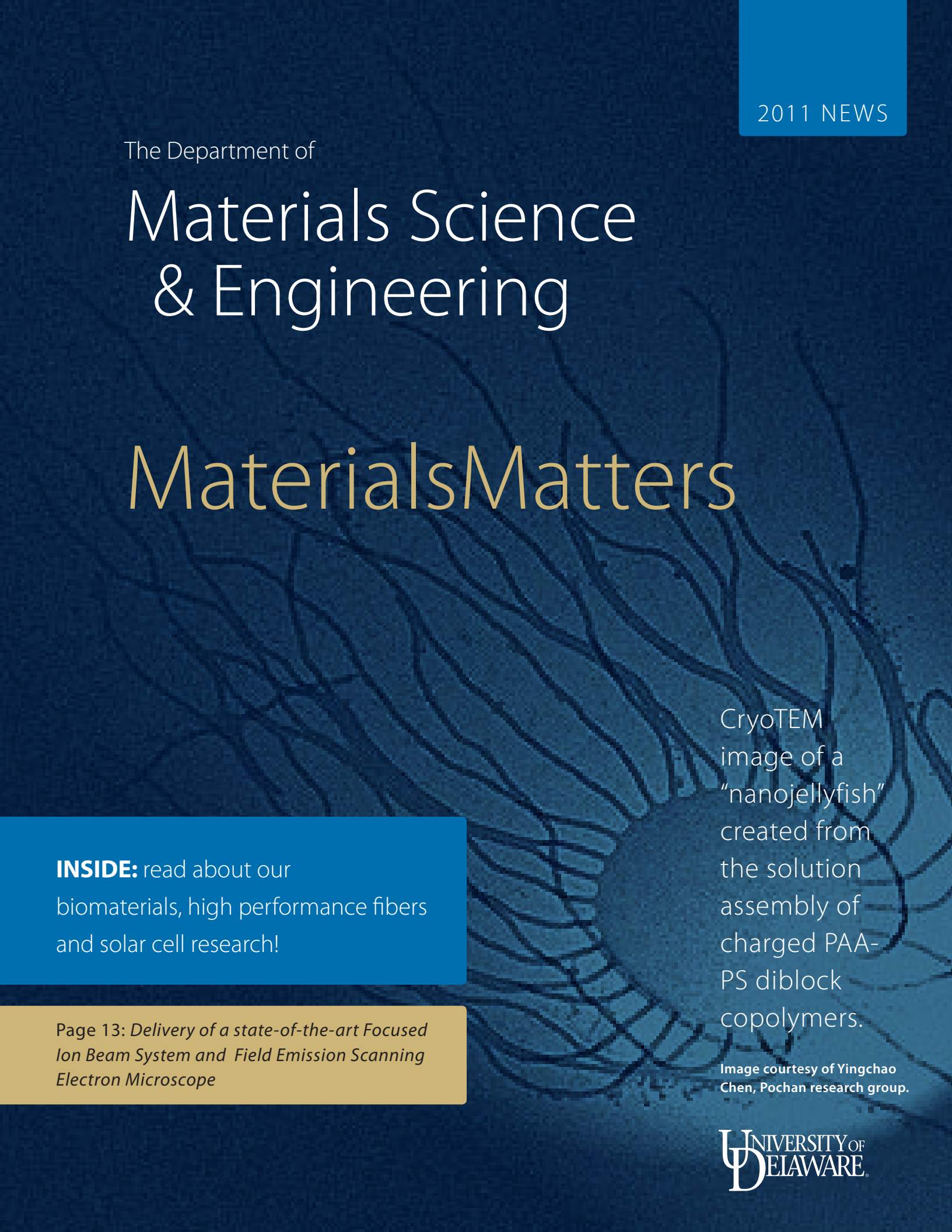
2011 NEWS

The Department of

Materials Science & Engineering

MaterialsMatters

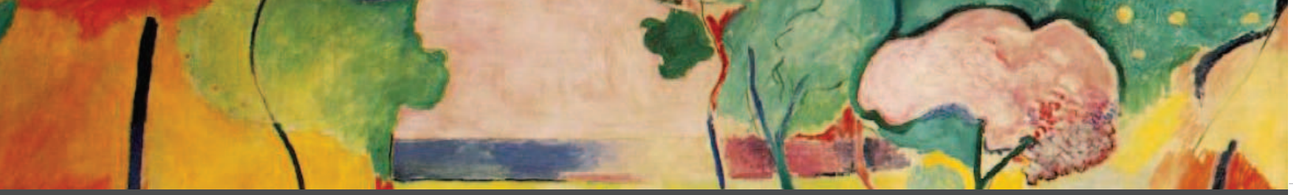


CryoTEM image of a "nanojellyfish" created from the solution assembly of charged PAA-PS diblock copolymers.

Image courtesy of Yingchao Chen, Pochan research group.

INSIDE: read about our biomaterials, high performance fibers and solar cell research!

UNIVERSITY OF DELAWARE



Message from the Chair

Thank you for your continued interest in the Materials Science and Engineering (MSEG) Department at the University of Delaware. This was a banner year for graduate student enrollment, with 19 new students coming to study at UD from all over the U.S. and from several international institutions.

We held a well-attended, special symposium at Clayton Hall on Materials in Art last November, in collaboration with the Department of Art Conservation and the Winterthur Museum. We also continue to expand and diversify our MSEG research portfolio with new projects funded this past year by the National Science Foundation, the National Institutes of Health and the Department of Defense.

Significant progress is being made on the construction of the new Interdisciplinary Science and Engineering Laboratory (ISE-lab), currently on target to open the fall of 2013. The MSEG department continues to establish strong international connections, including a visit of representatives from Tsinghua University in March, and a visit from Engineering Deans in Columbia this June. Our faculty are also actively establishing productive international relationships, including a sabbatical leave by Prof. Darrin Pochan at Kyoto University (2010-2011) and an upcoming leave by Prof. Ismat Shah to Azjerbijan, Pakistan, and Turkey in 2011-2012, on a Fulbright Fellowship. We also gladly recognize the promotion of Xinqiao Jia to associate professor with tenure, and Kristi Kiick to full professor.

New state-of-the-art instruments enhance our ability to examine the structure and properties of materials, including a recently ordered a multipurpose dual beam Zeiss Auriga 60 Crossbeam Focused Ion Beam / Scanning Electron Microscope (FIB/SEM), which will ultimately be housed in the new ISE-lab central microscopy facility. This ~$1.7M instrument, due on campus this fall, will provide a significant upgrade in our ability to examine the local nanostructure and composition of a wide variety of both soft and hard materials. Of particular interest is the equipment's capability for cryogenic sectioning for TEM of organic and biological materials, and for correlative optical and electron microscopy of the same area on any given sample.

There have been some recent changes to the administrative structure here in the College of Engineering at UD, including a newly appointed interim dean of the College of Engineering (Babatunde Ogunnaike from chemical engineering). Additionally, our own Kristi Kiick has been named deputy dean. Biomedical engineering (BMEG) recently began providing undergraduate degrees (with 53 students admitted in 2010, and another 59 anticipated for 2011), and we are actively working to initiate BMEG graduate degrees as well. This fall we welcome Dawn Elliott to Delaware from UPenn, who will serve as the BMEG program director and help transition this activity into a new department in the next few years.

Within the department, the MSEG administrative office last year welcomed Robin Buccos, now the MSEG assistant to the chair; Dionne Putney is now the MSEG graduate program coordinator and Christine Williamson is our senior secretary. Charlie Garbini continues as our department engineer, and helps ensure we all work safely. Michele Schwander, who serves as the Undergraduate Coordinator for BMEG, was housed in the MSEG office while the BMEG program (now in Spencer Laboratory) was first getting started. We thank all of these individuals for their contributions to the MSEG operation; we would be lost without you.

As always, please contact us if you have any questions or concerns. In particular, we appreciate those of you who have made financial contributions to the department over the past year. These funds are extremely important to our ability to remain competitive and attract the best and brightest to join us here in Newark, Del. Please check us out on the web at **www.mseg.udel.edu** and as "Delaware MSEG" on Facebook.

Prof. David C. Martin
Karl W. and Renate Böer Professor and Chair
Materials Science and Engineering

STUDENTS

Eleven students win university & department awards

- **Pernell Dongmo** (Zide research group) has won the *Special Service Award*
- **Alexandra Farran** (Jia research group) has won the *Chairperson's Award*
- **Sarah Grieshaber**, (Jia and Kiick research groups) has won the *Graduate Teaching Award*
- **Weiwen Liu**, (Doty group) has won the *Outstanding Graduate Research Award*
- **Congqi Yan** (Pochan research group) has won the *Outstanding Graduate Research Award*
- **Linqing Li** (Kiick research group) has won the University of Delaware's Office of Graduate and Professional Education *University Graduate Fellows Award*
- **Liangqi Ouyang** was awarded *"MSEG 609 Best Research Proposal"* by his peers

National & international awards

- **Xiaoqian Ma** (Rabolt Group) 2010 Federation of Analytical Chemistry and Spectroscopy (FACSS) Student Poster Award winner: *Polarized Fourier Transform Infrared Spectroscopic Study on Molecular Orientation in Electrospun Polymer Fibers*
- **Amit Jha** (Jia group) was selected to present his work at the *Excellence in Polymer Graduate Research Symposium* at the 241st ACS National Meeting, Anaheim, California
- **Gaurav Nilakantan** (Gillespie group) wins *Colburn Dissertation Award*
- **Bakhtyar Ali** (Shah group) receives the *Society of Vacuum Coaters (SVC) Student Fellowship*
- **Emre Yassitepe** (Shah group) Full scholarship to attend *ESPCA-LNSL Synchrotron Application School*, Brazil
- **Jennifer Mueller** and **Quinn McAllister** (Gillespie group) are awarded *ARL Graduate Student Fellowships*

Gillespie Group excels in Student Achievement Award Poster Competition

- **Jennifer Mueller** won 2nd Place: *Interaction Volume Effects of Ultrasonically Consolidated Cu/Al*
- **Quinn McAllister** won 3rd Place: *Nano-Scale Property Measurements of Fibers by Nanoindentation: Methodology*
- **Quinn McAllister** was awarded the *CCM Progress Award*
- **Gaurav Nilakantan** was selected for *Roy L. McCullough Scholars Award* by the faculty awards committee chaired by Suresh Advani

What's inside?

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Doctoral student studies public policy in nation's capital

As a scientist, **Laura Povlich** believes in the need for scientific innovation. As an individual, she understands that the government plays a large role in the development of new technologies.

Povlich, a recently graduated doctoral student who conducted research at UD, was named the 2011 Congressional Fellow for the Materials Research Society (MRS) and the Optical Society of America.

She is currently serving a one-year term as a special legislative assistant to a member of Congress or a congressional committee in Washington, D.C., where her role is to study public policy and raise awareness of the important relationship between government and the nation's scientists and engineers in advancing scientific innovation.

Povlich will assist in congressional hearings and debates, conduct legislative work and prepare speeches, among other things. An orientation program through the American Association for the Advancement of Science (AAAS) will enhance her understanding of science and public policy issues.

"I'm interested in exploring the government's role in ensuring public safety while also encouraging scientific innovation, specifically as it relates to uncertain or risky technologies," explained Povlich, whose research involves developing novel conducting polymers to interface neural prosthetic devices with nervous tissue.

A visiting scholar from the University of Michigan, Ann Arbor, Povlich moved to UD in 2009 to complete her doctoral research under adviser **David C. Martin**, chair of the Department of Materials Science and Engineering. According to Martin, her self-motivation, leadership skills and research interests make her the perfect fellowship candidate.

"Laura is a clear leader," said Martin, adding that Povlich was actively involved with the MRS student chapter at UD and was the founding vice president of the American Chemical Society POLY campus chapter at the University of Michigan.

Povlich said her interest in science policy stems from the Science, Ethics and Public Policy (SEPP) program at UD and "Science Outside the Lab," a Washington, D.C., program hosted by the Consortium for Science, Policy and Outcomes of Arizona State University.

After attending seminars through SEPP and auditing a class at UD called The Ethics of Nanoscience, she became aware of the thought processes and potential policies involved in the development of new technologies.

"It's difficult to make the transition from academic research to policy without outside assistance, and the congressional fellowships provide a convenient pathway for anyone with a Ph.D. in science or engineering," added Povlich.

Povlich earned her doctoral degree in Macromolecular Science and Engineering as a Rackham Merit Fellow and an NIDCR Tissue Engineering and Regeneration Training Grant recipient at the University of Michigan. She plans to pursue a career in science policy focusing on education, health care, science and the funding of developing technologies.

STUDENT SPOTLIGHT

Chelsea Haughn

The penalty for mistakenly leaving a blank field on a form could be getting a Ph.D. degree in Materials Science.

When Chelsea Haughn forgot to fill in her "area of interest," for a high school summer camp, the camp organizers assigned her to Materials Science. This initial exposure developed into a bachelor's degree in Materials Science from the University of Michigan and then led Chelsea to graduate school at UD, where she recently finished her second year in the Department of Materials Science and Engineering. Chelsea is working with Professor Matthew Doty to characterize energy transfer in new photovoltaic materials using photoluminescence spectroscopy. "It is a little more physics than what I wanted, but I like the combination of the 3-Ps, Physics, Photovoltaics and PL spectroscopy," said Chelsea.

The move from Michigan to Delaware was instigated by Professor Martin, also from the University of Michigan, who suggested Chelsea look into UD's Materials Science and Engineering Program. She visited UD and liked the campus, the people and the activities around photovoltaics. While she loves the proximity of the University to big cities, the weather, she says, is a different story. In her free time, Chelsea is a triathlete who, despite recently having her road bike stolen, says she is determined to compete again. In fact, her new bike "spends the same amount of time in the lab as I do," she said .

Shah to conduct research, teach in Azerbaijan as Fulbright Scholar

The U.S. Department of State and the J. William Fulbright Foreign Scholarship Board recently announced that UD **Professor S. Ismat Shah** has received a 2011-12 Fulbright Scholar grant to conduct research and lecture at Baku State University in the Republic of Azerbaijan.

Azerbaijan is an Eastern European country situated on the Caspian Sea, adjacent to politically embroiled countries including Armenia, Georgia, Iran and Turkey.

"Given the political state of international affairs at the moment, it is highly commendable that Professor Shah is helping to improve the quality of our interactions between the U.S. and Eastern Europe," said Dave Martin, Karl W. and Renate Böer Professor and chair of the Department of Materials Science and Engineering at UD. "We are particularly proud that he is helping the University, and the materials science department in particular, to be a beacon of hope in this volatile part of the world."

Shah's research focuses on the synthesis and characterization of nanoscale materials, with a particular focus on energy applications. His expertise in thin-film photovoltaics, or solar cells made from plastics, is of special interest to scientists in Baku State University's Nano Center because solar power is considered an untapped resource in Eastern Europe, a region that receives abundant sunshine throughout much of the year.

"Everyone is aware of the global energy problem, but some of the solutions we have developed in the U.S. may also be useful in these countries," noted Shah, who holds joint appointments in materials science, and physics and astronomy. "I fully expect my time in Azerbaijan will result in collaborative research, joint papers and successful future grant proposals."

In addition to direct research with his host institution colleagues, Shah will advise graduate students and teach courses on thin film and nanomaterials processes, and the ethics and social implications of nanoscale materials.

He is also working with the U.S. Embassy in Azerbaijan to coordinate community speaking engagements with local high school and college students, and plans to lecture at universities in Georgia and Armenia.

"Fulbrighters are considered ambassadors for everything from social and scientific issues to culture. It is an exciting opportunity," Shah said.

Before returning to the U.S., Shah will establish an organic solar cell research laboratory at a university in Pakistan, in cooperation Salamat Ali, through a previously funded grant from the State Department. He also plans to spend two months in Turkey working alongside former students who are now professors.

Highly regarded among his peers and by his students, Shah received UD's highest teaching award, the Excellence in Teaching Award, in 2011. He was similarly honored by the College of Engineering in 2007. In addition to his regular teaching responsibilities, Shah has taught at universities across the globe in Germany, Italy, Greece, Turkey, Spain, France and Taiwan.

UD ranks among the nation's top tier of Fulbright Scholars producers, according to a 2010 report by the Institute of International Education (IIE) published in a special Fulbright section in the Chronicle of Higher Education. ❖

Sabbatical fosters strong relationships with international colleagues

Darrin Pochan spent the 2010-2011 academic year on sabbatical in Kyoto, Japan, with his wife Beth (also on sabbatical from the Department of Psychology) and their three sons Max, Alek and Hugo.

Both Darrin and Beth were stationed at the University of Kyoto, where Darrin is split time between the Department of Polymer Chemistry and the Institute of the Frontiers of Medical Sciences. He explored new materials for biomedical applications and new methods of nanostructure formation from polymer molecule solution assembly.

In an effort to develop relationships with colleagues throughout Japan and Asia, Darrin spent time in Tokyo, Osaka, and Kyushu, Japan, Beijing, China, India, Taiwan and in Seoul, Korea giving research talks and meeting with world experts of soft materials.

His family loved the country and the people of Japan, and they witnessed first-hand as the Japanese people worked together to recover after the earthquake and tsunami disasters in March 2011. In fact, Darrin said that most large companies and universities across Japan are taking pay cuts of five percent and sending the saved money to northern Japan for reconstruction efforts; a true national sacrifice for the many people impacted so horribly through this disaster.

He hopes that the many science and personal relationships that he has formed this year will continue beyond his sabbatical. ❖

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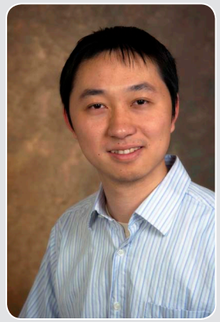
WE'RE ON facebook

New additions



Juejun Hu

Juejun Hu, better known as JJ, is the newest addition to the Department of Materials Science and Engineering. JJ originally came from Fujian, in southern China. As a child he loved to visit the islands from which he could see the lights of Kinmen, Taiwan, across from the Strait of Taiwan. He grew up watching a lot of Taiwanese TV.

JJ earned his bachelor's of engineering from Tsinghua University in Beijing, China, and his Ph.D. in Materials Science at MIT.

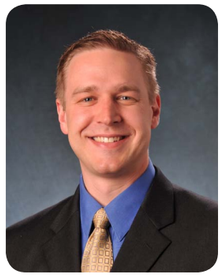
"I always wanted to do theory but ended up in a lab working with chalcogenide glasses for sensing and PV applications. My advisor was a hands-off type of person, which made it difficult to get going in the beginning but once I got started, the freedom of chalking your own path was wonderful," says JJ.

He met his wife in Tsinghua but the romance did not flourish until they both met each other again in the U.S. He has traveled extensively throughout the world and in the United States. His most favorite place is Paris, France.

JJ is currently in the process of setting up his laboratory. He is interested in pursuing research in novel materials and devices for exploiting interactions of light with matter. Specifically, his research will include: nanophotonic devices for chem-bio sensing, cavity optomechanics; light trapping in thin film photovoltaics; and integrated magneto-optical isolator on silicon. ❖

April and Chris Kloxin join UD

April Kloxin is now an assistant professor in the Department of Chemical Engineering. To meet the need for complex, dynamic cell culture environment, April is developing materials with highly controlled properties for spaciotemporal regulation of the cell niche and utilizing biological techniques to characterize and exploit these materials for cell culture and tissue regeneration.

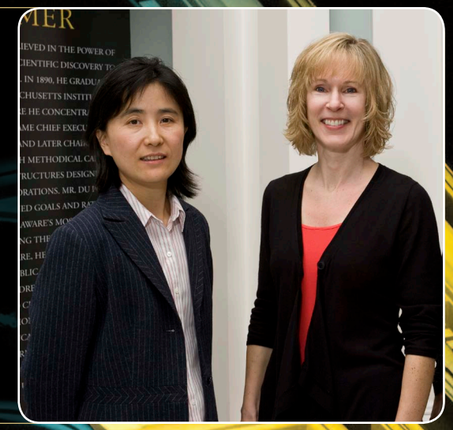


Chris Kloxin has joined the Department of Materials Science as an assistant professor. Chris' primary research focus is on stimuli-responsive materials, which include light-actuated, environmentally adaptable and self-healing materials, for applications ranging from low stress and healable dental restoratives to photo-induced delivery of gene therapeutics. ❖

On the move

Xinqiao Jia (left) has been promoted to the rank of associate professor with tenure.

Kristi Kiick has been promoted to the rank of professor and now also serves as the college's deputy dean. ❖



Jia, Doty awarded DuPont Young Professor grants

Xianqiao Jia and **Matthew Doty** were among 12 young professors from universities in the United States and China to receive DuPont Young Professor grants for original research in 2010. This innovative grant program, which began in 1967, is designed to provide unrestricted start-up assistance to promising young and untenured research faculty working in areas of interest to DuPont's long-term business. Jia and Doty will each receive a $75,000 grant, given in $25,000 increments over three years. The grants may be used to obtain matching funds through the National Science Foundation or other organizations. ❖

Shah recognized for outstanding teaching

Ismat Shah was one of four University faculty recognized with the 2011 Excellence in Teaching Award in May. Excellence in Teaching Awards are based primarily on nominations from current and past students. Winners have their portraits hung in Morris Library for five years and have a brick, inscribed with his or her name, installed in Mentors' Circle, between Hullihen Hall and the Morris Library. ❖

CCM Corner

Improving Fabric Impact Performance

Quinn McAllister and Jack Gillespie

Local contact mechanics and nanoindentation of high performance fibers are shedding light on the energy dissipative deformation mechanisms improving the impact resistance of textile composites. Hard, spherical particles (Ø ~ 500 nm) infused into flexible fabrics indent and gouge along fiber surfaces in an impact event, increasing inter-fiber friction and decreasing the fiber mobility. Diamond indentation tips used in nanoindentation (and nanoscratching) impart contact sizes similar to those by the particles, and allow for probing of fibers on length scales similar to their heterogeneous microstructure. Using a variety of probe shapes and sizes, we are developing a better understanding of the local properties and deformation mechanics of high performance fibers (specifically Kevlar ®) with respect to indentation size, scratch length, depth, geometry, rate, and damage sensitivity, which give rise to the improved fabric impact performance.

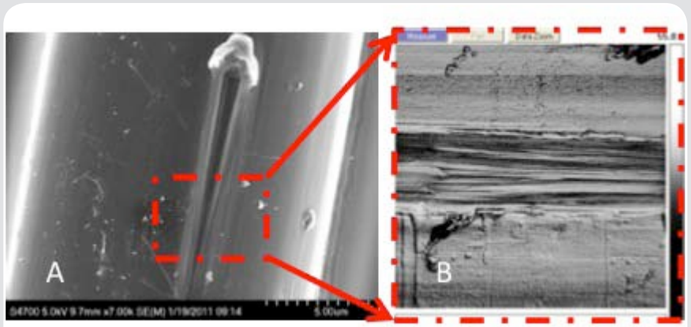


Figure 1: A) A SEM image of a scratch made on a Kevlar fiber (Ø ~ 13 µm) with a 500 nm radius, 60° sphero-conical diamond indentation probe. B) An AFM image of the highlighted region of (A), exposing the disrupted microfibril structure of Kevlar.

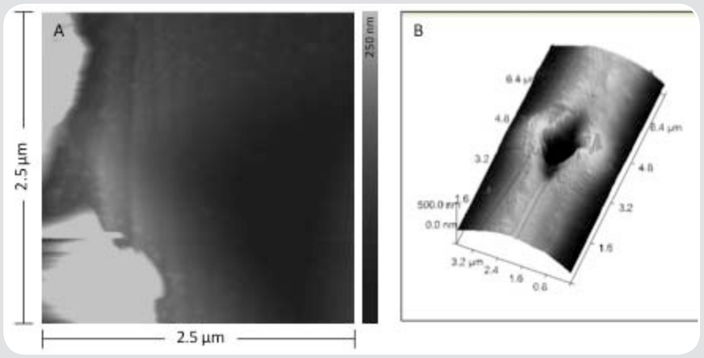


Figure 2: Representative indents on Kevlar. A) An AFM topography image of an indentation made with a larger Berkovich indentation tip which exhibits fibril compression beneath the indenter. In contrast, B) is an AFM 3D render of an indent made with a smaller 500 nm radius, 60 ° sphero-conical probe which exhibits fibril splitting along the fiber axis that generates the elliptical residual indent shape observed.

Paper documents new solar cell characterization method

Michael Mackay, Distinguished Professor of Materials Science and Engineering at the University of Delaware, has co-authored a paper demonstrating a new method for characterizing polymer-based solar cells.

The paper, "Phase-Sensitive Neutron Reflectometry Measurements Applied in the Study of Photovoltaic Films," appeared in the August 21, 2010 issue of The Journal of Chemical Physics. Co-authors include Jon Kiel, Mackay's doctoral student at Michigan State University, and three researchers from the National Institute of Standards and Technology (NIST).

Mackay explained that polymer-based solar cells have the potential to supplement ever-increasing demands for energy due to their low cost and ease of manufacture. However, commercialization will not be feasible until device performance reaches an efficiency level approaching that of inorganic cells, such as silicon solar cells. "Achieving this level of performance requires precise control of morphology or structure at the nanoscale," he said.

According to the researchers, the use of phase-sensitive neutron reflectometry (PSNR) may be the key to achieving this control, as the technique exploits the large neutron scattering contrast between the materials comprising the device. Other characterization techniques are not sensitive enough. Experiments conducted by the research team confirmed that components within the device are not distributed in an ideal way, paving the way for better control of this distribution in the future.

The material used in the study was a mixture of poly(3-hexylthiophene) (P3HT) and [6,6]-phenyl-C61-butyric acid methyl ester (PCBM). The P3HT/PCBM samples for the study were prepared in Mackay's lab at UD and transported to NIST's Center for Neutron Scattering in Gaithersburg, Md., where the PSNR measurements were performed. NIST scientists on the project were Brian Kirby, Brian Maranville, and Charles Majkrzak.

The Journal of Chemical Physics publishes reports of significant research in methods and applications of chemical physics, including spectroscopy, kinetics, statistical mechanics, quantum mechanics, polymers, materials, surfaces and interfaces, information theory and biological systems. According to Thomson Reuters, JCP was the most highly cited journal in atomic, molecular and chemical physics in 2009.

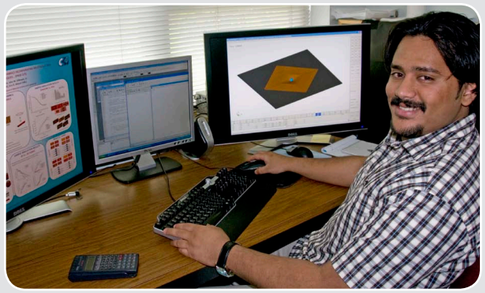
Mackay, who earned a bachelor's degree with distinction in chemical engineering at UD in 1979, joined the UD faculty in 2008. He was previously a member of the faculty at Michigan State University. His current research focuses on polymer-based solar cells, with an emphasis on controlling and measuring their structure and nanoscale phenomena within polymer nanocomposites to create the next generation of materials. His work has been supported by the National Science Foundation, the Department of Energy, NIST, several national laboratories and industry.

Doctoral recipient wins Colburn Prize for best dissertation in math and engineering

Gaurav Nilakantan, who completed his doctorate in materials science and engineering at UD in 2010, has won the Allan P. Colburn Prize for his dissertation, "Modeling the Impact of Flexible Textile Composites through Multiscale and Probabilistic Methods." The prize is given annually to recognize the best dissertation in engineering and mathematical sciences.

Nilakantan was advised by John W. (Jack) Gillespie, Jr., Donald C. Phillips Professor and director of UD's Center for Composite Materials, and Michael Keefe, associate professor of mechanical engineering.

Funded by the Army Research Laboratory, Nilakantan's dissertation focused on flexible textile fabrics made of Kevlar that are used as an important component of body armor. The purpose of the fabric is to arrest and absorb the impact energy of projectiles without major trauma to the soldier. Nilakantan developed advanced computational models to shed light on the fundamental interactions and energy-dissipating mechanisms that occur when these fabrics are subjected to extreme dynamic loading.



"A large part of this understanding comes from bridging the various length scales from the filament to the fabric level," said Gillespie.

"Gaurav's work provides researchers with a probabilistic predictive capability to assess the penetration response of fabrics, previously possible only through destructive testing."

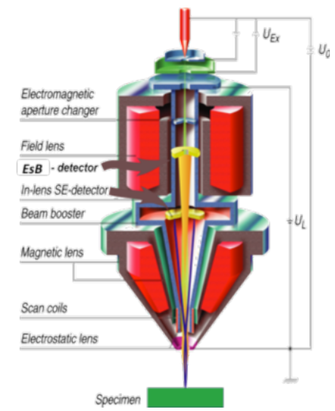
Gillespie added, "The insight gained from his research has established a material-by-design approach for the development of next-generation multifunctional materials and architectures for textile composites, and his work also makes an important contribution to science and national security."

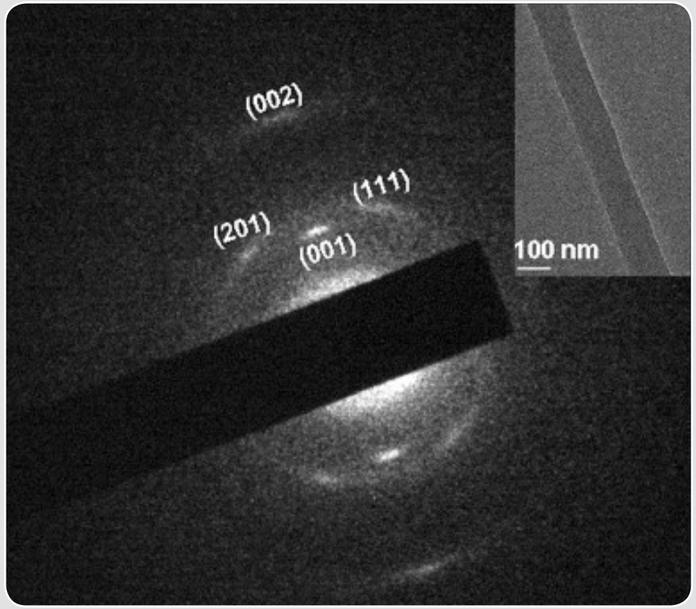
Currently a research associate at CCM, Nilakantan's work has resulted in seven first-author journal publications and a patent application. He has won a number of awards including the American Society for Composites Ph.D. Research Scholarship award. He also founded his own company, Nilakantan Composites.

New Focused Ion Beam and Field Emission Scanning Electron Microscope

Dr. David Martin, with the help of **Dr. Chaoying Ni**, has been spearheading an effort on bringing in a top-notch Focused Ion Beam and Field Emission Scanning Electron Microscope (FIB/FESEM) for the W.M. Keck Advanced Microscopy Facility. After thorough evaluation, a Zeiss Auriga-60 has been selected and delivered this September. The Auriga-60 combines the cutting-edge ion-beam technology with a high resolution SEM for nano-fabrication and characterization of advanced materials and devices. In addition to a resolution of 1 nm or better for SEM imaging with various modes and a highly flexible and efficient ion beam probe for milling and imaging, a group of ancillary hardware and software also allows STEM (scanning transmission electron microscopy) operating in BF/DF/HAADF modes, EBSD (electron back-scattered diffraction) for structural analysis, high throughput SDD (silicon drifted detector) XEDS (x-ray energy dispersive spectroscopy), and 3D reconstructions for image, elemental distribution, and crystal orientation by slicing & view schemes. Other capabilities include cryo-SEM, gas injections for elemental deposition of nanometer features, and correlative microscopy.

This instrument will initially be housed in 022 Spencer, but will eventually be moved to the ISE Lab currently under construction where a dedicated characterization suite of 3,000 square feet sits on a single concrete slab of 28" thick as shown in the photo. The ISE Lab is anticipated to open in 2013.





Single fiber diffraction pattern from electrospun fibers obtained for the first time

Xiaoqian Ma (Rabolt/Chase research group), **Jinglin Liu** (Martin research group) and Professor **Chaoying Ni** (Director of the W.M. Keck Electron Microscopy Facility) have obtained single fiber selected area electron diffraction (SAED) patterns from electrospun poly (vinylidene fluoride) (PVDF) nanofibers for the first time.

Low dose TEM techniques (on the 200 kV JEOL JEM-2010F FasTEM) were used due to the high electron beam sensitivity of the PVDF fibers (~0.002 C/cm^2). The SAED patterns demonstrated that a high degree of local molecular orientation of the crystalline PVDF can be obtained in the electrospun fibers, depending on the details of how the nanofibers are solidified during solvent evaporation. These exciting results complement both IR and Raman spectroscopic measurements, providing detailed insights about the driving force for molecular orientation during the electrospinning process. ✣

2011 Distinguished Lecture Series Speakers

September 21, 2011

Shaoyi Jiang, Boeing-Roundhill Professor of Chemical Engineering and Adjunct Professor of Bioengineering, University of Washington, Seattle, WA

September 28, 2011

Mitra Taheri, Hoeganaes Assistant Professor of Metallurgy, Drexel University, Philadelphia, PA

October 5, 2011

Antonio Badolato, Assistant Professor of Physics and Astronomy, University of Rochester, NY

November 2, 2011

Cherie Kagan, Professor of Electrical and Systems Engineering, University of Pennsylvania, Philadelphia, PA

Quantum Dots for optoelectronics applications

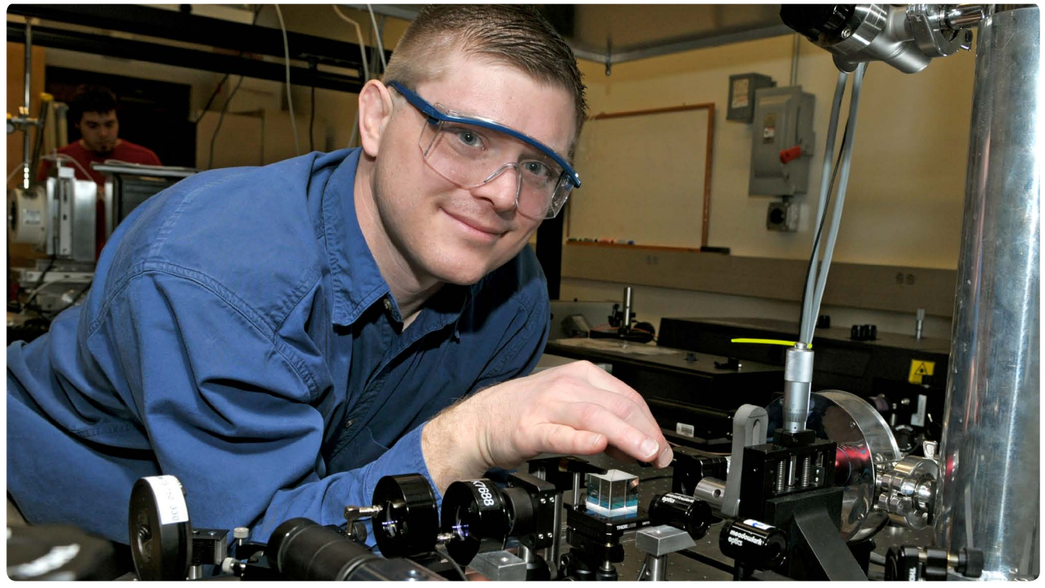
Assistant professor **Matthew Doty** has received two new grants from the National Science Foundation (NSF). One will explore the use of quantum dot molecules for next generation optoelectronic applications, while the second, in collaboration with Joshua Zide, assistant professor, will use quantum dots as a probe of nanostructured rare earth inclusions in GaAs.

Quantum dots are nanometer sized regions of a semiconductor confined in all three dimensions by a different semiconductor with larger bandgap. Because of this confinement, quantum dots have discrete energy levels analogous to atoms. Quantum dot molecules are a novel material structure in which controllable quantum mechanical coupling between two adjacent quantum dots leads to the formation of molecular orbitals with unique and tunable properties. Doty is internationally recognized for his pioneering work in exploring the basic physical interactions and properties of quantum dot molecules. With support from the Electronic, Photonic, and Magnetic Devices program at NSF, Doty will now turn his expertise toward engineering the properties of these quantum dot molecules to serve as wavelength-tunable elements of scalable all-optical quantum information processing. The proposed work is expected to overcome one of the largest obstacles to scalable ultrafast quantum information processing using optics.

In a separate award, the Electronic Materials program of the NSF is supporting a collaborative effort between Profs. Zide and Doty to study new GaAs materials containing rare-earth nanoinclusions. The formation of these nanoinclusions has been established by Zide's pioneering work in developing the materials synthesis protocols, but the electronic properties of the nanoinclusions are poorly understood.

Using time-resolved optical measurements, Doty will analyze macroscopic carrier dynamics in these materials. The macroscopic measurements will be complemented by microscopic measurements of single InAs quantum dots electronically coupled to individual nanoinclusions. Because the properties of single InAs quantum dots are reasonably well understood, this approach will allow the quantum dots to be used as a probe of the local electronic structure of each nanoinclusion. The results of these macroscopic and microscopic measurements will be used to optimize the materials for applications in ultrafast optics and electronics.

Doty is also a 2010 recipient of the *DuPont Young Professor Award*. ✣



UD's Xinqiao Jia recognized for biomaterials research

Research in the areas of drug delivery and tissue engineering has witnessed tremendous progress in recent years due to its unlimited potential to improve human health.

Smart biomaterials with nanoscale organization, defined biological functions and robust mechanical properties have the potential to enhance cancer treatment and improve tissue regeneration.

Xinqiao Jia, professor in the Department of Materials Science and Engineering and the Department of Biological Sciences, is developing intelligent biomaterials that closely mimic the molecular composition, biological function, mechanical responsiveness and nanoscale organization of the natural matrices surrounding the cells.

This biomimetic approach allows Jia to construct a three-dimensional microenvironment that will improve the understanding of cell biology and aid in the engineering of intelligent nanoparticles for targeted delivery and controlled release of cancer therapeutics.

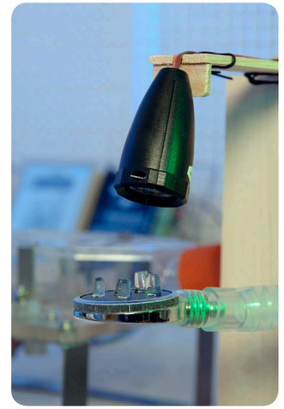
"Combining cell biology and engineering principles, we are actively developing methodologies for the engineering of healthy replacement tissues such as cartilage and vocal folds, as well as pathological tissues such as tumor tissues," Jia explained.

The polymeric nanoparticles her group has developed are being evaluated as nanocarriers for anticancer drugs. The ultimate goal is to enhance the efficacy of the drugs while minimizing their debilitating side effects.

For her novel approach, Jia received the Academic Research Award at the Delaware BioScience Association's (Delaware Bio) 2011 Annual Awards Gala on April 11, held in Wilmington, Del. The award recognizes significant contributions to the advancement of life science research at an academic or medical research institution in Delaware.

A previous recipient of the National Science Foundation's Faculty Early Career Development Award, Jia was nominated by fellow faculty member S. Ismat Shah.

"Professor Jia is one of our brightest young faculty members. Her research is being recognized nationally and internationally with coverage of her work appearing not only in high impact journals, but also in popular magazines," said Shah, professor in the Department of Materials Science and Engineering and in the Department of Physics and Astronomy.



Jia was also a 2010 recipient of the DuPont Young Professor Award and was named an Outstanding Junior Faculty in UD's College of Engineering the same year.

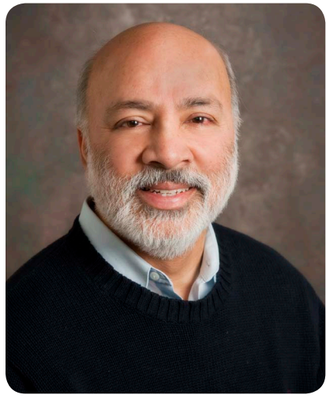
She received her bachelor's degree in applied chemistry and master's degree in polymer chemistry and physics from Fudan University in Shanghai. Jia earned her doctoral degree in polymer science and engineering from the University of Massachusetts at Amherst.

Prior to joining UD in 2005, she conducted postdoctoral research with Robert Langer, a pioneer in drug delivery and tissue engineering at the Massachusetts Institute of Technology. ❖

Organic polymer-based photovoltaics, like the one pictured here, are smaller, lighter and more flexible than their inorganic silicon counterparts.

Solar cell research at UD may impact Pakistan

S. Ismat Shah, a UD professor with joint appointments in the Department of Materials Science and Engineering and the Department of Physics and Astronomy, is helping researchers in Pakistan study solar energy as an alternative to fossil fuels.



Pakistan currently depends on fossil fuels for more than 80 percent of its energy requirements. Solar power, particularly photovoltaics, is considered an untapped resource due to the country's geographical location in a region that receives abundant sunshine throughout much of the year.

"The great thing about solar cell technology is that it brings electricity without wires. You take a panel, put it up on your hut or shanty and you've got power," said Shah. He estimates that 40 to 45 percent of villages in Pakistan do not have electricity.

Inter-university collaboration

Photovoltaics, also known as solar cell technology, is the process of generating electricity from light.

Shah's work is funded through a $216,000 grant from the U.S. Department of State under Phase 4 of the Pakistan-U.S. Science and Technology Cooperation Program. The program aims to increase cooperation in science, technology, engineering and education between the two countries.

Shah is collaborating with Salamat Ali of Government College University (GCU) in Lahore, Pakistan, to establish a research laboratory at GCU and to train Pakistani researchers in creating, testing and studying organic polymer-based photovoltaics (OPV) as a means to address the country's critical energy needs in a sustainable manner. To date, Pakistani research in photovoltaics is almost nonexistent.

"There are very good scientists in Pakistan; what they lack is resources," said Shah, whose proposal was one of only 28 selected from among 270 applicants to receive funding. Ali will receive separate funding from Pakistan's Higher Education Commission (HEC).

Versatile applications

Polymer-based photovoltaics are flexible and can literally be painted on almost any surface, eliminating the need for sophisticated equipment. In Pakistan, this will enable even those living in remote villages to harness the sun's energy to create electricity where infrastructure hasn't yet reached. "This is similar," explained Shah, "to the off-grid-electrification technology currently used to pump water to secluded villages in Africa by UD's Engineers Without Borders program."

In the U.S., they can also be used for many purposes. For example, the solar cells could be painted onto a woman's purse, allowing her to charge her cell phone on the way to work, or they could be placed on a farmer's irrigation system so that crops can be watered without using electricity.

Although cheaper than their inorganic silicon counterparts, polymer photovoltaics have had limited success so far. The three-year project will address the three major issues affecting polymer solar cell technology -- efficiency, transport and lifetime. If successful, these nontraditional approaches could potentially reduce barriers to efficient large-scale production of organic photovoltaics in Pakistan.

Under the grant, Shah will teach courses in solar cell technology and thin-film technology at GCU to draw beginning Pakistani researchers into this effort. In addition, undergraduate and graduate students on both sides will visit each other's universities to learn from one another and share findings. Shah said he hopes that by working together on a project of shared scientific interest, participants will forge both personal and professional ties.

"One of my personal goals for the project is the development of a mutual respect between the scientists and students, both in Pakistan and here in the United States," added Shah, who is originally from Pakistan. "This grant opens the possibility of taking all of my current students to Pakistan to witness the achievements of scientists there, scientists who do wonderful things with very few resources."

Strengthening global partnerships

Engineers from Tsinghua University in Beijing, China, traveled nearly 7,000 miles across three continents to share their research with University of Delaware faculty at a joint nanotechnology workshop held on campus April 27-28.

Tsinghua University is one of China's top universities. UD formed a mutual agreement with the academic institution in 2008 to foster research and educational collaborations among faculty, especially in engineering.

According to Provost Tom Apple, the workshop illustrates several of the University's most important goals: to expand international reach and amplify impact; to strengthen global partnerships; and to develop collaborative initiatives in international and transnational issues.

"These are key priorities in our strategic plan -- our Path to Prominence™ -- and we are committed to ensuring that UD plays a significant role in the global community," Apple said.

Advances in nanotechnology -- the science of the very small -- have direct implications in computing, communications, the environment, security, energy independence and health, according to workshop organizer **Bingqing Wei**, associate professor in the Department of Mechanical Engineering.

Keynote speakers **Tsu-Wei Chou**, Pierre S. du Pont Chair of Engineering at UD, and Feiyu Kang, materials science professor and supervisor of the New Carbon Materials Laboratory at Tsinghua University, discussed some of the challenges facing today's scientists.

Chou shared recent advances in carbon nanotubes, while Kang addressed new technologies in energy storage devices that use nano-sized materials. Faculty presentations, a poster session and a tour of UD laboratories rounded out the two-day conference

"Partnerships such as this are critical to UD establishing a presence on the worldwide stage and enhancing its global impact," said **Babatunde Ogunnaike**, interim dean of the College of Engineering.

About Tsinghua University

Tsinghua University, which traces its origins to 1911, is one of the most prominent, and highly selective, institutions of higher education in China. This comprehensive university consists of 15 schools, 55 departments and over 74 research institutes, including 12 state key laboratories and three national engineering laboratories. While engineering has been the primary focus at Tsinghua University, academic offerings have been significantly expanded to include medicine, sciences, law, liberal arts, education and management, among others. The school is comprised of both graduate and undergraduate students and boasts an enrollment of more than 29,000 students. ❖

GLOBAL TIES

MSEG/PHYS Study Abroad bound for France, China over Winter Session 2012

MSEG Study Abroad, the forerunner of Engineering Study Abroad programs, is bound for both France and China this year. Each program offers course combinations that will excite engineers and non-engineers alike.

Based in Marseilles, along the edge of the French Riviera, study abroad in France course offerings include MSEG 302: Materials science for Engineers, HIST 339: Topics in modern European history, or PHYS 143: Energy, Technology and Society. Excursions to historical sites in Marseilles, Paris, Barcelona, Avignon and more, offer an experience rich in history, industry and culture.

Courses taught through the study abroad in Hainan, China are MSEG 302: Materials Science for Engineers and MSEG 467: Materials Through the Ages: A Chinese Historical Perspective. This lifetime experience covers interests in materials science, cuisine, history and culture.

For details, visit our website: www.udel.edu/igs/studyabroad ❖

Materials in Art Symposium inspires future materials scientists

Students from Avon Grove High School in West Grove, Pa., got a taste of what it's like to be a materials scientist at the "Materials in Art 2010: Making Stuff" symposium at the University of Delaware's Clayton Hall last November.

During a session with PlastiVan, a special program from the Society of Plastics Industry that helps excite middle and high school students about engineering opportunities, students learned about the science of plastics.

Other attendees learned how advanced scientific methods can be used to improve understanding of the structure and properties of art, including paintings, sculpture, textiles and photographs. The symposium featured speakers whose research interests involve both materials science issues and art. In addition to invited talks and a poster session, the symposium program included equipment demonstrations and a "materials as art" contest.

The ethics of the very small

Two UD professors, Ismat Shah and Tom Powers, will host two international conferences on nanoethics in November, stopping first in Lahore, Pakistan, and then in Dubai.

Shah is a professor of materials science and engineering as well physics and astronomy. Powers is a professor of philosophy and directs the Science, Ethics, and Public Policy Program at the University. The two combined their interests and expertise to examine the ethical implications of emerging nanotechnology and will be discussing the various risks and benefits that arise with nanoscience and engineering at the conferences.

Nanoscience is the science of the very small—a nanometer is one-billionth of a meter. Nanoparticles are so small that they can only be viewed with electron microscopes. Researchers can re-engineer elements that occur naturally, such as carbon, so that they become new substances, which have properties that are very different from their original properties.

Shah initially won a grant from the National Science Foundation's Office of International Science and Engineering (OISE) in 2008 to support undergraduate education in nanoscience and nanotechnology related to alternative energy. As part of that grant, Shah and Powers teamed up to teach a course at UD called "Ethics in Nanoscience." In conjunction with the class, the two will hold a campuswide workshop on nanoethics aimed at UD undergraduate and graduate students on April 26.

Now Shah and Powers have received further funding from OISE to host the conference in Pakistan -- where Shah grew up -- on Nov. 14-17, followed by another iteration of the program in Dubai on Nov. 18-19.

Shah and Powers believe that it is important for researchers and experts in the area to understand the potential consequences of experimenting with materials whose effects are largely unknown.

"The problem is that we get so carried away with the possibilities that we don't think about the probabilities, which are more ethical issues. We are making nanomaterials quite casually. If I am not an ethical scientist, there could be a lot of damage done," said Shah.

Powers agrees, and notes that "collaborations between scientists, engineers, and ethicists on this topic are increasing and could help to head off problems that have derailed other new technologies, such as genetically modified foods."

Products made with nanotechnology are already available in the marketplace, such as titanium dioxides in sunscreen. The effects of nanotechnology have the potential to be groundbreaking and very profitable for medicine, alternative energy sources, and so much more. But what are the consequences of using this technology? What becomes of nanoparticles that are released into the environment? The conferences in Pakistan and Dubai will focus on these types of ethical questions.

"There is a lot of science that people know and a lot of ethics that other people know, but they don't know anything about each other's technology or methodology," explained Shah. "Philosophers need to be educated on the science part and vice versa; scientists and engineers don't know as much about the ethical considerations. The idea for the conference is to educate both groups."

Connecting MSEG with industry

Are you looking to recruit UD MSEG students to your company? I invite you to visit our career services website at www.udel.edu/CSC/ to learn more about how you and your company can partner with UD.

WWW.UDEL.EDU/ISELAB

ALUMNI

The Interdisciplinary Science & Engineering Laboratory and its impact on Materials Science and Engineering at UD

Talent Magnet, Idea Leadership, Discovery Learning: these phrases embody the ongoing work of our faculty and students within the College of Engineering and the Department of Materials Science and Engineering (MSEG). They also express the vision for engineering innovation and teaching at the University of Delaware. MSEG is leading a college- and university-wide charge to increase cross disciplinary collaboration, learning and problem solving. Through this approach, the department and its faculty are inspiring innovation and preparing the next generation of engineering leaders for our region, nation and world.

In October 2010, the University broke ground on a 194,000 square foot Interdisciplinary Science & Engineering Laboratory (ISE Lab). The state-of-the-art building will not only significantly raise the bar for engineering and science instruction on campus; it will increase UD's profile and impact in recruiting talented faculty and students.

My colleagues and I welcome the opportunity to speak one-on-one with any alumnus/alumna interested in making an impact on this vital project.

ISE Lab is the first laboratory in 20 years to be constructed on campus and specifically devoted to science and engineering. Attractive naming opportunities in the building are available. To stay informed of the progress, I invite you to visit the ISE-Lab website, **www.udel.edu/iselab**.

Higher education is expensive. Yet it is essential that access to new knowledge is sustained. As one of the fastest growing departments leading the way for interdisciplinary learning, MSEG will need the generous financial support of alumni, industry partners and friends.

We encourage you to make an impact with your annual contribution and support the Department of Materials Science and Engineering. Your gift does make a difference when combined with the support of others.

Please visit **www.udel.edu/development/makeagift** to make your gift today!

Dan Sarkissian
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Pictured are, from left, *Jack Gillespie*, director of the Center for Composite Materials; *Ashish Diwanji* of Owens Corning; UD President *Patrick Harker*; and *David Weir*, director of the Office of Economic Innovation and Partnerships.

Owens Corning VP wins alumni award, shares career advice

Many inspirational speakers advise others to follow their passion in determining a career path, but **Ashish Diwanji** believes that's not enough.

"Following your passion is good," he told an audience at the University of Delaware Center for Composite Materials on April 12, "but you have to match your passion with your skills. Pursue the things you love, but make sure you're good at them."

Diwanji obviously knows what he's talking about. Recipient of the 2011 CCM Distinguished Alumni Award, he has melded his leadership and entrepreneurship skills with his love of advanced composites over the past two decades, emerging as vice president of innovation in Owens Corning's composites solutions business.

In introducing Diwanji during the award ceremony, then engineering dean **Michael Chajes** referred to him as an example of UD's "Talent Magnet" pillar.

"You're an entrepreneur and a great example of what we're trying to promote among our students," Chajes said.

Diwanji shared advice and anecdotes from his 21-year career with more than 100 students, faculty, and staff at the ceremony.

After earning his Ph.D. in materials science at UD in 1990, Diwanji joined Lord Corporation, where he spent the next five years learning about the fundamentals of buying and selling.

In 1995, he joined Owens Corning, the company known for its pink insulation. Diwanji said that OC's discovery of fiberglass was actually a mistake, but that proved to be a lesson in innovation for him.

He went on to work in various facets of the composites business, including engineering, product development, and management. He couldn't make the jump to leadership, however, until he was willing to give up the need to do everything himself and lead others in doing. "That's the difference between a manager and a leader," he said.

Diwanji finished his talk by highlighting his rules for success: be credible and trustworthy, be decisive, always leave an impact, and be balanced. "Grow talent by challenging people and encouraging them to explore new competencies," he said.

In selecting Diwanji for the award, CCM recognized not only his professional accomplishments but also his successful mentoring of the next generation of composites engineers.

Diwanji was the brains behind OC's 2010 Composite App Challenge, a global competition to find new applications for composite materials. Two CCM-affiliated doctoral students, **Cedric Jacob** and **John Gangloff**, won a $10,000 cash prize in the challenge for their concept of an integrated structural composite fuel cell.

The pair shared their experience with the audience at the end of the award ceremony. Both have a firm grasp on the need for multi-functionality in new products and of the suitability of composites for making that happen. They also understand the process of bringing an idea from the lab to the marketplace.

Ashish Diwanji of Owens Corning (center) is honored by Jack Gillespie (left), director of the Center for Composite Materials, and Michael Chajes (right), former dean of the College of Engineering.

"We can't come out with a new product in 10 years unless we're doing the fundamental work now," Jacob said.

Gangloff added, "What we've learned from CCM is that it's all about engagement and learning from others."

"Listening to John and Cedric, you can certainly see the tremendous impact that Ashish and Owens Corning have had on CCM," said center director **Jack Gillespie**.

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DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING

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