors and Camera Systems, 2nd edition* (SPIE Press, 2011) by Terrence Lomheim and Gerald Holst.

## Introduction to CCD and CMOS Imaging Sensors and Applications

**SC504**

**Course Level: Introductory**

**CEU: 0.65 \$665 Members | \$775 Non-Members USD**

**Monday 8:30 am to 5:30 pm**

This course provides a review of general theory and operation for CCD and CMOS imaging technologies looking at the development and application statuses of both. Performance differences between CMOS and CCD imaging arrays are covered. Fundamental performance limits behind major sensor operations are presented in addition to image defects, shorts, device yield, popular chip foundries, chip cost; custom designed and off-the-shelf sensors. We discuss operation principles behind popular commercial and scientific CMOS pixel architectures, and various array readout schemes. We cover backside illuminated arrays for UV, EUV and x-ray applications; high QE frontside illuminated sensors; deep depletion CCDs, ultra large CMOS and CCD arrays; high speed/ low noise parallel readout sensors. We describe the photon transfer technique in measuring performance and calibrating camera and chip systems, and charge transfer mechanisms. We review correlated double sampling theory used to achieve low noise performance and conclude with a look at future research and development trends for each technology.

### LEARNING OUTCOMES

This course will enable you to:

- describe operating CMOS and CCD arrays and camera systems for commercial and scientific imaging applications
- explain how CCD and CMOS arrays are designed, fabricated, tested and calibrated
- know how to apply test methodologies and performance standards
- list specifications and requirements to select a sensor for your imaging application
- recognize performance differences between CMOS and CCD technologies
- understand how video signals are processed for optimum signal-to-noise performance
- become familiar with current and future imaging technologies and applications

### INTENDED AUDIENCE

This course is for scientists, engineers, and managers involved with high performance CCD and CMOS imaging sensors and camera systems.

### INSTRUCTOR

**James Janesick** is currently the director of the CMOS advanced development group for Sarnoff Corporation. Previously he was with Conexant Systems Inc. developing CMOS imaging arrays for commercial applications. He was technology director of Pixel Vision, Inc. for five years developing high speed backside illuminated CCDs for scientific and cinema cameras. Prior to this Janesick was with the Jet Propulsion Laboratory for 22 years where as group leader he designed scientific ground and flight based imaging systems. He has authored 75 publications and has contributed to many NASA Tech Briefs and patents for various CCD and CMOS innovations. Janesick received NASA medals for Exceptional Engineering Achievement (1982 and 1992) and was the recipient of the SPIE Educator Award (2004) and was SPIE /IS&T Imaging Scientist of the Year (2007).

COURSE PRICE INCLUDES the texts *Scientific Charge Coupled Devices* (SPIE Press, 2001), and *Photon Transfer* (SPIE Press, 2007) by James Janesick.

## Digital Camera and Sensor Evaluation Using Photon Transfer

**SC916**

**Course Level: Introductory**

**CEU: 0.65 \$580 Members | \$690 Non-Members USD**

**Tuesday 8:30 am to 5:30 pm**

Photon transfer (PT) is a popular and essential characterization standard employed in the design, operation, characterization, calibration, optimization, specification and application of digital scientific and commercial camera systems. The PT user friendly technique is based on only two measurements- average signal and rms noise which together produce a multitude of important data products in evaluating digital camera systems (most notably CCD and CMOS). PT is applicable to all imaging disciplines. Design and fabrication process engineers developing imagers rely heavily on PT data products in determining discrete performance parameters such as quantum efficiency (QE), quantum yield, read noise, full well, dynamic range, nonlinearity, fixed pattern noise, V/e- conversion gain, dark current , image , etc.. Camera users routinely use the PT technique to determine system level performance parameters to convert relative measurements into absolute electron and photon units, offset correction, flat field and image S/N, ADC quantizing noise, optimum encoding, minimum detectable luminance, operating temperature to remove dark current , reliability, stability, etc. PT is also the first go/no-go test performed to determine the health of new camera system and/or detector as well as provide a power tool in trouble shooting problems. This course will review these aspects and many others offered by PT.

### LEARNING OUTCOMES

This course will enable you to:

- describe PT theory
- take PT data and determine important CCD and CMOS performance parameters
- show example PT data products generated by CCD and CMOS imagers
- calibrate a camera system in absolute physical units
- use PT to determine the best camera or CCD/CMOS imager for the application
- use PT to demonstrate and verify the camera system is reliable and in good operating order
- discuss guidelines for the novice and advanced user in generating PT, Modulation and Lux Transfer curves
- use PT to optimally remove fixed pattern noise sources in images for the highest S/N possible through flat fielding
- comprehend signal-to-noise image theory through PT

### INTENDED AUDIENCE

Engineers, scientists, and technical managers working with commercial and scientific digital camera systems. Some familiarity with CCD and CMOS imagers is recommended.

### INSTRUCTOR

**James Janesick** is currently the director of the CMOS advanced development group for Sarnoff Corporation. Previously he was with Conexant Systems Inc. developing CMOS imaging arrays for commercial applications. He was technology director of Pixel Vision, Inc. for five years developing high speed backside illuminated CCDs for scientific and cinema cameras. Prior to this Janesick was with the Jet Propulsion Laboratory for 22 years where as group leader he designed scientific ground and flight based imaging systems. He has authored 75 publications and has contributed to many NASA Tech Briefs and patents for various CCD and CMOS innovations. Janesick received NASA medals for Exceptional Engineering Achievement (1982 and 1992) and was the recipient of the SPIE Educator Award (2004) and was SPIE /IS&T Imaging Scientist of the Year (2007).

COURSE PRICE INCLUDES the text *Photon Transfer* (SPIE Press, 2007) by James R. Janesick.

# COURSES

## MTF in Optical and Electro-Optical Systems

### SC157

**Course Level: Introductory**

**CEU: 0.65 \$565 Members | \$675 Non-Members USD**

**Sunday 8:30 am to 5:30 pm**

Modulation transfer function (MTF) is used to specify the image quality achieved by an imaging system. It is useful in analysis of situations where several independent subsystems are combined. This course provides a background in the application of MTF techniques to performance specification, estimation and characterization of optical and electro-optical systems.

### LEARNING OUTCOMES

This course will enable you to:

- list the basic assumptions of linear systems theory, including the concept of spatial frequency
- identify relationship between impulse response, resolution, MTF, OTF, PTF, and CTF
- estimate the MTF for both diffraction-limited and aberration-limited systems
- explain the relationship between MTF, line response, and edge response functions
- identify MTF contributions from finite detector size, crosstalk, charge transfer inefficiency, and electronics
- summarize the effects of noise

### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of MTF to specifying, estimating, or characterizing performance. Some prior background in Fourier concepts is helpful.

### INSTRUCTOR

**Glenn Boreman** is the Chairman of the Department of Physics and Optical Science at the University of North Carolina at Charlotte since 2011. He received a BS in Optics from Rochester and PhD in Optics from Arizona. Prof. Boreman served on the faculty of University of Central Florida for 27 years, with 25 PhD students supervised to completion. His research interests are in infrared detectors, infrared metamaterials, and electro-optical sensing systems. Prof. Boreman is a Fellow of SPIE, OSA, and the Military Sensing Symposium, and is the 2015 Vice-President of SPIE.

**COURSE PRICE INCLUDES** the text *Modulation Transfer Function in Optical and Electro-Optical Systems* (SPIE Press, 2001) by Glenn D. Boreman.

## Introduction to Optical Remote Sensing Systems

### SC567

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

This course provides a broad introduction to optical remote sensing systems, including both passive sensors (e.g., radiometers and spectral imagers) and active sensors (e.g., laser radars or LIDARs). A brief review of basic principles of radiometry and atmospheric propagation (absorption, emission, and scattering) is followed by a system-level discussion of a variety of ground-, air-, and space-based remote sensing systems. Key equations are presented for predicting the optical resolution and signal-to-noise performance of passive and active sensing systems. Sensor system examples discussed in the class include solar radiometers, passive spectrometers and hyperspectral imagers, airborne imaging spectrometers, thermal infrared imagers, polarization imagers, and active laser radars (LIDARs and LADARs). The course material is directly relevant to sensing in environmental, civilian, military, astronomical, and solar energy applications.

### LEARNING OUTCOMES

This course will enable you to:

- review the principles of optical radiometry used to describe and calculate the flow of optical energy in an optical sensor system or solar energy system
- describe how the atmosphere affects the propagation of optical radiation
- explain how optical atmospheric effects influence remote sensing measurements or solar energy
- use system parameters in basic radiometric calculations to predict the signal received by passive and active sensors
- compare systems at the block-diagram level remote sensing measurements
- explain the difference between passive imaging based on reflection and emission
- acquire the operating principles of laser radar (lidar/ladar) systems for distributed and solid target sensing

### INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who find themselves working on (or curious about) optical remote sensing systems or data. Undergraduate training in engineering or science is assumed.

### INSTRUCTOR

**Joseph Shaw** is a professor of electrical engineering and physics at Montana State University and previously worked at the NOAA research labs. He is a recognized expert in development, calibration, and analysis of optical optical remote sensing systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona. Dr. Shaw is a Fellow of both the OSA and SPIE.

## Radiometry Revealed

### SC915

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

This course explains basic principles and applications of radiometry and photometry. A primary goal of the course is to reveal the logic, systematic order, and methodology behind what sometimes appears to be a confusing branch of optical science and engineering. Examples are taken from the ultraviolet through the long-wave infrared portions of the electromagnetic spectrum. Anyone who wants to answer questions such as, "how many watts or photons do I have?" or "how much optical energy or radiation do I need?" will benefit from taking this course.

### LEARNING OUTCOMES

This course will enable you to:

- describe the fundamental units and quantities used to quantify electromagnetic radiation at wavelengths from the ultraviolet through the visible and infrared
- use, understand, and convert between radiometric and photometric quantities
- apply radiometry to typical applications, such as calibrating an imaging system, determining human-perceived brightness of a display, or calculating electricity produced by a solar cell
- calculate areas and solid angles to determine the energy, energy density, or brightness in an optical system
- explain the role of rays, stops, and pupils in defining the field of view and light-gathering capability of an optical system
- determine the throughput of an optical system and use it in radiometric calculations
- quantify the radiant energy in optical images from point and extended sources

- transfer radiant energy into and throughout optical systems
- identify radiometric standards and calibration methods
- be familiar with radiometers and photometers

## INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who wish to learn more about how to quantify radiant energy in optical systems and measurements. Undergraduate training in engineering or science is assumed.

## INSTRUCTOR

**Joseph Shaw** is Director of the Optical Technology Center and Professor of Electrical Engineering and Physics at Montana State University in Bozeman, Montana. He previously worked at the NOAA research labs in Boulder, Colorado. He is a widely recognized expert in the development, calibration, and analysis of optical systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona and is a Fellow of both the OSA and SPIE.

This course is also available in online format.

## Gradient Index (GRIN) Optical Design



### SC1167

**Course Level: Intermediate**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 1:30 pm to 5:30 pm**

Gradient index (GRIN) lenses are more common than you may know. The human lens is a gradient index optic, and the last time you scanned a document the scanner probably used a gradient index lens array. In a homogeneous lens, light refracts at the surfaces, only bending when it enters and exits the material. In a GRIN lens, light refracts at the surfaces and also bends inside the lens. The ability of GRIN optics to bend light gives an optical designer more variables to work with and opens up new design spaces. This course is designed to introduce optical designers and engineers to existing and emerging GRIN materials and to teach them the essentials necessary to use GRIN materials in optical designs.

This course begins with an introduction to gradient index phenomenon and the basic principles of GRIN optics. The properties of axial, radial and spherical optical systems will be presented as well as a review of aberration theory. A variety of GRIN materials that cover wavelength bands from the visible to the long wave infrared will be discussed. GRIN chromatic properties will be reviewed, and the GRIN Abbe number will be introduced. The course will review software tools written to help optical designers use GRIN materials in their systems along with easy-to-understand examples.

## LEARNING OUTCOMES

This course will enable you to:

- describe how light propagates in gradient index materials
- list gradient index optical materials
- classify axial, radial, and spherical GRIN lenses
- describe the chromatic properties of GRIN materials
- design a color corrected radial GRIN singlet

## INTENDED AUDIENCE

This course is intended for optical designers, engineers, and students who are interested in learning how to specify, design, and analyze GRIN materials in an optical system and to have a better understanding of the subject. Previous knowledge of geometrical optics, and optical design, is strongly recommended.

## INSTRUCTOR

**Duncan Moore** received his PhD in Optics in 1974 and his master's degree in Optics from the University of Rochester. He previously earned his bachelor's degree in Physics from the University of Maine. Currently he is the Vice Provost of Entrepreneurship and the Kingslake Professor of Optical Engineering as well as a Professor of Business Administration at the University of Rochester. Dr. Moore has extensive experience in the academic, research, business and governmental arenas of science and technology. He is an expert in gradient-index optics, solar cell design, computer-aided design, and the manufacture of optical systems.

## REMOTE SENSING

### Introduction to Optical Remote Sensing Systems

### SC567

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

This course provides a broad introduction to optical remote sensing systems, including both passive sensors (e.g., radiometers and spectral imagers) and active sensors (e.g., laser radars or LIDARs). A brief review of basic principles of radiometry and atmospheric propagation (absorption, emission, and scattering) is followed by a system-level discussion of a variety of ground-, air-, and space-based remote sensing systems. Key equations are presented for predicting the optical resolution and signal-to-noise performance of passive and active sensing systems. Sensor system examples discussed in the class include solar radiometers, passive spectrometers and hyperspectral imagers, airborne imaging spectrometers, thermal infrared imagers, polarization imagers, and active laser radars (LIDARs and LADARs). The course material is directly relevant to sensing in environmental, civilian, military, astronomical, and solar energy applications.

## LEARNING OUTCOMES

This course will enable you to:

- review the principles of optical radiometry used to describe and calculate the flow of optical energy in an optical sensor system or solar energy system
- describe how the atmosphere affects the propagation of optical radiation
- explain how optical atmospheric effects influence remote sensing measurements or solar energy
- use system parameters in basic radiometric calculations to predict the signal received by passive and active sensors
- compare systems at the block-diagram level remote sensing measurements
- explain the difference between passive imaging based on reflection and emission
- acquire the operating principles of laser radar (lidar/ladar) systems for distributed and solid target sensing

## INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who find themselves working on (or curious about) optical remote sensing systems or data. Undergraduate training in engineering or science is assumed.

# COURSES

## INSTRUCTOR

**Joseph Shaw** is a professor of electrical engineering and physics at Montana State University and previously worked at the NOAA research labs. He is a recognized expert in development, calibration, and analysis of optical remote sensing systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona. Dr. Shaw is a Fellow of both the OSA and SPIE.

## Infrared Systems - Technology & Design

### SC835

#### Course Level: Advanced

**CEU: 1.3 \$1,155 Members | \$1,410 Non-Members USD**  
**Monday–Tuesday 8:30 am to 5:30 pm**

This course covers the range of topics necessary to understand the theoretical principles of modern infrared-technology. It combines numerous engineering disciplines necessary for the development of infrared systems. Practical engineering calculations are highlighted, with examples of trade studies illustrating the interrelationships among the various hardware characteristics.

This course is comprised of four sections:

Section 1 introduces the geometrical optics concepts including image formation, stops and pupils, thick lenses and lens combinations, image quality, and the properties of infrared materials.

Section 2 covers the essentials of radiometry necessary for the quantitative understanding of infrared signatures and flux transfer. These concepts are then developed and applied to flux-transfer calculations for blackbody, graybody, and selective radiator sources. Remote temperature calibrations and measurements are then used as an illustration of these radiometric principles.

Section 3 is devoted to fundamental background issues for optical detection-processes. It compares the characteristics of cooled and uncooled detectors with an emphasis on spectral and blackbody responsivity, detectivity ( $D^*$ ), as well as the noise mechanisms related to optical detection. The detector parameters and capabilities of single detectors and third generation focal plane arrays (FPAs) are analyzed.

With this acquired background, Section 4 considers the systems-design aspects of infrared imagers. The impact of scan format on signal-to-noise ratio is described, and the engineering tradeoffs inherent in the development of infrared search and track (IRST) systems are explained. Figures of merit such as MTF, NETD, and MRTD of staring arrays are examined for the performance metrics of thermal sensitivity and spatial resolution of thermal imaging systems (TIS). Contrast threshold functions based on Johnson and visible cycles (often denoted as N- and V-cycles) are specified. The interrelationships among the design parameters are identified through trade-study examples.

## LEARNING OUTCOMES

This course will enable you to:

- learn the principles and fundamentals of infrared optical design
- choose the proper infrared materials suite for your applications
- quickly execute flux-transfer calculations
- calibrate infrared sources and target signatures
- recognize the importance of background in thermal signatures
- have an appreciation for the capacity of infrared systems and learn the interaction of its critical components (optics, detectors, and electronics) in the production of a final infrared image
- assess the influence of noise mechanisms related to optical detection
- comprehend the fundamental response mechanisms and differences between cooled and uncooled single detectors as well as focal plane arrays (FPAs)

- comprehend the central theory behind third generation infrared imagers
- define and use common descriptors for detector and system performance (R, D\*, NEP, NEI, MTF, NETD, and MRTD)
- estimate system performance given subsystem and component specifications
- apply design tradeoffs in both infrared search and track systems (IRST) and thermal-imaging systems (TIS)
- carry out the preliminary design of infrared systems for different thermal applications

## INTENDED AUDIENCE

This course is directed to the practicing engineers and/or scientists who require both theoretical and effective practical technical information to design, build, and/or test infrared systems in a wide variety of thermal applications. A background at the bachelor's level in engineering is highly recommended. The participant should also have ample understanding of Fourier analysis and random processes.

## INSTRUCTOR

**Arnold Daniels** is a senior lead engineer with extensive experience in the conceptual definition of advance infrared, optical, and electro-optical systems. His background consists of technical contributions to applications for infrared search & track, thermal imaging, and ISR systems. Other technical expertise include infrared radiometry (testing and measurements), infrared test systems (i.e., MTF, NETD, and MRTD), thermographic nondestructive testing (TNNDT), optical design, precision optical alignment, stray light analysis, adaptive optics, Fourier analysis, image processing, and data acquisition systems. He earned an M.S. in Electrical Engineering from the University of Tel-Aviv and a doctorate in Electro-Optics from the School of Optics (CREOL) at the University of Central Florida. In 1995 he received the Rudolf Kingslake medal and prize for the most noteworthy original paper to appear in SPIE's Journal of Optical Engineering. He is presently developing direct energy laser weapon systems for defense applications.

COURSE PRICE INCLUDES the *Field Guide to Infrared Systems, Detectors, and FPAs, 2nd Edition* by Arnold Daniels (SPIE, 2010) and *Infrared Detectors and Systems* (Wiley, 1996) by Eustace L. Dereniak and Glenn D. Boreman.

## Introduction to Electro-Optical Systems

### Design

### SC1112

#### Course Level: Intermediate

**CEU: 0.65 \$590 Members | \$700 Non-Members USD**  
**Monday 8:30 am to 5:30 pm**

Using communication theory, this full-day course explains the universal principles underlying a diverse range of electro-optical systems. From visible / infra-red imaging, to free space optical communications and laser remote sensing, the course relates key concepts in science and systems engineering to practical systems issues. To provide realistic understanding of the concepts presented, many real-world examples are included.

This course summarizes laser propagation fundamentals, coherent and incoherent optical system characterization, the effects of optical turbulence and particulate scattering on propagating laser beams, atmospheric and submarine laser communication systems concepts, and laser radar and optical imaging basics. Also included are discussions of adaptive optics, adaptive image processing, and statistical hypothesis testing and its effect on system performance.

## LEARNING OUTCOMES

This course will enable you to:

- perform Fourier and Geometric Optics Analyses of electro-optical systems
- estimate detector noise statistics, detector performance, and signal-to-noise ratio
- perform first order image processing, including statistical image enhancements of incoherent images
- calculate contrast, irradiance and radiance created by the propagation of light in particulate environments
- calculate the system link budgets for laser systems
- perform statistical hypothesis testing, which includes how to calculate logarithmic likelihood ratio tests, test statistics, and probabilities of false alarm and detection
- assess and understand real-world Adaptive Optical system performance

## INTENDED AUDIENCE

This course is intended for scientists, technical managers and design engineers who are interested in understanding first-order electro-optical system design and the effects that limit system performance.

## INSTRUCTOR

**Larry Stotts** is a consultant and was the Deputy Office Director in the Strategic Technology Office of the Defense Advanced Research Projects Agency. He earned his Ph.D. in Electrical Engineering (Communications Systems) at the University of California at San Diego. He has published over 102 technical reports and journal articles and 2 co-authored books. Recognition of his work includes a Department of Defense Medal for Distinguished Civilian Service; two Secretary of Defense Medal for Meritorious Civilian Service Awards; two DARPA Technical Achievement Awards; The Technical Cooperation Program Technical Achievement Award, and the Naval Ocean Systems Center Technical Director's Award. Dr. Stotts is a Life Fellow of the SPIE, Fellow of the IEEE and a Senior Member and Fellow of OSA.

COURSE PRICE INCLUDES the text *Fundamentals of Electro-Optic Systems Design: Communications, Lidar and Imaging* by S. Karp and L. B. Stotts (Cambridge Press, 2013).

## MTF in Optical and Electro-Optical Systems

### SC157

#### Course Level: Introductory

**CEU: 0.65 \$565 Members | \$675 Non-Members USD**

**Sunday 8:30 am to 5:30 pm**

Modulation transfer function (MTF) is used to specify the image quality achieved by an imaging system. It is useful in analysis of situations where several independent subsystems are combined. This course provides a background in the application of MTF techniques to performance specification, estimation and characterization of optical and electro-optical systems.

## LEARNING OUTCOMES

This course will enable you to:

- list the basic assumptions of linear systems theory, including the concept of spatial frequency
- identify relationship between impulse response, resolution, MTF, OTF, PTF, and CTF
- estimate the MTF for both diffraction-limited and aberration-limited systems
- explain the relationship between MTF, line response, and edge response functions
- identify MTF contributions from finite detector size, crosstalk, charge transfer inefficiency, and electronics
- summarize the effects of noise

## INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of MTF to specifying, estimating, or characterizing performance. Some prior background in Fourier concepts is helpful.

## INSTRUCTOR

**Glenn Boreman** is the Chairman of the Department of Physics and Optical Science at the University of North Carolina at Charlotte since 2011. He received a BS in Optics from Rochester and PhD in Optics from Arizona. Prof. Boreman served on the faculty of University of Central Florida for 27 years, with 25 PhD students supervised to completion. His research interests are in infrared detectors, infrared metamaterials, and electro-optical sensing systems. Prof. Boreman is a Fellow of SPIE, OSA, and the Military Sensing Symposium, and is the 2015 Vice-President of SPIE.

COURSE PRICE INCLUDES the text *Modulation Transfer Function in Optical and Electro-Optical Systems* (SPIE Press, 2001) by Glenn D. Boreman.

## Multispectral and Hyperspectral Image Sensors

### SC194

#### Course Level: Advanced

**CEU: 0.35 \$380 Members | \$435 Non-Members USD**

**Wednesday 1:30 pm to 5:30 pm**

This course will describe the imaging capabilities and applications of the principal types of multispectral (MS) and hyperspectral (HS) sensors. The focus will be on sensors that work in the visible, near-infrared and shortwave-infrared spectral regimes, but the course will touch on longwave-infrared applications. A summary of the salient features of classical color imaging (human observation) will also be provided in an appendix.

## LEARNING OUTCOMES

This course will enable you to:

- understand many of the applications and advantages of multispectral (MS) and hyperspectral (HS) imaging
- describe and categorize the properties of the principal MS / HS design types (multi-band scanner, starers with filter wheels, dispersive, wedge, and Fourier transform imagers with 2D arrays, etc.)
- list and define the relevant radiometric radiometric quantities, concepts and phenomenology
- understand the process of translating system requirements into sensor hardware constraints and specifications
- analyze signal-to-noise ratio, modulation-transfer-function, and spatial / spectral sampling for MS and HS sensors
- define, understand and apply the relevant noise-equivalent figures-of-merit (Noise-equivalent reflectance difference, Noise-equivalent temperature difference, Noise-equivalent spectral radiance, Noise-equivalent irradiance, etc.)
- describe the elements of the image chain from photons-in to bits-out (photon detection, video signal manipulation, analog processing, and digitization)
- list and review key imager subsystem technology elements (optical, focal plane, video electronics, and thermal)
- formulate a detailed end-to-end design example of a satellite imaging scanning HS sensor
- provide an appendix that summarizes color imaging principles and sensor associated elements for human observation applications (e.g. color television, still cameras, etc.)

## INTENDED AUDIENCE

Engineers, scientists, and technical managers who are interested in understanding and applying multispectral and hyperspectral sensors in advanced military, civil, scientific and commercial applications.

# COURSES

## INSTRUCTOR

**Terrence Lomheim** holds the position of Distinguished Engineer at The Aerospace Corp. He has 34 years of hardware and analysis experience in visible and infrared electro-optical systems, focal plane technology, and applied optics, and has authored and co-authored 63 publications in these technical areas. He is a Fellow of the SPIE.

COURSE PRICE INCLUDES the text *CMOS/CCD Sensors and Camera Systems, 2nd edition* (SPIE Press, 2011) by Terrence Lomheim and Gerald Holst.

## Introduction to CCD and CMOS Imaging Sensors and Applications

### SC504

#### Course Level: Introductory

CEU: 0.65 \$665 Members | \$775 Non-Members USD

Monday 8:30 am to 5:30 pm

This course provides a review of general theory and operation for CCD and CMOS imaging technologies looking at the development and application statuses of both. Performance differences between CMOS and CCD imaging arrays are covered. Fundamental performance limits behind major sensor operations are presented in addition to image defects, shorts, device yield, popular chip foundries, chip cost; custom designed and off-the-shelf sensors. We discuss operation principles behind popular commercial and scientific CMOS pixel architectures, and various array readout schemes. We cover backside illuminated arrays for UV, EUV and x-ray applications; high QE frontside illuminated sensors; deep depletion CCDs, ultra large CMOS and CCD arrays; high speed/ low noise parallel readout sensors. We describe the photon transfer technique in measuring performance and calibrating camera and chip systems, and charge transfer mechanisms. We review correlated double sampling theory used to achieve low noise performance and conclude with a look at future research and development trends for each technology.

## LEARNING OUTCOMES

This course will enable you to:

- describe operating CMOS and CCD arrays and camera systems for commercial and scientific imaging applications
- explain how CCD and CMOS arrays are designed, fabricated, tested and calibrated
- know how to apply test methodologies and performance standards
- list specifications and requirements to select a sensor for your imaging application
- recognize performance differences between CMOS and CCD technologies
- understand how video signals are processed for optimum signal-to-noise performance
- become familiar with current and future imaging technologies and applications

## INTENDED AUDIENCE

This course is for scientists, engineers, and managers involved with high performance CCD and CMOS imaging sensors and camera systems.

## INSTRUCTOR

**James Janesick** is currently the director of the CMOS advanced development group for Sarnoff Corporation. Previously he was with Conexant Systems Inc. developing CMOS imaging arrays for commercial applications. He was technology director of Pixel Vision, Inc. for five years developing high speed backside illuminated CCDs for scientific and cinema cameras. Prior to this Janesick was with the Jet Propulsion Laboratory for 22 years where as group leader he designed scientific ground and flight based imaging systems. He has authored 75 publications and has contributed to many NASA Tech Briefs and patents for various CCD and CMOS innovations. Janesick received NASA medals for Exceptional Engineering Achievement (1982 and 1992) and was the recipient of the SPIE Educator Award (2004) and was SPIE /IS&T Imaging Scientist of the Year (2007).

COURSE PRICE INCLUDES the texts *Scientific Charge Coupled Devices* (SPIE Press, 2001), and *Photon Transfer* (SPIE Press, 2007) by James Janesick.

## Radiometry Revealed

### SC915

#### Course Level: Introductory

CEU: 0.35 \$300 Members | \$355 Non-Members USD

Monday 8:30 am to 12:30 pm

This course explains basic principles and applications of radiometry and photometry. A primary goal of the course is to reveal the logic, systematic order, and methodology behind what sometimes appears to be a confusing branch of optical science and engineering. Examples are taken from the ultraviolet through the long-wave infrared portions of the electromagnetic spectrum. Anyone who wants to answer questions such as, "how many watts or photons do I have?" or "how much optical energy or radiation do I need?" will benefit from taking this course.

## LEARNING OUTCOMES

This course will enable you to:

- describe the fundamental units and quantities used to quantify electromagnetic radiation at wavelengths from the ultraviolet through the visible and infrared
- use, understand, and convert between radiometric and photometric quantities
- apply radiometry to typical applications, such as calibrating an imaging system, determining human-perceived brightness of a display, or calculating electricity produced by a solar cell
- calculate areas and solid angles to determine the energy, energy density, or brightness in an optical system
- explain the role of rays, stops, and pupils in defining the field of view and light-gathering capability of an optical system
- determine the throughput of an optical system and use it in radiometric calculations
- quantify the radiant energy in optical images from point and extended sources
- transfer radiant energy into and throughout optical systems
- identify radiometric standards and calibration methods
- be familiar with radiometers and photometers

## INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who wish to learn more about how to quantify radiant energy in optical systems and measurements. Undergraduate training in engineering or science is assumed.

## INSTRUCTOR

**Joseph Shaw** is Director of the Optical Technology Center and Professor of Electrical Engineering and Physics at Montana State University in Bozeman, Montana. He previously worked at the NOAA research labs in Boulder, Colorado. He is a widely recognized expert in the development, calibration, and analysis of optical systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona and is a Fellow of both the OSA and SPIE.

This course is also available in online format.

## Digital Camera and Sensor Evaluation Using Photon Transfer

### SC916

**Course Level: Introductory**

**CEU: 0.65 \$580 Members | \$690 Non-Members USD**

**Tuesday 8:30 am to 5:30 pm**

Photon transfer (PT) is a popular and essential characterization standard employed in the design, operation, characterization, calibration, optimization, specification and application of digital scientific and commercial camera systems. The PT user friendly technique is based on only two measurements- average signal and rms noise which together produce a multitude of important data products in evaluating digital camera systems (most notably CCD and CMOS). PT is applicable to all imaging disciplines. Design and fabrication process engineers developing imagers rely heavily on PT data products in determining discrete performance parameters such as quantum efficiency (QE), quantum yield, read noise, full well, dynamic range, nonlinearity, fixed pattern noise, V/e- conversion gain, dark current , image, etc.. Camera users routinely use the PT technique to determine system level performance parameters to convert relative measurements into absolute electron and photon units, offset correction, flat field and image S/N, ADC quantizing noise, optimum encoding, minimum detectable luminance, operating temperature to remove dark current , reliability, stability, etc. PT is also the first go/no-go test performed to determine the health of new camera system and/or detector as well as provide a power tool in trouble shooting problems. This course will review these aspects and many others offered by PT.

## LEARNING OUTCOMES

This course will enable you to:

- describe PT theory
- take PT data and determine important CCD and CMOS performance parameters
- show example PT data products generated by CCD and CMOS imagers
- calibrate a camera system in absolute physical units
- use PT to determine the best camera or CCD/CMOS imager for the application
- use PT to demonstrate and verify the camera system is reliable and in good operating order
- discuss guidelines for the novice and advanced user in generating PT, Modulation and Lux Transfer curves
- use PT to optimally remove fixed pattern noise sources in images for the highest S/N possible through flat fielding
- comprehend signal-to-noise image theory through PT

## INTENDED AUDIENCE

Engineers, scientists, and technical managers working with commercial and scientific digital camera systems. Some familiarity with CCD and CMOS imagers is recommended.

## INSTRUCTOR

**James Janesick** is currently the director of the CMOS advanced development group for Sarnoff Corporation. Previously he was with Conexant Systems Inc. developing CMOS imaging arrays for commercial applications. He was technology director of Pixel Vision, Inc. for five years developing high speed backside illuminated CCDs for scientific and cinema cameras. Prior to this Janesick was with the Jet Propulsion Laboratory for 22 years where as group leader he designed scientific ground and flight based imaging systems. He has authored 75 publications and has contributed to many NASA Tech Briefs and patents for various CCD and CMOS innovations. Janesick received NASA medals for Exceptional Engineering Achievement (1982 and 1992) and was the recipient of the SPIE Educator Award (2004) and was SPIE /IS&T Imaging Scientist of the Year (2007).

COURSE PRICE INCLUDES the text *Photon Transfer* (SPIE Press, 2007) by James R. Janesick.

## Probability for Systems Engineers

New

### SC1165

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course explains basic principles for the use of probability analysis as applied to systems engineering. A primary goal of the course is explaining the logic, construction and application of performance and error budgeting. This probabilistic methodology should be a tool in every engineer's tool kit and is key to understanding the probability of a successful system. Examples are taken from various problems in systems engineering of astronomical and laser systems. This course will be of benefit to anyone who wants to answer the question, "what are the chances of success of my project?"

## LEARNING OUTCOMES

This course will enable you to:

- compose a performance or error budget
- calculate the distribution of likely outcomes of a design process
- calculate the most likely value for the performance of a component or system
- identify the sensitivity of performance to all parameters in the system
- explain the probability of the success of design project

## INTENDED AUDIENCE

Scientists, engineers, technicians, or managers who wish to learn more about how to apply probability to engineering problems. Undergraduate training in engineering or science is assumed.

## INSTRUCTOR

**Jonathan Arenberg** has been working as an optical and systems engineer for over 30 years. His work experience has included tactical and high-power laser components and systems and major space astronomical projects such as Chandra and the James Webb Space Telescope. He holds degrees in physics and engineering from the University of California, Los Angeles and currently the Chief Engineer for Northrop Grumman Aerospace Systems on the James Webb Space Telescope. Dr. Arenberg is an SPIE Fellow.

# COURSES

## ASTRONOMICAL OPTICS AND INSTRUMENTATION

### The Proper Care of Optics: Cleaning, Handling, Storage and Shipping

**SC1114**

**Course Level: Introductory**

**CEU: 0.35 \$345 Members | \$400 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

There are many ways to clean optics; some are learned from experience and/or failure. This course explains the proper cleaning methods for optics that are used by professional optical technicians and engineers.

How to clean optics has always been a challenging and controversial subject. Searching the Internet will yield hundreds of articles and videos that claim to know the best methods. This course will explain the simple steps used in cleaning optics. It will also describe the proper handling, storage and shipping of optical components. The course is designed for a diverse audience, from a first-time optical cleaner to an engineer searching for methods of handling and packaging optics. An in-class demonstration on inspecting and cleaning optics will be presented.

#### LEARNING OUTCOMES

This course will enable you to:

- identify proper cleaning tools and their use
- explain safety guidelines, personal protection equipment and basic worktable layout
- compare lighting types required for inspection and cleaning
- identify solvents and cleaning liquids used for removing contaminants
- describe hand techniques used for applicators, wipes, and how to fold wipes
- explain inspection methods for optical surfaces
- list the types of contaminants and describe a short history of scratch and dig
- describe visual methods used: unaided eye, eye loupe, microscope (light and digital)
- describe types of optical coatings
- explain proper cleaning of small, large and infrared optics
- describe special cleaning techniques
- explain techniques used for instrument inspection, disassembly, assembly, and cleaning
- describe various instrument types
- describe the tricks of the trade: edge cleaning, protection, black paint and removing glue
- describe handling of optics using tweezers, cups, trays, storage and protection methods
- summarize shipping containment methods
- explain outdoor field cleaning

#### INTENDED AUDIENCE

Technicians, engineers, scientists and managers who wish to learn the methods of cleaning, handling, storage and shipping of optics. High school to graduate degree.

#### INSTRUCTOR

**Robert Schalck** is an Optical Engineer with over 40 years experience in the optical industry, and author of the text "The Proper Care of Optics" (SPIE Press, 2013) as well as an SPIE Online Course of the same title. He presented his first paper on cleaning optics at the OSA OF&T workshop in 1975. In 1989, he delivered a paper on Classical Optical Cleaning at the OSA "How to Conference." Over several decades, he has given presentations on how to clean optics to groups and organizations. He is a Senior Member of OSA and SPIE.

COURSE PRICE INCLUDES the text *The Proper Care of Optics: Cleaning, Handling, Storage and Shipping* (SPIE Press, 2013), by Robert Schalck.

**This course is also available in online format.**

## Radiometry Revealed

**SC915**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

This course explains basic principles and applications of radiometry and photometry. A primary goal of the course is to reveal the logic, systematic order, and methodology behind what sometimes appears to be a confusing branch of optical science and engineering. Examples are taken from the ultraviolet through the long-wave infrared portions of the electromagnetic spectrum. Anyone who wants to answer questions such as, "how many watts or photons do I have?" or "how much optical energy or radiation do I need?" will benefit from taking this course.

#### LEARNING OUTCOMES

This course will enable you to:

- describe the fundamental units and quantities used to quantify electromagnetic radiation at wavelengths from the ultraviolet through the visible and infrared
- use, understand, and convert between radiometric and photometric quantities
- apply radiometry to typical applications, such as calibrating an imaging system, determining human-perceived brightness of a display, or calculating electricity produced by a solar cell
- calculate areas and solid angles to determine the energy, energy density, or brightness in an optical system
- explain the role of rays, stops, and pupils in defining the field of view and light-gathering capability of an optical system
- determine the throughput of an optical system and use it in radiometric calculations
- quantify the radiant energy in optical images from point and extended sources
- transfer radiant energy into and throughout optical systems
- identify radiometric standards and calibration methods
- be familiar with radiometers and photometers

#### INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who wish to learn more about how to quantify radiant energy in optical systems and measurements. Undergraduate training in engineering or science is assumed.

#### INSTRUCTOR

**Joseph Shaw** is Director of the Optical Technology Center and Professor of Electrical Engineering and Physics at Montana State University in Bozeman, Montana. He previously worked at the NOAA research labs in Boulder, Colorado. He is a widely recognized expert in the development, calibration, and analysis of optical systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona and is a Fellow of both the OSA and SPIE.

**This course is also available in online format.**

## Probability for Systems Engineers

**SC1165**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course explains basic principles for the use of probability analysis as applied to systems engineering. A primary goal of the course is explaining the logic, construction and application of performance and error budgeting. This probabilistic methodology should be a tool in every engineer's tool kit and is key to understanding the probability of a successful system. Examples are taken from various problems in systems engineering of astronomical and laser systems. This course will be of benefit to anyone who wants to answer the question, "what are the chances of success of my project?"

### LEARNING OUTCOMES

This course will enable you to:

- compose a performance or error budget
- calculate the distribution of likely outcomes of a design process
- calculate the most likely value for the performance of a component or system
- identify the sensitivity of performance to all parameters in the system
- explain the probability of the success of design project

### INTENDED AUDIENCE

Scientists, engineers, technicians, or managers who wish to learn more about how to apply probability to engineering problems. Undergraduate training in engineering or science is assumed.

### INSTRUCTOR

**Jonathan Arenberg** has been working as an optical and systems engineer for over 30 years. His work experience has included tactical and high-power laser components and systems and major space astronomical projects such as Chandra and the James Webb Space Telescope. He holds degrees in physics and engineering from the University of California, Los Angeles and currently the Chief Engineer for Northrop Grumman Aerospace Systems on the James Webb Space Telescope. Dr. Arenberg is an SPIE Fellow.

## Finite Element Analysis of Optics

**SC1120**

**Course Level: Intermediate**

**CEU: 0.65 \$595 Members | \$705 Non-Members USD**

**Thursday 8:30 am to 5:30 pm**

This course presents the use of finite element methods to model and predict the behavior of optical elements and support structures including lenses, mirrors, windows, and optical mounts in the presence of mechanical and environmental loads. Students will learn general FEA modeling strategies and guidelines specific to optical systems including how to develop low-fidelity models to quickly perform optomechanical design tradeoffs as well as the creation of high-fidelity models to support detailed design.

Emphasized will be the application of FEA techniques to meet optical system error budget allocations including mounting tolerances, alignment errors, optical surface distortions, image stability, and wavefront error. In addition, use of FEA to ensure structural integrity requirements including yield, buckling, and fracture will be discussed.



### LEARNING OUTCOMES

This course will enable you to:

- develop optical component and system level finite element models
- model conventional and lightweight mirrors including evaluating the impact of optical coatings
- analyze optical mounts including kinematic, flexure, and optical bond designs
- predict optical alignment errors due to mechanical, assembly, and environmental loads
- perform optical surface error analyses using Zernike polynomials
- predict optical system image motion due to thermal and dynamic environments
- evaluate the effects of temperature and stress on optical performance

### INTENDED AUDIENCE

This course is intended for mechanical engineers interested in learning about the application of finite element analysis in the mechanical design of optical systems. An interest in optomechanical engineering and/or familiarity with finite element software is recommended.

### INSTRUCTOR

**Keith Doyle** has over 25-years experience in the field of optomechanical engineering, specializing in the multidisciplinary modeling of optical systems. He is a co-author of the book titled *Integrated Optomechanical Analysis*, has authored or co-authored over 40-publications in the field, and is a Fellow of SPIE. He is currently employed at MIT Lincoln Laboratory as a Group Leader in the Engineering Division. Previously he served as Vice President of Sigmadyne Inc. and as a Senior Systems Engineer at Optical Research Associates. He received his Ph.D. in engineering mechanics with a minor in optical sciences from the University of Arizona.

**Victor Genberg** has over 40-years experience in the application of finite element methods to high-performance optical structures and is a recognized expert in opto-mechanics. He is currently President of Sigmadyne, Inc. and a Professor of Mechanical Engineering at the University of Rochester where he teaches courses in optomechanics, finite element analysis, and design optimization. He is the co-author of the book titled *Integrated Optomechanical Analysis* has over 40 publications in this field including two chapters in the CRC Handbook of Optomechanical Engineering. Prior to founding Sigmadyne, Dr. Genberg spent 28-years at Eastman Kodak serving as a technical specialist for military and commercial optical systems.

COURSE PRICE INCLUDES the text *Integrated Optomechanical Analysis, 2nd Edition* (SPIE Press, 2012) by Keith Doyle, Victor Genberg, and Gregory Michels.

## Strength Properties of Glass and Ceramics

**SC796**

**Course Level: Intermediate**

**CEU: 0.35 \$340 Members | \$395 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course provides attendees with a basic understanding of the terminology and analyses used in a fracture mechanics approach to determine the strength of glass, crystals, and ceramics. The course focuses on the determination of inert strength based on surface flaws, and reduction of such strength of these materials in the presence of time and moisture. Included are the effects of residual stress on lifetime, and basic reliability predictions. Examples from the literature are presented to bear out the theoretical design principles.

# COURSES

## LEARNING OUTCOMES

This course will enable you to:

- review the strength of unflawed, perfect surfaces
- identify the processes that reduce glass strength
- name and define the critical fracture mechanics terms
- estimate the strength of glass, crystals, and ceramics in the presence of flaws and moist environments
- compose strength vs. time diagrams
- understand the effects of residual stress and design limitations
- list and compare alternative methods of crack propagation strength analyses

## INTENDED AUDIENCE

This material is intended for structural, mechanical and optical engineers who wish to obtain an understanding of the principles of strength determination for optical components. Those who work with ground, air, or space-based systems will leave with a keen understanding of fracture mechanics applications without the need for complex and unwieldy computation.

## INSTRUCTOR

**John Pepi** is a senior principal mechanical engineer with L-3 Communications SSG in Wilmington, MA. He holds a Master's degree in Structural Engineering, and has over 35 years' experience in the structural design of lightweight optical systems. He is an internationally recognized authority on mirror design principles, has authored a score of papers on opto-structural design principles, and has been a previous instructor for SPIE at its annual meetings. He has recently published a tutorial text through SPIE Press on this topic, which is available as a companion to this course.

COURSE PRICE INCLUDES the text *Strength Properties of Glass and Ceramics* (SPIE Press, 2014) by John W. Pepi.

## Infrared Systems - Technology & Design

### SC835

#### Course Level: Advanced

**CEU: 1.3 \$1,155 Members | \$1,410 Non-Members USD**

**Monday–Tuesday 8:30 am to 5:30 pm**

This course covers the range of topics necessary to understand the theoretical principles of modern infrared-technology. It combines numerous engineering disciplines necessary for the development of infrared systems. Practical engineering calculations are highlighted, with examples of trade studies illustrating the interrelationships among the various hardware characteristics.

This course is comprised of four sections:

Section 1 introduces the geometrical optics concepts including image formation, stops and pupils, thick lenses and lens combinations, image quality, and the properties of infrared materials.

Section 2 covers the essentials of radiometry necessary for the quantitative understanding of infrared signatures and flux transfer. These concepts are then developed and applied to flux-transfer calculations for blackbody, graybody, and selective radiator sources. Remote temperature calibrations and measurements are then used as an illustration of these radiometric principles.

Section 3 is devoted to fundamental background issues for optical detection-processes. It compares the characteristics of cooled and uncooled detectors with an emphasis on spectral and blackbody responsivity, detectivity ( $D^*$ ), as well as the noise mechanisms related to optical detection. The detector parameters and capabilities of single detectors and third generation focal plane arrays (FPAs) are analyzed.

With this acquired background, Section 4 considers the systems-design aspects of infrared imagers. The impact of scan format on signal-to-noise ratio is described, and the engineering tradeoffs inherent in the development of infrared search and track (IRST) systems are explained. Figures of merit such as MTF, NETD, and MRTD of staring arrays are examined for the performance metrics of thermal sensitivity and spatial resolution of thermal imaging systems (TIS). Contrast threshold functions based on Johnson and visible cycles (often denoted as N- and V-cycles) are specified. The interrelationships among the design parameters are identified through trade-study examples.

## LEARNING OUTCOMES

This course will enable you to:

- learn the principles and fundamentals of infrared optical design
- choose the proper infrared materials suite for your applications
- quickly execute flux-transfer calculations
- calibrate infrared sources and target signatures
- recognize the importance of background in thermal signatures
- have an appreciation for the capacity of infrared systems and learn the interaction of its critical components (optics, detectors, and electronics) in the production of a final infrared image
- assess the influence of noise mechanisms related to optical detection
- comprehend the fundamental response mechanisms and differences between cooled and uncooled single detectors as well as focal plane arrays (FPAs)
- comprehend the central theory behind third generation infrared imagers
- define and use common descriptors for detector and system performance (R,  $D^*$ , NEP, NEI, MTF, NETD, and MRTD)
- estimate system performance given subsystem and component specifications
- apply design tradeoffs in both infrared search and track systems (IRST) and thermal-imaging systems (TIS)
- carry out the preliminary design of infrared systems for different thermal applications

## INTENDED AUDIENCE

This course is directed to the practicing engineers and/or scientists who require both theoretical and effective practical technical information to design, build, and/or test infrared systems in a wide variety of thermal applications. A background at the bachelor's level in engineering is highly recommended. The participant should also have ample understanding of Fourier analysis and random processes.

## INSTRUCTOR

**Arnold Daniels** is a senior lead engineer with extensive experience in the conceptual definition of advance infrared, optical, and electro-optical systems. His background consists of technical contributions to applications for infrared search & track, thermal imaging, and ISR systems. Other technical expertise include infrared radiometry (testing and measurements), infrared test systems (i.e., MTF, NETD, and MRTD), thermographic nondestructive testing (TNNDT), optical design, precision optical alignment, stray light analysis, adaptive optics, Fourier analysis, image processing, and data acquisition systems. He earned an M.S. in Electrical Engineering from the University of Tel-Aviv and a doctorate in Electro-Optics from the School of Optics (CREOL) at the University of Central Florida. In 1995 he received the Rudolf Kingslake medal and prize for the most noteworthy original paper to appear in SPIE's Journal of Optical Engineering. He is presently developing direct energy laser weapon systems for defense applications.

COURSE PRICE INCLUDES the *Field Guide to Infrared Systems, Detectors, and FPAs, 2nd Edition* by Arnold Daniels (SPIE, 2010) and *Infrared Detectors and Systems* (Wiley, 1996) by Eustace L. Dereniak and Glenn D. Boreman.

## Introduction to Optical Remote Sensing Systems

### SC567

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

This course provides a broad introduction to optical remote sensing systems, including both passive sensors (e.g., radiometers and spectral imagers) and active sensors (e.g., laser radars or LIDARs). A brief review of basic principles of radiometry and atmospheric propagation (absorption, emission, and scattering) is followed by a system-level discussion of a variety of ground-, air-, and space-based remote sensing systems. Key equations are presented for predicting the optical resolution and signal-to-noise performance of passive and active sensing systems. Sensor system examples discussed in the class include solar radiometers, passive spectrometers and hyperspectral imagers, airborne imaging spectrometers, thermal infrared imagers, polarization imagers, and active laser radars (LIDARs and LADARs). The course material is directly relevant to sensing in environmental, civilian, military, astronomical, and solar energy applications.

#### LEARNING OUTCOMES

This course will enable you to:

- review the principles of optical radiometry used to describe and calculate the flow of optical energy in an optical sensor system or solar energy system
- describe how the atmosphere affects the propagation of optical radiation
- explain how optical atmospheric effects influence remote sensing measurements or solar energy
- use system parameters in basic radiometric calculations to predict the signal received by passive and active sensors
- compare systems at the block-diagram level remote sensing measurements
- explain the difference between passive imaging based on reflection and emission
- acquire the operating principles of laser radar (lidar/ladar) systems for distributed and solid target sensing

#### INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who find themselves working on (or curious about) optical remote sensing systems or data. Undergraduate training in engineering or science is assumed.

#### INSTRUCTOR

**Joseph Shaw** is a professor of electrical engineering and physics at Montana State University and previously worked at the NOAA research labs. He is a recognized expert in development, calibration, and analysis of optical remote sensing systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona. Dr. Shaw is a Fellow of both the OSA and SPIE.

## Introduction to Optical Alignment Techniques

### SC010

**Course Level: Introductory**

**CEU: 0.65 \$525 Members | \$635 Non-Members USD**

**Tuesday 8:30 am to 5:30 pm**

This course discusses the equipment, techniques, tricks, and skills necessary to align optical systems and devices. You learn to identify errors in an optical system, and how to align lens systems.

#### LEARNING OUTCOMES

This course will enable you to:

- determine if errors in the optical system are due to misalignment errors or other factors such as fabrication, design, or mounting problems
- recognize and understand the fundamental imaging errors associated with optical systems
- diagnose (qualitatively and quantitatively) what is wrong with an optical system by simply observing these fundamental imaging errors
- use the variety of tools available for aligning optical systems, and more importantly, how to "tweak" logically the adjustments on these devices so that the alignment proceeds quickly and efficiently
- align basic lens systems and telescopes
- align more complex optical systems such as those containing off-axis aspheric surfaces, and maintain alignment using automatic mounting techniques

#### INTENDED AUDIENCE

This course is directed toward engineers and technicians needing basic practical information and techniques to achieve alignment of simple optical systems, as well as seemingly more complicated off-axis aspheric mirrors. To benefit most from this course you will need a basic knowledge of the elementary properties of lenses and optical systems (i.e. focal lengths, f/numbers, magnification, and other imaging properties) and a working knowledge of simple interferometry. Some familiarity with the basic aberrations such as spherical aberration, coma, and astigmatism will be helpful.

#### INSTRUCTOR

**Kenneth Castle** Ph.D. is president of Ruda-Cardinal, Inc., an optical engineering consulting firm located in Tucson, Arizona. Ken has worked with Mitch Ruda, the originator of this course, for 28 years. Mitch passed away August 31, 2013, and Ruda-Cardinal is continuing the tradition of this course in his memory.

## Introduction to Optomechanical Design

### SC014

**Course Level: Introductory**

**CEU: 1.3 \$1,000 Members | \$1,255 Non-Members USD**

**Sunday - Monday 8:30 am to 5:30 pm**

This course will provide the training needed for the optical engineer to work with the mechanical features of optical systems. The emphasis is on providing techniques for rapid estimation of optical system performance. Subject matter includes material properties for optomechanical design, kinematic design, athermalization techniques, window design, lens and mirror mounting.

#### LEARNING OUTCOMES

This course will enable you to:

- select materials for use in optomechanical systems
- determine the effects of temperature changes on optical systems, and develop design solutions for those effects
- design high performance optical windows
- design low stress mounts for lenses
- select appropriate mounting techniques for mirrors and prisms
- describe different approaches to large and lightweight mirror design

# COURSES

## INTENDED AUDIENCE

Engineers who need to solve optomechanical design problems. Optical designers will find that the course will give insight into the mechanical aspects of optical systems. The course will also interest those managing projects involving optomechanics. Short course SC690, Optical System Design: Layout Principles and Practice, or a firm understanding of its content, is required as background to this course.

## INSTRUCTOR

**Daniel Vukobratovich** is a senior principal engineer at Raytheon. He has over 30 years of experience in optomechanics, is a founding member of the SPIE working group in optomechanics, and is fellow of SPIE. He has taught optomechanics in 11 countries, consulted with over 50 companies and written over 50 publications in optomechanics.

This course is also available in online format.

## Mounting of Optical Components

### SC1019

#### Course Level: Introductory

CEU: 0.65 \$605 Members | \$715 Non-Members USD

Tuesday 8:30 am to 5:30 pm

This course introduces the optomechanical engineering principles for the mounting of optical components such as lenses, mirrors, windows, prisms, and filters. Oriented towards practicing engineers and managers, case studies are used to show how mount design is driven by a combination of environmental, performance, and cost requirements. Standard industry practices and common mounting techniques are reviewed, including:

- Mounting of lenses into barrels using adhesives or retaining rings
- Mounting of prisms and small mirrors using adhesives or clamps
- Mounting of assemblies using flexures
- Mounting and sealing of windows

Without using finite-element analysis (FEA), first-order engineering estimates are used to predict the performance of various mount types.

## LEARNING OUTCOMES

This course will enable you to:

- isolate the effects of the environment on optics
- identify critical aspects of the optic-to-mount interface
- compare alternate low-strain mounting techniques for common types of elements
- estimate survivability for vibration and thermal loading
- design mounts that balance performance, survivability, and cost
- estimate optomechanical tolerances for optical assemblies using standard designs

## INTENDED AUDIENCE

Intended for engineers (mechanical, optical, electrical, and systems), scientists, technicians, and managers who are developing, specifying, or purchasing optical, electro-optical, infrared, or laser systems. The material is at an introductory level, but a basic familiarity with optomechanical engineering principles is useful.

## INSTRUCTOR

**Keith Kasunic** has more than 25 years of experience developing optical, electro-optical, infrared, and laser systems. He holds a Ph.D. in Optical Sciences from the University of Arizona, an MS in Mechanical Engineering from Stanford University, and a BS in Mechanical Engineering from MIT. He has worked for or been a consultant to a number of organizations, including Lockheed Martin, Ball Aerospace, Sandia National Labs, Nortel Networks, and Bookham. He is currently the Technical Director of Optical Systems Group, LLC. He is also an Adjunct Professor at Univ. of Central Florida's CREOL - The College of Optics and Photonics, as well as an Affiliate Instructor with Georgia Tech's SENSIAC, and an Instructor for the Optical Engineering Certificate Program at Univ. of California Irvine.

COURSE PRICE INCLUDES the text *Mounting Optics in Optical Instruments, 2nd edition* (SPIE Press, 2008), by Paul R. Yoder, Jr.

This course is also available in online format.

## Optomechanical Systems Engineering

### SC1085

#### Course Level: Introductory

CEU: 0.65 \$595 Members | \$705 Non-Members USD

Thursday 8:30 am to 5:30 pm

This course emphasizes a systems-level overview of optomechanical engineering. Starting with the fundamentals of imaging, it reviews how optical system concepts flow down into optomechanical requirements on optical fabrication, alignment, structural design, mechanics of materials (metals, composites, and glasses), structural vibrations, thermal management, and kinematic mounts. The focus is on real-world design problems, as well as the commercial off-the-shelf (COTS) components used to solve them.

## LEARNING OUTCOMES

This course will enable you to:

- utilize the basic concepts and terminology of optical engineering required for the development of optomechanical components
- read conventional and ISO-10110 drawings used for the fabrication of lenses
- develop an alignment plan with an emphasis on critical tolerances, alignment mechanisms, and "go-no go" decisions for adjusting tilt, decenter, despace, and defocus
- quantify the ability of a structural design to maintain alignment using efficient architectures and lightweight materials; compare low-strain lens and mirror mounts for reducing wavefront error (WFE)
- utilize the results of STOP (structural-thermal-optical) analysis for the deflection and distortion of optical components under static loads; estimate the impact of stress concentrations and contact stresses; select optical materials with appropriate structural properties
- estimate the effects of vibration environments on the alignment of optomechanical systems; select COTS components for vibration isolation
- predict the effects of conductive, convective, and radiative thermal environments on the performance of optical systems; select materials and off-the-shelf hardware to manage the effects of heat loads and temperature changes
- compare kinematic and semi-kinematic mounts and the limitations of COTS hardware

**INTENDED AUDIENCE**

Intended for engineers (systems, optical, mechanical, and electrical), scientists, technicians, and managers who are developing, specifying, or purchasing optical, electro-optical, infrared, or laser systems.

**INSTRUCTOR**

**Keith Kasunic** has more than 25 years of experience developing optical, electro-optical, infrared, and laser systems. He holds a Ph.D. in Optical Sciences from the University of Arizona, an MS in Mechanical Engineering from Stanford University, and a BS in Mechanical Engineering from MIT. He has worked for or been a consultant to a number of organizations, including Lockheed Martin, Ball Aerospace, Sandia National Labs, Nortel Networks, and Bookham. He is currently the Technical Director of Optical Systems Group, LLC. He is also an Adjunct Professor at Univ. of Central Florida's CREOL - The College of Optics and Photonics, as well as an Affiliate Instructor with Georgia Tech's SENSIAC, and an Instructor for the Optical Engineering Certificate Program at Univ. of California Irvine. This course is based on courses he teaches at CREOL and Georgia Tech's SENSIAC.

COURSE PRICE INCLUDES the text *Optomechanical Systems Engineering* (Wiley, 2015) by Keith Kasunic.

**Structural Adhesives for Optical Bonding****SC015****Course Level: Intermediate**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

Optomechanical systems require secure mounting of optical elements. Adhesives are commonly used, but rarely addressed in the literature. This course has compiled an overview of these adhesives, their properties, and how to test them. How to use them is addressed in detail with guidelines and examples provided. A summary of common adhesives is presented with justification for their use. Consideration and analysis of adhesive strength, reliability, and stability are included. Different design approaches to optimize the application are presented and discussed. Many examples are described as well as lessons learned from past experience. Discussions are encouraged to address current problems of course attendees.

**LEARNING OUTCOMES**

This course will enable you to:

- describe and classify adhesives and how they work (epoxy, urethane, silicone, acrylic, RTV, VU-cure, etc.)
- obtain guidance in: adhesive selection, surface preparation, application, and curing
- develop a basis for analysis of stress and thermal effects
- recognize contamination/outgassing and how to avoid it
- review design options
- create and use an adhesive check list

**INTENDED AUDIENCE**

This course is for engineers, managers, and technicians. This course provides a foundation for the correct design for successful optical mounting; an understanding of the best options to employ for each application, and the selection and approach conducive to production. A bound course outline (that is a good reference text) is provided, including summaries of popular adhesives and their properties.

**INSTRUCTOR**

**John Daly** has 35 years of experience in lasers and optomechanics. Over this period, he has worked optical bonding problems since his thesis projects, as an employee of several major corporations, and now as a consultant. His academic background in mechanical engineering and applied physics complements this discipline. His work experience has been diverse covering areas such as: military lasers, medical lasers, spectroscopy, point and standoff detection, and E-O systems. His roles over these years have included analysis, design, development, and production. He is a SPIE member, with numerous publications, and is a committee member of the SPIE Optomechanical Engineering Program.

**Introduction to Electro-Optical Systems Design****SC1112****Course Level: Intermediate**

**CEU: 0.65 \$590 Members | \$700 Non-Members USD**

**Monday 8:30 am to 5:30 pm**

Using communication theory, this full-day course explains the universal principles underlying a diverse range of electro-optical systems. From visible / infra-red imaging, to free space optical communications and laser remote sensing, the course relates key concepts in science and systems engineering to practical systems issues. To provide realistic understanding of the concepts presented, many real-world examples are included.

This course summarizes laser propagation fundamentals, coherent and incoherent optical system characterization, the effects of optical turbulence and particulate scattering on propagating laser beams, atmospheric and submarine laser communication systems concepts, and laser radar and optical imaging basics. Also included are discussions of adaptive optics, adaptive image processing, and statistical hypothesis testing and its effect on system performance.

**LEARNING OUTCOMES**

This course will enable you to:

- perform Fourier and Geometric Optics Analyses of electro-optical systems
- estimate detector noise statistics, detector performance, and signal-to-noise ratio
- perform first order image processing, including statistical image enhancements of incoherent images
- calculate contrast, irradiance and radiance created by the propagation of light in particulate environments
- calculate the system link budgets for laser systems
- perform statistical hypothesis testing, which includes how to calculate logarithmic likelihood ratio tests, test statistics, and probabilities of false alarm and detection
- assess and understand real-world Adaptive Optical system performance

**INTENDED AUDIENCE**

This course is intended for scientists, technical managers and design engineers who are interested in understanding first-order electro-optical system design and the effects that limit system performance.

**INSTRUCTOR**

**Larry Stotts** is a consultant and was the Deputy Office Director in the Strategic Technology Office of the Defense Advanced Research Projects Agency. He earned his Ph.D. in Electrical Engineering (Communications Systems) at the University of California at San Diego. He has published over 102 technical reports and journal articles and 2 co-authored books. Recognition of his work includes a Department of Defense Medal for Distinguished Civilian Service; two Secretary of Defense Medal for Meritorious Civilian Service Awards; two DARPA Technical Achievement Awards; The Technical Cooperation Program Technical Achievement Award, and the Naval Ocean Systems Center Technical Director's Award. Dr. Stotts is a Life Fellow of the SPIE, Fellow of the IEEE and a Senior Member and Fellow of OSA.

COURSE PRICE INCLUDES the text *Fundamentals of Electro-Optic Systems Design: Communications, Lidar and Imaging* by S. Karp and L. B. Stotts (Cambridge Press, 2013).

# COURSES

## MTF in Optical and Electro-Optical Systems

### SC157

#### Course Level: Introductory

CEU: 0.65 \$565 Members | \$675 Non-Members USD

Sunday 8:30 am to 5:30 pm

Modulation transfer function (MTF) is used to specify the image quality achieved by an imaging system. It is useful in analysis of situations where several independent subsystems are combined. This course provides a background in the application of MTF techniques to performance specification, estimation and characterization of optical and electro-optical systems.

#### LEARNING OUTCOMES

This course will enable you to:

- list the basic assumptions of linear systems theory, including the concept of spatial frequency
- identify relationship between impulse response, resolution, MTF, OTF, PTF, and CTF
- estimate the MTF for both diffraction-limited and aberration-limited systems
- explain the relationship between MTF, line response, and edge response functions
- identify MTF contributions from finite detector size, crosstalk, charge transfer inefficiency, and electronics
- summarize the effects of noise

#### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of MTF to specifying, estimating, or characterizing performance. Some prior background in Fourier concepts is helpful.

#### INSTRUCTOR

**Glenn Boreman** is the Chairman of the Department of Physics and Optical Science at the University of North Carolina at Charlotte since 2011. He received a BS in Optics from Rochester and PhD in Optics from Arizona. Prof. Boreman served on the faculty of University of Central Florida for 27 years, with 25 PhD students supervised to completion. His research interests are in infrared detectors, infrared metamaterials, and electro-optical sensing systems. Prof. Boreman is a Fellow of SPIE, OSA, and the Military Sensing Symposium, and is the 2015 Vice-President of SPIE.

COURSE PRICE INCLUDES the text *Modulation Transfer Function in Optical and Electro-Optical Systems* (SPIE Press, 2001) by Glenn D. Boreman.

## Optical Scatter Metrology for Industry

### SC1003

#### Course Level: Intermediate

CEU: 0.35 \$370 Members | \$425 Non-Members USD

Monday 8:30 am to 12:30 pm

Optical scatter, originally used almost exclusively to characterize the stray light generated by optically smooth surfaces, is now being used as a sensitive, economical way to monitor the surface texture requirements in a variety of industries. For example, the photo-voltaic industry uses specific types of texture on surfaces to increase absorption and system efficiency. Texture is often an important requirement for the metal producing industry and it changes with roll wear. The appearance of every day appliances (from door hinges to computer cases) varies dramatically with texture. The quality of flat panel displays depends on the scatter characteristics of the screen and components behind it. SEMI and ASTM are responding to the new applications with "scatter standards" to help communication between manufacturers, vendors and customers.

The low signal (hard to measure) optical applications were solved first because the math was easy. Rougher surface scatter relationships are more complicated, but the signals are much larger - making instrumentation easier. The course starts with the optical applications and then explores the transition to rougher industry surfaces. Between a good optical mirror and a concrete sidewalk there are thousands of industry surfaces that can be monitored with scatter metrology. There are two key points for these "in-between" surfaces: (1) If the texture changes - the scatter changes and (2) these changes (and product function) cannot be adequately monitored by a single variable - such as RMS Roughness, Haze or Gloss. The course emphasizes quantifying, measuring and understanding scatter. The modeling of scatter is mentioned, but is not emphasized here.

#### LEARNING OUTCOMES

This course will enable you to:

- quantify and analyze scatter in terms of BRDF, TIS, Haze and DSC units
- explain the instrumentation for obtaining scatter data and evaluate system calibration
- describe and overcome the various difficulties in comparing roughness statistics found from profilometers and scatterometers for both one- and two- dimensional samples
- convert scatter to roughness statistics when possible and understand when it is not possible
- evaluate the use of scatter measurement for specific applications such as: stray system radiation, surface micro-roughness, particulate sizing, background sensor noise
- explain the use of polystyrene latex sphere depositions as an optical scattering standard
- review scattering standards for the semiconductor and photovoltaic industries

#### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of scatter metrology to laboratory research and industrial process control. Some knowledge of calculus is helpful, but the course does not require that the student follow mathematical derivations. The instructor has worked with Thomas Germer (SC492 instructor) to avoid overlap between the two courses.

#### INSTRUCTOR

**John Stover** is President of The Scatter Works, Inc., a Tucson firm concentrating on scatter based metrology standards, consulting, and measurement as they apply to diverse industries. He has researched light scatter related problems for over 30 years and led teams of engineers who developed state-of-the-art scatterometers, verified theoretical relationship between surface roughness and scatter and characterized surface defects to improve wafer metrology. He has been involved with international standards organizations for over 20 years, is an SPIE Fellow, and has been active as an author, conference chairman, and editor, and has over one hundred publications.

COURSE PRICE INCLUDES the text *Optical Scattering: Measurement and Analysis, 3rd Edition* (SPIE Press, 2012) by John Stover.

## Predicting, Modeling, and Interpreting Light Scattered by Surfaces

**SC492****Course Level: Intermediate****CEU: 0.35 \$300 Members | \$355 Non-Members USD****Monday 1:30 pm to 5:30 pm**

The measurement of light scattered by surfaces can be used to locate and identify roughness, particulates, and defects on a wide variety of materials. Applications include the inspection of silicon wafers, optics, and storage media, characterization of thin film roughness, identification of objects in remote sensing, and prediction of optical system performance. The aim of this course is to provide tools to engineers and scientists to enable them to predict scattering for different sources, differentiate amongst different scattering sources, and to design instrumentation that maximizes sensitivity or differentiation amongst scattering sources for their specific application. Emphasis will be placed on the use of the SCATMECH library of scattering codes and the Modeled Integrated Scatter Tool (MIST) in order to minimize the mathematics that can often be a barrier to those who would otherwise be interested in using optical scatter. The measurement of scatter is emphasized in SC1003 taught by John Stover.

### LEARNING OUTCOMES

This course will enable you to:

- quantify scatter in terms of intensity and polarization properties
- identify likely sources of scatter from a material or thin film
- predict scatter from specific scatter sources: roughness, particles, and subsurface defects
- design experiments that differentiate among scattering sources
- use MIST to evaluate or visualize optical scatter in a variety of applications.
- define the limitations of light scattering

### INTENDED AUDIENCE

This course is intended for scientists and engineers who are interested in modeling, predicting, and interpreting light scatter from surfaces for material inspection, optical design, or remote sensing applications.

The instructor has designed the course to complement SC1003, working in conjunction with SC1003's instructor John Stover to coordinate the material.

### INSTRUCTOR

**Thomas Germer** is a physicist specializing in measurements and modeling of the optical properties of materials at the National Institute of Standards and Technology in Gaithersburg, Maryland. He has published over one hundred technical papers, covering topics of electron and ultrafast time-resolved surface spectroscopy, diffuse optical scattering from particles, roughness, and defects near surfaces and thin films, polarimetry, critical dimension metrology by grating scatterometry, and biomedical optics. He is the developer of the SCATMECH library of light scattering codes and the associated MIST program. Dr. Germer received a B.A. from the University of California, Berkeley, and a M.S. and Ph.D. from Cornell University, and is a Fellow of SPIE.

Following the course, attendees will be provided with an electronic copy of the public domain SCATMECH library, the MIST program, and all of the example programs discussed in the class.

## Optical Materials, Fabrication and Testing for the Optical Engineer

**SC1086****Course Level: Introductory****CEU: 0.35 \$300 Members | \$355 Non-Members USD****Wednesday 8:30 am to 12:30 pm**

This course is designed to give the optical engineer or lens designer an introduction to the technologies and techniques of optical materials, fabrication and testing. This knowledge will help the optical engineer understand how the choice of optical specifications and tolerances can either lead to more cost effective optical components, or can excessively drive the price up. Topics covered include optical materials, traditional, CNC and novel optical fabrication technologies, surface testing and fabrication tolerances.

### LEARNING OUTCOMES

This course will enable you to:

- identify key mechanical, chemical and thermal properties of optical materials (glass, crystals and ceramics) and how they affect the optical system performance and cost of optical components
- describe the basic processes of optical fabrication
- define meaningful surface and dimensional tolerances
- communicate effectively with optical fabricators
- design optical components that are able to be manufactured and measured using state of the art optical fabrication technologies
- choose the optimum specifications and tolerances for your next project

### INTENDED AUDIENCE

Optical engineers, lens designers, or managers who wish to learn more about how optical materials, fabrication and testing affect the optical designer. Undergraduate training in engineering or science is assumed.

### INSTRUCTOR

**Jessica DeGroote Nelson** is the Director of Engineering at Optimax Systems, Inc, where she oversees Optimax engineering, quality and research and development departments. She is an adjunct faculty member at The Institute of Optics at the University of Rochester teaching an undergraduate course on Optical Fabrication and Testing, and has given several guest lectures on optical metrology methods. She earned a Ph.D. in Optics at The Institute of Optics at the University of Rochester. Dr. Nelson is a member of both OSA and SPIE.

## Introduction to Interferometric Optical Testing

**SC213****Course Level: Introductory****CEU: 0.35 \$335 Members | \$390 Non-Members USD****Wednesday 8:30 am to 12:30 pm**

This short course introduces the field of interferometric optical testing. Topics covered include basic interferometers for optical testing, and concepts of phase-shifting interferometry including error analysis. Long wavelength interferometry, testing of aspheric surfaces, measurement of surface microstructure, and the state-of-the-art of direct phase measurement interferometers are also discussed.

# COURSES

## LEARNING OUTCOMES

This course will enable you to:

- explain the basic concepts of interferometric optical testing
- describe the power, capabilities, and limitations of phase-shifting interferometry
- describe techniques, advantages, and disadvantages of long-wavelength interferometry
- compare different aspheric testing techniques
- list capabilities and techniques for measuring surface microstructure
- describe the current state-of-the-art of direct phase measurement interferometers

## INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand the basic concepts of interferometric optical testing.

## INSTRUCTOR

**James Wyant** is Professor of Optical Sciences at the University of Arizona. He is currently Chairman of the Board of 4D Technology. He was a founder of the WYKO Corporation and served as its president from 1984 to 1997. Dr. Wyant was the 1986 President of SPIE.

COURSE PRICE INCLUDES the text *Field Guide to Interferometric Optical Testing* (SPIE Press, 2006) by Eric P. Goodman and James C. Wyant.

## Wavefront Data Analysis



### SC1164

#### Course Level: Intermediate

CEU: 0.35 \$375 Members | \$430 Non-Members USD

Sunday 1:30 pm to 5:30 pm

The course begins with an overview of basic aberrations and tolerance analysis in optical imaging systems. Zernike circle polynomials and their use in wavefront data analysis are presented as are analytical methods for cases involving non-circular pupils such as annular, square, hexagonal and elliptical pupils. The calculation of orthonormal aberration coefficients from the wavefront error data obtained by phase-shifting interferometry or wavefront slope error data obtained with a Shack-Hartmann sensor is explained, and numerical analyses of both types of data are demonstrated.

## LEARNING OUTCOMES

This course will enable you to:

- acquire a working knowledge of basic aberrations
- specify aberration/fabrication tolerance based on Strehl ratio and Rayleigh's quarter wave rule
- explain what Zernike polynomials are and why they are used in wavefront data analysis
- determine Zernike coefficients from optical design or testing wavefront data.
- determine Zernike coefficients from wavefront slope data
- relate Zernike coefficients to Seidel coefficients
- interpret data generated by wavefront or wavefront slope sensors
- develop effective communication between system engineers or engineering managers and optical designers, fabricators, and testers.

## INTENDED AUDIENCE

Scientists, engineers, and managers involved in lens and optical system design, fabrication, or optical testing. Some knowledge of aberrations and/or experience with optical design, fabrication, or testing is helpful but not necessary.

## INSTRUCTOR

**Virendra Mahajan** is a graduate of the College of Optical Sciences, University of Arizona, where he is an adjunct professor. He has 40 years of experience working on space optical systems, the last 31 with The Aerospace Corporation. He is a Fellow of SPIE, OSA, and the Optical Society of India, and recipient of SPIE's 2006 Conrady award, and 2015 Educator award. Dr. Mahajan is the author of *Aberration Theory Made Simple*, 2nd ed. (2011), the editor of *Selected Papers on Effects of Aberrations in Optical Imaging* (1993), and the author of *Optical Imaging and Aberrations, Part I: Ray Geometrical Optics* (1998), *Part II: Wave Diffraction Optics*, 2nd ed. (2011), *Part III: Wavefront Analysis* (2013), *Fundamentals of Geometrical Optics* (2014), all published by SPIE Press. He is also an Associate Editor of OSA's *Handbook of Optics*, 3rd ed.

COURSE PRICE INCLUDES the text *Optical Imaging and Aberrations, Part III: Wavefront Analysis* (SPIE Press 2013) by Virendra N. Mahajan

## NANOSCIENCE

### Nanophotonics and Metaphotonics

#### SC1082

#### Course Level: Introductory

CEU: 0.35 \$300 Members | \$355 Non-Members USD

Tuesday 8:30 am to 12:30 pm

Nanophotonics, defined as nanoscale optical science and technology, is a rapidly growing field which offers challenging opportunities for studying the interaction between light and matter on a scale much smaller than the wavelength of radiation, as well as for the design of novel nanostructured optical materials and devices and for developing nanocharacterization tools. An important dimension of Nanophotonics is control of excitation dynamics by manipulating local relaxation and energy transfer to judiciously utilize the excitation energy for a specific purpose.

Metaphotonics is a rapidly emerging new direction in Nanophotonics that deals with manipulation of electric and magnetic fields and their coupling in nanoengineered materials to control the field distribution and propagation of electromagnetic waves. An important aim for Metaphotonics is achieving negative refractive index for light manipulation. Another important direction is producing Switchable/Transformable Materials in which electrical, optical, and magnetic fields can be used for dynamic and reversible control of an optical field as well as linear and nonlinear optical functions. Their applications range from photonics communications, electronics, to solar energy harvesting, to sensor technology, biomedical technology and health care.

This course will cover the fundamentals of nanoscale light-matter interaction; various nanoscale linear and nonlinear optical effects, coupling of electric and magnetic properties using nanotechnology, and novel optical effects in nanostructural hybrid materials.

## LEARNING OUTCOMES

This course will enable you to:

- define the fundamentals of nanoscale linear and nonlinear optical interactions
- describe quantum dots, quantum rods and quantum wells
- describe plasmonic materials
- explain how to control the fate of excitation energy for a specific application
- explain up-conversion of radiation and novel materials efficiently producing it
- outline the application of nanophotonics to solar energy conversion
- describe biomedical applications of nanophotonics
- define Metaphotonics and Metamaterials
- describe different approaches to produce Metamaterials with near zero or negative refractive index

- explain how magneto-optics, magneto-plasmonic and spin-photonics increases the scope of Metaphotonics
- list different approaches for switchable and transformable photonic functions
- describe opportunities in Nanophotonics and Metaphotonics

#### INTENDED AUDIENCE

This course is intended for anyone who needs to learn about light-matter interactions and their manipulation in nanoengineered novel materials as well as their applications in Energy, Health Care, Semiconductor Industry, Defense Technology and Sensor Technology. The course is appropriate for a multidisciplinary audience, including engineers, materials scientists, optical physicists, theorists, chemists and biomedical researchers.

#### INSTRUCTOR

**Paras Prasad** Ph.D., is the SUNY Distinguished Professor of Chemistry, Physics, Electrical Engineering, and Medicine; the Samuel P. Capen Chair; and the Executive Director of the Institute for Lasers, Photonics and Biophotonics at the University at Buffalo. He was named among the top 50 Science & Technology leaders in the world by Scientific American in 2005. He has published ~700 scientific and technical papers in high impact journals, 3 monographs that practically defined the fields of Organic Nonlinear Optics, Biophotonics and Nanophotonics, and 8 edited books. He holds numerous patents. He is the recipient of many scientific awards and honors (Morley Medal; Schoellkopf award; Guggenheim fellowship; Sloan fellowship; Western New York Health Care Industries Technology/Discovery award; Fellow of APS, OSA & SPIE). He is a pioneer in nanophotonics and chiral metaphotonics, and has been giving Plenary, Opening and Keynote Lectures worldwide in this field.

**Alexander Baev** earned his Ph.D. in Theoretical Physics and Computational Quantum Chemistry from the Royal Institute of Technology (KTH) in Stockholm, Sweden, under the supervision of Prof. Hans Ågren. He is currently a research associate professor at the Institute for Lasers, Photonics and Biophotonics at the University at Buffalo, SUNY, working with Prof. Paras N. Prasad. Dr. Baev has published extensively in the fields of nonlinear optics of organic materials, nano-plasmonics and computational electromagnetics. His current research spans nonlinear optics and chiral/metaphotonics with an emphasis on the rational design of novel photonic materials including organic and metallo-organic

complexes for multi-photon absorption and nonlinear refraction and metamaterials and plasmonic-based media for photonic, telecommunication and bio-sensing applications. Dr. Baev has authored over 90 peer-reviewed journal articles and book chapters.

## Fabrication Technologies for Micro- and Nano-Optics

### SC454

#### Course Level: Introductory

CEU: 0.35 \$300 Members | \$355 Non-Members USD

Tuesday 8:30 am to 12:30 pm

Applications of micro and nano-scale optics are widespread in essentially every industry that uses light in some way. A short list of sample application areas includes communications, solar power, biomedical sensors, laser-assisted manufacturing, and a wide range of consumer electronics. Understanding both the possibilities and limitations for manufacturing micro- and nano-optics is useful to anyone interested in these areas. To this end, this course provides an introduction to fabrication technologies for micro- and nano-optics, ranging from refractive microlenses to diffractive optics to sub-wavelength optical nanostructures.

After a short overview of key applications and theoretical background for these devices, the principles of photolithography are introduced. With this backdrop, a wide variety of lithographic and non-lithographic fabrication methods for micro- and nano-optics are discussed in detail, followed by a survey of testing methods. Relative advantages and disadvantages of different techniques are discussed in terms of both technical capabilities and scalability for manufacturing. Issues and trends in micro- and nano-optics fabrication are also considered, focusing on both technical challenges and manufacturing infrastructure.

#### LEARNING OUTCOMES

This course will enable you to:

- describe example applications and key ‘rules of thumb’ for micro- and nano-optics
- explain basic principles of photolithography and how they apply to the fabrication of micro- and nano-optics
- identify and explain multiple techniques for micro- and nano-optics fabrication
- compare the advantages and disadvantages of different manufacturing methods
- describe and compare performance and metrological testing methods for micro- and nano-optics
- evaluate fabrication trends and supporting process technologies for volume manufacturing

#### INTENDED AUDIENCE

Engineers, scientists, and managers who are interested in the design, manufacture, or application of micro/nano-optics, or systems that integrate these devices. A background in basic optics is helpful but not assumed.

#### INSTRUCTOR

**Thomas Suleski** has been actively involved in research and development of micro- and nano-optics since 1991 at Georgia Tech, Digital Optics Corporation, and since 2003, as a member of the faculty at the University of North Carolina at Charlotte. He holds 12 patents and more than 110 technical publications on the design, fabrication, and testing of micro- and nano-optical components and systems. Dr. Suleski is a Fellow of SPIE, the International Society for Optical Engineering, and currently serves as Senior Editor for JM3, the Journal of Micro/Nanolithography, MEMS and MOEMS.

# COURSES

## OPTICS + PHOTONICS FOR SUSTAINABLE ENERGY

### Optical Scatter Metrology for Industry

#### SC1003

Course Level: Intermediate

CEU: 0.35 \$370 Members | \$425 Non-Members USD

Monday 8:30 am to 12:30 pm

Optical scatter, originally used almost exclusively to characterize the stray light generated by optically smooth surfaces, is now being used as a sensitive, economical way to monitor the surface texture requirements in a variety of industries. For example, the photo-voltaic industry uses specific types of texture on surfaces to increase absorption and system efficiency. Texture is often an important requirement for the metal producing industry and it changes with roll wear. The appearance of every day appliances (from door hinges to computer cases) varies dramatically with texture. The quality of flat panel displays depends on the scatter characteristics of the screen and components behind it. SEMI and ASTM are responding to the new applications with "scatter standards" to help communication between manufacturers, vendors and customers.

The low signal (hard to measure) optical applications were solved first because the math was easy. Rougher surface scatter relationships are more complicated, but the signals are much larger - making instrumentation easier. The course starts with the optical applications and then explores the transition to rougher industry surfaces. Between a good optical mirror and a concrete sidewalk there are thousands of industry surfaces that can be monitored with scatter metrology. There are two key points for these "in-between" surfaces: (1) If the texture changes - the scatter changes and (2) these changes (and product function) cannot be adequately monitored by a single variable - such as RMS Roughness, Haze or Gloss. The course emphasizes quantifying, measuring and understanding scatter. The modeling of scatter is mentioned, but is not emphasized here.

#### LEARNING OUTCOMES

This course will enable you to:

- quantify and analyze scatter in terms of BRDF, TIS, Haze and DSC units
- explain the instrumentation for obtaining scatter data and evaluate system calibration
- describe and overcome the various difficulties in comparing roughness statistics found from profilometers and scatterometers for both one- and two-dimensional samples
- convert scatter to roughness statistics when possible and understand when it is not possible
- evaluate the use of scatter measurement for specific applications such as: stray system radiation, surface micro-roughness, particulate sizing, background sensor noise
- explain the use of polystyrene latex sphere depositions as an optical scattering standard
- review scattering standards for the semiconductor and photovoltaic industries

#### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of scatter metrology to laboratory research and industrial process control. Some knowledge of calculus is helpful, but the course does not require that the student follow mathematical derivations. The instructor has worked with Thomas Germer (SC492 instructor) to avoid overlap between the two courses.

#### INSTRUCTOR

**John Stover** is President of The Scatter Works, Inc., a Tucson firm concentrating on scatter based metrology standards, consulting, and measurement as they apply to diverse industries. He has researched light scatter related problems for over 30 years and led teams of

engineers who developed state-of-the-art scatterometers, verified theoretical relationship between surface roughness and scatter and characterized surface defects to improve wafer metrology. He has been involved with international standards organizations for over 20 years, is an SPIE Fellow, and has been active as an author, conference chairman, and editor, and has over one hundred publications.

COURSE PRICE INCLUDES the text *Optical Scattering: Measurement and Analysis, 3rd Edition* (SPIE Press, 2012) by John Stover.

### Predicting, Modeling, and Interpreting Light Scattered by Surfaces

#### SC492

Course Level: Intermediate

CEU: 0.35 \$300 Members | \$355 Non-Members USD

Monday 1:30 pm to 5:30 pm

The measurement of light scattered by surfaces can be used to locate and identify roughness, particulates, and defects on a wide variety of materials. Applications include the inspection of silicon wafers, optics, and storage media, characterization of thin film roughness, identification of objects in remote sensing, and prediction of optical system performance. The aim of this course is to provide tools to engineers and scientists to enable them to predict scattering for different sources, differentiate amongst different scattering sources, and to design instrumentation that maximizes sensitivity or differentiation amongst scattering sources for their specific application. Emphasis will be placed on the use of the SCATMECH library of scattering codes and the Modeled Integrated Scatter Tool (MIST) in order to minimize the mathematics that can often be a barrier to those who would otherwise be interested in using optical scatter. The measurement of scatter is emphasized in SC1003 taught by John Stover.

#### LEARNING OUTCOMES

This course will enable you to:

- quantify scatter in terms of intensity and polarization properties
- identify likely sources of scatter from a material or thin film
- predict scatter from specific scatter sources: roughness, particles, and subsurface defects
- design experiments that differentiate among scattering sources
- use MIST to evaluate or visualize optical scatter in a variety of applications.
- define the limitations of light scattering

#### INTENDED AUDIENCE

This course is intended for scientists and engineers who are interested in modeling, predicting, and interpreting light scatter from surfaces for material inspection, optical design, or remote sensing applications.

The instructor has designed the course to complement SC1003, working in conjunction with SC1003's instructor John Stover to coordinate the material.

#### INSTRUCTOR

**Thomas Germer** is a physicist specializing in measurements and modeling of the optical properties of materials at the National Institute of Standards and Technology in Gaithersburg, Maryland. He has published over one hundred technical papers, covering topics of electron and ultrafast time-resolved surface spectroscopy, diffuse optical scattering from particles, roughness, and defects near surfaces and thin films, polarimetry, critical dimension metrology by grating scatterometry, and biomedical optics. He is the developer of the SCATMECH library of light scattering codes and the associated MIST program. Dr. Germer received a B.A. from the University of California, Berkeley, and a M.S. and Ph.D. from Cornell University, and is a Fellow of SPIE.

Following the course, attendees will be provided with an electronic copy of the public domain SCATMECH library, the MIST program, and all of the example programs discussed in the class.

## Radiometry Revealed

### **SC915**

#### **Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

This course explains basic principles and applications of radiometry and photometry. A primary goal of the course is to reveal the logic, systematic order, and methodology behind what sometimes appears to be a confusing branch of optical science and engineering. Examples are taken from the ultraviolet through the long-wave infrared portions of the electromagnetic spectrum. Anyone who wants to answer questions such as, "how many watts or photons do I have?" or "how much optical energy or radiation do I need?" will benefit from taking this course.

#### **LEARNING OUTCOMES**

This course will enable you to:

- describe the fundamental units and quantities used to quantify electromagnetic radiation at wavelengths from the ultraviolet through the visible and infrared
- use, understand, and convert between radiometric and photometric quantities
- apply radiometry to typical applications, such as calibrating an imaging system, determining human-perceived brightness of a display, or calculating electricity produced by a solar cell
- calculate areas and solid angles to determine the energy, energy density, or brightness in an optical system
- explain the role of rays, stops, and pupils in defining the field of view and light-gathering capability of an optical system
- determine the throughput of an optical system and use it in radiometric calculations
- quantify the radiant energy in optical images from point and extended sources
- transfer radiant energy into and throughout optical systems
- identify radiometric standards and calibration methods
- be familiar with radiometers and photometers

#### **INTENDED AUDIENCE**

Scientists, engineers, technicians, or technical managers who wish to learn more about how to quantify radiant energy in optical systems and measurements. Undergraduate training in engineering or science is assumed.

#### **INSTRUCTOR**

**Joseph Shaw** is Director of the Optical Technology Center and Professor of Electrical Engineering and Physics at Montana State University in Bozeman, Montana. He previously worked at the NOAA research labs in Boulder, Colorado. He is a widely recognized expert in the development, calibration, and analysis of optical systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona and is a Fellow of both the OSA and SPIE.

**This course is also available in online format.**

## ILLUMINATION ENGINEERING

### **Design of Efficient Illumination Systems**

### **SC011**

#### **Course Level: Intermediate**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 1:30 pm to 5:30 pm**

Illumination systems are included in fiber illuminators, projectors, and lithography systems. The design of an illumination system requires balancing uniformity, maximizing the collection efficiency from the source, and minimizing the size of the optical package. These choices are examined for systems using lightpipes, lens arrays, faceted optics, tailored edge rays designs, and integrating spheres through a combination of computer simulations, hardware demonstrations and discussions.

#### **LEARNING OUTCOMES**

This course will enable you to:

- describe the differences between illuminance, intensity and luminance
- compute the required source luminance given typical illumination system specifications
- compute the change in luminance introduced by an integrating sphere
- distinguish between a Kohler illuminator and an Abbe illuminator
- explain the difference in uniformity performance between a tailored edge ray reflector and a standard conic reflector
- design a lightpipe system to provide uniform illuminance
- design a lens array system to create a uniform illuminance distribution
- design a reflector with facets to create a uniform illuminance distribution

#### **INTENDED AUDIENCE**

Individuals who design illumination systems or need to interface with those designers will find this course appropriate. Previous exposure to Optical Fundamentals (Reflection, Refraction, Lenses, Reflectors) is expected.

#### **INSTRUCTOR**

**William Cassarly** is a Senior Scientist with Synopsys (formerly Optical Research Associates). Before joining ORA 18 years ago, Cassarly worked at GE for 13 years, holds 47 US patents, and has worked extensively in the areas of illumination system design, sources, photometry, light pipes, and non-imaging optics. Bill was awarded the GE Corporate 'D. R. Mack Advanced Course Supervisor Award' for his efforts in the training of GE Engineers and is an SPIE Fellow.

# COURSES

## MTF in Optical and Electro-Optical Systems

**SC157**

**Course Level: Introductory**

**CEU: 0.65 \$565 Members | \$675 Non-Members USD**

**Sunday 8:30 am to 5:30 pm**

Modulation transfer function (MTF) is used to specify the image quality achieved by an imaging system. It is useful in analysis of situations where several independent subsystems are combined. This course provides a background in the application of MTF techniques to performance specification, estimation and characterization of optical and electro-optical systems.

### LEARNING OUTCOMES

This course will enable you to:

- list the basic assumptions of linear systems theory, including the concept of spatial frequency
- identify relationship between impulse response, resolution, MTF, OTF, PTF, and CTF
- estimate the MTF for both diffraction-limited and aberration-limited systems
- explain the relationship between MTF, line response, and edge response functions
- identify MTF contributions from finite detector size, crosstalk, charge transfer inefficiency, and electronics
- summarize the effects of noise

### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of MTF to specifying, estimating, or characterizing performance. Some prior background in Fourier concepts is helpful.

### INSTRUCTOR

**Glenn Boreman** is the Chairman of the Department of Physics and Optical Science at the University of North Carolina at Charlotte since 2011. He received a BS in Optics from Rochester and PhD in Optics from Arizona. Prof. Boreman served on the faculty of University of Central Florida for 27 years, with 25 PhD students supervised to completion. His research interests are in infrared detectors, infrared metamaterials, and electro-optical sensing systems. Prof. Boreman is a Fellow of SPIE, OSA, and the Military Sensing Symposium, and is the 2015 Vice-President of SPIE.

COURSE PRICE INCLUDES the text *Modulation Transfer Function in Optical and Electro-Optical Systems* (SPIE Press, 2001) by Glenn D. Boreman.

## Radiometry Revealed

**SC915**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

This course explains basic principles and applications of radiometry and photometry. A primary goal of the course is to reveal the logic, systematic order, and methodology behind what sometimes appears to be a confusing branch of optical science and engineering. Examples are taken from the ultraviolet through the long-wave infrared portions of the electromagnetic spectrum. Anyone who wants to answer questions such as, "how many watts or photons do I have?" or "how much optical energy or radiation do I need?" will benefit from taking this course.

### LEARNING OUTCOMES

This course will enable you to:

- describe the fundamental units and quantities used to quantify electromagnetic radiation at wavelengths from the ultraviolet through the visible and infrared
- use, understand, and convert between radiometric and photometric quantities
- apply radiometry to typical applications, such as calibrating an imaging system, determining human-perceived brightness of a display, or calculating electricity produced by a solar cell
- calculate areas and solid angles to determine the energy, energy density, or brightness in an optical system
- explain the role of rays, stops, and pupils in defining the field of view and light-gathering capability of an optical system
- determine the throughput of an optical system and use it in radiometric calculations
- quantify the radiant energy in optical images from point and extended sources
- transfer radiant energy into and throughout optical systems
- identify radiometric standards and calibration methods
- be familiar with radiometers and photometers

### INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who wish to learn more about how to quantify radiant energy in optical systems and measurements. Undergraduate training in engineering or science is assumed.

### INSTRUCTOR

**Joseph Shaw** is Director of the Optical Technology Center and Professor of Electrical Engineering and Physics at Montana State University in Bozeman, Montana. He previously worked at the NOAA research labs in Boulder, Colorado. He is a widely recognized expert in the development, calibration, and analysis of optical systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona and is a Fellow of both the OSA and SPIE.

**This course is also available in online format.**

## METROLOGY

### Wavefront Data Analysis

New

**SC1164**

**Course Level: Intermediate**

**CEU: 0.35 \$375 Members | \$430 Non-Members USD**

**Sunday 1:30 pm to 5:30 pm**

The course begins with an overview of basic aberrations and tolerance analysis in optical imaging systems. Zernike circle polynomials and their use in wavefront data analysis are presented as are analytical methods for cases involving non-circular pupils such as annular, square, hexagonal and elliptical pupils. The calculation of orthonormal aberration coefficients from the wavefront error data obtained by phase-shifting interferometry or wavefront slope error data obtained with a Shack-Hartmann sensor is explained, and numerical analyses of both types of data are demonstrated.

## LEARNING OUTCOMES

This course will enable you to:

- acquire a working knowledge of basic aberrations
- specify aberration/fabrication tolerance based on Strehl ratio and Rayleigh's quarter wave rule
- explain what Zernike polynomials are and why they are used in wavefront data analysis
- determine Zernike coefficients from optical design or testing wavefront data.
- determine Zernike coefficients from wavefront slope data
- relate Zernike coefficients to Seidel coefficients
- interpret data generated by wavefront or wavefront slope sensors
- develop effective communication between system engineers or engineering managers and optical designers, fabricators, and testers.

## INTENDED AUDIENCE

Scientists, engineers, and managers involved in lens and optical system design, fabrication, or optical testing. Some knowledge of aberrations and/or experience with optical design, fabrication, or testing is helpful but not necessary.

## INSTRUCTOR

**Virendra Mahajan** is a graduate of the College of Optical Sciences, University of Arizona, where he is an adjunct professor. He has 40 years of experience working on space optical systems, the last 31 with The Aerospace Corporation. He is a Fellow of SPIE, OSA, and the Optical Society of India, and recipient of SPIE's 2006 Conrady award, and 2015 Educator award. Dr. Mahajan is the author of Aberration Theory Made Simple, 2nd ed. (2011), the editor of Selected Papers on Effects of Aberrations in Optical Imaging (1993), and the author of Optical Imaging and Aberrations, Part I: Ray Geometrical Optics (1998), Part II: Wave Diffraction Optics, 2nd ed. (2011), Part III: Wavefront Analysis (2013), Fundamentals of Geometrical Optics (2014), all published by SPIE Press. He is also an Associate Editor of OSA's Handbook of Optics, 3rd ed.

COURSE PRICE INCLUDES the text *Optical Imaging and Aberrations, Part III: Wavefront Analysis* (SPIE Press 2013) by Virendra N. Mahajan.

## Introduction to Interferometric Optical Testing

### SC213

#### Course Level: Introductory

**CEU: 0.35 \$335 Members | \$390 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This short course introduces the field of interferometric optical testing. Topics covered include basic interferometers for optical testing, and concepts of phase-shifting interferometry including error analysis. Long wavelength interferometry, testing of aspheric surfaces, measurement of surface microstructure, and the state-of-the-art of direct phase measurement interferometers are also discussed.

## LEARNING OUTCOMES

This course will enable you to:

- explain the basic concepts of interferometric optical testing
- describe the power, capabilities, and limitations of phase-shifting interferometry
- describe techniques, advantages, and disadvantages of long-wavelength interferometry
- compare different aspheric testing techniques
- list capabilities and techniques for measuring surface microstructure
- describe the current state-of-the-art of direct phase measurement interferometers

## INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand the basic concepts of interferometric optical testing.

## INSTRUCTOR

**James Wyant** is Professor of Optical Sciences at the University of Arizona. He is currently Chairman of the Board of 4D Technology. He was a founder of the WYKO Corporation and served as its president from 1984 to 1997. Dr. Wyant was the 1986 President of SPIE.

COURSE PRICE INCLUDES the text *Field Guide to Interferometric Optical Testing* (SPIE Press, 2006) by Eric P. Goodman and James C. Wyant.

## Optical Scatter Metrology for Industry

### SC1003

#### Course Level: Intermediate

**CEU: 0.35 \$370 Members | \$425 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

Optical scatter, originally used almost exclusively to characterize the stray light generated by optically smooth surfaces, is now being used as a sensitive, economical way to monitor the surface texture requirements in a variety of industries. For example, the photo-voltaic industry uses specific types of texture on surfaces to increase absorption and system efficiency. Texture is often an important requirement for the metal producing industry and it changes with roll wear. The appearance of every day appliances (from door hinges to computer cases) varies dramatically with texture. The quality of flat panel displays depends on the scatter characteristics of the screen and components behind it. SEMI and ASTM are responding to the new applications with "scatter standards" to help communication between manufacturers, vendors and customers.

The low signal (hard to measure) optical applications were solved first because the math was easy. Rougher surface scatter relationships are more complicated, but the signals are much larger - making instrumentation easier. The course starts with the optical applications and then explores the transition to rougher industry surfaces. Between a good optical mirror and a concrete sidewalk there are thousands of industry surfaces that can be monitored with scatter metrology. There are two key points for these "in-between" surfaces: (1) If the texture changes - the scatter changes and (2) these changes (and product function) cannot be adequately monitored by a single variable - such as RMS Roughness, Haze or Gloss. The course emphasizes quantifying, measuring and understanding scatter. The modeling of scatter is mentioned, but is not emphasized here.

## LEARNING OUTCOMES

This course will enable you to:

- quantify and analyze scatter in terms of BRDF, TIS, Haze and DSC units
- explain the instrumentation for obtaining scatter data and evaluate system calibration
- describe and overcome the various difficulties in comparing roughness statistics found from profilometers and scatterometers for both one- and two-dimensional samples
- convert scatter to roughness statistics when possible and understand when it is not possible
- evaluate the use of scatter measurement for specific applications such as: stray system radiation, surface micro-roughness, particulate sizing, background sensor noise
- explain the use of polystyrene latex sphere depositions as an optical scattering standard
- review scattering standards for the semiconductor and photovoltaic industries

# COURSES

## INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of scatter metrology to laboratory research and industrial process control. Some knowledge of calculus is helpful, but the course does not require that the student follow mathematical derivations. The instructor has worked with Thomas Germer (SC492 instructor) to avoid overlap between the two courses.

## INSTRUCTOR

**John Stover** is President of The Scatter Works, Inc., a Tucson firm concentrating on scatter based metrology standards, consulting, and measurement as they apply to diverse industries. He has researched light scatter related problems for over 30 years and led teams of engineers who developed state-of-the-art scatterometers, verified theoretical relationship between surface roughness and scatter and characterized surface defects to improve wafer metrology. He has been involved with international standards organizations for over 20 years, is an SPIE Fellow, and has been active as an author, conference chairman, and editor, and has over one hundred publications.

COURSE PRICE INCLUDES the text *Optical Scattering: Measurement and Analysis, 3rd Edition* (SPIE Press, 2012) by John Stover.

## Predicting, Modeling, and Interpreting Light Scattered by Surfaces

### SC492

#### Course Level: Intermediate

CEU: 0.35 \$300 Members | \$355 Non-Members USD

Monday 1:30 pm to 5:30 pm

The measurement of light scattered by surfaces can be used to locate and identify roughness, particulates, and defects on a wide variety of materials. Applications include the inspection of silicon wafers, optics, and storage media, characterization of thin film roughness, identification of objects in remote sensing, and prediction of optical system performance. The aim of this course is to provide tools to engineers and scientists to enable them to predict scattering for different sources, differentiate amongst different scattering sources, and to design instrumentation that maximizes sensitivity or differentiation amongst scattering sources for their specific application. Emphasis will be placed on the use of the SCATMECH library of scattering codes and the Modeled Integrated Scatter Tool (MIST) in order to minimize the mathematics that can often be a barrier to those who would otherwise be interested in using optical scatter. The measurement of scatter is emphasized in SC1003 taught by John Stover.

## LEARNING OUTCOMES

This course will enable you to:

- quantify scatter in terms of intensity and polarization properties
- identify likely sources of scatter from a material or thin film
- predict scatter from specific scatter sources: roughness, particles, and subsurface defects
- design experiments that differentiate among scattering sources
- use MIST to evaluate or visualize optical scatter in a variety of applications.
- define the limitations of light scattering

## INTENDED AUDIENCE

This course is intended for scientists and engineers who are interested in modeling, predicting, and interpreting light scatter from surfaces for material inspection, optical design, or remote sensing applications.

The instructor has designed the course to complement SC1003, working in conjunction with SC1003's instructor John Stover to coordinate the material.

## INSTRUCTOR

**Thomas Germer** is a physicist specializing in measurements and modeling of the optical properties of materials at the National Institute of Standards and Technology in Gaithersburg, Maryland. He has published over one hundred technical papers, covering topics of electron and ultrafast time-resolved surface spectroscopy, diffuse optical scattering from particles, roughness, and defects near surfaces and thin films, polarimetry, critical dimension metrology by grating scatterometry, and biomedical optics. He is the developer of the SCATMECH library of light scattering codes and the associated MIST program. Dr. Germer received a B.A. from the University of California, Berkeley, and a M.S. and Ph.D. from Cornell University, and is a Fellow of SPIE.

Following the course, attendees will be provided with an electronic copy of the public domain SCATMECH library, the MIST program, and all of the example programs discussed in the class.

## Principles of Fourier Optics and Diffraction

### SC017

#### Course Level: Intermediate

CEU: 0.65 \$660 Members | \$770 Non-Members USD

Tuesday 8:30 am to 5:30 pm

This course introduces the application of Fourier theory in diffraction and image formation. The first part of the course provides a review of a number of mathematical topics, including convolution and the Fourier transform. Next, the phenomenon of diffraction is introduced, the effects of lenses on diffraction are discussed, and the propagation of Gaussian beams is treated. Finally, the effects of diffraction on the performance of image-forming systems and other optical devices are discussed.

## LEARNING OUTCOMES

This course will enable you to:

- understand convolution and Fourier transform operations
- describe the general effects of diffraction in the Fresnel and Fraunhofer regions
- understand the effects of lenses on diffraction
- predict the Fraunhofer diffraction patterns associated with specific apertures
- describe the propagation of Gaussian beams
- understand the effects of diffraction on image formation and image resolution
- calculate the Point-Spread Functions (PSF) and Optical Transfer Functions (OTF) for various imaging systems

## INTENDED AUDIENCE

This course is intended for scientists and engineers who need to understand the diffraction of optical wavefields and the effects of diffraction on the performance of image-forming systems and other optical devices.

## INSTRUCTOR

**Jack Gaskill** is Professor Emeritus of Optical Sciences at the University of Arizona where, for more than 30 years, his teaching activities were devoted primarily to the applications of Fourier theory in optics. He has taught more than 40 off-campus short courses in Fourier optics and related subjects. Gaskill is author of the textbook, *Linear Systems, Fourier Transforms, and Optics* (Wiley, 1978), and is a Past President of SPIE.

COURSE PRICE INCLUDES the text *Linear Systems, Fourier Transforms, and Optics* (Wiley, 1978) by Jack D. Gaskill.

# NANOENGINEERING

## Fabrication Technologies for Micro- and Nano-Optics

**SC454**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Tuesday 8:30 am to 12:30 pm**

Applications of micro and nano-scale optics are widespread in essentially every industry that uses light in some way. A short list of sample application areas includes communications, solar power, biomedical sensors, laser-assisted manufacturing, and a wide range of consumer electronics. Understanding both the possibilities and limitations for manufacturing micro- and nano-optics is useful to anyone interested in these areas. To this end, this course provides an introduction to fabrication technologies for micro- and nano-optics, ranging from refractive microlenses to diffractive optics to sub-wavelength optical nanostructures.

After a short overview of key applications and theoretical background for these devices, the principles of photolithography are introduced. With this backdrop, a wide variety of lithographic and non-lithographic fabrication methods for micro- and nano-optics are discussed in detail, followed by a survey of testing methods. Relative advantages and disadvantages of different techniques are discussed in terms of both technical capabilities and scalability for manufacturing. Issues and trends in micro- and nano-optics fabrication are also considered, focusing on both technical challenges and manufacturing infrastructure.

### LEARNING OUTCOMES

This course will enable you to:

- describe example applications and key 'rules of thumb' for micro- and nano-optics
- explain basic principles of photolithography and how they apply to the fabrication of micro- and nano-optics
- identify and explain multiple techniques for micro- and nano-optics fabrication
- compare the advantages and disadvantages of different manufacturing methods
- describe and compare performance and metrological testing methods for micro- and nano-optics
- evaluate fabrication trends and supporting process technologies for volume manufacturing

### INTENDED AUDIENCE

Engineers, scientists, and managers who are interested in the design, manufacture, or application of micro/nano-optics, or systems that integrate these devices. A background in basic optics is helpful but not assumed.

### INSTRUCTOR

**Thomas Suleski** has been actively involved in research and development of micro- and nano-optics since 1991 at Georgia Tech, Digital Optics Corporation, and since 2003, as a member of the faculty at the University of North Carolina at Charlotte. He holds 12 patents and more than 110 technical publications on the design, fabrication, and testing of micro- and nano-optical components and systems. Dr. Suleski is a Fellow of SPIE, the International Society for Optical Engineering, and currently serves as Senior Editor for JM3, the Journal of Micro/Nanolithography, MEMS and MOEMS.

## Nanophotonics and Metaphotonics

**SC1082**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Tuesday 8:30 am to 12:30 pm**

Nanophotonics, defined as nanoscale optical science and technology, is a rapidly growing field which offers challenging opportunities for studying the interaction between light and matter on a scale much smaller than the wavelength of radiation, as well as for the design of novel nanostructured optical materials and devices and for developing nanocharacterization tools. An important dimension of Nanophotonics is control of excitation dynamics by manipulating local relaxation and energy transfer to judiciously utilize the excitation energy for a specific purpose.

Metaphotonics is a rapidly emerging new direction in Nanophotonics that deals with manipulation of electric and magnetic fields and their coupling in nanoengineered materials to control the field distribution and propagation of electromagnetic waves. An important aim for Metaphotonics is achieving negative refractive index for light manipulation. Another important direction is producing Switchable/Transformable Materials in which electrical, optical, and magnetic fields can be used for dynamic and reversible control of an optical field as well as linear and nonlinear optical functions. Their applications range from photonics communications, electronics, to solar energy harvesting, to sensor technology, biomedical technology and health care.

This course will cover the fundamentals of nanoscale light-matter interaction; various nanoscale linear and nonlinear optical effects, coupling of electric and magnetic properties using nanotechnology, and novel optical effects in nanostructural hybrid materials.

### LEARNING OUTCOMES

This course will enable you to:

- define the fundamentals of nanoscale linear and nonlinear optical interactions
- describe quantum dots, quantum rods and quantum wells
- describe plasmonic materials
- explain how to control the fate of excitation energy for a specific application
- explain up-conversion of radiation and novel materials efficiently producing it
- outline the application of nanophotonics to solar energy conversion
- describe biomedical applications of nanophotonics
- define Metaphotonics and Metamaterials
- describe different approaches to produce Metamaterials with near zero or negative refractive index
- explain how magneto-optics, magneto-plasmonic and spin-photonics increases the scope of Metaphotonics
- list different approaches for switchable and transformable photonic functions
- describe opportunities in Nanophotonics and Metaphotonics

### INTENDED AUDIENCE

This course is intended for anyone who needs to learn about light-matter interactions and their manipulation in nanoengineered novel materials as well as their applications in Energy, Health Care, Semiconductor Industry, Defense Technology and Sensor Technology. The course is appropriate for a multidisciplinary audience, including engineers, materials scientists, optical physicists, theorists, chemists and biomedical researchers.

# COURSES

## INSTRUCTOR

**Paras Prasad** Ph.D., is the SUNY Distinguished Professor of Chemistry, Physics, Electrical Engineering, and Medicine; the Samuel P. Capen Chair; and the Executive Director of the Institute for Lasers, Photonics and Biophotonics at the University at Buffalo. He was named among the top 50 Science & Technology leaders in the world by Scientific American in 2005. He has published ~700 scientific and technical papers in high impact journals, 3 monographs that practically defined the fields of Organic Nonlinear Optics, Biophotonics and Nanophotonics, and 8 edited books. He holds numerous patents. He is the recipient of many scientific awards and honors (Morley Medal; Schoellkopf award; Guggenheim fellowship; Sloan fellowship; Western New York Health Care Industries Technology Discovery award; Fellow of APS, OSA & SPIE). He is a pioneer in nanophotonics and chiral met photonics, and has been giving Plenary, Opening and Keynote Lectures worldwide in this field.

**Alexander Baev** earned his Ph.D. in Theoretical Physics and Computational Quantum Chemistry from the Royal Institute of Technology (KTH) in Stockholm, Sweden, under the supervision of Prof. Hans Agren. He is currently a research associate professor at the Institute for Lasers, Photonics and Biophotonics at the University at Buffalo, SUNY, working with Prof. Paras N. Prasad. Dr. Baev has published extensively in the fields of nonlinear optics of organic materials, nano-plasmonics and computational electromagnetics. His current research spans nonlinear optics and chiral/metaphotonics with an emphasis on the rational design of novel photonic materials including organic and metallo-organic

complexes for multi-photon absorption and nonlinear refraction and metamaterials and plasmonic-based media for photonic, telecommunication and bio-sensing applications. Dr. Baev has authored over 90 peer-reviewed journal articles and book chapters.

## Optical Scatter Metrology for Industry

### SC1003

**Course Level:** Intermediate

**CEU: 0.35 \$370 Members | \$425 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

Optical scatter, originally used almost exclusively to characterize the stray light generated by optically smooth surfaces, is now being used as a sensitive, economical way to monitor the surface texture requirements in a variety of industries. For example, the photo-voltaic industry uses specific types of texture on surfaces to increase absorption and system efficiency. Texture is often an important requirement for the metal producing industry and it changes with roll wear. The appearance of every day appliances (from door hinges to computer cases) varies dramatically with texture. The quality of flat panel displays depends on the scatter characteristics of the screen and components behind it. SEMI and ASTM are responding to the new applications with "scatter standards" to help communication between manufacturers, vendors and customers.

The low signal (hard to measure) optical applications were solved first because the math was easy. Rougher surface scatter relationships are more complicated, but the signals are much larger - making instrumentation easier. The course starts with the optical applications and then explores the transition to rougher industry surfaces. Between a good optical mirror and a concrete sidewalk there are thousands of industry surfaces that can be monitored with scatter metrology. There are two key points for these "in-between" surfaces: (1) If the texture changes - the scatter changes and (2) these changes (and product function) cannot be adequately monitored by a single variable - such as RMS Roughness, Haze or Gloss. The course emphasizes quantifying, measuring and understanding scatter. The modeling of scatter is mentioned, but is not emphasized here.

## LEARNING OUTCOMES

This course will enable you to:

- quantify and analyze scatter in terms of BRDF, TIS, Haze and DSC units
- explain the instrumentation for obtaining scatter data and evaluate system calibration
- describe and overcome the various difficulties in comparing roughness statistics found from profilometers and scatterometers for both one- and two- dimensional samples
- convert scatter to roughness statistics when possible and understand when it is not possible
- evaluate the use of scatter measurement for specific applications such as: stray system radiation, surface micro-roughness, particulate sizing, background sensor noise
- explain the use of polystyrene latex sphere depositions as an optical scattering standard
- review scattering standards for the semiconductor and photo-voltaic industries

## INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of scatter metrology to laboratory research and industrial process control. Some knowledge of calculus is helpful, but the course does not require that the student follow mathematical derivations. The instructor has worked with Thomas Germer (SC492 instructor) to avoid overlap between the two courses.

## INSTRUCTOR

**John Stover** is President of The Scatter Works, Inc., a Tucson firm concentrating on scatter based metrology standards, consulting, and measurement as they apply to diverse industries. He has researched light scatter related problems for over 30 years and led teams of engineers who developed state-of-the-art scatterometers, verified theoretical relationship between surface roughness and scatter and characterized surface defects to improve wafer metrology. He has been involved with international standards organizations for over 20 years, is an SPIE Fellow, and has been active as an author, conference chairman, and editor, and has over one hundred publications.

COURSE PRICE INCLUDES the text *Optical Scattering: Measurement and Analysis, 3rd Edition* (SPIE Press, 2012) by John Stover.

## SIGNAL, IMAGE, AND DATA PROCESSING

### MTF in Optical and Electro-Optical Systems

### SC157

**Course Level:** Introductory

**CEU: 0.65 \$565 Members | \$675 Non-Members USD**

**Sunday 8:30 am to 5:30 pm**

Modulation transfer function (MTF) is used to specify the image quality achieved by an imaging system. It is useful in analysis of situations where several independent subsystems are combined. This course provides a background in the application of MTF techniques to performance specification, estimation and characterization of optical and electro-optical systems.

## LEARNING OUTCOMES

This course will enable you to:

- list the basic assumptions of linear systems theory, including the concept of spatial frequency
- identify relationship between impulse response, resolution, MTF, OTF, PTF, and CTF
- estimate the MTF for both diffraction-limited and aberration-limited systems
- explain the relationship between MTF, line response, and edge response functions
- identify MTF contributions from finite detector size, crosstalk, charge transfer inefficiency, and electronics
- summarize the effects of noise

## INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of MTF to specifying, estimating, or characterizing performance. Some prior background in Fourier concepts is helpful.

## INSTRUCTOR

**Glenn Boreman** is the Chairman of the Department of Physics and Optical Science at the University of North Carolina at Charlotte since 2011. He received a BS in Optics from Rochester and PhD in Optics from Arizona. Prof. Boreman served on the faculty of University of Central Florida for 27 years, with 25 PhD students supervised to completion. His research interests are in infrared detectors, infrared metamaterials, and electro-optical sensing systems. Prof. Boreman is a Fellow of SPIE, OSA, and the Military Sensing Symposium, and is the 2015 Vice-President of SPIE.

COURSE PRICE INCLUDES the text *Modulation Transfer Function in Optical and Electro-Optical Systems* (SPIE Press, 2001) by Glenn D. Boreman.

## Introduction to Electro-Optical Systems Design

### SC1112

#### Course Level: Intermediate

**CEU: 0.65 \$590 Members | \$700 Non-Members USD**

**Monday 8:30 am to 5:30 pm**

Using communication theory, this full-day course explains the universal principles underlying a diverse range of electro-optical systems. From visible / infra-red imaging, to free space optical communications and laser remote sensing, the course relates key concepts in science and systems engineering to practical systems issues. To provide realistic understanding of the concepts presented, many real-world examples are included.

This course summarizes laser propagation fundamentals, coherent and incoherent optical system characterization, the effects of optical turbulence and particulate scattering on propagating laser beams, atmospheric and submarine laser communication systems concepts, and laser radar and optical imaging basics. Also included are discussions of adaptive optics, adaptive image processing, and statistical hypothesis testing and its effect on system performance.

## LEARNING OUTCOMES

This course will enable you to:

- perform Fourier and Geometric Optics Analyses of electro-optical systems
- estimate detector noise statistics, detector performance, and signal-to-noise ratio
- perform first order image processing, including statistical image enhancements of incoherent images
- calculate contrast, irradiance and radiance created by the propagation of light in particulate environments
- calculate the system link budgets for laser systems
- perform statistical hypothesis testing, which includes how to calculate logarithmic likelihood ratio tests, test statistics, and probabilities of false alarm and detection
- assess and understand real-world Adaptive Optical system performance

## INTENDED AUDIENCE

This course is intended for scientists, technical managers and design engineers who are interested in understanding first-order electro-optical system design and the effects that limit system performance.

## INSTRUCTOR

**Larry Stotts** is a consultant and was the Deputy Office Director in the Strategic Technology Office of the Defense Advanced Research Projects Agency. He earned his Ph.D. in Electrical Engineering (Communications Systems) at the University of California at San Diego. He has published over 102 technical reports and journal articles and 2 co-authored books. Recognition of his work includes a Department of Defense Medal for Distinguished Civilian Service; two Secretary of Defense Medal for Meritorious Civilian Service Awards; two DARPA Technical Achievement Awards; The Technical Cooperation Program Technical Achievement Award, and the Naval Ocean Systems Center Technical Director's Award. Dr. Stotts is a Life Fellow of the SPIE, Fellow of the IEEE and a Senior Member and Fellow of OSA.

COURSE PRICE INCLUDES the text *Fundamentals of Electro-Optic Systems Design: Communications, Lidar and Imaging* by S. Karp and L. B. Stotts (Cambridge Press, 2013).

## Digital Camera and Sensor Evaluation Using Photon Transfer

### SC916

#### Course Level: Introductory

**CEU: 0.65 \$580 Members | \$690 Non-Members USD**

**Tuesday 8:30 am to 5:30 pm**

Photon transfer (PT) is a popular and essential characterization standard employed in the design, operation, characterization, calibration, optimization, specification and application of digital scientific and commercial camera systems. The PT user friendly technique is based on only two measurements- average signal and rms noise which together produce a multitude of important data products in evaluating digital camera systems (most notably CCD and CMOS). PT is applicable to all imaging disciplines. Design and fabrication process engineers developing imagers rely heavily on PT data products in determining discrete performance parameters such as quantum efficiency (QE), quantum yield, read noise, full well, dynamic range, nonlinearity, fixed pattern noise, V/e- conversion gain, dark current , image, etc.. Camera users routinely use the PT technique to determine system level performance parameters to convert relative measurements into absolute electron and photon units, offset correction, flat field and image S/N, ADC quantizing noise, optimum encoding, minimum detectable luminance, operating temperature to remove dark current , reliability, stability, etc. PT is also the first go/no-go test performed to determine the health of new camera system and/or detector as well as provide a power tool in trouble shooting problems. This course will review these aspects and many others offered by PT.

## LEARNING OUTCOMES

This course will enable you to:

- describe PT theory
- take PT data and determine important CCD and CMOS performance parameters
- show example PT data products generated by CCD and CMOS imagers
- calibrate a camera system in absolute physical units
- use PT to determine the best camera or CCD/CMOS imager for the application
- use PT to demonstrate and verify the camera system is reliable and in good operating order
- discuss guidelines for the novice and advanced user in generating PT, Modulation and Lux Transfer curves
- use PT to optimally remove fixed pattern noise sources in images for the highest S/N possible through flat fielding
- comprehend signal-to-noise image theory through PT

# COURSES

## INTENDED AUDIENCE

Engineers, scientists, and technical managers working with commercial and scientific digital camera systems. Some familiarity with CCD and CMOS imagers is recommended.

## INSTRUCTOR

**James Janesick** is currently the director of the CMOS advanced development group for Sarnoff Corporation. Previously he was with Conexant Systems Inc. developing CMOS imaging arrays for commercial applications. He was technology director of Pixel Vision, Inc. for five years developing high speed backside illuminated CCDs for scientific and cinema cameras. Prior to this Janesick was with the Jet Propulsion Laboratory for 22 years where as group leader he designed scientific ground and flight based imaging systems. He has authored 75 publications and has contributed to many NASA Tech Briefs and patents for various CCD and CMOS innovations. Janesick received NASA medals for Exceptional Engineering Achievement (1982 and 1992) and was the recipient of the SPIE Educator Award (2004) and was SPIE /IS&T Imaging Scientist of the Year (2007).

COURSE PRICE INCLUDES the text *Photon Transfer* (SPIE Press, 2007) by James R. Janesick.

## Principles of Fourier Optics and Diffraction

### SC017

#### Course Level: Intermediate

**CEU: 0.65 \$660 Members | \$770 Non-Members USD**

**Tuesday 8:30 am to 5:30 pm**

This course introduces the application of Fourier theory in diffraction and image formation. The first part of the course provides a review of a number of mathematical topics, including convolution and the Fourier transform. Next, the phenomenon of diffraction is introduced, the effects of lenses on diffraction are discussed, and the propagation of Gaussian beams is treated. Finally, the effects of diffraction on the performance of image-forming systems and other optical devices are discussed.

## LEARNING OUTCOMES

This course will enable you to:

- understand convolution and Fourier transform operations
- describe the general effects of diffraction in the Fresnel and Fraunhofer regions
- understand the effects of lenses on diffraction
- predict the Fraunhofer diffraction patterns associated with specific apertures
- describe the propagation of Gaussian beams
- understand the effects of diffraction on image formation and image resolution
- calculate the Point-Spread Functions (PSF) and Optical Transfer Functions (OTF) for various imaging systems

## INTENDED AUDIENCE

This course is intended for scientists and engineers who need to understand the diffraction of optical wavefields and the effects of diffraction on the performance of image-forming systems and other optical devices.

## INSTRUCTOR

**Jack Gaskill** is Professor Emeritus of Optical Sciences at the University of Arizona where, for more than 30 years, his teaching activities were devoted primarily to the applications of Fourier theory in optics. He has taught more than 40 off-campus short courses in Fourier optics and related subjects. Gaskill is author of the textbook, *Linear Systems, Fourier Transforms, and Optics* (Wiley, 1978), and is a Past President of SPIE.

COURSE PRICE INCLUDES the text *Linear Systems, Fourier Transforms, and Optics* (Wiley, 1978) by Jack D. Gaskill.

## ATMOSPHERIC AND SPACE OPTICAL SYSTEMS

## The Proper Care of Optics: Cleaning, Handling, Storage and Shipping

### SC1114

#### Course Level: Introductory

**CEU: 0.35 \$345 Members | \$400 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

There are many ways to clean optics; some are learned from experience and/or failure. This course explains the proper cleaning methods for optics that are used by professional optical technicians and engineers.

How to clean optics has always been a challenging and controversial subject. Searching the Internet will yield hundreds of articles and videos that claim to know the best methods. This course will explain the simple steps used in cleaning optics. It will also describe the proper handling, storage and shipping of optical components. The course is designed for a diverse audience, from a first-time optical cleaner to an engineer searching for methods of handling and packaging optics. An in-class demonstration on inspecting and cleaning optics will be presented.

## LEARNING OUTCOMES

This course will enable you to:

- identify proper cleaning tools and their use
- explain safety guidelines, personal protection equipment and basic worktable layout
- compare lighting types required for inspection and cleaning
- identify solvents and cleaning liquids used for removing contaminates
- describe hand techniques used for applicators, wipes, and how to fold wipes
- explain inspection methods for optical surfaces
- list the types of contaminants and describe a short history of scratch and dig
- describe visual methods used: unaided eye, eye loupe, microscope (light and digital)
- describe types of optical coatings
- explain proper cleaning of small, large and infrared optics
- describe special cleaning techniques
- explain techniques used for instrument inspection, disassembly, assembly, and cleaning
- describe various instrument types
- describe the tricks of the trade: edge cleaning, protection, black paint and removing glue
- describe handling of optics using tweezers, cups, trays, storage and protection methods
- summarize shipping containment methods
- explain outdoor field cleaning

## INTENDED AUDIENCE

Technicians, engineers, scientists and managers who wish to learn the methods of cleaning, handling, storage and shipping of optics. High school to graduate degree.

## INSTRUCTOR

**Robert Schalck** is an Optical Engineer with over 40 years experience in the optical industry, and author of the text "The Proper Care of Optics" (SPIE Press, 2013) as well as an SPIE Online Course of the same title. He presented his first paper on cleaning optics at the OSA OF&T workshop in 1975. In 1989, he delivered a paper on Classical Optical Cleaning at the OSA "How to Conference." Over several decades, he has given presentations on how to clean optics to groups and organizations. He is a Senior Member of OSA and SPIE. COURSE PRICE INCLUDES the text *The Proper Care of Optics: Cleaning, Handling, Storage and Shipping* (SPIE Press, 2013), by Robert Schalck.

**This course is also available in online format.**

## Probability for Systems Engineers

**SC1165**



**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

This course explains basic principles for the use of probability analysis as applied to systems engineering. A primary goal of the course is explaining the logic, construction and application of performance and error budgeting. This probabilistic methodology should be a tool in every engineer's tool kit and is key to understanding the probability of a successful system. Examples are taken from various problems in systems engineering of astronomical and laser systems. This course will be of benefit to anyone who wants to answer the question, "what are the chances of success of my project?"

### LEARNING OUTCOMES

This course will enable you to:

- compose a performance or error budget
- calculate the distribution of likely outcomes of a design process
- calculate the most likely value for the performance of a component or system
- identify the sensitivity of performance to all parameters in the system
- explain the probability of the success of design project

### INTENDED AUDIENCE

Scientists, engineers, technicians, or managers who wish to learn more about how to apply probability to engineering problems. Undergraduate training in engineering or science is assumed.

### INSTRUCTOR

**Jonathan Arenberg** has been working as an optical and systems engineer for over 30 years. His work experience has included tactical and high-power laser components and systems and major space astronomical projects such as Chandra and the James Webb Space Telescope. He holds degrees in physics and engineering from the University of California, Los Angeles and currently the Chief Engineer for Northrop Grumman Aerospace Systems on the James Webb Space Telescope. Dr. Arenberg is an SPIE Fellow.

## MTF in Optical and Electro-Optical Systems

**SC157**

**Course Level: Introductory**

**CEU: 0.65 \$565 Members | \$675 Non-Members USD**

**Sunday 8:30 am to 5:30 pm**

Modulation transfer function (MTF) is used to specify the image quality achieved by an imaging system. It is useful in analysis of situations where several independent subsystems are combined. This course provides a background in the application of MTF techniques to performance specification, estimation and characterization of optical and electro-optical systems.

### LEARNING OUTCOMES

This course will enable you to:

- list the basic assumptions of linear systems theory, including the concept of spatial frequency
- identify relationship between impulse response, resolution, MTF, OTF, PTF, and CTF
- estimate the MTF for both diffraction-limited and aberration-limited systems
- explain the relationship between MTF, line response, and edge response functions
- identify MTF contributions from finite detector size, crosstalk, charge transfer inefficiency, and electronics
- summarize the effects of noise

### INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of MTF to specifying, estimating, or characterizing performance. Some prior background in Fourier concepts is helpful.

### INSTRUCTOR

**Glenn Boreman** is the Chairman of the Department of Physics and Optical Science at the University of North Carolina at Charlotte since 2011. He received a BS in Optics from Rochester and PhD in Optics from Arizona. Prof. Boreman served on the faculty of University of Central Florida for 27 years, with 25 PhD students supervised to completion. His research interests are in infrared detectors, infrared metamaterials, and electro-optical sensing systems. Prof. Boreman is a Fellow of SPIE, OSA, and the Military Sensing Symposium, and is the 2015 Vice-President of SPIE.

COURSE PRICE INCLUDES the text *Modulation Transfer Function in Optical and Electro-Optical Systems* (SPIE Press, 2001) by Glenn D. Boreman.

## Introduction to Optical Remote Sensing Systems

**SC567**

**Course Level: Introductory**

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

This course provides a broad introduction to optical remote sensing systems, including both passive sensors (e.g., radiometers and spectral imagers) and active sensors (e.g., laser radars or LIDARs). A brief review of basic principles of radiometry and atmospheric propagation (absorption, emission, and scattering) is followed by a system-level discussion of a variety of ground-, air-, and space-based remote sensing systems. Key equations are presented for predicting the optical resolution and signal-to-noise performance of passive and active sensing systems. Sensor system examples discussed in the class include solar radiometers, passive spectrometers and hyperspectral imagers, airborne imaging spectrometers, thermal infrared imagers, polarization imagers, and active laser radars (LIDARs and LADARs). The course material is directly relevant to sensing in environmental, civilian, military, astronomical, and solar energy applications.

### LEARNING OUTCOMES

This course will enable you to:

- review the principles of optical radiometry used to describe and calculate the flow of optical energy in an optical sensor system or solar energy system
- describe how the atmosphere affects the propagation of optical radiation
- explain how optical atmospheric effects influence remote sensing measurements or solar energy
- use system parameters in basic radiometric calculations to predict the signal received by passive and active sensors
- compare systems at the block-diagram level remote sensing measurements
- explain the difference between passive imaging based on reflection and emission
- acquire the operating principles of laser radar (lidar/ladar) systems for distributed and solid target sensing

### INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who find themselves working on (or curious about) optical remote sensing systems or data. Undergraduate training in engineering or science is assumed.

# COURSES

## INSTRUCTOR

**Joseph Shaw** is a professor of electrical engineering and physics at Montana State University and previously worked at the NOAA research labs. He is a recognized expert in development, calibration, and analysis of optical remote sensing systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona. Dr. Shaw is a Fellow of both the OSA and SPIE.

## Radiometry Revealed

### SC915

#### Course Level: Introductory

**CEU: 0.35 \$300 Members | \$355 Non-Members USD**  
**Monday 8:30 am to 12:30 pm**

This course explains basic principles and applications of radiometry and photometry. A primary goal of the course is to reveal the logic, systematic order, and methodology behind what sometimes appears to be a confusing branch of optical science and engineering. Examples are taken from the ultraviolet through the long-wave infrared portions of the electromagnetic spectrum. Anyone who wants to answer questions such as, "how many watts or photons do I have?" or "how much optical energy or radiation do I need?" will benefit from taking this course.

## LEARNING OUTCOMES

This course will enable you to:

- describe the fundamental units and quantities used to quantify electromagnetic radiation at wavelengths from the ultraviolet through the visible and infrared
- use, understand, and convert between radiometric and photometric quantities
- apply radiometry to typical applications, such as calibrating an imaging system, determining human-perceived brightness of a display, or calculating electricity produced by a solar cell
- calculate areas and solid angles to determine the energy, energy density, or brightness in an optical system
- explain the role of rays, stops, and pupils in defining the field of view and light-gathering capability of an optical system
- determine the throughput of an optical system and use it in radiometric calculations
- quantify the radiant energy in optical images from point and extended sources
- transfer radiant energy into and throughout optical systems
- identify radiometric standards and calibration methods
- be familiar with radiometers and photometers

## INTENDED AUDIENCE

Scientists, engineers, technicians, or technical managers who wish to learn more about how to quantify radiant energy in optical systems and measurements. Undergraduate training in engineering or science is assumed.

## INSTRUCTOR

**Joseph Shaw** is Director of the Optical Technology Center and Professor of Electrical Engineering and Physics at Montana State University in Bozeman, Montana. He previously worked at the NOAA research labs in Boulder, Colorado. He is a widely recognized expert in the development, calibration, and analysis of optical systems used in environmental and military sensing. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization's Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona and is a Fellow of both the OSA and SPIE.

**This course is also available in online format.**

## Digital Camera and Sensor Evaluation Using Photon Transfer

### SC916

#### Course Level: Introductory

**CEU: 0.65 \$580 Members | \$690 Non-Members USD**  
**Tuesday 8:30 am to 5:30 pm**

Photon transfer (PT) is a popular and essential characterization standard employed in the design, operation, characterization, calibration, optimization, specification and application of digital scientific and commercial camera systems. The PT user friendly technique is based on only two measurements- average signal and rms noise which together produce a multitude of important data products in evaluating digital camera systems (most notably CCD and CMOS). PT is applicable to all imaging disciplines. Design and fabrication process engineers developing imagers rely heavily on PT data products in determining discrete performance parameters such as quantum efficiency (QE), quantum yield, read noise, full well, dynamic range, nonlinearity, fixed pattern noise, V/e- conversion gain, dark current , image , etc.. Camera users routinely use the PT technique to determine system level performance parameters to convert relative measurements into absolute electron and photon units, offset correction, flat field and image S/N, ADC quantizing noise, optimum encoding, minimum detectable luminance, operating temperature to remove dark current , reliability, stability, etc. PT is also the first go/no-go test performed to determine the health of new camera system and/or detector as well as provide a power tool in trouble shooting problems. This course will review these aspects and many others offered by PT.

## LEARNING OUTCOMES

This course will enable you to:

- describe PT theory
- take PT data and determine important CCD and CMOS performance parameters
- show example PT data products generated by CCD and CMOS imagers
- calibrate a camera system in absolute physical units
- use PT to determine the best camera or CCD/CMOS imager for the application
- use PT to demonstrate and verify the camera system is reliable and in good operating order
- discuss guidelines for the novice and advanced user in generating PT, Modulation and Lux Transfer curves
- use PT to optimally remove fixed pattern noise sources in images for the highest S/N possible through flat fielding
- comprehend signal-to-noise image theory through PT

## INTENDED AUDIENCE

Engineers, scientists, and technical managers working with commercial and scientific digital camera systems. Some familiarity with CCD and CMOS imagers is recommended.

## INSTRUCTOR

**James Janesick** is currently the director of the CMOS advanced development group for Sarnoff Corporation. Previously he was with Conexant Systems Inc. developing CMOS imaging arrays for commercial applications. He was technology director of Pixel Vision, Inc. for five years developing high speed backside illuminated CCDs for scientific and cinema cameras. Prior to this Janesick was with the Jet Propulsion Laboratory for 22 years where as group leader he designed scientific ground and flight based imaging systems. He has authored 75 publications and has contributed to many NASA Tech Briefs and patents for various CCD and CMOS innovations. Janesick received NASA medals for Exceptional Engineering Achievement (1982 and 1992) and was the recipient of the SPIE Educator Award (2004) and was SPIE /IS&T Imaging Scientist of the Year (2007).

COURSE PRICE INCLUDES the text *Photon Transfer* (SPIE Press, 2007) by James R. Janesick.

## Introduction to Electro-Optical Systems Design

### SC1112

**Course Level: Intermediate**

**CEU: 0.65 \$590 Members | \$700 Non-Members USD**

**Monday 8:30 am to 5:30 pm**

Using communication theory, this full-day course explains the universal principles underlying a diverse range of electro-optical systems. From visible / infra-red imaging, to free space optical communications and laser remote sensing, the course relates key concepts in science and systems engineering to practical systems issues. To provide realistic understanding of the concepts presented, many real-world examples are included.

This course summarizes laser propagation fundamentals, coherent and incoherent optical system characterization, the effects of optical turbulence and particulate scattering on propagating laser beams, atmospheric and submarine laser communication systems concepts, and laser radar and optical imaging basics. Also included are discussions of adaptive optics, adaptive image processing, and statistical hypothesis testing and its effect on system performance.

#### LEARNING OUTCOMES

This course will enable you to:

- perform Fourier and Geometric Optics Analyses of electro-optical systems
- estimate detector noise statistics, detector performance, and signal-to-noise ratio
- perform first order image processing, including statistical image enhancements of incoherent images
- calculate contrast, irradiance and radiance created by the propagation of light in particulate environments
- calculate the system link budgets for laser systems
- perform statistical hypothesis testing, which includes how to calculate logarithmic likelihood ratio tests, test statistics, and probabilities of false alarm and detection
- assess and understand real-world Adaptive Optical system performance

#### INTENDED AUDIENCE

This course is intended for scientists, technical managers and design engineers who are interested in understanding first-order electro-optical system design and the effects that limit system performance.

#### INSTRUCTOR

**Larry Stotts** is a consultant and was the Deputy Office Director in the Strategic Technology Office of the Defense Advanced Research Projects Agency. He earned his Ph.D. in Electrical Engineering (Communications Systems) at the University of California at San Diego. He has published over 102 technical reports and journal articles and 2 co-authored books. Recognition of his work includes a Department of Defense Medal for Distinguished Civilian Service; two Secretary of Defense Medal for Meritorious Civilian Service Awards; two DARPA Technical Achievement Awards; The Technical Cooperation Program Technical Achievement Award, and the Naval Ocean Systems Center Technical Director's Award. Dr. Stotts is a Life Fellow of the SPIE, Fellow of the IEEE and a Senior Member and Fellow of OSA.

**COURSE PRICE INCLUDES** the text *Fundamentals of Electro-Optic Systems Design: Communications, Lidar and Imaging* by S. Karp and L. B. Stotts (Cambridge Press, 2013).

## PROFESSIONAL DEVELOPMENT

### Critical Skills for Compelling Research Proposals

#### WS1058

**Course Level: Introductory**

**CEU: 0.35 \$50 Members | \$100 Non-Members USD**

**Wednesday 8:30 am to 12:30 pm**

A successful research proposal requires hundreds of hours of effort, and the stakes are high. Just beginning the process is intimidating. This interactive workshop teaches students to overcome their apprehensions by starting with small steps, building a strong proposal from the inside out.

#### LEARNING OUTCOMES

This course will enable you to:

- align your research goals to the funding opportunity
- develop solid research plans and believable budgets
- communicate your research to a general audience

#### INTENDED AUDIENCE

This course is intended for all scientists and engineers seeking to improve the quality of their research proposals.

#### INSTRUCTOR

**Damon Diehl** is the founder and owner of Diehl Research Grant Services. He has a Ph.D. in optical engineering from the University of Rochester Institute of Optics and a B.A. in physics from the University of Chicago. His class is based on nineteen years of academic and industrial research experience.

This course is free to SPIE Student Members, but **you must register to attend**.

### Resumes to Interviews: Strategies for a Successful Job Search

#### WS1059

**Course Level: Introductory**

**CEU: 0.35 \$50 Members | \$100 Non-Members USD**

**Wednesday 1:30 pm to 5:30 pm**

This course reviews effective strategies and techniques for a successful job search such as: compiling resumes, writing cover letters, and interviewing tips. The primary goal of the course is to provide creative and proven techniques for new college graduates and professionals to plan and conduct their job search and secure a job. Creative and comprehensive job search techniques will be discussed as well as actual resume and interviewing examples and tips. Anyone who is getting ready to enter the work force who wants to answer questions such as, "when and how do I start my job search?", "what kind of cover letter and resume gets noticed?" or "how do I sell myself in an interview?" will benefit from taking this course.

#### LEARNING OUTCOMES

This course will enable you to:

- start and create your job search plan
- create an online networking presence
- build and write effective cover letters and resumes that get noticed
- avoid common resume and cover letter mistakes
- interview with confidence

# COURSES

## INTENDED AUDIENCE

Graduate students, new graduates, and early-career professionals who wish to learn more about creating a job search plan, writing an effective cover letter and resume that gets you noticed, and techniques for successful interviews.

## INSTRUCTOR

**Paige Lawson** has been in professional recruiting for more than 20 years. She has extensive experience with both in-house corporate environments as well as outside agency/consulting environments. Paige is currently a recruiter for LightWorks Optical Systems in Murrieta, CA, and a member of the local networking group Professionals in Human Resources (PHIRA).

**Suzanne Krinsky** has been in human resources and corporate recruiting for more than 15 years. She has extensive experience with both in-house corporate environments as well as outside agency/consulting environments. Suzanne is currently the Human Resource Director for Daylight Solutions in San Diego, and also a long-time Board member for the Biotech Human Resource Development Coalition (BEDC) and Human Resource Roundtable member.

This workshop is **free** to SPIE Student Members. **You must register to attend.**

This workshop presents introductory information and is intended primarily for university students and others with little professional experience.

## Effective Technical Presentations

### WS897

#### Course Level: Introductory

**CEU: 0.35 \$75 Members | \$125 Non-Members USD**

**Monday 8:30 am to 12:30 pm**

Oral presentation skills are a key to success for researchers. This course proposes a five-step methodology that will take you from scratch to an effective technical presentation. It also offers tips on how to manage the nervousness associated with speaking in public.

## LEARNING OUTCOMES

This course will enable you to:

- plan your presentation efficiently
- organize your material into an effective structure
- create slides that get the message across
- deliver your presentation effectively, both verbally and nonverbally
- handle even the most difficult questions

## INTENDED AUDIENCE

This material is intended for anyone who must prepare and deliver oral presentations. Both novice and experienced speakers can expect to learn much from it.

## INSTRUCTOR

**Jean-luc Doumont** runs lectures, workshops, and training programs in oral, written, and graphical communication for engineers, scientists, and managers worldwide. He is an engineer from the University of Louvain and a doctor in applied physics from Stanford University. This course is based on his popular lecture on oral presentations at over 15 top-ranked engineering schools (MIT, Stanford U, UC Berkeley, Caltech, Harvard, etc.).

This course is free to SPIE Student Members, **but you must register to attend.**

## Effective Scientific Papers

### WS908

#### Course Level: Introductory

**CEU: 0.35 \$75 Members | \$125 Non-Members USD**

**Monday 1:30 pm to 5:30 pm**

Strong writing skills are a key to success for researchers. This course proposes a methodology that will take you from scratch to an effective scientific or technical document—a question of structure, not style. The approach is applicable across languages and for a wide range of document types beyond scientific papers, too.

## LEARNING OUTCOMES

This course will enable you to:

- plan your document efficiently
- create an effective abstract, introduction, and conclusion
- organize your material into an accessible structure
- construct paragraphs that get the message across
- write sentences that are easy to read

## INTENDED AUDIENCE

This material is intended for anyone who must write or edit technical documents in general and scientific papers in particular. Both novice and experienced writers can expect to learn much from it.

## INSTRUCTOR

**Jean-luc Doumont** runs lectures, workshops, and training programs in oral, written, and graphical communication for engineers, scientists, and managers worldwide. He is an engineer from the University of Louvain and a doctor in applied physics from Stanford University. This course is based on his lectures and workshops on scientific and technical writing at universities and research centers around the world (MIT, Shell, Johnson & Johnson, etc.).

This course is free to SPIE Student Members, **but you must register to attend.**

## WORKSHOPS FOR OPTICS EDUCATORS

### Dumpster Optics: Real optical science with free stuff



**WS1156**

**Course Level: Introductory**

**CEU: 0.2 \$10 Members | \$15 Non-Members USD**

**Tuesday 10:30 am to 12:30 pm**

Engage in inquiry-based activities illustrating basic optics concepts using inexpensive, commonly found materials. This workshop is for budget-constrained teachers who have little to no funds for formal kits and expensive supplies. Many of these activities have been taken from the PHOTON projects of the New England Board of Higher Education, funded by the National Science Foundation's Advanced Technological Education, and the Hands-on-Optics program to provide professional development for instructors.

*What will you do in this workshop?*

- Activities on light and color—Candies and Rainbows: What color is it?
- Light and shadows, mirror and reflection activities—Light rays to fool your eyes
- Activities on fluorescence, phosphorescence, ultraviolet light—Light you can't see

*What will you take home?*

Complete instructions, several "make-and-take" cool optics, list of suppliers and other free resources, ongoing technical assistance (by email), and the opportunity to join the PHOTON listserv of educators and industry mentors.

#### LEARNING OUTCOMES

This course will enable you to:

- Make pinhole images!
- Discover reflection!
- See a rainbow in a light bulb!
- Turn a tomato into a plum!

#### INTENDED AUDIENCE

Secondary and post-secondary instructors who want to teach basic optical science concepts and photonics technology. The workshop is also appropriate for anyone who wants a few engaging, low-cost, simple demonstrations to take into their community for outreach purposes.

#### INSTRUCTOR

**Judith Donnelly** is an emeritus professor of physics at Three Rivers Community Technical College and the 2003 recipient of the SPIE Educator of the Year award. She is the co-author of "Light: Introduction to Optics and Photonics" and the co-creator of "Laser Camp", a hands-on introduction to optics and careers for High School students.

**Nancy Magnani** is a Grant Facilitator/Science Specialist for EAST-CONN's Teaching and Learning Services. Her projects include facilitating Inter-district grant programs for K-12 students, including Energy for the Future, the 4th R: Robotics, Minds in Motion and Making Waves: Optics and Acoustics. In addition, Nancy facilitates EAST-CONN Science Council, developing and providing science-based professional development for K-12 teachers in alignment with NGSS and Connecticut state science standards.

### It's Elementary—Light and Optics for Kids

**WS1142**

**Course Level: Introductory**

**CEU: 0.2 \$25 Members | \$50 Non-Members USD**

**Tuesday 8:30 am to 10:30 am**

Using the simple, yet powerful Light Blox kit, the official kit for the International Year of Light, you can introduce light and optics to kids ages 5-16. Engage and excite young scientists with 10 fun activities that lay the foundation for understanding the fundamentals of light and optics: reflection, refraction, color, shadows and more. Using the kit, create your own demonstration or activity!

#### LEARNING OUTCOMES

This course will enable you to:

- describe young students' common misconceptions about light and optics
- demonstrate age appropriate activities and demonstrations that introduce students to light and optics, and address their misconceptions
- design an age appropriate activity or demonstration using the kit and common items

#### INTENDED AUDIENCE

Students and professionals interested in outreach, teaching or demonstrating light and optics to young students, teachers and parents.

#### INSTRUCTOR

**Colette DeHarppoate** is the founder of LASER Classroom and the inventor of LASER Blox. LASER Classroom is dedicated to creating equipment, kits and curricula that get students and teachers excited and engaged in the science of light, lasers, optics and photonics. She holds a BS in Public Health Education from the University of Southern California in Los Angeles, CA, and a MA in Organizational Leadership from Concordia University in St. Paul, MN.



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**Light-based technologies respond  
to the needs of humankind**

## **Join us in celebrating the International Year of Light**

The International Year of Light is a global initiative highlighting to the citizens of the world the importance of light and light-based technologies in their lives, for their futures, and for the development of society.

We hope that the International Year of Light will increase global awareness of the central role of light in human activities and that the brightest young minds continue to be attracted to careers in this field.

For more information on how you and your organization can participate, visit:

[www.spie.org/IYL](http://www.spie.org/IYL)



INTERNATIONAL  
YEAR OF LIGHT  
2015



**SPIE.**

## REGISTRATION

### Onsite Registration and Badge Pick-Up Hours

Convention Center, Sails Pavilion (Upper Level)

Sunday 9 August · 7:00 am to 5:00 pm

Monday 10 August · 7:15 am to 5:00 pm

Tuesday 11 August · 7:30 am to 5:00 pm

Wednesday 12 August · 7:30 am to 5:00 pm

Thursday 13 August · 7:45 am to 4:00 pm

### Conference Registration

Includes admission to all conference sessions, plenaries, panels, and poster sessions, admission to the Exhibition, Welcome Reception, coffee breaks, and a choice of proceedings. Student pricing does not include proceedings.

### Exhibition Registration

Open Tuesday - Thursday

Exhibition-Only visitor registration is complimentary.

### Course and Workshop Registration

Courses and workshops are priced separately. Course-only registration includes your selected course(s), course notes, coffee breaks, and admittance to the exhibition. Course prices include applicable taxes. Onsite, please go to Course Materials after you pick up your badge.

Multiple facilities may be used for courses; allow yourself enough time to register, pick up your materials and possibly walk to a nearby facility before your course begins.

### Early Registration Pricing and Dates

Conference registration prices increase by US\$150 (Students, \$50) and course prices increase \$75 after 24 July 2015. The online form will automatically display the increased prices.

### SPIE Member, SPIE Student Member, and Student Pricing

- SPIE Members receive conference and course registration discounts. Discounts are applied at the time of registration.
- SPIE Student Members receive a 50% discount on all courses.
- Student registration rates are available only to undergraduate and graduate students who are enrolled full time and have not yet received their Ph.D. Post-docs may not register as students. A student ID number or proof of student status is required with your registration.

### PRESS REGISTRATION

For credentialed press and media representatives only. Please email contact information, title, and organization to [media@spie.org](mailto:media@spie.org).

### SPIE Cashier

Registration Area

Open during registration hours.

### REGISTRATION PAYMENTS

If you are paying by cash or check as part of your onsite registration, wish to add a course, workshop, or special event requiring payment, or have questions regarding your registration, visit the SPIE Cashier.

### RECEIPTS AND CERTIFICATE OF ATTENDANCE

Preregistered attendees who did not receive a receipt or attendees who need a Certificate of Attendance may obtain those from the SPIE Cashier at Badge Corrections and Receipts.

### BADGE CORRECTIONS

Badge corrections can be made by the SPIE Cashier at the Badge Corrections station. Please have your badge removed from the badge holder and marked with your changes before approaching the counter.

### REFUND INFORMATION

There is a US \$50 service charge for processing refunds. Requests for refunds must be received by 30 July 2015; all registration fees will be forfeited after this date. Membership dues, SPIE Digital Library subscriptions, or Special Events purchased are not refundable.

### U.S. GOVERNMENT CREDIT CARDS

U.S. Government credit card users: have your purchasing officer contact the credit card company and get prior authorization before attempting to register. Advise your purchasing agent that SPIE is considered a 5968 company for authorization purposes.

SPIE is the international society for optics and photonics, a not-for-profit organization founded in 1955 to advanced light-based technologies. The Society serves nearly 264,000 constituents from approximately 166 countries, offering conferences, continuing education, books, journals, and a digital library in support of interdisciplinary information exchange, professional growth, and patent precedent. SPIE provided over \$4 million in support of education and outreach programs in 2014.

# GENERAL INFORMATION

## AUTHOR / PRESENTER INFORMATION

### Speaker Check-In and Preview Station

Convention Center, Ballroom 6 Lobby (Upper Level)

Sunday through Thursday · 7:30 am to 5:00 pm

All conference rooms have a computer workstation, projector, screen, lapel microphone, and laser pointer. All oral presenters are requested to come to Speaker Check-In with their memory devices or laptops to confirm their presentation display settings.

### Poster Setup Instructions

Convention Center, Hall B2 (Ground Level)

Monday 10 August

Setup: 10:00 am to 4:30 pm, Session: 5:30 pm to 7:30 pm

Wednesday 12 August

Setup: 10:00 am to 4:30 pm, Session: 5:30 pm to 7:30 pm

Poster presenters must set up their posters between 10:00 am and 4:30 pm on the day of their assigned presentation.

- Paper numbers will be posted on the poster boards in numerical order; please find your paper number and post your poster in the designated space.
- A poster author or coauthor is required to stand by the poster during the scheduled poster session to answer questions from attendees.
- Presenters who have not placed their papers on their assigned board by 4:30 pm on the day of their presentation will be considered a "no show" and their manuscript will not be published.
- Presenters must remove their posters immediately after the poster session. Posters not removed will be considered unwanted and will be discarded. SPIE assumes no responsibility for posters left up after the end of each poster session.

## ONSITE SERVICES

### Internet Access

#### WIRED INTERNET ACCESS

Convention Center, Ballroom 6 Lobby (Upper Level)

Complimentary wired Internet access is available; attendees can hook up their laptops or use provided workstations.

#### WIFI

Upper Level Lobbies

Complimentary wireless access is also available; instructions will be posted onsite.

#### SPIE CONFERENCE AND EXHIBITION APP

On your Smart Phone (iPhone, Android)

Search and browse the program, special events, participants, exhibitors, courses, and more.

### SPIE Bookstore

Convention Center, Sails Pavilion (Upper Level)

The SPIE Bookstore is your source for the latest SPIE Press Books, Proceedings, and Education and Professional Development materials. Become an SPIE member, explore the Digital Library, take home a free SPIE poster, or buy a souvenir (tie, t-shirt, educational toys, and more).

### SPIE Education Services

Convention Center, Sails Pavilion (Upper Level)

Browse course offerings and the other education services available: SPIE courses, videos, and CDs as well as customized in-company courses.

### SPIE Press Room

Convention Center, Sails Pavilion (Upper Level)

Open during Registration hours

For Registered Press only. The Press Room provides meeting space, refreshments, access to exhibitor press releases, and Internet connections. Press are urged to register before the meeting by emailing name, contact information, and name of publication to [media@spie.org](mailto:media@spie.org). Preregistration closes approximately 10 days before the start of the event.

### SPIE Luggage and Coat Check

Convention Center, Hall A Lobby (Ground Level)

Sunday and Monday · 7:15 am to 6:00 pm

Tuesday and Wednesday · 7:30 am to 6:00 pm

Thursday · 7:45 am to 6:00 pm

Complimentary luggage, package, and coat storage are available. Please note hours; no late pickup available.

### FedEx Kinko's

Convention Center, Hall B Lobby (Ground Level)

Monday through Thursday

Services include photocopying, faxing, printing services, and shipping. Office supplies are also available. Phone 619-525-5450

### Restaurant and City Information

Convention Center, Hall B2 (Ground Level)

10:00 am to 6:00 pm

Services include sightseeing, shopping, and restaurant information.

### Child Care Services

Marion's Childcare, Inc.

Email: [amy@hotelchildcare.com](mailto:amy@hotelchildcare.com)

Telephone: 619-303-4379, or 888-891-5029

• NOTE: SPIE does not imply an endorsement nor recommendation of these services. They are provided on an "information only" basis for your further analysis and decision. Other services may be available.

# GENERAL INFORMATION

## Urgent Message Line

An urgent message line is available during registration hours: 619-525-6200

## Lost and Found

Cashier, Convention Center, Sails Pavilion (Upper Level)

Open during Registration Hours

Found items will be kept at Cashier for the duration of the meeting. At the end of the meeting, all found items will be turned over to the San Diego Convention Center Security, lost and found hotline: 619-525-5407.

## FOOD AND BEVERAGE SERVICES

### Coffee Breaks

Sunday and Monday  
Upper Level Lobby

Tuesday and Wednesday  
Exhibition Hall, Sails Pavilion (Upper Level)

Thursday · 10:00 to 11:00 am  
Exhibition Hall, Sails Pavilion (Upper Level)

Thursday · 3:00 to 4:00 pm  
Upper Level Lobby

Complimentary coffee will be served twice daily, at 10:00 am and 3:00 pm. Check individual conference listings for exact times and locations.

### Food and Refreshments for Purchase

Upper Level Lobby Service Carts

Sunday through Thursday · 9:00 am to 3:00 pm

Food Outlet – Exhibition Hall, Sails Pavilion (Upper Level)

Tuesday through Thursday · 11:00 am to 2:00 pm

Hot and cold snacks, hot entrees, deli sandwiches, salads, and pastries are available for purchase. Cash and credit cards accepted.

### Desserts

Complimentary tickets for dessert snacks are included in course and conference attendee registration packets.

## TRAVEL

SPIE Optics + Photonics will be held at the San Diego Convention Center, 111 West Harbor Drive, San Diego, California, 92101.

With the countless number of things to see, do, taste and experience in San Diego, determining how to get around is as important as planning your itinerary. San Diego offers plenty of options for public transportation, be it by trolley, train, bus, taxi, ferry, or even a limousine. The easiest option is to rent a car, so you can roam freely through the vast and various San Diego regions. But if you're looking to save a buck or be eco-friendly, plan to make the most of San Diego's convenient and easy public transport options.

Learn more at [www.sandiego.org](http://www.sandiego.org)

### Taxi

Taxi service from the San Diego Airport to the downtown hotels is approximately \$12 - \$16 depending on traffic.

### Shuttles

#### SuperShuttle

SPIE Optics + Photonics attendees will receive a \$2 discount one way with an advance reservation. Make a reservation online or by phone by calling 1-800-258-3826.

#### Bayfront Shuttle

Bayfront Shuttle - \$1 - Hop on the Big Bay Shuttle along the bay with stops at various hotels, Seaport Village, Navy Pier, Maritime Museum.

### San Diego Trolley

Trolley cars travel above ground on light rail lines every 15 minutes. Learn more at [www.sdcommute.com](http://www.sdcommute.com)

### Car Rental

Hertz Car Rental is the official car rental agency for SPIE Optics + Photonics. To reserve a car, identify yourself as a conference attendee using the Hertz Meeting Code CV# 029B0020. When booking from International Hertz locations, the CV # must be entered with the letters CV before the number, i.e. CV029B0019.

- Reserve online at [www.Hertz.com](http://www.Hertz.com)
- In the United States call 1-800-654-2240
- In Canada call 1-800-263-0600, or 1-416-620-9620 in Toronto
- In Europe and Asia call a Hertz Reservation Center or travel agent
- Outside of these areas call 1-405-749-4434

## SPIE EVENT POLICIES

# Acceptance of Policies and Registration Conditions

The following Policies and Conditions apply to all SPIE Events. As a condition of registration, you will be required to acknowledge and accept the SPIE Registration Policies and Conditions contained herein.

### Granting Attendee Registration and Admission

SPIE, or their officially designated event management, in their sole discretion, reserves the right to accept or decline an individual's registration for an event. Further, SPIE, or event management, reserves the right to prohibit entry or remove any individual whether registered or not, be they attendees, exhibitors, representatives, or vendors, who in their sole opinion are not, or whose conduct is not, in keeping with the character and purpose of the event. Without limiting the foregoing, SPIE and event management reserve the right to remove or refuse entry to any attendee, exhibitor, representative, or vendor who has registered or gained access under false pretenses, provided false information, or for any other reason whatsoever that they deem is cause under the circumstances.

### Misconduct Policy

SPIE is a professional, not-for-profit society committed to providing valuable conference and exhibition experiences. SPIE is dedicated to equal opportunity and treatment for all its members and meeting attendees. Attendees are expected to be respectful to other attendees, SPIE staff, and contractors. Harassment and other misconduct will not be tolerated; violators will be asked to leave the event.

### Identification

To verify registered participants and provide a measure of security, SPIE will ask attendees to present a government-issued Photo ID at registration to collect registration materials.

Individuals are not allowed to pick up badges for attendees other than themselves. Further, attendees may not have some other person participate in their place at any conference-related activity. Such other individuals will be required to register on their own behalf to participate.

### Capture and Use of a Person's Image

By registering for an SPIE event, I grant full permission to SPIE to capture, store, use, and/or reproduce my image or likeness by any audio and/or visual recording technique (including electronic/digital photographs or videos), and create derivative works of these images and recordings in any SPIE media now known or later developed, for any legitimate SPIE marketing or promotional purpose.

By registering for an SPIE event, I waive any right to inspect or approve the use of the images or recordings or of any written copy. I also waive any right to royalties or other compensation arising from or related to the use of the images, recordings, or materials. By registering, I release, defend, indemnify and hold harmless SPIE from and against any claims, damages or liability arising from or related to the use of the images, recordings or materials, including but not limited to claims of defamation, invasion of privacy, or rights of publicity or copyright infringement, or any misuse, distortion, blurring, alteration, optical illusion or use in composite form that may occur or be produced in taking, processing, reduction or production of the finished product, its publication or distribution.

### Payment Method

Registrants for paid elements of the event, who do not provide a method of payment, will not be able to complete their registration. Individuals with incomplete registrations will not be able to attend the conference until payment has been made. SPIE accepts VISA, MasterCard, American Express, Discover, Diner's Club, checks and wire transfers. Onsite registrations can also pay with Cash.

### Authors/Coauthors

By submitting an abstract, you agree to the following conditions:

- An author or coauthor (including keynote, invited, and solicited speakers) will register at the author registration rate, attend the meeting, and make the presentation as scheduled.
- A full-length manuscript (minimum 6 pages) for any accepted oral or poster presentation will be submitted for publication in the SPIE Digital Library, printed conference Proceedings, and CD. (Some SPIE events have other requirements that the author is made aware of at the time of submission.)
- Only papers presented at the conference and received according to publication guidelines and timelines will be published in the conference Proceedings and SPIE Digital Library (or via the requirements of that event).

### Audio, Video, Digital Recording Policy

Conferences, courses, and poster sessions: For copyright reasons, recordings of any kind are prohibited without prior written consent of the presenter or instructor. Attendees may not capture or use the materials presented in any meeting/course room or in course notes on display without written permission. Consent forms are available at Speaker Check-In. Individuals not complying with this policy will be asked to leave a given session and/or asked to surrender their recording media.

**EXHIBITION HALL:** For security and courtesy reasons, recordings of any kind are prohibited unless one has explicit permission from on-site company representatives. Individuals not complying with this policy will be asked to surrender their recording media and to leave the exhibition hall.

Your registration signifies your agreement to be photographed or videotaped by SPIE in the course of normal business. Such photos and video may be used in SPIE marketing materials or other SPIE promotional items.

## Laser Pointer Safety Information/Policy

SPIE supplies tested and safety-approved laser pointers for all conference meeting rooms. For safety reasons, SPIE requests that presenters use provided laser pointers.

Use of a personal laser pointer represents user's acceptance of liability for use of a non-SPIE-supplied laser pointer. If you choose to use your own laser pointer, it must be tested to ensure <5 mW power output. Laser pointers in Class II and IIIa (<5mW) are eye safe if power output is correct, but output must be verified because manufacturer labeling may not match actual output. Come to Speaker Check-In and test your laser pointer on our power meter. You are required to sign a waiver releasing SPIE of any liability for use of potentially non-safe, personal laser pointers. Misuse of any laser pointer can lead to eye damage.

## Access to Technical and Networking Events

Persons under the age of 18 including babies, carried or in strollers, and toddlers are not allowed in technical or networking events. Anyone 18 or older must register as an attendee. All technical and networking events require a valid conference badge for admission.

## Underage Persons on Exhibition Floor Policy

For safety and insurance reasons:

- No persons under the age of 18 will be allowed in the exhibition area during move-in and move-out.
- Children 14 and older, accompanied by an adult, will be allowed in the exhibition area during open exhibition hours only.
- All children younger than 14, including babies in strollers and toddlers, are not allowed in the exhibition area at any time.

## Unauthorized Solicitation Policy

Unauthorized solicitation in the Exhibition Hall is prohibited. Any non-exhibiting manufacturer or supplier observed to be distributing information or soliciting business in the aisles, or in another company's booth, will be asked to leave immediately.

## Unsecured Items Policy

Personal belongings should not be left unattended in meeting rooms or public areas. Unattended items are subject to removal by security. SPIE is not responsible for items left unattended.

## Wireless Internet Service Policy

At SPIE events where wireless is included with your registration, SPIE provides wireless access for attendees during the conference and exhibition but cannot guarantee full coverage in all locations, all of the time. Please be respectful of your time and usage so that all attendees are able to access the internet.

Excessive usage (e.g., streaming video, gaming, multiple devices) reduces bandwidth and increases cost for all attendees. No routers may be attached to the network. Properly secure your computer before accessing the public wireless network. Failure to do so may allow unauthorized access to your laptop as well as potentially introduce viruses to your computer and/or presentation. SPIE is not responsible for computer viruses or other computer damage.

## Mobile Phones and Related Devices Policy

Mobile phones, tablets, laptops, pagers, and any similar electronic devices should be silenced during conference sessions. Please exit the conference room before answering or beginning a phone conversation.

## Smoking

For the health and consideration of all attendees, smoking, including e-cigarettes, is not permitted at any event elements, such as but not limited to: plenaries, conferences, workshops, courses, poster sessions, hosted meal functions, receptions, and in the exhibit hall. Most facilities also prohibit smoking and e-cigarettes in all or specific areas. Attendees should obey any signs preventing or authorizing smoking in specified locations.

## Hold Harmless

Attendee agrees to release and hold harmless SPIE from any and all claims, demands, and causes of action arising out of or relating to your participation in the event you are registering to participate in and use of any associated facilities or hotels.

## Event Cancellation

If for some unforeseen reason SPIE should have to cancel the event, registration fees processed will be refunded to registrants. Registrants will be responsible for cancellation of travel arrangements or housing reservations and the applicable fees.

## Confidential Reporting of Unethical or Inappropriate Behavior

SPIE is an organization with strong values of responsibility and integrity. Our Ethics Statement and Code of Professional Conduct contain general guidelines for conducting business with the highest standards of ethics. SPIE has established a confidential reporting system for staff & other stakeholders to raise concerns about possible unethical or inappropriate behavior within our community. Complaints may be filed by phone or through the website, and, if preferred, may be made anonymously. The web address is [www.SPIE.ethicspoint.com](http://www.SPIE.ethicspoint.com) and the toll free hotline number is 1-888-818-6898.

## SPIE INTERNATIONAL HEADQUARTERS

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Fax: +44 29 2089 4750  
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# Proceedings.

Full paid registration includes your choice of Proceedings of SPIE. See the attached list for product order numbers for proceedings options from this meeting. You will need a product order number when you make your proceedings choice on the registration form.

## Available as part of registration:

**Symposium CD Collection**—a searchable CD of one or multiple proceedings volumes. Available within 8 weeks of the meeting.

**Symposium Online Collection**—online access to multiple related proceedings volumes via the SPIE Digital Library. Available as papers are published.

**Printed Proceedings Volume**—a printed book of a single proceedings volume. Available 6 weeks after the meeting.

**Online Proceedings Volume**—online access to a single proceedings volume via the SPIE Digital Library. Available as papers are published.

You may also purchase additional proceedings products beyond what you choose with your registration plan. (**Note: Online proceedings volumes not available for separate purchase.**) See below for pricing and product order numbers.

## Accessing Online Proceedings

Access to purchased online proceedings will be ongoing using your SPIE login credentials; papers are available as they are published.

To access your purchased proceedings:

- Go to <https://spiedigitallibrary.org> and sign in with your SPIE account credentials. If you do not have an SPIE account, create one using the email address you used to register for the conference.
- Once you have signed in, click the My Account link at the top of the page. You can access your proceedings in the My Conference Proceedings tab.

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Should you need any assistance, please contact SPIE:

**Email:** SPIEDSupport@spie.org

**Phone (North America):** +1 888 902 0894

**Phone (Rest of World):** +1 360 685 5580

## Proceedings Collections

Online collections are not available for separate purchase.

		Collection Title/Included Volumes (See next page for volume titles and editors)	Price for CD separate purchase
Symposium CD Collection	Symposium Online Collection		
CDS577	DLC577	<b>Optics and Photonics 2015: Nanoscience and Engineering</b> <i>Includes Proceedings Vols. 9544, 9545, 9546, 9547, 9548, 9549, 9550, 9551, 9552, 9553, 9554, 9555, 9556, 9557, 9558, 9560, and 9572</i>	\$155
CDS578	DLC578	<b>Optics and Photonics 2015: Sustainable Energy</b> <i>Includes Proceedings Vols. 9559, 9560, 9561, 9562, 9563, 9567, and 9572</i>	\$155
CDS579	DLC579	<b>Optics and Photonics 2015: Organic Photonics and Electronics</b> <i>Includes Proceedings Vols. 9564, 9565, 9566, 9567, 9568, and 9569</i>	\$155
CDS580	DLC580	<b>Optics and Photonics 2015: Illumination Engineering; Optomechanics and Optical Manufacturing; Optical Design and System Engineering</b> <i>Includes Proceedings Vols. 9570, 9571, 9572, 9573, 9574, 9575, 9576, 9577, 9578, 9579, 9580, 9581, 9582, and 9583</i>	\$155
CDS581	DLC581	<b>Optics and Photonics 2015: Photonic Devices and Applications</b> <i>Includes Proceedings Vols. 9571, 9584, 9585, 9586, 9587, and 9609</i>	\$155

		Collection Title/Included Volumes (See next page for volume titles and editors)	Price for CD separate purchase
Symposium CD Collection	Symposium Online Collection		
CDS582	DLC582	<b>Optics and Photonics 2015: X-Ray, Gamma-Ray, and Particle Technologies</b> <i>Includes Proceedings Vols. 9588, 9589, 9590, 9591, 9592, 9593, 9594, and 9595</i>	\$155
CDS583	DLC583	<b>Optics and Photonics 2015: Signal, Image, and Data Processing</b> <i>Includes Proceedings Vols. 9596, 9597, 9598, 9599, and 9600</i>	\$155
CDS584	DLC584	<b>Optics and Photonics 2015: Astronomical Optics and Instrumentation</b> <i>Includes Proceedings Vols. 9601, 9602, 9603, 9604, 9605, and 9606</i>	\$155
CDS585	DLC585	<b>Optics and Photonics 2015: Remote Sensing; Atmospheric and Space Optical Systems</b> <i>Includes Proceedings Vols. 9607, 9608, 9609, 9610, 9611, 9612, 9613, 9614, 9615, 9616, and 9617</i>	\$155

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## Single Proceedings Volumes from Nanoscience and Engineering

Product Order Number	Printed Proceedings Volume	Online Proceedings Volume	Volume Title/Volume Editors	Price for print volume separate purchase
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9545	DL9545		<b>Nanophotonic Materials XII</b> <i>Stefano Cabrini, Gilles Léonard, Adam M. Schwartzberg, Taleb Mokari</i>	\$60
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9556	DL9556		<b>Nanoengineering: Fabrication, Properties, Optics, and Devices XII</b> <i>Eva M. Campo, Elizabeth A. Dobisz, Louay A. Eldada</i>	\$90
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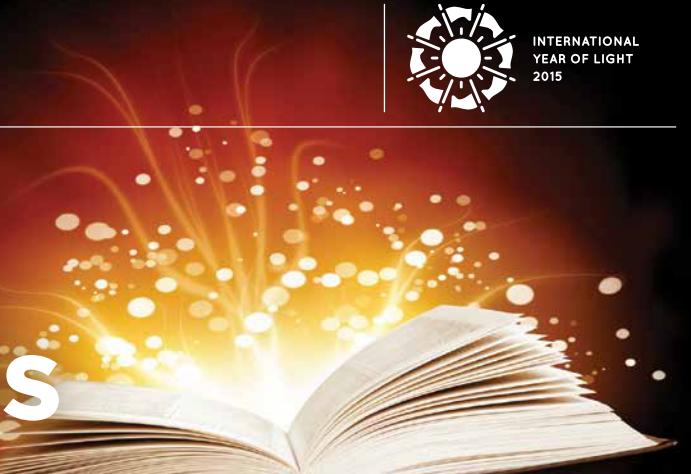
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Printed Proceedings Volume	Online Proceedings Volume		
9570	DL9570	The Nature of Light: What are Photons? VI <i>Chandrasekhar Roychoudhuri, Al F. Kracklauer, Hans De Raedt</i>	\$80
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9595	DL9595	Radiation Detectors: Systems and Applications XVI <i>Gary Grim, H. Bradford Barber</i>	\$53
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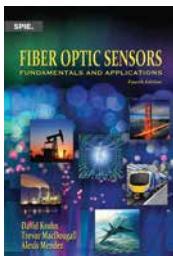


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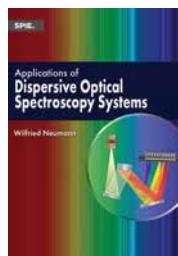
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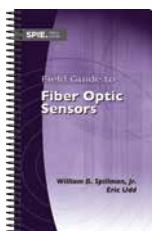
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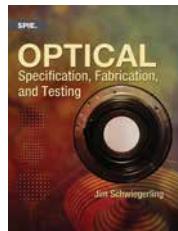
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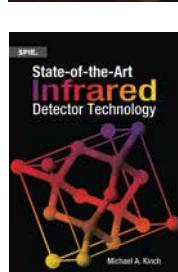
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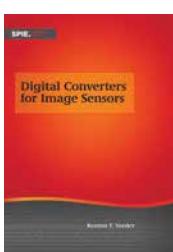
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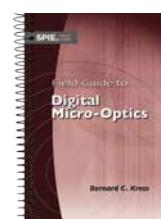
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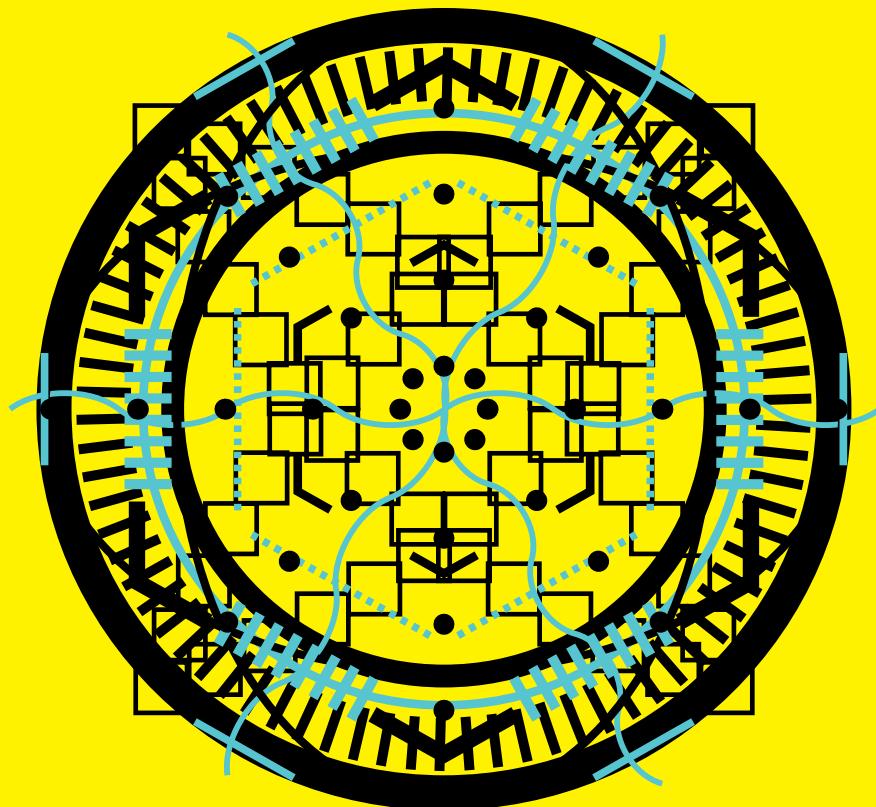
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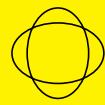
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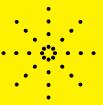
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