Spring 2007

WIMS WORLD

Director's Message

Spring is a wonderful time of year, but it is busy. In April, our Annual Report for the National Science Foundation is due, and in May our Industrial Advisory Board meets along with our NSF Site Visit. These events give us an opportunity to take stock of where we are, and today the ERC has 118 projects involving 174 graduate and 190 undergraduate students working under 32 faculty members across 9 universities. It has graduated over 50 Ph.D. students in the past two years, and our two testbeds—the Environmental Monitoring Testbed (EMT) and the Implantable Neural Prostheses Testbed—are now hot topics worldwide. Our pre-college short courses have enrolled 955 students to date, including 489 women and 658 minorities, and of those who have now started college, 80% have majored in science or engineering. Not nearly as many would have selected these majors without the exposure to WIMS. We shared all this with our IAB and Site Visit Committee in May and had a very productive three-way exchange.

In June, the biennial *International Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers '07)* was held in Lyon, France. It was good to see old friends and new progress. Many of the developments in nanotechnology are of particular interest for sensing, and it is clear the WIMS ERC is in a great position to take advantage of them. The University of Michigan presented 18 papers at the meeting and was one of its strongest contributors. Denver, Colorado, will be the site of the 2009 meeting, with Khalil Najafi serving as general chair and Chip Spangler managing local arrangements; then in 2011 it will be on to Beijing, China, and after that, in 2013, to Barcelona, Spain.

The next three years will see increasing ERC focus in two areas. The first will be to bring our testbed microsystems to closure. This may not mean solving all of the problems, but it will mean reaching important milestones. For the μGC, it will mean fielding a working microsystem that combines high speed and high resolution in a device the size of a small calculator, understanding the device's power/speed/size limits, and moving it toward commercialization. For the neural microsystem, it will mean realizing a dime-size device, applying it to breakthrough mapping experiments, and, again, commercialization. Both of these are tall orders.

The second focus will be on better positioning the ERC for life beyond NSF funding. Integrated microsystems will continue as the likely theme, but should they be approached from a technology perspective or from within a single application area? Technology is what we do. It is our strength. Integrated microsystems are going to be pervasive in all kinds of applications, tackling most of the problems we will face in coming decades. A technology focus plays to the real strength of microsystems —their pervasiveness—but there are arguments for an application focus as well. Real impact is made not through technology itself but through applications of that technology to improving quality of life; even a single area such as health care can provide many opportunities for doing that. Ultimately, we must appeal to a broader segment of the population than just technologists, and we must get to the application stage. One thing is clear, whether the focus is based on technology or application, the ERC will need to involve leaders from across academia, from across the country, and from across the world, because whatever we do, we must strive to be the very best at doing it. We face some formidable problems, and we need real solutions, not just scattered efforts. ■

The International Steering Committee for Transducers '07 at their meeting in Lyon, France. Of the 21 people in attendance, 5 had Michigan backgrounds.

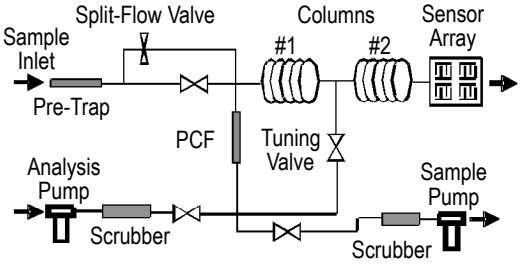
Ken D. Wise

Director, Engineering Research Center for
Wireless Integrated MicroSystems

Research Highlights

Rapid Determination of Environmental Tobacco Smoke Markers at Part-Per-Trillion Levels

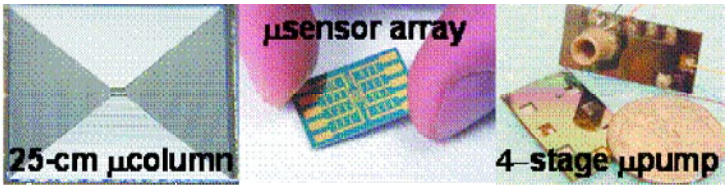
Qiongyan (Judy) Zhong and Edward T. Zellers

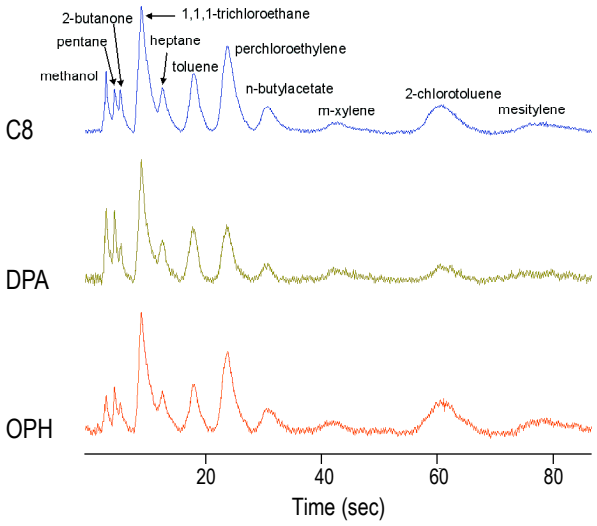


Environmental tobacco smoke (ETS) is a complex mixture of compounds collectively classified by the International Agency for Research on Cancer as carcinogenic. The complexity of ETS and the presence of confounding sources in many environments have impeded accurate exposure assessments and have led to efforts to find surrogate measures of ETS contamination levels. Two such markers are 3-ethenylpyridine (3-EP) and 2,5-dimethylfuran (2,5-DMF). In a study completed this year, selective preconcentration, dual-column separation, and sensor-array detection were combined in a meso-scale gas chromatograph for the determination of these two markers in a complex matrix of indoor air pollutants. Conditions were established to quantitatively capture the markers, separate them from the 34 most prominent co-contaminants found in real-world samples (from a bowling alley), and detect them using response patterns from a chemiresistor array coated with gold-thiolate nanoparticles, using ambient air as the carrier gas. A complete analysis can be performed every 15 minutes. Projected detection limits are 580 and 80 parts-per-trillion for 2,5-DMF and 3-EP, respectively, for a 1-liter sample volume, which are sufficiently low to determine these markers in typical smoking-permitted environments. This project entailed collaborations among three departments across the University of Michigan campus (Environmental Health Sciences, Chemistry, and Electrical Engineering and Computer Science), as well as a small manufacturer of gas monitoring instrumentation. Results are being used to guide the application of the WIMS μGC, which shares several design features and the same detector technology, to similar environmental monitoring problems. ■

First Micropump-Driven Micro Gas Chromatograph Separation

William H. Steinecker, Hanseup S. Kim, Gordon R. Lambertus, Shaelah M. Reidy, Robert J. Gordenker, Khalil Najafi, Kensall D. Wise, and Edward T. Zellers



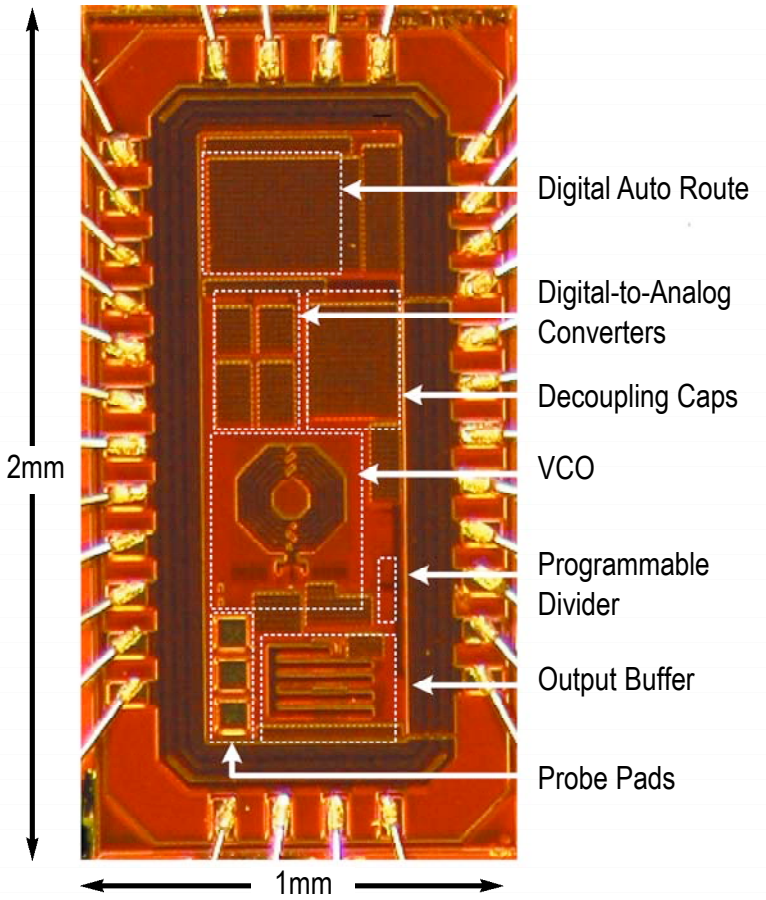


The capability of gas chromatographic (GC) analyzers to separate and quantify the components of complex vapor mixtures renders them invaluable tools for chemical analysis. The WIMS μGC development program exemplifies efforts by several groups around the world to realize a high-performance gas analyzer small enough to fit in a shirt pocket or be deployed unobtrusively in the environment as part of a wireless sensing network. Among several unique features of the WIMS μGC that set it apart from contemporary alternatives is the incorporation of a MEMS vacuum pump to provide gas transport through the microsystem. Since prior efforts to develop low-power micropumps with a combination of high-volumetric gas flow and high-differential pressure generation have been unsuccessful, gas analyzers have had to rely on large off-chip pumps, which preclude full miniaturization and limit field applications. Last year, we reported on the development of such a micropump. This year, we have succeeded in integrating it with a microcolumn and a microsensor array to achieve the first micropump-driven, multi-vapor chromatographic analysis ever reported. The separation and detection of 11 volatile organic compounds with this all-MEMS microsystem was achieved in less than 80 seconds, while consuming just 15mW of power. With temperature programming this analysis can be completed in 24 seconds with only a slight loss in resolution. ■

A Digital Fractional-N Frequency Synthesizer With Improved Data Rate and Energy Efficiency

Michael P. Flynn and Mark A. Ferriss

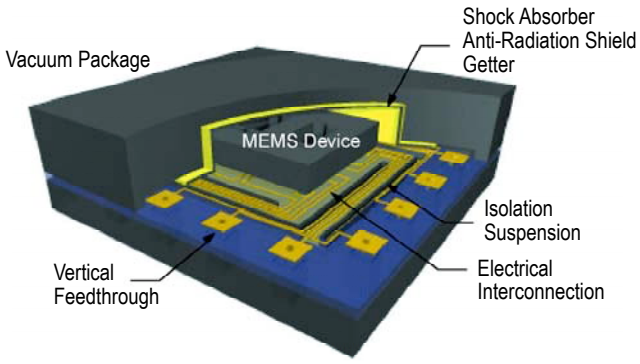
A fractional-N frequency synthesizer is a key building block of wireless systems because it can both generate a high-frequency signal with a well-defined frequency and modulate that signal, allowing an entirely wireless transmitter to be implemented with only a fractional-N frequency synthesizer and a power amplifier. Two limitations of this architecture have been overcome: the reliance on complex analog circuitry in deep sub-micron technology, and the trade-off between low-loop bandwidth for good ΣΔ noise rejection and high-loop bandwidth for fast modulation rates. First, new techniques make the design more straightforward by eliminating analog circuitry, which in turn improves energy efficiency by allowing signal processing to be done digitally in nanometer complimentary metal oxide semiconductor (CMOS) technology. Specifically, the new architecture uses a novel all-digital phase detector in place of the conventional analog-intensive phase detector, charge pump, and loop filter blocks. Second, a digital dual-modulation scheme is used to alleviate the tradeoff between loop bandwidth and modulation rates. A 14mW, 2.2GHz minimum shift keying (MSK) transmitter with a transmission rate of 927.5kbit/s has been demonstrated. Energy efficiency is improved by a factor of 3 compared to the state-of-the-art. ■



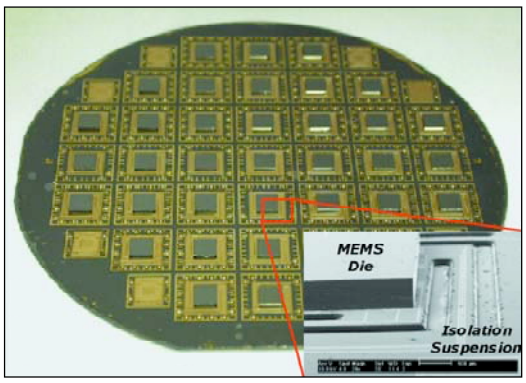
A Generic Packaging Technology to Protect Microsystems From Harsh Environments

Sang-Hyun Lee, Sang Woo Lee, and Khalil Najafi

To improve the performance of sensors, harmful environmental effects must be eliminated. A new generic microsystem packaging technology comprising thermal and vibration isolation, as well as vacuum/hermetic encapsulation, has been developed. Microsystems containing sensors can be mounted on top of an isolation platform fabricated from 100μm-thick glass. The platform is supported and suspended using 100μm-thick glass tethers, which provide excellent thermal isolation and mechanical support. Using a temperature sensor and heater, the microsystem is maintained at constant temperature with minimal power. Vertical feedthroughs transfer signals to and from the microsystem. All manner of devices can be transferred to the platform at the die or wafer level using a generic process. In addition to the isolation platform, the technology comprises vacuum encapsulation. Vacuum pressures as low as 30mTorr have been achieved, and a micromachined gyroscope has been integrated into the packaging technology as well. ■



Schematic view of the package, showing the protected microsystem sensor, in this instance, a MEMS device.



Sensor dice batch transferred onto glass isolation platforms (before vacuum encapsulation).

Recent Events

National Science Foundation Site Team Visit and Industrial Advisory Board Meeting Held in May

The WIMS ERC hosted its annual NSF Site Team Visit and IAB Meeting on the University of Michigan's North Campus, May 15–16, 2007. This year, a joint meeting for both NSF and the IAB was held at the Lurie Engineering Building. WIMS ERC Director Ken Wise offered a Center update, and the thrust leaders apprised participants of the latest advances in their areas of research, followed by discussions. Separate poster sessions were held for both the NSF site team and IAB members at the Duderstadt Center gallery. Attendees had the opportunity to meet with WIMS graduate students at their posters to explore the projects in detail. Some posters were accompanied by physical demonstrations. Among these was a demonstration provided by students from the University of Puerto Rico at Mayaguez, who displayed the functionality of the cochlear implant using three modules. The first module was a labview interface to simulate transmission of amplitude and frequency data to the implant's microcontroller. The second module demonstrated command word generation, and the third demonstrated site addressing and amplitude modulation by driving appropriate light-emitting diodes (LED) represented on a graphical interface. Michigan Technological University's demonstration of the Data Acquisition Cube (DAC), developed by the WIMS MTU Enterprise Team, revealed how high-school students are taught to make scientific measurements of acceleration using the DAC and an acceleration probe. These two devices allow the students to generate acceleration graphs which they subsequently evaluate to reach conclusions. Another notable demonstration was arranged by students from the University of Utah. They showed the interoperability between two chips developed by University of Michigan students: the WIMS Gen-2 processor developed by Eric Marsman and Rob Senger, and the Cochlear ASIC developed by Pamela Bhatti and Jianbai Wang. Nathaniel Gaskin, shown top center below, designed the printed circuit board that demonstrates the working components. The demonstration highlighted the ability of the Gen-2 processor to control the cochlear chip's ability to send electrical impulses to multiple sites. These sites would correspond to sites along the cochlear electrode. The interface on the screen (shown below) allows a user to program the site to which a pulse is sent and set the magnitude of the pulse. Overall, these poster sessions and demonstrations allowed students to meet directly with representatives of industry and make contacts for future endeavors. ■

Education Highlights

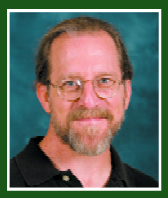
Undergraduate Research Program for Summer 2007 Unites Students in Utah and Michigan

The WIMS ERC hosted nine undergraduate students for summer 2007 participating in the Louis Stokes Alliance for Minority Participation (LSAMP) Research Experiences for Undergraduates (REU) program. The program started with student arrivals and an opening reception on May 29 and ended with a Closing Symposium on August 10, followed by student departures on August 11. This year, two of the nine students participated remotely at the University of Utah. Professor Richard Brown facilitated their participation.

The LSAMP REU is structured with the primary goal that each student works on an existing WIMS research project of an advanced graduate student mentor under the direction of a WIMS faculty member. In addition, the program comprises several secondary components. The first secondary component is technical communication instruction focused on teaching the students to document each research project via its descriptions and plans (at the start of the summer), progress reports, and results in final reports; then at the Closing Symposium each student makes an oral presentation of his/her research project and results. Additional secondary components encompass sessions for professional ethics, LSAMP awareness, and graduate study, each with the format of presentation followed by engaged discussion among the students and presenter. The professional ethics sessions have presentations on principles for ethical analysis, codes of conduct, and case studies with dilemmas. The LSAMP awareness sessions include dilemmas and notable contributions by racial and ethnic minorities, historical development and growth of LSAMPs since their start in 1991, and opportunities for LSAMP students. The graduate study sessions cover motivation for and career benefits after graduate degrees; selection of graduate schools in the academic area of interest; admission applications (procedures and requirements, essays, and example profiles of successful applicants); and financial aid (types, applications, and sources). The Utah and Michigan sites connected via videoconferencing equipment for the primary and secondary components. Ancillary activities at U of M included a day at the Henry Ford Museum—to observe history of innovation and industry in the United States—and a tour of the Michigan Nanofabrication Facility at U of M. Once again, the LSAMP REU program concluded with a celebratory social activity of dinner, miniature golf and electronic games, and an ice cream treat. The Utah research group was struck with luck when one student won a sweepstakes to attend a local concert of Harry Connick Jr. Felix and Jose were able to go along with the rest of the students on this evening of entertainment. A mid-summer dinner and get together marked the middle of the time in Utah. This allowed the students a chance to mingle outside of school and get to know their advisor better. After the closing ceremonies, the LSAMP participants and the other students went to dinner, which left them with full bellies before their long flight home to Puerto Rico. ■

2007 LSAMP REU Students.

Personnel Focus



Edward T. (Ted) Zellers earned a B.A. degree in Chemistry from Rutgers University in 1978 and both M.S. (1984) and Ph.D. (1987) degrees in Environmental Health Sciences from the University of California, Berkeley. From 1978–1981, he worked at Bell Laboratories, Murray Hill, New Jersey, on the synthesis and characterization of electrically conductive organic materials. He joined the faculty at the University of Michigan in 1987 and is currently a Professor jointly appointed in the Department of Environmental Health Sciences (EHS) and the Department of Chemistry. He has been the director of the EHS' Occupational Health Program since 1999, and has been the leader of the ERC's Environmental Sensors and Subsystems Thrust since 2001.

Professor Zellers' primary role in the Center is as faculty coordinator for the integration and testing of the micro gas chromatograph (μGC), which is the centerpiece of the Environmental Monitoring Testbed. In addition, he and his students have specific responsibility for developing materials and device structures for several critical μGC components, as well as modeling, testing, and optimizing their performance. Professor Zellers has also spearheaded efforts to apply WIMS technologies to problems in environmental and occupational health. His group led the demonstration of the first all-MEMS μGC prototype for the determination of complex mixtures of volatile organic indoor air contaminants. He has also used the ultra-low-power microsensor arrays developed by the Center in a meso-scale GC prototype for the analysis of signature compounds emitted by U.S. paper currency (of interest in border control applications) and environmental tobacco smoke markers (of interest in studies of second-hand smoke) at concentrations in the part-per-trillion range. He is currently working on applications of the WIMS μGC in explosives detection, lung cancer identification via breath monitoring of biomarkers, and extra-terrestrial environmental screening for evidence of biotic synthesis.

Professor Zellers has received numerous invitations to deliver keynote and plenary lectures on the WIMS μGC at a wide variety of venues, including the Hilton Head Workshop, Eurosensors, Transducers Conferences (sensors, actuators, and microsystems); the Pittsburgh Conference, the Materials Research Society Meeting (analytical and materials chemistry); and the American Industrial Hygiene Association Conference (occupational health). He spent the 2003–04 academic year on sabbatical, first at the Physical Electronics Laboratory, ETH, Zurich, Switzerland, and then at the Berkeley Sensors and Actuators Center in California. ■

Faculty/Student Awards

Professor Kamal Sarabandi Recognized by National Aeronautics and Space Administration

Professor Kamal Sarabandi, Director of the University of Michigan's Radiation Laboratory and a Professor in the Electrical Engineering and Computer Science Department, received a NASA Certificate of Appreciation for Significant Contribution as a member of NASA's Advisory Council to the Workshop on Science Associated with the Lunar Exploration Architecture, from Dr. Michael Griffin, NASA Administrator, and Senator Harrison H. Schmitt, Chairman of NASA's Advisory Council. Read more about his research in an article that appeared in the Spring-Summer 2007 issue of *EECS News*. ■

Professor Amir Sodagar Publishes Textbook

Assistant Professor Amir Sodagar, the ERC's Technical Director for Biomedical Microsystems, has authored a textbook, *Analysis of Bipolar and CMOS Amplifiers*, just published by CRC Press.

The classical approach to analog circuit analysis is a daunting prospect to many students, requiring tedious enumeration of contributing factors and lengthy calculations. *Analysis of Bipolar and CMOS Amplifiers* offers students an alternative that enables quick and intuitive analysis and design: the analysis-by-inspection method.

Working from the basics of amplifiers and transistors to biasing; single- and multistage amplifiers; current sources and mirrors; and analysis at midband, low, and high frequencies; the author demonstrates the interrelationship between behavior in both the time and frequency domains and balances the discussion between bipolar and CMOS circuits. Each chapter closes with a set of simulation examples in SPICE and MATLAB® that give students hands-on experience applying the concepts and methods using industry-standard tools. ■

(Continued on page 8)

Industrial Liaison's Report

Industrial Advisory Board Meeting October 23–24, 2007

Those who attended the May 2007 Industrial Advisory Board meeting noted that the Center has graduated a large number of doctoral students (28) in the last year. This is not unusual (23 were graduated the previous year). As the Center matures, we certainly expect to have a healthy number of graduates. Several companies commented on how ERC students appear to be more attuned to industrial research than non-ERC graduates.

The ERC is aimed at training students, not only in their respective disciplines, but also in what I like to call "application engineering." They need to understand how the customer utilizes their individual research. In this instance, the customer is a Center testbed—the Environmental Monitoring Testbed (EMT) or the Implantable Neural Prostheses Testbed—and in some instances, both. Students learn how their research, combined with other research, advances a system solution. For example, the development of a micropump requires understanding of both the volume requirements and pressure needs of the system. One cannot just design and fabricate a device that makes a significant technical contribution in an area (required for a degree). The device needs to address the specific requirements of the system as well. This is constantly put before the ERC students during the testbed meetings with the technical directors. Our technical directors strive to instill in students that the ERC requires that the system (testbed) goals are a key aim of their efforts.

This training results in ERC students not graduating with "project engineer's myopia." Rather, they realize the importance of working toward the customer's needs and wants. A study has estimated that an ERC doctoral graduate saves a company $100,000 in mentoring cost. While this is significant, I believe that the team concept and system thinking garnered during their studies is even more valuable.

Each fall, the Center distributes to our members the resumés of students who are graduating and those seeking internships in the coming year. At our upcoming Industrial Advisory Board meeting October 23 and 24, members will have the opportunity to meet these students as well as all our other researchers. Remember to mark your calendar and attend the meeting. Our Web site will have the details soon at (www.wimserc.org).

If you, or one of your colleagues, is interested in sharing your activities with our students, please contact me at either (734) 615-3096 or giachino@eecs.umich.edu to schedule a seminar.

As always, please visit when in the Ann Arbor area so we can share our latest technical developments and progress with the laboratory expansion. ■

Joseph M. Giachino
Associate Director, Industry

Presentations and Publications

Conference Presentations

Proceedings 6th International Workshop and Training Course on Microelectronics; Micro- and Nano-Electronics and Photonics, Islamabad, Pakistan, April 2007
D. M. Aslam, Invited, "Carbon Based Micro- and Nano-Technologies; Materials, Devices and Systems," p. 3

D. M. Aslam and A. Ross, Invited, "Microsystems, RFID Technology and Supply Chain Management; Research and Education," p. 34

Conference of the IEEE Engineering in Medicine and Biology Society (EMBS), Kohala Coast, Hawaii, May 2007
M. R. Abidian, L. G. Salas, A. Yazdan Shahmorad, T. C. Marzullo, D. C. Martin, and D. R. Kipke, "*In-Vivo* Evaluation of Chronically Implanted Neural Microelectrode Arrays Modified With Poly (3,4-ethylenedioxythiophene) Nanotubes"

G. J. Gage, E. L. Wilbur, D. J. Burke, and D. R. Kipke, "Decoding the Direction of Movements From Interneuron and Projection Cell Populations in the Basal Ganglia"

M. J. Lehmkuhle, S. S. Bhangoo, and D. R. Kipke, "The Electrocorticogram as a Feedback Control Signal for Deep Brain Stimulation of the Subthalmic Nucleus in the Hemi-Parkinsonian Rat"

T. C. Marzullo, M. J. Lehmkuhle, and D. R. Kipke, "A Direct Visual and Motor Neural Interface Demonstration in a Rat"

A. M. Sodagar, G. E. Perlin, Y. Yao, K. Najafi, and K. D. Wise, "Chronic Neural Recording With a 64-Channel Cortical Microsystem," pp. 402–405

Y. Yao, M. N. Gulari, B. E. Casey, J. A. Wiler, and K. D. Wise, "Silicon Microelectrodes With Flexible Integrated Cables for Neural Implant Applications," pp. 398–401

A. Yazdan-Shahmorad, G. J. Gage, T. C. Marzullo, E. Kim, and D. R. Kipke, "Linear Electrode Depth Estimation in Rat Motor Cortex by Laminar Analysis of Ketamine-Xylazine-Induced Oscillations"

CERMACS, Cincinnati, Ohio, May 2007
R. A. Veeneman and E. T. Zellers, "Characterization of Carbon Nanotubes and Graphitized Carbons as Adsorbents in a Microfabricated Vapor Preconcentrator/Focuser for a μGC"

211th Electrochemical Society Meeting, Chicago, Illinois, May 2007
F. Albano, D. Blaauw, D. M. Sylvester, and A. M. Sastry, "Design of Hybrid Implantable Power Systems (HIPS): Optimization Based on Fundamentals of Materials and Energetics"

2007 ASEE Annual Conference and Exposition, Honolulu, Hawaii, June 2007
M. McCorquodale and R. B. Brown, "Mobius Microsystems: A Case Study in the Commercialization of Graduate Research in Electrical Engineering"

IEEE Symposium on VLSI Circuits, Kyoto, Japan, June 2007
S. Hanson, B. Zhai, M. Seok, B. Cline, K. Zhou, M. Singhal, M. Minuth, J. Olson, L. Nazhandali, T. Austin, D. M. Sylvester, and D. Blaauw, "Performance and Variability Optimization Strategies in a Sub-200mV, 3.5pJ/inst, 11nW Subthreshold Processor"

IEEE International Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers '07), Lyon, France, June 2007
M. Tabib-Azar, R. Wang, S. Mutlu, C. H. Mastrangelo, and Y. B. Gianchandani, "Microfabricated Gate-Modulated Electrochemical Ion Spectroscopy Sensor," pp. 2307–2310

A. Basu and Y. B. Gianchandani, "A 128-Bit Digitally-Programmable Microfluidic Platform for Non-Contact Droplet Actuation Using Marangoni Flows," pp. 771–774

A. Evans, J. M. Park, G. F. Nellis, S. A. Klein, J. R. Feller, L. Salerno, and Y. B. Gianchandani, "A Low-Power, Microvalve-Regulated Drug Delivery System Using a Si Micro-Spring Pressurized Balloon Reservoir," pp. 359–363

S. R. Green, M. T. Richardson, F. A. Shariff, and Y. B. Gianchandani, "Photochemically Patterned Biliary Stents With Integrated Perfremanent Magnets and Deformable Assembly Features for Wireless Magnetoelastic Tissue Growth Sensing," pp. 213–217

N. K. Gupta, N. D. Masters, W. Ye, and Y. B. Gianchandani, "Gas Flow in Nano-Channels: Thermal Transpiration Models With Application to a Si-Micromachined Knudsen Pump," pp. 2329–2332

W. L. Huang, S.-S. Li, Z. Ren, and C. T.-C. Nguyen, "UHF Nickel Micromechanical Spoke-Supported Ring Resonators"

H. Kim, W. H. Steinecker, S. M. Reidy, G. R. Lambertus, A. A. Astle, K. Najafi, E. T. Zellers, L. P. Bernal, P. D. Washabaugh, and K. D. Wise, "A Micropump-Driven High-Speed MEMS Gas Chromatography System," pp. 1505–1508

S.-H. Lee, S. W. Lee, and K. Najafi, "A Generic Environment-Resistant Packaging Technology for MEMS," pp. 335–338

T. Li, A. Barnett, D. Xiao, M. Zhong, and Y. B. Gianchandani, "An *In-Vivo* Blood Microsampling Device for Pharmacokinetic Applications," pp. 225–228

A. M. Sodagar, G. E. Perlin, Y. Yao, K. D. Wise, and K. Najafi, "An Implantable Microsystem for Wireless Multi-Channel Cortical Recording," pp. 69–72

K. Udeshi and Y. B. Gianchandani, "A DC-Powered High-Voltage Generator Using a Bulk Pt/Rh Oscillating Micro-Relay," pp. 1151–1154

W. C. Welch, K. Najafi, "Nickel-Tin Transient Liquid Phase (Tlp) Wafer Bonding for MEMS Vacuum Packaging"

E. T. Zellers, S. M. Reidy, R. A. Veeneman, R. J. Gordenker, W. H. Steinecker, G. R. Lambertus, H. Kim, J. A. Potkay, M. P. Rowe, Q. Zhong, C. Avery, H. K. L. Chan, R. D. Sacks, K. Najafi, and K. D. Wise, "An Integrated Micro-Analytical System for Complex Vapor Mixtures," pp. 1491–1496, (invited presentation)

Sensors Expo and Conference, Rosemont, Illinois, June 2007
J. Giachino, "The Future of Wireless Sensing in Vehicles"

J. Mitchell, J. Giachino, and K. Najafi, "Wafer Level Vacuum/Hermetic Packaging of MEMS Devices"

ACM/IEEE Design Automation Conference, San Diego, California, June 2007
S. Hanson, D. M. Sylvester, and D. Blaauw, "Nanometer Device Scaling in Subthreshold Circuits," pp. 700–705

M. Seok, S. Hanson, D. M. Sylvester, and D. Blaauw, "Analysis and Optimization of Sleep sModes in Subthreshold Circuit Design," pp. 694–699

American Industrial Hygiene Association Conference and Exposition, Philadelphia, Pennsylvania, June 2007
G. Serrano, S. M. Reidy, and E. T. Zellers, "Testing the Reliability of Microfabricated GC Columns," (poster presentation)

Publications

K. Agarwal, R. Rao, D. M. Sylvester, and R. B. Brown, "Parametric Yield Analysis and Optimization in Leakage-Dominated Technologies," *IEEE Transactions on Very Large Scale Integration (VLSI) Systems*, vol. 15 (6), pp. 613–623, June 2007.

A. Basu and Y. B. Gianchandani, "Shaping High-Speed Marangoni Flow in Liquid Films by Microscale Perturbations in Surface Temperature," *Applied Physics Letters*, 90, 034102, 2007.

S. M. Reidy, D. George, M. Agah, and R. D. Sacks, "Temperature-Programmed GC Using Silicon Microfabricated Heaters and Temperature Sensors," *Analytical Chemistry*, vol. 79 (7), pp. 2911–2917, April 2007.

K. D. Wise, "Integrated Sensors, MEMS and Microsystems: Reflections on a Fantastic Voyage," (Invited), *Sensors and Actuators A: Physical*, vol. 136 (1), pp. 39–50, May 2007.

A. M. Sodagar, K. D. Wise, and K. Najafi, "A Fully Integrated Mixed-Signal Neural Processor for Implantable Multichannel Cortical Recording," *IEEE Transactions on Biomedical Engineering*, vol. 54 (6), pp. 1075–1088, July 2007.

W. H. Steinecker, M. P. Rowe, and E. T. Zellers, "Model of Vapor-Induced Resistivity Changes in Gold-Thiolate Monolayer-Protected Nanoparticle Sensor Films," *Analytical Chemistry*, vol. 79, pp. 4977–4986, 2007.

C. G. Wilson and Y. B. Gianchandani, "Selective Deposition of Silicon at Room Temperature Using DC Microplasmas," *IEEE Transactions on Plasma Science*, vol. 35 (3), pp. 573–577, June 2007.

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Faculty/Student Awards

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Professor Sastry Receives Gustus L. Larson Memorial Award

Professor Ann Marie Sastry has been selected to receive the Gustus L. Larson Memorial Award, bestowed jointly by Pi Tau Sigma and American Society of Mechanical Engineers (ASME).

This prestigious honor was established in 1973 to acknowledge engineering graduates who have demonstrated outstanding achievements in mechanical engineering within ten to twenty years following graduation. ■

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