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FALL 2015

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UD welcomes four materials leaders

THE ART *of* SCIENCE

Artful discoveries in student work

UNIVERSITY OF DELAWARE

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***FALL** 2015*

MATERIALS MATTER

Materials Matter is published by the Office of Communications in the College of Engineering for the alumni, friends and peers of the College of Engineering.

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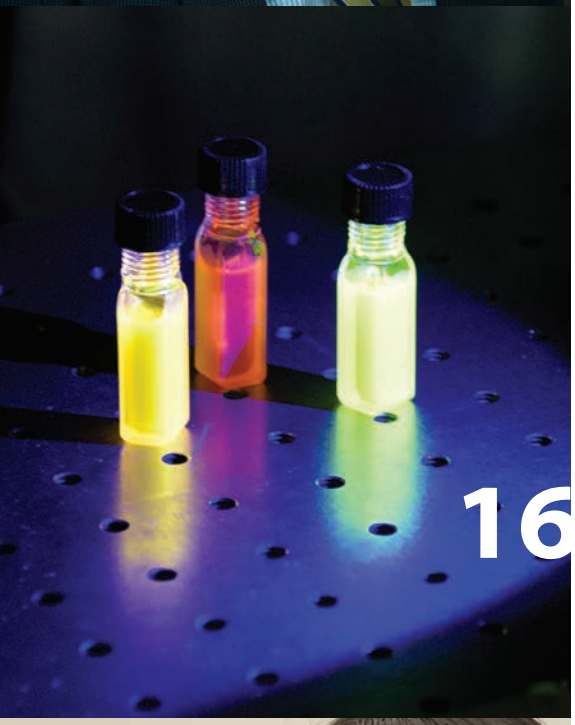

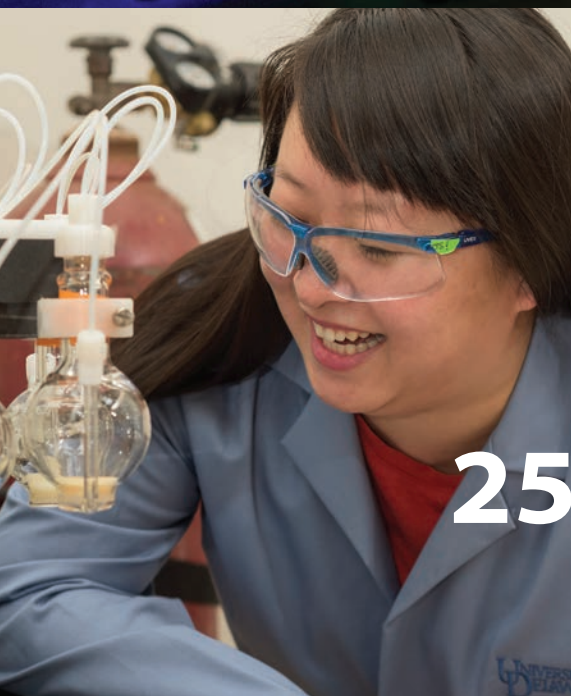

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MATERIALS MATTER

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FEATURES

DEPARTMENTS

FEATURE

Q&A *with* DEPARTMENT CHAIR

DARRIN POCHAN

Q: Let's start with the department's upcoming birthday—what's the number?

A: As a department, we'll be celebrating 20 years in 2018. That might not sound like a big milestone, particularly when compared with UD chemical engineering marking 100 years in 2014 and mechanical engineering celebrating its 125th anniversary in 2016.

But I have two comments about our relative youth.

The first is that we don't look like a 16-year-old department—we look much older in terms of our impact.

We've graduated 120 PhDs who are now teaching and conducting research around the U.S. and across the globe. They're working in industry at all levels from small startups, some of which have grown out of research programs here, to large companies like Intel, DuPont and IBM.

We boast NSF CAREER awardees, Fulbright Scholars, and NSF Graduate Fellowship winners. Our faculty and students are innovators in a broad range of materials science areas from health to energy. They've developed new materials characterization technologies that are now used in thousands of labs across the U.S., and they've helped researchers in Pakistan study solar energy as an alternative to fossil fuels.

The second is that while we've been a department only since 1998, the history of materials science at UD goes back to the 1960s, with strong research and education

programs in areas like advanced composites for the aerospace and automotive industries.

Q: What differentiates UD's materials science program?
A: Partially because of our relative youth as a department, our research perspective is extremely modern. Our faculty work in a completely collaborative and open atmosphere in core facilities and shared laboratories. They're addressing cutting-edge topics in both soft and hard materials.

Our approach is to achieve excellence in several core areas—we're not trying to do everything. Current focus areas include materials constructed from biomolecules, soft nanomaterials, materials for biomedicine, optoelectronic materials, composites, molecular beam epitaxy, materials in the environment, nanoparticles and III-V semiconductor materials.

Q: What's your leadership approach?
A: I became chair in July 2014, and I was fortunate to step into this position in an environment that matched my own philosophy. This is a very democratic department: From assistant professors to named faculty, from first-year students to postdocs, everyone has a voice in the development of the department. When I joined the department in 1999, I was the fifth faculty member. When we were just five faculty, everyone was critical. Now we're 17 and everyone is still critical.

Q: Is the department still growing?
A: We've recently added four new faculty, two women and two men, who exemplify the direction we're going while also testifying to the reputation we already have.

Chris Kloxin had already been here for several years as a research professor when he became a tenure-track assistant professor in Fall 2014. Chris came to UD with his wife, April, who has a primary appointment in the Department of Chemical and Biomolecular Engineering and a secondary appointment here. When Chris joined us, he immediately began collaborating with a number of other faculty members, and his recent transition to the tenure track was an easy and clear choice for us based on his tremendous previous success in soft matter research.

Anderson Janotti, who is originally from Brazil, joins UD after over a decade as a research professor at the University of California–Santa Barbara, which is a top-10 MSE program. Anderson is an established world expert in hard materials theory who came here specifically to have excellent experimental collaborators.

Arthi Jayaraman, formerly at the University of Colorado–Boulder, also came here primarily because of people she can work with. Arthi is a soft materials theorist who immediately began working with the many experimental collaborators here at UD.

Stephanie Law was recruited as the Clare Boothe Luce Assistant Professor, a very prestigious designation. We were very lucky both for UD to be awarded the position from the Clare Boothe Luce Foundation and to attract Stephanie. Her research focuses on the use of molecular beam epitaxy to grow new materials that can provide new functionality for applications in optoelectronic and spintronic devices.

In addition to growing our faculty, we're currently considering the addition of an undergraduate degree program. Currently, we offer only graduate degrees, but there is strong interest in a bachelor's program in materials science and engineering here at UD.

Q: Can you talk a little bit about the current state of funding for materials science research?
A: We recently received a $1-million grant from the Keck Foundation to support nanomaterials research with applications in biomedicine (Doty, PI, see page 16). This grant is indicative of the type of research that leads to innovation and is possible only through intimate, interdisciplinary collaboration. And I think it's critical for the federal government to fund the innovative work that will stem from this type of high-risk foundation-supported research.

In an effort to reverse this trend, UD is one of more than 250 organizations that recently signed "Innovation: An American Imperative," a document aimed at encouraging federal decision makers and legislators to continue to invest in the basic research and development that are behind new products, from medical devices and drugs to defense and space technologies to innovative business practices. We hope to demonstrate that this type of investment is essential to America's ability to continue as a technology leader in the 21st century.

Q: You sound excited about where the department is headed….
A: I am, and I think you'll see why when you read the articles in this magazine and learn more about our new faculty, the Keck award, leadership roles of our established faculty, our global impact, and our latest research on topics ranging from novel battery membranes to smart hydrogels that can deliver medicine on demand. It is exciting to work everyday with excellent colleagues and students to reach the upper echelons of materials impact in the near future. ■

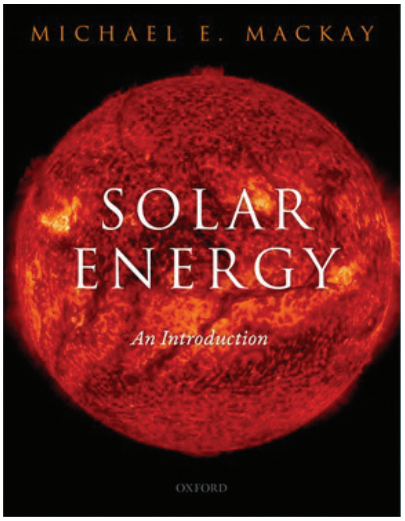
> *We don't look like a 16-year-old department—* ***we look much older in terms of our impact.***

NEW FACULTY

ARTHI JAYARAMAN

Arthi Jayaraman joined UD as Associate Professor in August 2014 after spending six years as Assistant Professor at the University of Colorado, Boulder. She earned her Ph.D. in chemical engineering at North Carolina State University in 2006. Her research group studies polymer-based materials using molecular simulations. "We use theory and simulations to get a molecular-level understanding of complex phenomena observed in experiments and use this insight to predict and design new materials for target applications," she says. Specific projects range from designing polymer functionalized nanoparticles and polymer nanocomposites for optics, photonics, and organic photovoltaics to designing polymers for DNA and drug delivery. Jayaraman was attracted to UD for its known excellence in materials science and chemical engineering, but she has found the University's location to be a big plus. "Proximity to big cities like Philadelphia and Baltimore allows me to really enjoy arts, theater and excellent restaurants," she says.

We use theory and simulations to get a molecular-level understanding of phenomena observed in experiments and use this insight to predict/design new materials for target applications.



SOLAR ENERGY

Mackay publishes solar energy textbook

An introductory textbook on solar energy by Michael Mackay, Distinguished Professor in the Departments of Materials Science and Engineering and Chemical and Biomolecular Engineering, was published this summer by Oxford University Press.

The book, *Solar Energy: An Introduction*, is aimed at the advanced undergraduate and beginning graduate levels. It provides an overview of solar photovoltaic and solar thermal technologies and includes detailed discussion of solar technologies such the solar chimney, solar (power) tower, and solar-thermal electricity generation. The text also includes extensive tutorial material, images, examples and end-of-chapter exercises.

The publisher's website describes the text as providing "a balanced and compelling case for why use of solar energy should be pursued." ■

NOBELS CROSS DISCIPLINES

Faculty share expertise on Nobel prizes

Two MSEG faculty members — Joshua Zide, associate professor, and Ismat Shah, professor of both materials science and engineering and of physics and astronomy — lent their expertise to a UD faculty panel convened to explore last year's Nobel Prize-winning work in depth.

Zide detailed work behind the prize in physics, awarded to Isamu Akasaki, Hiroshi Amano and Shuji Nakamure "for the invention of efficient blue light-emitting diodes (LEDs), which has enabled bright and energy-saving white light sources."

"The physics prize is really unusual this year because there's no new physics" in the laureates' work, which instead was based on materials science, said Zide. He traced the research over the years that led to the original red LEDs in 1962 and the new discoveries that enabled the development of blue lights. Blue, he said, was the most challenging to develop but is particularly important because it is necessary in order to make white light.

White LEDs are extremely efficient sources of light, with an incandescent bulb rated at about 4 percent efficiency, a household compact fluorescent bulb at about 10 percent and white LEDs at well over 50 percent, and perhaps as high as 75 percent, Zide explained. Having such efficient light in, for example, a solar-powered desk lamp, "is a real game-changer for the developing world," where many people have no reliable source of lighting, he said.

Shah, who was born in Pakistan to parents born and raised in India, enlightened the audience on the Nobel Peace Prize, awarded jointly in 2014 to Malala Yousafzai and Kailash Satyarthi "for their struggle against the suppression of children and young people and for the right of all children to education."

He pointed out that the two co-winners were an Indian and a Pakistani — two nations often in conflict — and a Hindu and a Muslim. Their connection, he said, is their focus on children and their "common struggle for education and against extremism."

Satyarthi has protested and worked to free children from forced labor and other forms of exploitation throughout South Asia. Yousafzai, the youngest Peace Prize recipient in history at age 17, and a leading spokesperson for girls' rights to education, gained international recognition in 2012 after being shot in an attack by the Taliban.

Now in its eighth year, UD's Nobel symposium explores the groundbreaking work often not fully explained in news coverage of the prizes. Along with Zide's and Shah's commentaries on the physics and peace prizes, fellow panel members explained the Nobel prizes in the areas of literature, physiology or medicine, economics, and chemistry. ■

"The physics prize is really unusual this year because there's no new physics"

Joshua Zide (back, left) and Ismat Shah (back, right) were part of a UD faculty panel convened to explore last year's Nobel Prize-winning work in depth.

NEW FACULTY

CHRIS KLOXIN

Chris Kloxin is a new tenure-track faculty member in materials science but not a new face at UD. He earned his Ph.D. at North Carolina State University in 2006 and later joined the University as a researcher in 2011. Kloxin's research focuses on engineering materials at the molecular level. "Designing materials from the basic molecular-level building block, or monomer, not only gives us better control over their properties for application tailorability but also improves our understanding of how small structural changes at this level affect large-scale properties so that we get better at it over time," he says. Kloxin recently won a Strategic Initiative Grant from the University of Delaware Research Foundation to build click nucleic acid polymers (CNA) for use in the assembly of hydrogels that can deliver medicine to specific, targeted cells. Kloxin was part of the team that invented CNA while he was doing postdoctoral work at the University of Colorado, Boulder.

Designing materials from the basic molecular-level building block, or monomer, not only gives us better control over their properties for application tailorability but also improves our understanding of how small structural changes at this level affect large-scale properties so that we get better at it over time.

PATHWAYS *to* INNOVATION

Engineering/Business partnership promotes culture of innovation, entrepreneurship

John Rabolt, Karl W. and Renate Boer Professor of Materials Science and Engineering, is co-leading a Pathways to Innovation team working to bring innovation and entrepreneurial education to students across disciplines as part of the National Center for Engineering's Pathways to Innovation Program. The team includes faculty from both the College of Engineering and the Alfred Lerner College of Business and Economics.

Run by Stanford University and the nonprofit organization VentureWell, and funded by the National Science Foundation, the Pathways to Innovation program focuses specifically on undergraduate engineering curricula. Experiential learning in entrepreneurship and innovation is being integrated into the engineering college's First Year Experience course.

"The overarching objective is simply to re-engineer our undergraduate programs to prepare students for the careers of tomorrow — which, by definition, may not yet exist currently," said Babatunde Ogunnaike, dean of the College of Engineering.

In February, the team traveled to Phoenix to plan UD's first Pathways projects, working with teams from 25 diverse universities. Future projects will include creating entirely new courses and opportunities to learn from successful entrepreneurs.

Rabolt explained that students don't have to start their own businesses to benefit from entrepreneurial thinking. The team calls innovating within a large company "intrapreneurship," he said, and this concept is essential for the many UD graduates who build careers with established businesses.

"Big companies want people who have ideas and will push a startup enterprise within the company," he said. "They need the right kind of people who can think entrepreneurially within a company and put together the resources and ideas to make it work."

Rabolt came to UD in 1996 after 20 years at IBM, and has been working to export the excitement and entrepreneurial spirit of Silicon Valley to UD through his "Entrepreneurship and Risk" course, co-created by accounting chairperson Scott Jones.

This course has led to the creation of multiple successful companies, including multi-touch trackpad manufacturers Fingerworks. Apple Inc. acquired Fingerworks in 2005 and its technology served as the basis for the finger gesture protocols used in the iPhone released later that year.

Students recruited for VentureWell's Innovation Fellows program joined a national network of students from other campuses working to create a culture of innovation and entrepreneurship.

"If students understand when to take risks — and how to manage such risks — then we have provided them with a new set of tools to take with them as they pursue their career goals," said Ogunnaike. ■

"We want to change our culture to one of innovation and entrepreneurship, and build a community of creative problem-formulators and problem-solvers devoted to issues in sustainability, energy, health care and the environment."

- Babatunde Ogunnaike, Dean

NEW FACULTY

STEPHANIE LAW

Stephanie Law, who earned her Ph.D. in physics in 2012 from the University of Illinois at Urbana-Champaign, joined UD in September 2014 as the Clare Boothe Luce Assistant Professor. Law uses molecular beam epitaxy to build new optical materials layer by layer. The technique confers complete control over the structure and optical properties of the material and allows tailoring of the materials to their potential applications, which include thermal imaging, gas sensing, thermophotovoltaics, communications, and pharmaceuticals. Law has already initiated collaborations with a number of other researchers, including Josh Zide and Matt Doty in materials science and John Xiao in physics. "This is a great department," Law says. "I've gotten tremendous support in getting my lab set up, and I really appreciate that people are interested in my opinion and my work even though I'm a young faculty member."

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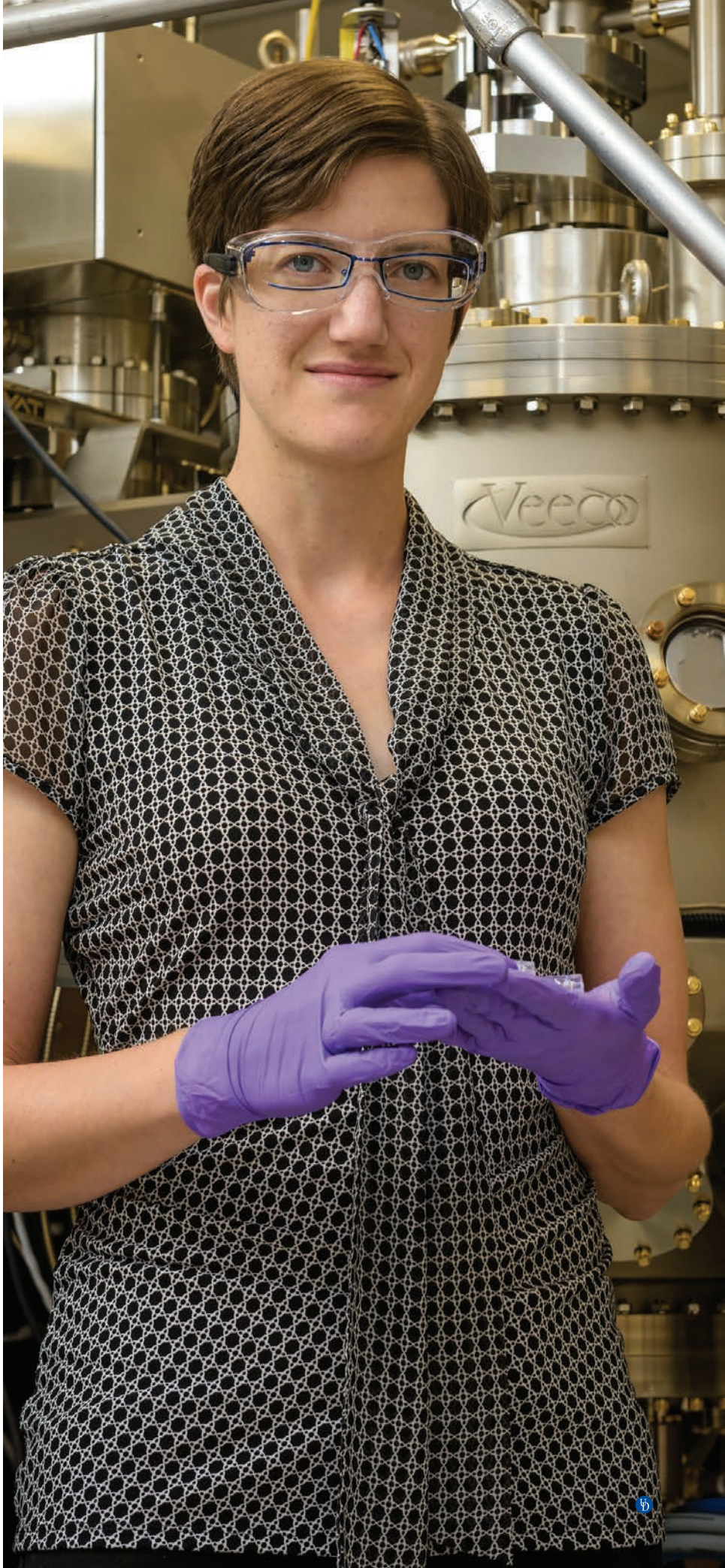


LIGHT BEHAVIOR, HARD MATERIALS

Clare Boothe Luce Program supports young UD engineering professor

Stephanie Law, who studies the use of new materials to control and manipulate light in the mid- and and far-infrared ranges, joined the University of Delaware last fall as the Clare Boothe Luce Assistant Professor of Materials Science and Engineering.

The Clare Boothe Luce Program, which began giving grants in 1989, is now the single most significant source of private support for women in science, mathematics and engineering.

Law's work has applications in a wide range of areas, including thermal imaging, gas sensing, thermophotovoltaics, communications and pharmaceuticals.

"We use a technique called molecular beam epitaxy to grow these materials layer by layer, which enables complete control over the structure of the material as well as its optical properties, allowing us to tailor the material to the application," she said.

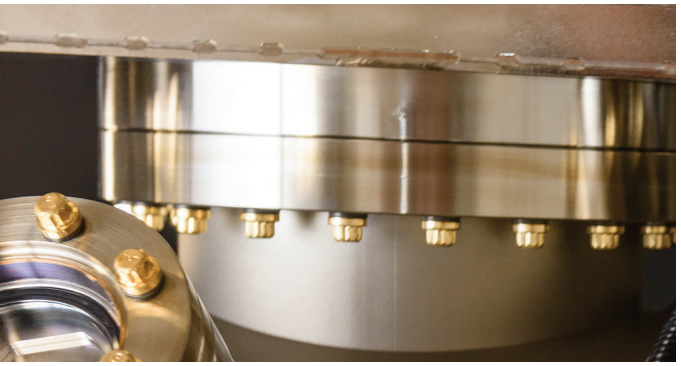
"We plan to investigate how light behaves in these systems and then use them to create novel devices, such as coatings to enhance the efficiency of emitters or detectors in these wavelength ranges or hyperlenses for subwavelength imaging, which is useful for biological applications."

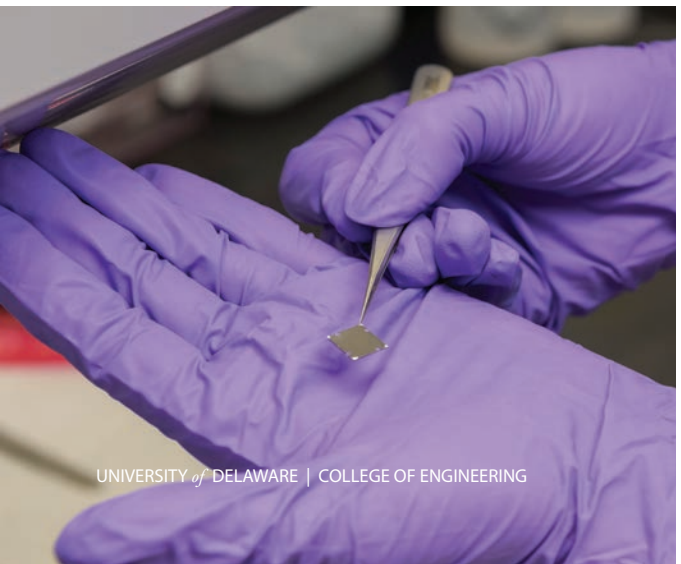
Nationwide, and at UD, there is an extreme dearth of women faculty in the general area of 'hard materials,' an area represented in a number of disciplines, including materials science, mechanical engineering, and electrical engineering, said Pam Cook, Unidel Professor of Mathematical Sciences and associate dean of engineering.

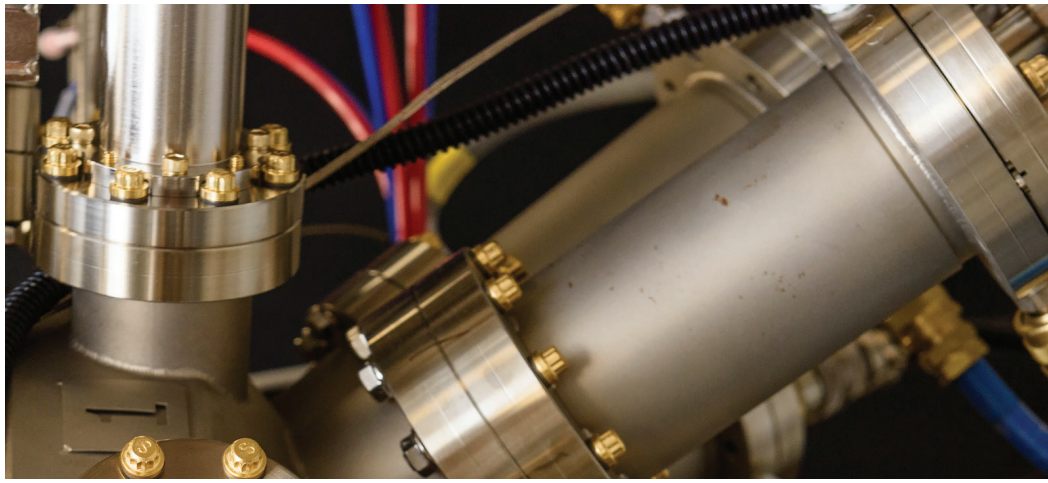
"The Clare Boothe Luce Assistant Professor will be strongly mentored and supported both from within the department and from the larger college community to further enable the career success of this most promising researcher," Cook said.

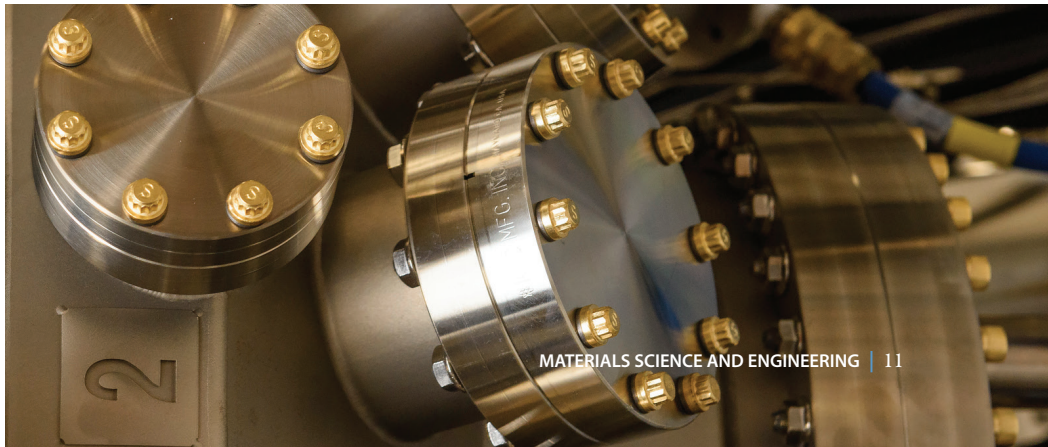
Babatunde Ogunnaike, dean of the College of Engineering, says the Clare Boothe Luce Program is part of an ongoing effort within the college to drive a cultural shift for women in traditionally male-dominated science, technology, engineering and mathematics fields. ■

"We plan to investigate how light behaves in these systems and then use them to create novel devices."







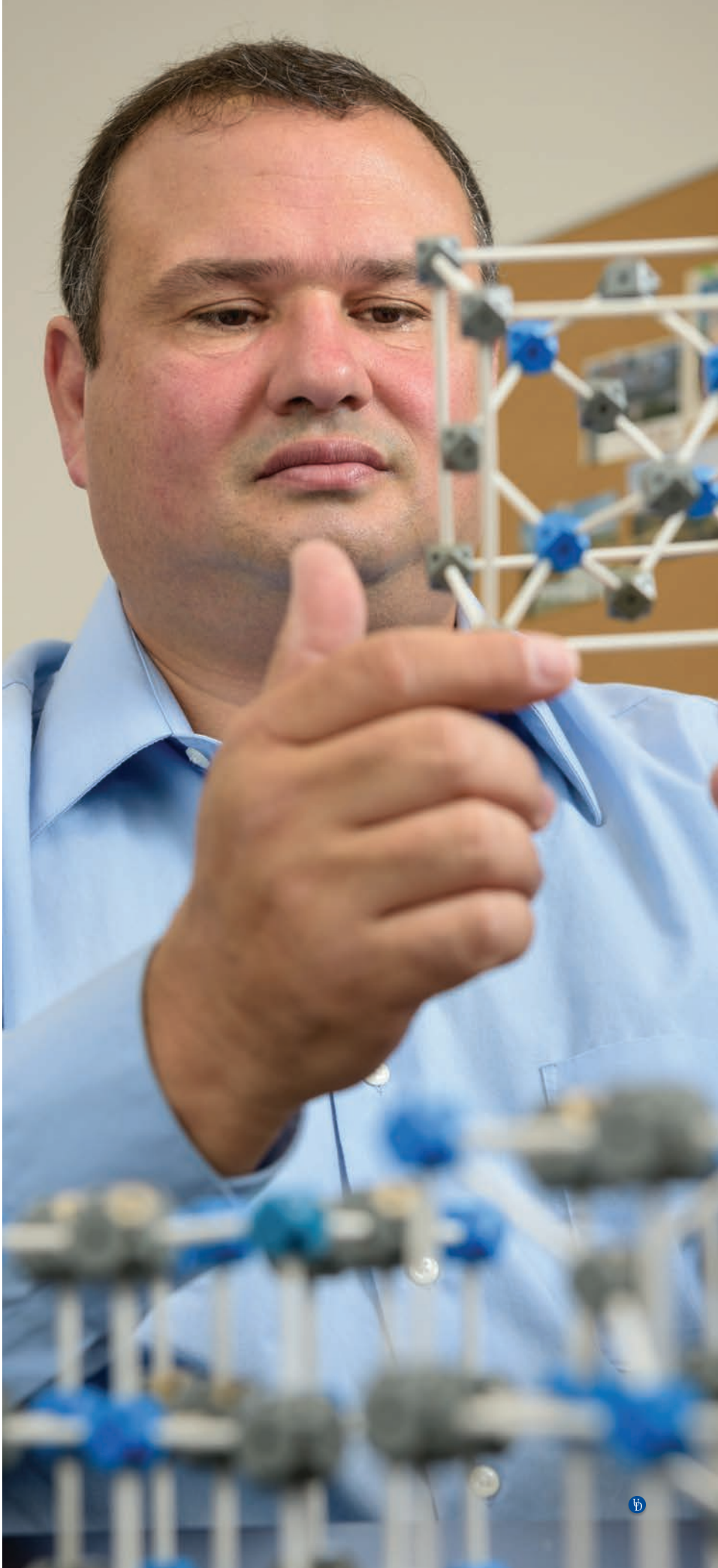


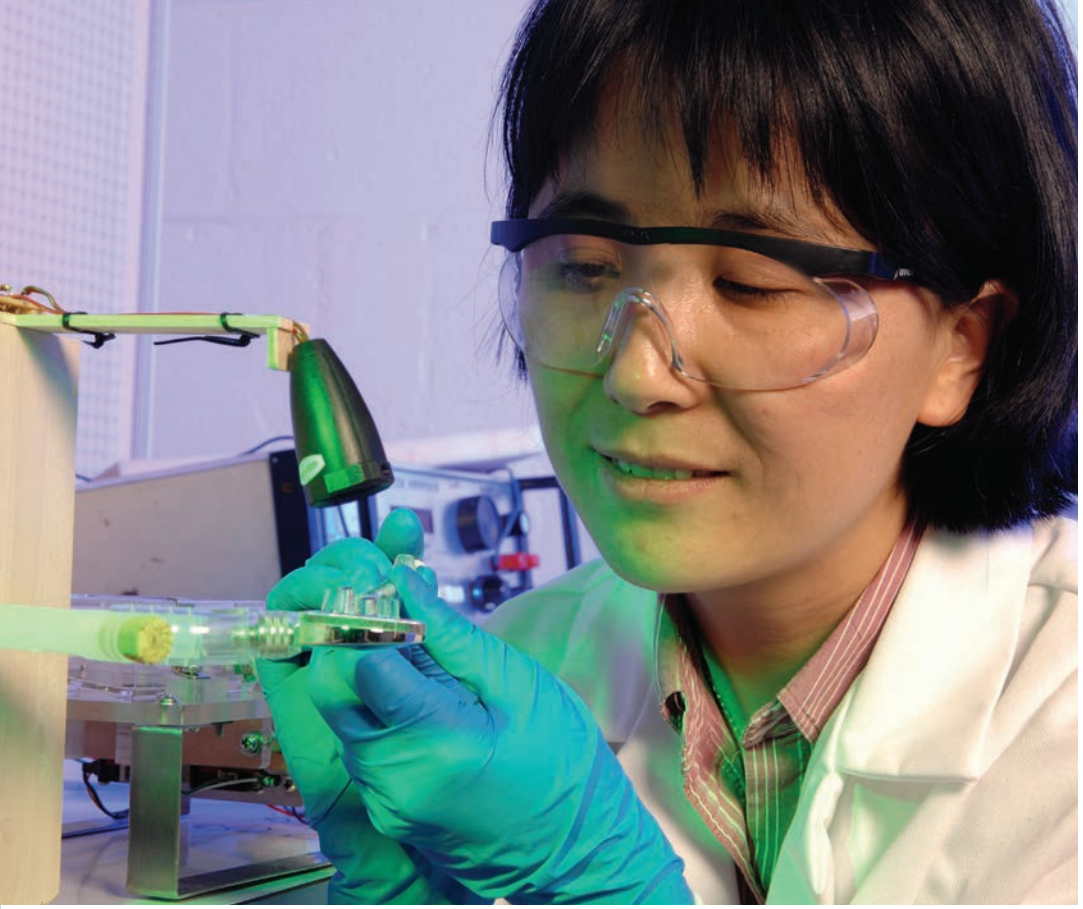
NEW FACULTY

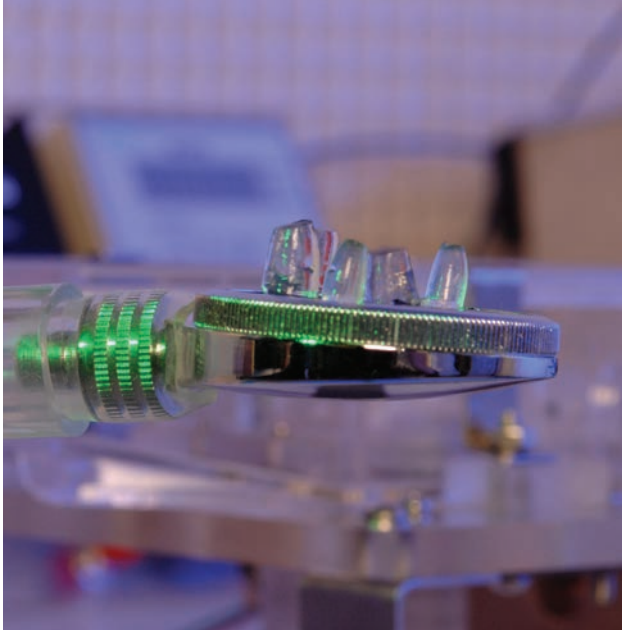
ANDERSON JANOTTI

Anderson Janotti spent 11 years as a project scientist at the University of California, Santa Barbara before joining UD in August 2015. A native of Brazil, Janotti earned his doctoral degree in physics at the University of São Paulo in 1999. He came to the United States in 2000 and since then has worked at the National Renewable Energy Laboratory in Colorado and Oak Ridge National Laboratory in Tennessee. Janotti's research focuses on simulation and design of new materials using computation and quantum mechanics. "Coming to Delaware is providing me with a great opportunity to advance my career," he says. The older of Janotti's two daughters, Catarina, is also a new Blue Hen, joining UD as a sophomore majoring in psychology.

Coming to Delaware is providing me with a great opportunity to advance my career.







Xinqiao Jia and her research group in DuPont Hall work with gels in relationship to auditory research.

FACULTY NEWS

GET SMART

UD-developed smart gels deliver medicine on demand

Researchers at the University of Delaware have developed a "smart" hydrogel that can deliver medicine on demand, in response to mechanical force.

"The idea of a smart hydrogel that can release medicine over time is not new," said Xinqiao Jia, UD professor of materials science and engineering and biomedical engineering. "What's new is our ability to have medicine released in response to force — a major challenge for people with osteoarthritis and other 'wear and tear' injuries that compromise a person's ability to perform everyday activities."

The researchers believe the hyaluronic acid-based hydrogels developed at UD can be injected into an injury site — such as a knee or hip joint — and that as a patient walks or participates in therapeutic exercise, the walking motion will cause accelerated release of the drug, reducing inflammation and pain.

Laboratory testing confirmed that as the hydrogel is compressed, the encapsulated drugs are discharged into the surrounding environment. Preliminary cell testing confirmed the anti-inflammatory activity of the released drug molecules.

The team has also collaborated with colleagues at Rush University in Chicago to test the hydrogels in animal models. Early results indicate that the gel is biocompatible, which Jia said is because hyaluronic acid is a naturally occurring substance in cartilage, making it more readily accepted in the body.

She also said the hydrogel could help with ligament tears or other injury areas under high tension, and possibly even with vocal fold disorders. The research team is also investigating whether future iterations of the hydrogel can be imbued with properties that would stimulate tissue regeneration and repair.

UD collaborators on the project include Darrin Pochan, professor of materials science and engineering; Chandran Sabanayagam, an associate scientist at the Delaware Biotechnology Institute; and Longxi Xiao and Zhixiang Tong, Jia's former students, and Yingchao Chen, a former student of Darrin Pochan.

The researchers published their findings in *Biomacromolecules*, a publication of the American Chemical Society (ACS). ■

"What's new is our ability to have medicine released in response to force — a major challenge for people with osteoarthritis and other 'wear and tear' injuries that compromise a person's ability to perform everyday activities."

BETTER BATTERY MEMBRANES

UD researchers develop safer electrolytes

A research team led by Thomas H. Epps, III, the Thomas and Kipp Gutshall Associate Professor of Chemical Engineering, is designing novel solid electrolytes using tapered block polymers to replace the liquid electrolytes and reduce the risk of spontaneous fires due to failures in lithium-ion batteries.

In recent years, block polymers have received considerable attention as viable rechargeable conducting and transport membrane materials, due to their unique combination of thermal, mechanical and electrochemical stability.

Epps, who has a joint appointment in MSE, and his team have taken the concept of block polymers a step further by tapering the interface — or the transition region between blocks — so that the properties of the different polymer blocks are interspersed.

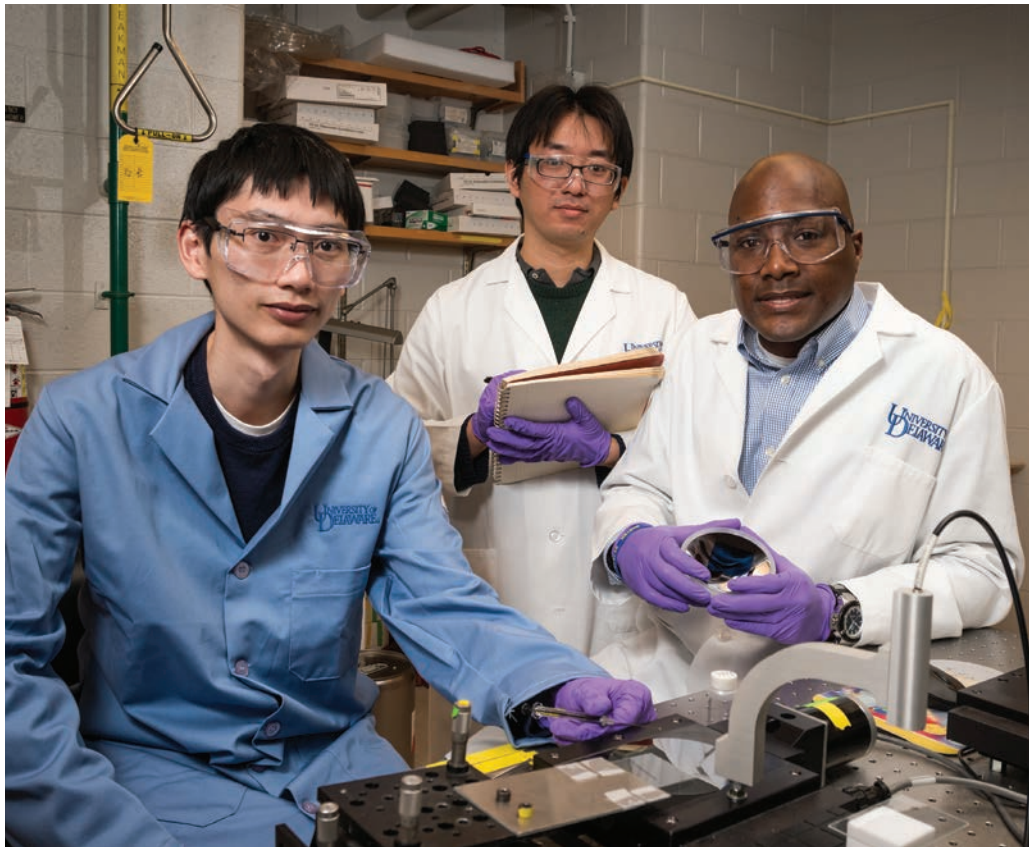
A primary challenge in using block polymers lies in controlling and analyzing the location and spatial distribution of the various nanoscale and atomic-scale components in these self-assembling materials. Any methods used to evaluate the materials must be able to "see" the structure at the nanoscale without causing damage that confuses or otherwise confounds analysis.

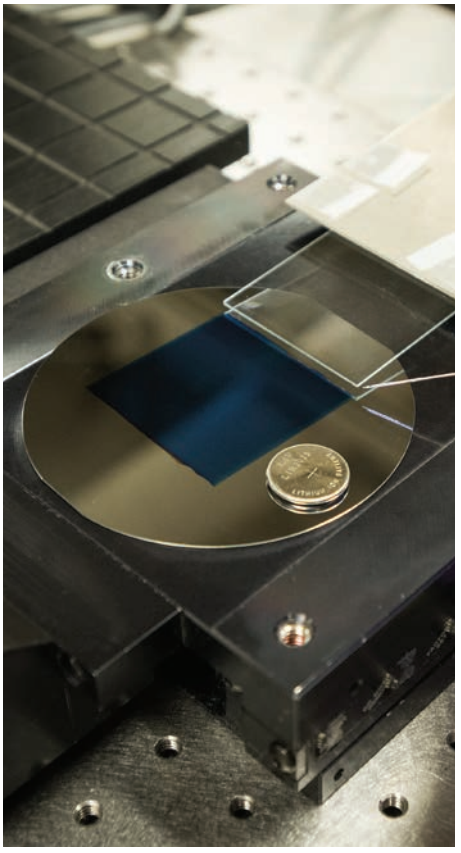
In collaboration with researchers at MIT, Epps helped apply a new technique — C_{60}^{+} depth-profiling x-ray photoelectron spectroscopy

(XPS) — to nanostructured polymers. "Although we've successfully applied the technique to evaluate materials for battery applications, we believe that its unique capabilities make it a powerful tool for the analysis of nanostructured polymer thin films in applications ranging from energy storage and generation to surface coatings and nanoscale templates, Epps says."

The team's work was documented this year in *RSC Advances* and in *ACS Nano*. ■

"Now that we have a way to more fully characterize what's happening at the nanoscale in tapered block polymers, we can design them with the precise properties needed for specific applications."

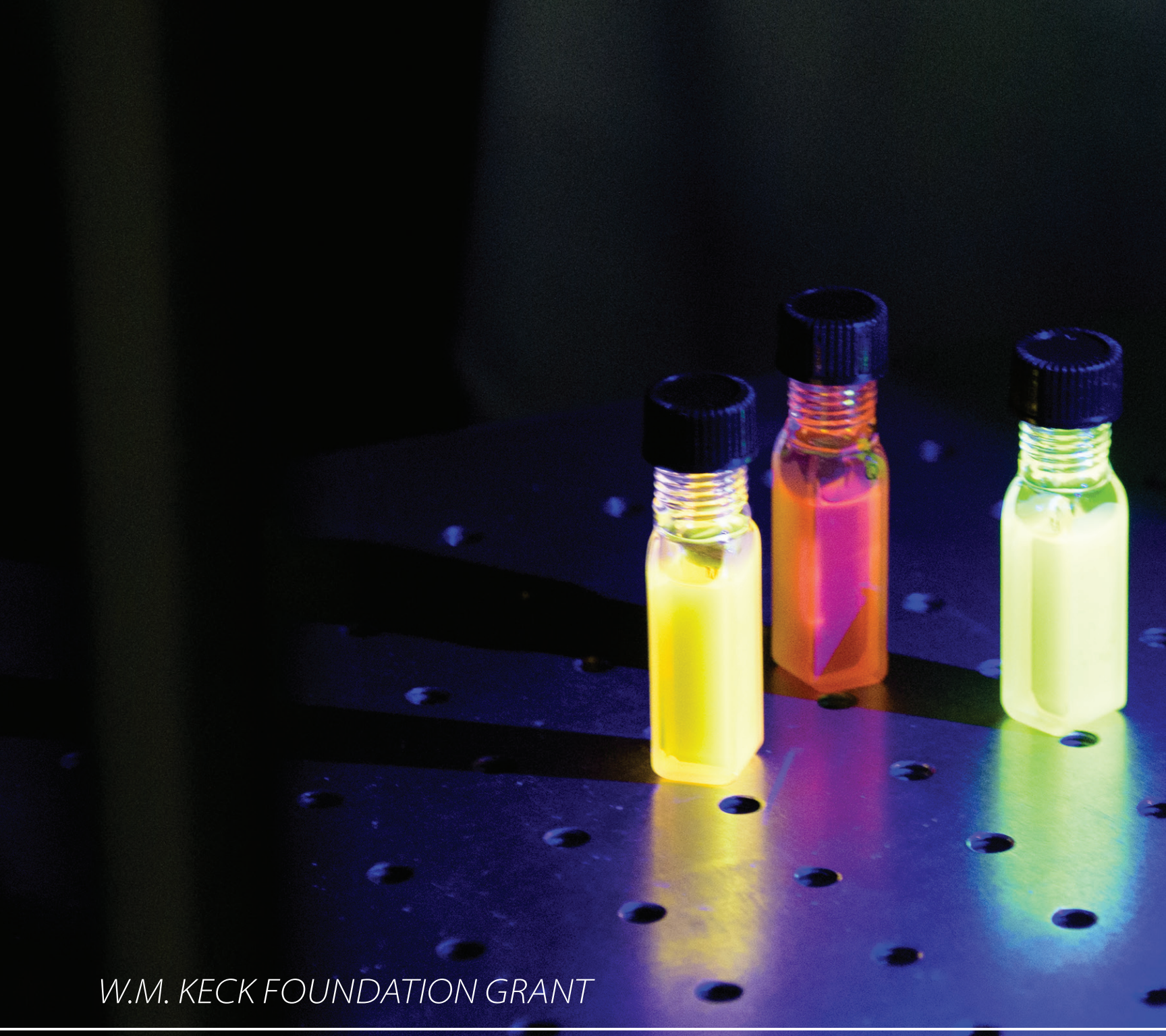




FACULTY SENATE

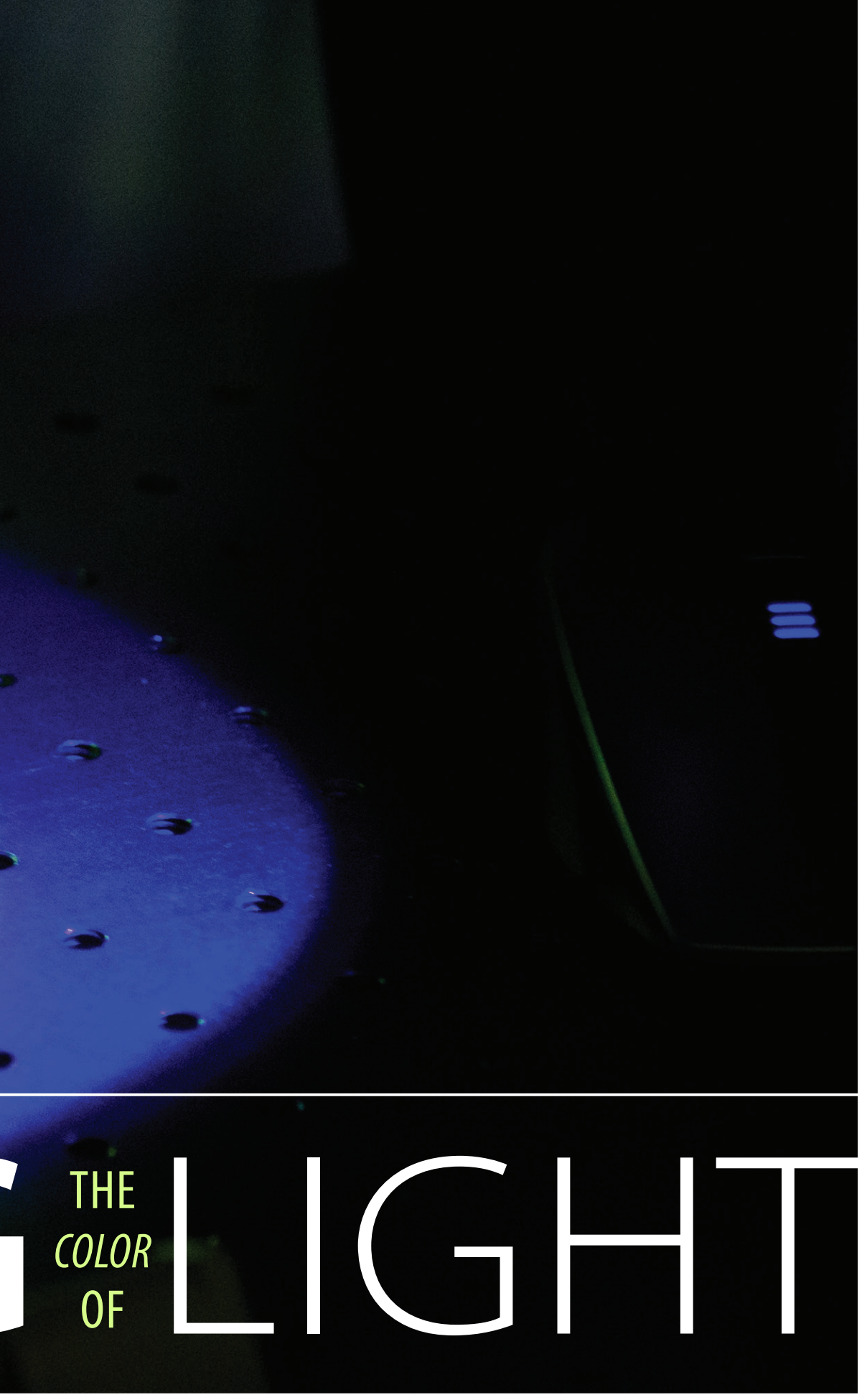
ROBERT OPILA

Robert Opila will serve as president of the University of Delaware Faculty Senate for the 2015-16 academic year. Opila is a professor of materials science and engineering at UD, with joint appointments in the chemistry and biochemistry and electrical and computer engineering departments. His research emphasizes the conduction of electrons and light through devices composed of a variety of materials. Opila earned his doctorate from the University of Chicago in 1982 and then worked at Bell Laboratories for 19 years before joining UD in 2002. In 2012-13, Opila won a Fulbright Scholarship to teach and conduct research at Bilkent University in Ankara, Turkey, where he taught a course in solid state materials and renewable energy and conducted research with his colleague chemistry professor Sefik Suzer. The work built upon a jointly developed method by Opila and Suzer to measure the electrical and material properties of simple electronic devices systematically and nondestructively using photoelectron spectroscopy.



W.M. KECK FOUNDATION GRANT

CHANGING



THE *COLOR* OF LIGHT

FACULTY RESEARCH

UD team awarded $1 million Keck Foundation grant for novel research on light

A $1 million grant from the W.M. Keck Foundation of Los Angeles will help UD materials science researchers explore a new idea that could increase the efficiency of commercial solar cells by 25 to 30 percent. While the initial focus of the three-year project will be on improving solar energy harvesting, the team also will use the grant to explore biomedical applications, such as medical imaging and the more efficient delivery of chemotherapy.

Matthew Doty, associate professor of materials science and engineering and associate director of UD's Nanofabrication Facility, leads the team in designing a new kind of semiconductor nanostructure that will act like a ratchet, turning low-energy colors of light, such as red, into higher-energy colors, like blue or green.

It will absorb two red photons, one after the other, to push an electron into an excited state when it can emit a single high-energy (blue) photon.

The amount of light absorbed and energy emitted by the structures could be customized for a variety of applications, from light bulbs to laser-guided surgery.

The UD team has shown theoretically that their semiconductors could reach an "upconversion" efficiency of 86 percent, which would be a vast improvement over the 36 percent efficiency demonstrated by today's best materials.

"A ray of light contains millions and millions of individual units of light called photons," said Doty. "The energy of each photon is directly related to the color of the light — a photon of red light has less energy than a photon of blue light. You can't simply turn a red photon into a blue one, but you can combine the energy from two or more red photons to make one blue photon."

These nanostructures will be so teeny they can only be viewed when magnified a million times under a high-powered electron microscope.

Doty's co-investigators include Joshua Zide, Diane Sellers and Chris Kloxin, all in the Department of Materials Science and Engineering; and Emily Day and John Slater, both in the Department of Biomedical Engineering.

While photon upconversion isn't new, the team's approach to it is.

They are developing new semiconductor structures containing multiple layers of different materials, such as aluminum arsenide and gallium bismuth arsenide, each only a few nanometers thick. This "tailored landscape" will control the flow of electrons into states with varying potential energy, turning once-wasted photons into useful energy.

One of their techniques is molecular beam epitaxy, in which nanostructures are built by depositing layers of atoms one at a time. Each structure is tested to see how well it absorbs and emits light, and the results will be used to tailor the structure to improve performance.

The researchers also will develop a milk-like solution filled with millions of identical individual nanoparticles, each one containing multiple layers of different materials. The multiple layers of this structure will implement the photon ratchet idea.

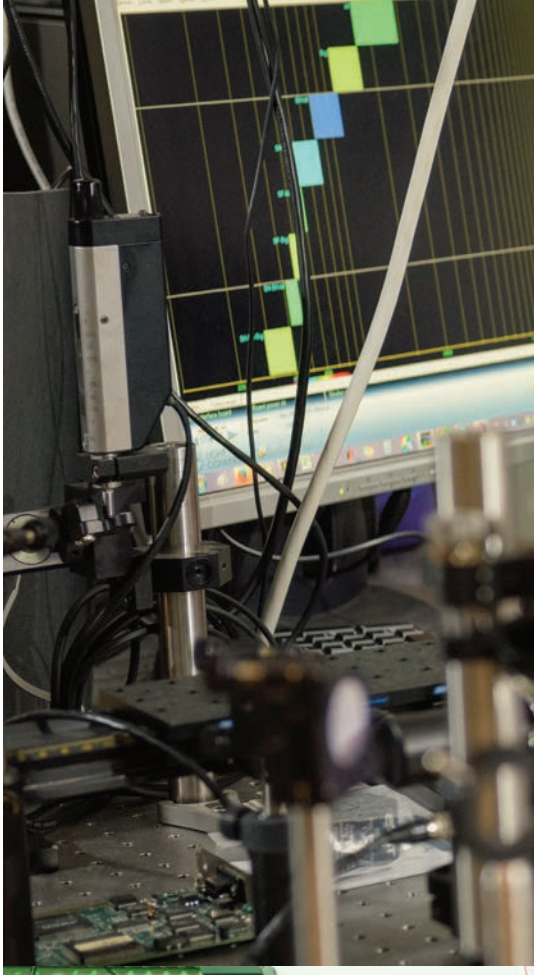
They envision a future upconversion "paint" that could be easily applied to solar cells, windows and other commercial products.

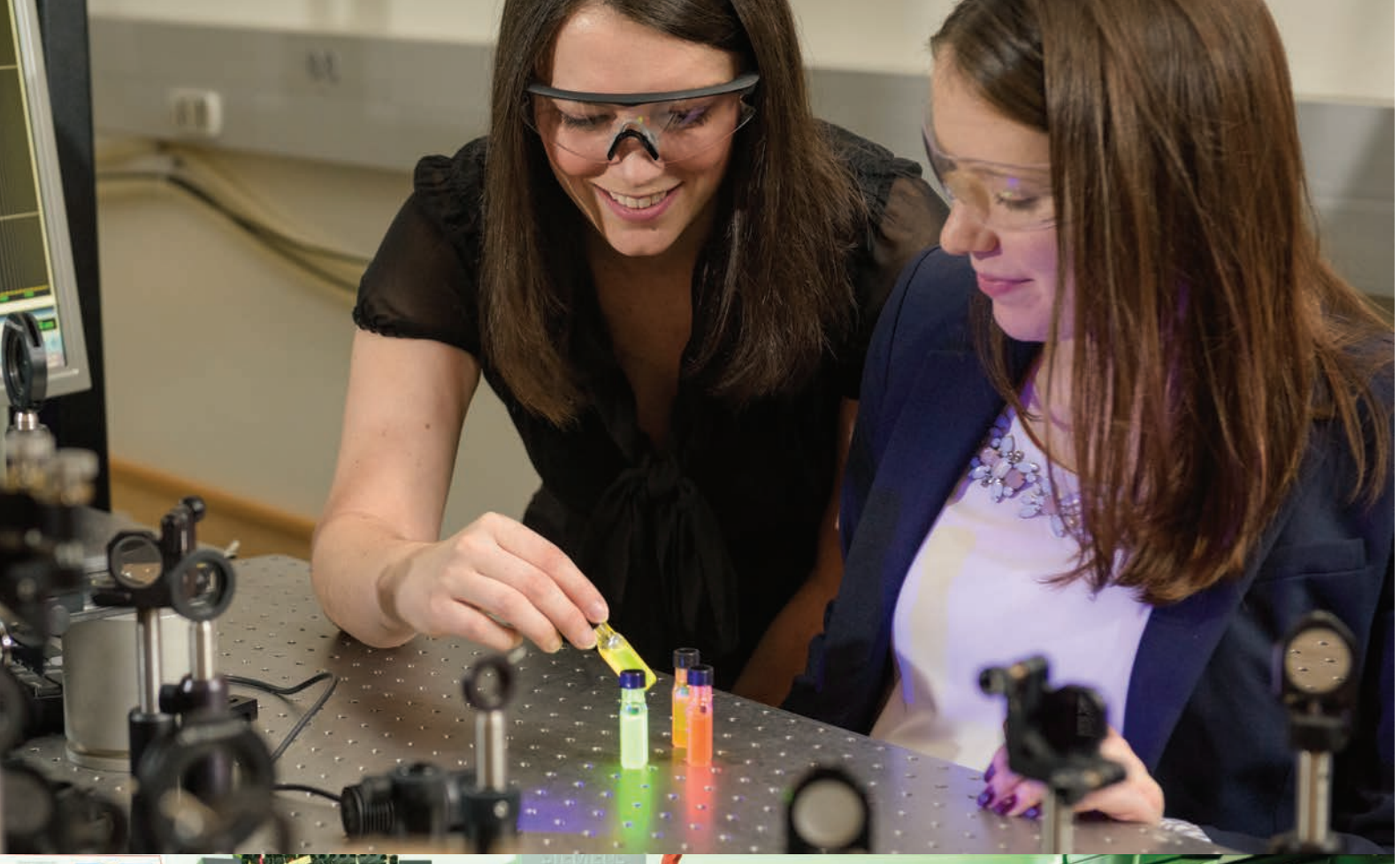
The same upconversion technology used to harvest more energy could also help the researchers improve a number of diagnostic tests and medical treatments, ranging from CT and PET scans to chemotherapy, which rely on the release of fluorescent dyes and pharmaceutical drugs.

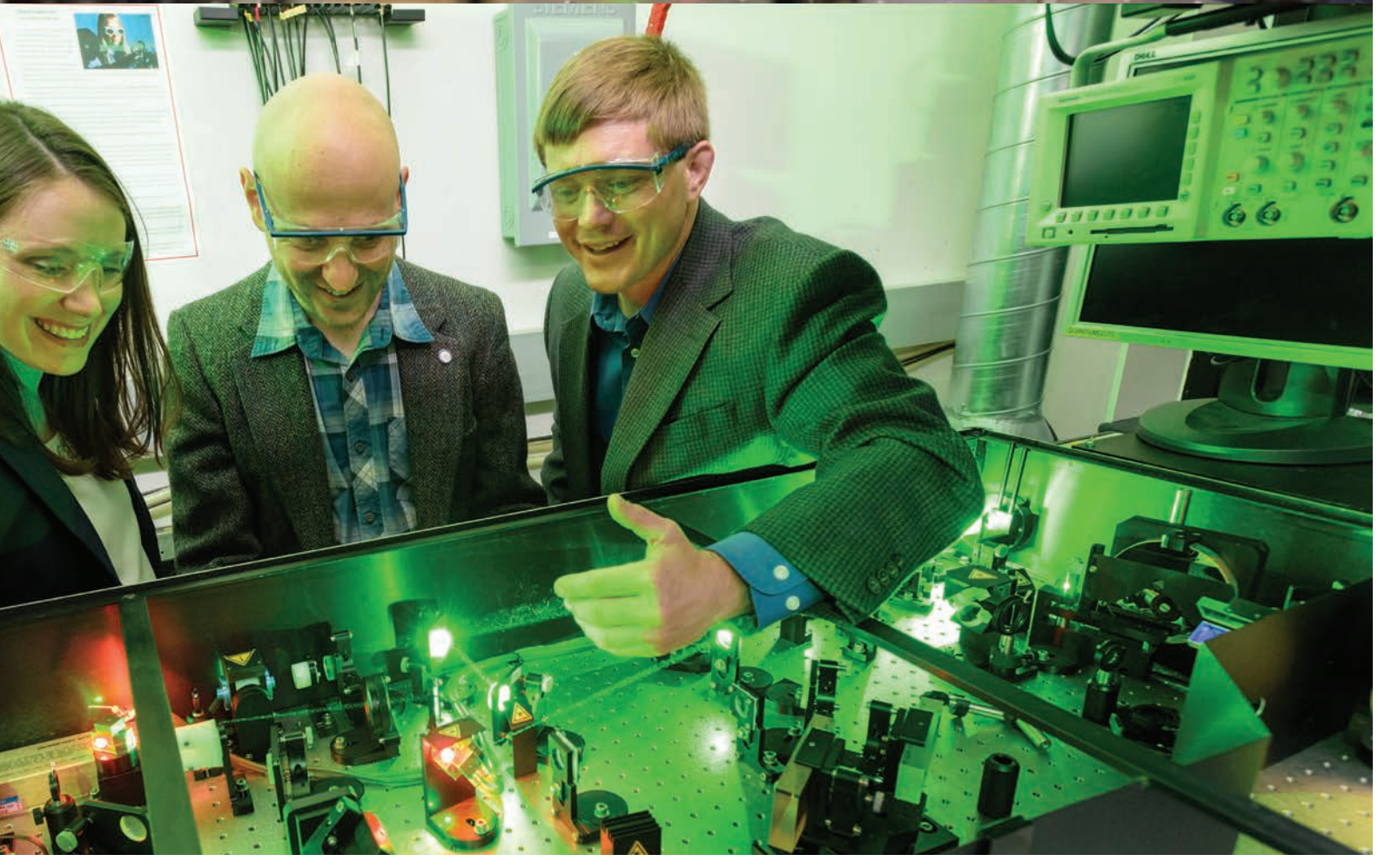
The team hopes to develop an upconversion nanoparticle that can be triggered by light to achieve the controlled release of drug therapies deep within diseased human tissue. By minimizing the laser power required, the team believes peripheral damage to normal tissue could be reduced.

"This is high-risk, high-reward research," Doty said. "High-risk because we don't yet have proof-of-concept data. High-reward because it has such a huge potential impact in renewable energy to medicine. It's amazing to think that this same technology could be used to harvest more solar energy and to treat cancer." ■

This prestigious $1 million grant from the Keck Foundation underscores the excellence and innovation of our University of Delaware faculty.







FIBER FUNDS

CCM to participate in NIST-funded manufacturing technology consortium

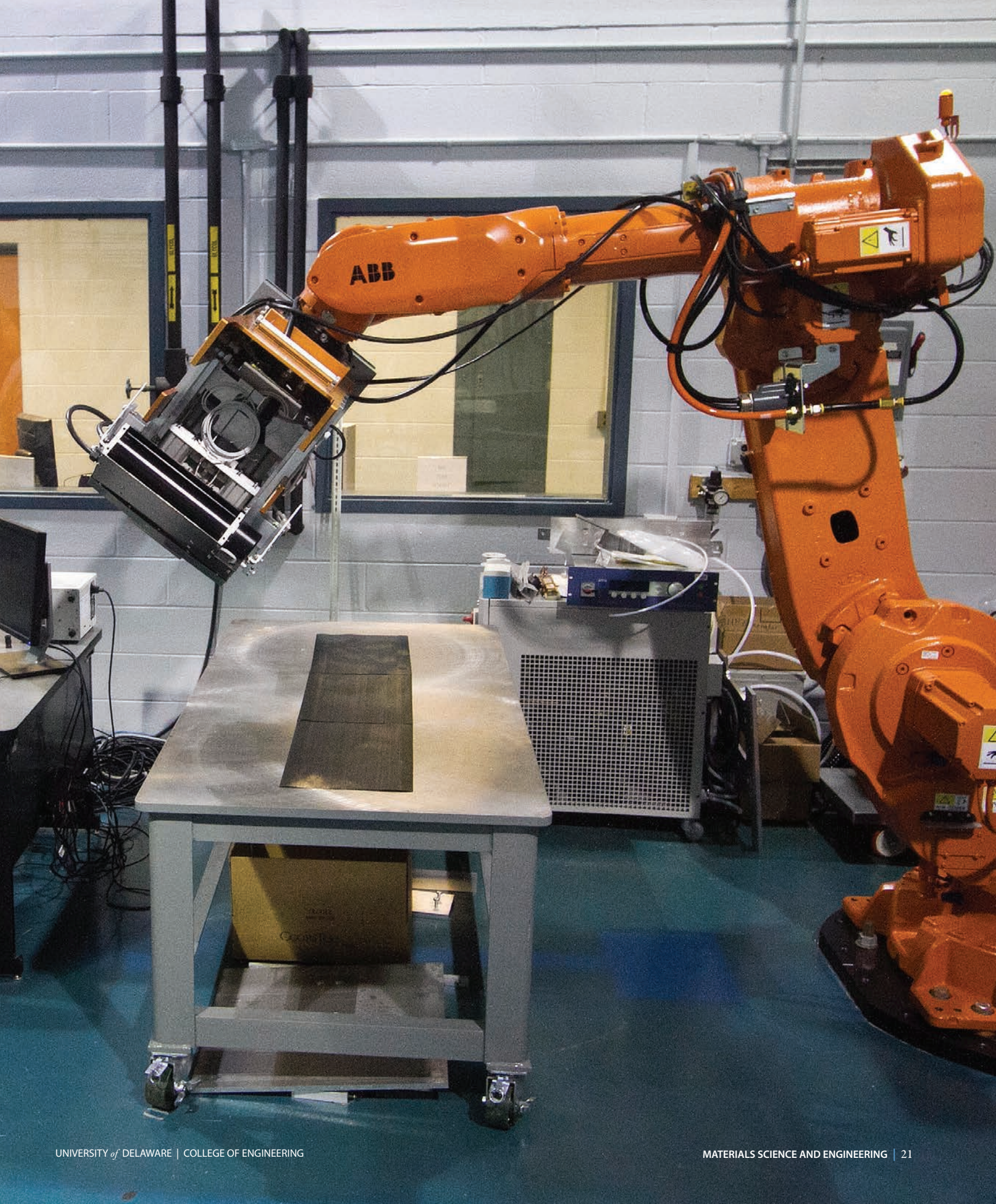
The University of Delaware's Center for Composite Materials is among the five universities and more than 50 companies and organizations that have joined forces to launch the Facilitating Industry by Engineering, Roadmapping and Science (FIBERS) Consortium, led by researchers at the University of Massachusetts Lowell.

Engineers, industry and national laboratories are collaborating to study long-term industrial research challenges in an effort to advance U.S. manufacturing of composite materials. The work is funded through a $496,439 grant from the National Institute of Standards and Technology's (NIST) Advanced Manufacturing Technology Consortia (AMTech) program.

The industry-led polymer composites consortium will develop a technology roadmap to identify shared technical obstacles and define pathways toward manufacturing advances that will enable scale-up of cost-effective, high-volume production processes

According to Jack Gillespie, CCM director and co-principal investigator on the project, advantages of using composites materials include weight and energy savings, lower maintenance costs and greater design flexibility. These advantages, however, often are overshadowed by high materials costs, due largely to manufacturing limitations, and manufacturing cycle time and yield. Processes are difficult to scale up and usually are implemented through trial-and-error methods, making new approaches critical to long-term success. ■

Now a $20 billion global industry, composites manufacturing is expected to grow at rates that outpace the global domestic product over the next decade.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FACULTY AWARDS

OUTSTANDING YOUNG RESEARCHER

Zide wins AVS Peter Mark Memorial Award

Joshua Zide, associate professor of materials science and engineering won the 2014 Peter Mark Memorial Award from AVS, an interdisciplinary society for materials, interface and processing technology. The award recognizes an outstanding young researcher (35 or younger) who has contributed work to AVS publications.

Zide is a pioneer in using bismuth in semiconductor technology, described as "a big step outside the norm that's now starting to catch on." Incorporating bismuth produces unusual electronic properties that can allow for better conductivity and potentially be useful for working with infrared radiation, making possible new types of electronics and applications in spectroscopy.

"People would just use things like silicon and gallium arsenide" as semiconductors, said Robert Opila, professor of materials science and engineering, who nominated Zide for the Peter Mark Award. "But now the whole periodic table's open, and he's opening up that periodic table."

An active member of the electronic materials community, Zide has served on the program committees for the North American Conference on Molecular Beam Epitaxy and the Electronic Materials Conference.

His research focuses on creating and characterizing nanomaterials with applications in thermoelectrics (devices that convert heat differences into electrical energy) and optoelectronics (devices that generate or detect light), including techniques like molecular beam epitaxy, where electronic materials can be grown one atom-thick layer at a time. His work often involves experimenting with unconventional electronic materials or finding new ways of manufacturing so that promising electronic technologies can be used on a larger scale.

"There's a theme in my work that stuff that works well that's expensive is impractical," he says, and this new fusion of technologies could make nanocomposites — used in energy-converting devices like solar cells — cheaper and easier to produce. ■

Mackay named PSME Fellow

Michael Mackay, professor of materials science and engineering, is one of five new fellows inducted into the Polymeric Materials: Science and Engineering Division Fellow Program in 2015 honoring members for scientific and technological contributions to polymer material science and engineering.

Mackay joins fellow 2015 honorees representing Case Western Reserve, IMB, the Massachusetts Institute of Technology and Cornell University, in being honored "for critical insights into the improvement of polymer performance through the inclusion of nanoparticles in making novel devices and materials."

Epps receives Owens-Corning Award for groundbreaking polymer research

Thomas H. Epps, III, the Thomas and Kipp Gutshall Associate Professor of Chemical and Biomolecular Engineering and associate professor of materials science and engineering, has been selected as the 2015 winner of the Owens-Corning Early Career Award by the Materials Engineering and Sciences Division (MESD) of the American Institute of Chemical Engineers (AIChE).

The award recognizes outstanding independent contributions to the scientific, technological, educational, or service areas of materials science and engineering by people who are under the age of 40.

Epps was cited for "groundbreaking research in understanding and engineering block polymer interfacial energetics toward the nanoscale self-assembly of polymers in bulk, thin films and solutions."

Epps will receive the award and deliver an award address at the AIChE Annual Meeting in Salt Lake City in November.

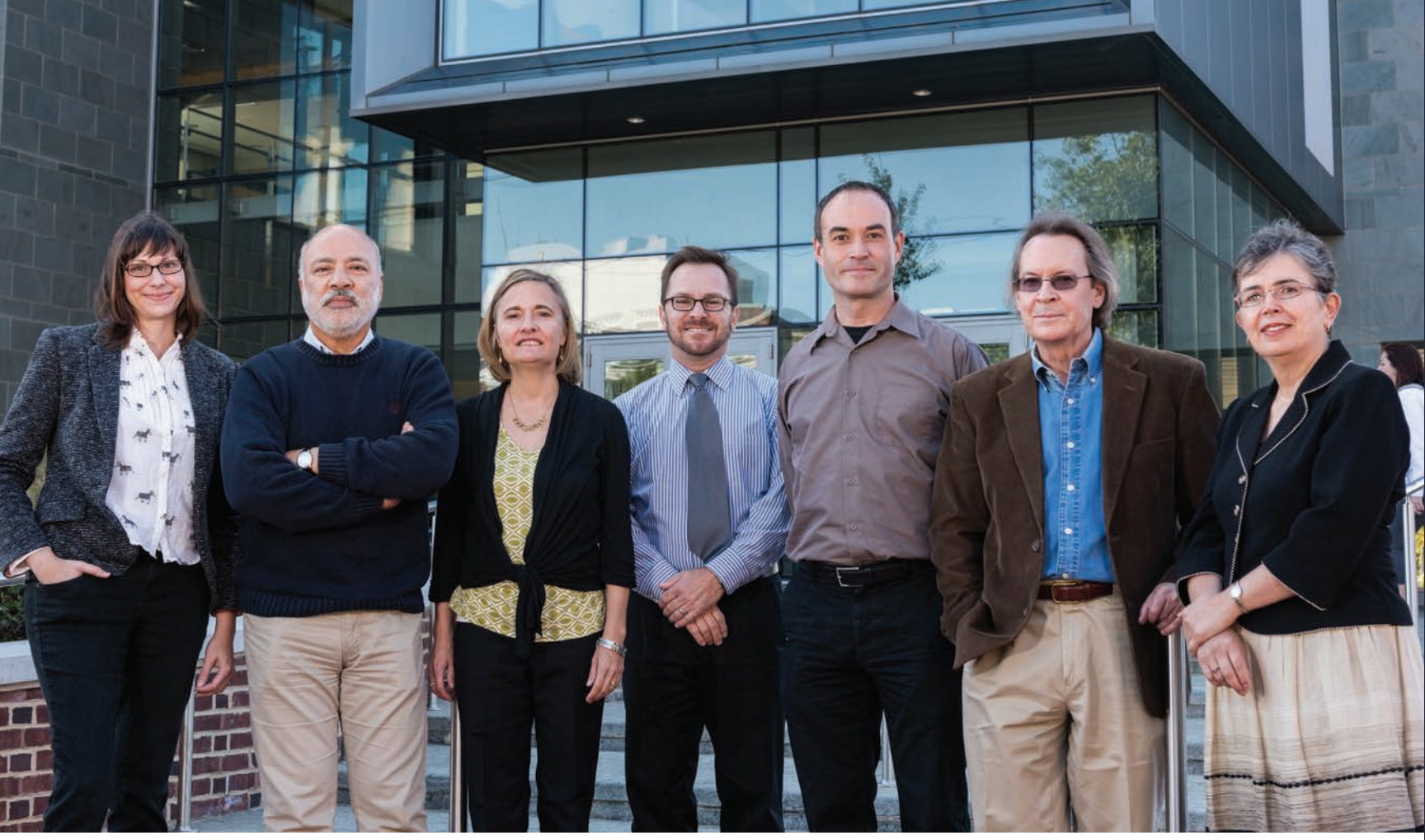
Kiick named ACS Fellow

Kristi L. Kiick, deputy dean of engineering and professor of materials science and engineering and biomedical engineering was named to the 2014 American Chemical Society (ACS) Class of Fellows for outstanding accomplishments in scientific research, education and public service.

An expert in the synthesis, characterization and application of biomaterials, Kiick's research investigates new materials for drug delivery and tissue engineering, focusing on the development of cardiovascular, cancer and vocal fold therapies.

She was named a fellow of the ACS Division of Polymer Chemistry in 2014, where she serves on the organization's board of directors. She is also a member of the American Association for the Advancement of Science (AAAS), the Society for Biomaterials and the American Institute of Medical and Biological Engineering.

She has served on the advisory and editorial boards for *Macromolecular Bioscience*, *Biomacromolecules, Macromolecules* and *ACS Biomaterials Science & Engineering*.



FACULTY AWARDS

INTERNATIONAL ETHICS

Interdisciplinary team addresses ethics in global STEM research

The University of Delaware has been awarded more than $200,000 by the National Science Foundation to collaborate with the National Academy of Engineering (NAE) on an international research ethics project.

Led by Tom Powers, director of the Center for Science, Ethics, and Public Policy (CSEPP) at UD, the five-year project includes a team of eight faculty members from four UD colleges.

"As research, practice and education in science and engineering become increasingly global, we must expand our efforts to address their ethical dimensions," said Powers. "Two important factors are the cultural and linguistic diversity among engineering and science researchers. Through this collaboration, the UD teams will help the NAE to undertake a worldwide project in ethics to address emerging global issues."

Ismat Shah, professor in the Department of Materials Science and Engineering, points out that new developments in areas like nanotechnology sometimes blur the ethical considerations scientists and science administrators need to keep in mind.

"While there is much work to be done in the U.S., developing nations have to balance even more carefully the fast track to technological advances and the ethics and safety concerns associated with those advances," he says. "I will be working with colleagues in this group to interact with scientists in developing nations to help all of us understand the consequences of the swiftness that is generally part and parcel of new technologies."

The grant, which is a supplement to a $3 million award to the NAE, is aimed at developing the international components of the enhanced Online Ethics Center for Engineering and Science (OEC). The supplement will support the incorporation of international perspectives and resources for ethical reasoning and practice, as well as social responsibility in science and engineering.

The UD team will assist the OEC by identifying and engaging a multidisciplinary cohort of international collaborators to collect and review materials in five areas: research ethics; engineering; life and environmental sciences; computer, mathematics, and physical sciences; and social, behavioral, and economic sciences.

Contacts have already been identified at some 20 universities and professional organizations across Europe, China, Brazil, and Japan, and, according to Powers, that list will grow as the project unfolds. ■

STUDENT PROFILE

JESSIE SUN

Jessie Sun thinks people should be a lot more interested in science than they are.

"We all love our iPhones, but most people just accept them at face value without thinking about the technology behind them," she says.

For Sun, who just completed her Ph.D. working in Darrin Pochan's research group, what goes on behind the scenes with materials is fascinating.

"Materials science touches everything we do in modern life," she says. "Hard materials are evident in our phones, TVs, and computers, while soft materials are found in shampoos, the plastics we use in everything, even the food we eat, and the cosmetics we wear."

Sun's doctoral research focused on soft materials, specifically on the use of hydrogels for medical applications including targeted drug delivery and cartilage replacement.

"I love that polymers are so new," she says. "Polymer science wasn't even considered a real field until after World War II, when nylon began to replace silk in parachutes. It's so new that the fundamentals of how certain polymers interact still isn't fully understood—there is still so much to do."

After she defended her dissertation, Sun headed to Ohio, where her husband has a faculty appointment. Although she hadn't yet lined up a job herself, she wasn't worried. She's keeping her career options open and is particularly interested in STEM education and science outreach.

"UD does a really good job in these areas," she says. "I gained valuable experience with middle and high school students while I was working on my Ph.D. I was well connected to the community, especially through my affiliation with the Delaware Biotechnology Institute."

Sun refers to UD's materials science department as "welcoming and tight knit."

"We have amazing, yet still accessible, professors who are doing really innovative work that wins prestige and awards," she says. "Our department is very good about acknowledging these achievements and recognizing hard work. We also have a lot of cross communication, so if anyone needs help from another lab, it can be easily obtained within the department."

Sun will undoubtedly keep busy while she's job hunting—she enjoys baking and crocheting in her free time.

She's also looking forward to living with her husband. "We haven't lived together since we got married due to work," she says. "So that will be a nice change while I figure out my next step."

STUDENT AWARDS

EXTERNAL AWARDS

> Microscopy & Microanalysis 2015 Presidential Scholar Award
Jinglin Liu

> NASA Delaware Space Grant College and Fellowship Program,
Cory Bomberger
Graduate Fellowship
Kevin Bichoupan
Undergraduate Tuition Award

> ASM & MSEG Poster Award
Doug Bishop
(Hard Materials | R. Birkmire) $100
Jessie Sun
(Soft Materials | Pochan) $100

DEPARTMENTAL AWARDS

>Chairperson's Outstanding Graduate Student Award
Liang Gong

>Outstanding Graduate Student Teaching Award
Eric Chen
YingKai Liang
Bradford Paik

>Outstanding Graduate Student Research Award
Ngoc Nguyen

>Outstanding Graduate Student Service Award
Jing Qu

LAIRD FELLOW

Tumor researcher, martial artist and dancer named 2014 Laird Fellow

Doctoral student Sarah Geiger, whose research focuses on developing a better understanding of tumor behavior in artificial environments, received the College of Engineering's 2014 Laird Fellowship.

The prestigious award recognizing character, creativity, imagination and perseverance, and encouraging recipients to engage in "broadening intellectual pursuits," honors the memory of George W. Laird, a UD mechanical engineering graduate who died in an accident at the age of 35.

Geiger credits the concentration and self-discipline she gained by studying Tang Soo Do martial arts since the age of 13 — as well as a love of dance, which focused her communication skills by forcing her to maintain a strong connection with her partner — with enhancing her research and qualifying her for the award.

Co-advised by Xinqiao Jia, associate professor, and Juejun Hu, assistant professor, both of materials science and engineering, Geiger is incorporating flexible photonic stress/strain sensors into three-dimensional artificial cell scaffolds made from biocompatible hydrogels.

"We hope to strengthen the fight against cancer by providing a dynamically controllable and biocompatible platform for studying the mechanics of tumor growth," she said. ■

"We hope to strengthen the fight against cancer by providing a dynamically controllable and biocompatible platform for studying the mechanics of tumor growth."

STUDENT PROFILE

PERNELL DONGMO

Before starting his new job with IBM in Vermont, Pernell Dongmo realized he needed to buy two things: a heavy winter coat and a four-wheel-drive vehicle. But the Washington, D.C. native, whose parents were both born in Cameroon, is ready for the challenges of both a new climate and a new career.

Armed with a Ph.D. in materials science, Dongmo's work at IBM will focus on materials characterization for chips to be used in smartphone applications.

After earning his bachelor's degree in electrical and computer engineering at the University of Delaware, Dongmo entered UD's doctoral program in materials science. "I made the decision to go to grad school during my junior year, when I was involved with the IGERT program," Dongmo says.

The NSF-sponsored IGERT (Integrative Graduate Research and Traineeship) program at UD focused on sustainable energy from solar hydrogen. "I really enjoyed working with other students on outreach, demonstrating the technology through solar cell racecars," Dongmo says.

Although he originally set his sights on a master's degree, Dongmo ultimately chose to pursue a Ph.D. He credits the RISE Program (Resources to Insure Successful Engineers) with giving him the tools he needed to succeed, including time management and organizational skills.

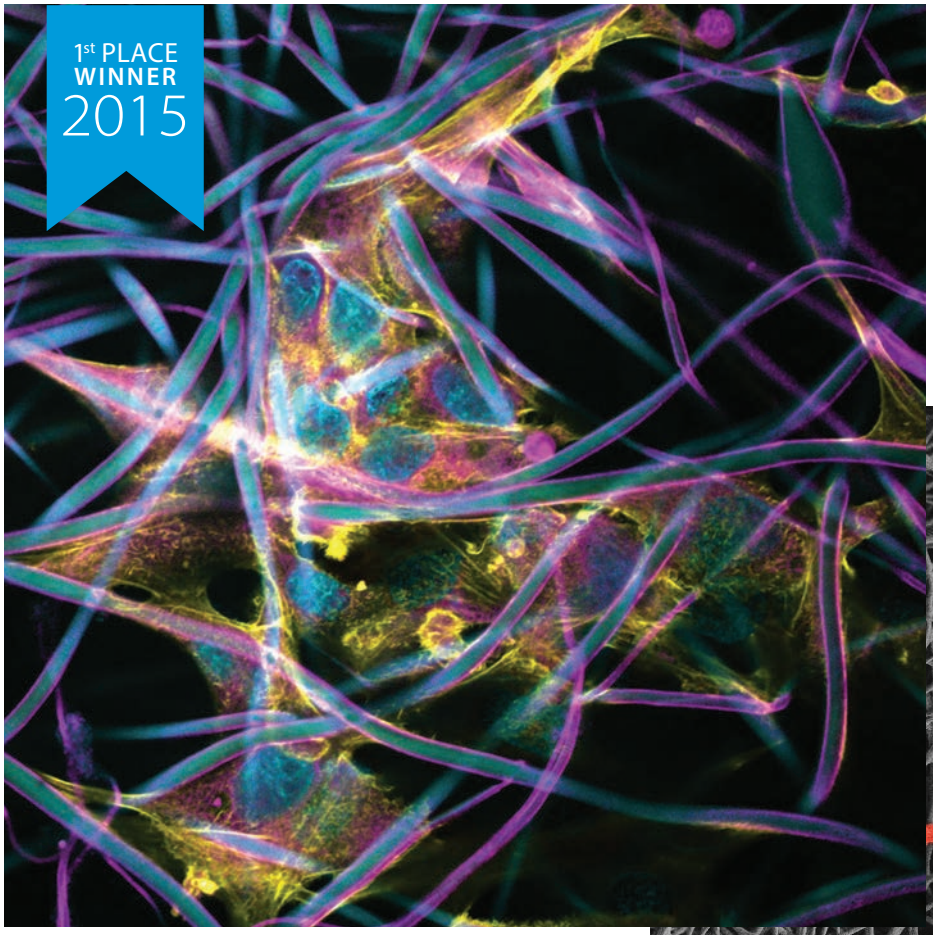
Dongmo's work on epitaxial growth of semiconductors as a PhD student in Joshua Zide's lab has prepared him well for his new work, which is focused on characterization of silicon-germanium films produced via chemical vapor deposition.

"I really enjoyed my graduate experience," Dongmo says. "Materials science at UD is small compared to other programs, but there's a lot of interaction among students, and it's a very friendly department. It was really beneficial to learn about what students in the other research groups were doing."

Dongmo worked hard enough to earn the program's 2014 Outstanding Graduate Student Research Award, but he also knows how to have fun—primarily on the basketball court and traveling.

ART *in* MATERIALS

Each year, graduate students are invited to submit research-related artwork for the Art in Materials contest. The competition celebrates and showcases the creative and experimental nature of engineering and challenges students to visually convey the intrinsic beauty of scientific research.



Our 2nd and 3rd Annual Winners: 2015 First Place: The Rainbow Lorikeet by Anitha Rankrishnan; 2015 Second Place: Wedding Dance by Liang Gong ; 2014 First Place: Trapped Heart by Liang Gong; 2014 Second Place: Solar System by Ngoc Nguyen

STUDENT PROFILE

NANDITA BAGHWAT

As co-founder of a student-launched entrepreneurial venture called Voltaic Coatings, Nandita Bhagwat is no stranger to what it means to be involved with a startup.

"Your job description has a list of your responsibilities, but it really should say 'Do it all,'" jokes the recent Ph.D. recipient who was advised by Profs. Kristi Kiick and David Martin.

Bhagwat moved from Delaware to California in June to follow her husband, who earned a Ph.D. last year and is now working in the Bay area.

But it was a Delaware connection that helped her land a position with Biotectix, which provides conducting polymer materials for biomedical applications. The company's materials optimize communication between devices and tissue, enabling a next generation of smaller, less invasive, multi-functional, and more energy-efficient medical devices.

Biotectix was started by Jeff Hendricks, who studied under UD's David Martin when he was at the University of Michigan.

The timing was perfect for Bhagwat —as she finished her doctoral degree, the company was moving from Michigan to California, and they needed someone with her qualifications.

"There's only four of us out here at this point, but so far, I love it," she says. "I'm doing a little bit of everything from research and development to quality assurance and production."

Bhagwat earned her undergraduate degree in India in polymer engineering and chose UD for her doctoral work because she was interested in biomedical applications of polymers.

"I knew there were a lot of people here working in this area," she says. "It turned out to be a perfect fit for me because I changed the direction of my Ph.D. research when I was halfway through, but I was always able to find someone to work with regardless of the direction I wanted to take."

She's found her new job to be a perfect fit. "I got a great foundation in polymer science and engineering at UD and now I'm working on actual applications."

2014-15 GRADUATES

BRIAN ALLIK | MMSE 2014

JONATHAN HENRY BOYLE | PhD 2014 | Birkmire
Characterization of the (Ag,Cu)(In,Ga)Se2 Thin FIlm Alloy System for Solar Cells

NICHOLAS CASTRO | MMSE 2014

MAXIME JOSEPH DEMPAH | MMSE 2014 | Gillespie
Development of Spray On Bag For Manufacturing of Large Composites Parts: Diffusitivity Analysis

CHENGYI HAN | MMSE 2014

CHELSEA HAUGHN | PhD 2014 | Doty
Energy Transfer in Nanostructured Materials

JUN JIANG | PhD 2014 | Hertz
The role of strain and structure on oxygen ion conduction in nanoscale zirconia and ceria thin films

ANTHONY KOTLARCZYK | MMSE 2014

ROSHAN MISHRA | MMSE 2014

LIANGQI OUYANG | PhD 2014 | Martin
Crosslinking, Electrografting, and In Vivo Polymerization of Poly(3,4-Ethylenedioxythiophene) (Pedot) and Derivatives As Reliable Neural Interfacing Materials

NOPPORN RUJISAMPHAN | PhD 2014 | Shah
Interface and Charge Transport Studies In Organic Solar Cells Based on P3HT:PCBM Bulk Heterojunctions

SAMEER SATHAYE | PhD 2014| Pochan
Multifunction Hybrid Networks Based on Self Assembling Peptide Sequences

JENNIFER SIETINS (MUELLER) | PhD 2014 | Gillespie
Exploring Diffusion of Ultrasonically Consolidated Aluminum and Copper Films Through Scanning and Transmission Electron Microscopy

HAMED SIMCHI | PhD 2014 | Shafarman
Back Surface Studies of Cu(In,Ga)Se2 Thin Film Solar Cells

WENQIONG TANG | PhD 2014 | Rabolt
Fabrication of Novel Gold Nanorod/Polymer Nanocomposite Fibers and Their Application in Heavy Metal Ion Sensing

MICHAEL WANG | MMSE 2014

YUJUN ZHONG | PhD 2014 | Zide
Dilute Bismuthides On InP Platform: Growth, Characterization, Modeling, and Application

STEVEN ACKERMAN | MMSE 2015

NANDITA BHAGWAT | PhD 2015 | Kiick
Novel Conjugates of Peptides and Conjugated Polymers for Optoelectronics and Neural Interfaces

YINCHAO CHEN | PhD 2015 | Pochan
Construction and Characterization of Hybrid Nanoparticles via Block Copolymer Blends and Kinetic Control of Solution Assembly

JONATHAN CHURCH | PhD 2015 | Opila
Thin Film Subsurface Environments; Advanced X-Ray Spectroscopies and A Novel Bayesian Inference Modeling Algorithm

PERNELL DONGMO | PhD 2015 | Zide
The Properties of Dilute Bismuthides and Rare-Earth Containing Materials for Applications in Thermoelectrics, Optoelectronics, and Terahertz Technology

VINU KRISHNAN | PhD 2015 | Rajasekaran & Jia (Co-Chair)
Bioengineering Targeted Nanodrugs for Hematologic Malignancies: An Innovation in Pediatric Oncology

CHUNYIN LENG | MMSE 2015

HONGTAO LIN | PhD 2015 | Hu
Chalcogenide Glass Mi-Infrared On-Chip Sensor for Chemical Sensing

CHRISTOPHER LELAND MCGANN |PhD 2015 | Kiick
Resilin-Like Polypeptide-Poly (Ethylene Gylcol) Hybrid Hydrogels for Mechanically-Demanding Tissue Engineering Applications

JESSIE SUN | PhD 2015 | Pochan
Hydrophobic Payload Encapsulation and Release Characteristics in Self-Assembled Peptide Hydrogel

XINRAN ZHOU | PhD 2015 | Doty
Spectroscopic Properites of Self-Assembled Lateral Quantum Dot Molecules

YI ZOU | PhD 2015 | Hu
Novel Low-Symmetry Gratings for Ultimate Light Trapping Enhancement in Next-Generation Photovoltaics

STUDENT CLUBS

MATERIALS RESEARCH SOCIETY (MRS)

President | Eric Chen | eyc@udel.edu
Vice President | Bo Tew | botew@udel.edu
Treasurer | Anitha Ravikrishnan | anitha@udel.edu
Secretary | Jee Young Lee | jeeylee@udel.edu
Outreach Officer | Tess Ginley | tginley@udel.edu
Assistant Officer | Mike Lloyd | mlloyd@udel.edu
MA Representative | Jimmy Hack | hack@udel.edu
ACS Poly/PMSE Representative | Bryan Sutherland | bsuth@udel.edu

MATERIALS ADVANTAGE CHAPTER
Student chapter of the American Society for Materials (ASM)

President | Ngoc Nguyen | nanguyen@udel.edu
Vice President | Matthew Lewis | mrlewis@udel.edu
Treasurer | Mohamed Bah | alphabah@udel.edu
Secretary | Chun-Yen Hsu | cyhsu@udel.edu

EDUCATIONAL OUTREACH

TEACHING THE TEACHERS

Science teachers learn about materials in UD's Harker Lab

Science teachers from area middle schools and high schools were the students this summer as they attended an ASM Materials Camp at the University of Delaware. Presented by the ASM Materials Education Foundation and UD's Department of Materials Science and Engineering, the camp was an opportunity for teachers to re-visit science principles, do experiments and bring new lessons into the classroom.

The event took place at UD's Patrick T. Harker Interdisciplinary Science & Engineering Laboratory (Harker Lab) where problem-based learning instructional laboratories feature lab spaces adjoining classrooms. This unique arrangement allowed participants to discuss and then immediately conduct their experiments.

During this one-week workshop, teacher participants learned the basics of Materials Science Technology (MST) as taught at the high school level. They worked hands-on with metals, ceramics, polymers and composites, and developed a greater appreciation for the importance of these materials to modern life.

The program, developed at the University of Washington and Edmonds Community College and supported by the National Science Foundation's Advanced Technology Education program, aims to brings together academic and vocational instructors in a common goal of exciting students about science, technology and engineering.

Support for the camp at UD was provided by a unique partnership between the university, industry, foundations and professional organizations. This included Agilent Technologies, UD's Department of Materials Science and Engineering, Harker Lab, ASM Brandywine Valley Chapter, ASM Philadelphia Liberty Bell Chapter, ASM Materials Education Foundation, Law Offices of Jeffery Ramberg, Rowan Foundation, Seven Springs International Symposium Committee, Southco Inc., and E.I. du Pont de Nemours and Company. ■

College of Engineering

Department of Materials Science & Engineering
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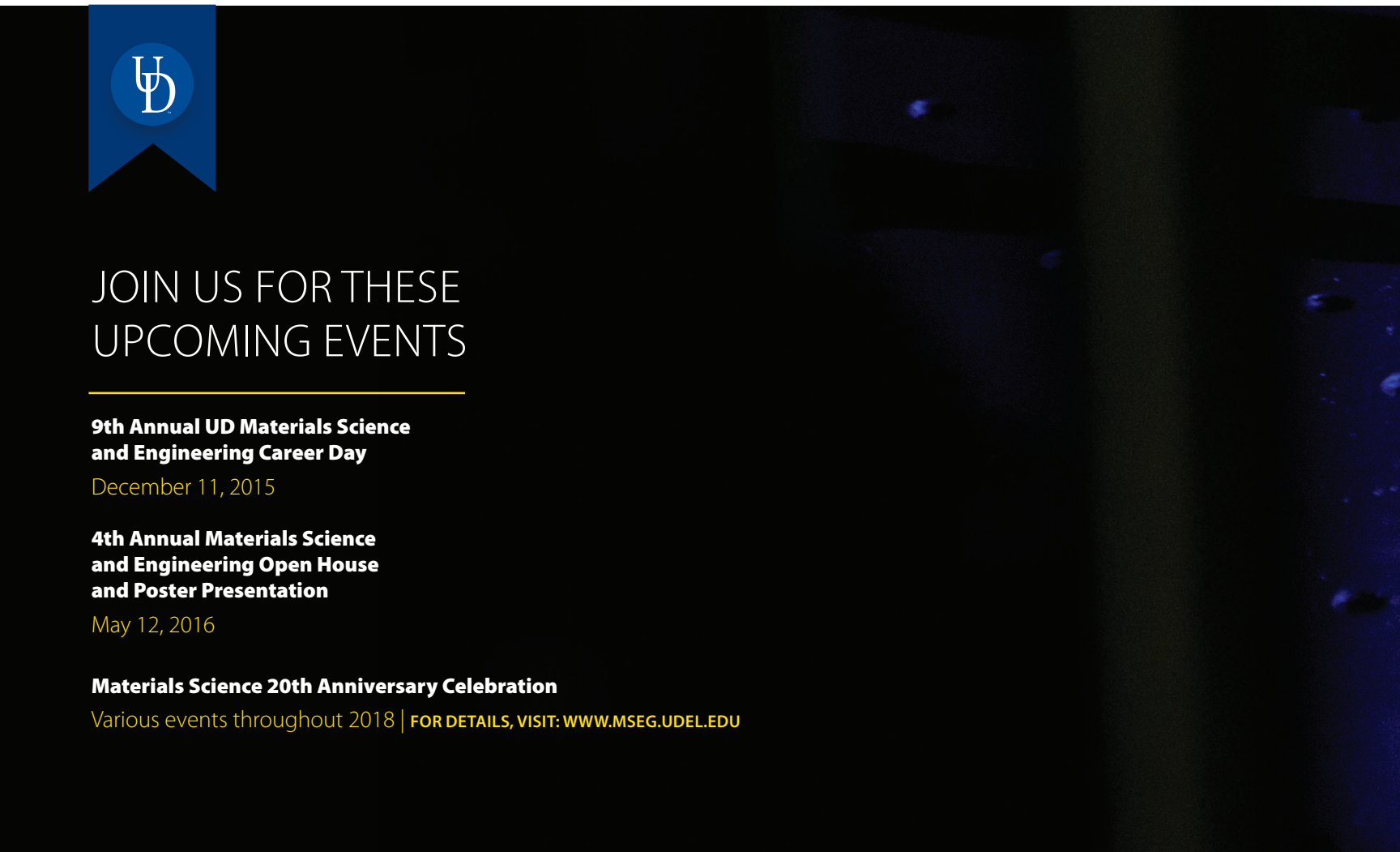

JOIN US FOR THESE UPCOMING EVENTS

9th Annual UD Materials Science and Engineering Career Day

December 11, 2015

4th Annual Materials Science and Engineering Open House and Poster Presentation

May 12, 2016

Materials Science 20th Anniversary Celebration

Various events throughout 2018 | **FOR DETAILS, VISIT: WWW.MSEG.UDEL.EDU**