

WIMS WORLD

University of Michigan

Michigan State University

Michigan Technological University

Director's Message

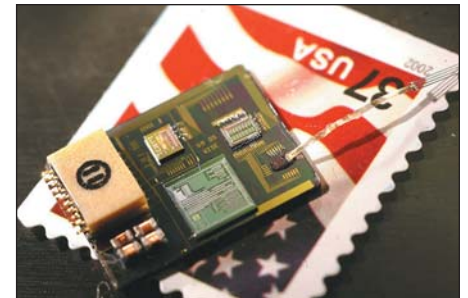


We just passed the halfway point in our ten-year run as an active ERC, and it is interesting to look back at what has been accomplished and forward at some of the exciting opportunities ahead. ERCs are all about interdisciplinary team research on engineered systems and to some extent that runs counter to academic culture, which is set up more to reward individual accomplishment than to recognize group achievement. For that reason, working on engineered microsystems is a bit like swimming upstream (or perhaps up Niagara Falls). We've chosen testbeds as a way of engaging our projects at the system level and making sure we don't disintegrate into a collection of unrelated activities. Such an undertaking would not work without an outstanding group of faculty, staff, and students that enjoy working together, and even then it is a bit of a stretch. But something has happened in this Center over the past six months. It is true that as we approach our six-year review next spring we need to show working microsystems, and that as some of these systems approach realization, there is more and more emphasis on them. But something has happened. It seems to me that we have moved from a time when we talked about *systems* but really worked on *components* to a time when we are really working on *systems*. If the full systems don't work, then maybe the components don't matter as much. That's a really scary thought!

I once remarked that to be successful, a testbed has to be compelling—like a quest for the Holy Grail. It's something that the faculty, staff, and students want to be part of no matter what. Our testbeds are like that. The neural prostheses we are working on will revolutionize our understanding of the brain and promise to provide electronic interfaces to the nervous system for treating disorders such as deafness, blindness, paralysis, Parkinson's disease, and epilepsy. And our environmental monitor will have a profound impact on homeland security and on confronting the problems of global warming, which have been so much in evidence lately. Solutions to these critical problems require that everyone set aside some of their own work to realize the larger system. But like I say, something has happened recently. We are *engaged* in microsystem development.

I'll relate one example. This summer, in mid-August, we were getting ready for a workshop on neural interfaces sponsored by the National Institutes of Health. We were trying to get as many results on our cortical microsystem as we could and had finally managed to realize most of the needed components—probes, amplifiers, a neural spike detector, and a wireless interface. I hoped we could at least complete component characterization,

but there was not much time left. And then one morning in a meeting with one of my graduate students, she announced "We're going to integrate all of this, and we're going to have it working in-vivo in time for the Workshop." I was surprised and delighted. "Great," I said, "go to it!" crossing my fingers and everything else available. And so she and two of our key staff members went to work. Every couple of days, I would casually inquire where things were, and every couple of days I got the notion that these people were organized, engaged, and indeed consumed in this effort. The Workshop was the day after Labor Day, and by Sunday of that weekend, they had assembled the entire microsystem, recruited surgical help, and were using the system to acquire in-vivo data, exercising the entire analog signal path. A picture of that microsystem is shown. It is an example of drive and dedication that I won't soon forget, and I sense this sort of thing is spreading. It isn't just the components any more. It's the *system*, and that's the reason I'm so optimistic that we are going to make a big impact with the things coming out of this Center. It's the excitement and the dedication and the commitment of the people, and it's contagious!



A cortical microsystem, consisting of a multi-channel probe, integrated parylene ribbon cable, amplifier bank, neural spike processor, and wireless interface.

Ken D. Wise

Director, Engineering Research Center for
Wireless Integrated MicroSystems

Inside

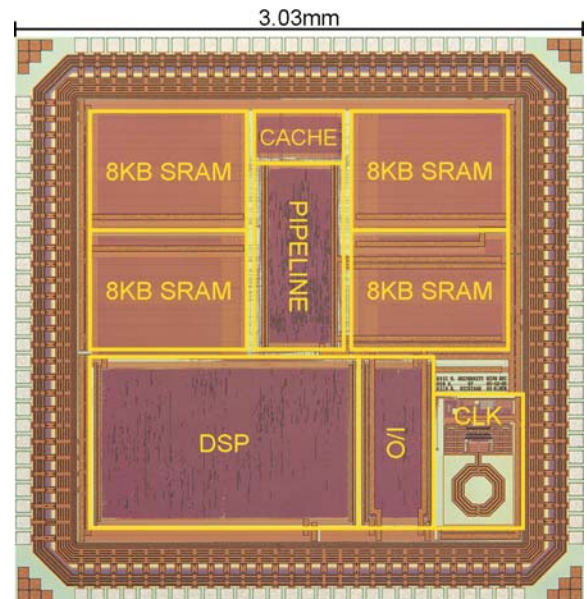
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Research Highlights

A DSP Capable Microsystem for Use in Cochlear Implants

Eric Marsman, Robert Senger, and Richard B. Brown

The next-generation WIMS Microcontroller has been realized in a TSMC 0.18 μm process, occupies 9.18mm², and contains 2.3 million transistors. This is a 28% reduction in area over the previous version. It combines an energy-efficient microcontroller unit (MCU), a low-power DSP core, and a monolithic self-referenced hybrid temperature-compensated LC oscillator (TC-LCO) and ring oscillator clock reference in a single bulk CMOS SoC. The 16-bit MCU contains a 3-stage pipeline, 32kB of on-chip memory, a loop cache, and several peripheral communication interfaces. The DSP core performs a 16-channel version of the Continuous Interleaved Sampling (CIS) speech processing algorithm. The low-power architecture is expandable, programmable, and fully-synthesizeable. Interfaces to an external ADC and electrode array are included. The self-referenced hybrid clock source, courtesy of Mobius Microsystems, consists of a highly-accurate TC-LCO and an independent tunable ring oscillator. The synthesizer supports a reduced-power standby mode in which the TC-LCO is powered down while the system operates from the low-power, low-frequency ring oscillator. The entire clock synthesizer occupies 0.25mm² of silicon area. Maximum power consumption of the complete microsystem is 45.64mW at 100MHz and 1.8V. On-the-fly frequency scaling allows an operating range of 78kHz to 100MHz. Operating at 10MHz and 1.2V reduces the complete microsystem power consumption to 2.54mW. DSP mode consumes 1.79mW from a 1.2V supply, the lowest reported digital CI power consumption. Standby power consumption is 370 μW , a 50% reduction over the previous microsystem.

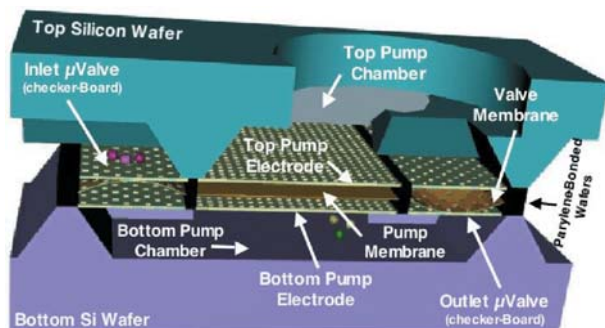


Die micrograph of the complete microsystem in the TSMC 0.18 μm mixed-mode RF process.

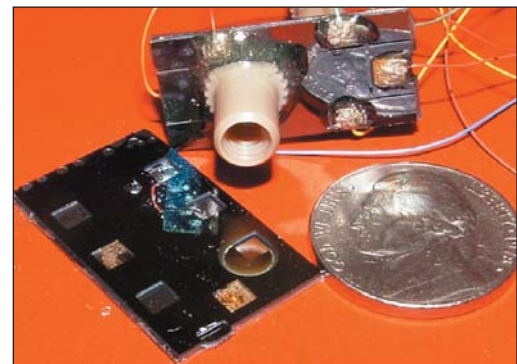
A Low-Power Integrated Micromachined Gas Micropump

Hanseup Kim, Aaron Astle, Khalil Najafi, Luis Bernal, and Peter Washabaugh

A four-stage peristaltic pump structure designed as proof-of-concept for a multistage (18-stage) gas micropump for use in a micro gas chromatography (μGC) system has been developed. The fabricated pump successfully integrates 'pull-pull' dual electrostatic electrodes with small gap distance, active checkerboard microvalves, flexible polymer (Parylene) pumping membranes, and dual pumping chambers using two Parylene-bonded wafers. The dual electrodes allow the pump to be operated at high frequencies and the Parylene membrane provides large compliance to reduce operating voltage. The active part of the MEMS pump chip measures 0.8 x 0.5cm². The electrostatic micropump operates at 7kHz using a 100V drive voltage and produces an air flow rate of up to 2.4cc/min and generates up to 6900Pa of pressure. An 18-stage pump is currently in fabrication and is expected to increase the flow rate to 30cc/min and provide a pressure of 50kPa.



Structure of the micropump. A thin Parylene membrane is sandwiched between two silicon wafers containing drive electrodes to form the pump membrane and two checkerboard valves.



Fabricated 4-stage pump, with and without the external fluidic port, next to a U.S. nickel.

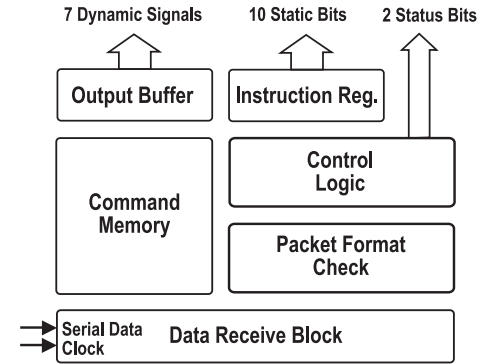
Generic Controller Dedicated to Telemetry-Controlled Microsystems

Amir M. Sodagar, Kensall D. Wise, and Khalil Najafi

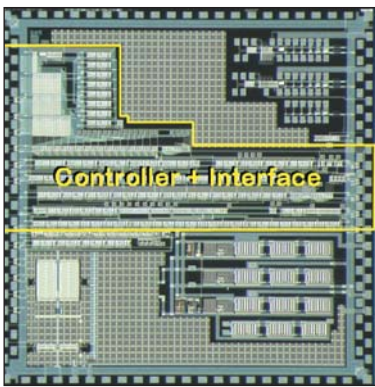
Telemetry-controlled wireless microsystems are of increasing interest in a wide variety of applications. In general, such systems are usually controlled via a wireless link that allows for the transfer of a serial stream of digital information required to control microsystem operation. To meet the requirements of a safe asynchronous data transfer through the wireless link, the main data bits are accompanied by parity bits and usually follow a start pulse that informs the microsystem that data is about to arrive.

A generic controller has been designed that is capable of receiving these data packets through a serial link, checking the accuracy of their structure and contents. In addition, having defined a specific structure for the arriving data packet, the controller also decodes the received data packets and executes the received commands. Based on a *microprogrammed* central processing unit (CPU) architecture, the controller has a read-only mask-programmable *microprogram memory* that defines *flexible* commands. Executing received commands, the controller is capable of generating

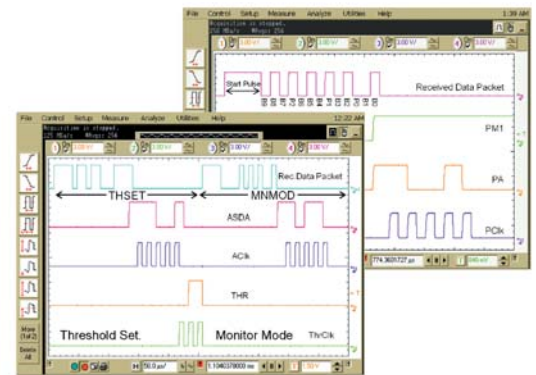
- up to 7 dynamic control signals with arbitrary transitions between 0 and 1 over 16 cycles of the master clock,
- up to 10 static bits, and
- 3 status bits indicating the start and the end of command execution, and the occurrence of a parity error.



Simplified block diagram of the controller.



Micrograph of the bidirectional telemetry chip containing the controller and an application-specific interface.



Samples of the controller's functional test results.

The controller has been employed in a telemetry-controlled inductively-powered multi-channel neural recording system, consisting of four multi-channel neural recording active probes and a mixed-signal neural processing chip in addition to the bidirectional telemetry chip.

Education Highlights

WIMS Pre-College Education Programs

The WIMS Pre-College Education Program was very busy this summer. Youth from fourth to twelfth grades chose from among eight different programs:

- DAPCEP WIMS Short Course
- Women In Engineering (WIE)
- WIMS for Teens
- Michigan Indian Leadership Program (MILP)
- World of Microsystems Technology Workshop 2005
- National Heritage Academy Program
- LEGO Robotics to WIMS (Engineering Exploration)
- Girls In Science and Engineering (GISE)
- Robotics Camp

In these programs, some of which were residential, math and science concepts were taught, as well as microcontroller programming and control strategies. Hands-on learning was emphasized as the students constructed either robots or electronic thermometers with digital conversion and displays. The more advanced programs included an introduction to programming languages, computer-aided design and modeling, and PowerPoint presentations, which were presented, along with posters, at their Closing Programs.

The **Women In Engineering** program had two exciting thrills this year in the form of special field trips. The first highlight was attending the Firestone Indy 400 race at the Michigan International Speedway (MIS), preceded by several pre-race

(continued on next page)

Education Highlights (continued)

activities. Prior to the race, the group watched the last warm-up session, toured the Honda mobile race team offices, visited with crews and drivers in the paddocks, participated in a lengthy and informative interview with drivers Kosuke Matsuura and Scott Sharp, and had the special experience of visiting the pit-lane area during an inactive session. Perhaps the biggest moment of the day occurred during the lunch break as highly publicized first-year driver Danica Patrick spoke to the group, followed by a question and answer session. Then they settled in to watch an exciting Firestone Indy 400 race where the winner ensured his victory only in the last seconds.



Racecar driver Danica Patrick talks to Women In Engineering participants.

The second memorable field trip took place at Ilmor Engineering in Plymouth, Michigan. The young ladies and program staff saw design and evaluation of Honda racing engines. Many thanks go to Joe Giachino, the WIMS Industrial Liaison, for arranging both fantastic field trips.

Robotics Camp was offered to another 185 K–12 students in seven repeated sessions during July and August 2005 at Michigan State and Oakland County schools, through the leadership of Professor Dean Aslam. Also, during Summer 2005, the Aslam team unveiled two new programmable robots: the primary robot has 10 user-programmable ports for sensors and actuators; a second robot was developed to demonstrate miniaturization.



One of the Native American program participants proudly displaying her WIMS robot.

Of the eight WIMS pre-college education programs offered this year, three were new. One program involved our hosting 37 middle and high school Native American students, in two sessions each day, during the week-long **Michigan Indian Leadership Program (MILP)** held at Michigan State University in mid July, with leadership

by Michaelina Magnuson and Drew Kim. During the sessions, the MILP students were informed about careers in science, math, and engineering, with relevance coming from WIMS applications. The second new program had Michigan Technological University hosting a new **World of Microsystems Technology Workshop 2005** for six Native American high school students in late July. Professors Bergstrom and Friedrich, assisted by graduate students, provided individual hands-on experiences for the students. Discussions on the fabrication and applications of microsystems were held, along with many

laboratory activities. Students used a variety of metrology tools to inspect and measure microstructures and learned how these tools are used in the MEMS industry. The third program involved 14 seventh and eighth grade girls who were part of the University of Michigan's **Women In Science and Engineering (WISE) / Girls In Science and Engineering (GISE) Summer Camp** in mid June. The girls completed a hands-on project designing, building, programming, and testing robotic devices that had to perform specific tasks, with a culminating competition. Several of the girls demonstrated enthusiasm for the program by enrolling in the new all girls Ann Arbor area First LEGO Robotics League started this fall with sponsorship by WISE and WIMS, with leadership by Jamie Saville.

WIMS Outreach Activities

The annual **Sally Ride Festival** for fifth- to eighth-grade girls, held on September 24th, was once again a big success. After a morning of looking at displays and listening to Dr. Sylvia Earle, world famous ocean explorer, the girls participated in two workshops about building an electronic thermometer using temperature sensors, a microcontroller, and digital display circuitry. Drew Kim, the WIMS Pre-College Education Program Associate,



Drew Kim demonstrates the newly-developed WIMS digital thermometer.

presented the workshops, based on a thermometer designed and developed by Nathan Usher, Kim's assistant and former MSU student. Each workshop session included 20 girls. Each girl was able to take a thermometer home, to engender a continuing interest in science and engineering.



WIMS Digital Thermometer.

On September 29th, WIMS was invited to present a display at the **Pfizer Science Education Task Force (SETF) Open House** for middle and high school science teachers. The WIMS electronic thermometer unit was displayed. Several science teachers expressed an interest in learning more about WIMS pre-college initiatives generally and the electronic thermometer specifically. Relationships will be explored with middle and high school physical science teachers in the near future.

Recent Events

WIMS Invites Hurricane Victims to Center/UM

While New Orleans and Tulane University recover from the disaster inflicted by Hurricane Katrina, two Tulane graduate students (and former WIMS REU participants), Fatima Otori and D'Mark Hunter, were invited to enroll temporarily at the University of Michigan to continue their WIMS research projects and related coursework. UM administration waived tuition for students displaced by the hurricane, and the WIMS administration developed a way to continue their Tulane research appointment and stipend. By September 2nd, the essential financial support pieces were in place. To further ease the transition, a WIMS faculty member expedited the two students' application and admission to UM. Each student is now taking two classes. Their Tulane research advisor, Professor Dale Joachim, also has a WIMS appointment during Fall Term 2005.



Items collected for students displaced by Katrina.

On the non-academic side, WIMS students, staff, and faculty made a phenomenal response to facilitate the students' move to Ann Arbor. When the Tulane students first evacuated New Orleans, assuming to return in a couple days, they took only enough clothing and personal items for that short period. With their unexpected travel to Ann Arbor during the following week, each needed to set up an apartment. A list was generated, with the students' input, indicating items that were needed. WIMS ERC personnel, along with two churches that virtually adopted the two students, provided many items on the list, including a new microwave and two new TI-89 calculators provided by one family.

The two Tulane students are now settled into their apartments and have become accustomed to the weekly challenging homework assignments, and they have experienced their first midterm exam in each class. The WIMS ERC is seeking to make the devastation in the New Orleans area an opportunity for the two students to develop closer relationships with UM students and faculty, and use the Michigan Nanofabrication Facility. Professor Joachim has also developed formal relationships with WIMS researchers at MSU and UM.

WIMS ERC Summer Retreat at Crystal Mountain Resort

Sunshine and blue skies greeted everyone at the scenic Crystal Mountain Resort in Northern Michigan, as faculty, staff, graduate students, and their families gathered for the 2005 WIMS Summer Retreat from July 13–16. "Charting A Course For Excellence" for the remaining five years of the Center was the main theme and goal of the retreat.

This was an opportunity to bring together people from our collaborating universities, among them Tulane, Michigan State, Puerto Rico at Mayaguez, and Michigan Technological University with a total of 171 participants attending, which included 97 faculty, students, and staff, and 74 family members.

The daily breakout sessions, which included presentations and group discussions led by faculty moderators, brought up important questions: What do we need to do to prepare for the critical sixth-year review in 2006? What are the ten-year legacy accomplishments we want from the ERC in August 2010? How do we ensure sustainability of the Center beyond 2010? Lastly, what form do we want the "graduated" Center to take? These and many other concerns and possible solutions were discussed regarding strategic planning at this critical halfway point as an ERC.

Outside of the meetings, many opportunities allowed participants to enjoy the company of others. Among the activities was a welcome mixer; a chairlift ride to a "Top of the Mountain" barbecue; an evening cookout, including rock climbing and pool party; and the famed WIMS Olympics. Teams made up of faculty, students, staff, and their families took part in this friendly, but fierce, competition. The activities included playing games of Jenga; building the tallest balloon towers; racing in frisbee toss relays; and launching marshmallows from catapults. The Overall Championship was awarded to the team led by Professor Michael Flynn, which scored the highest number of points combining all four games.



Professor Michael Flynn accepts a trophy for his first place team in the WIMS Olympics.

Faculty/Student Awards

Twenty-nine faculty members, including three from WIMS, were recognized for their teaching, scholarship, service, and creative activities at a dinner on October 5 in Rackham Assembly Hall.



Distinguished Faculty Achievement Award, Khalil Najafi

Professor Najafi has excelled as a faculty member and as an expert in the field of integrated sensors, microelectromechanical systems, and microsystems. He has made important contributions in organizing the circuits and microsystems curriculum, and he brings excitement to his lectures. He is deputy-director of the WIMS ERC, and the director of the NSF National Nanotechnology Infrastructure Network, and since 1998 he has been director of the Solid-State Electronics Laboratory. He serves on the executive committee of his department and is active in national and international service to his profession. He has been editor or associate editor of five journals and has received numerous achievement awards in his career. Overall, his work has had a significant impact on the field of biomedical devices and microsystems.



Faculty Recognition Award, Kamal Sarabandi

Professor Sarabandi has established himself as a major scientific leader in the field of microwave remote sensing. He is internationally recognized for his work in physics-based electromagnetic modeling of terrestrial targets for remote sensing, wave propagation in scattering media, microwave and millimeter wave radar system design, antenna development, and other related fields. A research leader who uses an innovative combination of rigorous theory and careful experiments, Sarabandi has an impressive funding and publication record. As Director of the Radiation Laboratory, he has worked hard to establish and maintain a healthy and productive research environment for students, staff, and faculty of the lab. He has received numerous awards, most recently the IEEE Geoscience and Remote Sensing Distinguished Achievement Award, for "Outstanding research in advancement of theoretical and experimental radar remote sensing."



Faculty Recognition Award, Ann Marie Sastry

As one of the most visible and active young researchers in the U.S., Professor Sastry has established a diverse and well-funded research program. In her state-of-the-art laboratories, her groundbreaking research combines high-performance computing with tightly coupled experiments. Her work on statistical modeling of disordered materials has led to scientific advances in biology and novel designs of energy storage materials. Sastry is also a respected teacher and mentor, having introduced a new course, revamped her department's capstone laboratory course, and developed new projects for beginning students. She has made significant service contributions to the University and her profession, has received many honors, has published numerous articles and book chapters, and has delivered countless seminars. Her work also has been featured widely in the national media.

Industrial Liaison's Report



In July, we held a Center retreat to help the faculty, staff, and students share ideas on how to make WIMS more beneficial to the stakeholders. One of the major stakeholders is the industrial member. A recommendation from the retreat was to explore ways to engage more directly with member company researchers. To increase interaction with our members, we are encouraging our faculty, as well as our students, to become more proactive in contacting corporate members concerning specific research where members have expressed an interest. We are also encouraging member companies to present at our regular seminar series. These seminars, attended by both faculty and students, offer an opportunity to familiarize the Center with your company's activities. They allow the presenter to meet individually with faculty and students. These individual meetings allow for in-

depth discussions in areas of mutual interest. Please contact me if you have an interest in taking part in our seminar series.

We will be electronically distributing our "4th Annual Student Résumé Book" to our members. Attendees of the October 25 Industrial Advisory Board meeting will receive a hard copy. This document contains the résumés of undergraduate and graduate students interested in internships and/or full-time positions in a member company. If you are a member of a Center company who wishes to obtain the electronic version just send me an e-mail (giachino@eecs.umich.edu) request, and we will send it to you.

As always, please visit when in the Ann Arbor area.

Joseph M. Giachino
Associate Director, Industry

Presentations and Publications

Conference Presentations

Proceedings, ASME/Pacific Rim Technical Conference and Exhibition on Integration and Packaging of MEMS, NEMS, and Electronic Systems (InterPack05), San Francisco, CA, July 2005

J. S. Mitchell, G. R. Lahiji, and K. Najafi, "Reliability and Characterization of Micro-Packages in a Wafer Level Au-Si Eutectic Vacuum Bonding Process"

W. C. Welch, M. Dokmeci, N. Yazdi, and K. Najafi, "A Flux-Free Pb-Sn Solder Bonding Technology for Wafer-Level Chip-Scale Vacuum Packaging"

Other Conference Presentations

M. A. Jimenez and N. G. Santiago, "The Supporting Role of CAD/CAM Tools in Undergraduate Research Education in Electrical and Computer Engineering," *International Conference on Information Technology Based Higher Education and Training*, Juan Dolio, Dominican Republic, pp. S3C-23 to S3C-26, July 2005.

M. D. Johnson, R. K. Franklin, K. A. Scott, R. B. Brown, and D. R. Kipke, "Neural Probes for Concurrent Detection of Neurochemical and Electrophysiological Signals In Vivo," *IEEE Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)*, Shanghai, China, September 2005.

Y. Shimamura, K. Udeshi, L. Que, J. Park, and Y. B. Gianchandani, "Energy Efficiency of Pulse Driven Bent-Beam Electrothermal Actuators," *Proceedings of Mechanical Engineering Congress*, Chofu, Japan, 2005 Japan (MECJ-05), 05-1(7), pp. 123-124, September 2005.

W. H. Steinecker, M. P. Rowe, H. Xu, Q. Zhong, C. Jin, L. Farina, C. Kurdak, and E. T. Zellers, "Au-Thiolate Nanoparticles as Interfacial Layers on Microsensor Arrays for Micro Gas Chromatography," *Euroensors XIX*, Barcelona, Spain, pp. 11-16, September 2005.

R. P. Taylor, G. F. Nellis, S. A. Klein, D. W. Hoch, J. Fellers, P. Roach, J. Park, and Y. B. Gianchandani, "Measurements of the Material Properties of a Laminate Piezoelectric Stack at Cryogenic Temperatures," *30th International Cryogenic Materials Conference*, Keystone, CO, September 2005.

K. D. Wise, "Wireless Integrated MicroSystems: Coming Revolution in the Gathering of Information," (Invited), *Robert V. Adams Distinguished Lecture*, Purdue University, September 2005.

Y. Yao, M. N. Gulari, S. Ghimire, J. F. Hetke, and K. D. Wise, "A Low-Profile Three-Dimensional Silicon/Parylene Stimulating Electrode Array for Neural Prosthesis Applications," *Digest IEEE Conf. on Engr. in Med. and Biol.*, Shanghai, September 2005.

W. Zhu, Y. B. Gianchandani, G. F. Nellis, and S. A. Klein, "Micromachined Heat Exchanger for a Cryosurgical Probe," *International Workshop on Thermal Investigations of ICs and Systems (THERMINIC)*, Belgirate, Italy, pp. 112-116, September 2005.

Publications

R. H. Olsson III, D. Buhl, A. M. Sirota, G. Buzsaki, and K. D. Wise, "Band-Tunable and Multiplexed Integrated Circuits for Simultaneous Recording and Stimulation with Microelectrode Arrays," *IEEE Trans. Biomed. Eng.*, 52, pp. 1303-1311, July 2005.

C.-J. Lu, W. H. Steinecker, W.-C. Tian, M. C. Oborny, J. Nichols, M. Agah, J. A. Potkay, H. K. Chan, J. A. Driscoll, R. D. Sacks, K. D. Wise, S. W. Pang, and E. T. Zellers, "First Generation Hybrid MEMS Gas Chromatograph," *Lab On A Chip*, 5, pp. 1123-1131, August 2005.

R. A. Ravindran, R. M. Senger, E. D. Marsman, G. S. Dasika, M. R. Guthaus, S. A. Mahlke, and R. B. Brown, "Partitioning Variables Across Multiple Register Windows to Reduce Spill Code in a Low-Power Processor," *IEEE Transactions on Computers*, 54, pp. 998-1012, August 2005.

T. J. Harpster, S. A. Nikles, M. Dokmeci, and K. Najafi, "Long-Term Hermeticity and Biological Performance of Anodically-Bonded Glass-Silicon Implantable Packages," *IEEE Transactions on Device and Materials Reliability*, 5, September 2005.

K. D. Wise, "Silicon Microsystems for Use in Neuroscience and Neural Prostheses: Interfacing with the Central Nervous System at the Cellular Level," *IEEE Eng. in Medicine and Biology Magazine*, 24, pp. 22-29, September/October 2005.

Doctoral Dissertations

University of Michigan, 2005

Alan J. Drake, "Power Reduction in Digital Systems Through Local Resonant Clocking and Dynamic Threshold MOS" Postgraduate Position: Research Staff Member, IBM Austin Research Laboratory, Texas Advisor: Richard B. Brown

Stefan A. Nikles, "A Micromachined Sieve Electrode for Chronic Recording From Multiple, Isolated Gustatory Nerve Fibers" Postgraduate Position: Senior Research Scientist, Guidant Corporation, Minnesota Advisor: Khalil Najafi

Ying Yao, "A 1024-Site Neural Stimulating Array With On-Chip Current Generation" Postgraduate Position: Research Fellow, University of Michigan Advisor: Kensall D. Wise

Personnel Focus



Robert Gordenker was appointed as the Center's System Integrator for the Environmental Testbed. Robert brings with him a great deal of experience in system design, product development, and test instrumentation. He helped develop both WIMS testbeds—neural as well as environmental—and has been intimately involved with the environmental testbed during the past year as work has been done to develop monolithic electrofluidic substrates for the testbed microsystems. Robert began his career in 1978 as a Senior Technician in Product Design with Irwin International. In 1981, he became Manager of Test Engineering at Irwin Magnetics, where he remained until 1992. He received the BS degree in electrical engineering (summa cum laude) from the University of Michigan in 1994, at which time he joined Electro Scientific Industries as Manager of Product Engineering. He returned to the University of Michigan in 2000 with the responsibility for test instrumentation in the WIMS ERC. Robert's experience includes engineering project management, product design for testability and manufacturability, failure analysis, and instrumentation. He holds one U. S. patent. We appreciate Robert's expertise and enthusiasm and we look forward to his continued contributions to the Center.

Seminar Series

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

* June 21, 2005

Anoop Mathur, PhD
Honeywell, Inc.
"Wireless Sensor Network Technology Opportunities and Challenges"

* June 28, 2005

Professor William P. King
Georgia Tech
"Thermal Processing and Thermal Measurements at Extremely Small Scales: 10 Nanometers to 50 Micrometers"

* July 19, 2005

Professor Patrick Fay
University of Notre Dame
"Advances in Devices for Wireless and Optoelectronic Systems"

* July 26, 2005

Professor Florian Solzbacher
University of Utah
"The Utah Integrated Neural Interface—A Fully Integrated Next Generation Neural Interface for Chronic Implantation"

September 13, 2005

Eui-Hyeok Yang, PhD
Cal Tech/NASA Jet Propulsion Labs
"Development of Microactuator Technologies for Space Applications"

**Available for viewing on website*

* September 20, 2005

Professor Kensall D. Wise and Amir Sodagar, PhD
University of Michigan
"A Wireless Integrated Microsystem for Single-Unit Recording in Primate Motor Cortex"

* September 27, 2005

Hanseup (Steve) Kim and Aaron Astle
Graduate Students, U-M
"Fabrication and Performance of an Integrated Electrostatic Dual-Curved Electrode Micropump With Integrated Checker-Board Microvalves" (Hanseup Kim)
"Design and Simulation of the WIMS μ GC Vacuum Pump" (Aaron Astle)

Schedule of upcoming seminars, as well as a listing of publications, are available at <http://wimserc.org>

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Samsung Electronics
Sandia National Laboratories
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