



Materials Matters

2010

**MATERIALS
SCIENCE AND
ENGINEERING**

News
Faculty
Students
Research
Development



MESSAGE FROM THE CHAIR

DAVID
MARTIN

UD MSEG continues to grow, adding Prof. Michael Mackay from Michigan State in 2008, as well as Prof. Joshua Zide, who now has his primary appointment in materials science. Our own group moved to Newark this past summer from the University of Michigan, with research interests focusing on the development of electronically and ionically active conjugated polymers for interfacing biomedical devices with living tissue. In addition, Prof. JueJun (JJ) Hu—whose work focuses on nanophotonics, photovoltaics, and magneto-optics—will be moving to UD from MIT Microphotonics Center this year.

Other news includes the College of Engineering's plan to significantly expand its faculty and student cohort over the next few years and to introduce an undergraduate degree in biomedical engineering this fall, as well as UD's purchase of the former Chrysler site and its commitment to build a new Interdisciplinary Science and Engineering Laboratory (ISE-Lab). The ISE-Lab will include a new microscopy suite, an open advanced materials characterization laboratory, a synthesis facility, a nanoprocessing/clean-room facility, and space for UD's energy and environmental institutes.

I hope that you'll continue to follow developments here and plan to reconnect with us at Forum & Reunion Weekend from June 4-6, 2010 (visit udconnection.com to learn more and to register). We will have the inaugural visit of the MSEG External Advisory Committee on June 4 as part of this event. Thanks to all who have made financial contributions—these funds enable us to attract the best students to UD and remain competitive. Please contact me at milty@udel.edu if you have any questions or concerns.

A handwritten signature in yellow ink, appearing to read "D. Martin".

David C. Martin, Ph.D.
Karl W. and Renate Böer Professor and Chair
Materials Science and Engineering

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Cover photo by
MSEG student
AYSEGUL ALTUNBAS.
Read more about the
student photo contest
on p.14–15.



**DELAWARE
MSEG**
CHECK IT OUT!

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MSEG/PHYS Study Abroad Program is Italy Bound

PHOTO BY ISMAT SHAH

MSEG Study Abroad, the forerunner of Engineering Study Abroad programs, is Italy bound this year. The course taught through this program will include MSEG 302: Materials Science for Engineers, PHYS 143: Energy, Technology and Society, and HIST 341: Ancient Rome. Based primarily in Milan and Rome, several industrial site visits all over the "boot" are planned along with excursions to historical sites. For details visit our website (www.international.udel.edu/studyabroad/programs).

ALUMNI FOCUS COLIN BAKER



Dr. Colin Baker graduated from UD in 2004 with a Ph.D. in materials science and engineering. He is currently employed as a Research Scientist at the Naval Research Laboratory (NRL) in Washington, DC.

Baker feels that the preparation he received at UD helped him immensely in his job. His group at NRL is interested in many areas of research with thin films and nanoparticulate materials.

At UD he had the opportunity to do research and publish journal articles in these areas. His current supervisor looks to

his expertise to solve existing problems and help generate new research ideas.

The diverse research background Baker gained from his studies at UD have become invaluable to his career. He keeps in touch with a few people from UD and has found that scientific conferences are a good way to reconnect. As a graduate student at UD, Baker had the opportunity to travel to Pakistan and see how students in a different culture do research.

When asked what the department could do to better prepare students for their careers, Baker replied, "Keep doing the voodoo that you do. My training at UD, both scientifically and intellectually, is the reason I am where I am, and I am very happy where I am."

Postdoc Workshop:

SUCCESS STRATEGIES FOR EMERGING FACULTY

The UD College of Engineering is sponsoring a workshop, "*Success Strategies for Emerging Faculty*," from **September 11–13, 2010**. The main topics of interest in this inaugural workshop are the fields of energy and bioengineering, with a goal of introducing future faculty members, particularly from under-represented groups, to strategies for applying for, interviewing for, negotiating for, and succeeding in an academic career.

Participants in the workshop will present short research presentation, be linked with senior faculty members/mentors in their fields, and learn successful strategies for navigating careers in academia. A variety of keynote lectures, activities, and panel discussions will be presented

by leaders in the field on grant writing, communication, negotiation, and career/life balance. There will be many opportunities for formal and informal networking, which will help participants establish a community of peers at the very early stages of their careers.

If you are interested, or know of someone interested, in an academic career, particularly in energy or bioengineering, please contact Profs. Kristi Kiick (kiick@udel.edu) or Michael Mackay (mem@udel.edu) for more details. We are actively seeking participants with interests in materials for these workshops. Financial assistance for attending this workshop is available.

UD Receives NSF Grant for Nanotechnology Education

An interdisciplinary team of researchers at UD has received a two-year \$200,000 grant from the National Science Foundation's Nanotechnology Undergraduate Education (NUE) in Engineering Program.

Entitled "Connecting Nanotechnology and Alternative Energy Approaches Through Undergraduate Education in Engineering," the program will be led by Ismat Shah, professor in MSE and Physics and Astronomy.

In addition to Shah, the team includes the following faculty:

- **Jingguang Chen**
Claire D. LeClaire Professor
Chemical Engineering
- **Thomas Powers**
Assistant Professor
Philosophy
- **Matthew Doty**
Assistant Professor
Materials Science
- **Ajay Prasad**
Professor
Mechanical Engineering
- **James Kolodzey**
Charles Black Evans Professor
Electrical Engineering
- **Valery Roy**
Associate Professor
Mechanical Engineering
- **Michael Mackay**
Distinguished Professor
Materials Science
- **Joshua Zide**
Assistant Professor
Materials Science

According to Shah, the grant will enable establishment of a comprehensive program to prepare undergraduate students for nanotechnology by providing them with both the knowledge and the background to become part of the fast-growing community of researchers at the local, national, and global levels in this area.

The focus of the program will be on coursework and training related to the application of nanomaterials for alternative energy research. "Participating students will have the opportunity to choose topics from a variety of current research going on in the energy and nanotechnology areas on campus," Shah says.

The program will also include a component to educate the future work force in the ethics of nanotechnology through course work and workshops to be organized in collaboration with co-principal investigator Thomas Powers, who directs the Delaware Interdisciplinary Ethics Program, and with the Science, Ethics and Public Policy Program (SEPP) program at the Delaware Biotechnology Institute. The workshops will be open to the University community.



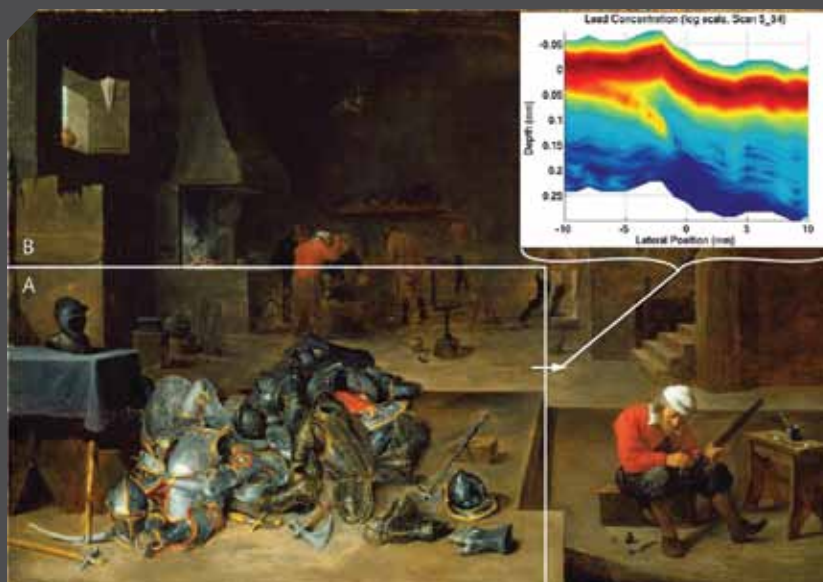
NEW ISE LAB

Plans are well underway for a new interdisciplinary science and engineering building, known as the "ISE Lab," that will be constructed at UD with donor support. With a goal of engaging students and stimulating excitement about science and engineering, the 194,000-square-foot building is designed to be dynamic, dramatic and distinctive, while providing badly needed classroom and lab space for a growing number of engineering students. Facilities include state-of-the-art space for microscopy suite, nano-processing, as well as class 1,000 and class 100 clean rooms—all with central temperature and vibration control.

Materials in Art 2010: Making Stuff Symposium



MSE, in collaboration with Materials Research Society, Winterthur museum, Fabric Works in Arlington, MA, Departments of Art Conservation, Chemical Engineering, UD, and local Schools Districts, is organizing a symposium titled ***Materials in Art 2010: Making Stuff,*** to be held UD's Clayton Hall, on **Friday, November 12, 2010**. The focus of this symposium will be a series of speakers whose research interests involve both MSE issues and Art. There will also be a series of hands-on demonstrations appropriate for middle school and high school students, presented by the Society of Plastic Industry (SPI) PlastiVan. An equipment demonstration by vendors interested in making information known about their instruments, including microscopes, spectrometers, and X-ray diffraction systems is also planned.



ONE PAINTING OR TWO

Originally thought to be a painting of the Flemish painter David Teniers (1640–45) turned out to be two paintings by two different artists put together. The detective work was done using confocal X-ray fluorescence microscopy which gave the information of the buried paint layer at the interface between the two panels. (G. Bilderback and J. Mass NSF-DMR Grant).

Center for Composite Materials



JACK GILLESPIE
CCM Director

The Center for Composite Materials is an internationally recognized, multidisciplinary center at UD that includes a number of affiliated faculty from materials science and engineering. Director Jack Gillespie has joint appointments in materials science and civil engineering. The following summarizes recent news from the Center.

CCM Celebrates 35th Anniversary

CCM kicked off the celebration its 35th anniversary in September by hosting the First Joint Canadian and American Technical Conference. The event attracted an international group of more than 325 scientists and engineers from academia, industry, and government representing 22 countries. Technical talks included 62 invited speakers participating in the Chou and Cardon symposia and 247 papers overall. The 2009 Medal of Excellence in Composites was awarded to two distinguished individuals, one from the United States and one from Canada: Tsu-Wei Chou, Pierre S. du Pont Chair of Engineering at UD, and Anoush Poursartip, Professor of Materials Engineering at the University of British Columbia.

Center Director Wins Major Composites Award

John W. Gillespie Jr., professor of MSE and director of CCM, received the 2009 Outstanding Research Award from the American Society for Composites at the conference. The award is given to individuals who "have made contributions to the science and technology of composite materials by way of analytical modeling, numerical modeling, design methodologies, and/or experimental work that have led to a greater understanding of the behavior of composite materials." The society's most prestigious prize, the Outstanding Research Award has been given to 22 pioneers in the field since it was initiated in 1988.

UD Signs CRADA with Army

UD and the U.S. Army Research, Development and Engineering Command (RDECOM) signed a Cooperative Research and Development Agreement (CRADA) on Jan. 26, creating a powerful research partnership between UD's Category 1 research capabilities and Aberdeen Proving Ground (APG) in Maryland. The CRADA was signed by UD President Patrick Harker and Maj. Gen. Nickolas Justice, commanding general of RDECOM and installation commander of APG, during a ceremony at UD. At the same event, John Miller (director of the Army Research Laboratory), Gary Blohm (director of the Army's Communications–Electronics Research, Development, and Engineering Center), and CCM director Jack Gillespie signed a Cooperative Statement of Work to be carried out under the new CRADA. The work will focus on antenna technology and composite materials.

FACULTY TIDBITS

- **ROBERT BIRKMIRE** is a plenary speaker at the NIST Grand Challenge for Advanced Photovoltaic Technologies and Measurements workshop in May, 2010.
- **MATTHEW DOTY** received an NSF CAREER Award (read more on p.11).
- **JOHN W. GILLESPIE** received the Outstanding Research Award from the American Society for Composites (read more on p.8).
- **XINQIAO JIA** was named the 2010 Outstanding Junior Faculty Member for the UD College of Engineering (read more on p.12). Jia also organized the symposium "Glycosaminoglycan Biomaterials in Medicine" at the 2010 Society for Biomaterials Annual Meeting and the symposium "Nanostructured Materials for Future Therapy" at the American Chemical Society (ACS) National Meeting (2009). In addition, Jia has been invited to speak at the International Symposium on Polymer Chemistry in Suzhou, China, June 2–6, 2010.
- **KRISTI KIICK** was the Program Co-chair of the Polymer Chemistry Division National ACS Meeting (2010). She is also the keynote speaker for the symposium "Polysaccharides: Chemistry, Structure, Properties and Technology" at The 43rd IUPAC World Polymer Congress, Macro2010, July, 2010.
- **MICHAEL MACKAY** was named Distinguished Professor of Materials Science and Engineering. He is an invited speaker at the symposium "Colloidal and Nanoscale Polymer Composites: Fundamentals Through to Applications" at The 43rd IUPAC World Polymer Congress, Macro2010, July, 2010.
- **DAVID MARTIN** is the new Karl Böer Chair of Materials Science and Engineering.
- **CHAORYING NI** has been promoted to the rank of Associate Professor.
- **ROBERT OPILA** became the Editor for *Applied Surface Science*, Elsevier. He also served as the Immediate Past President of the American Vacuum Society's Electronic Materials and Processing Division.
- **DARRIN PCHAN** became the Associate Editor for North America for *Soft Matter*, published by the Royal Society of Chemistry. He also co-chaired the Spring 2010 MRS meeting in San Francisco and is one of four invited speakers for the symposium "Polymers in Therapeutics: Polymer Nanomedicines" at The 43rd IUPAC World Polymer Congress, Macro2010, July, 2010.
- **JOHN RABOLT** is spending his well-deserved sabbatical year at Columbia University in New York.
- **ISMAT SHAH** will give a series of invited talks at the annual Nathiagali Summer College in Pakistan, June 2010, on Physics for Contemporary Needs.
- **JOSHUA ZIDE** received the ONR Young Investigator Award (read more on p.10). He also served on the Program Committees for the North American Conference on MBE and Electronic Materials.

Zide Receives ONR Young Investigator Award to Develop New Semiconductor Materials



Assistant professor Joshua Zide has been selected to receive a prestigious Young Investigator award from the Office of Naval Research (ONR) to develop new semiconductors and nanocomposites for thermoelectric power generation and other applications. The three-year \$510,000 grant is one of just 15 awarded nationwide.

Zide's research will focus on growing bismuth on an indium-gallium-arsenide substrate (InGaBiAs), an achievement that has been reported in only three labs throughout the world and none in the U.S. Traditional uses of bismuth as a semiconductor have been on other substrates.

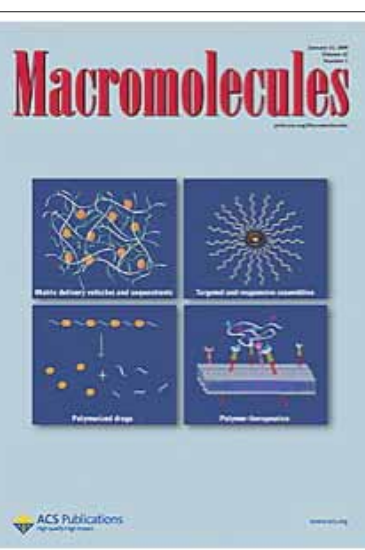
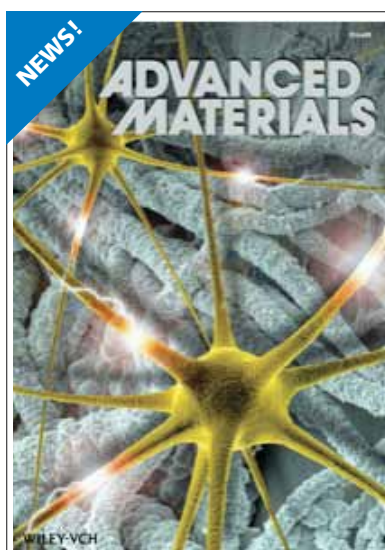
"Dilute bismides are a new, virtually unexplored, and extremely promising material system for thermoelectric power generation," Zide says. "They offer the potential for significant reduction in thermal conductivity and improvements in electronic properties over other semiconductors in this class, enabling high-efficiency thermoelectric materials."

Thermoelectric devices create a voltage when there is a different temperature on each side. Conversely, application of a voltage to such a device creates a temperature difference. This effect can be used to generate electricity, as well as to heat or cool objects. "Thermoelectric conversion is analogous to the work done by a solar cell, but it provides heat rather than light," Zide explains. One potential application is in hybrid cars, where excess heat could be converted to energy.

"Thermoelectric power generation is highly relevant to ONR's mission and goals," Zide says. "For several naval customers, waste heat recovery is extraordinarily important, and efficient thermoelectric power generation is an attractive technology, especially in applications where robust, solid-state technologies offer a reliable alternative to existing technologies."

In addition to the new InGaBiAs semiconductors, Zide will explore the use of excess bismuth to produce bismuth-rich precipitates within an InGaBiAs matrix as a novel and promising class of metal-semiconductor nanocomposites. Such nanocomposites offer size- and shape-dependent advantages resulting in improved optical and electronic properties over those of bulk materials.

Zide, who earned his Ph.D. in materials science at the University of California Santa Barbara, joined the UD faculty in September 2007.



ON THE COVER

Professors Martin and Kiick made it to the covers of *Advanced Materials* and *Macromolecules*, respectively. The *Advanced Materials* cover had the added honor of being chosen the cover of the year.

Doty Receives Prestigious CAREER Award

Assistant professor Matthew Doty has received an NSF CAREER award for his work on quantum dot molecules. The five-year \$525,000 award will support not only Doty's research but also hands-on research and curriculum development for K–12 teachers, hands-on exploratory science experiences for K–12 students, and the development of interdisciplinary courses on nanoscale materials for advanced undergraduate students.

Doty explains that quantum dots (QDs) are often referred to as "artificial atoms" because, like natural atoms, they have bound, discrete electronic states. Recent advances in materials science and nanofabrication techniques have made it possible to controllably couple individual QDs to create artificial molecules.

In contrast to natural molecules, however, where the degree of coupling is determined by the electro-negativity of each atom and the spacing between the atoms, in QD molecules (QDMs), the coupling can be engineered. "This control over quantum mechanical coupling at the level of single electrons and holes opens the door for design of novel materials with revolutionary properties," Doty says.

The applications for this technology include optoelectronic devices such as lasers and sensors, quantum information processing, and functional materials. "For QDMs to be of use in future technologies," Doty says, "we have to understand the signatures and mechanisms of quantum mechanical coupling. This will require identifying their unique properties at the single molecule level while also figuring out how to scale the process up to increase the size of QDM assemblies."

"Progress towards any of these possible applications requires answers to many fundamental questions about the coupling between quantum dots," he adds. "What are the physical mechanisms of coupling? Do particles tunnel between dots or transfer via resonant energy transfer? How do the mechanisms of coupling depend on the material composition of the dots, their spatial separation, their energy levels, or the scaffold that connects the dots? What are the dynamics of interactions between electrons? How can we tune the degree of coupling in situ to create active materials?"



PROFESSOR MATT DOTY

Quest for answering fundamental questions about quantum dots. UD's Matthew Doty has won a prestigious NSF Career Award for his work in quantum dot molecules. [Read more on p.19.](#)

He hopes that his research over the next five years will yield answers to some of those questions.

As a part of the CAREER program, Doty will host two high school teachers in his lab each summer, in an expansion of UD's ongoing Research Experiences for Teachers (RET) Nature InSpired Engineering (NISE) Program. He also intends to create a portable experiment demonstrating the application of spectroscopy to materials characterization that teachers can borrow for use in their classrooms. "In the long term," Doty says, "I'd like to build a library of these types of modules to serve as a resource for middle- and high-school teachers."

Doty joined the UD faculty in 2007 after a three-year stint as a National Research Council Research Associate at the Naval Research Laboratory. He earned his Ph.D. in physics at the University of California, Santa Barbara.

Although the prestigious CAREER awards are granted to help young investigators launch their independent research careers, Doty anticipates collaborating with colleagues both here at UD and at other institutions to explore various applications of his work. "You can't do science today by yourself," he says.

Professor Xinqiao Jia: Taking Research from the Lab to Clinical Applications

If Julie Andrews sings again, it might have something to do with Professor Xinqiao Jia's research, which involves the development of synthetic vocal folds that can replace damaged vocal cords. "This is my goal, translating research from bench top to clinical applications," she says. "This is the dream whose realization is my ultimate challenge."

Jia was born in Taiyuan, China, in 1971, in a family where her father was a self-taught electrical engineer and her mother was a high school English teacher. "I was always interested in learning new languages, particularly English," Jia says. "I used to frequently go to a local park where there was a corner especially reserved for people who liked to meet and practice English."

She did her B.S. in applied chemistry from Fudan University in 1995, followed by an M.S. in polymer chemistry and physics from the same university. "We were 20 students in the class

In April 2010, Jia was named the 2010 Outstanding Junior Faculty Member for the College of Engineering. She will be formally recognized at the College of Engineering's Convocation Ceremony on May 29, 2010. The award carries a \$5,000 prize for professional development during the next academic year; recipients are selected by named professors of the College of Engineering.



**PROFESSOR
XINQIAO JIA**

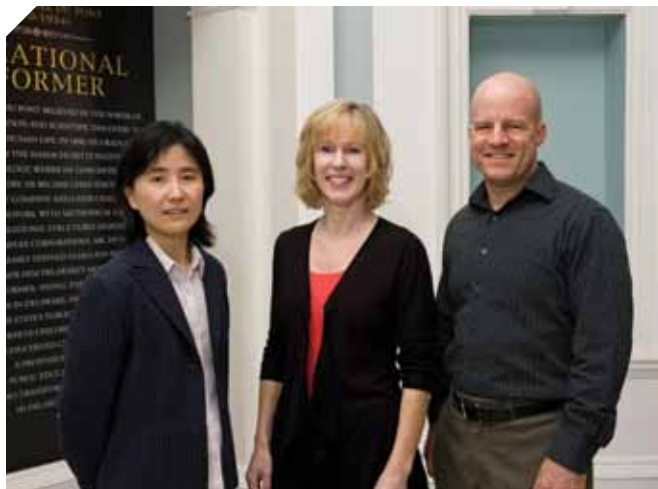
"Being available to the students makes a good advisor."

and almost all applied to go to universities in the U.S.," she says. "I was curious about the 'new world.' A professor from the University of Massachusetts at Amherst came to recruit students from Fudan University. The program at U Mass was very well known, and everyone had that at the top of their list. I guess I got lucky and he chose me."

Jia says that she never dreamed of becoming a professor. She just wanted to get her Ph.D. degree in the U.S. She also ended up doing a post-doc in a very well-known group, that of Professor Bob Langer at MIT.

"Both of my experiences, first as a graduate student and then as a post-doc, were in groups that were quite large, and it was difficult to directly interact with the professors. Initially, I felt neglected, but the good thing that came out of these experiences was that I became an independent researcher, and that is what piqued my interest in academia."

Jia joined UD MSE in the fall of 2005. She says that while she was visiting the department for the interview, she was overwhelmed by the energy and vibrancy of the science community in a department that was young with great potential. She was able to immediately start close collaborations with Professor Randy Duncan in the Department of Biological Sciences. Jia currently has six students and three post-docs. "I like educating people, seeing people learn, looking at students maturing scientifically right in front of your eyes," she says. "Since I felt neglected while I was a graduate student, I make sure that I am available to all my students as much as possible, and above all, the best thing that can happen to a scientist is that her work be recognized by the scientific community."



COBRE BIOMATERIALS TEAM

Xinqiao Jia, Kristi Kiick, and Darrin Pochan

Biomaterials Research Supported by COBRE Grant

Profs. Kristi Kiick, Darrin Pochan, and Xinqiao Jia are all members of one of UD's Centers of Biomedical Research Excellence (COBRE), "Molecular Design of Advanced Biomaterials." This \$10.5M center, funded by the National Center for Research Resources of the National Institutes of Health, involves 11 researchers from materials science, chemical engineering, and chemistry and biochemistry and is aimed at the development of molecular approaches in the assembly of drug delivery vehicles, tissue engineering scaffolds, and therapeutics.

Kiick and Jia head a project on the design of block polymers and elastomeric polypeptides for the regeneration of vocal fold tissue. Their groups have designed materials with high elasticity, excellent recoil, and are testing the utility of these materials to deform elastically at high frequencies to support the development of vocal fold tissues. Pochan's project centers on the assembly of peptide-based materials and their applications in liver tissue engineering.

This center serves a focal point for the expansion of biomaterials research at UD and will support seed projects and new faculty hires and bring internationally renowned biomaterials scientists to UD's campus on an annual basis.

Professor David Martin Elected Fellow of APS

Congratulations to Prof. David Martin for his election as a Fellow of the American Physical Society. Prof. Martin joined the University of Delaware as professor and department chair in 2009. Prior to that, he was a member of the faculty at the University of Michigan.

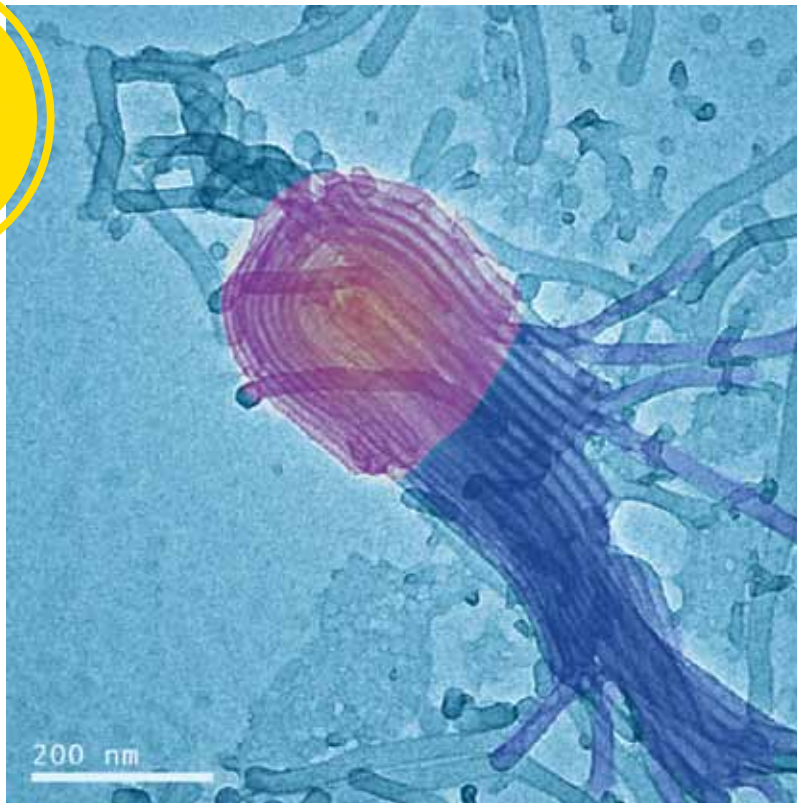
Martin, who received his Ph.D. in 1990 from the University of Massachusetts at Amherst, has research interests in organic electronics and electroactive biomaterials. The APS cited him for significant contributions to the understanding of phase transformations in molecular crystals and crystalline polymers using low dose, high resolution electron microscopy (HREM), optical microscopy and X-ray diffraction techniques.

Martin is now the Karl Böer Chair of Materials Science and Engineering at UD.



MSE WELCOMES ASSISTANT PROFESSOR JUEJUN "JJ" HU

MSE is pleased to announce the addition of Assistant Professor Juejun "JJ" Hu. JJ comes to Delaware from MIT Microphonic Center. His interests are in nanophotonics, photo voltaics and magneto-optics.



**BY SAMEER SATHAYE
& JIAHUA ZHU**

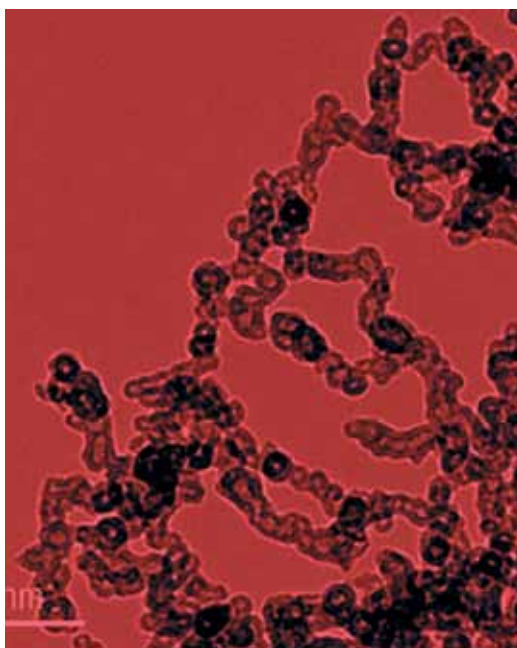
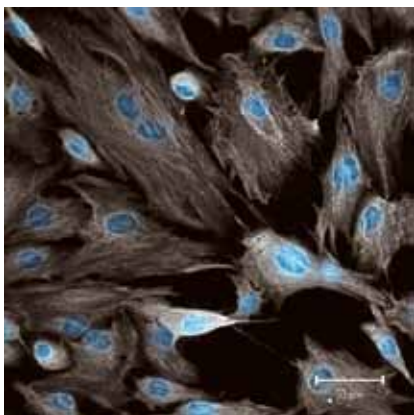
Jello the Jellyfish—
Assembly of cylindrical
micelles of PAA-PS di
block copolymer.

Science as Art Contest

MSE held a contest in search of photos that were “the most outstanding in both scientific and aesthetic appeal.” Students were asked to submit micrographs and other photos from their research work that could also be viewed as artistic. The winner of the grand prize, a brand new 8 GB iPod Touch, was Sameer Sathaye (Pochan group) for *Jello the Jellyfish*. A larger collection of the pictures appeared in a calendar published by MSE. To purchase the calendar, e-mail sameers@udel.edu.

BY ALEXANDRA ▼
FARRAN

Modified PVF cells

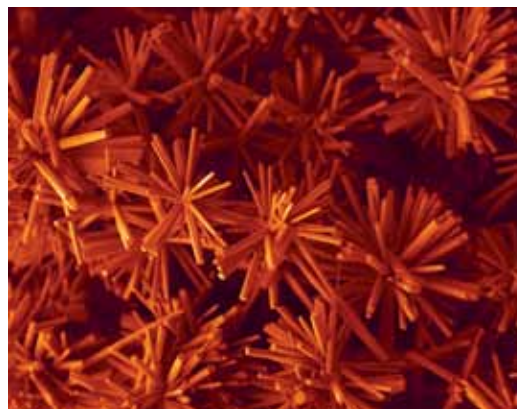
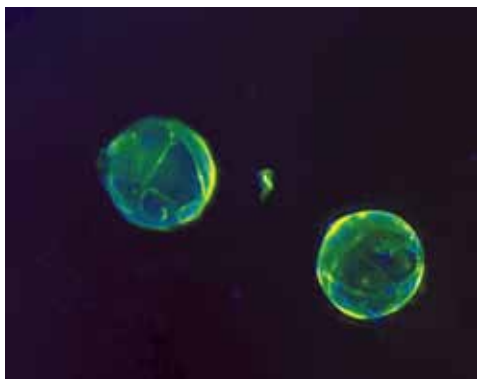


◀ BY HASSNAIN
JAFFARI

Nickel Ferrite Hollow
Nanoparticles

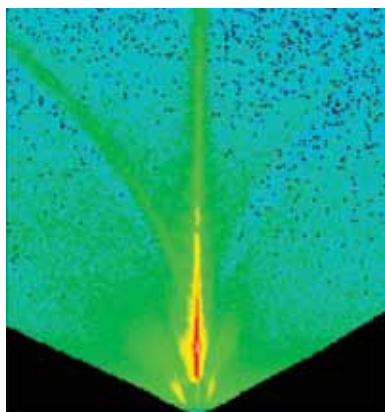
BY DR. TING NIE ▶

Human Umbilical Vein
Endothelial Cells



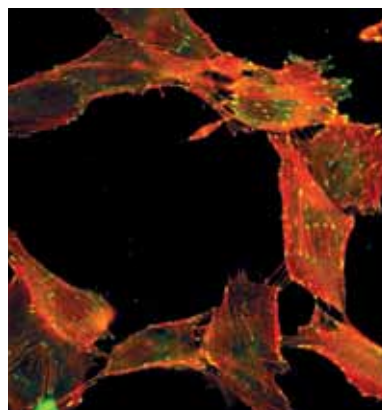
BY JON KIEL ▶

Grazing Incidence
Small Angle Neutron
Scattering data for a
P3HT:PCBM organic
solar cell.



▲ BY BEVERLY
WRIGHT

Zinc Oxide Crystals



◀ BY AYSEGUL
ALTUNBAS

Actin and vinculin
staining of human
osteosarcoma cells on
polylysine. *Featured on
the cover.*

UD Travel Abroad Fellowship Awarded to Carl Giller

The UD Travel Abroad Fellowship for International Research, Internships, and Performances is awarded every year by the Institute of Global Studies. This year one of the winners is Carl Giller, a graduate student in Prof. John Rabolt's research group.

Giller used the funds for beam time at the European Synchrotron Radiation Facility (ESRF), an internationally renowned institution located in Grenoble, France.

He is studying a new class of well-defined stereoblock elastomeric polypropylenes with unique mechanical properties.

Giller says that the value of casually interacting and socializing with other scientists who came from varied technical, national, and cultural backgrounds has been immeasurable and has made him realize just how small the world has become.



MSE Graduate Student Invited to Participate in Polymer Research Symposium



MSE Ph.D. student Ohm Krishna was selected to participate in the American Chemical Society's Excellence in Graduate Polymer Research Symposium.

Sponsored by the Division of Polymer Chemistry, the symposium invites participants based on a competitive submission process. The students

presented their papers at the 2010 Spring National ACS Meeting, held in San Francisco from March 21-25, 2010.

Krishna, who is advised by Kristi Kiick, associate professor in MSE, is conducting research focused on developing new bio-materials for biological applications such as wound healing.

He is currently developing collagen-containing, thermo-responsive block copolymer systems, modeled after the tough, elastomeric mussel byssus protein.

"The mussel adhesive protein has exceptional mechanical properties, including high toughness, high elasticity, and excellent adhesion under aqueous conditions," Kiick says. "Ohm's research aims to harness these properties in a peptide-polymer synthetic conjugate with both biological and assembly properties that can be manipulated."

Krishna plans a career in either academia or industry where his goals are to diversify and use his expertise in designing natural/synthetic polymeric materials with biological applications.



IGERT PROGRAM

Four Fellows in UD's Solar Hydrogen IGERT Program—Cory Budischak, Erik Koepf, Keith Douglass, and Sarah Mastroianni—unveiled a Mobile Solar Demonstration System at the Newark Center for Creative Learning on April 17. The hands-on learning tool is equipped with all the components of a typical photovoltaic installation—solar panels, charge controllers, batteries, and inverters—but in a manner safe and easy for kids to experiment with. The students can wire the components together to perform experiments through a simple color-coded panel equipped with plug-and-play-style terminals.

Four Students Receive Departmental Awards

Four materials science students have received departmental awards for 2010:

- **CONAN WEILAND**, a member of the Opila research group, received the Research Award for his outstanding contribution to the field of molecular electronics.
- **LONGXI XIAO** a member of the Jia research group, won the Teaching Award for his excellent performance as a teaching assistant for MSEG 630/CHEG600.
- **AYSEGUL ALTUNBAS** a member of the Pochan research group, received the Chair's Award for her exceptional leadership as the president of the MRS chapter at UD.
- **JON SEPPALA** a member of the Mackay research group, won the Service Award for his dedication to departmental service.

Bakhtyar Ali Wins Two Awards: University Graduate Scholar and Society of Vacuum Coaters Fellowship



Bakhtyar Ali, a graduate student in Prof. Ismat Shah's group, recently won two awards, the University Graduate Scholar Award and the Society of Vacuum Coaters (SVC) Fellowship.

The University Graduate Scholar Award is given by the Office of Graduate and Professional

Education following a nomination by a department at UD. These competitive awards are based on many criteria, including challenging social, economic, educational, cultural or other life circumstances, and academic achievements.

The competitive SVC Fellowship intended to further the education of people entering or already participating in a course of study important to vacuum coating technology at an accredited institution.

Ali's research is focused on materials and device issues in polymer-based solar cells. He is a two-time recipient of the SVC Fellowship.

Bill Baron Award Goes to Fang Fang



Each year the Institute of Energy Conversion (IEC) gives out the Bill Baron Award to two University of Delaware students who are "carrying out or have recently completed an exceptional piece of supervised research in engineering, science or energy policy in the renewable energy field with a strong preference for research emphasizing photovoltaics."

The award was established in memory of Bill N. Baron (1943 - 1992), who served UD and the photovoltaic community from 1975 to 1992 as a scientist, manager, and deputy director at IEC.

This year, the recipient of one of the awards is Fang Fang, who is working with Professor Robert Opila on studying the energy level alignment at interfaces of thin film structures for renewable energy applications.

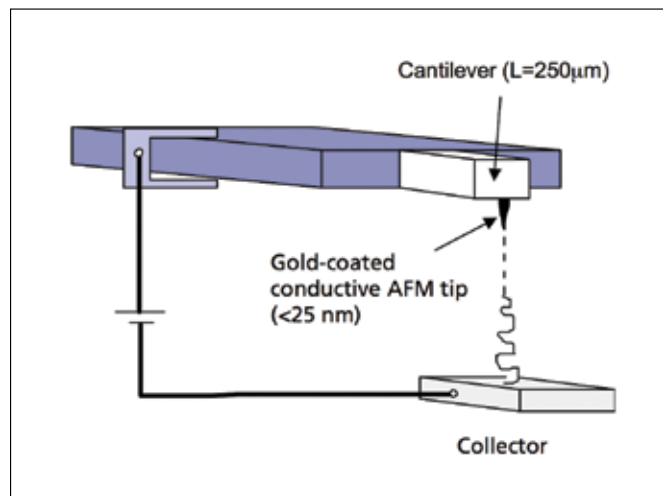
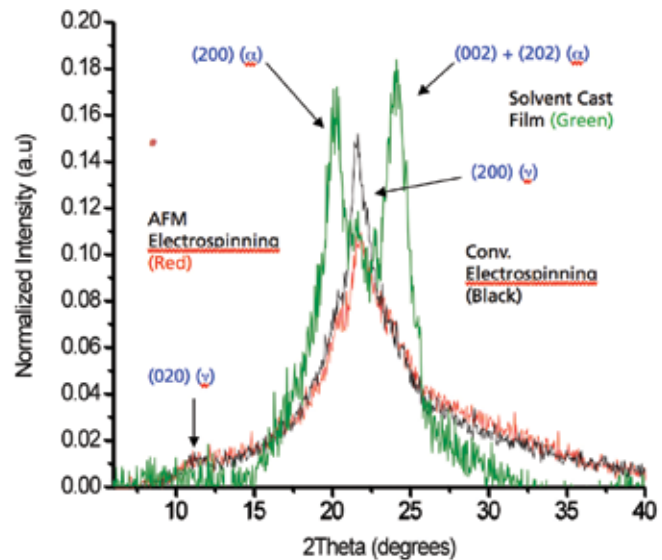
Electrospinning Polymer Fibers Using an AFM Tip

(John Rabolt and Bruce Chase, NSFDMR-0704970)

We have successfully electrospun Nylon-6 nanofibers using an atomic force microscopy (AFM) probe as an electrospinning tip. The nanometer-size tip enabled controlled deposition of uniform polymeric nanofibers with a sample spot size of about 1 cm in diameter compared to a spot size of 10 cm for syringe-based electrospinning at the same tip-to-collector distance. A subsequent decrease in crystallinity and fiber diameter was also observed for the AFM tip-based electrospun fibers.

John Rabolt and Bruce Chase are the co-founders of PAIR Technologies in Newark, DE. The vision of PAIR Technologies is to design, market, and sell the next generation of IR spectrographic instrumentation. For more information, please visit their website (www.PAIRtech.com).

WAXS data indicating that the AFM ES mat (red) and Conventional ES mat (black) formed predominant γ crystalline form while the Solvent cast film (green) formed α crystals. A significant difference in full width at half maximum (FWHM) can be noted for the AFM electrospun mat and conventional electrospun mat indicating smaller crystallites (higher FWHM) for AFM based setup. Small but significant crystallinity differences were noted for AFM electrospun fibers compared to conventional electrospun fibers.



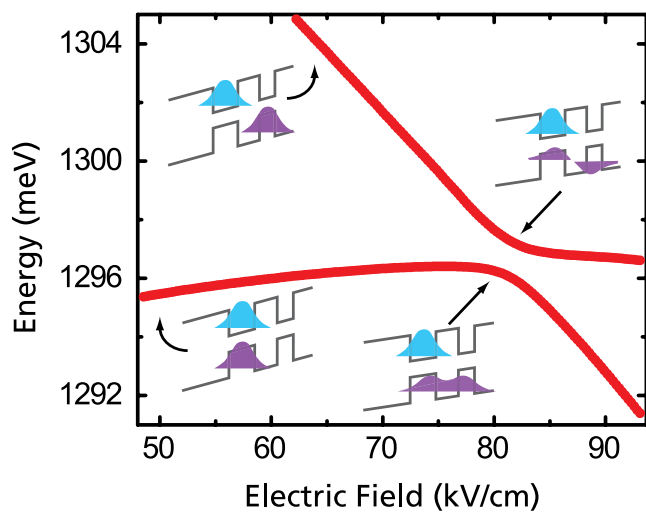
A schematic of atomic force microscopy tip based electrospinning process.

M Doty Plays with Q Dots

Structure, Symmetry, and Spin

Quantum dots are often described as artificial atoms because they have three dimensional energy confinement on nanometer length scales that leads to discrete electron and hole energy states analogous to atomic energy levels. These discrete states, whose energy can be controlled by the dot size, have enabled quantum dots to find wide applications in biological imaging and optoelectronic devices. Quantum dots are being

intensely investigated as potential elements of next generation photovoltaics and spin-based optoelectronic devices. Research in the Doty group seeks to understand the mechanisms of interaction between quantum dots and to learn how desired properties can be engineered with the structure and arrangement of the quantum dots.



The figure shows the photoluminescence energies from recombination of a single electron and single hole in a pair of InAs / GaAs quantum dots. Coherent tunneling of holes between the two dots at a particular value of the applied electric field leads to the formation of delocalized molecular states as depicted in the insets. The formation of molecular orbitals provides unique tools for controlling single spins. The material composition and structure of the quantum dots and barrier can be used to create electrically tunable g factors and molecular ground states with both symmetric and antisymmetric orbitals. Tunable g factors may enable all-electrical control of single spins while the reversal of the orbital symmetry for the energetic ground state may allow engineering of optically dark energetic ground states. Breaking the symmetry of the molecule by offsetting one dot relative to the other leads to a surprising mixing of opposite hole spins that suggests new and more efficient methods for manipulating single spins. Together, these results point the way towards the design of quantum dot materials with tailored structure and symmetry that can enable revolutionary new optoelectronic devices.

What is the Matter with Matisse?

One of the most famous of Matisse's works is the *Joy of Life* (1905-06), which is on display at the Barnes Foundation in Merion, Pa. Time is taking its toll on the painting, with several areas flaking and either fading or changing color. These effects are related to the pigment choices made by Matisse and his contemporaries. In a collaborative effort among Professors Opila and Shah (MSEG), Dr. Jennifer Mass (Winterthur Museum), and paintings conservator Barbara Buckley at the Barnes Foundation, the materials

used by Matisse are being analyzed and the causes of the degradation investigated. A related proposal is being submitted to the National Science Foundation that involves the University of Delaware, Winterthur Museum, the Barnes Foundation, and Cornell University.

Professors Rabolt and Chase, in collaboration with Winterthur Museum, are developing a non-invasive IR characterization method to evaluate cultural heritage objects using focal point arrays.

"Making Stuff—
Materials Science
in Art," a symposium
on Friday, November
12, 2010. See p.7
for details.

SAVE
THE
DATE!

JOY OF LIFE

By Henri Matisse



Institute of Energy Conversion Grows

The Institute of Energy Conversion (IEC) is currently in an expansion mode, with over 50 people including full-time staff, undergraduate and graduate students, postdocs, and visiting scholars. Of the 16 graduate students supported by IEC, six are from Materials Science.

Over the past year, we began work on multiple new contracts focused on a-Si, c-Si, CdTe and CuInSe₂-based alloys. To meet the contract demands, we have upgraded our facilities and enhanced our analytic capabilities, including the following:

- Expanding our hydride gas facility to safely handle additional gases
- Installing a new 6-inch reactor for the growth of CuInSe₂-based alloys by the reaction of metal precursors
- Bringing on-line a multi-target sputtering system for new TCO materials and an e-beam/sputtering system for general processing
- Installation of two environmental chambers for 85°C/85% humidity to evaluate new encapsulants under full illumination; and
- Purchasing a Raman Microscope and FTIR spectrometer.



ENVIRONMENTAL CHAMBERS

Environmental chambers for stability testing of large area solar cells and modules used to evaluate new encapsulant materials at IEC.

Two technical results of note have been achieved recently with CuInSe₂ thin films under DOE-sponsored projects. A new (AgCu)(InGa)Se₂ alloy has been developed for wide bandgap and high voltage solar cells, and promising material and device results have been demonstrated. Also, solar cells with greater than 15% efficiency have been demonstrated using roll-to-roll deposition of Cu(InGa)Se₂ on a novel insulator-coated foil substrate that enables monolithic integration for module fabrication.

**STUDENT
SPOTLIGHT**

PERNELL DONGMO

From Cameroon to Delaware



“When I first came to visit Delaware, I was so impressed by the beauty of UD campus, the openness of the University atmosphere, and the friendliness of the people in and around the University that right there and then I decided, this is where I wanted to go to school,” says Pernell Dongmo.

He was speaking of his visit in 2005 when he was looking for “that perfect University” to do his undergraduate studies. Pernell has since graduated from Electrical Engineering Department and is currently an MSE graduate student. He works with Professor Joshua Zide. “Designing and synthesizing new materials excites me, and if these materials are for application in an areas which have

immediate societal impact, energy harvesting, then so much the better,” Pernell says of his work involving the use of Molecular Beam Epitaxy (MBE) and thermoelectricity. In MBE, one can design and create a material atomic layer by atomic layer in an ultra pure atmosphere. Thermoelectricity is the field of converting heat, either directly from sun or the waste heat, into electricity.

Pernell Dongmo was born in Washington, D.C. on April 14, 1987. His parents emigrated from Cameroon. Pernell had the opportunity to visit the home country of his parents in 1999, when he was only 12 years old. Having never been outside of the USA until that visit to Cameroon, the difference in almost all aspects of life took him by surprise. “You never see any fast food restaurants. All food is home cooked, even the food that is sold on the street side. There is little to no electricity in the native town of my parents, and people speak French. I learned French earlier, but I am not fluent in it. Communication was an issue.” Pernell says that he would like to go back to Cameroon again just to check up on his relatives. He is looking forward to graduating from UD and finding a job in a large corporation.

GIVING

As the youngest and one of the fastest growing areas within the College of Engineering, the Materials Science and Engineering (MSEG) Department at UD possesses perhaps the greatest start-up needs.



DAN SARKISSIAN

ASSOCIATE DIRECTOR OF DEVELOPMENT
COLLEGE OF ENGINEERING

This list includes state-of-the-art microscopes and new central synthesis, characterization and nanoprocessing facilities. The newly proposed Interdisciplinary Science and Engineering Building will play an important role in the research conducted by MSEG by providing substantial new low vibration, environmentally controlled, magnetic and electric field isolated space for locating cutting-edge instrumentation. While our distinguished faculty work to solve some of society's most challenging problems, at the root of every cutting edge experiment, every research proposal, and every new lab, remain our capable students. The excitement, energy and innovation they bring to the department and its laboratories is remarkable.

Realizing the need for graduate scholarships in MSEG, an anonymous donor recently presented a challenge gift of \$20,000 to encourage alumni, faculty and friends to give back and in doing so, create a fully endowed scholarship fund. This challenge gift will match dollar for dollar all new gifts and pledges of \$500 or more if received before June 30, 2010, in support of the Materials Science Graduate Support Scholarship Fund—up to \$20,000. We need your participation and support in order to take full advantage of this generous challenge! Using this challenge as leverage, the goal is to raise enough funds to endow one scholarship at \$50,000. Gifts can be made online at www.udel.edu/development/makeagift or mailed to 102 DuPont Hall in the College of Engineering at UD. In either case, be sure to designate your gift to the MSEG Department by indicating this within the notes section of the online giving form or on the memo section of your check.

The research and teaching currently taking place within the MSEG Department is nothing short of spectacular. If you wish to tour the MSEG labs or discuss your financial support of the program above and beyond an annual gift, please contact Dan Sarkissian at (302) 831-0165 or djs@udel.edu.

Your gifts are used for many worthwhile purposes, including support of our research and educational programs. To make a donation, please visit **UD Connection** (www.udconnection.com) and click **Donate Today**.

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