# Microsystems Monthly

**Registration open**

**-MEMS Alliance Fall Symposium**

**MEMS, Nano and Microsystems in the Green Revolution**

Oct 1, 2009
Issue 8


**Mid-Atlantic MEMS Alliance Mission Statement:** To network expertise, capabilities, and research to facilitate the development of new applications and commercialization of miniaturization technologies.


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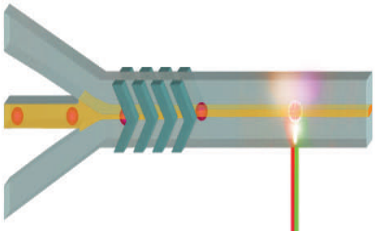
***The Naval Research Lab (NRL) in Washington, DC is the Navy's corporate research lab.*** *In this issue, we continue our NRL MEMS/microsystems focus.*

*By M.W. Pruessner, with M. Christophersen, J.S. Kim, F.S. Ligler and H.S. Newman*

## Micro-Opto-Fluidic Bio-Sensors



A significant research effort at NRL's Center for Bio-Molecular Science and Engineering is aimed at developing microfabricated systems for bacteria and toxin detection. Jason Kim, part of a team led by Frances Ligler, has developed a novel micro-opto-fluidic cytometer capable of detection sensitivity equal to that of much larger commercial systems.

Flow cytometry is an established technique by which individual particles or cells in a fluid flow can be counted and analyzed using optical or electronic means. More specifically, fluorescence-based flow cytometry uses optical probing of the particles with lasers. The resulting fluorescence signals (wavelength and signal strength) uniquely identify the particles/cells. A key step towards miniaturization has been the development of an inexpensive microfluidic particle focusing system that utilizes periodic angled (chevron-shaped) grooves and fluidic channels fabricated in PDMS. Ligler's team found that the chevron grooves result in three-dimensional focusing of a stream of particles suspended in a fluid flow. The cross-section focus area is as small as 24 um wide by 34 um high.

Next, Kim aligned optical fibers on the microfluidic chip for fluorescence excitation of the focused particles; the fibers transmit laser light at 532 nm and 635 nm wavelength, respectively. The resulting fluorescence and scattered light emissions were interrogated with four collection fibers. Measurements showed that the micro-flow-cytometer exhibits bacteria and toxin detection sensitivity similar to a much larger commercial system. A significant advantage results from multi-wavelength probing, which enables multiplexed detection of several analytes present in a single fluid stream. The team's device is inexpensive and can potentially be used for point-of-care diagnostics.

The work was recently published in the journal *Analytical Chemistry* (J.S. Kim et al., 2009). Further, Kim and Ligler have prepared *The Microflow Cytometer* (scheduled release 2010, PanStanford Publishing), a text describing the development of microfabricated flow cytometers with contributions from other NRL scientists and top researchers from academia, government, and industry.

# MEMS ALLIANCE—MIDATLANTIC

## Chairperson's Notes———-

The November 30, 2009 MEMS Alliance Symposium "Micro- and Nano- technology in the Green Revolution: Energy and Environmental Sensing" is shaping up to be our most exciting Symposium yet, and based on initial response we are expecting record attendance. Please note that this year we are offering a free luncheon at the French Embassy (which is a short walking distance from the conference venue) for the first 60 registrants. We are expecting these spaces to be used up quickly, so please register soon. Registration is available on-line at www.mems-alliance.org.

We are pleased to announce that Professor Frank Tittel of Rice University will be giving our keynote address in the area of micro-technology for environmental sensing. Professor Tittel has been involved in many innovative developments in quantum electronics and laser technology since the discovery of the laser in 1960, with applications ranging from laser spectroscopy to environmental monitoring. His most recent devices utilize telecommunications technology and novel quantum cascade lasers to achieve compact, robust instrumentation that can be deployed for field applications, such as at NASA's Johnson Space Center related to air and water quality issues relevant to the International Space Station, by the Environmental Protection Agency for urban formaldehyde monitoring, and by the National Institute of Health for non-invasive NO and CO detection in biomedical systems. Long-term, sensitive, selective, and real time trace gas monitoring and quantification has been realized for trace gas concentrations ranging from the part per million to the part per trillion levels in ambient air using laser absorption spectroscopy with fiber amplified diode laser and quantum cascade laser based gas sensors.

For our Energy keynote address, we are thrilled to welcome Professor Pradeep Haldar of the newly formed School of Nanosciences and Nanoengineering at the University at Albany, State University at New York (SUNY). Dr. Haldar also serves as Director of the Energy and Environmental Technology Applications Center, Albany NanoTech. Dr. Haldar has assisted several start-up and larger companies in technology development initiatives and to overcome technical, market and business development barriers by accelerating the insertion of nanotechnology into energy and environmental application areas including fuel cells. Prior to joining the University at Albany, Dr. Haldar served as General Manager and Technical Director of IGC-SuperPower, LLC, where he was responsible for the formation and startup of rapidly growing SuperPower, a new subsidiary of Intermagnetics General Corporation.

Finally, we are pleased to announce the speakers for our invited technical sessions: Professor Gary Rubloff of the University of Maryland and Dr. Jerry Fitzpatrick of NIST for the Energy session, as well as Dr. Todd Stievater of the Naval Research Laboratory and Dr. Bill Heaps from NASA/Goddard Space Flight Center for the Environmental Sensing track.

Please register today, and help get the word out to your colleagues about this opportunity to hear world class speakers, network and have fun.

Best regards,

Brian Jamieson

THE WHITE HOUSE

****Patrick Gallagher Nominated as As Director of NIST - President Obama nominated Patrick Gallagher, for Director of the National Institute of Standards and Technology, Department of Commerce. Dr. Gallagher is currently the Deputy Director and Acting Director of NIST, a position which provides high-level oversight and direction for agency. Dr. Gallagher received his Ph.D. in physics at the University of Pittsburgh in 1991 and joined NIST in 1993 as an instrument scientist at the NIST Center for Neutron Research (NCNR). Dr. Gallagher became Director of the NCNR in 2004, where he served until assuming his current duties as NIST Deputy Director in September 2008. From 1999 to 2001, Gallagher was a NIST agency representative at the National Science and Technology Council. He remains active in the area of U.S. policy for scientific user facilities and has chaired the Interagency Working Groups on neutron and light source facilities

# Funding Opportunities

*****National Science Foundation - Additional NSF funding listed here:

http://www.nsf.gov/funding/

Small Business Innovation Research Program Phase I Solicitation-2 FY-2010 (SBIR) - The Small Business Innovation Research (SBIR) Program stimulates technological innovation in the private sector by strengthening the role of small business concerns in meeting Federal research and development needs, increasing the commercial application of federally supported research results, and fostering and encouraging participation by socially and economically disadvantaged and women-owned small businesses. Full Proposal Deadline(s) (due by 5 p.m. proposer's local time): December 03, 2009 (Do not submit a proposal prior to 3 November 2009.)

DARPA BAA 09-71, Bioinspired Nanophotonics, FedBizOpps/CBD 17 August 2009.

DARPA SN-09-62, Novel Energy Storage Systems (NESS), FedBizOpps/CBD 24 August 2009.

USSOCOM F2VUG0-BAA-USSOCOM-200900817, Science and Technology Broad Agency Announcement, FedBizOpps/CBD 17 August 2009.

*****Nominations Open for New Award Recognizing Outstanding Researcher-Entrepreneurs - The Ewing Marion Kauffman Foundation and the National Postdoctoral Association announced that they are accepting nominations for the Outstanding Postdoctoral Entrepreneur Award, which recognizes a researcher who has successfully brought his or her discovery to market. Nominees must have completed postdoctoral training in the United States and founded companies to commercialize their scientific discoveries. (To learn more about eligibility requirements for the award, go here.) The winner of the award, which includes a $10,000 honorarium, will be announced at the NPA's annual meeting in March 2010 in Philadelphia. Learn more about the Outstanding Postdoctoral Entrepreneur Award. Click here for the nomination form. Nominations must be submitted electronically or by mail by 2 November 2009.

# Upcoming Events


**PowerMEMS 2009 (http://www.powermems.org/ )**

The 9th International Workshop on Micro and Nanotechnology for Power Generation and Energy Conversion Applications Washington DC Dec 1-4, 2009 www.powermems.org.

ALSO: The 8th Annual IEEE Confeerence on Sensors is 25-28 October 2009 in Christchurch, Canterbury New Zealand IEEE Sensors 2009 Conference (http://www.ieee-sensors2009.org/)


8:00 a.m. - 4:00 p.m. Georgetown University
3700 O St NW
Washington, DC 20057-0002 ***For Agenda Click Here >>***

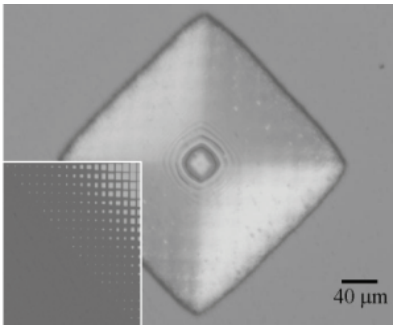
- **Featuring Keynote Addresses from Pradeep Haldar (SUNY/Albany)and Frank Tittel (Rice University)Poster Session with best student poster award**
- **Technology Pull panel discussions, matching government and commercial technology pull w/ technology pushes**

Registration Now Open >>

| REGISTRATION FEES: | |
|---|---|
| **Early Registration (First 60 Registrants, includes Lunch at the French Embassy Cafeteria)** | **$175** |
| **Regular Registration** | $175 |
| **At The Door** | $225 |
| **Student** | $100 |
| **Student w/ First Author Poster*** **abstract must be submitted w/ registration* *See Student Poster Presentation Rules >>* | **$75** |

NRL/MEMs and Microsystems continued from page 1

## 3-D Gray-Tone Lithography Via Contact Aligner

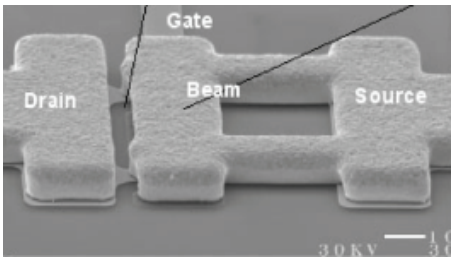



Three-dimensional lithography techniques are being developed at NRL for various applications. Gray-scale lithography aims to create arbitrary 3-D profiles in photo-resist. Analog gray-scale masks, such as HEBS glass, control the light transmission by local transparency of the mask material. The realization of gray-scale with binary quartz/chrome halftone masks is more complicated. Traditionally, this is done by creating *sub-resolution* pixels and patterns on a photo-mask, creating a local blur effect during exposure that leads to pre-determined curved resist profiles. In order to blur the mask features adequately, expensive projection lithography is used.

Marc Christophersen, a postdoctoral researcher in the Space Sciences Division at NRL has a different approach. He has developed a technique to randomize light using an optical diffuser in combination with an inexpensive contact aligner. Diffusers are commercial optical components commonly used in the spread and homogenization of otherwise non-uniform illumination. It is well-known that common surface diffusers such as ground glass and holographic diffusers scatter light with a Gaussian intensity profile. A new generation of diffuser elements enables control not only of diffusing angles but also the distribution of energy with high efficiency. In contrast to the *sub-resolution* pixels used in projection gray-scale lithography, Christophersen's technique enables the use of large pixels (>2.5 um) in a standard contact aligner. The diffuser serves to blur the pixels, resulting in a smooth variation of the dose reaching the photoresist. The technique is simple, does not require expensive sub-resolution photomasks, and can be performed on any standard contact aligner.
Sinusoidal gratings and optical lenses have been demonstrated in photoresist (M. Christophersen et al., *Appl. Phys. Lett.* 2008). Curved radiation detectors were presented at the *2008 Nuclear Science Symposium* (B. Phlips et al.).

## Reliability of RF MEMS Switches

Microwave and RF switches are an active research area in the MEMS community. As with most switches, the insertion loss, isolation, and operating bandwidth are a primary consideration. However, and perhaps more importantly, the lifetime and reliability of these switches needs to be studied, especially if the switches are to be used in non-serviceable applications and environments.




Harvey Newman has been studying RF MEMS switching devices for a DARPA-sponsored program in the Electronics Science & Technology Division at NRL. In particular, he has been looking at their reliability over many switching cycles. The RF device under investigation, fabricated by Radant MEMS Inc., of Stow MA, consists of an electroplated cantilever beam that forms part of a single-pole-single-throw (SPST) switch. In order to increase reliability, the devices were packaged using a wafer-capping process that results in a hermetic seal. During initial testing the switches exhibited 0.4 dB insertion loss and better than 20 dB isolation at 10 GHz. The bias required to deflect the cantilever and hence switch the device was 60 V. Lifetime and reliability testing was performed with a 10 GHz source signal at 20 dBm and a switching bias of 90 V. The tests were done at a cycle rate of 20 kHz and took over 17 months of continuous testing to accumulate the data. Although some devices failed early on due to electrostatic discharge damage, most devices lasted far longer with several achieving 914 billion cycles, with a median lifetime of over 430 billion switching cycles. RF MEMS switches have thus been shown to be reliable enough for system insertion opportunities as well as environments where repair or replacement is not an option. Newman and his DoD co-workers published their findings in the Journal *IEEE Microwave and Wireless Components Letters* (2008).

## Reza Ghodssi Appointed Director of the Institute for Systems Research at University of Maryland

A. James Clark School of Engineering Dean Darryll Pines has announced that Professor **Reza Ghodssi** will become the new director of the Institute for Systems Research (ISR), effective October 1, 2009, for a five-year renewable term.

"Dr. Ghodssi brings exceptional research, management and interpersonal skills to his new role, and possesses the vision needed to propel this excellent and well regarded institution to still higher levels of accomplishment and impact," Dean Pines said. "I congratulate Dr. Ghodssi on his appointment, and encourage all of you to offer him your support."

"The ISR director provides the institute research, education, and administrative leadership, identifying new research directions, coordinating emerging opportunities with faculty interests, and developing large project funding from government and industry," Dean Pines said. "Dr. Ghodssi is eminently prepared for these tasks."

Dr. Ghodssi is the Herbert Rabin Distinguished Professor and holds a joint appointment in the Department of Electrical and Computer Engineering and ISR. At the Clark School he also is affiliated with the Fischell Department of Bioengineering and the Materials Science and Engineering Department; his university affiliations include the University of Maryland Energy Research Center and the Maryland NanoCenter. Dr. Ghodssi is the director of the Microelectromechanical Systems (MEMS) Sensors and Actuators Lab.