



SPRING 2007

# TECHSTRAKS

MATERIALS SCIENCE AND ENGINEERING

A. JAMES CLARK SCHOOL of ENGINEERING

[www.mse.umd.edu](http://www.mse.umd.edu)

A NEWSLETTER FOR ALUMNI AND FRIENDS OF THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING AT THE A. JAMES CLARK SCHOOL OF ENGINEERING, UNIVERSITY OF MARYLAND.

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## Big Developments at the Small Scale

### MAJOR UPGRADES AND FUNDING FOR UMD MICROSCOPY FACILITIES

The National Science Foundation has provided funds to upgrade the Maryland NanoCenter's Nanoscale Imaging, Spectroscopy, and Properties Laboratory (NISPLab), located in the Jeong H. Kim Engineering Building.

The grant was awarded to an interdisciplinary team of researchers from Engineering, Physics, Chemistry and Biology at the University of Maryland, led by materials science and engineering (MSE) Professor **Lourdes Salamanca-Riba** (see p. 4). The funds will be used to purchase accessories for composition analysis of materials with very high spatial resolution and for characterization of biological systems and soft materials at low temperatures.

The upgrades will allow researchers to detect the composition of material and evaluate its chemical state. "These instruments essentially let us 'see' individual atoms in material," said Department of Chemistry and Biochemistry Professor **Bryan Eichhorn**.

"This award is central to our continued progress as a leader in science, engineering and nanotechnology research on structure at the molecular- and nanoscale," said MSE Professor **Gary Rubloff**, director of the Maryland NanoCenter. "The NSF award builds on major investments the campus has

made in electron microscopy, providing funds to add pivotal chemical analysis capabilities to our new instrumentation.

This makes our nanoscale electron microscopy competitive with the best, and available to researchers in the region through the open door of the Maryland NanoCenter."

The NISPLab's electron microscopy capabilities at the University of Maryland include 2 new JEOL transmission electron microscopes: a 2100F field emission with energy dispersive x-ray analysis and electron energy loss spectroscopy; and a thermionic 2100 LaB<sub>6</sub>. The lab also features a JEOL SuperProbe 840, an electron microprobe microscope with 5 wavelength dispersive x-ray spectrometers for chemical analysis. Several existing electron microscopes have also been incorporated into the NISPLab.

The NISPLab and its new equipment are already having a positive effect throughout the university. "The quality of



JEOL 2100F

*continued on p. 2*





ROBERT M. BRIBER

WELCOME TO THE UNIVERSITY OF MARYLAND MATERIALS SCIENCE AND ENGINEERING DEPARTMENT SPRING 2007 NEWSLETTER. THERE ARE A TREMENDOUS NUMBER OF EXCITING THINGS HAPPENING AT MARYLAND.

The new transmission electron microscopy facility, called the NISP Lab (see cover story) brings outstanding new capabilities to the Department and campus. Similarly the success and recognition for the NanoCenter, with Professor Gary Rubloff from MSE as Director, has resulted in an investment of over \$3M from the State in equipment for research in nanofabrication and characterization (see p. 3).

Assistant Professor Joonil Seog (see p. 10) has joined MSE with a joint appointment in Bioengineering and brings an expertise in measuring the mechanical properties of single biomolecules. The Department has an open search for a new faculty member in the area of nanoelectronics and/or materials for energy research. Look to the next issue of the newsletter to meet the new faculty member.

Be sure to read about some of the interesting research projects going on in the Department which are reviewed in this issue, including work on nano-hydrogels and characterization of  $\text{BiFeO}_3$  films (see pp. 4-6).

Our students are having success at finding jobs with companies such as Intel, Seagate and Micron and both the undergraduate and graduate academic programs are growing.

Our students and faculty continue to win awards, with undergraduate Maeling Tapp winning both NASA and ExxonMobil scholarships and Professor Aris Christou winning the 2007 ASM International George Kimball Burgess Memorial Award.

If you are in the Washington, D.C. area please stop by the Department and the University and learn about the new things happening here. If you are an alumni keep us informed on the changes in your career.

Robert M. Briber  
Professor and Chair  
Department of Materials Science and Engineering

*continued from p. 1*

the images has really affected how well we can interpret our data," said MSE Assistant Professor **John Cumings**. The new facilities are making his new thermal imaging project possible, and will also drive a project to study the magnetic structure of materials.

Cumings is optimistic about the NISPLab's role and future. "I think the most important part of NISPLab's mission is to be a place where people come to get questions answered, and where people learn how to ask questions to solve problems. The more types of people working together in the same place—chemists, biologists, engineers, physicists—the more likely you are to learn new techniques, ideas, and concepts. We're also now able to offer this type of technology when the purpose is strictly education."

The NISPLab recently received approval to acquire a new field emission scanning electron microscope (SEM) with a resolution of 1.5 nanometers. Key accessories for the JEOL 2100F that will allow elemental mapping are also on the way: an X-Ray energy-dispersive spectrometer, and an Electron Energy Loss Spectrometer (EELS). The lab will also receive two specialized sample holders, one for experiments conducted at temperatures up to 1000° C, and one capable of operation at liquid nitrogen temperature.

The NISPLab is also expanding its staff. In November 2006, it hired Director **Wen-An Chiou** (see related story, p. 3), and the addition of more staff is planned for the future.

In addition to being a part of the Maryland NanoCenter, the NISPLab is a collaborative research facility of the University of Maryland and its "Beltway Partner" institutions, Howard, Catholic, George Washington and Georgetown Universities.

## STATE APPROVES \$3.65 MILLION FOR NANOCENTER

In July 2006, the Maryland General Assembly approved \$3.65 million in funding for the Maryland NanoCenter, to be drawn from the state's "Sunny Day Fund" and former Governor **Robert Erlich's** nanotechnology initiative. The money will be used to purchase major capital equipment that enables the fabrication of nanoscale patterns using electron beams as well as novel printing approaches, the controlled deposition of material at atomic and nanoscale dimensions, the characterization of nanostructure and properties, and associated support equipment for the NanoCenter's FabLab in the Jeong H. Kim Engineering Building.

"This funding will allow the University of Maryland to continue its outstanding work partnering with local companies to provide both technical expertise and easy access to critical equipment," said Ehrlich.

The Maryland NanoCenter (formerly Maryland Center for Integrated Nano Science and Engineering) is a partnership of the A. James Clark School of Engineering and the Colleges of Computer, Math and Physical Sciences, and Chemical and Life Sciences. It promotes major nano research and education initiatives, provides one-stop shopping for those seeking nano expertise and/or partnerships at the University, and supplies the infrastructure to facilitate nano activities at the University. Nano research at UMD includes key areas such as scanning probe instrumentation, complex oxide and multifunctional materials, focused ion beam research, ultrasmall devices, biomolecular engineering, biomaterials, polymer composites, and ultrafast dynamics.

## NIST, NANOCENTER ANNOUNCE PARTNERSHIP

The National Institute of Standards and Technology (NIST) has awarded a \$1.5 million grant to the Maryland NanoCenter toward a new cooperative program to

further their efforts to develop measurement technologies and other new tools that support the creation of new nanotechnologies.

The new nanotechnology program is the latest of several collaborative efforts between the Clark School and NIST. Last year the two institutions created the UM-NIST Center for Nanomanufacturing and Metrology, a joint venture created to advance the science and technology of manufacturing products based on the unique properties achieved at the nanoscale. Clark School engineers also have numerous partnerships with NIST researchers in a variety of areas, from nanomaterials fabrication to nanoscale characterization.

The bulk of the new grant will support the work of 13 research scientists and engineers in the NanoCenter and NIST's new Center for Nanoscale Science and Technology. A portion of the grant will be used for national outreach and education efforts directed toward young faculty members and post-doctoral researchers. The grant also will accelerate the scale-up of NIST's Center for Nanoscale Science and Technology, which was launched in March 2006. The grant is renewable annually for up to five years.

## NEW DIRECTOR FOR NISPLAB

In November 2006, Dr. **Wen-An Chiou** was appointed Director of the Nanoscale Imaging Spectroscopy, and Properties Laboratory (NISPLab), a major new campus facility for electron microscopy and characterization (see cover story). He comes to Maryland from the University of California, Irvine, where he was the Director of the Department of Chemical Engineering & Materials Science's Materials Characterization Center. He specializes in a variety of microscopy techniques, and the application of electron microscopy in materials characterization and research.

Chiou himself admits that at first glance he may seem like an unusual man for the job—his Ph.D. is in oceanography, and he holds masters degrees in marine science and geology. "We all study materials," he said,

pointing out that both disciplines study fundamental materials such as metals, alloys, oxides, ceramics, silicate, semiconductors and biomaterials. "The actual difference

is that one studies a natural system, while the other works with the man-made. The fundamental materials are the common threads that make new interdisciplinary discoveries possible. Connections to biology and medicine come, for example, with the study of bone or the composition of cells." One of Chiou's research interests is to study, observe and measure materials' smallest basic entities *in situ*, for which he is currently developing an *in situ* environmental (wet cell) transmission electron microscope (TEM).

Chiou has high hopes and ambitious goals for the NISPLab that include building a shared resource that serves scientists throughout the DC area, whether they are in academia, industry, or government; combining older facilities and equipment with the new; providing the best microscopy education to students and users; acquiring a unique collection of equipment; and becoming a center capable of developing new microscopy and technology.

With new equipment in place and more on the way, the current challenge is spreading awareness of the availability of the NISPLab's services, both on and off campus. "We're opening our doors to anyone who wants to use it," he says. "We are here to help."

No single PI could have the breadth of equipment and facilities the NISPLab offers, he told us, and neither can most universities—its 400kV JEOL 4000FX TEM, although one of the older microscopes in the facility, is one of only 35 found in the best electron microscopy facilities throughout the world. "I want to build one of the best microscopy facilities in the nation," he said with enthusiasm, "right here in the nation's capitol."



WEN-AN CHIOU



## POLYMER NANO-HYDROGELS SYNTHESIZED WITH IONIZING IRRADIATION

*Jung-Chul An, Ph.D. Candidate; Advisor: Professor Mohamad Al-Sheikhly*

Nano-sized structures are gaining increasing interest for their unique properties and performance, derived in large part from their specific size. Soft materials, namely polymer gels, having mutability and responsiveness to their surroundings, can also be engineered to form nano-structural products. These products have been drawing attention for their potential applications as drug-delivery carriers, sensors, nano-reactors and bio-mimic mechanical devices (e.g., artificial muscle).

A polymer nano-hydrogel is a three-dimensional polymer network composed of hydrophilic crosslinked macromolecular chains, 1-100 nanometers in diameter and swollen with liquid. Conventional methods used to synthesize nano-hydrogels normally require toxic chemicals to form the gel structure, and additional steps to remove unreacted or extra chemicals. This makes the procedure complicated, environmentally unfriendly, and hence generally unsuitable for biomedical uses.

The Al-Sheikhly group is developing simple, efficient methods of producing polymer nano-hydrogels for use as nano-sized drug carriers from polymeric aqueous solutions using ionizing irradiation. Using these carriers for drug delivery in cancer therapy has many potential advantages, including selective drug distribution in the tumor tissue with minimized side effects. Using a high energy electron beam is a very effective method to form nano-hydrogels. Since the only substances used

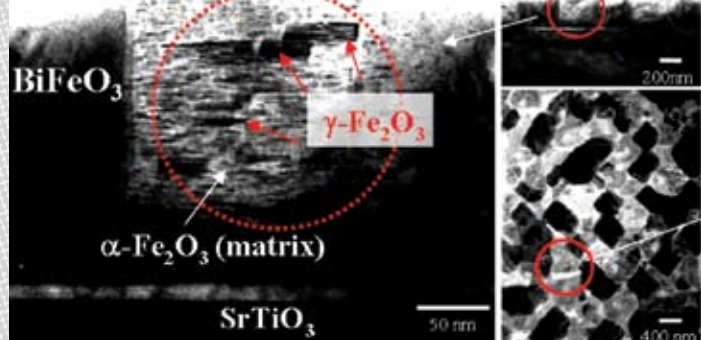
are polymer molecules and water, harmful agents and purification steps are excluded, making this process clean and environmentally friendly.

## THE ROLE OF MULTIPHASE FORMATION ON THE PROPERTIES OF $\text{BiFeO}_3$ FILMS.<sup>1</sup>

*Professor Lourdes Salamanca-Riba*

The recent arrival of the JEOL 2100F transmission electron microscope in the NISPLab has enabled MSE graduate student **Sung Hwan Lim**, working under the direction of Professor **Lourdes Salamanca-Riba** and in collaboration with Associate Professor **Ichiro Takeuchi**, to observe the effects of varying the partial oxygen pressure during the production of magnetic thin films by pulsed laser deposition. Such materials could form the basis for a diverse array of electronics used in applications ranging from cars to computers. The discovery, which shows that decreasing oxygen pressure leads to a higher magnetization of the film, could allow the creation of inexpensive sensors that respond to both magnetic fields and electrical charges.

To understand the role of processing parameters on the properties of multiferroic thin films of Bi-Fe-O, the research group has performed a systematic study of the structure of these films grown on  $\text{SrTiO}_3$  substrates. They found that the films with highest magnetization and polarization are grown at low oxygen partial pressures. Transmission electron microscopy shows that films grown at high oxygen partial pressures are pure epitaxial  $\text{BiFeO}_3$  while films grown at low oxygen partial pressures contain  $\alpha$ - and  $\gamma$ - $\text{Fe}_2\text{O}_3$  phases embedded in the  $\text{BiFeO}_3$  matrix (see figure, top center). Their results show that the observed increase in magnetization is proportional to the amount of ferromagnetic  $\gamma$ - $\text{Fe}_2\text{O}_3$  in the films. The  $\text{Fe}_2\text{O}_3$  phases form because the volatile Bi



**$\text{BiFeO}_3$  FILMS GROWN AT LOW OXYGEN PARTIAL PRESSURE SHOW FORMATION OF  $\alpha$ - AND  $\gamma$ - $\text{Fe}_2\text{O}_3$  PHASES EMBEDDED IN  $\text{BiFeO}_3$  MATRIX. THE  $\gamma$ - $\text{Fe}_2\text{O}_3$  PHASE IS RESPONSIBLE FOR AN INCREASE IN MAGNETIZATION IN THESE FILMS. (A) TOP MIDDLE AND LEFT CROSS SECTIONAL IMAGES; BOTTOM MIDDLE AND RIGHT PLAN VIEW IMAGES FROM A  $\text{BiFeO}_3$  FILM GROWN AT 5 mTorr. (B) AND (C) EDS SPECTRA FROM THE TWO REGIONS IN (A) AND (D) M-H HYSTERESIS LOOPS FOR PURE  $\text{BiFeO}_3$  GROWN AT 20 mTorr AND MULTIPHASE  $\text{BiFeO}_3$  FILMS GROWN AT 1 mTorr.**

evaporates from the films at low oxygen partial pressure giving rise to regions in the film which are Bi-deficient. These regions transform to  $\alpha$ - and  $\gamma$ - $\text{Fe}_2\text{O}_3$  with a 19% reduction in volume. This volume reduction relaxes the strain in the film which arises due to the crystal lattice mismatch between  $\text{BiFeO}_3$  and  $\text{SrTiO}_3$ . The group's future work will be to measure the composition profiles across the  $\text{BiFeO}_3$  and  $\text{Fe}_2\text{O}_3$  to determine the reasons for the observed enhancement in the ferroelectric properties of the films.

<sup>1</sup> Supported by the National Science Foundation under MRSEC DMR-00-0520471. The NISP laboratory is a shared experimental facility of the NSF MRSEC at UMD.

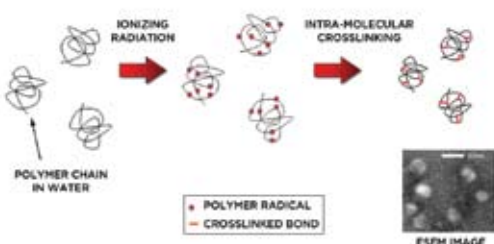
## NOVEL PHOTORESIST/ORGANIC MASKING MATERIALS AND PLASMA PROCESSES FOR NANOSTRUCTURE FABRICATION

*Professor Gottlieb S. Oehrlein (MSE, IREAP) and Associate Professor Raymond Phaneuf (MSE, LPS)*

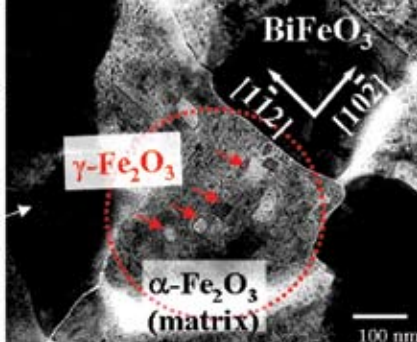
Two projects funded by the National Science Foundation are aimed at laying a foundation for designing resist masks which are suitable for nanoscale manufacturing with new polymers and plasma processing.

Photolithography and plasma-based transfer of resist patterns to produce devices are part of the basic suite of manufacturing techniques used in information technology, flat panel displays, microsystems, and other devices requiring patterned films or substrates. The extension of current

### FORMATION OF NANOHYDROGELS







microscale patterning approaches to the nanoscale is made difficult by our lack of understanding of the interaction of the plasma species with the organic macromolecules and the chemical, morphological and topographic changes induced by these interactions. Uncontrolled plasma-macromolecule interactions can produce chemical changes and lead to surface and line edge roughening of the mask pattern, and introduce unacceptable changes in the dimensions of features. The reasons for these changes are not understood, and depend in a complex way on both the properties of the organic mask material, and the reactive particle fluxes in the plasma and detailed parameters of the plasma processing environment.

The goal of the research is to identify and overcome the factors that control the introduction of nanoscale roughness in current technology. The work is being carried out by MSE graduate students **Sebastian Engelmänn**, **Robert Bruce**, **Taesoon Kwon**, and **Florian Weilnböck**, who, working under the supervision of Professors **Oehrlein** and **Phaneuf**, also collaborate with visiting scientist **Masatoshi Sumiya** (Hitachi Incorporated) and researchers at UC Berkeley, UT Austin, Lam Research Corporation, Rohm and Haas Electronic Materials, General Electric Global Research and ITC-IRST, Italy.

## A SELECTION OF INVITED LECTURES BY MSE FACULTY IN 2006-07

### Mohamad Al-Sheikhly

"Uncertainty Considerations for PGNA Measurement of Chlorides in Concrete", 15th Annual Meeting of the Council on Ionizing Radiation Measurements and Standards, NIST, Gaithersburg, MD, October 2006

"Effects of Ionizing Radiation on Volatile Organic Contaminants", 2nd Coordinated Research Project on "Electron Beam Treatment of Organic Pollutants Contained in Gaseous Streams" of the International Atomic Energy Agency, Beijing, China, October 2006

### Robert M. Briber

"SANS as a User Facility", at the 2006 American Conference on Neutron Scattering, Argonne, Ill. June 2006

"Counterion Dependent Folding of RNA", International Conference on Small Angle Scattering, Kyoto, Japan July 2006

"Experiments on Polymer Chain Conformation: From Thin Films to RNA", National Institutes of Health, NICHD/NIH, Bethesda, Md., October 2006

### Aristos Christou

"Advances in Defect Isolation in Surfaces and Interfaces of BiCMOS Integrated Circuit Technology", Freescale Semiconductor Inc, Kuala Lumpur, Malaysia, June 2006.

"Advances in Defect Isolation in Microelectronic Packaging and Their Impact on Component Reliability", Semiconductor Manufacturing Consortium of China, Tiajjin, China, June 2006

"Yield Enhancement Techniques in Microelectronic Manufacturing", Texas Instrument Educational Center, Dallas Tx., August 2006

### John Cumings

"A Tunable Anomalous Hall Effect in a Non-Ferromagnetic System", American Physical Society March Meeting, Denver, Co., March 2007

"The Anomalous Hall Effect in a Paramagnetic 2DEG", Harvard University, Division of Engineering and Applied Sciences, CMAP Colloquium, Cambridge, Mass., January 2006

"The Electron Microscope as a Nanolaboratory", Cornell University, Kavli Institute Workshop, Thirty Years of Analytical EM: Nanoscale Physics in the Electron Microscope, Ithaca, Ny., July 2006

"In-Situ Operation of Nanoelectronic Devices", Microscopy & Microanalysis 2006, Chicago, Ill., August 2006

### Isabel Lloyd

"Microwave Processing of Ceramics", 11th International Ceramics Congress, Sicily, Italy, June 2006

### Luz Martinez-Miranda

"The NSHP: What We Are, What We Stand for, Our Main Work", SEED Project, Harvard University, Cambridge, Mass., January 2006

"Interaction Between Liquid Crystals and Magnetic Particles", University of Puerto Rico in Humacao, Humacao, Puerto Rico, February 2006

"Effect of the Functionalization Compound on the Magnetic Nanoparticle—Smectic-A Liquid Crystal Interaction: A Phenomenological Model", presented at the Centre de Recherche Paul Pascal (CNRS), Pessac, Bordeaux, France, May 2006

### Gottlieb Oehrlein

"Plasma Processing of Nanostructures and Nanomaterials", SVC Annual Technical Conference, Washington D.C., April 2006

### Lourdes Salamanca-Riba

"Microstructural Characterization of Multiphase Formation and its Effect on the Properties of Multiferroic Thin Films", Physics Symposium, Ensenada, Mexico February, 2007

"Multiferroic BiFeO<sub>3</sub>, Formation and Properties", 2007 Joint Annual Conference of the National Society of Black Physicists (NSBP) and the National Society of Hispanic Physicists (NSHP), Boston, Mass., February 2007

### Ichiro Takeuchi

"Combinatorial Investigation of Magnetic Alloys", MRS Spring Meeting, San Francisco, Ca., April 2006

### Manfred Wuttig

"Fundamentals of Magnetic Shape Memory Alloys", Tegernsee, Germany, February 2007

"Progress in the Combinatorial Approach to Materials", Peter G. Schultz Symposium, San Diego, Ca., June 2007

## DEUTSCH FOUNDATION: \$1 MILLION FOR NANO-BIO INITIATIVE

The Robert W. Deutsch Foundation will give more than \$1 million over four years to the University of Maryland's A. James Clark School of Engineering for biological research on the nanoscale.

A cross-disciplinary group of researchers, including MSE Professor and Maryland NanoCenter Director **Gary Rubloff**, is developing a new "biochip" technology that promises to give doctors a new way to discover drugs to treat bacterial infections—without stimulating resistance-building mutations. The Deutsch Foundation, based in Baltimore, is funding the work in the hope of speeding development of new life-saving drugs and advancing the new field of nano-biotechnology.

Anthrax, tuberculosis, meningitis and pneumonia are all caused by bacteria and treated through the use of antibiotics. But bacteria can mutate, and develop resistance to antibiotics—even to vancomycin, the most potent antibiotic currently available to doctors.

University of Maryland researchers—from the Clark School and the University of Maryland Biotechnology Institute in College Park and the School of Pharmacy in Baltimore—are developing a nanoscale, microfluidic biochip that can serve as a tiny drug discovery laboratory. The chip can, in effect, serve as a miniature test subject—accepting a drug and reporting back on how it performs. The Deutsch Foundation is funding a specific biochip research program designed to complete the group's work and demonstrate its usefulness. The program will investigate biochips that address quorum-sensing bacteria, or bacteria that gather in an

area of the body and signal each other until there are enough bacteria gathered to mount an attack. If a drug is found that can block the bacteria from signaling each other, the attack can be prevented.

The biochip can be used as a testbed for such drugs—drugs that the bacteria won't be able to develop a resistance to, unlike antibiotics. Success for this application could have widespread implications for testing drugs for a range of health problems.

## UNIQUE MICROSCOPE FOR KECK LAB

A new combination scanning tunneling microscope (STM)/near-field microwave microscope will soon be installed in the The W. M. Keck Foundation Laboratory for Combinatorial Nanosynthesis and Multiscale Characterization, located in the Jeong H. Kim Engineering Building. The microscope is the result of a collaboration with Intematix, a company specializing in products used in combinatorial materials research, and MSE Associate Professor **Ichiro Takeuchi**. Its construction was funded by the W. M. Keck Foundation, and represents the second half of the Keck Lab's major equipment.

"It's literally unique," says doctoral student **Chris Long** (Physics), who helped set up the system with Takeuchi. Takeuchi explained its importance: "Now we can image materials with atomic resolution scanning tunneling microscopy while simultaneously measuring microwave impedance, something which has never been done before." This added functionality creates images by recording where and how much a material interacts with microwaves, a technique relevant to radars and wireless communications.

The microscope was built at Intematix in California. Takeuchi and Long visited during the assembly process, performing tests and preliminary experiments. The microscope was shipped to Maryland for a spring 2007 installation.

## POLYMER SYMPOSIUM

The Departments of Materials Science and Engineering (MSE), Chemistry and Biochemistry, Chemical and Biomolecular Engineering (ChBE), and the Fischell Department of Bioengineering (BioE) hosted a half-day symposium on current polymer research at the University of Maryland.

Approximately 35 undergraduate and graduate students and postdoctoral associates from the research groups of Professors **Mohammad Al-Sheikhly** (MSE), **Robert Briber** (MSE), **Sandra Greer** (ChBE and Chemistry), **Peter Kofinas** (BioE), **Srinivasa Raghavan** (ChBE), and **Lawrence Sita** (Chemistry) presented the results of recent research projects. The goal of the symposium was to foster interactions and collaborations between students in different research groups.

The cross-department, cross-school symposium was a first for those engaged in polymer research at the University, and participants were enthusiastic about its potential. Plans are in the works to make the polymer symposium an annual event, with additional research groups participating.

The symposium's subjects covered a broad range of science and engineering on polymer and biopolymer systems, including these from MSE students:

- "Porogen/Matrix Effects on the Microstructure of Nanoporous Poly(methylsilsequioxane) Thin Films"—**Zhaoliang (Frank) Lin**
- "Electron-Beam Induced Formation of Nanogels"—**Jun-Chul An**
- "Flammability of Polymer/Layered Nanocomposites"—**Xin Zhang**
- "Nanopatterning of Recombinant Proteins and Viruses Using Block Copolymer Templates"—**Arthur Cresce**
- "Small Angle Neutron Scattering of Structured Hydrogels"—**Wonjoo Lee**

## POLYMER SYMPOSIUM





## MSGS

*Erin Robertson, President*

The Materials Science Graduate Society (MSGS) was established in the fall of 2005 to provide a means for graduate students to interact with other students and faculty who are interested in Materials Science and Engineering. Our meetings are held on a bi-weekly basis, where we offer our members lunch before the departmental seminars held on Fridays. This past fall we had a ribbon cutting ceremony for the grand opening of the Materials Science Graduate Student Lounge. A large group of students and faculty attended to check out the new study area equipped with a refrigerator, microwave, couches, and snack food/drinks that can be bought at a cheaper price than the school's vending machines. Selling food in the lounge has been one means of fundraising for the MSGS. Another very successful fundraiser is a spirit night we host at the local restaurant California Tortilla. When diners order with a special password, MSGS receives 25% of that person's sale. Besides fundraising, we help the department host the open house for perspective MSE, Chemical and Biomolecular, and Bioengineering graduate students. This year was very successful. We took several students out for dinner at Chipotle and played pool at Galaxy in Silver Spring. We ended the night by taking them to a night club in downtown D.C. to see a fashion show that was a part of D.C. Fashion Week Showcase. At the end of the semester, we held our 2nd annual Departmental BBQ in conjunction with the undergraduate society, where we awarded our first Teacher and Advisor of the Year awards.

## MatES

*Maeling Tapp, President*

This school year was a very busy and productive one for the Materials Engineering Society (MatES), which is also a Material

Advantage Chapter. Under the leadership of President Maeling Tapp, Vice President Margaret Bennett, Treasurer Max Grace, and Secretary Christina Senagore, the society has sponsored a number of social and professional development programs for its members.

In the fall, MatES officers visited Introduction to Engineering classes to promote the society, as well as to encourage undecided-major engineering students to come to the open houses sponsored by the Department of Materials Science and Engineering. We also hosted a "Welcome Back" bowling social, which encouraged MSE students to get to know each other. General body meetings included highlighting a member's study abroad experiences, and a technical presentation by Dr. Rothschild from the MIT Lincoln Laboratory, discussing recent developments in optical lithography techniques. MatES members also had the opportunity to participate in a NIST site visit sponsored by the ASM International Washington, D.C. chapter, which included a tour and presentation of the structural steel in the World Trade Center.

In the spring, MatES attended a networking event hosted by the ASM International Washington, D.C. chapter, held at Dave and Buster's restaurant. Members met fellow MSE students from other universities in the area, as well as professionals working in industry and academia. One of the notable attendees included the newly-inducted president of the Minerals, Metals & Materials Society (TMS), Dr. Robert Schull. Seven MatES members attended the 2007 TMS conference, held in Orlando, Fla., where they enjoyed technical presentations, and professional development forums geared specifically for the students in attendance.



MatES MEMBERS WITH THEIR ADVISOR, PROFESSOR ANKEM, AND THE NEWLY INDUCTED TMS PRESIDENT, DR. ROBERT SCHULL AT THE 2007 TMS CONFERENCE IN ORLANDO, FL. LEFT TO RIGHT: MARGARET BENNETT, ABIODUN OSHO, DR. ANKEM, DR. SCHULL, MICHAEL FIGUEROA, MAELING TAPP, CHRISTINA SENAGORE, MAX GRACE, ARON CEPLER

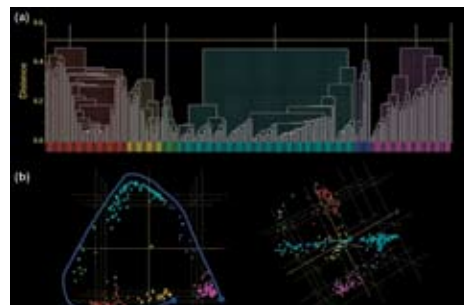
## LONG AND TAKEUCHI GROUP WIN SECOND BRUKER AXS SCHOLARSHIP

**Chris Long**, a graduate student working with Associate Professor **Ichiro Takeuchi**, was awarded one of two 2006 Bruker AXS Excellence in X-ray Diffraction scholarships at the 2006 Materials Research Society (MRS) Fall Meeting.

The award was established in 2005, and Long and the Takeuchi group have won it two years in a row. This year, the winning paper was titled "Rapid Structural Mapping of the Ternary Metallic Alloy Systems Using the Combinatorial Approach and Cluster Analysis." It will appear in the *Review of Scientific Instruments* in 2007.

The work is in combinatorial materials science, a field in which a large number of different materials can rapidly be synthesized and screened. The technique improves researchers' ability to discover new materials, making the process faster and more efficient.

Bruker AXS manufactures x-ray systems for materials research and analysis. A panel of independent judges from industry, academia, and research facilities chose the recipients of the company's scholarships.



A DENDROGRAM SHOWING THE SIMILARITY DISTANCE BETWEEN ALL THE X-RAY SPECTRA FROM A COMBINATORIAL LIBRARY.



## JANIAK SELECTED FOR FUTURE FACULTY PROGRAM

MSE graduate student **Daniel Janiak**, advised by Fischell Department of Bioengineering

Professor **Peter Kofinas**, was among only 20 students chosen to participate in the Clark School's new Future Faculty Program (FFP). The program, launched this year, was created to prepare students for academic careers in top-50 engineering schools. It includes seminars, a teaching practicum, and a research mentoring practicum.

Janiak explained his interest in becoming a professor: "It gives you the opportunity to do your own research—I don't think you have that kind of freedom in industry. I hope [the FFP] leaves me better prepared to get a job as a faculty member because it's so competitive [a field]."

The initial noncredit component of the program introduced students to faculty "role models" who discussed why they chose a career in academia, how they secured tenure-track positions, and how they have achieved success. Students who wished to stay with the program were required to apply. After a competitive selection process 20 students, including at least one representative from each of the Clark School's departments, were chosen to be Future Faculty Fellows. Fellows are awarded a supplemental fellowship, in addition to any teaching or research assistantships they may already have. Half of the funds are reserved for travel to professional conferences.

During the second, third, and fourth semesters of the program, Future Faculty Fellows attend seminars on topics such as technical

writing, oral presentations, creating syllabi and curriculum, teaching and learning styles, identifying research areas, writing grants, and interviewing for faculty positions. Each Fellow is paired with a senior faculty member with whom they will teach a course and supervise an undergraduate research project, and from whom they will receive mentoring and career counseling.

## TAPP WINS NASA, EXXONMOBIL SCHOLARSHIPS

MSE senior **Maeling Tapp** has been named a 2006 NASA Motivating Undergraduates in Science and Technology (MUST) Program Scholar. MUST is funded by a \$1.75 million grant from NASA and is administered by a consortium lead by the Hispanic College Fund (HCF), with the support of the Society of Hispanic Professional Engineers (SHPE) and the United Negro College Fund Special Programs Corporation (UNCFSP). The MUST Program awards scholarships of up to \$10,000 and internships to undergraduate students in science, technology, engineering, and math. MUST Scholars also have access to tutoring, summer research programs, and lectures, as well as academic, industry, and peer mentors.

In the past year, Tapp has also received an ExxonMobil Technical Scholarship, which recognized her for her academic excellence and outstanding performance during her recent summer internship with the company.

Recognition has come in other forms as well: Tapp was profiled on the *Engineer Girl* website, and most recently was awarded the Shirley Chisholm Certificate of Recognition

for Outstanding Academic Performance.

Tapp is very active in both the Department and the Clark School. She is a member of the Quality

Enhancement Systems and Teams (QUEST) program and the Engineering Honors program, president of the undergraduate Materials Engineering Society (MatES), and is also pursuing a minor in Spanish. Last year, she served as the secretary of the UMD chapter of the Society of Women Engineers and was co-chair of the Pre-Collegiate Initiative Committee of the National Society of Black Engineers.

## SAIED WINS KIRSCHSTEIN NATIONAL RESEARCH SERVICE AWARD FELLOWSHIP

MSE graduate student **Mey Saied**, advised by MSE Associate Professor **Isabel Lloyd**, has won the Ruth L. Kirschstein National Research Service Award Predoctoral Fellowship for Minority Students. This high-profile, competitive five-year grant is funded by the National Institutes of Health (NIH). The fellowship supports minority students engaged in cross-disciplinary research in biomedical, behavioral sciences, or health services.

Saied's research is conducted in collaboration with the National Institute of Standards and Technology (NIST), Princeton University, New Jersey State University Dental School, and New York University. Saied's proposal, "Effects of Glass Joins on Performance and Lifetime of Layered Ceramic Systems," which focuses on new compositing techniques for manufacturing and increasing the lifespan of dental crowns, was the top-scorer among those submitted.

## HATTRICK-SIMPERS WINS NIST/NRC POSTDOCTORAL FELLOWSHIP

MSE graduate student **Jason "Jac" Hattrick-Simpers** has been awarded a fellowship from the prestigious NIST/NRC Postdoctoral Research Associateships Program. The program provides two-year temporary appointments for outstanding scientists and engineers chosen through a national competition administered by



MAELING TAPP



the National Research Council of the National Academy of Sciences. Hatrick-Simpers, advised by Associate Professor **Ichiro Takeuchi**, won for his proposal titled "A New Quantitative Metrology and Combinatorial Thin Film Approach for the Measurement of Hydrogen Storage Properties." He will be working with the Materials Science and Engineering Laboratory's (MSEL) Metallurgy Group, developing a rapid screening technique for measuring the hydrogen storage capacity of thin film composition spread samples. He is scheduled to begin his position at NIST in fall 2007, after his Ph.D. defense this summer.



### UM AMONG "BEST VALUES"; CLARK SCHOOL RANKED HIGHLY NATIONALLY, INTERNATIONALLY

The latest *Kiplinger Personal and Finance Magazine* rankings for the best value in higher education for 2006 shows the University of Maryland at No. 15—up three positions from last year. *Kiplinger's* also ranks the value of an education for out-of-state students. This year, UM rose from No. 20 to No. 13—another all-time best ranking.

The Institute of Higher Education and Center for World-Class Universities has ranked the Clark School 13th in the world among all engineering programs for 2007.

The institute, a unit of Shanghai Jiao Tong University in China, based the rankings on total engineering-related research expenditures, highly cited research articles, articles included in the Scientific Citation Index and the percentage of articles published in the top 20 percent of engineering journals.

In *U.S. News and World Report's* annual ranking of graduate school programs, the Clark School is tied for 16th among engineering schools in the nation. The Clark School remains among the top 10 public university engineering programs in the country.

## recentGRADUATES

### 2006-2007 B.S. GRADUATES

Margaret Bennett  
Matthew Castille  
Aron Cepler  
Michael Figueroa  
Max Grace  
Paul Ledwith  
Abiodun Osho  
Brian Smith  
Patrick Stahl

### 2006-2007 M.S. GRADUATES

Dennis Brown  
Bowen Lee  
Lei Zheng

### 2006-2007 PH.D. GRADUATES

**Arthur (Von) Cresce:** Nanopatterning of Recombinant Proteins and Viruses Using Block Copolymer Templates. Advisor: Kofinas (BioE).

**James Lee:** Mechanics of Brittle Layered Structures Supported with High Modulus Composite. Advisor: Lloyd.

**Li Ling:** Plasma Etching of Dielectric Materials Using Inductively and Capacitively Coupled Fluorocarbon Discharges: Mechanistic Studies of the Surface Chemistry. Advisor: Oehrlein.

**Greg Oberson:** An Experimental and Theoretical Investigation of the Low Temperature Creep Deformation Mechanisms of Single-Phase Titanium Alloys. Advisor: Ankem.

**Jung Jin Park:** Development of BioMEMS Device and Package for a Spatially Programmable Biomolecule Assembly. Advisor: Rubloff.

**Sanwarit (Alex) Prasertchoung:** Pulse Switching and Scaling Behavior of Ferroelectric Thin Films Using Atomic Force Microscopy. Advisor: Ramesh

**Tabassom Tadayyon-Eslami:** Temperature Dependence of the Growth Made During Homoepitaxy on Patterned GaAs (001): The Role of Roughening. Advisor: Phaneuf

**Yijun Wang:** High Modulus Dental Resin Composites. Advisor: Lloyd

**Peng Zhao:** Magnetoelastic Coupling In NiMnGa Ferromagnetic Shape Memory Alloys. Advisor: Wuttig.

## studentAWARDS

### UNDERGRADUATE AWARDS FOR 2006-2007

**Chairman's Outstanding Senior Award:** Arthur Maxwell Grace

**Outstanding Materials Student Service Award:** Michael Figueroa

**ASM/TMS Materials Undergraduate Service Award:** Maeling Tapp

**Outstanding Engineering Co-op/Intern Award:** Matthew Castille



JOONIL SEOG

## SEOG JOINS FACULTY

The Department of Materials Science and Engineering (MSE) and The Fischell Department of Bioengineering (BioE) are pleased to welcome their newest faculty member, Dr. **Joonil Seog**, who was jointly appointed to the Departments

as an Assistant Professor in Spring 2007.

Seog received his Ph.D. from the Massachusetts Institute of Technology (MIT) in 2003. Before joining our faculty he was a research fellow at the CBR Institute for Biomedical Research, Inc., located at the Harvard Medical School. He will be developing and teaching undergraduate courses in the MSE and BioE programs and a graduate-level course in single molecule mechanics. One of his goals is to get students involved in cutting-edge research.

Seog's research will provide insight into the design of nanomechanically tailored smart biomaterials that can enhance tissue regeneration or slow down disease progression. His focus will be on studying the structure-function relationship of biological molecules using single molecule force spectroscopy. Previously, Seog studied the molecular origin of cartilage biomechanical properties, and by directly measuring intermolecular forces discovered that about 50% of the compressive resistance of cartilage originates from the highly charged polysaccharides within it. This was the first study elucidating the structure and biomechanical function of polysaccharides in cartilage using tools that could measure very small forces such as individual molecular interactions.

Seog is currently pursuing a study of the structural change of biological molecules in relationship to diseases. Many diseases are

caused by mutations in the genes that result in structural change in the cell, leading to the degeneration of the body's auto-immune response. Seog believes that understanding how these changes affect the nanomechanical properties of proteins and tissues can help prevent or cure diseases.

He also explores the interaction between synthetic and biological materials. His research in this area will support current efforts to incorporate biological molecules into small devices in order to utilize them as molecular sensing devices such as DNA chips, protein chips, and silicon-based drug delivery devices.

Seog also will also be examining the single molecule mechanical properties of synthetic and biological macromolecules. His goal is to enhance our understanding of basic biological and physical phenomena, as well as enable us to apply them directly when building smart molecular devices or single molecule devices.

## PHANEUF ARTICLE SELECTED FOR ONLINE COMPILATION

An article published by Associate Professor **Ray Phaneuf** and his group in *Applied Physics Letters*, "Systematic Study of the Size and Spacing Dependence of Ag Nanoparticle Enhanced Fluorescence Using Electron-Beam Lithography," was selected for the March 27, 2006 issue of the *Virtual Journal of Nanoscale Science and Technology*. The *Journal*, which is published by the American Institute of Physics and the American Physical Society in cooperation with numerous other societies and publishers, is an edited compilation of links to articles from participating publishers, covering a focused area of frontier research. The article describes the use of Ag nanopillars whose size, shape and spacing is varied systematically using electron beam lithography to produce enhancements as large as a factor of ~20 in the fluorescence from molecules placed in close proximity. Biologists employ fluorescence to take

advantage of the ability to attach tags to target molecules including proteins and DNA, and reveal the presence of these target molecules. Passive enhancement of fluorescence, provided by proximity to noble metal nanoparticles is expected to allow the development of highly sensitive biomolecule detectors. Phaneuf and his group find that the size, shape and spacing dependence is in qualitative agreement with a model based upon resonant coupling with particle plasmon polaritons.

## CUMINGS INVITED TO SPEAK AT AMERICAN PHYSICAL SOCIETY

MSE Assistant Professor **John Cumings** delivered an invited presentation titled "A Tunable Anomalous Hall Effect in a Nonferromagnetic System" at the March 2007 Meeting of the American Physical Society in Denver, Colorado. The presentation is based on his recently-published work of the same title, which appeared in *Physical Review Letters* 96, 196404 (2006).

The American Physical Society is the premiere physics society in the country, with over 40,000 members involved in academic, national, international, and governmental work. It publishes some of the most prestigious physics journals, including *Physical Review Letters*. Its so-called "March Meeting", which focuses on condensed matter and materials physics, is the largest it sponsors. A showcase for some of the best in physics and materials research, speakers are selected and invited after a competitive nomination process.

This was the first time Cumings has presented at the meeting as an invited speaker. "This was an opportunity for me to bring my discoveries about tuning ferromagnetic



RAYMOND PHANEUF



properties to a broad and well-informed audience," he said. "I was also excited because it's very competitive. It's an honor to be giving one of these talks so early in my career."

Unlike ferromagnetic materials whose spin (magnetic strength) is predetermined by their chemical makeup, the properties of paramagnetic semiconductors like the alloy in Cumings' study can be tuned by varying carrier density, magnetic field, or temperature. The ability to control the spin of and electron transport through a material makes it tunable; it can be used in multiple applications and devices, and its magnetic properties can be altered or turned on and off as needed. Devices created with such materials—spintronics—could prove to be more efficient and diversified than traditional electronics.

#### 5 MSE PROFESSORS RECOGNIZED FOR SPONSORED RESEARCH

MSE Professors **Robert M. Briber**, **Gottlieb S. Oehrlein**, **Ray Phaneuf**, **Gary Rubloff**, and **Manfred Wuttig** were among 233 University faculty recognized for their efforts in bringing sponsored research dollars to campus.

Briber works in the area of polymer physics, with projects including nanoporous materials, nanocomposites, RNA folding and polymer hydrogels. His research is supported by the NSF, FAA and NIST.

Oehrlein (MSE, IREAP and Director, Laboratory for Plasma Processing of Materials) and Phaneuf were awarded a Nanoscale Interdisciplinary Research Teams (NIRT) project from the NSF for a proposal to investigate "Nanotechnological Manufacturing: Nanostructured Polymers Designed for Plasma/Energetic Beam Templating of Materials." Professor Phaneuf is also supported by the Laboratory for Physical Sciences for work on patterning directed self assembly and nanoparticle enhancement of fluorescence and light energy harvesting, and by the NSF-MRSEC for nanometer-scale spectroscopy of organic film interfaces.

Rubloff (MSE, ISR and Director, Maryland NanoCenter) was one of a group of Clark School faculty that received funding from the Robert W. Deutsch Foundation to develop a nanoscale, microfluidic biochip that can serve as a tiny drug discovery laboratory (see related story, p. 6).

Wuttig's research focuses on phase transformation in thin films, the mechanics of thin films and membranes, and smart materials.

#### BRIBER PARTICIPATES IN PROJECT SUPPORTED BY \$14M NSF GRANT

MSE Professor and Chair **Robert M. Briber** and coworkers have been named subcontractors on a 5-year, \$14 million National Science Foundation (NSF) grant given to CalTech entitled "IMR-MIP DANSE—Distributed Data Analysis for Neutron Scattering Experiments". The portion of the work produced at the University of Maryland's A. James Clark School of Engineering will be to develop software and modeling for the analysis of neutron reflectivity data. Neutron reflectivity is a powerful technique for measuring the structure of thin films with sub-nanometer resolution in the direction of the film thickness. Briber's team will receive \$1.3 million of the total grant.

#### CHRISTOU RECEIVES ASM AWARD

Professor **Aris Christou** (MSE, Mechanical Engineering, and Reliability Engineering) is the winner of the 2006-2007 ASM International George Kimball Burgess Memorial Award. The award was presented in April 2007 at ASM International's Washington, D.C. chapter meeting in Bethesda, Maryland. Christou, who conducts research in compound semiconductor materials and process science, radiation effects in materials and devices, manufacturing science, and reliability, was cited "[f]or seminal scientific contributions in the fields of electronic materials, packaging, and devices."

The George Kimball Burgess Memorial Award was established in 1941 by the Washington, D.C. Chapter of the American Society for Metals as a tribute to Dr. Burgess in appreciation of his outstanding contributions to the science of metallurgy. The award is given to a member of the chapter in recognition of outstanding achievement in research or administration and for original contributions to the fields of metallurgy, materials, or mechanics; or to a member who has demonstrated outstanding leadership in those fields within the 5 year period prior to the award. The Burgess Award is the highest award for scientific achievement given by the D.C. chapter.

Christou is a former chairman of the Department of Materials Science and Engineering, former director of the Center of OptoElectronic Devices, Interconnects and Packaging (COEDIP), a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), a Fullbright Fellow, and the current president of the Washington, D.C. Federation of Materials Societies. Last summer, in conjunction with MSE Professor **S. Ankem**, ASM, the National Association of Corrosion Engineers (NACE) Foundation and the National Science Foundation's Division of Materials Research, he hosted the Clark School's first Materials Camp, a 4-day program for high school educators about teaching fundamental materials science and using applied engineering demonstrations in the classroom.



#### KATZ JOINS MSE STAFF

**RACHEL KATZ**, ASSISTANT DIRECTOR OF CONTRACT GRANT ACCOUNTING, "GLADLY RETURNED" TO THE DEPARTMENT IN OCTOBER 2006 AFTER WORKING IN ANOTHER FOR 3 YEARS. SHE HANDLES ALL CONTRACT AND GRANT BUDGETS, INCLUDING TRAVEL, FOR MSE AND THE DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING, MANAGES PROPOSAL ROUTING, AND PROVIDES BUDGET PROJECTIONS AND MONITORING. SHE CAN BE REACHED AT (301) 405-7356.



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Contribute to the department through the University of Maryland's *Great Expectations* campaign and support our mission to transform lives through exceptional educational and research opportunities. Your contributions can support MSE initiatives such as graduate fellowships, undergraduate scholarships, and named professorships. Please visit [www.greatexpectations.umd.edu](http://www.greatexpectations.umd.edu) to learn more.

Gifts may also be made by check to "University of Maryland College Park Foundation (UMCPF)." Please designate "Materials Science and Engineering" in the memo line, and mail to:

Robert M. Briber, Professor and Chair  
Department Materials Science and Engineering  
2135 Chemical and Nuclear Engineering Building  
University of Maryland, College Park, MD 20742

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Department Chair: Dr. Robert M. Briber  
Editor: Faye Levine

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TO LEARN MORE ABOUT FACULTY RESEARCH, SEE PP. 4-6.



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