Materials Science & Engineering **Spring 2007**

Roberts Hall Review

UNIVERSITY OF WASHINGTON
COLLEGE of ENGINEERING
A Community of Innovators

In this issue

New Micron CME Lab Opens

UW, Micron Launch Materials-testing Lab in Quest for Next-generation Microchips

The computer chip industry is facing a predicament: as chips get smaller they are reaching a physical limit. Today's semiconductor devices are made of parts containing just a few hundred atoms of silicon and other materials. As consumers demand even faster and smaller devices, nanoscale effects will change the materials' behavior.

"Silicon is still an absolutely good material for the active area, where the electrons travel," said Fumio Ohuchi, University of Washington professor of materials science and engineering. "But the supporting material, the surrounding scaffold, will have to change as we're pushing the technical limit. Smaller devices will require new combinations of materials."

Finding these materials is the first goal of the UW's new Micron Laboratory for Combinatorial Materials Exploration, which opened today in a ribbon-cutting ceremony at the UW. Boise-based Micron Technology Inc., manufacturer of memory chips and image sensors, and the Micron Foundation helped launch the new lab with more than $400,000 in equipment and $500,000 in cash.

(l-r) Scott DeBoer, Micron Technology Director of Process Development; Prof. Fumio Ohuchi; Dean Matt O'Donnell, College of Engineering

"In order to compete in the fast-paced microelectronics industry, Micron must continue to innovate and execute on the cutting-edge material science technologies of tomorrow," said Scott DeBoer, Micron's director of process development. "By collaborating with the UW on combinatorial materials, we have a unique opportunity to enhance collaborative research leading to faster, more efficient and cost-effective screening of new materials," Ohuchi said.

"Combinatorial Materials Exploration is a new protocol for materials development" - Fumio Ohuchi

The lab is part of Micron's university relations efforts to advance education, primarily in science and engineering, by establishing strategic partnerships with premier research universities.

Today's silicon-based transistors, used in all computer processors and memory chips are predicted to be obsolete by 2025, Ohuchi said. New materials will be required to combine optical and

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Message from MSE Chair Alex Jen

Dear Alumni and Friends,

Welcome to the spring issue of the Roberts Hall Review. In this issue you will find stories focusing on two of our leading researchers and their current efforts. Our front page story is about the new Combinatorial Materials Exploration laboratory Professor Fumio Ohuchi has just opened with funding support from Micron Technology, Inc. The work that will come out of this new lab promises to play a big role in the next generation of microchips and memory devices. I think you will also enjoy our article about the very exciting biomaterials work being done by Associate Professor Miqin Zhang. Prof. Zhang is one of our leaders in interdisciplinary work as she pursues materials research into the medical arena.

We have recently established the External Advisory Board comprised of corporate and educational leaders from around the country to provide advice and assistance to the Department on matters pertaining to the Department's mission in education, research, development, and professional service. The Board will play a very critical role in helping our Department meet the goals of our educational and research programs, as well as assisting with strategic planning and external relations. The first meeting will take place in October and the autumn issue of the Roberts Hall Review will include an article on the new board and its members.

On a sad note, I am sorry to report that Professor Emeritus Thomas Archbold passed away in March. Tom, who retired from the Department in 1997, was a mainstay of our Metallurgical Engineering program and will be missed by his colleagues and former students.

I would be happy to hear from any of our alums, whether to discuss the state of MSE or just to say hello. If you find yourself in Seattle and have time to visit the Department, I would enjoy taking you to lunch. Just give me a call. One of the most satisfying aspects of being chair is to hear from and see our alums.

IN MEMORIAM: Thomas Archbold

We are sad to report that Professor Emeritus Thomas F. Archbold passed away on March 19, 2007. Born in Fort Wayne, Indiana, Prof. Archbold attended school in Indiana, receiving his BS, MS and Ph.D. in Metallurgical Engineering from Purdue University. He joined the Materials Science Engineering faculty at UW in 1961 as an Assistant Professor. He was promoted to Associate Professor in 1968 and to Professor in 1973. Prof. Archbold served the Department until his retirement in 1997 as Professor Emeritus. His earliest responsibilities as a faculty member included materials studies on the electron microscope. In 1967, Prof. Archbold became the Principal Investigator for the National Science Foundation's sponsored study of diffusion in order-disorder arrays. During his tenure, his teaching and scholarship in physical metallurgy, corrosion, diffraction, and metal failure helped define the character of the Department. In addition to his faculty duties, Prof. Archbold also did considerable consulting work on metallurgical issues, including pro bono work for the Washington State Patrol. Outside of his educational and research work, Prof. Archbold had wide-ranging interests that included music, photography, and travel. He'll be greatly missed by his family that includes his wife of 47 years, Barbara Connelly, sons, Brian (Sook) and Mike, daughter, Becky (Jeff Spelman), grandchildren, Aidan and Madeline Spelman and brother-in-law, John Connelly (Evey). A Memorial Concert honoring Prof. Archbold's life was held at the University of Washington Club on April 4th.

CME Lab Opening, *continued from pg. 1*

magnetic signals, two directions for future microchips, with the existing silicon electronics. At the moment many different possible successors are vying for favor. Testing them all quickly is beyond the ability of conventional materials testing, Ohuchi said.

The Micron lab's machines automate materials testing by creating a wafer, called a materials library, whose properties change gradually. By layering these wafers, a single test can evaluate all possible combinations of important factors -- such as manufacturing process, material composition and atomic structure -- to see which produce the best attributes. The word "combinatorial" in the lab's name refers to this system for combining different materials.

Similar techniques for screening candidates have long been used in the pharmaceutical industry, but are only beginning to be used in materials research, Ohuchi said. The new lab will work cooperatively with other institutions using combinatorial materials testing, including the National Institute of Materials Science in Japan, the Pacific Northwest National Laboratory in Richland, Wash., and the University of Maryland in College Park. Materials scientists predict that the abundance of data generated by this type of screening will have the same effect on their field that the Human Genome Project had on biology.

(l-r) John Smythe, Micron Process R&D; Fumio Ohuchi

The lab will be directed by a multidisciplinary team of five UW faculty. In addition to Ohuchi, physicist Marjorie Olmstead will help to assess why the material responds in certain ways. Materials scientist Raj Bordia will study whether the combinations are compatible and stable. Electrical engineers Bruce Darling and Scott Dunham will conduct modeling experiments and build prototype devices. The fast pace of today's computer industry means research once carried out in many steps, Ohuchi said, is now being done simultaneously.

"The Micron lab will provide a total integration of expertise within the University of Washington to speed up material development," said professor Alex Jen, chair of the Department of Materials Science & Engineering. "This investment will also build much tighter relationships with our neighboring semiconductor companies."

All results will be collected in a publicly accessible computer database. While the initial motivation for the lab is to test semiconductors for the computer industry, over time it may be used to test new materials for energy

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(L-R) Scott DeBoer, Director of Process Development; Kipp Bedard, President Micron Technology Foundation and VP Investor Relations Micron Technology; Dee Mooney, Executive Director, Micron Technology Foundation; John Smythe, Sr. Engineer, Process R&D; Janine Rush-Byers, Micron University Relations Manager; Dianna Santos, Micron Scholarship Coordinator.

The CME Team: (l-r) Bruce Darling, Electrical Engineering; Scott Dunham, Electrical Engineering; Fumio Ohuchi, Materials Science & Engineering; Marjorie Olmstead, Physics. Not pictured is Raj Bordia, Materials Science & Engineering.

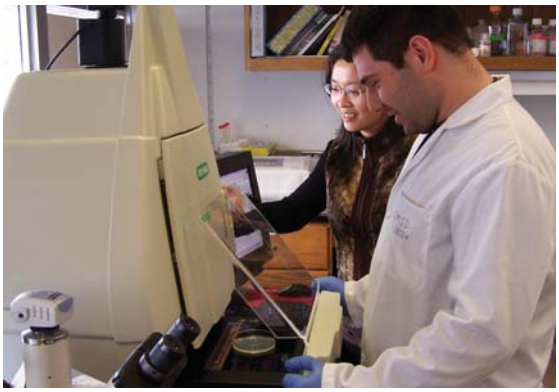
Grad student Shiho Iwanaga at the Chemical Beam Epitaxy unit

Miqin Zhang Lab: On the

Prof. Miqin Zhang and her research group have received frequent media coverage during the past couple of years in print and online publications such as the NSTI Nano World News, Nature Nanotechnology, and NCI Nanotech News. The Zhang group is working on the cutting-edge of biomaterials, biotechnology and nanotechnology and Prof. Zhang has established extensive interdisciplinary research programs with the School of Medicine, Bioengineering, UW Engineered Biomaterials, the Fred Hutchinson Cancer Center, and Children's Hospital. She is also successfully developing grant funding to support her work, including a recent, major grant from the National Institutes of Health (NIH). Following is a summary of the work currently being done in Prof. Zhang's group and it demonstrates some of the exiting new areas into which materials science and engineering has moved.

Nanoparticle Lab

Prof. Zhang's Nanoparticle Lab continues to get media coverage as it focuses its research on brain cancer diagnosis and treatment



Using a Gel-doc instrument, Omid Veiseh and Miqin Zhang examine bacterial colonies engineered to produce rare proteins which selectively target cancer cells

through imaging enhancement and targeted, controlled therapeutic payload delivery through the use of nanoconjugates or multifunctional nanovectors. These are chemically modified nanoparticles which serve as "vehicles" that carries biomolecules to target cells. The nanoparticles specifically target cancer cells, imposing minimal side effects to healthy tissue. Ultimately, the goal is to create fluorescent nanoparticle probes that will locate and illuminate cancer cells, allowing surgeons to more precisely remove tumors and avoid damage to surrounding brain tissue.

Zhang's work focuses on developing new techniques to synthesize these nanoparticles, modifying them with different chemistries, and functionalizing them with various targeting agents and therapeutic drugs. The Zhang group is actually constructing the nanoparticles which are tiny to the extreme -- it would take 100,000 of them to equal the thickness of a sheet of paper. During the past few years, a number of nanoconjugates and nanovectors have been developed. A recent example is a

Matthew Leung extracts RNA molecules from stem cells grown on engineered scaffolds in order analyze the cell differentiation using real time PCR

multifunctional nanovector designed to target and treat glioma tumors, the most common form of primary brain cancer. This multifunctional nanovector comprises a superparamagnetic iron oxide nanoparticle core coated with a biodegradable polymer PEG, a fluorescence dye Cy5.5 and a targeting agent chlorotoxin and is detectable by both MRI and fluorescence microscopy. Because the MRI and optical signals come from the same nanoparticles, the surgeon would be able to use the MRI scan as a roadmap to the fluorescently labeled glioma within the brain. Glioma tumors are the most common and most deadly form of brain cancer and a real-time MRI visual guide for brain surgery is the vision that inspires Prof. Zhang and her colleagues.

Tissue Engineering Lab

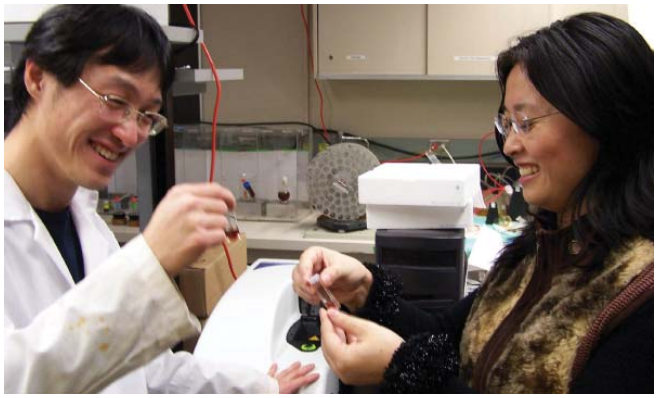
Prof. Miqin Zhang and her research group have also been highlighted for their work in developing natural polymer based

Miqin Zhang and Ryan Buckmaster at the electrospinning equipment in the Tissue Engineering lab. Zhang's group fabricates natural polymer-based nanofibrous matrices and studies their mechanical and biological properties for tissue engineering and regenerative medicine

nanofibers for cartilage repair. This research holds great promise for millions of people who suffer articular cartilage degeneration as a result of osteoarthritis or traumatic injury. This cartilage

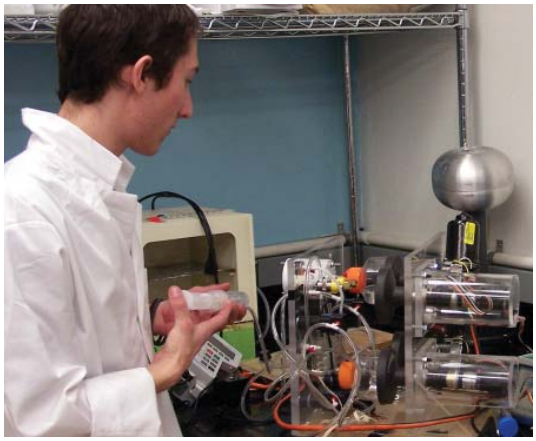
Biomaterials Cutting Edge

has very limited capability for self-healing and current treatments available are rarely able to restore full function.



Chen Fang and Miqin Zhang visually inspect the colloidal stability of a synthesized nanoparticle suspension. The equipment shown in the background is a dynamic light scattering instrument which enables measurements of nanoparticle hydrodynamic size and zeta potential.

Prof. Zhang's Tissue Engineering Lab concentrates on development of biocompatible materials that can serve as biodegradable scaffolds and/or drug delivery depots. A scaffold, in the context of tissue engineering and regenerative medicine, is designed to functionally restore or repair diseased or lost tissue in the human body and is usually made for a particular tissue type to stimulate or accelerate the tissue growth. This process is initiated by encouraging cell attachment, proliferation, and differentiation. The cells populated in the scaffold then "secrete" the natural extracellular matrix as the scaffold gradually degrades. Nanofibrous matrices introduced as scaffolds may have a better structural resemblance to target tissues because of our ability to manipulate the structure, composition, and chemistry of the matrices at the nanoscale. Only when the materials can be manipulated at the nanoscale can light be shed on tissue engineering. The Zhang lab fabricates natural polymer-based nanofibrous matrices by electrospinning, and studies their mechanical and biological properties for tissue engineering and regenerative medicine. For repairing minor tissue defects, Hydrogels are used in tissue engineering to serve as scaffolds or drug delivery depots. Use of injectable hydrogels for sustained drug release avoids surgical procedures for implantation, an advantage simply unbeatable by other approaches.



In a Tissue Engineering lab, Michael Rossol tests a bioreactor engineered for dynamic cell culture applications. This instrument enables testing of scaffolds in an environment where the cell chemistry and mechanics more closely resemble In Situ conditions.

Biosensor Lab

The Biosensor Lab targets the detection and identification of chemical and biological agents and development of drug screening techniques. The goal is to develop surface modification techniques to pattern proteins and live cells on microchips to study their responses to external stimuli. These responses are transformed into optical or electronic signals that are addressed and processed by computers via data acquisition and control interfaces. Cell-based sensors are hybrid systems (biology + device) that utilize cells' remarkable abilities to detect, transduce, and amplify very small changes of chemistry, light, temperature, and other parameters. These sensors will have many applications, including bio-warfare toxin detection, drug evaluation, pollutant identification, and recognition of viruses, bacteria, and cell types in health/food industries.

In the Biosensor lab, Ryan Buckmaster exams microfabricated gold and silicon electrode arrays for cell-based biosensor devices.

Your Donations Make a Difference

We thank our 2006 donors. Individual donors play a special role in the Department of Materials Science & Engineering's ability to maintain and expand its educational programs. Your gifts allow us to offer fellowship and scholarship aid to a growing number of postgraduate and undergraduate students; they provide funds to support a valuable seminar series; they allow us to grant travel awards so that many of our students have the opportunity to attend professional conferences where they gain valuable experience and contacts that are important to their future careers; they fund our annual Visit Day when top applicants for our graduate program travel to MSE to see what our faculty and student body has to offer. These are just a few of the many things your gifts make possible every year and we are grateful for your support.

To find out more about contributing to Materials Science & Engineering, you can contact David Iyall at College of Engineering Development, 206-685-9816.

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Alumni Spotlight: Kumar & Roberta Bhasin

In August of 2006, Materials Science and Engineering alumnus Kumar Bhasin and his wife Roberta made a generous gift to create a graduate fellowship fund in the College of Engineering. The A. Kumar and Roberta L. Bhasin Endowed Fellowship will provide financial assistance to graduate students in the College of Engineering, with a special focus on supporting students with a link to India.

A graduate of the Indian Institute of Technology, Kumar holds an M.S. and Ph.D. in Metallurgical Engineering from the University of Washington and an M.B.A. from Pepperdine University. He worked for Marcona, FMC and Amax corporations prior to retiring in 1998 as President of Alumax Technical Center, a subsidiary of Alcoa, Inc. Kumar remembers his time at the UW with fondness, including his memories of professors Brien, Stoebe, and Mueller.

Roberta Bhasin is also a highly accomplished professional, with a B.A. in English from the University of Washington and an M.B.A. from Pepperdine University. She worked for US West and Seattle City Light, retiring in 2001 as Vice President of Communications for Colorado's community college system. She is widely published in business, telecommunications, and education and is author of Mastering Management: A Guide for the Technical Professional.

In addition to the endowed fellowship, the Bhasins have worked with the UW's Office of Gift Planning to establish a charitable remainder unitrust, a gift that provides an immediate income tax deduction, provides an annual income for the donor and supports the University of Washington in a meaningful way. The Department of Materials Science and Engineering and the College of Engineering are grateful for the Bhasins generosity, which makes a tremendous impact on the lives of our students and faculty.

MSE Faculty Awards

Raj Bordia Named UW Graduate Mentor for 2007

On March 9, 2007, UW President Mark A. Emmert announced the selection of Prof. Rajendra Bordia as the 2007 recipient of the Marsha L. Landolt Distinguished Graduate Mentor Award. In his letter to Prof. Bordia, President Emmert noted that "your students and colleagues nominated you with the highest praise for your exemplary commitment to mentoring graduate students." The Landolt award recognizes a faculty member who excels at the intense, one-on-one teaching that is the hallmark of graduate study. First awarded in 1999, the award was renamed in memory of Marsha L. Landolt, who served as dean of The Graduate School from 1996-2004. The recipient receives a stipend of $5,000. The award will be officially presented on June 7th at the University Recognition Ceremony in Meany Hall Auditorium and Prof. Bordia will also be recognized during 2007 Commencement exercises on June 9th.

Tom Stoebe Receives ASM George A. Roberts Award

Professor Thomas G. Stoebe has been named the 2006 recipient of the George A. Roberts Award by ASM International. Stoebe, MSE professor emeritus and Fellow of ASM, is recognized for "his focus on using the materials of everyday life to instill in students a basic understanding of how things behave, demonstrating that we all have an innate knowledge of science through our everyday experience." This award was established in 2003 to highlight the importance of educational outreach and is presented annually to an individual who has made a significant impact to reach students and teachers, in efforts to increase awareness of materials and applied science careers. The award is named for Dr. George Roberts, president of ASM in 1955, who has served the materials community with great distinction for more than 50 years. "The Roberts Award was given to Professor Stoebe for his great contribution and impact on educational outreach to students and teachers for increasing awareness of materials and applied science careers", says MSE Acting Chair Alex Jen.

Ohuchi Named AVS Fellow by AVS Trustees, Nov. 2006

Prof. Fumio Ohuchi been selected by the American Vacuum Society Trustees to receive the honor of "Fellow of the Society". The Fellowship recognizes AVS members who have made sustained and outstanding scientific and technical contributions in research, engineering, technical advancement, academic education, or managerial leadership for at least ten (10) years. This honor reflects the profound impact of Prof. Ohuchi's accomplishments as judged by his colleagues and concurred by the AVS Trustees, and recognizes Prof. Ohuchi's advances in the surface and interface science of chalcogenide and oxide thin films, along with educational leadership in nanoscience and nanotechnology. The honor will be officially bestowed at the AVS Awards Assembly on November 15, 2006, during the AVS Symposium in San Francisco.

Alex Jen Named to WTC Board of Directors

Governor Christine Gregoire recently appointed Prof. Alex Jen to serve on the Board of Directors for the Washington Technology Center (WTC). The board consists of representatives from industry and higher education throughout Washington State and it's purpose is to guide WTC in its commitment to becoming a nationally preeminent organization, focusing state, federal, and private resources on the development and commercialization of new products and

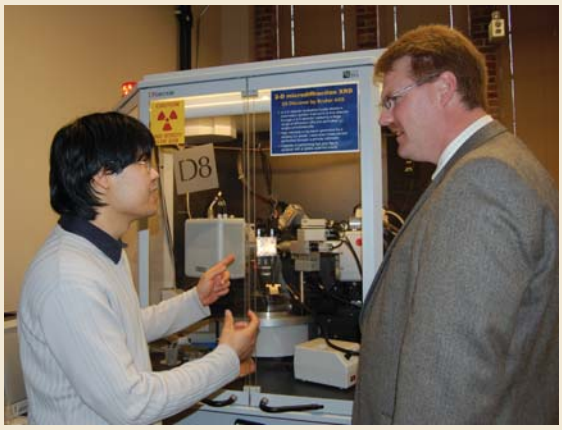
continued on next page

CME Lab Opening, *continued from pg. 3*

and environmental uses, such as components for solar cells and fuel cells, or to discover replacements for dwindling resources, such as the indium used in flat-panel display screens, Ohuchi said.

"We want to have a global impact," he said. "Together we hope to become a nucleus for research and also education, preparing students for the work force of tomorrow."

written by Hannah Hickey, Public Information Specialist



Postdoctoral researcher Kunakorn Poochinda (l) and Scott De-Boer of Micron discuss the 2-D microdiffraction XRD in the New Micron CME Lab

Faculty Awards, *continued from pg. 7*

technologies as a vital part of Washington's economic growth. Alex's term runs from January 2007 to July 2009.

Alex Jen Named 2007 Faculty Innovator for Research

The College of Engineering *Community of Innovators Awards* for 2007 were presented on April 24th in a ceremony in the HUB Ballroom. MSE Acting Chair Alex Jen was named the *Faculty Innovator for Research* for his work in the area of organic and polymeric functional materials and nanotechnology. Described as the "sparkplug and central figure" in winning multi-million dollar grants, Alex has developed and led several large, innovative and inter-disciplinary research programs and has developed an international reputation for his work. He has also the co-inventor on 23 patents and has been instrumental in two, local start-up companies, Lumera and Advanced Electroluminescent Sciences.

Alex Jen with Tuesday Kuykendall (left) and Bichtien Thach, staff nominees for COE Innovator Awards

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