

# Lab on a Chip

Miniaturisation for chemistry, physics, biology, materials science and bioengineering

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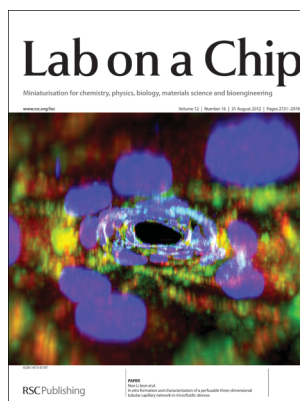
## IN THIS ISSUE

ISSN 1473-0197 CODEN LCAHAM 12(16) 2751–2978 (2012)



### Cover

See Ju Min Kim *et al.*, pp. 2807–2814. Image reproduced by permission of Ju Min Kim from *Lab Chip*, 2012, 12, 2807.



### Inside cover

See Noo Li Jeon *et al.*, pp. 2815–2822. Image reproduced by permission of Noo Li Jeon from *Lab Chip*, 2012, 12, 2815.

## HIGHLIGHT

2763

### Research highlights

Šeila Selimović, Gulden Camci-Unal, Mehmet R. Dokmeci and Ali Khademhosseini\*

Driving liquids on-chip using SAWs—Cell cycle synchronization—Aging of yeast.



## FOCUS

2766

### Surface acoustic wave (SAW) acoustophoresis: now and beyond

Sz-Chin Steven Lin, Xiaole Mao and Tony Jun Huang\*

Tony Jun Huang and co-workers discuss surface acoustic wave (SAW) acoustophoresis – Part of a series of Focus articles elucidating bio-related issues that impact on lab on a chip and microfluidic research.



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# Lab on a Chip

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*Lab on a Chip* publishes new developments, current applications and fundamental research associated with miniaturisation (on or off chips) at both the micro- and nano-scale across a variety of disciplines including: chemistry; biology; (bio)physics; electronics; clinical/medical science; (bio)engineering and materials science.

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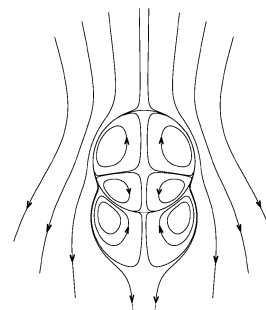
## FOCUS

2771

**Acoustofluidics 16: acoustics streaming near liquid–gas interfaces: drops and bubbles**

S. S. Sadhal

In this sixteenth tutorial of the series on “*Acoustofluidics – exploiting ultrasonic standing waves forces and acoustic streaming in microfluidic systems for cell and particle manipulation*,” we continue our discussion on the analytical aspects of the streaming phenomenon.



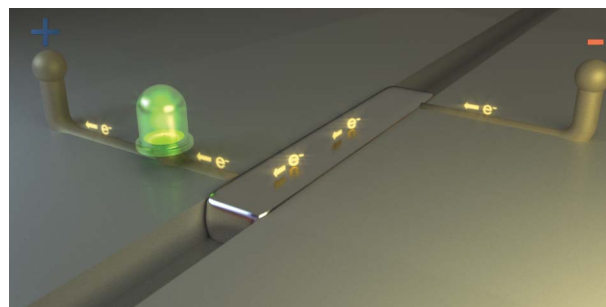
## CRITICAL REVIEW

2782

**Microfluidic electronics**

Shi Cheng\* and Zhigang Wu\*

In this review we cover recent research outcomes in the field of microfluidic electronics, and address current technical challenges and issues. The outlook of future developments in microfluidic electronic devices and systems, as well as new fabrication techniques, is also discussed.



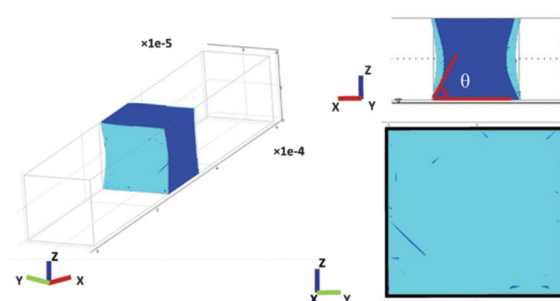
## COMMUNICATIONS

2792

**An electrokinetically driven micro liquid piston for leak-tight gas pumping**

Jian Jiao and Jae Wan Kwon

This paper introduces a new method for gas pumping with an electrokinetically driven liquid piston, which can provide a leak-tight sealing in a microfluidic channel by fully wetting inner surfaces without leaving any void spots.

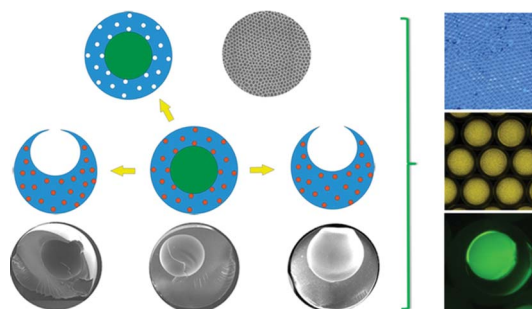


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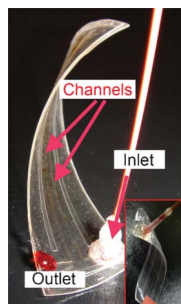
**Construction of multifunctional photonic crystal microcapsules with tunable shell structures by combining microfluidic and controlled photopolymerization**

Jianying Wang, Yuandu Hu, Renhua Deng, Wenjing Xu, Shanqin Liu, Ruijing Liang, Zhihong Nie and Jintao Zhu\*

A combined technique of microfluidic- and controlled-photopolymerization is developed to prepare multifunctional photonic crystal (PC) microcapsules with tunable shell structures.



2799

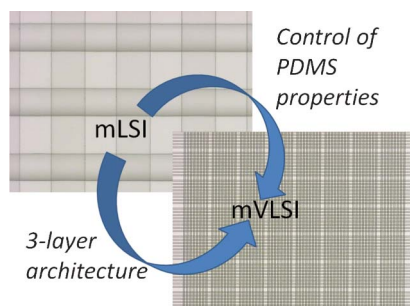


## Thermoplastic fusion bonding using a pressure-assisted boiling point control system

Taehyun Park, In-Hyounk Song, Daniel S. Park,  
Byoung Hee You and Michael C. Murphy\*

Pressure-assisted boiling point control of thermal fusion bonding yields strong bonds over multiple scales including flexible, three-dimensional geometries.

2803



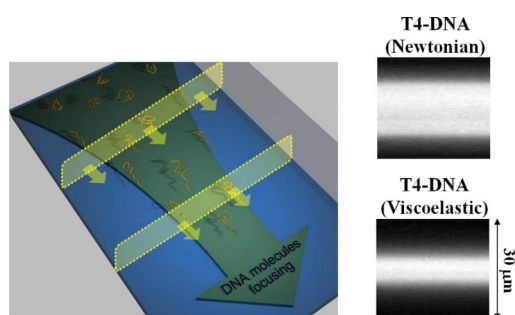
## Microfluidic very large scale integration (mVLSI) with integrated micromechanical valves

Ismail Emre Araci and Stephen R. Quake

Microfluidic very large scale integration (mVLSI), enabled by soft lithography, allows improvement of density by two orders of magnitude over the current technology.

## PAPERS

2807

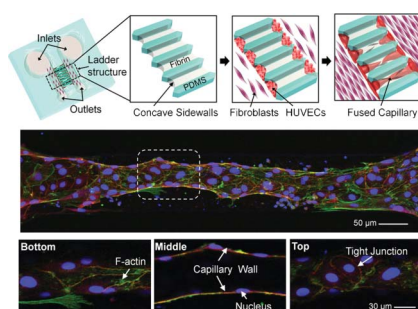


## Lateral migration and focusing of colloidal particles and DNA molecules under viscoelastic flow

Jae Young Kim, Sung Won Ahn, Sung Sik Lee and  
Ju Min Kim\*

We present a novel approach for the continuous focusing of sub-micron rigid particles and the enhancement of DNA focusing using the medium viscoelasticity of a dilute polymer solution.

2815



### ***In vitro* formation and characterization of a perfusable three-dimensional tubular capillary network in microfluidic devices**

Ju Hun Yeon, Hyun Ryul Ryu, Minhwan Chung,  
Qing Ping Hu and Noo Li Jeon\*

We demonstrated the *in vitro* formation and characterization of a perfusable capillary network made of HUVECs in microfluidic devices (MFDs). Using this platform an array of 3D tubular capillaries of various dimensions can be formed reproducibly and RBC and beads can flow through capillary vessels.

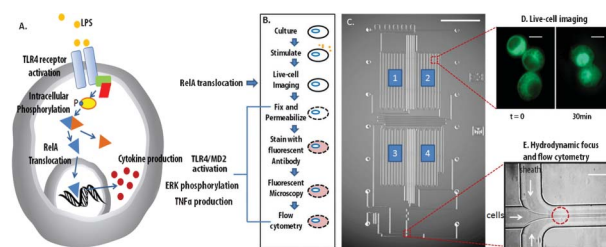


2823

### Microfluidically-unified cell culture, sample preparation, imaging and flow cytometry for measurement of cell signaling pathways with single cell resolution

Meiye Wu, Thomas D. Perroud, Nimisha Srivastava, Catherine S. Branda, Kenneth L. Sale, Bryan D. Carson, Kamlesh D. Patel, Steven S. Branda and Anup K. Singh\*

Microfluidically-unified cell culture, sample preparation, imaging and flow cytometry for measurement of cell signaling pathways with single cell resolution.

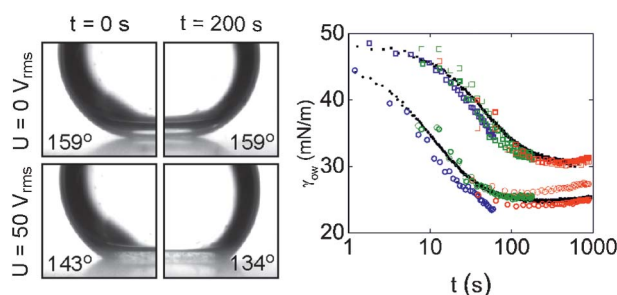


2832

### Use of electrowetting to measure dynamic interfacial tensions of a microdrop

Riëlle de Ruiter,\* Peter Wennink, Arun G. Banpurkar, Michèl H. G. Duits and Frieder Mugele

Analyzing the variation in contact angle with applied voltage allows simultaneous monitoring of the oil–water and effective water–substrate interfacial tension (difference)s.

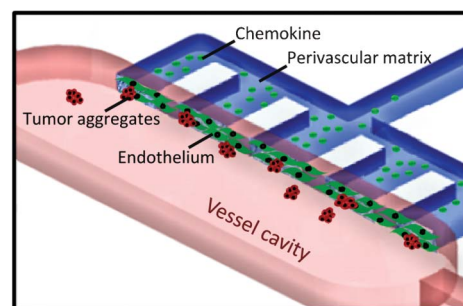


2837

### A microfluidic-based device for study of transendothelial invasion of tumor aggregates in realtime

Qian Zhang, Tingjiao Liu\* and Jianhua Qin\*

Blood vessel model for the study of transendothelial invasion of tumor aggregates.

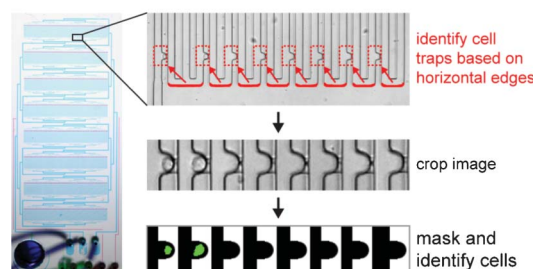


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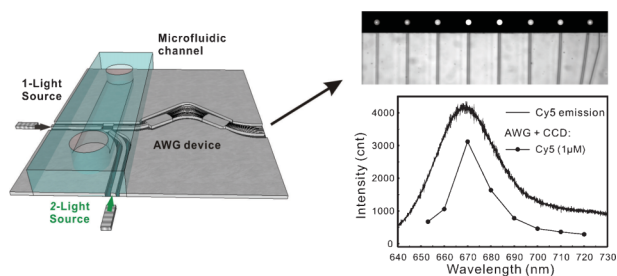
### Automated analysis of single stem cells in microfluidic traps

Stefan A. Kobel, Olivier Burri, Alexandra Griffla, Mukul Girotra, Arne Seitz and Matthias P. Lutolf\*

A versatile and fast algorithm is presented to segment microfluidic chips and to identify cells in single-cell traps.



2850

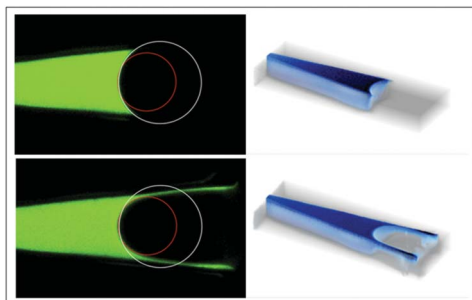


### Integrated microspectrometer for fluorescence based analysis in a microfluidic format

Zhixiong Hu, Andrew Glidle, Charles N. Ironside, Marc Sorel, Michael J. Strain, Jon Cooper and Huabing Yin\*

We developed an arrayed waveguide grating (AWG) microspectrometer integrated with microfluidics to perform spectroscopic fluorescence measurements as used in biological assays.

2858

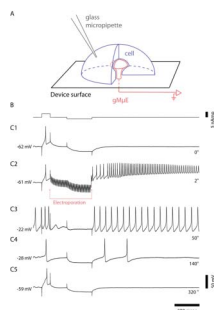


### Pinned films and capillary hysteresis in microfluidic channels

Yihong Liu, David D. Nolte and Laura J. Pyrak-Nolte

Tension from pinned films acts as an elastic tether that modifies the capillary curvature and shifts the pressure hysteresis in a microfluidic channel.

2865

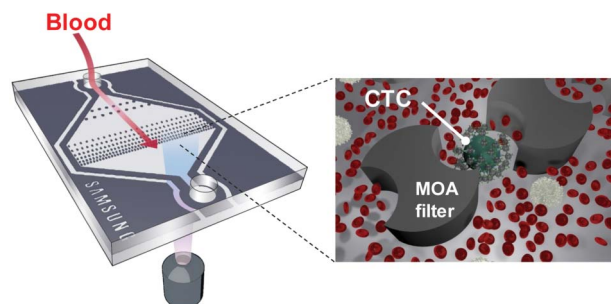


### On-chip electroporation, membrane repair dynamics and transient in-cell recordings by arrays of gold mushroom-shaped microelectrodes

Aviad Hai and Micha E. Spira\*

This study demonstrates the use of on-chip gold mushroom-shaped microelectrodes (gMμEs) to generate localized electropores in the plasma membrane of adhering cultured neurons and to electrophysiologically monitor the ensuing membrane repair dynamics.

2874



### SSA-MOA: a novel CTC isolation platform using selective size amplification (SSA) and a multi-obstacle architecture (MOA) filter

Minseok S. Kim, Tae Seok Sim, Yeon Jeong Kim, Sun Soo Kim, Hyoyoung Jeong, Jong-Myeon Park, Hui-Sung Moon, Seung Il Kim, Ogan Gurel, Soo Suk Lee,\* Jeong-Gun Lee\* and Jae Chan Park

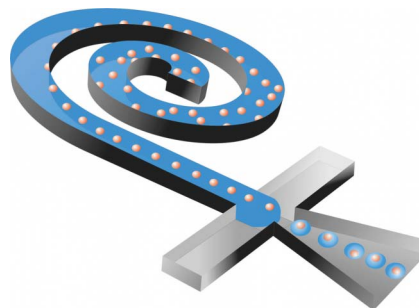
This paper describes a new CTC capture concept based on combining a size-based separation method with a novel multi-obstacle filter with high recovery rates and high purity.

2881

### High-yield cell ordering and deterministic cell-in-droplet encapsulation using Dean flow in a curved microchannel

Evelien W. M. Kemna,\* Rogier M. Schoeman, Floor Wolbers, Istvan Vermes, David A. Weitz and Albert van den Berg

This paper describes high-yield and high-speed single cell droplet encapsulation using Dean coupled cell ordering in a microfluidic device using a simple continuous curved microchannel.

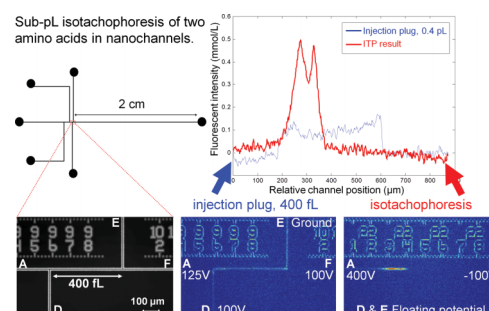


2888

### Limits of miniaturization: Assessing ITP performance in sub-micron and nanochannels

Kjeld G. H. Janssen, Jiajie Li, Hanh T. Hoang, Paul Vulto, Richard J. B. H. N. van den Berg, Herman S. Overkleeft, Jan C. T. Eijkel, Niels R. Tas, Heiko J. van der Linden and Thomas Hankemeier\*

Isotachopheresis was successfully miniaturized in sub-micron channels for the first time. An unexpected limit on upon further downscaling in nanochannels was encountered: The new phenomenon of electrocavitation.

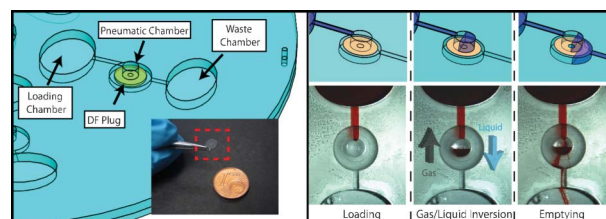


2894

### Centrifugo-pneumatic valving utilizing dissolvable films

Robert Gorkin III,\* Charles E. Nwankire, Jennifer Gaughran, Xin Zhang, Gerard G. Donohoe, Martha Rook, Richard O'Kennedy and Jens Duerée

Novel dissolvable film based valving in centrifugal microfluidics is examined for mechanical validation, biocompatibility, and sequential processing for automation of bioassay protocols.

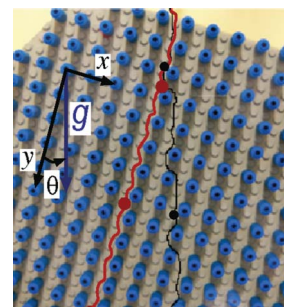


2903

### Force driven separation of drops by deterministic lateral displacement

Timothy Bowman, Joelle Frechette\* and German Drazer\*

Separation of drops using a scaled-up version of a force-driven deterministic lateral displacement ( $f$ -DLD) microdevice.



2909

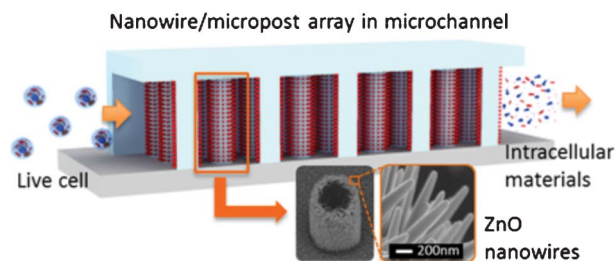


### A fluidic diode, valves, and a sequential-loading circuit fabricated on layered paper

Hong Chen, Jeremy Cogswell, Constantine Anagnostopoulos and Mohammad Faghri\*

We create a fluidic diode, a two-terminal component fabricated entirely on layered paper, to regulate wicking. We use the diode to build paper-based microfluidic valves and circuits.

2914

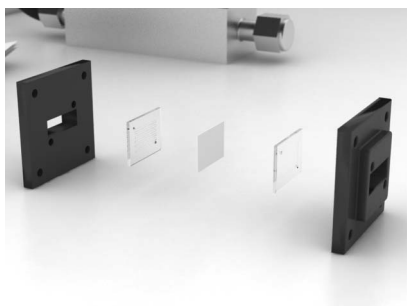


### Nanowire-integrated microfluidic devices for facile and reagent-free mechanical cell lysis

Jung Kim, Jung Woo Hong, Dong Pyo Kim, Jennifer H. Shin and Inkyu Park\*

We demonstrate a high-throughput and reagent-free mechanical cell lysis device using ZnO nanowire-integrated microfluidic channels to obtain both intracellular protein and nucleic acid molecules.

2922

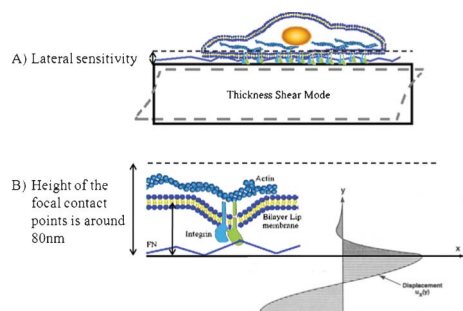


### Oxygenation by a superhydrophobic slip G/L contactor

Elif Karatay and Rob G. H. Lammertink\*

Micro-structured membranes that exceed the performance of flat membranes were integrated within microfluidic devices for gas-liquid contacting purpose.

2930



### Multi-modal biochip for simultaneous, real-time measurement of adhesion and electrical activity of neurons in culture

Massoud Khraiche and Jit Muthuswamy\*

We present a novel biochip capable of simultaneous, quantitative, real-time monitoring of integrin-mediated adhesion and electrophysiology of primary neurons *in vitro*. The proposed technology combines acoustic micro-resonators capable of tracking changes in neuronal adhesion and microelectrodes for recording extracellular unit activity.



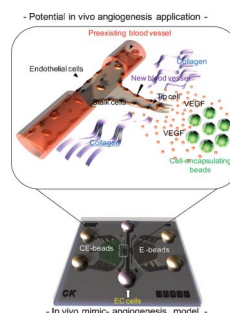
## PAPERS

2942

***In vitro* angiogenesis assay for the study of cell-encapsulation therapy**

Choong Kim, Seok Chung, Liu Yuchun, Min-Cheol Kim, Jerry K. Y. Chan, H. Harry Asada and Roger D. Kamm\*

We introduce a new assay for evaluating and quantifying capillary growth from an intact endothelial cell monolayer in response to factors released from human fetal lung fibroblasts encapsulated in beads.

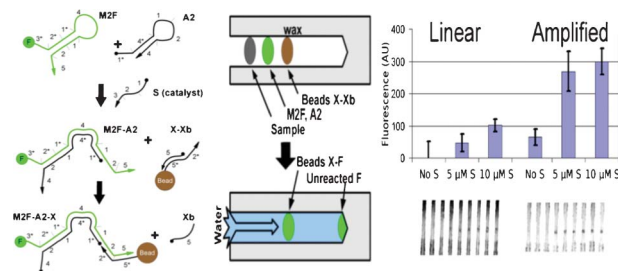


2951

**DNA circuits as amplifiers for the detection of nucleic acids on a paperfluidic platform**

Peter B. Allen, Seyed A. Arshad, Bingling Li, Xi Chen and Andrew D. Ellington

We apply non-enzymatic, DNA-based catalyzed hairpin assembly amplification to generate a readable signal within a paper-based analytical device.

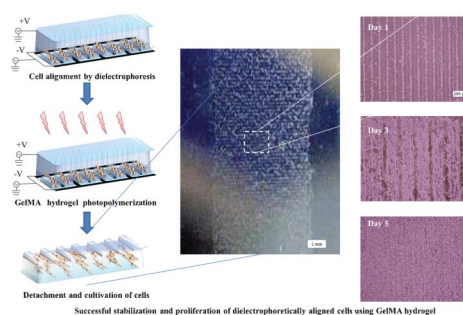


2959

**Gelatin methacrylate as a promising hydrogel for 3D microscale organization and proliferation of dielectrophoretically patterned cells**

Javier Ramón-Azcón, Samad Ahadian, Raquel Obregón, Gulden Camci-Unal, Serge Ostrovidov, Vahid Hosseini, Hirokazu Kaji, Kosuke Ino, Hitoshi Shiku, Ali Khademhosseini\* and Tomokazu Matsue\*

Establishing the 3D microscale organization of cells has numerous practical applications, such as in determining cell fate and in making functional tissue constructs.



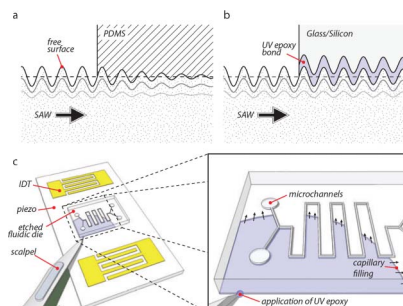
## METHOD

2970

**UV epoxy bonding for enhanced SAW transmission and microscale acoustofluidic integration**

Sean M. Langelier, Leslie Y. Yeo and James Friend\*

Surface acoustic waves (SAWs) are appealing as a means to manipulate fluids within lab-on-a-chip systems.



The 16th International Conference on  
Miniaturized Systems for Chemistry and Life Sciences

## CALL FOR PAPERS and ADVANCE ANNOUNCEMENT



Date : **Oct.28-Nov.1,2012**

Location : **Okinawa Convention Center**  
4-3-1 Mashiki, Ginowan City, Okinawa, Japan

Conference Chair : **Teruo Fujii**  
*IIS, University of Tokyo, JAPAN*



The Sixteenth International Conference on Miniaturized Systems for Chemistry and Life Sciences ( $\mu$ TAS2012) will be held at the Okinawa Convention Center in Okinawa, Japan from October 28 to November 1, 2012.

$\mu$ TAS 2012 continues a series of Conferences that are the premier forum for reporting and exchanging research results in microfluidics, microfabrication, nanotechnology, integration, materials and surfaces, analysis and synthesis, and detection technologies for life science and chemistry. The Conference offers plenary talks as well as contributed oral presentations and posters selected from submitted abstracts. Following Tokyo in 2006, Paris in 2007, San Diego in 2008, Jeju in 2009, Groningen in 2010, and Seattle in 2011, we anticipate over 900 international scientists and professionals engaged in research on and in the use of integrated microsystems and nanotechnology for chemistry and life sciences.

### IMPORTANT DATES

**Abstract Deadline : April 15, 2012**

**Author Notification : June 20, 2012**

**Manuscript Deadline : July 23, 2012**

### TOPICS

#### Microfluidics and Nanofluidics

- Micro / Nano Liquid Handling
- Micro / Nano Flow Measurement
- Fluid Mechanics / Modelling
- Multi-Phase & Digital Microfluidics
- Multiscale / Integrative Microfluidics

#### Life Science Applications

- Omics Technologies
- Drug Development / Analysis
- Cell Culture / Handling / Analysis
- Tissue Engineering
- Implantable Devices

#### Analysis and Synthesis Applications

- Separation Science
- Microreactors
- Flow Chemistry / Synthesis
- In-Line Analysis / Process Control
- Integrated Process Systems

#### MEMS and NEMS Technologies

- Micro - & Nanofabrication
- Materials and Surface Modification
- Microfluidic Components and Packaging
- New Device Materials
- Integration Technologies

#### Nanotechnologies

- Nanoengineering
- Molecular Systems
- Nanobiotechnology
- Nanoassembly
- Nanostructured Materials

#### Imaging and Detection Technologies

- Visualization
- Optical / Optofluidic
- Electrochemical
- Mass Spectrometry

#### Integrated Sample-to-Answer Systems

- Point-of-Care Testing
- Clinical Diagnostics
- Forensics
- Integrated Analytical Systems

#### Application to Green Technologies

- Fuel Cells / Solar Cells
- Low Carbon/Emission Technologies
- Water / Air / Soil Management
- Building / Architecture
- Other Energy / Power Devices

#### Other Applications

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- Food & Nutrition
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