

# WIMS WORLD

University of Michigan

Michigan State University

Michigan Technological University

## Director's Message



**A**s I write this, the winter term has started, and the MEMS Conference in Miami Beach just provided a much-needed break from a very cold winter in Michigan. When the thermometer hits -15°F, it's time to get moving, and Michigan was well represented at the Conference this year, with ten percent of the total papers and more

than 40 faculty, staff, students, and alumni in attendance. All told, the Conference attracted about 700 people and featured some 218 papers. The acceptance rate was less than 30%, so by most standards it was highly competitive, but it is a far different publishing picture today than it was when I started out. In those days, sensor papers were usually relegated to the smaller rooms at conferences such as the International Electron Devices Meeting (IEDM) and the International Solid-State Circuits Conference (ISSCC), but they were expected to be finished pieces of work. Today, some papers seem closer to progress reports. Now I recognize that getting the latest results out quickly helps to cross-pollinate new ideas and get researchers together to share those ideas, but students today very often expect to hit two or three major conferences a year. I hope we are really that productive. With an acceptance rate below 30%, it concerns me not only that good papers are being rejected, but that a lot of poor papers are being submitted.

I was also struck by the fact that 86% of the papers at MEMS this year were from academia. While microelectronics has been heavily commercialized and pushed far into the nanosphere, much of MEMS is still in the research laboratory. To be sure, the silicon end of MEMS (e.g., silicon pressure sensors, inertial devices) has matured to some extent and seen significant commercialization, but the newer areas are still far from it. The MEMS Conference has always been oriented toward new processes and structures, and it seems to me that the diversity there is greater now than ever before, involving self-assembly, fluidics, new materials, and optical structures. The largest topic area at this year's conference was that of biological and chemical devices.

I reflected yesterday with a friend on the changes we have seen over the years in the "hot topics" at sensor meetings. In the 1970s and early 80s, it was bulk silicon devices and micromachining. By the late 80s, we were focused on surface micromachining, whose polysilicon was best, how to control stiction, how to partition the electronic system, and whether to integrate circuitry on the sensor chip or not. In the 90s, we saw sensors move toward microsystems and witnessed the emergence

of sub-fields such as RF-MEMS, inertial-MEMS, bio-MEMS, optical-MEMS, and microfluidics. It seems to me that the greatest progress in the future will likely occur in these new areas. Although today much of this work is far removed from microelectronics, the two will eventually have to join, and that will happen in microsystems.



**Portion of Michigan contingent at MEMS '05.**

It has been suggested that MEMS may spark progress in mechanical or chemical or optical systems that will eventually be even greater than what we have seen in microelectronics. Will we really strike gold again in some of these new areas? Compared to what I have seen in the last four decades in microelectronics, I doubt it. But that's what the vacuum-tube folks thought. So maybe ...

## Ken D. Wise

Director, Engineering Research Center for  
Wireless Integrated MicroSystems

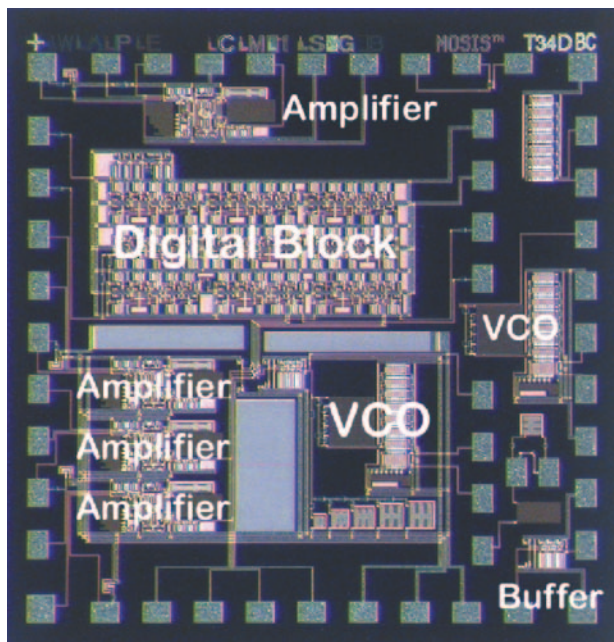
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## Research Highlights

### Multichannel Wireless FM Microsystems for Biopotential Recording Applications

Pedram Mohseni and Khalil Najafi



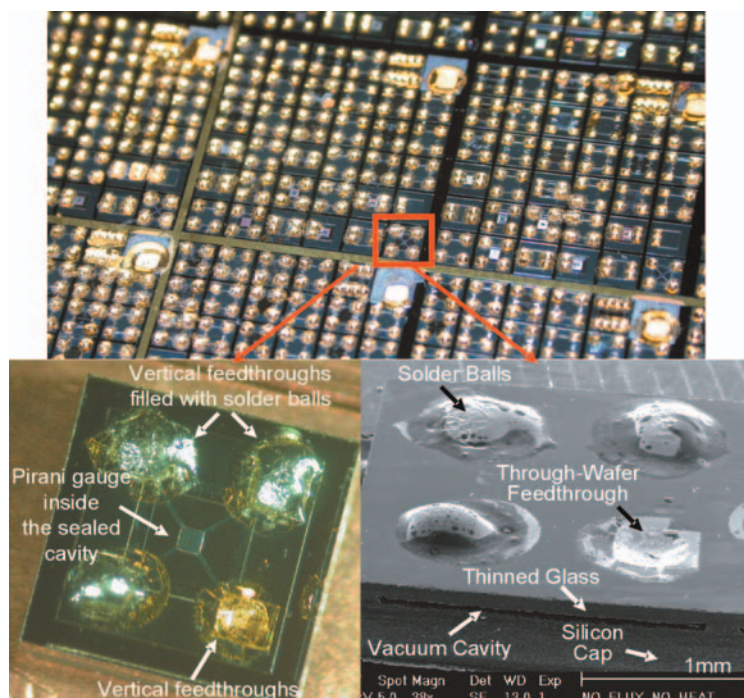
**Microphotograph of a 4-channel wireless FM biopotential recording system chip.**

A low-power, multichannel, stand alone, integrated wireless FM system has been developed for a variety of biomedical recording applications. The entire system is operated using two coin-cell batteries (see figure), and is assembled on several small PC boards that connect to chronically implanted electrodes. Signals are recorded by micromachined electrodes, amplified, time-division multiplexed, and then modulated onto an FM carrier. The transmitted signal is picked up by an FM receiver, which decodes it and then displays it for future use. Wireless reconstruction of pre-recorded neural activities, evoked by an acoustic white noise burst from the Inferior Colliculus (IC) of a guinea pig, using this microsystem operating in the 94–98MHz frequency band over a distance of ~13cm, is shown. This project is supported by NIH grant R01-DC04198-01.

### Wafer-Level Vacuum Package with Vertical Feedthroughs

Junseok Chae, Joseph M. Giachino, Sang-Hyun Lee, Andrew Kuo, Navid Yazdi, and Khalil Najafi

A vacuum package with wet-etched through-wafer holes in glass at the wafer level to form feedthroughs is reported. A standard-thickness glass substrate is used to support MEMS devices formed from either silicon or electroplated metal. After device fabrication, the silicon package wafer is anodically bonded to the glass substrate wafer. The bonded wafer sandwich is then dropped in HF to thin the glass wafer down to a thickness of ~150 $\mu$ m to facilitate formation of holes for vertical feedthroughs. Feedthrough holes are now photolithographically patterned and wet etched at the wafer level to reach bonding pads on the front, inside the sealed cavity. Finally, a gold layer is evaporated inside the holes to form the vertical feedthroughs, and the holes are optionally filled with solder paste. Photographs of a portion of a 4" wafer, and close-up views of the individual packages, are shown. The package has been tested for more than four months with no apparent leak.



**Optical and SEM photos of a finished package looking through glass (Pirani gauge is visible), and of the feedthroughs holes filled with solder balls.**



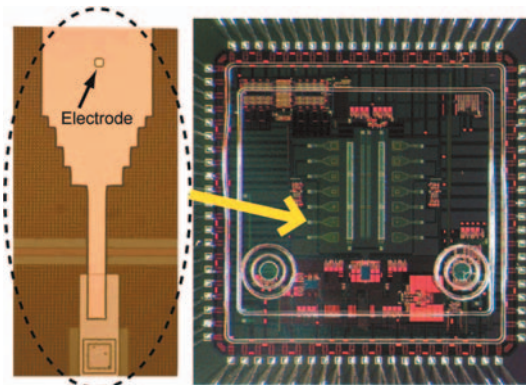
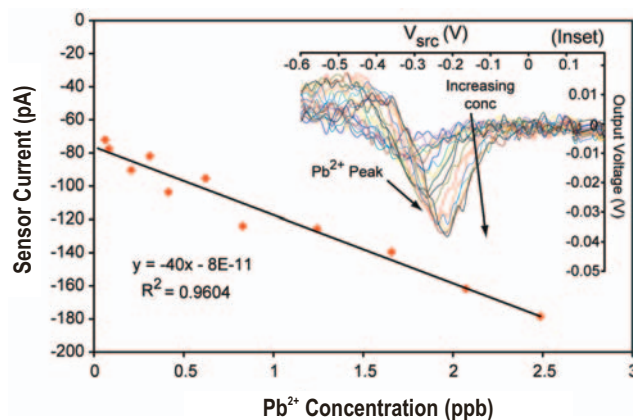
## New CMOS-Integrated Microsystem for Trace Environmental Monitoring

Steve Martin

According to the US EPA's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), lead, arsenic, and mercury have been cited as the top three most critical hazardous substances in the environment due to their toxicity and potential for human exposure. Researchers at the University of Michigan have developed a CMOS-integrated microinstrument for the detection of these heavy metals at trace concentrations.

The single-chip microsystem includes all of the necessary front-end electronics and sensors. The front-end was developed in AMIS's  $0.5\mu\text{m}$  CMOS process and consists of a pseudo-differential potentiostat, a programmable gain instrumentation amplifier, a  $\Sigma\Delta$  ADC, and a current-steering DAC. The system dissipates  $16\text{mW}$  with a signal-to-noise plus distortion ratio (SNDR) of  $115.4\text{dB}$  and a minimum detectable signal of  $4.94\text{pA}$ . Three-electrode voltammetric sensors are post-CMOS processed on top of the foundry fabricated electronics and consist of gold, platinum, and silver/silver-chloride electrodes. The active sensor elements range in size from  $1\text{e}^{-4}$  to  $1\text{e}^{-6}\text{cm}^2$ , while the 84pin pad-limited test device occupies  $36\text{mm}^2$ .

The microsystem has been used to successfully detect  $0.8\text{ppb}$  lead using two  $3\text{e}^{-6}\text{cm}^2$  electrodes and a subtractive anodic stripping voltammetry method. The measured calibration curve was linear with a slope of  $-40\text{pA/ppb Pb}^{2+}$  and an  $R^2$  value of  $0.96$ . These results represent a  $13\text{X}$  improvement in the detection limit/electrode area product and a  $58\text{X}$  improvement in the detection limit/power dissipation product versus existing systems.



## Personnel Focus

### Percy Pierre Honored for Creating Opportunities

Percy A. Pierre, WIMS professor of electrical and computer engineering at Michigan State University, has been selected as one of the "50 Most Important Blacks in Research Science" for 2004, according to *Science Spectrum* magazine. The individuals featured in the September/October 2004 edition of the magazine are recognized for the important contributions they make on a daily basis as a small but influential group of African Americans in the field. The awards meeting and luncheon took place in Nashville, Tennessee, during the Emerald Honors Conference for Research Science.

Dr. Pierre was also honored at a 30th anniversary gala in New York City as one of the founders of the National Action Council for Minorities in Engineering Inc. (NACME). He had the good fortune to watch a dream he promoted grow into a major contributor, which today has spent more than \$100 million putting 18,000-plus minority students through college.

Also, Dr. Pierre, along with Barbara O'Kelly, research specialist in electrical and computer engineering, were selected to receive "MSU's Excellence Within Community" Award for their teamwork promoting diversity in the engineering college and the MSU community. Together they have established programs for student recruitment and retention, and secured grants to support their programs and students. Their initiatives have fostered a thirty-six percent increase in the enrollment of African American and Hispanic doctoral students in the College of Engineering.

Pierre continues to serve as an inspiration to minority students and the engineering community.



## Recent Events

### Industrial Advisory Board Meeting Held in October

The WIMS Semi-Annual Industrial Advisory Board Meeting was held at the Kensington Court Ann Arbor on October 19-20, 2004. Industrial members had the opportunity to talk with the students during the poster sessions. This meeting again had an individual poster for each of 111 projects. During the poster sessions the researchers were available to discuss their projects with the members. As always, private space was available for extended discussions.

Members were made aware that they are eligible for a discount for Distance Education courses fees offered through the College



**Joe Giachino with industrial member Jeff Dykstra from Motorola at IAB poster session.**

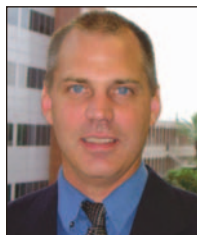
of Engineering Interdisciplinary Professional Programs (InterPro). Over six MEMS courses are available or committed to this program. One of the highlights of the IAB meeting was the presentation of the Student Leadership Council Outstanding Leadership Award. Shown is Neil Welch receiving the award from SLC President Joe Potkay.



**SLC President, Joe Potkay (right), presents award to Neil Welch.**

### Daryl Kipke Invited to Speak

Daryl Kipke, WIMS ERC Biomedical Sensors and Subsystems Thrust Leader, was invited to speak at the Neural Interfacing Mini-Symposium at the 26th International IEEE-EMBS Conference on "Implantable Probe Systems for Cortical Neuroprostheses" in San Francisco, California in September. Dr. Kipke also gave an invited talk at the Neural Interfaces Symposium, in Bethesda, Maryland, in the Neural Prosthesis Workshop in November.



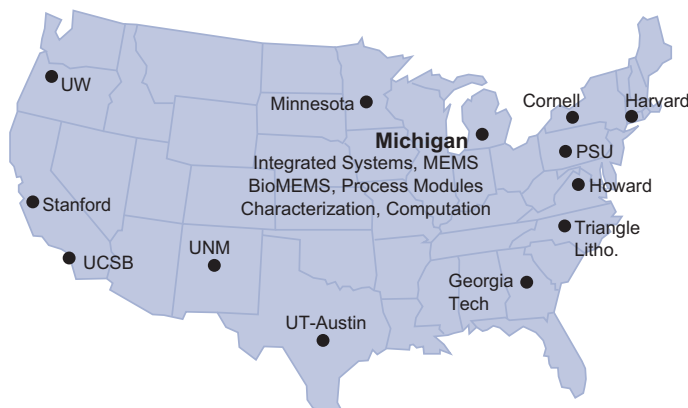
### Two Keynote Talks on K-12 Education Given



During October and December 2004, Dean Aslam, WIMS Associate Director for MSU, gave two keynote talks related to K-12 education in Albuquerque, New Mexico; one on "Micro- and Nano- Technologies in K through PhD Education and Research" in the Second World Congress on Biomimetics, Artificial Muscles and Nano-Bio (Nano-Bio 2004), and another on "Small Tech Education" in the High Desert MNT Regional Workshop.

### The National Nanotechnology Infrastructure Network (NNIN)

In March 2004, the NSF funded a 13-university network called the National Nanotechnology Infrastructure Network (NNIN). The Network is funded to provide open access to the facilities of the member universities in support of all aspects of micro and nano device fabrication, characterization, computation, and analysis. The NNIN also supports a number of outreach and educational programs, and it is a platform for addressing research in social-ethical issues involved in nanotechnology. The University of Michigan's Solid-State Electronics Laboratory (SSEL) is a member of this network and will provide its expertise in general micro and nano fabrication, MEMS, BioMEMS, Integrated MicroSystems, packaging, and circuit fabrication and integration. The other members of the network are: Cornell University, Stanford University, Georgia Tech., University of Minnesota, University of Texas-Austin, UC Santa Barbara, Harvard University, Howard University, Penn State University, University of Washington, University of New Mexico, and North Carolina State University. More detailed information about the NNIN's capabilities can be found on its website ([www.nnin.org](http://www.nnin.org)) or the website of SSEL ([www.eecs.engin.umich.edu/ssel](http://www.eecs.engin.umich.edu/ssel)).





## Education Highlights

### Michigan Young Engineers and Scientists Expo



From left to right (Assata Moore, George Bibbs, Andy Ball, Robyn Mackey, and Nathan Usher) assisted Drew Kim, Assistant Director of Diversity Programs Office in this all day event.

The Michigan State University College of Engineering Diversity Programs Office represented MSU and the Wireless Integrated MicroSystems (WIMS) Engineering Research Center at the first ever Michigan Young Engineers and Scientists Expo on Saturday, November 6th in Ann Arbor, Michigan. Over 1,200 pre-college students attended the event designed to increase the number of junior and high school students interested in science and engineering as their future career. All state of Michigan universities exhibited their current science and engineering programs and projects to peak student interest. Michigan State University's WIMS final projects, such as the drag race timer, karaoke machine, and matching video games, received a lot of attention from future scientists and engineers as well as their parents.

### Introduction to WIMS Session

On December 7th, eighty-six undergraduate students attended an evening session entitled "Introduction to WIMS Undergraduate Research." This meeting was designed to inform students about the exciting fields of MEMS and microsystems, and encourage them to participate in the WIMS Undergraduate Research (WUGR) Program. WIMS ERC Director Ken Wise gave an overview of the Center, followed by brief introductions to the varied research areas by the thrust leaders. A student panel discussion followed with graduate and undergraduate students talking about their research experiences and the benefits of working with the WIMS Center. Time was scheduled after the meeting for those interested in talking directly with the faculty and graduate students to answer specific questions. Many of the undergraduate students attending have shown an enthusiastic interest in WIMS, and are in the process of submitting applications for possible involvement in the research program.

### 1st Place Winners at First LEGO Robotics League

MSU's TechnoSpartans won first place overall at the "Ready, Set, LEGO" regional competition on Saturday, November 20th, in Saginaw, Michigan. This competition was sponsored by Delphi Corporation. The team of six 7th and 8th grade students worked together for eight weeks designing, building, programming, and testing LEGO robots. These robots perform specific tasks that could be helpful for people with disabilities in the real-world. Instruction in math and programming were also included in their training. At the competition, the TechnoSpartans were given the Most Innovative Programming Award and 2nd place honors for the Technical Interview portion of the competition. They have since competed at the State Competition in Novi, Michigan.



Setting up a robot for the regional competition.

WIMS Kids, a second team of 4th through 6th graders, placed 13<sup>th</sup> out of 23 teams. Both teams competed in four categories: robot performance, research presentation, technical interview, and teamwork. Parents of team members were very involved and helped during the eight-week course. A banquet and awards ceremony was held the night before the regional competition honoring the students and their parents. Graduate and undergraduate coaches were also recognized for their time and effort in mentoring these students.

### Website Undergoes "Extreme Makeover"



Please visit our newly re-designed WIMS website. The first thing you'll notice is it's fresh new look. We've also made accessing information easier than ever. As a work in progress, we will continue to improve and

expand the site, as well as add new features and services. Please feel free to contact the webmaster, Jean Eggertsen, if you have any comments or suggestions at [jegger@umich.edu](mailto:jegger@umich.edu).

## Student Leadership

### Student Leadership Council (SLC) News

The SLC held its annual election meeting in December and chose the following people to serve on the Student Leadership Council for 2005:

Warren (Neil) Welch ..... President  
 Ruba Borno ..... Vice President  
 Burcu Ucok ..... Industrial Chair  
 Gayatri Perlin ..... Educational Chair  
 André Snellings and Becki Veeneman ..... Co-Social Chairs  
 Willie Steinecker ..... University Affairs Chair

Nelson Sepulveda-Alanastro and Tania Yusaf are serving as Chair and Assistant Chair at Michigan State University, and Jianlin Liang and Shailesh Gugale are serving as Chair and Assistant Chair at Michigan Technological University.

In December, the WIMS ERC was chosen to represent the University of Michigan's College of Engineering at the Pursuit of Excellence Symposium in Novi. The symposium was held to showcase various opportunities at the university to high school applicants and their parents. The SLC set up several microscopes and posters and handed out WIMS key chains to passing students. The student response was exceptional, and it provided an excellent opportunity for the SLC to discuss WIMS research programs and engineering in general.

The SLC has several events coming up in the next few months. Student seminars are being organized to increase the communication between the various disciplines within WIMS. Any WIMS student interested in speaking at a student seminar should contact Willie Steinecker at [wsteinec@umich.edu](mailto:wsteinec@umich.edu). Notification of seminar dates and times will be sent via email. The annual WIMS DAPCEP program will be held March 12th through April 9th. This is a great opportunity for WIMS students to get involved as mentors. Contact Neil Welch at [welchw@umich.edu](mailto:welchw@umich.edu) if you are interested in participating. The annual WIMS Resumé Booklet is distributed to all member companies and is a great way to get an internship or job after graduation. WIMS students interested in including a resumé in the annual WIMS Resumé Booklet should contact Burcu Ucok at [aucok@umich.edu](mailto:aucok@umich.edu).



**Left to Right – Burcu Ucok, Willie Steinecker, Becki Veeneman, André Snellings, Ruba Borno, Neil Welch, Gayatri Perlin**

## Industrial Liaison's Report



As the cool zephyrs blow across North Campus and the new term begins, it allows us a moment to assess the first five years of the Center. The Center has spun-out five companies. We have launched a new program with the Samuel Zell and Robert H. Lurie Institute to help students understand the business issues that surround the process of commercializing

technology. At our May Industrial Advisory Board meeting, we will summarize the studies done by the Zell Lurie Institute and the Center's students. We have licensed technology to members and assisted in implementing the technology.

We want to continue assisting our members in applying our technology to their specific needs. To facilitate our members in growing their businesses, we are studying how to accelerate the implementation of our technology with Center members in areas other than the platform we are using to demonstrate feasibility. An example is the remote power technology used for the cardiovascular antenna stents

integrated with micosensors (stentenna). This technology is, in my estimation, appropriate to other applications—from tire pressure/temperature monitoring to measuring flow conditions in conduits where supply power via a battery is expensive and continuous readings are not required. There are similar examples in our environmental sensing platform (ie, silicon columns, sensors, packaging) and the biomedical platform (ie, low-power circuits, packaging, micro-controllers) where the technology can be used in a variety of applications. I invite our Center members to take a moment to think about how our technologies can help solve your specific problem. We are available to discuss with you how best to apply Center technology to your specific application.

As always, we invite you to visit whenever you are in the Ann Arbor area.

## Presentations and Publications

### Presentations

**Society for Neuroscience Conference, San Diego, CA, October 2004**

J. Seymour and D. Kipke, "Biodegradable Polymers for Short-Term Drug Delivery on Neural Microelectrodes"

J. Subbaroyan, E. Purcell, D. Martin, and D. Kipke, "Characterization of the Electrode-Tissue Interface in Chronic Neural Implants"

K. J. Otto, M. D. Johnson, and D. R. Kipke, "Rejuvenation of Chronically Implanted Neural Probes"

K. Ludwig, T. Marzullo, R. Miriani, N. Langhals, and D. Kipke, "Generating a Two-Dimensional Control Signal from Motor and Cingulate Cortex Using a Novel Adaptive Filter Paradigm"

**NIH Neural Interfaces Workshop, Bethesda, MD, November 2004**

D. Kipke and R. Vetter, "Microscale Neural Implant Systems," (Invited).

K. Ludwig, J. Uram, J. Yang, and D. Kipke, "Chronic Neural Recordings Using Silicon Microelectrode Arrays Electrochemically Deposited With a Conductive Polymer"

D. M. Aslam and Y. Lu, "CNT for Micro GC and Chemical Sensors," *Sensors Expo Conference*, Detroit, MI, June 2004, (Invited).

E. T. Zellers, D. M. Aslam, and Yang Lu, "Materials and Processing Challenges Related to the Fabrication of a MEMS Micro Gas Chromatograph," *Symposium on Materials, Mechanisms, and Systems for Chemical and Biological Detection and Remediation, Materials Research Society Meeting*, San Francisco, CA, April 2004, (Keynote).

M. Agah, G. Lambertus, R. Sacks, and K. Wise, "High-Speed MEMS-Based Gas Chromatography," *IEEE Electron Devices Meeting*, San Francisco, CA, 2004.

M. Flynn, "WIMS Wireless Devices and Research," *Harvard University EE Seminar Series*, October 2004.

### Publications

A. S. Basu, S. McNamara, and Y. B. Gianchandani, "Scanning Thermal Lithography: Maskless, Submicron Thermo-Chemical Patterning of Photoresist by Ultracompliant Probes," *Journal of Vacuum Science and Technology B*, vol. 22, pp. 3217–3220, 2004.

D. R. Kipke, "Brain-Machine Interfaces Using Thin-Film Silicon Microelectrode Arrays," *Proceedings of the International Symposium on Circuits and Systems*, Vancouver, Canada, May 2004, pp. V497–V499, (Invited).

D. R. Kipke, "Implantable Probe Systems for Cortical Neuro-Prostheses," *Proceedings of the International Joint Conference on Neural Networks*, Budapest, Hungary, July 2004, (Invited).

G. E. Perlin and K. D. Wise, "The Effect of the Substrate on the Extracellular Neural Activity Recorded with Micromachined Silicon Microprobes," *Digest IEEE Conf. on Engr. in Med. and Biol.*, San Francisco, CA, pp. 2002–2005, September 2004.

G. Gage, K. Otto, K. Ludwig, and D. Kipke, "Co-adaptive Kalman Filtering in a Naïve Rat Cortical Control Task," *Proceedings of the 26th International IEEE-EMBS Conference*, San Francisco, CA, pp. 4367–4370, September 2004.

J. Zhang, N. Trombly, and A. Mason, "A Low-Noise Readout Circuit for Integrated Electrochemical Biosensor Arrays," *IEEE International Conference on Sensors*, Vienna, Austria, October 2004.

J. Zhang and A. Mason, "Characterization of a Configurable Sensor Signal Conditioning Circuit for Multi-Sensor Microsystems," *IEEE International Conference on Sensors*, Vienna, Austria, October 2004.

J. Chae, H. Kulah, and K. Najafi, "An In-Plane High-Sensitivity, Low-Noise Micro-g Silicon Accelerometer with CMOS Readout Circuitry," *IEEE/ASME Journal of Microelectromechanical*

*Systems (JMEMS)*, vol. 13, no. 4, pp. 628–635, August 2004.

K. Najafi and M. Ghovanloo, "A Multichannel Monolithic Wireless Microstimulator," *26th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)*, San Francisco, CA, September 2004.

K. King, S.W. Yoon, N.C. Perkins, and K. Najafi, "The Dynamics of the Golf Swing as Measured by Strapdown Inertial Sensors," *Proceedings 5th International Conference on the Engineering of Sport*, vol. 2, pp. 276–282, (Eds. Hubbard, Mehta, Pallis), September 2004.

K. Takahata and Y. B. Gianchandani, "A Planar Approach for Manufacturing Cardiac Stents: Design, Fabrication, and Mechanical Evaluation," *IEEE and ASME Journal of Microelectromechanical Systems*, 13(6), pp. 933–939, 2004.

M. Agah, G. R. Lambertus, R. D. Sacks, and K. D. Wise, "High-Speed MEMS-Based Gas Chromatography," *Digest Int. Electron Devices Meeting*, San Francisco, CA, pp. 27–30, December 2004.

M. Ghovanloo and K. Najafi, "In-Vitro and In-Vivo Testing of a Wireless Multichannel Stimulating Telemetry Microsystem," *26th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)*, San Francisco, CA, September 2004.

M. Ghovanloo and K. Najafi, "Fully Integrated Wideband High-Current Rectifiers for Inductively Powered Devices," *IEEE J. Solid-State Circuits*, vol. 39, no. 11, pp. 1976–1984, November 2004.

M. Ghovanloo and K. Najafi, "A Modular 32-site Wireless Neural Stimulation Microsystem," *IEEE J. Solid-State Circuits*, vol. 39, no. 12, pp. 2457–2466, December 2004.

M. Johnson, K. Otto, J. Williams, and D. Kipke, "Bias Voltages at Microelectrodes Change Neural Interface Properties In-Vivo," *Proceedings of the 26th International IEEE-EMBS Conference*, San Francisco, CA, pp. 4103–4106, September 2004.

N. Sepulveda-Alancastro and D. M. Aslam, "Polycrystalline Diamond Technology for RFMEMS Resonators," *Microelectronic Engineering*, 73–74, 435–440, 2004.

N. Yazdi and K. Najafi, "Precision Readout Circuits for Capacitive Microaccelerometers," *Third IEEE International Conference on Sensors*, Vienna, Austria, October 2004.

P. Mohseni and K. Najafi, "Wireless Multichannel Biopotential Recording Using an Integrated FM Telemetry Circuit," *26th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)*, San Francisco, CA, September 2004.

R. M. Worden, B. Hassler, P. Kim, N. Kohli, A. Mason, J. G. Zeikus, M. Laivenieks, and R. Ofoli, "Biomimetic Interfaces for a Multifunctional Biosensor Array Microsystem," *IEEE International Conference on Sensors*, Vienna, Austria, October 2004.

S. McNamara, A. S. Basu, and Y. B. Gianchandani, "Ultra-Compliant Thermal Probe Arrays," *Journal of Micromechanics and Microengineering*, vol. 15, pp. 237–243, 2004.

R. J. Vetter, J. C. Williams, J. F. Hetke, E. A. Nunamaker, and D.R. Kipke, "Chronic Neural Recording Using Silicon-Substrate Microelectrode Arrays Implanted in Cerebral Cortex," *IEEE Trans. on Biomed. Eng.*, vol. 51(6), pp. 896–904, 2004.

Y. Yao, M. N. Gulari, J. F. Hetke, and K. D. Wise, "A Low-Profile Three-Dimensional Neural Stimulating Array with On-Chip Current Generation," *Digest IEEE Conf. on Engr. in Med. and Biol.*, San Francisco, CA, pp. 1994–1997, September 2004.

X. Zhu, D. M. Aslam, Y. Tang, B. Stark, and K. Najafi, "The Fabrication of All Diamond Packaging Panels With Built-In Interconnects For Wireless Integrated Micro-Systems," *IEEE Journal of Microelectromechanical Systems*, vol. 13, pp. 396–405, 2004.



## Seminar Series

Visit our website at <http://wimserc.org> to find out more information about these seminars and to view them on streaming video.

### \* October 5, 2004

Professor Mark Banaszak-Holl

### \* November 2, 2004

Professor Alex N. Cartwright

### \* November 3, 2004

Professor Masayoshi Esashi

### \* November 9, 2004

Professor Mark G. Allen

### November 16, 2004

Michael Barnes, PhD

### \* November 30, 2004

Professor Donhee Ham

### \* December 7, 2004

Professor Franco Cerrina

### \* December 14, 2004

Steven N. Kempka, PhD

\*Available for viewing on website

## Doctoral Dissertations

Rahul M. Rao, "Digital Circuit Design Techniques for Low-Leakage Silicon-On-Insulator (SOI) CMOS Technologies"

University of Michigan, 2004

Current Position: Research Staff Member, IBM

Advisor: Professor Richard B. Brown

Luciana W. da Silva, "Integrated Micro Thermoelectric Cooler: Theory, Fabrication and Characterization"

University of Michigan, 2004

Advisor: Massoud Kaviani

Robert W. Hower, "The Integration of Potentiometric and Optical Chemical Sensor Arrays"

University of Michigan, 2004

Advisor: Richard B. Brown

Steve M. Martin, "CMOS-Integrated Liquid Chemical Microdetection Systems"

University of Michigan, 2004

Advisor: Richard B. Brown

Fadi Gebara, "Mixed-Signal Circuits Design Issues In Nanoscale PD-SOI"

University of Michigan, 2004

Advisor: Richard B. Brown

## Faculty/Student Awards

Jichun Zhang received the MSU Dissertation Competition Fellowship.

Jichun Zhang received the MSU ECE Department Graduate Office Fellowship.

E. F. Hasselbrink (Assistant Professor, Mechanical Engineering) was selected as Professor of the Term by the Pi Rho chapter of the Pi Tau Sigma Mechanical Engineering Honor Society.

## Member Companies

Ardesta, LLC

Corning, Inc.

Delphi Corporation

Dexter Research Center, Inc.

Discera, Inc.

EV Group, Inc.

Freescal Semiconductor, Inc.

Honeywell International

Intel Corporation

Integrated Sensing Systems, Inc.

MEDC

Medtronic Corporation

Mobius Microsystems, Inc.

Motorola, Inc.

Samsung Electronics

Sandia National Laboratories

Sensicore, Inc.

Suss MicroTec, Inc.

Texas Instruments, Inc.

David A. Brandon  
Laurence B. Deitch  
Olivia P. Maynard  
Rebecca McGowan  
Andrea Fischer Newman  
S. Martin Taylor  
Katherine E. White  
Mary Sue Coleman (ex officio)

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