Curriculum Vitae

HSUEH-CHIA CHANG www.nd.edu/~changlab

Education	B.S.	Chemical Engineering	California Institute of Technology	June 1976
	Ph.D.	Chemical Engineering	Princeton University	June 1980

Research: My early research was on interfacial fluid dynamics, particularly wave dynamics on falling films. I received the Frenkiel Award from the American Physical Society for this work. I developed new mathematical tools (weighted spectral stability theory and low-dimensional projection of solitary wave dynamics) to decipher the various wave transitions on a falling film, beyond the first transition described by the classical linear theory. After finishing a book on falling-film waves in 2002, I reoriented my research towards diagnostic biochips by applying my knowledge in fluid mechanics--- and my skills in matched asymptotics to decipher the coupling between different time and spatial scales. My analysis offered insight into non-equilibrium electrokinetic phenomena and led to the discovery of new ones. I utilized the unique features of non-equilibrium electrokinetics (analyte concentration, surface charge-sensitive electro-convective instability, singular Maxwell pressure at corners/tips, water splitting, pH control etc) to invent ionic circuits for molecular diagnostics. I recruited postdocs and collaborators from Chemistry and Biology to complement my skillset. I also leveraged my diverse cultural background (Taiwan, Singapore, Malaysia and US) to engage with the growing world-wide biochip community, particularly Asian communities with semiconductor chip manufacturing know-how.

I believe that low-cost point-of-care (POC) biochips will transform health care within the next decade. I have introduced several key DC and AC electrokinetic technologies for such integrated biochips. The technologies allow cell/pathogen/exosome extraction/lysing and identification/quantification of their molecular cargo, without tedious lab-bound sample prep. Sixteen of these technologies have been patented, with 5 more pending. Five have been licensed to startups. I served as the Chief Scientific Advisor of FCubed LLC, which is developing a food safety technology. I have recently cofounded a startup, Aopia Biosciences, to commercialize my cancer screening technologies and I am its interim CTO. I have written well-cited reviews and coauthored a seminal 2009 book on electrokinetics. I collaborate with several cancer researchers (USC, Vanderbilt, Harper), tropical disease experts (Naval Med Lab), tissue culture experts (Advanced Regenerative Manufacturing Institute) and food scientists (Purdue). I also work with multinationals (IBM, Far Eastern) and startups (F Cubed, AgnDx, ImpeDx, Aopia) to develop manufacturing and commercialization strategies.

Contribution to Community and University: Among my approximately 30 Postdoc and 50 PhD students, more than 30 have embarked on academic careers as tenure-track professors at Chemical Engineering, Bioengineering, Mechanical Engineering, Electrical Engineering, Food Science, Chemistry departments in 5 continents. My first PhD (Mobolaji Aluko) is an African American and was the Chemical Engineering Chair at Howard University. Three of them (Jason Keith, Zilin Chen and Leslie Yeo) hold endowed chairs, two (Jason Keith and Adrienne Minerick) are Deans and five (Jayne Wu, Dmitry Kopelevich, Adrienne Minerick, Zach Gagnon and Sagnik Basuray) were awarded the NSF Career Award. I am the founding editor of Biomicrofluidics, the first American Institute of Physics journal in biology/medicine. I was also an Associate Editor of SIAM J of Applied Math. My early career included a stint as the Department Chair (at 34) during which I hired the first woman engineering faculty to Notre Dame (now member of NAE) and doubled the department faculty size and research expenditure. I have 16 US patents and 5 more pending, 5 of them have been licensed to 5 startups. The South Bend startups have hired more than 25 employees and have attracted talents like the former VPs of Roche Diagnostics and Honeywell Diagnostics to the area. I have raised funds and organized international microfluidics conferences in Hong Kong, Singapore, Dalian, Beijing, Hobart and Notre Dame. I have delivered over 200 lectures in 5 continents.

Professional Appointments

1980-1983	Assistant Professor, Chemical Engineering, University of California, Santa Barbara
1983-1984	Associate Professor, Chemical Engineering, University of California, Santa Barbara
1984-1987	Associate Professor, Chemical Engineering, University of Houston
1985-1990	Presidential Young Investigator, National Science Foundation
1987-1998	Professor, Chemical Engineering, University of Notre Dame
1993	Senior Visitor, Dept of App. Math and Theoretical Physics, Cambridge University
1989-1995	Chairman, Chemical Engineering, University of Notre Dame
1997-	Fellow of the American Physical Society, Hydrodynamics Division.
1998-	Bayer Corporation Endowed Professor of Engineering, University of Notre Dame
2003-	Director, Center for Microfluidics and Medical Diagnostic
2007-2018	Editor, Biomicrofluidics, American Institute of Physics
2010-	Chief Scientific Advisor, FCubed LLC.
2010-2014	Courtesy Appointment at National Tsinghua University, Taiwan
2011	United Kingdom Royal Society of Engineering Distinguished Professor, Imperial College
2020-	Interim Chief Technology Officer, Aopia Biosciences.

Honors and Awards

1978	Wallace Memorial Honor Award, Princeton University
1980	Regent's Junior Faculty Award, University of California, Santa Barbara
1985	Presidential Young Investigator Award, National Science Foundation
1988	Colburn Lecture, University of Delaware
1990	Sigma Xi Outstanding Research Award, University of Notre Dame
1991	Francois N. Frenkiel Award, Fluid Dynamics Division of American Physical Society
1997	Fellow of the American Physical Society
2002	Corrsin Hydrodynamics Lecture, Johns Hopkins
2011	Distinguished Visiting Fellow Award, Royal Society of Engineering, UK
2013	1st Source Bank Outstanding Commercialization Award, University of Notre Dame
2018	Distinguished Lecture, Boston University
2019	Lifetime Achievement Award, American Electrophoresis Society
2020	Fellow of the National Academy of Inventors

Key Contributions to Microfluidics and Electrokinetics

My book and review articles on electrokinetics and microfluidics are:

1. Chang, H.-C. and Yeo, L. (2009) Electrokinetically Driven Microfluidics and Nanofluidics, Cambridge Press.
2. Yeo, L. Y., Chang, H.-C., Chan, P. P. Y. and Friend, J. R. (2011). Microfluidic Devices for Bioapplications, *Small,* **7**, 12-48.
3. Chang, H.-C., Yossifon, Y. and Demekhin, E. A. (2012). Nanoscale Electrokinetics and Microvortices: How Hydrodynamics Affects Nanofluidic Ion Flux, *Annual Review of Fluid Mechanics*, **44**, 401-426.
4. Slouka, Z., Senapati, S. and Chang, H.-C. (2014). Microfluidic Systems with Ion-Selective Membranes", *Annual Review of Analytical Chemistry*, **7**, 317-335.
5. Egatz-Gomez, A., Wang, C., Klacsmann, F., Pan, Z., Marczak, S., Wang, Y., Sun, G., Senapati,S. and Chang, H.-C., “Future Microfluidic and Nanofluidic Platforms for Nucleic Acid Biopsy in Precision Medicine”, *Biomicrofluidics*, 10, 032902(2016).

Notable contributions and publications:

1. **Droplet Dynamics**. My early publications focused on the fundamentals of interfacial dynamics. The approach is to use matched asymptotics to provide universal correlations for some salient properties. Those relevant to modern biotechnologies like digital/emulsion PCR and droplet microfluidics are:
    a. Ratulowski, J. and Chang, H.-C. (1989) Transport of gas bubbles in capillaries, *The Physics of Fluids*, 1, 1642-1655.
    b. Ratulowski, J. and Chang, H.-C. (1990) The effect of surfactant transport on the motion of gas bubbles in capillaries, *Journal of Fluid Mech*., 210, 303-328.
    c. Chang, H.-C., Demekhin, E. A. and Kalaidin, E. (1999) Iterated stretching of viscoelastic jets, *Phys. Fluids*, 11, 1717-1737.
    d. Takhistov, P., Indeikina A. and Chang, H.-C. (2002) Electrokinetic displacement of air bubbles In microchannels, *Phys of Fluids*, 14, 1-14.
    e. Yeo, L., Lastochkin, D., Wang, S.-C. and Chang, H.-C. (2004) A New ac Electrospray Mechanism by Maxwell-Wagner Polarization and Capillary Resonance, *Phys Rev Lett*, 92, 133902-133904.
    f. Chetwani, N., Maheshwari, S. and Chang, H.-C., "Universal Cone Angle of ac Electrosprays due to net charge entrainment", *Phys Rev Lett*., 101, 204501 (2008).

2. **Electrokinetics due to ion-selective membranes**. I explored several new electrokinetic phenomena relating to concentration polarization, space charge creation and ionization that eventually led to the development of microfluidic pretreatment and sensing technologies with ion-selective membranes. I was the first to reveal the mechanism for the over-limiting current and used it to create a new molecular biosensor. I was the first to capture the mechanism for ion current rectification due to asymmetry.
    a. Ben, Y. and Chang, H.-C. (2002) Nonlinear Smoluchowski Slip Velocity and Vortex Generation, *J. Fluid Mech.*, 461, 229-238.
    b. Chen, Z., Wang, P. and Chang, H.-C. (2005) An electro-osmotic micropump based on monolithic silica for micro-flow analyses and electro-sprays", *Anal. Bioanal Chem*, 382, 817-824.
    c. Yossifon, G. and Chang, H.-C. (2008) Selection of Nonequilibrium overlimiting currents: universal depletion layer formation dynamics and vortex instability, *Phys Rev Lett*., 101, 254501.
    d. Cheng, L.-J. and Chang, H.-C. (2011) Microscale pH actuation by splitting water, *Biomicrofluidics*, 5, 046502.
    e. Yan, Y., Wang, L., Xue, J., and Chang, H.-C. (2013) Ion Current Rectification in Conic Nanopores: Nonequilibrium Ion Transport Biased by Ion Selectivity and Spatial Asymmetry, *J Chem. Phys.*, 138, 044706.
    f. Pan, Z., Wang, C., Li, M. and Chang, H.-C., Universal Scaling of Robust Thermal Hotspot and Ionic Current Enhancement by Focused Ohmic Heating in a Conic Nanopore, *Physical Review Letters*, 117, 134301(2016).

3. **Dielectrophoretic cell separation and carbon nanotube assembly**. I invented several dielectrophoretic cell separation technologies that led to the first integrated chip for multi-cell sorting. Dielectrophoretic assembly of CNTs led to a patented technology for DNA sensing. It removes the need for CNT growth in reactors, which is the main manufacturing obstacle to CNT sensors.
    a. Cheng, I-F., Chang, H.-C., Hou, D. and Chang, H.-C. (2007) An integrated dielectrophoretic chip for continuous bioparticle filtering, focusing, trapping and detecting, *Biomicrofluidics*, 1, 021503.
    b. Basuray, S., Senapati, S., Ajian, A., Mahon, A. R. and Chang, H.-C. (2009) Shear and AC field enhanced Carbon Nanotube impedance assay for rapid, sensitive and mismatch-discriminating DNA hybridization", *ACS Nano*, 3, 1823-1830.
    c. Cheng, I-F., Froude, V. E., Zhu, Y., Chang, H.-C. and Chang, H.-C. (2009), A Continuous High-Throughput Bioparticle Sorter Based on 3D Traveling-Wave Dielectrophoresis, *Lab-on-a-Chip*, **9**, 3193.
    d. Gagnon, Z., Mazur, J. and Chang, H.-C. (2010) Integrated AC electrokinetic cell separation in a closed-loop device, *Lab-on-a-Chip*, 10, 718-726.
    e. Kuczenski, R. S., Chang, H.-C.* and Revzin, A. (2011) Dielectrophorestic Device for Continuous Sorting of Escherichia coli from blood cells, *Biomicrofluidics*, 5, 032005.

f. Li, D., Wang, C., Sun, G., Senapati, S. and Chang, H.-C. (2017) A shear-enhanced CNT-assembly nanosensor platform for ultra-sensitive and selective protein sensing, *Biosensors and Bioelectronics*, 97, 143-152.

4. **AC Electro-Spraying and Electrospinning**. Realizing that AC electrokinetics can reduce charge build up during electrospraying and suppress the whipping instability during electrospinning, I invented several AC electrokinetic technologies for generating nanoaerosol, nanofibers and nanoemulsion. Some of these led to patented technologies for "soft ionization" AC electrospray mass spectrometry, material synthesis, digital droplet PCR and conformal cell encapsulation:
    a. Yeo, L. Y., Gagnon, Z and Chang, H.-C. (2005) AC Electrospray Biomaterials Synthesis, *Biomaterials*, 26, 6122-6128.
    b. Maheshwari, S. and Chang, H.-C. (2009) Assembly of multi-stranded nanofiber threads through ac electrospinning", *Adv Mater.*, 21,349-354.
    c. Chetwani, N., Cassou, C. A., Go, D. B. and Chang, H.-C. (2010) High-Frequency AC Electrospray Ionization for Mass Spectrometry of Biomolecules, *J Am Soc Mass Spect*, 21, 1852.
    d. Ho, J., Tan, M. K., Go, D. B., Friend, J. R. and Chang, H.-C. (2011) A Paper-Based Microfluidic Surface Acoustic Wave Sample Delivery and Ionization Source for Rapid and Sensitive Ambient Mass Spectrometry", *Anal. Chem.*, 83, 3260-3266.
    e. Pan, Z., Men, Y., Senapati, S. and Chang, H.-C. (2018) Immersed AC Electrospray (iACE) for monodispersed aqueous droplet generation", *Biomicrofluidics*, 12, 044113. (Editor's Pick)
    f. Pan, Z., Bui, L., V. Yadav, Fan, F., Chang, H.-C.*, HanjayaPutra, D.* (2021) Conformal Single Cell Hydrogel Coating with Electrically Induced Tip Streaming at an AC Cone, *Biomaterials Science* , 9, 3284-2392

5. **Integrated ionic/fluidic circuits for multi-plex molecular/nanocarrier fractionation and quantification**. Currently, I am focusing on integrating these individual phenomena and components into integrated diagnostic biochips with embedded ionic circuitry to concentrate, purify and quantify exosomes and molecules. We have also embarked on large-scale manufacturing of these integrated biochips.
    a. Taller, D., Richards K., Slouka, S., Senapati, S., Hill, R., Go, D. B. and Chang, H.-C. (2015) On-Chip Surface Acoustic Wave Lysis and ion-exchange membrane detection of exosomal RNA for pancreatic cancer study and diagnosis, *LabChip* , 15, 1656-1666. (Cover Article)
    b. Sun, G., Slouka, Z. and Chang, H.-C. (2015) Fluidic based ion memristors and ion latches", *Small*, 11, 5206-5213.
    c. Ramshani, Z., Zhang, C., Richards, K., Chen, L., Xu, G., Stiles, B., Hill, R., Senapati, S., Go, D.B. and Chang, H.-C. (2019) Extracellular microRNA quantification from plasma using an integrated microfluidic device, *Comm. Biology*, 2(1), 189-197.
    d. Zhang, C., Sun, G., Senapati, S. and Chang, H.-C. (2019) A bifurcated continuous field-flow fractionation (BCFFF) chip for high-yield and high-throughput nucleic acid extraction and purification", *LabChip*, 19, 3853-3861.
    e. Yin, Z., Ramshani, Z., Waggoner, J. J., Pinsky, B. A., Senapati, S. and Chang, H.-C. (2020) A Non-Optical Multiplexed PCR Diagnostics Platform for Serotype Specific Detection of Dengue Virus, *Sensors and Actuators B: Chemical*, 310, 127854.
    f. Wang, C., Sensale, S., Pan, Z., Senapati, S. and Chang-H.-C.(2021) Slowing Down DNA Translocation through Solid-State Nanopores by Edge-Field Leakage, *Nature Communications* , 12, 140.

Research Funding: Over $25 million from NSF, NIH, DoD, DoE, NASA, IBM, Far Eastern etc.

Student Placement :

Postdocs : 28 total including

Leslie Yeo, Distinguished Professor, Chemical Engineering, RMIT, Australia
Gilad Yossifon, Professor, Mechanical Engineering, University of Tel Aviv, Israel

Zilin Chen, Luojia Professor, Pharmacy, Wuhan University, China
Jayne Wu, Professor, Electrical Engineering, University of Tennessee
Larry Cheng, Associate Professor, Electrical Engineering, Oregon State

PhD students: 50 total including

Mobolaji Aluko, Vice-Chancellor (President), Federal University,Nigeria
Serafim Kalliadasis, Professor of Fluid Mechanics, Chemical Engineering, Imperial College
Jason Keith, Deavenport Professor, Chemical Engineering and Engineering Dean, Mississippi State
Gaurav Arya, Professor, Mechanical Engineering, Duke University.
Adrienne Minerick, Professor, Chemical Engineering and Dean, Michigan Tech.
Zach Gagnon, Associate Professor, Chemical Engineering, Texas A & M.
Diana Hou, Manager in charge of Vaccine Production, Merck.
Sagnik Basuray, Associate Professor, Chemical Engineering, NJIT.
Emily Yunshan Wang, Assistant Professor, Chemical Engineering, Utah.

Complete CV

Plenary and Keynote Lectureships

Invited General Lecture at International Union of Theoretical and Applied Mechanics Symposium on Nonlinear Instability of Nonparallel Flows, Potsdam, 1993

Invited General Lecture at International Union of Theoretical and Applied Mechanics Symposium on Structure and Dynamics of Nonlinear Waves in Liquids, Hannover, Germany, 1994.

Invited General Lecture at International Union of Theoretical and Applied Mechanics. Nonlinear Singularities in Deformation and Flow(Haifa, 1997).

Keynote Lecture, Second Joint US/China Chemical Engineering Conference, Beijing, May 1997.

Keynote Lecture, 13th International Congress of Chemical and Process Engineering CHISA'98, Prague, August 1998.

Keynote Speaker, ASME International Conference on Micro-channels and Mini-channels, Rochester, June 2004; Pohang, June 2009.

Keynote Speaker, Biomedical Engineering Society 2004 Annual Symposium, Tainan, Taiwan, December, 2004.

Keynote Speaker, Indiana Biosensor Symposium, Indianapolis, April, 2005.

Keynote Lecturer, The Bianchi Session on Thin Films of Soft Matter, International Center for Mechanical Sciences, Udine, Italy, July 2005.

Keynote Lecturer, Annual Conference of the Society of the Korean Analytical Science and Technology, Mokpo, Korea, May, 2006.

Keynote Lecture, Advances in Microfluidics and Nanofluidics, Hong Kong, 2009; Singapore, 2011; Dalian, 2012; Notre Dame, 2013; Taipei, 2014; Beijing, 2015.

Keynote Lecturer, ACS Colloid and Interfacial Science Symposium, Columbia University, June 2009.

Keynote Lecture, ASME Mini/Micro/NanoChannels Conference, Pohang, Korea, June 2009.

Keynote Lecture, Asian-Pacific LabChip Conference, Shanghai, October 2009.

Invited Speaker, Workshop on Electrokinetics, IMA, University of Minnesota, Dec 2009.

Keynote Lecturer, Second ASME Micro/Nanoscale Heat/Mass Transfer International Conference, Jiaotung University, Shanghai, December 2009.

Plenary Lecture, Wave Phenomena IV, Edmonton, Canada, June 2010.

Invited Lecture, Phoresis Workshop, Pohang, Korea, September 2010.

Plenary Speaker, China-Japan-Korea Symposium on Analytical Chemistry,Wuhan 2010.

Plenary Speaker, Electrokinetics Workshop, Haifa, Israel, December 2010.

Keynote Speaker, AMN-APLOC, Singapore, January, 2011.

Plenary Speaker, Electrokinetics Workshop, Imperial College, London, 2011.

Invited Speaker, Electrokinetics Symposium, APS-DFD Annual Meeting, Baltimore, November 2011.

Keynote Speaker, International Conference of Applied Science, Opening of Applied Science Division Building, Academia Sinica, Taiwan, October, 2013.

Keynote Speaker, Foundations of NanoScience, Snowbird, Utah, April, 2014.

Invited Lecturer, Dielectrophoresis 2014, London, July 2014.

Keynote Speaker, China-German Optical Medical Devices Conference, Suzhou, Sept 18, 2014.

Keynote Speaker, Taiwan Institute of Chemical Engineers Annual Meeting, Taoyuan, Dec 13, 2014.

Plenary Speaker, 7th WACBE World Congress on Bioengineering, Singapore, July 6, 2015.

Keynote and Plenary Lectures: Select Bioscience, Microfluidics Congress San Diego, September 2015, 2016, 2017, 2018, 2019; March, Boston, 2017

Keynote Lecture, Bionics Center PhD Congress, Budapest, Hungary, November 2016.

Plenary Lecture, Advances in Pharmaceutical Advances, Wuhan, November 2017, 2019.

Chemical Engineers in Medicine Plenary Lecture, AIChE Annual Meeting, 2019.

Editorial Experience

Founding and Chief Editor of Biomicrofluidics of the American Institute of Physics (2006-2018). First AIP journal in medical/biological fields and first to be electronic only. Highest ranked journal in the ISI Fluids and Plasma Physics category. Founded and raised funds for an affiliated conference Advances in Microfluidics and Nanofluidics held at Hong Kong, Singapore, Dalian, Notre Dame, Taipei, Beijing, Singapore and Hobart.

Editorial board: Membrane, 2011-Present

Associate Editor: SIAM Journal of Applied Math, 2000 – 2009

Advisory Board of Acta Mechanica, 2003-2005

International Journal of Bifurcation and Chaos in Applied Sciences and Engineering, 1990 – 1995

Administrative Experience and University Service

Department Chair of Chemical and Biomolecular Engineering (1989-1995)

Hired five faculty members as Chemical Engineering department Chair (1989-95), including the first woman to the Engineering College (Joan Brennecke, member of NAE). Mentored five junior faculty: Ed Maginn, Elaine Zhu, David Go, Arezoo Ardekani, Jeremy Zartman and Donny HanjayaPutra at Notre Dame. Five won NSF Career Awards and two are women. Research expenditure doubled during my chairmanship.

Founding Director of Center for Microfluidics and Medical Diagnostics (CMMD, 2003-2020). The Center initiated Tech Transfer at Notre Dame. 16 issued patents.

Founding executive committee of the Notre Dame Advanced Diagnostics and Therapeutics Initiative.

Advisory Committee to VP of Research Notre Dame 2016-18.

Press Highlights

. Indiana Business Magazine, “Biosensor Technology in Indiana”, March, 2005.
. Bioscience Technology, “Microfluidic Analyzers: Slow, Steady Progress”, October, 2005
.“Channeling Microfluidic Devices into Point-of-Care Diagnostics”, Medical Product Manufacturing News, June 2010.
. “Fighting for Innovative HealthCare”, NBC-Notre Dame, national TV, 2010
. South Bend Tribune article about FCubed and the local economy Oct 26, 2014.
. National Science Foundation Discovery Website about Group’s efforts on tech transfer, October, 2014.
. CBS (Philly, South Bend), feature on exRNA analyses for cancer diagnostics (September, 2019)
. A Festschrift Issue in Biomicrofluidics (BMF, 13, 060401 (2019)) for my contributions to BMF and micro/nanofluidics, particularly nanoelectrokinetics.
. Medical Device Development: Under the Microscope
. Liquid Biopsy Microfluidics: South Bend ABC57
. COVID-19 research Notre Dame News and Notre Dame Magazine(2020, 2021) NIH exRNA

Patents

1. Process and Apparatus for Enhancing In-Tube Heat Transfer by Chaotic Mixing (with Mihir Sen), US Patent US5, 311, 932 (1994). Sequential twisting of a heating coil in two different planes enhances heat transfer by chaotic mixing action of inertial Dean vortices.

2. Method and Apparatus for treating exhaust gas (with David Leighton), United States Letters Patent US6,428,754 (2002). A by-pass design reduces the heat load into a catalytic converter such that ignition occurs at the leading edge of the converter and the heat of reaction can be profitably used to lightoff the entire converter. With the bypass, the converter lights off in less than a minute compared to the10 minute light-off without the bypass.

3. Microfluidic Mixer (with Shau-Chun Wang, Hsiao-Ping Chen and Chia-Yu Lee), Taiwan patent TW1322032B (2008). Mini and microvortices around a perm-selective granule or perm-selective membrane is used to achieve rapid mixing at micron to mm scales. Free-floating granules are propelled by asymmetry of the vortices due to asymmetric concentration polarization in the field direction. This ballistic motion allows the granule to achieve global mixing in a large reservoir.

4. Method and Apparatus for Rapid Particle Manipulation and Characterization(with Zachary Gagnon) US Patent US7,744,738. (2010). A serpentine wire design allows high-field dielectrophoretic trapping and manipulation of cells, molecules and other bioparticles. The field is significantly higher than that possible for disjoint electrode pairs to achieve much higher capture efficiency.

5. Methods and Apparatus to Capture and Release Microbe Particles Using Amine functionalized Silica (with Zilin Chen), licensed to Scientific Methods Inc. (www.scientificmethods.com) US Patent 7,960,180 (2011). Silica beads with different functionalized surface groups can trap and release virus in different buffers due to proper tuning of double-layer effects. The technology can be used to clean water or concentrate pathogens for detection.

6. Methods and apparatus for AC Electrospray (with Leslie Yeo, Shau-Chun Wang, Zach Gagnon and Dmitry Lastochkin) US Patent US8,267,914 (2012). A new high-frequency AC Electrospraying, droplet generation and electrospinng technology. The AC cone exihibits an 11 degree angle different from the 49 degrees DC Taylor cone and produces small electro-neutral drops. AC frequency minimizes field and current penetration and hence enhances molecular and cell viability. AC electrospinning provides mechanically strong multi-fiber threads at high throughput without the whipping instability of DC electrospinning, thus allowing high-throughput production.

7. Rapid Detection of Viable Bacteria System and Method (with Shramik Sengupta and Sachidevi Puttaswamy. Licensed to ImpeDx) US Patents US8635028 (2011); US10273522 (2019); Canadian patents CA2702276C. A rapid dielectrophoresis and impedance method for detecting bacteria viability by concentrating and sensing bubbles generated by the antibiotically screened bacteria.

8. Microfluidic Platforms for Multi-Target Detection (with Jason Gordon, S. Senapati, Zach Gagnon and Sagnik Basuray. licensed to F Cubed, LLC, now CubedLaboratories) US Patent US8771938 (2014), CA2702276C. Molecular hybridization onto probe-functionalized nanostructures sensitively affects their polarizability and dielectrophoretic mobility, allowing rapid detection of hybridization events and multi-plex diagnostics on biochips. The large polarizability and induced field of carbon nanotubes is used to assemble them across electrodes and to rapidly trap analyte molecules from a flowing solution.

9. Methods and apparatus for mass spectrometry utilizing an AC electrospray device (with David Go, Nishant Chetwani, Catherine Cassou) US Patent US8,716, 675 (2014). AC electrospray is used for mass spectrometry applications. The microjet from AC spray, unlike DC spary, does not develop a plume that loses much of the analyte. Hence, AC spray can be used without a sheath flow. AC sprayed droplets are weakly charged and hence can achieve soft ionization. AC spray can also preferentially entrain low-mobility anions and offer a means of controlling the pH in the spray by tuning the frequency. Since the charge state of proteins is a function of pH, this offers a means of producing large and distinct charge/mass signals.

10. Microchamber Electrochemical Cell having a Nanoslot (with G. Yossifon, S. Basuray) US Patent 8,969,007 (2010). We use a nanoslot to achieve on-chip ionic strength and pH control and to concentrate nanoparticles or macromolecules for sensing applications. The nanoparticles can be functionalized with probes such that their dielectrophoretic mobility change upon functionalization, thus achieving preferential trapping and quantification of hybridized nanoparticles.

11. Method and Apparatus for a nanopipette Biosensor (with Shoupeng Liu, S Senapati, Yunshan Wang and Yu Yan) US patent US9856518 (2014). Dancon, a nanopipette biosensor capable of detecting a small concentration of target molecules within a sample solution using optical detection methods. The biosensor includes a nanopipette that connects a nanocolloid reservoir containing a nanocolloid solution and a sample reservoir containing a sample solution, where the nanopipette is tapered at the end connected to the sample reservoir. The nanocolloid solution includes nanoparticles functionalized with probes specific to miRNA of the target molecules and reporters. During the detection process, the nanocolloids nanoparticles aggregate such that plasmonic hotspots are formed. These hotspots magnify the reporter signals produced when the probes hybridize with target molecules.

12. Methods and Apparatus for nanomembrane-based nucleic acid sensing for portable diagnostics. (with Zdenek Slouka, S. Senapati and Li-Jing Cheng, licensed to AgenDx LLC. US Patent US10,557,820 P01010 (2016). Charge inversion upon hybridization onto probes on permselective membrane is used for selective and sensitive nucleic acid detection. Ion depletion from the membrane surface in the limiting and overlimiting regions allows small change in surface charge to sensitively gate the ion current to achieve large (>100 mV) voltage shifts. Although charge-based, it is not sensitive to variable screening due to different bulk ionic strengths because of the ion depletion action. The microvortices near the surface also endow specificity by its washing action.

13. Integrated Membrane Sensor for Rapid Molecular Detection (with Zdenek Slouka, S. Senapati and Sunny Shah, licensed to AgenDx LLC) US Patent US10,247,720 (2019) P01116 (2015). Charged molecules and ions can be concentrated a-million fold for easier detection by exploiting internal and external concentration polarization of nanoporous granule/membrane/nanoslot to electrophoretically and dielectrophoretically accumulate the analyte. Molecules can be isolated and separated by the high field of the depletion action. They can also be concentrated at a specific position by controlling the depletion front with an applied voltage.

14. Ultra-Sensitive Multi-Target Lateral Flow Molecular Assay with Field-Induced Precipitation (with Steve Marczak, Zdenek Slouka and S. Senapati) US Patent US10669572. An electric field in a gel packs nanoparticles and molecules at an ion-selective membrane to achieve high association rate. Upon reversal of the field, the membrane depletes the ion in the gel and the resulting high field can precipitate target-tehered nanoparticles while removing the unlinked nanoparticles. Different particles precipitate at different locations to allow multi-target, rapid and sensitive detection. The high-field in the ion depleted region also break up non-specifically bound nanoparticles to reduce false positives.

15. Methods and Apparatus for a Shear-Enhanced CNT-Assembly NanoSensor Platform for Ultra-Sensitive and Selective Protein Detection (with Diya Li, Gongchen Sun, Ceming Wang and S. Senapati) US Patent US 10,955,380. A DC/AC protocol is invented to assemble Carbon Nanotubes (CNT) across an electrode pair rapidly and irreversibly. The CNTs and electrodes are functionalized by probes, using the target molecule as a link in a sandwitch scheme. The large hydrodynamic drag of the high-aspect ratio allows shear to remove non-specifically bound CNTs. The result is a very sensitive and selective sensor, capable of differentiating isoforms from target proteins with comparable dissociation constants and reducing the detection to 10 fM, orders of magnitude below the antibody-antigen dissociation constant.

16. Simultaneous Isolation and Preconcentration of Exosomes by Ion Concentration Polarization Method and Apparatus (with Steve Marczak, Zeinab Ramshani, David Go, Reginald Hill and Senapati). US Patent US 10983085. Exosomes are isolated electrophoretically from a flowing plasma stream on a chip by using the high electric field in an ion-free region that is created by ion-depletion action of an on-chip ion-selective membrane. The field drives the exosomes transversely into a gel reservoir for latter collection or further on-chip analysis. It has a much higher yield than Ultra-Centrifugation and can be easily integrated with downstream assays like magnetic bead immunocapture, RNA extraction and quantification.

Publication

(H factor: 73, >17,000 total citations, ~900 citations/year ; Google Scholar)

Books

"Complex Wave Dynamics on Thin Films" (with Evgeny A. Demekhin), Elsevier Scientific Press, 2002.

"Electrokinetically Driven Microfluidics and Nanofluidics" (with Leslie Yeo), Cambridge Univ Press (2009).

Journal Publications and Book Chapters

Fluid Mechanics: Phys Fluid (20 papers), PRE(16), Phys Rev Letter (14), JFM (14), JCIS (6), SIAM J App Math (3), Phil Trans Royal Soc (2), Annual Review of Fluid Mech (2)

Micro-Nanofluidics: Biomicrofluidics (24), JCP(12), Electrophoresis (12), Lab Chip (10), Biosensors & Bioelectronics (6), Analytical Chemistry (5), JPC(3), Adv Materials (2), ACSNano (2), Small (2), Talanta (2), ACS Appl Materials & Interface (2), Annual Review of Analytical Chem (1), Nanoscale (1), Nature Comm (1), Comm Bio (1), Nature Comm (1)

Reaction Engineering/Control : Chem Eng Sci (25), AIChE J (9)

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281. Yin, Z., Ramshani, Z., Waggoner, J. J., Pinsky, B. A., Senapati, S. and Chang, H.-C.”A Non-Optical Multiplexed PCR Diagnostics Platform for Serotype Specific Detection of Dengue Virus”, Sensors and Actuators B: Chemical, 310, 127854(2020).

282. Wang, C., Senapati, S. and Chang, H.-C.,”Liquid Biopsy Technologies based on Membrane Microfluidics: High-Yield Purification and Selective Quantification of Biomarkers in Nanocarriers”. Electrophoresis, 41, 1878-1892 (2020).

283. Zhang, Y., Chen, X., Wang, C., Roozbahani, G. M., Chang, H.-C. and Guan, X, “Chemically functionalized conical PET nanopore for protein detection at the single-molecule level”, Biosensors and Bioelectronics, 165, 112289 (2020).

284. Vivek, Y., Chong, N., Ellis, B., Ren, X., Senapati, S., Chang, H.-C.* and Zorlutuna, P.*,“Constant-potential environment for activating and synchronizing cardiomyocite colonies with on-chip ion-depleting perm-selective membranes”, LabChip, 20, 4273 (2020).

285. Moon, S., Zhang, Q., Huang, D., Senapati, S., Chang, H.-C., Lee, E. and Luo, T. , “Biocompatible and direct deposition of functionalized nanoparticles using shrinking surface plasmon bubble”, Adv. Material Interface , 7, 2000597(2020).

286. Sensale, S., Wang, C. and Chang, H.-C., “Resistive Amplitude Fingerprints during Translocation of Linear Molecules Through Charged Solid-State Nanopores”, J Chem Phys, 153, 035102 (2020).

287. Chuang, J.-N., Diao, P.-Y., Huang, W.-S., Huang, L.-F., Senapati, S. Chang, H.-C and Sun, Y-M., “Novel Homogeneous Anion Exchange Membranes for Reproducible and Sensitive Nucleic Acid Detection via

Current–Voltage Characteristic Measurement", ACS Applied Materials and Interfaces, 12, 54459-54472 (2020).

288. Ramshani, Z., Fan, F., Wei, A., Romanello-Giroud-Joaquim, M., Gil, C.-H., George.M., Yoder, M. C., Hanjaya-Putra, D., Senapati, S. and Chang, H.-C., "A Multiplexed Immuno-Sensor for On-Line and Automated Monitoring of Tissue Culture Protein Biomarkers", Talanta, 225, 122021 (2021).

289. Wang, C., Sensale, S., Pan, Z., Senapati, S. and Chang-H.-C., "Slowing Down DNA Translocation through Solid-State Nanopores by Edge-Field Leakage", Nature Communications , 12, 140 (2021).

290. Sensale, S., Ramshani, Z., Senapati, S. and Chang, H.-C., "Universal Features of Non- Equilibrium Ionic Currents through Perm-Selective Membranes: Gating by Charged Nanoparticles/Macromolecules for Robust Biosensing Applications", J. Phys Chem B , 125, 1906-1915(2021).

291. Ren, X., Gomez, J., Bashar, M. K., Ji, J., Can, U. I., Chang, H.-C., Shukla, N. , Dutta, S. and Zorlutuna, P., "Cardiac Muscle Cell-Based Oscillator for Collective Computing", Advanced Intelligent Systems, 3, 2000253(2021) (Back cover) .

292. Pan, Z., Bui, L., V. Yadav, Fan, F., Chang, H.-C.*, HanjayaPutra, D.* "Conformal Single Cell Hydrogel Coating with Electrically Induced Tip Streaming at an AC Cone", Biomaterials Science , 9, 3284-2392(2021). (Cover Article).

293. Chen, L., Yadav, V., Zhang, C., Huo, X., Wang, C., Senapati, S., Chang, H.-C., "Elliptica Pipette Generated Large Microdroplets for POC Visual ddPCR Quantification of Low Viral Load", Analytical Chemistry , 93, 6456-6462(2021)

294. Ren, X., Ellis, B. W., Ronan, G., Blood, S. R., Deshetler, C., Senapati, S. , Keith, L. M.,Handberg, E., Anderson, E., Pepine, C., Chang, H.-C. and Zorlutuna, P. "A MultiplexedIon-Exchange Membrane based miRNA (MIX-miR) detection platform for rapid diagnosis of myocardial infarction", LabChip, 21, 3876-3887 (2021) (Back Cover)

295. Zhang, Y., Chen, X., Wang, C., Chang, H.-C. and Guan, S. "Nanoparticle AssistedDetection of Nucleic Acids in a Polymeric Nanopore with a Large Pore Size", Biosensor and Bioelectronics, 196, 113697(2021).

Invited Seminars (over 200)

"A Singular Perturbation Analysis of the Dynamics of Two-Species Heterogeneous Catalytic Reactions," University of California at Davis, 1980.

"Quasi-Steady-State Analysis of Heterogeneous Catalytic Systems," University of Houston, 1980.

"Multi-Scale Analysis of Global Dynamics in Heterogeneous Catalytic Systems," University of Southern California, 1982.

"The Nonlinear Effects of Stabilizing an Unstable Reactor by Linear Feedback Control," Notre Dame, 1983.

"Nonlinear Dynamic Behavior in Chemical Systems," Texas A & M, 1983.

"High Reynolds Number Flow Through Cubic Arrays of Spheres," University of California, San Diego, 1983.

"Transport in periodic Arrays of Spheres and Cylinders," University of Houston, 1984.

"Bifurcations of a Falling Liquid Film," University of Wisconsin, 1984,

"Evolution on Nonlinear Waves on Falling Films - A Normal Analysis," University of Massachusetts, 1985.

"Effective Conductivity and Diffusivity in Two-Phase Media," Michigan State University,1985.

"Nonlinear Interfacial Instability," Schlumberger-Doll, Ridgefield, Connecticut, 1985.

"Modelling of Flow in Permeable Media," Gordon Research Conference, New Hampshire, 1986.

"A Galerkin/Spectral Analysis of Flow Transition in Several Model Systems," Princeton University, 1986.

"Nonlinear Dynamics of Systems Under PID Control," University of Texas, Austin, 1986.

"Design of PID Controllers for Nonlinear Systems-A Model Independent Method Based on Bifurcation Theory," Caltech, 1986.

"Flow Transition in Porous Media," University of Notre Dame, 1987.

"PID Control of Nonlinear Systems," University of Pennsylvania, 1987.

"Tuning of PI Controllers for Unknown Systems," East China Institute of Chemical Technology, 1987.

"Nonlinear Waves on Falling Films," East China Institute of Chemical Technology, 1987.

"Flow Transition in Porous Media, "Academia Sinica, 1988.

"Bubble Transport in Capillaries", Colburn Lectureship, University of Delaware, 1988.

"General Dynamic Properties of Nonlinear Systems under PI Control", National Taiwan University, 1988.

"Bubble Transport in Capillaries", National Taiwan University, 1988.

"Nonlinear Dynamics of Systems Under Feedback Control", Illinois Institute of Technology, 1989.

"The Marangoni Effect on the Transport of Bubbles in Capillaries", Engineering Science and Applied Math Dept., Northwestern University, 1990.

"Apparent Viscosity of Bubble Trains in Capillaries", Rheology Seminar, University of Wisconsin, 1990.

"A Generalized Sideband Stability Theory", Aerospace Engineering and Mechanics Dept., University of Minnesota, 1990.

"Selection of Periodic Patterns in Unbounded Domains", Institute of Theoretical Chemistry, University of Tubingen, Germany, 1990.

"Selection of Periodic Patterns in Unbounded Domains", Institute of Paper Science and Technology, Georgia Institute of Technology, 1990.

"Displacement of Liquid by Air Bubbles in Capillaries - the Marangoni Effect", Clarkson University, 1990.

"Displacement of Liquids by Air Bubbles in Capillaries - the Marangoni Effect", MIT, 1991.

"Bifurcation of a Torus in a Delayed Feedback System", Institute of Control Science, USSR Academy of Science, Moscow, 1991.

"Heat Transfer Enhancement by Chaotic Mixing", Argonne National Laboratory, 1991.

"Transition and Pattern Formation in Multi-Phase Channel Flow," Chemical Engineering Dept., Cornell University, 1991.

"Interfacial Patterns and Invariant Manifolds", Applied Math. Group, Cornell University, 1991.

"Spatial Patterns in Two-Phase Flow", Chemical Engineering Department, University of Iowa, 1992.

"Pattern Formation in Multi-Phase Flow", Mathematics Department, Virginia Tech, 1992.

"Interfacial Wave Dynamics on Thin Films", James and Catherine Pattern Seminar, University of Colorado, Boulder, 1992.

"Interfacial Wave Dynamics", West Virginia University, 1992.

"Surface-Tension Driven Flow", West Virginia University, 1992.

"Spatio-Temporal Chaos and Control on a Catalytic Wafer",National Taiwan Institute of Technology, Taipei, December 22, 1992.

"Heat Transfer Enhancement by Chaotic Mixing", National Taiwan University, Taipei, December 22, 1992.

"Heat Transfer Enhancement by Chaotic Mixing", National Tsing Hua University, Hsinchu, December 23, 1992.

"Interfacial Chaos", Tunghai University, Taichung, December 23, 1992.

"Instabilities in Free Convection Near a Heated Plane", Chemical Engineering Department, National Cheng Kung University, Tainan, December 26, 1992.

"Displacement of Liquid by Air Bubbles in Capillaries", Chemical Engineering Department, National Cheng Kung University, Tainan, December 28, 1992.

"Heat-Transfer Enhancement by Chaotic Mixing", Aeronautical Department, National Cheng Kung University, Tainan, December 29, 1992.

"Spatio-Temporal Chaos and Control on a Catalytic Wafer", Chemical Engineering Department, National Cheng Kung University, Tainan, December 30, 1992.

"Interfacial Chaos", Mechanical Engineering Department, National Cheng Kung University, Tainan, December 31, 1992.

"Wave Evolution on a Falling Film," Department of Applied Mathematics and Theoretical Physics, Cambridge University, October 22, 1993.

"Wave Evolution on a Falling Film," Prague Institute of Chemical Technology, October 26, 1993.

"Wave Evolution on a Falling Film", Department of Mathematics, University of Birmingham, November 19, 1993.

"Self-similar Solutions in Interfacial Dynamics", Chemical Engineering Department, Carnegie-Mellon, January 25, 1994.

"Interaction Dynamics of Solitary Waves on a Falling Film", Complex Fluid Seminar Series, Princeton University, Sept. 26, 1994.

"Waves on a Falling Film", Levich Institute of Hydrodynamics, City College of New York, Sept. 27, 1994.

"Wave Dynamics on a Falling Film", University of Missouri-Rolla, March 29, 1995.

"Wave Evolution on a Falling Film", Spatially Extended Conference on Complex Dynamics in Spatially Extended Systems, Niels Bohr Institute, Denmark, Sept. 26, 1995.

"Wave Dynamics on a Falling Film", University of Wisconsin, January 24, 1996

"Self-Similarity in Interfacial Dynamics", Physics Department, University of Chicago, April 15, 1996.

"Falling Film Dynamics,", Mathematics Department, University of Alabama, May 1, 1996.

"A Description of Film Wave Dynamics by Coherent Structure Theory", Applied Mathematics Department, Northwestern University, May 12, 1997.

"Pattern Formation During Electropolishing", Fritz-Haber-Institut der Marx-Planck-Gesellscaft, Berlin, July 21, 1997.

"Drop Formation in Viscoelastic Jets", Department of Mathematical Sciences, Indiana/Purdue University, Indianapolis, October 15, 1997.

"Drop Formation and Pinchoff in Viscoelastic Jets", Mech. Eng. Dept., Arizona State University, November 21, 1997.

"Wave Dynamics on Thin Films", "Pattern Formation in Corrosion and Electropolishing" and "Breakup of Viscoelastic Jets", Mathematics and Engineering Departments, Institute of Technology at Bundung, Indonesia, January 7-9, 1998.

"Wave Dynamics on a Falling Film", Mech. Eng. Dept., MIT, February 27, 1998.

"Modulation Instability of Kinematic Interfacial Waves", Mech. Eng. Dept., UCLA, May 14, 1998.

"Wave Dynamics on a Falling, Film", Chem. Eng. Dept., UCLA, May 15, 1998.

"Homogenization and Scaling Theories for Molecular Transport in Zeolites", Chem. Eng. Dept., University of Naples, June 16, 1998.

"Arnold Diffusion in Zeolite Crystals", Aerospace and Mechanical Engineering Dept., University of Notre Dame, Aug. 31, 1999.

"Nanoscale Pattern Formation During Electrode Dissolution", Chemical Engineering Dept., University of Florida, Oct. 18, 1999.

"Nanoscale Pattern Formation During Electrode Dissolution", Chemical Engineering Dept., University of Houston, November 19, 1999.

"Fast-Igniting Catalytic Converters", Chemical Engineering Dept., Iowa State, March 2, 2000.

"Nanoscale Pattern Formation", Fritz-Haber-Institut der Marx-Planck-Gesellscaft, Berlin, June 16, 2000.

"Fast-Igniting Catalytic Converters", Department of Mathematics, University of Minnesota, Minneapolis, September 7, 2000; Nonlinear Dynamics Seminar Series, Applied Math Program, Princeton University, October 23, 2000.

"Fast-Igniting Catalytic Converters",Department of Mathematics, New Jersey Institute of Technology, Newark, November 3, 2000.

“Fast-Igniting Catalytic Converters”, Mathematics Department,Chinese Normal University, Taipei, Taiwan, December 27, 2000.

“Microdevices and Nanoporous Materials”, College of Engineering, Yuan Ze University, Taiwan, December 28, 2000.

“Microfluidics”, Chemical Engineering, National Taiwan University, Dec 18, Chung Cheng University, Dec 20, Cheng Kung University, Dec 22, Changan Hospital and University, Dec 24, Taiwan, 2001.

“Microfluidics”, Chemical Engineering, Natioal Seoul University, January 8, KAIST, January 10, KIST, January 11, Korea, 2002.

“ Wave Dynamics on Thin Films”, Department of Mathematics, Penn State, February, 2002.

“Electrokinetic Microfluidics”, Stanley Corrsin Hydrodynamics Lecture, Johns Hopkins University, March 7, 2002.

"Electrokinetic Microfluidics", University of Wisconsin, April 9, 2002.

"Nonlinear Electrokinetic Phenomena and their Microfluidic Applications", Mechanical Engineering Dept, Louisiana State University, September 18, 2002.

"Bioparticle Separation and Detection with Micro-Devices", Academia Sinica, Taipei, Taiwan, December 26, 2002.

"Miniature Medical Diagnostic Kits", National Nano-Device Laboratory, Hsin-Chu, Taiwan, December 27, 2002.

"Application of Electrokinetics to Micro-Fluidic Devices", Carnegie-Mellon, Feb 18, 2003.

"Engineering Double Layers to Control Electro-Dissolution Processes", Ashland Research Laboratory, Columbus, Ohio, April 16, 2003.

"Nano-scale Dissolution Patterns During Electropolishing and Anodization", Argonne National Laboratory, Material Science Division, May 1, 2003.

"Nonlinear Electrokinetics and Microfluidic Devices", Workshop on Complex Fluids, Argonne National Laboratory, July 28 to 31, 2003.

"Application of Electrokinetics in Micro-fluidic Devices", University of Minnesota, Oct 7, 2003.

"Application of Electrokinetics in Micro-fluidic Devices", Michigan Tech, Oct 23, 2003.

"Application of Electrokinetics in Micro-fluidic Devices", Tsinghua University, Dec 18, 2003.

"Application of Electrokinetics in Micro-fluidic Devices", National Taiwan University, Dec 24, 2003.

"Application of Electrokinetics in Micro-fluidic Devices", Center of Bioengineering and Mechanical Engineering Department, University of Missouri, April 6, 2004.

"Non-equilibrium Electrokinetics", Department of Aerospace and Mechanical Engineering, University of Notre Dame, Sept 28, 2004.

"AC Electrokinetic Devices", Department of Bioengineering, Rice University, December 11, 2004.

"Microfludic Designs for Miniature Medical Diagnostic Kits', Keynote Lecture, (Taiwan) Biomedical Engineering Society Annual Symposium, Tainan, Taiwan, December 18, 2004.

"Electrorkinetic Microdevices", Department of Chemical Engineering, Cheng-Kung University, Tainan, Taiwan, Dec 20, 2004.

"Miniature Blood Diagnostic Kits", Department of Biomedical Engineering, Cheng-Kung University, Tainan, Taiwan, Dec 21, 2004.

"Microfludic Designs for Miniature Medical Diagnostic Kits', College of Engineering Honor Lecture, Chong-Cheng University, Chia-Yi, Taiwan, Dec 24, 2004.

“Microfluidic Technology fro Rapid Diagnostic Kits”, Bioengineering Department, Rice University, January 31, 2005.

“Rapid Diagnostic Kits for Cancer Detection”, Han-Mo Koo Memorial Seminar, Van Andel Research Intitute, Grand Rapids, Feb 9, 2005.

“Microfluidic Technology fro Rapid Diagnostic Kits”. Chemical Engineering Department, University of Alberta, March 17, 2005.

“Microfluidic Technology for Rapid Diagnostic Kits”, Invited Speakers, Biosensor Symposium, Indianapolis, April 6, 2005.

“Microfluidic Technology for Rapid Diagnostic Kits”, Chemical Engineering Depart,ment, University of Houston, April 15, 2005.

“Microfluidic Technology for Rapid Diagnostic Kits”, Chemical Engineering Depart,ment, Tsinghua University, Beijing, May 12, 2005.

“Thin Films of Soft Matter”, The Bianchi Session, International Center for Mechanical Sciences, Udine, Italy, July 18 to 22, 2005.

“Designing DC and AC Electrokineitc Devices for Miniature Diagnostic Kits”, Chemical Engineering, Univ. of Mass, Amherst, Oct 6, 2005.

“Manipulating Nanobeads and Nanorods with Micro-Electrodes to Capture, Detect and Identify Virus/Bacteria”, International Symposium on Nano Bioengineering, Chung-Li. Taiwan, Dec 15-16, 2005.

“AC Electrokinetics due to Double Layer Charging”, Exxon-Mobil and Levich Institute, October 23 and 24, 2006.

“Directed Assembly of Colloids by AC Electrokinetics”, NSF-NSC US/Taiwan Workshop on Soft Materials, Taipei, Jan 4-6, 2007.

“Dielectrophoresis: Double-Layer Effects”, Invited Speaker, Material Research Society, San Francisco, April 13, 2007.

“Dielectrophoresis of Nano-Colloids---a New Microfluidic Platform for Biomedical Diagnostic Kits”, Monash University, University of Queensalnd and Melbourne University, Australia, May 21-29, 2007.

“Dielectrophoresis of Nano-Colloids”, Sandia National Lab., September 24; Bioengineering Department, UC Davis, September 25, 2007.

“Dielectrophoresis of Nano-Colloids”, Chemical Engineering, Caltech, Oct, 18, 2007.

“Dielectrophoresis of Nano-Colloids”, HKUST, Hong Kong, January, 2008; Academia Sinica, National Taiwan University, Cheng Kung University, Central University, Taiwan, March, 2009.

“Dielectrophoresis of Nano-Colloids”, Chemical Engineering, Princeton, April 23, 2008.

“AC Electrospray”, Kavli Institute of Physics, Beijing, June, 2008.

"Understanding Eletrokinetics at the Nanoscale", Mechanical Engineering department, University of Houston, February 2009.

"Understanding Electrokinetics at the Nanoscale", SEAS, University of Pennsylvania, April, 2009.

"Understanding Electrokinetics at the Nanoscale", Chinese Academy of Science, Applied Science Insitute, Shanghai, July 2009.

Keynote Lecturer, ACS Colloid and Interfacial Science Symposium, Columbia University, June 2009.

Keynote Lecture, ASME Mini/Micro/NanoChannels Conference, Pohang, Korea, June 2009.

Keynote Lecture, Asian-Pacific LabChip Conference, Shanghai, October 2009.

Invited Speaker, Workshop on Electrokinetics, IMA, University of Minnesota, Dec 2009.

Keynote Lecturer, Second ASME Micro/Nanoscale Heat/Mass Transfer International Conference, Jiaotung University, Shanghai, December 2009.

Invited Speaker, Electrokinetics Conference, Banff, February 2010.

"Rapid Label-Free Molecular Detection by Electrokinetics", EPA,Cincinnati, April 2010.

"Nanofluidics", Academia Sinica, Taiwan, June, 2010; National Tsing-Hua University, June, 2010. National Cheng Kung University, June, 2010.

"Vortices and Instabilities at the Micro/Nanoscale", Plenary Lecture, Wave Phenomena IV, Banff, Canada, June 2010.

"Polaritons at Geometric Singularities", Invited Speaker, Phoresis Workshop, Pohang, Korea, August 2010.

"Nanoporous Membrane Sensors for Portable Nucleic Acid Detection", Plenary Speaker, Chinese-Japan-Korea Analytical Chemistry Conference, Wuhan, October 2010.

"Polaritons at Geometric Singularities", Plenary Speaker, Electrokinetics Workshop, Haifa, Israel, December 2010.

"A new Nucleic Acid Detection Platform based on Nanoporous Membranes", Plenary Speaker, AMN-APLOC, Singapore, January, 2011.

"A Nanofluidic Platform for Cancer Biomarker Detection", Nano-Air Force Workshop, Seattle, March, 2011.

"Micro and Nanofluidics for Mass Spectrometry and Biosensing", Mechanical Engineering Department, University of Louisville, March, 2011.

"Polaritons and Geometric Singularities", Nanofluidics Colloquim, Physics department, Universitait Twente, June 2011.

"Electrokinetic Biochips", Chemical Engineering, Imperial College, June 2011.

"Electrokinetic Biosensors", Mechanical Engineering, University College, London, June 2011.

"Non-Equilibrium Nanofluidics: Rectification, Overlimiting Current and MicroVortex Instability", Engineering, Brown University, September 2011.

"Rectification, Hysteresis and Oscillations in Nanofluidics", Invited Speaker, Electrokinetics Symposium, APS-DFD Annual Meeting, Baltimore, November 2011.

"Microvortex Turbulence Driven by Non-Equilibrium Ion Flux through Ion-Selective Media", Fluid Seminar, Stanford University, January, 2012.

"Nanoporous Membrane Sensor", Plenary Lecture, Advances in Microfluidics and Nanofluidics, Dalian, China, May, 2012.

"Low-Cost Membrane Sensors for Portable Diagnostics", Marine Environmental Sensing Center, Dublin City University, Aug 30, 2012.

"Anomalous Phenomena at Geometric Singularities", Physics Department, University of Missouri, September 17, 2012

"Ion Rectifiers, Capacitors and Inductors", Mechanical Science and Engineering, University of Illinois, Urbana, September 18, 2012.

"Electrokinetic Technologies for Portable Diagnostic Devices", Chemical Engineering. Ohio State University, November 15, 2012.

"Next-Generation Molecular Diagnostics", Bionics Innovation Center, Pazmany P. Catholic University, Budapest, September 17, 2013.

"Field-Use Nucleic Acid Sensors", Bioengineering, University of Texas, El Paso, October 11, 2013.

"Next-Generation of Diagnostic Devices", Bionics Center, Budapest, Sept 17, 2013.

"Next Generation Molecular Diagnostics", Suzhou Institute of Biomedical Engineering and Technology, Oct 23, 2013.

"Next Generation Molecular Diagnostics", Plenary Talk, International Conference of Applied Science, Academia Sinica, Taiwan, Oct 25, 2013.

"Nanoporous Membrane Biosensor", Mechanical Engineering Department, Clemson University, Nov 21, 2013.

"Nanoparticle Assembly for Plasmonic Biosensing", Foundations of Nano Science, Snowbird, Utah.

"Membrane Microfluidics", Advances in Microfluidics and Nanofluidics, Academia Sinica, Taipei, May 24-26, 2014.

"Membrane Microfluidics", Dielectrophoresis 2014, Institute of Physics, London, July 14-16, 2014.

"Ultra-Sensitive Biosensing with Nanopore Ion-Currents and Nanoparticle Plasmonics" Keynote Speaker, China-German Optical Medical Devices Conference, Suzhou, Sept 18-19, 2014.

"Next-Generation Point-of-Care Diagnostics", Workshop on Bionics, Bionics Center, Pazamany Peter Catholic University Budapest, Oct 21-23, 2014.

“Next-Generation Point-of-Care Diagnostics”, Keynote Lecture, Taiwan Institute of Chemical Engineers Meeting, Taoyuan, Taiwan, Dec 13, 2014.

“Next-Generation Point-of-Care Diagnostics”, Applied Sciences Division, Academia Sinica, Taiwan, Feb 6, 2015.

“Next-Generation Point-of-Care Diagnostics”, University of Chile, Santiago, Chile, March 9, 2015. Catholic University, Santiago, Chile, March 11, 2015.

“Next-Generation Point-of-Care Diagnostics”, Plenary Speaker, 7th WACBE World Congress on Bioengineering, Singapore, July 6, 2015.

“Portable Nucleic Acid Sensors”, BioselectMicrofluidic Congress, San Diego, Sept 2015.

“Nucleic Acid Assay: How to beat Thermodynamic Equilibrium”, Bioengineering Department, University of California, San Diego, September 30, 2015.

“Integrated Membrane Sensor”, Plenary Speaker, Annual Meeting of American Electrophoresis Society, Salt Lake City, November 2015.

“Ionic Circuits”, Electrical Engineering Department, University of Utah, November 5, 2015.

“Next-Generation Point-of-Care Diagnostics”, Chemical Engineering Department, National University of Singapore, January 2016; IMRE, ASTAR, Singapore, January 2016.

“Membrane Microfluidics for miRNA Profiling”, Mechanical Engineering, University of Pittsburg, March 2016.

“A Billion-Droplet Digital PCR Platform”, Keynote lecture, Microfluidics Congress, San Diego, September 2016.

“Ionic Circuits for Molecular Analysis”, Keynote lecture, Bionics Center PhD Congress Budapest, Hungary, November 2016.

“Ionic Circuits for Molecular Diagnostics”, Physics of Microfluidics, Israel, January 2017.

"Nanotechnology for Exosome and miRNA Isolation/Quantification," Notre Dame Harper Cancer Institute-USC Norris Cancer Center retreat, University of Southern California,February 9, 2017.

“Biochips for Short Nucleic Acid Quantification Based on Nonlinear Ionic Circuitries with Perm-Selective Membranes”, Mechanical Engineering, University of Alberta, April 2017.

"Biochips for Short Nucleic Acid Quantification Based on Ion-Selective Nanoporous Membranes and Nanopores," Materials Week, Ohio State University, May, 2017.

"Nanopore Translocation and Unbiased miRNA Profiling," Plenary Talk, AMN-ISMN-APCBM-ANZNMF conference, Tasmania, Australia June 29, 2017

“Nanopore Quantification of miRNA”, Plenary Talk, Microfluidics Congress, San Diego, October 2, 2017.

“Towards quantification of large-library biomarkers for personalized medicine”, Plenary Talk, Advances in Pharmaceutical Analysis, Wuhan, November 18, 2017.

“Nanopore miRNA profiling Technology”, Plenary Talk, Microfluidics Workshop Chinese Academy of Science, Institute of Modern Physics, Lanzhou, June 13, 2018.

“Biosensors based on nonlinear ionic circuits, Distinguished lecture, Department of Mechanical Engineering, Boston University, September 14, 2018.

“PCR-Free MicroRNA Quantification Based on Ion-Selective Nanoporous Membranes and Nanopores”, Plenary talk, 10th Annual Lab-on-a-Chip and Microfluidics Congress, San Diego, October 1, 2018.

“Electrokinetics and Plasmonics at NanoScale Singularities”, Invited Talk, TIX Conference, Haifa, Israel, December 4, 2018.

“Electrokinetics and Plasmonics at NanoScale Singularities: Designing Next-Generation Molecular Diagnostics”, Okinawa Institute of Science & Technolog, Okinawa, December 20, 2018.

“High-yield Isolation and Quantification of Exosomes and Exosomal miRNA”, International Molecular Medicine Tri-Conference, San Francisco, March 11, 2019.

“Nanofluidic Technologies for Nanocarrier Biomarkers”, Mechanical Engineering, Vanderbilt University, September 9, 2019.

“Droplet Generation based on Electrokinetics” and “Multiplex Liquid Biopsy Platform for Fractionation of Heterogeneous Vesicles and Precision Analyses of RNA Cargo”, Keynote talks, Annual Lab-on-a-Chip and Microfluidics Congress, San Diego, October 9-10, 2019.

“Fractionation and Analyses of Exosomes”, Lifetime Achievement Award Lecture, Annual Meeting of American Electrophoresis Society, Palm Springs, Oct 16, 2019.

“Liquid Biopsy based on RNA Profiling of Exosomes and Stress Granules in Plasma”, Plenary Lecture, 3rd International Symposium on Advances in Pharmaceutical Analysis, Xian, October 25, 2019.

“Fractionation of Nanocarriers and Quantification of their Molecular Cargo”, IndianaCenter for Regenerative Medicine and Engineering, Indiana University Medical School, November 22, 2019.

"Isolation and Fractionation of Blood Exosomes and Profiling of miRNA for Precision Medicine Applications", Molecular Medicine Tri-Conference, San Francisco, March 4, 2020.

“An Automated High-Throughput Multiplex Detection Platform for on-line Monitoring of Protein Finger Prints”, Advanced Manufacturing Regenerative Initiative Spring Meeting, May 19, 2020.

“Isolation and Fractionation of Exosomes and Viruses”, Chemical Engineering Department, Washington State University, October 15, 2020 (Virtual).

“On-Line Monitoring of Biomarkers in Tissue Cultures”, Invited Panelist, Biomanufacturing Symposium, University of Virginia in Charlottesville, Oct 17, 2021.

Funded Research (Over $25 Million)

NSF, DOE, DOD, NASA, NIH, ARMI, USDA, IBM, ExxonMobil, Schlumberger, Naval Medical Lab, Air Force Office of Research, Army Corp of Engineering, DTRA, ACS-PRF, Great Lakes Conservation Agency, Welch Foundation, Walter Cancer Foundation, Far Eastern Foundation, Gas Research Institute, TAPPI, Bayer Diagnostics, US-Israel BSF.

"Perturbation Analysis of Heterogeneous Catalytic Dynamics," NSF, 1981-1984, $50,000.

"Analysis of Transient Behavior in Chemical Engineering," ACS-PRF, 1981-1983, $10,000.

"Transport in Porous Media - Steady and Dynamic Behaviors in Inertial and Turbulent Regions," ACS-PRF, 1984-1986, $33,000.

"Washing and Plugging Mechanism in Formation Damage," Schlumberger Well Service, 1985-1986, $20,000.

"Application of Nonlinear Techniques to Control and Fluid Dynamics - PYI Award," NSF, 1985-1990, $500,000. (REU Supplement: $15,000)

"Enhanced Oil Recovery Consortium," 1985-1987, $95,000/year from industrial sponsors, $50,000/year from state funds. (PI: H. Deans).

"Dynamic Modeling of CO Oxidation on Platinum," The Robert A. Welch Foundation, 1986-1987, $60,000.

"High Reynolds Number Flow in Porous Media," ACS-PRF, 1986-1988, $35,000.

"Dielectric Breakdown Due to Electrothermal Instability," Jesse M. Jones Faculty Research Fund, 1988-1989, $10,000.

"Stability of Core-Annular Flow in Lubricated Transport of Oil", ACS-PRF, 1988-1990, $40,000.

"Enhancement of Heat Transfer by Chaotic Mixing", Gas Research Institute, 1990-1993, $300,000.

"Nonlinear Dynamics and Control of Complex Patterns", NSF, 1991-1994, $200,000.

"Hydrodynamic Instability of Forming", TAPPI, 1992, $40,000.

"Wave Dynamics on Falling Films and Its Effects on Heat/Mass Transfer", DOE, 1992-1995, $185,000.

"Thermal Front Propagation of Fast Igniting Catalytic Converters", 1992-1995, NSF, $250,000. (REU Supplement: $15,000)

"Study of disturbances in fluid-fluid flows in open and closed systems", NASA, 1992-1995, $300,000.

"Fundamental Processes of Atomization in Fluid-Fluid Flows", NASA, 1996-2000, $520,000.

"Nonlinear Dynamics and Control," NSF, 1996-1999, $170,000. (REU Supplement: $20,000)

"When are Hexagons Preferred," Faculty Research Program, 1997, $7,500.

"Electrochemical Self-Organization," NSF, 1997-2000, $220,000.

"Molecular Design of Lubricants", Mobil Foundation, 1998-2000, $30,000.

"Wave-Enhanced Heat and Mass Transfer", NSF, 1998-2000, $160,000. (REU Supplement: $5,000)

"Electrokinetic Flow Design for Micro-Laboratories on a Chip", NSF, 1999-2002, $400,000.

"Self-Assembly During Evaporation of Colloidal Solutions", Kraft Food, 1999-2002, $65,000.

"Effects of Local Interfacial and Flow Dynamics on Foam Drying and Coarsening", NSF, 2001-2003, $488,000.

"Colloidal Microfluidics for Diagnostic Kits", Bayer Diagnostics, 2001, $5,000.

"Microcirculation Anomalies in Microgravity Blood Flow", NASA, 2001-2005, $400,000 .

"Fuel Cell Research", Army, 2003-2006, $1,600,000 (PI: P. J. McGinn), 10 PI's with $290,000 towards microfluidics research.

"Micro-Fuel Cells", 21st Century Fund, State of Indiana, 2004-2006, $1,000,000 (PI: P. J. McGinn).

"Center for Microfluidics and Medical Diagnostics", University of Notre Dame, 2003-2007. $400,000.

"Electromagnetically Controlled Self-Assembly of Nano and Micro Collloids for Miniature Medical Diagnotic Kits", Notre Dame-Argonne Frontiers in Material Science Grant, 2003-2005, $200,000.

"Faradaic Micro-fluidic Devices for Complex Fluids", NSF, 2005-2007, $100,000.

"Protein Micropump", SHOT Inc., 2005-2007, $48,000.

"Silica Beads for Rapid and Reversible Virus and Bacteria Trapping", Scientiflc Methods Inc., 2005, $20,000. (EPA-SBIR Phase I).

"Risk assessment and management of the Great Lakes species", Great Lakes Protection Fund, 2006-2009, $1,090,000, (PI: D. Lodge).

"Developing and Applying a Portable Real-Time Genetic Probe for Detecting Aquatic Invasive Species in Ship's Ballast, Great Lake Protection Fund, 2007-2010, $805,000, (PI: D. Lodge).

"Microfilters for Nano-Aerosol Filtration", Defense Threat Reduction Agency, 2008-2011
, $652,217.

"Collaborative Research: Development of a Biofluid Transport, Separation and Molecular Analysis System using Microfluidics and a Miniature Mass Spectrometer",National Science Foundation, 2009-2011, $1,500,000, PI: P. W Bohn (with G. Cooke and Z. Ou-yang) joint Purdue-ND project.

"Novel malaria vaccine targets linked to nutrient and lipid import". Gates Foundation Phase 1, 2009-2010, $100,000 (PI: K. Haldar).

"Novel Microsystems for Manipulation and Analysis of Immune Cells," National Science Foundation, 2009-2013, $2,000,000, (PI: A. Revzin).

“Dielectrophoresis of Nanocolloids: A New Technique for Capturing Biomolecules and Biomarkers”, United States-Israel Binational Science Foundation, 2010-2014, $156,975.

“A Nanomembrane-Based Nucleic Acid Sensing Platform”, National Science Foundation, 2011-2014, $325,000.

“Nanofluidic Pre-concentration Devices for Enhancing the Detection Sensitivity and Selectivity of Biomarkers for Human Performance Monitoring”, Air Force Office of Scientific Research, 2011-2014, $200,000 (PI:N. Swami).

“A Rapid and High-Throughput Pathogen RNA Detection System for Dairy Products”, US Department of Agriculture, 2012-2016, $500,000.

“Miniature Biosensor Unit for RNA detection of E coli”, US Army Corp of Engineers, 2012-2013, $110,000.

“Nanomembrane-Based Nucleic Acid Sensing for Simultaneous Papillomavirus (HPV) HPV-induced microRNAs in Oropharygeal Cancers”, Walther Cancer Institute, 2012-2014, $200,000.

“Develop a Multi-target Sensor to Detect Dengue Serotypes from Infected Mosquitoes”,National Institute of Health, 2014-2017, $418,000 (PI: S. Senapati)

“Next-Generation Diagnostic Devices for Genetically Modified Crops: Phase 1”, Far Eastern, 2015-2016, $200,000.

“Dielectrophoretic Assembly of Carbon Nanotubes for Next Generation FET Chips”, IBM, 2015-1016, $150,000 (+$67,000 ND Matching).

“Development of a non-PCR RNA-Based Integrated Biosensing Platform for Detection of all four Dengue Virus Serotypes”, Naval Medical Research Center, 2016, $66,000.

“A Solid State Nanopore miRNA Quantification Technology”, National Institute of Health, 2016-2019, $600,000.

“An Integrated Microfluidics Platform for Rapid and Sensitive Exosome RNA Detection” , National Institute of Health, 2016-2018, $425,000.

“Next-Generation Diagnotic Devices for Genetically Modified Crops: Phase 2”, Far Eastern, 2016-2018, $600,000.

“Thermal Evaporation around Optically Excited Functionalized Nanoparticles”, National Science Foundation, 2017-2020, $350,000 (PI: Tengfei Luo).

“The impact of Nanostructure Geometry on Photo-Thermal Evaporation Processes”CASIS (Center for the Advancement of Science in Space), 2017-2021,$420,000 (PI: Tengfei Luo)

“SemiSynBio: CardiacMuscle-Cell-Based Couple Oscillator Network”, 2018-2020, $1,125,000 NSF and $375,000 SRC (PI: P Zorlutuna).

“miRNA-based Detection of Reperfusion Injury for Therapy Management in Myocardial Infarction”, National Institute of Health R01, 2018-2022, $1,635,000 (PI: Zorlutuna).

“An Automated High-Throughput Multiplexed Detection Platform for Real-Time Monitoring of Protein Fingerprints in Cell Media”,Advanced Regenerative Manufacturing Institute, 2019-2021, $1,327,442.

“High Throughput Electrokinetic Fractionation and Analysis of Extracellular RNA Nanocarriers”, NIH UG3/UH3 , 2019-2023, $2,935,500.

“Highly Sensitive Multiplexed Nanocone Array for Point-of-Care Pan Cancer Screening”, National Science Foundation, 2019-2022, $381,449 (PI: Tengfei Luo).

“Next-Generation Diagnostic Devices for Genetically Modified Crops: Phase 3”, Far Eastern, 2020-2022, $450,000.

“A Transformative and Commercializable Platform Technology for Exosome Assay: Cancer Immunotherapy, Diagnostics and Biomarker Discovery”, Walter Cancer Foundation Cancer Cure Ventures, 2020-2022, $200,000.

“Highly Sensitive Rapid Lateral Flow SARS-CoV-2 Antigen Test”, AdvancedDiagnostics and Therapeutics Initiative, Notre Dame, 2020-2021, $40,000.

“Receptor Cross-Talk in Early Metastatic Dissemination”, NIH, 2022-23, $469,498 (PI: Sharon Stack).

Graduate Students Supervised (47 total, 16 Academics in Bold)

I.) University of California, Santa Barbara

M. Aluko, Ph.D., 1983, "Multiple-Time-Scale Analysis of Heterogeneous Catalytic Reaction Systems". Current position: **Vice-Chancellor (President), Federal University, Otuoke, Bayelsa State, Nigeria**.

V. Ravindran, M. S., 1984, "Mathematical Modelling of a Cycling Zone Extraction Process".

A. Lahbabi, Ph.D., 1985, "Solution of Navier-Stokes Equation in Periodic Media". Current position: **Professor at Ecole Nationale de L'Industrie, Morocco**.

II.) University of Houston

R. Srinivasan, M. S., 1986, "Application of Spectral Methods to Asymmetric Bifurcation of Flow Fields in Symmetric Closed Domains".

S.-S. Ni, M. S., 1986, "Bubble Flow in Capillary Tubes".

S.-H. Hwang, Ph.D., 1987, "Control of Nonlinear Systems - An Application of Dynamic Singularity Theory". Current position: **Professor at National Cheng Kung University, Taiwan**.

E. Boe, Ph.D., 1988, "The Dynamics and Control of Nonlinear Systems Possessing a Large Time Delay". Current position: Vice-President of Research at Pavilion.

J. Ratulowski, Ph.D., 1988, "Mathematical Modeling of the Mechanisms of Bubble Transport in Single Capillaries". Current position: Director of Flow Characterization, Schlumberger Well Service.

S.-M. F. Chiao, Ph.D., 1988, "Viscoelastic Flow in a Cylinder with a Rotating Lid - A Galerkin/Spectral Formulation". Current position: **Professor at Tung Hai University, Taiwan.**

III.) University of Notre Dame

A. K. Singh, M. S., 1990, "The Stability of Rimming Flows".

S. Ghosh, M.S., 1991, "Chaotic Enhancement of Heat Transfer", Current position: Group leader of fuel cell program at United Technologies.

T. Prokopiou, Ph.D., 1992, "Nonlinear Waves on Liquid Interfaces". [Joint with M. J. McCready]. Current position: Owner of Gnomon consulting firm..

C. C. Chen, Ph.D., 1992, "Pattern Formation and Control". Current position: **Professor and Chair of Chemical Engineering at Chong-Cheng University, Taiwan.**

M. Cheng, Ph.D., 1994, "Sideband and Subharmonic Instabilities of Finite-Amplitude Monochromatic Waves". Current position: Researcher at Chevron Research.

C. K. Cheng, M.S., 1994, "Study of Wave Evolution in Gas-Sheared Films and Falling Liquid Films Using Optical Imaging".

S. Kalliadasis Ph.D., 1994, "Self-Similar Interfacial and Wetting Dynamics". Current position: **Professor of Fluid Mechanics, Chemical Engineering Department, Imperial College, England**.

M. Sangalli, Ph.D., 1995, [Joint with M. J. McCready],"A Study of Weakly Nonlinear Waves in Stratified Fluid-Fluid Flows and Distributed Reactors". Current position: Senior Research Engineer at UOP.

I. Veretennikov, Ph.D., 1997, "Experimental Study of Contact-Line Dynamics". Current position: Research Engineer, Bruker USA.

A. Indeikina, Ph.D., 1998, "Averaging over Multiple and Continuous Scales".
Curent Position: Mother and housewife.

R. Roberts, Ph.D., 1998, [Joint with M. J. McCready], "Interfacial Wave Behavior and Mass Transfer of Multi-Fluid Flows". Current position: Researcher at Chevron.

Y. Ye, Ph.D., 1998, "Instabilities of Thin-Film Waves and Fronts". Current position: Research Engineer at DuPont.

V. V. Yuzhakov, Ph.D., 1999, [Joint with A. E. Miller],"Electrochemical Self-Organizaiton of Ordered Nanoscale Structures". Current position: Manager, Bayer Diagnostics.

P. Takhistov, M.S., 1999, "Experimental Study of Electro-Hydrodynamic Phenomena". Current position: **Associate Professor at Food Science Dept, Rutgers University.**

J. Keith, Ph.D., 2000 [Joint with D. T. Leighton], "Novel Reactor Design for Pollution Reduction". Shaheen Awardee for best Notre Dame PhD. Notre Dame Saheen Best Engineering PhD Awardee. Current position: **Deavenport Professor and Dean of Engineering, Mississippi State.**

K. Duginova, M. S., 2002, “Suspensions in Micro-Channels”.

D. Kopelevich Ph.D. 2002, “Transport in Nano-materials due to Thermal Noise and Deterministic Dynamics”. Current position: **Associate Professor, Chemical Engineering, University of Florida (2007 NSF Career Awardee).**

S. Thamida, Ph. D. 2002, “Instability Mechanisms in Micro-Fluidics and Nano-Materials”. Current position: **Associate Professor, Chemical Engineering, India Institute of Technology, Tirupati.**

G. Arya, Ph. D. 2003 (joint with E. J. Maginn), “Molecular Simulation of Transport in Nanoporous Material”, Current position: **Professor, Mechanical Engineering, Duke University.**

A. Minerick, Ph. D. 2003, “Medical Diagnostic Microfluidics and Physiological Blood Flow Dynamics”, Current position: **Professor and Dean, Michigan Tech (2007 NSF Career Awardee), member of National Academy for the Advancement of Science.**

Y. Ben, PhD. 2004, “Nonlinear Electrokinetic Phenomena in MicroDevices”, Current position: **Assistant Professor, Chinese Academy of Science, Beijing**.

R. Zhou, Ph. D. 2006, “Microfluidics of Micro- and Nano-Colloidal Suspensions: Designing Future Miniature Diagnostic Devices”. Current position: Research Engineer, Rohm and Haas.

P. Wang, Ph. D. 2007, “Electrokinetic Pumping and Spraying at Micro- and Nano-Scales”. Current position: Research Engineer, Chevron.

D. S. Hou, Ph. D., 2008, “Designing Microfluidic Components for Analyte Concentratoin and Identification Using AC Electrokinetics”. Current position: Research Engineer, Merck.

S. Maheshwari, Ph. D., 2008, “Anomalous Microfluidic Behavior Near Singular Interfaces”. Current Position: Research Engineer, Silverbrook Research, Sydney.

Zachary Gagnon, Ph. D., 2009, “Integrated AC Electrokinetics: Fundamental Design and Analysis for Portable Cellular and Molecular Diagnostics”. Shaheen Awardee for best Notre Dame PhD. Notre Dame Saheen Best Engineering PhD Awardee. Current Position: **Associate Professor, Chemical Engineering, Texas A & M, 2014 (NSF Career Awardee)**.

Sagnik Basuray, Ph.D. 2011, “Dielectrophoresis and Its Application to Biomedical Diagnostic Platforms”. Notre Dame Saheen Best Engineering PhD Awardee. Current position: **Associate Professor, Chemical Engineering, New Jersey Institute of Technology. (NSF Career Awardee)**

Xinguang Cheng, Ph. D. 2011, “Singular Harmonics near a Taylor cone”. Current position: Analyst, Kemper Corp.

Nishant Chetwani, Ph. D. 2011, “AC Electrospray at Interfacial Singularities”. Current position: Research Engineer, Intel.

Yunshan Wang, Ph. D. 2014, “Novel Optical Biosensors: Singular Intensity Amplification and Molecular Trapping Enhancement at Nanoscales”. Current position**: Assistant Professor, Chemical Engineering, University of Utah.**

Daniel Taller, Ph.D. 2015 [joint with David Go], “Surface Acoustic Wave Microfluidics: Droplets, Pinned Liquid Films and Biodetection”. Current position: Research Scientist, Livermore National Lab.

Yu Yan, PhD. 2015. “Non-Equilibrium Ion Transport in Nanofluidic Devices”. Current position: Research Engineer, Google.

Gongchen Sun. Ph.D. 2017. “Nonlinear Ionic Circuits and Ionic Memristors for Integrated Liquid Biopsy Chips”, Current position: Postdoc, Georgia Tech.

Steven Marczak, Ph.D. 2017. “Beyond Equilibrium: Using Ion Concentration Polarization to Enhance the Detection and Selectivity of Nucleic Acids and the Isolation of Exosomes”, Current position: Researcher, Defense Intelligence Agency.

Diya Li, Ph.D. 2019. “A CNT Switch for Identifying and Classifying Breast Cancer Tumor Cells in Plasma: Enhancing Selectivity of Molecular Assay with Nanoscale Hydrodynamic Shear”, Current position: Analyst, McKinsey.

Zehao Pan, Ph.D. 2019. “Focused Electric Field: Nanoscale Hotspot and Droplet Electrokinetics for High-Resolution Bioanalysis”, Current position: Postdoc, Princeton.

Sebastian Sensale, Ph.D. 2020. “DNA Kinetics and Resistive Signals in Nanopore Devices”, Current position: Post-Doc, Duke University.

Current PhD Students and Expected Graduation Dates

Chenguang Zhang (2021) (BS: MicroElectronics, Peking University)
Vivek (2022) (BS: Chemical Engineering, IIT)
Sonu Kumar (2024) (BS: Chemical Engineering, IIT)
Kyle McCarthy (2024) (BS: Chemical Engineering, Iowa State)

Liao Chen (2024) (BS: Chemical Engineering, Wuhan University of Technology)

Post-Docs and Research Professors Supervised (23 total, 16 academics in bold)

W. Q. Lu, 1984-1986, Current position: **Research Fellow, Institute of Mechanics, Chinese Academy of Science, Beijing. (Retired)**.

L.-H. Chen, 1984-1990, Current position: **Professor, East China University of Chemical Technology, China. (Retired)**

Eugene Kalaidin, 1996-1999, Current position: **Professor and Chair, Department of Applied Mathematics, Kuban State University, Russia.**

P. Takhisotv, 2000-2002, Current position: **Associate Professor, Food Science Dept, Rutgers University.**

J. Wu, 2003-2004: Current position: **Professor, Electrical Engineering, University of Tennessee. (2005 NSF Career Awardee.)**

E. A. Demekhin, 1994-2004. Current position: **Professor, Krasnodar University, Russia**.

D. Lastochkin, 2003-2005. Current position: Post-doc at University of Notre Dame.

L. Yeo, 2003-2005: Current position: **Distinguished Professor, Mechanical Engineering, Royal Melbourne Institute of Technology, Australia (2007 Young Tall Poppy Award for Top Young Australian Academic).**

Z. Chen, 2004-2007. Current position: **Luojia Chair Professor, Associate Dean,Pharmaceutical College, Wuhan University, China.**

S. Sengupta, 2005-2007 Current position: **Associate Professor, Bioengineering Department, University of Missouri, Columbia**.

G. Yossifon, 2007-2009. Current position: **Professor, Mechanical Engineering Department, Tel Aviv University, Israel.**

R. Kuczinski, 2009-2010. Current position: Research Engineer, Genentech

Ming Kwan Tan, 2010-2011. Current position: **Assistant Professor, Mechanical Engineering Swinburne University, Sarawak, Malaysia**.

Jenny Ho, 2010. Current position: Start-up, Singapore.

Z. Slouka, 2009-2011, 2012-2014. Current position: **Associate Professor, Chemical Engineering, Prague Institute of Technology, Czech Republic**.

Larry Li-Jing Cheng, 2010-2013 (Research Professor) Current position: **Associate Professor, Electrical Engineering, Oregon State.**

Shoupeng Liu, 2013-2014 (Postdoc) Current position: **Associate Fellow, Souzhou Institute of Biomedical Engineering and Technology, Chinese Academy of Science**.

Yongfan Men, 2014-16 (Postdoc) Current position: **Associate Professor, Shenzhen Institute of Advanced Technology, Chinese Academy of Science, Shenzhen, China.**

Jarrod Schiffbauer, 2016-17 (Postdoc) Current position: **Assistant Professor, Colorado Mesa**

Sunny Shah, 2010-2017 (Postdoc, Research Scientist) Current position**:** Project Manager, Endotronix.

Ze Yin, 2017-2019 (Postdoc) Current position: Senior Engineer, Quantum-Si (next-gen protein sequencing)

Ceming Wang, 2015-2020 (Postdoc) Current position: Lead Engineer, Aopia Biosciences (cancer screening)

Zeinab Ramshani, 2016-2021 (Postdoc) Current position: Research Engineer, Mesoscale Diagnostics

Current Postdocs, Senior Scientists and Research Professors

S. Senapati, 2007-Present (Research Professor)
Xiaoye Huo, 2019-Present (Postdoc)
Himani Sharma, 2019-Present (Postdoc)
Nalin Minaya, 2019-Present (Postdoc)
Ceming Wang, 2021-Present (Visiting Industrial Scientist)
Youwen Zhang, 2021-Present (Postdoc)

Undergraduate Researchers and Visiting Students

Name	Year	Undergrad. University	Subject	Graduate School
Tanto Hartono	1988-89	Notre Dame	Chaotic Dynamics of a Surge Tank	Caltech
Grace Su	1991-92	Michigan	Falling Film Wave Dynamics	UCLA
See-Eng Pham	1993-95	Cornell	Colloidal Rheology	Princeton
Abhishek Agarwal	1995-97	Purdue	Rivulet Dynamics	Wisconsin (EE)
Carolina Wu	1997-99	Notre Dame	Fractal Dewetting	Cornell
Kathy Wu	1997-98	Stanford	Corrosion Dynamics	Industry
Eric Sherer	1997-00	Caltech	Crystallization Patterns, Corrosion Dynamics and Fast Igniting Catalytic Converters	Purdue
Assoc Prof, Louisiana Tech				
Alison Weltner	1999-01	Notre Dame	Physiodogical Dynamics of a Fish, DNA Sequencing with Wavelets	Industry
Justin Burt	2001-02	Notre Dame	Microfluidics for Diagnostic Kits	Texas
Kim Hatley	2004-05	Notre Dame	Biotissue for Drug Encapsulation	Industry
Andy Downard	2004-05	Notre Dame	Microfluidics and Tech Transfer	Caltech
Mike Coogan	2005-06	Notre Dame	Bacteria Detection	Industry
WenTao Luo	2005-06	Notre Dame	Microfluidics	Industry
Korey Chu	2005-08	Notre Dame	Microfluidics	Industry
Donny Putra	2006-07	Notre Dame	CNT Sensors	Hopkins
Assist Prof, Notre Dame				
Andy Aijia	2007-08	Notre Dame	CNT Impedance	UCLA
Patrick Kuscik	2008-09	Notre Dame	Genetic Diagnostics	Med School
Peter Musheheimer	2008-10	Notre Dame	Nanoslot Electrokinetics	Wisconsin
Bryan Caufield	2008-09	Notre Dame	Genetic Diagnostics	Industry
Lauren Floccare	2008- 09	Notre Dame	Nanocolloid DEP	Industry
Yunshan Wang	2008	Peking Univ	Nanofabrication	Notre Dame
Assist Prof, University of Utah				
Thomas Hagan	2009-10	Notre Dame	Nanocolloid Impedance	UC San Diego
Andrew Loza	2009-10	Notre Dame	RNA Sensing	Washington U. Med School
AndrewChapouros	2009-11	Notre Dame	DNA Sensing	Industry
David Riehm	2009-11	Notre Dame	Solar Cells	Minnesota
Paul Scheel	2010-11	Notre Dame	Protein Sensing	Northwestern Medical Sch.
Truong Pham	2011-12	Notre Dame	Photoconductive Sensing	Minnesota
Christine Rusting	2011-12	Notre Dame	Nanoporous Membrane Sensor	Industry
Andrew Ayoob	2011-12	Notre Dame	Proteomic Mass Spectrometry	Harvard
Nick Rodriguez	2011- 12	Notre Dame	Membrane Sensor	Northwestern
Dario Mazza	2012	Imperial	Photoconductive Sensing	Imperial
Mark Sonderman	2012	Notre Dame	Membrane Sensor	Industry
Nicholas Schmeidler	2012	Notre Dame	Membrane Sensor	Industry
Sara Dale	2012	Notre Dame	Surface Acoustic Wave Mass Spect	Industry
Nicole McMillan	2012	Notre Dame	Membrane Sensor	Industry
Annie Shepherd	2013	Notre Dame	Membrane Sensor	Industry
Robin Lawler	2013	Notre Dame	Membrane Sensor	Georgia Tech
Chris Walker	2013	Notre Dame	Membrane Sensor	North Carolina State
Hongtan Du	2013	Peking Univ.	Nanofunnel Agglutination	Peking Univ
Didi She	2013	Peking Univ.	Si Cone Plasmonics	Univ of Penn
Bihan Zhu	2013	Notre Dame	Nanocone Array	Cornell
Karla Gonzalez	2013	Monterey Tec.	AC Electrospinning	Notre Dame

Andrew Chang	2013	Chung Cheng	Integrated Chip	Post Doc
Katelin Hansen	2014	Notre Dame	Membrane Sensor	Industry
David Schipper	2014	Notre Dame	RT-PCR with Conductance Sensors	Industry
Yurui Qu	2014	Zhejiang Univ	Positive Gain Nanoparticles	Zhejiang
Jia Chloe Gao	2014	Fudan	Membrane Sensors	UC Berkeley
Franklin Mejia	2014	Monterrey Tech	Upconversion Nanoparticles	Notre Dame
Rose Dorfler	2014-16	Notre Dame	Endotoxin Detection	Fulbright Carnegie-Mellon
Paul O'Neil	2015	Dublin City U	3D Chip Fabrication	DCU
Flora Kleicmann	2015-16	Eotvos, Hungary	miRNA Separation	Pazmony Catholic
Elaine Smith	2016-17	Notre Dame	Depletion nanoparticle assay	Industry
Olivia Frasher	2017-19	Notre Dame	membrane sensor	Rice
Ellen Cathill	2017	UC Dublin	transdermal microneedle array	UCDublin
Miguel Joachim	2019-20	Notre Dame	protein membrane sensor	
Mary Chen	2020	Notre Dame	COVID Screening Test	
Connor Martin	2020	Notre Dame	COVID Screening Test	
Sabrina Antonucci	2020	Notre Dame	COVID Screening Test	
Grace Gasper	2020	Notre Dame	COVID Screening Test	
Jessica Dirksen	2020	Notre Dame	COVID Screening Test	

High-School Interns

Name	Year	High School	Subject	College/Graduate School
Ashok Agarwal	1998-99	Elkhart	Wetting	Purdue (BS) Wisconsin (PhD)
Alex Cao	2012-2013	Penn	PCR Chip	Notre Dame (BS)
Raymond Han	2012	Adams	Fuel Cells	University of Chicago