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MATERIALS MATTERS

UNIVERSITY OF DELAWARE | COLLEGE OF ENGINEERING | DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

SPRING 2018

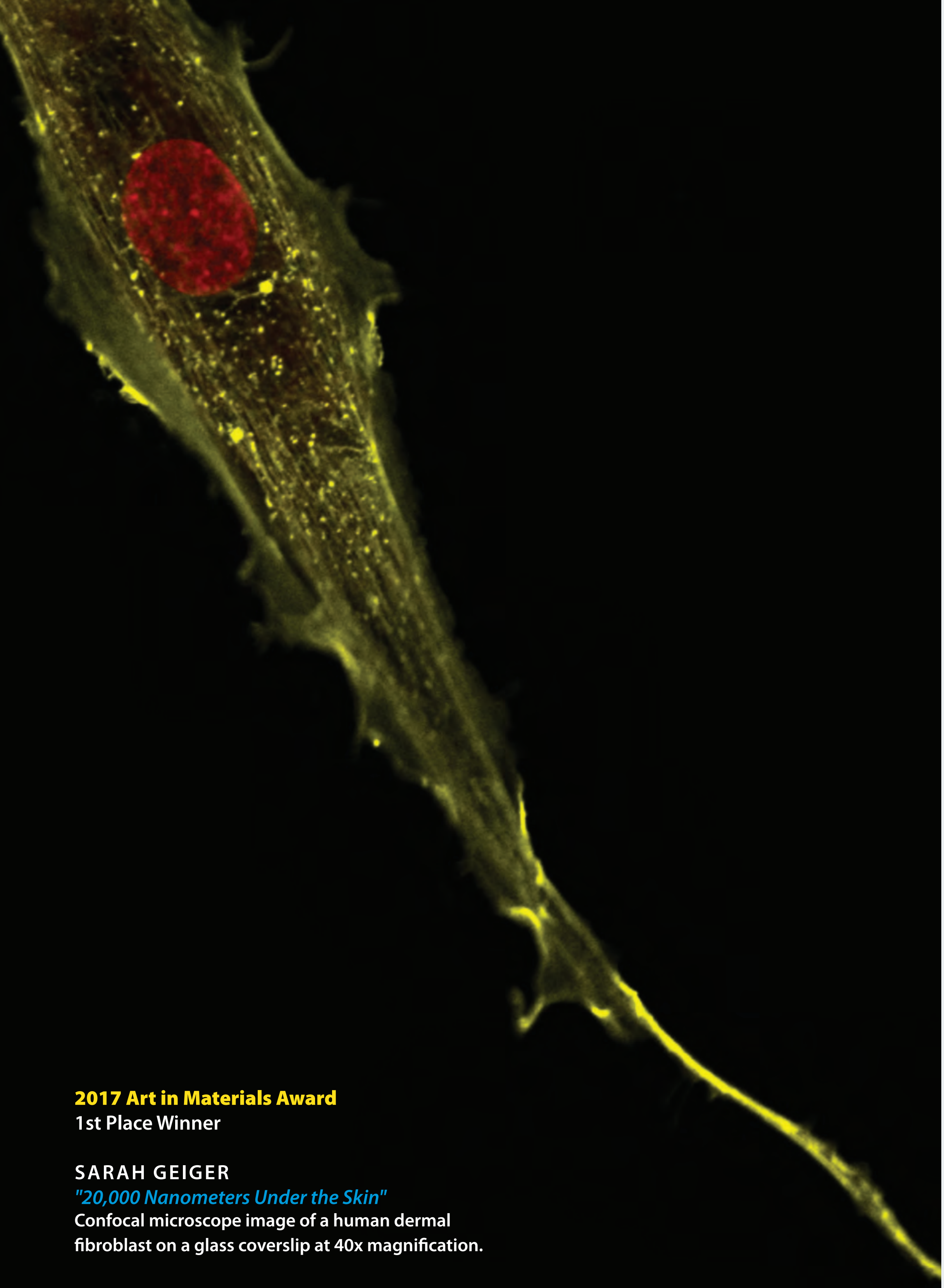
BIG MOMENT FOR TINY TECH

Nanofabrication Lab is the future of science

THE ART *of* SCIENCE

Artful discoveries in student work

UD College of Engineering
DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING



2017 Art in Materials Award
1st Place Winner

SARAH GEIGER
"20,000 Nanometers Under the Skin"
Confocal microscope image of a human dermal fibroblast on a glass coverslip at 40x magnification.

PAGE 28 for more winners & entries

SPRING 2018
MATERIALS MATTERS

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UNIVERSITY OF DELAWARE

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DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

MATERIALS MATTERS

FEATURES

DEPARTMENTS

20 YEARS OF MATERIALS SCIENCE

A BRIEF HISTORY

1960 **ROOTED IN METALLURGY**
UD offers courses in physical metallurgy through the Department of Chemical Engineering. UD's first Ph.D. and master's degrees in Metallurgy are awarded in 1965.

1986 **THE EARLY DAYS OF MATERIALS SCIENCE**
Materials and Metallurgy faculty are hired into all departments of the College of Engineering. The Metallurgy and Materials Program is renamed as the Materials Science Program. The Program operates college-wide electron microscope and x-ray diffraction facilities.

1998 **A NEW DEPARTMENT FOR ENGINEERING**
The Department of Materials Science and Engineering is established–the first new department in the College of Engineering since 1914.

1999 to 2016 **EXPANSION AND GROWTH**
The department continues to recruit world-class faculty and outfits labs with top-of-the-line technology and equipment. The Patrick T. Harker Interdiciplinary Science and Engineering Laboratory–home to the Advanced Materials Characterization Lab and the Keck Center for Advanced Microscopy and Microanalysis–opens in 2013, and the UD Nanofabrication Facility opens in 2016.

2018 **POISED FOR THE FUTURE**
Celebrating 20 years of Materials Science & Engineering at UD

JOIN US
20th Anniversary Celebration
Saturday, May 12, 2018

Department of MATERIALS SCIENCE & ENGINEERING

1998-2018 20 YEARS

MESSAGE FROM THE CHAIR

DARRIN POCHAN

Many people laid the groundwork for the Materials Science and Engineering department at UD.

There were the original materials and metallurgy faculty and students whose work motivated discussions about the need for a new department. There was Prof. Stuart Cooper, Dean of Engineering in the 1990s, who supported the effort. And, of course, there was John Rabolt, who was hired from IBM in 1996 to be the first department chair. When we launched in 1998, thus began the second phase of MSE, the nucleation and growth period. I'm fortunate that I was part of that growth, arriving in 1999 as the first assistant professor (and the fifth faculty member overall.)

While we worked hard in the early days to build infrastructure, recruit excellent students, and attract collaborative, pioneering faculty colleagues, we could not have predicted just how successful we would become. The graduate student body has grown to 75 students, with additional projected growth as we continue to hire new faculty members.

Now, we are searching for two new faculty members: one to join the growing user team of UD Nanofabrication Facility (directed by Materials Science's own Prof. Matt Doty) and one to focus on curriculum development for our new undergraduate major. Yes, you heard correctly. In the fall of 2019, we will launch an undergraduate major in Materials Science and Engineering. Highlights include the incorporation of computation and simulation throughout the curriculum, entrepreneurship skills, laboratory work in materials, nanofabrication, and a senior design component closely coupled with industrial partners. Materials Science and Engineering will be recognized worldwide for excellence in graduate education and research, coveted for available spots in our outstanding undergraduate program, and renowned for our collaborative, interdisciplinary culture.

We celebrate the past and present in this issue of Materials Matters. More importantly, we will celebrate the 20th anniversary of the Materials Science and Engineering department at the University of Delaware on Saturday, May 12, 2018. We are planning an afternoon of activities for past and present graduate students to celebrate where we are and where we are headed. You made our successes possible, and your future support will ensure our continued success and growth. We hope you will join our celebration this spring.

DARRIN POCHAN
Department Chair

TWO DECADES OF SCIENCE THAT MATTERS

In honor of our 20th anniversary, we asked a few alumni how MSEG set them up for success—and how the department's growth will benefit future students.

LISA HUGHES, D'05

Associate director at Janssen Pharmaceuticals

PROGRAM HIGHLIGHTS:

Cutting-edge research. Darrin Pochan, who is now department chair, advised Hughes. "In Darrin's group, we were definitely on the novel edge," she says. "We were looking at challenges that nobody had yet solved." Their work on peptide-based hydrogels resulted in multiple publications, including papers in *Nature* and *Nature Materials*. Pochan now has a lab team of eight students and continues to publish multiple papers a year in high-quality journals.

Growth potential. "As he was building his career, Darrin provided us a lot of opportunities to attend conferences and work with collaborators," she says. Just one example: Hughes was one of the first students in the department to work at the Delaware Biotechnology Institute, a partnership to establish the First State as a center of excellence in biotechnology and life sciences. "For a long time I was probably the only MSEG student in the DBI, and we grew from there," she says. "The collaborations you take, the types of people you meet just by being in that sort of young environment is essential."

A tight-knit community. "The department is built upon a large expertise base of very great people and very great science," she says. However, each lab is small enough and supportive enough that graduate students can really dig in to their projects, something unique among institutions of this caliber. "When you look at the amount of work you can accomplish and the knowledge base you have when you leave UD, it's impressive," she says.

CHANGES ON HER RADAR:

Today's MSEG students have access to even more impressive facilities, like the Bio-Imaging Center. Hughes also lauds the experience today's faculty bring to the department. "Over time I think as the department has grown, there has been a shift where you have people who are experienced in different fields of industry as well as people who are experienced in academia," she says. "And it definitely provides a support system for incoming students and really helps them develop the career they want and understand where they can go, where they'll be successful, and what aligns with their interests."

BRIAN POLIZZOTTI, D'06

Assistant Professor of Pediatrics at Harvard Medical School,
Director of the Translational Research Lab in the Department of Cardiology at Boston Children's Hospital

PROGRAM HIGHLIGHTS:

Flexibility. After two years at UD, Polizzotti realized he wanted to change his research focus—from metal catalysts to polymers. The department allowed him to switch mentors, to then-new professor Kristi Kiick, now the associate dean of the College of Engineering. "Kristi as a mentor—I can't speak highly enough of her," says Polizzotti. "There was a lot of support in the department. It's a very collaborative place, and I learned how to be a good student and a good scholar there."

Breadth. When Polizzotti switched labs, he had to bolster his understanding of biology and polymer chemistry. "I got a vast knowledge and grasp of different types of chemistry all the way down from small molecule synthesis all the way up to polymers, which is pretty diverse," he says. During work with bacteria, he got an inkling that he might pursue a career in medicine. "The benefit of materials science, in my opinion, is that it's interdisciplinary," he says. "You have to know the chemistry; you have to know the biology; you have to know the engineering, and that's what allows you to work in this gray space of interdisciplinary science."

Fearlessness. Polizzotti followed his time at UD with a post-doc at Howard Hughes Medical Institute (HHMI) and a stint at GE. Desiring more of a biological focus, he signed on to a second post-doc, this time studying molecular cardiology at Harvard Medical School. "I just wasn't afraid of learning a new field," he says. "I think I got that from Delaware—being able to learn different fields, to adapt, to think, and how to tackle problems." Polizzotti now directs a lab at Boston Children's Hospital. He and his team have developed a method to deliver oxygen intravenously in the blood stream, which they hope to eventually use to save oxygen-deprived patients in cardiac arrest.

CHANGES ON HIS RADAR:

"From what I've seen, the department continues to grow, and they're doing quite well," he says. Polizzotti visited campus on September 1, 2017 to give a seminar called Creating Intravenous Oxygen.

KORHAN DEMIRKAN, D'08
Lead engineer at Apple

PROGRAM HIGHLIGHTS:

Mentorship and collaboration. "I started the department on the same week as my mentor, Professor Bob Opila," says Demirkan, who describes Opila as "an encouraging and supportive advisor with a great sense of humor. I still contact him for advice". Demirkan also made lasting friendships at UD. "We got good exposure to each others' research projects, so we knew each others' challenges and tried to help each other," he says. "That kind of collaboration and learning how to become a good team member always pays back in the rest of your career."

A stake. When Demirkan joined the department in 2002, it was small but expanding fast. "I remember, every year we had a meeting to review the numbers, rankings and the goals for the department (I am sure if any of the friends that were in those meetings will have a smile when I remind them the blue arrow that Prof John Rabolt used in those presentations with his slides and the overhead projector). We felt part of a growing team and felt our own responsibility for achieving the departmental goals."

Industry partnerships. Demirkan studied semiconductor materials, applying surface characterization techniques. He worked on projects with companies such as GE, Bell Labs (which became Alcatel-Lucent) and AMD. "We provided these companies characterization and failure analysis services," he says. "It was an unprecedented experience for me that helped me a lot in my career."

CHANGES ON HIS RADAR:

The expanding faculty roster. "We had diverse research fields being covered, including hard materials like semiconductors and electronics and soft materials like polymers and biological materials," he says. "It seems like the new professors that joined brought in new exciting research areas, but even from the start, there was a good spectrum that covered all the different areas of materials science."

LIANG GONG, D'16
Senior research scientist at 3M

PROGRAM HIGHLIGHTS:

A welcoming environment. Gong arrived in Newark shortly after earning her bachelor's degree at Donghua University in Shanghai, China. She knew little English, but her professors helped her learn quickly. "This department is very friendly to international students," she says.

World-class equipment. When UD acquired equipment for atomic force microscope infrared-spectroscopy (AFM-IR), Gong was one of the first students to use it, doing work that led to publications in journals including *Macromolecules*. When 3M was looking for a candidate with experience doing AFM-IR, Gong was a natural fit.

Career preparation. The department's annual career day, bolstered by faculty members' strong connections with companies like Gore, Agilent and Dupont, helped Gong prepare for a career in industry. She networked with professionals and improved her job-search skills. "I got a lot of chances to practice for later interviews," she says

CHANGES ON HER RADAR:

The Patrick T. Harker Interdisciplinary Science & Engineering Laboratory (ISE Lab) opened a year before Gong graduated—and she would have loved to spend more time there. The 194,000-square-foot facility, which brings scientists of multiple disciplines together under one roof, offers a unique opportunity to share ideas and collaborate.

CORY BOMBERGER, D'16

Process engineer in semiconductors at Intel Corporation

PROGRAM HIGHLIGHTS:

Characterization skills. At UD, Bomberger worked in the lab of Joshua Zide, investigating molecular beam epitaxy (MBE) growth of novel materials. At Intel, he is in the path-finding EPI group, where he works in teams with researchers from other groups whose aim is to improve the performance of the company's next chip. One aspect of his job involves growth and characterization of semiconductors. "While my work in Joshua Zide's lab was not on the same exact materials, becoming an expert on the fine details of epitaxial growth and the characterization (including the details of the measurement, limitations of the measurements, and how to interpret measurements) allowed me to step right into my job and start contributing immediately in the development of new films," said Bomberger.

Craftiness. Another aspect of Bomberger's job is the maintenance and repair of the tools used to grow films. "Working in Joshua's group, I had many opportunities to learn how to repair and do the repairs of the tool we used," he said. "The knowledge of how to determine what is causing the problem, how to repair it, and how to prevent the problem translated over to the new type of tool I am using and again I was able to very quickly step in and start contributing to maintaining and repairing our tools."

Professional development. At UD, Bomberger was president of the student chapter of the Materials Research Society. He was also part of the NASA Delaware Space Grant College and Fellowship Program, chair of the President's Council of Student Advisors for The American Ceramic Society Board, and chair of the hard materials journal club. These activities helped him practice public speaking about science. "At Intel, I am routinely in meetings with people different scientific backgrounds where I frequently have to explain what I am working on and why it is important," he said. "It is important to be able to quickly assess what the other people are understanding and how to explain my work adequately."

CHANGES ON HIS RADAR:

During Bomberger's time at UD, he saw the materials science department grow in terms of students, faculty and resources. "I think this growth, combined with the industry experience of several of the faculty, really sets UD and the new resources (ISE lab) up to become one of the leading universities for materials science students who want to focus on electronic materials," he says. "I think this will also lead the material science and engineering program at UD to being one of the main programs top companies look to recruit from."

FEATURE

HERE FROM THE BEGINNING

John Rabolt, the founding chair of the materials science department, tells us how he got things started

John Rabolt was classified as a polymer chemist at IBM and had spent 20 years in Silicon Valley when he received a call from Stuart Cooper, dean of the University of Delaware's College of Engineering.

It was 1996. UD was starting a materials science department, and Cooper wanted Rabolt to head east and spearhead it.

Rabolt had gone to Silicon Valley in the '70s, when it was dotted with apple orchards. He worked just miles away from Steve Jobs, Steve Wozniak and other icons of the tech industry as they developed the first personal computers.

"I grew up, professionally, in Silicon Valley," said Rabolt. But he was ready for a change.

Rabolt told Cooper he would only come to Delaware if the College of Engineering was serious about building a materials science department that rivaled the best in the world. Rabolt had a vision for what a 21st century department should look like. He noticed that at many universities, materials science departments operated in silos, with professors concentrating in metals, ceramics, or polymers and competing with—rather than collaborating with—their colleagues. He wanted a more interdisciplinary approach. Step one: Recruit faculty with a foothold in more than one area.

His first five hires came from companies with the best research divisions—DuPont, AT&T, and Exxon. "I thought that was a good bet," he said. "Those labs were very competitive in those days, with a publish or perish philosophy."

He looked for team players. During interviews, he told applicants that he had a habit of asking faculty members to help move desks on some days since the department had few staff and was expanding every year. He called it the move-the-desk test. "I could tell when people thought that was beneath them," a quality that didn't suit the camaraderie he wanted for this burgeoning department.

Rabolt wanted to build a culture that would make people stay—which worked. He made many key hires that shaped the direction of the materials science department. He recruited current department chair Darrin Pochan as well as deputy dean Kristi Kiick. Only two of the professors he hired have left UD.

"I'm most proud of the faculty I hired," Rabolt said.

The curriculum is the foundation of any degree program, and Rabolt wanted modern, relevant, comprehensive courses. UD offered materials science courses already, and Rabolt reviewed every single one. He posed the question: "What do we want students to know in the 21st century as a materials scientist?"

The resulting list didn't just have technical requirements. It also featured soft skills like ethics and entrepreneurship. During his years at IBM, Rabolt had learned that these skills are critical to success. Then Rabolt checked every course offering against the list. Some classes were out, and some new ones took their places.

"At that stage, I knew we had something," he said. The department revisits that wish list of skills every few years.

To this day, Rabolt co-teaches a three-credit course on entrepreneurship for engineers in collaboration with the Alfred Lerner College of Business and Economics. Students learn about the financial, legal, scientific, and engineering issues associated with high-tech startups. Students work in teams on research and development and strategic planning for a new high-tech product.

When you start a new department, recruiting top-quality applicants can also be a challenge. When the fifth student joined, "one of the most promising students," it was "the beginning of a new generation," said Rabolt. That superstar student was Jeannie Stephens, who is now an assistant professor in biomedical engineering at UD.

Rabolt has been here all along as UD has added more and more stellar faculty to its roster and attracted talented students from all over the world. The materials science department's expertise base has grown, and so have its resources. For one, this department's work with nanoscale IR spectroscopy is among the best in the world.

Much of what Rabolt envisioned has come true—partially thanks to his tenacity.

"I come from the wrong side of the tracks in Brooklyn, and nothing is impossible for us," he said.

NEW FACULTY

LASHANDA KORLEY

LaShanda Korley joined UD in January 2018 as an associate professor of materials science and engineering, and chemical and biomolecular engineering after 10 years on the faculty of Macromolecular Science & Engineering at Case Western Reserve University. Korley earned her doctoral degree from the Massachusetts Institute of Technology in Chemical Engineering and the interdisciplinary Program for Polymer Science and Technology. At UD, her research group will study bio-inspired materials, including composites such as fiber-reinforced hydrogels, and actuating polymer-peptide hybrids. She also brings expertise in fiber and film manufacturing and would like to make an impact in bridging some of the materials components that are already strong themes at UD with new processing initiatives, she says. Korley is also passionate about mentoring students, especially through undergraduate research opportunities. She plans to conduct roundtable discussions and other outreach activities to empower women to consider careers in STEM.

ACCELERATING CANCER RESEARCH

Scientists at the University of Delaware and Nemours are developing new methods to test drugs

Long before a cancer drug lands on a pharmacy shelf, it is tested in cell cultures—groups of cells grown in a lab.

A research team from the University of Delaware and Nemours that includes materials science and engineering department chair Darrin Pochan and Dr. Sigrid Langhans, research scientist and affiliated professor of MSEG, wants to make these tests more efficient and effective. Their work, described in a recent paper published in Analytical Biochemistry, may help scientists develop cancer drugs—and maximize use of current therapies—faster.

New frontiers in drug discovery

Traditionally, scientists have cultured cells on flat plastic dishes. This method does not capture the complex relationship between cells and the materials that surround them. "Cells respond to their environment," said Peter Worthington, a graduate student in the Department of Biomedical Engineering. "The stiffness of the materials cells adhere to affects how they behave." Scientists are increasingly interested in developing three-dimensional cell cultures that more closely represent human tissue.

For the recently published paper, the team at the University of Delaware and Nemours worked with cells from pediatric brain tumors. Brain tissue, of course, is not stiff like plastic, so they built their cell cultures using hydrogel—a watery substance made of polymeric material. MAX8, a beta-hairpin peptide hydrogel, can be optimized to mimic the environments in several different types of tumors.

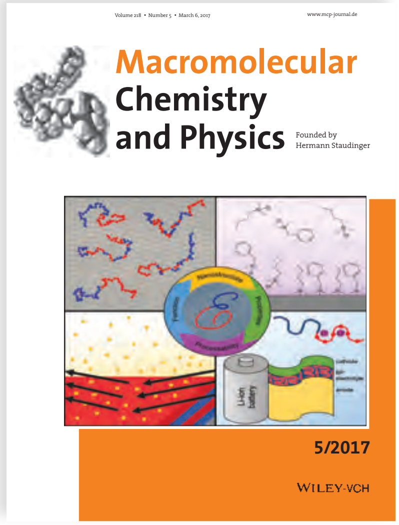
To test the effectiveness of drugs in cell cultures, many labs today use a technique called high-throughput screening. Automation is used to test many drugs in cell cultures in a short period of time. MAX8 has structural properties that make it compatible with the standard equipment used for these screening techniques.

The team tested three cancer drugs—cisplatin, vorinostat, and vismodegib—on their 3-D cell cultures as well as more traditional 2-D cultures to determine whether the assay was ready for high-throughput screening. They found that the cells behaved differently in their 3-D hydrogel models than they did in 2-D. Now, the researchers are trying to determine what these differences really mean, in hopes of enhancing the utility of this first stage of drug discovery.

"We're trying to make the first experiment more clinically relevant so that everything that follows is more accurate," said Worthington. "Maybe there's a family of compounds that 2-D screening overlooks but our 3-D screen could bring attention to."

Since submitting the Analytical Biochemistry paper for publication, the team has tested about 2,000 more drugs, including medicines from a wide variety of classes, not just cancer therapies.

For Pochan, co-author on the Analytical Biochemistry paper, "the possibility of finding a technological end use is really exciting."



TALENT ARTICLE

Epps team highlights work on tuning block polymers for nanostructured systems

High-performance materials are enabling major advances in a wide range of applications from energy generation and digital information storage to disease screening and medical devices.

Block polymers, which are two or more polymer chains with different properties linked together, show great promise for many of these applications, and a research group at the University of Delaware has made significant strides in their development over the past several years.

"We are using synthesis, processing and characterization methods that are robust and widely applicable, with an eye toward scaling these methods to facilitate the future industrial adoption of block polymers," says Thomas H. Epps, III, who leads the group.

Epps, who is the Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering and professor of Materials Science and Engineering at UD, and two of his graduate students, Melody Morris and Thomas Gartner, recently published an article highlighting this work in *Macromolecular Chemistry and Physics*. The piece was a "Talent" submission, a unique article type dedicated to young scientists.

The article highlights the Epps group's work aimed at tuning and characterizing block polymers in bulk and thin film geometries. The group has leveraged expertise in polymer chemistry, polymer physics, chemical engineering and materials science to manipulate the phase behavior, thermal transitions and mechanical and transport properties of block polymers to optimize materials design.

"Our goal was to show how a truly multidisciplinary approach can help solve problems in the development of next-generation materials — a development that requires simultaneous consideration of structure, properties and processing," Epps says.
He points to battery technologies as an example.

Battery membranes, and the associated electrolytes, used to enable ion transport for energy storage and generation applications can offer high performance in terms of rapid charging, long lifespan and minimal self-discharge. However, these benefits often are accompanied by safety — for example, explosion and fire — and environmental concerns.

"We want to design these membranes so that we can achieve the same, or better, performance as current technologies while also reducing the potential for explosions and other catastrophic failures," Epps says. "At the same time, we'd like to develop the ability to process these materials at lower temperatures and with decreased amounts of harmful solvents. In other words, we want to reduce defects and mitigate threats to the environment through control of fabrication."

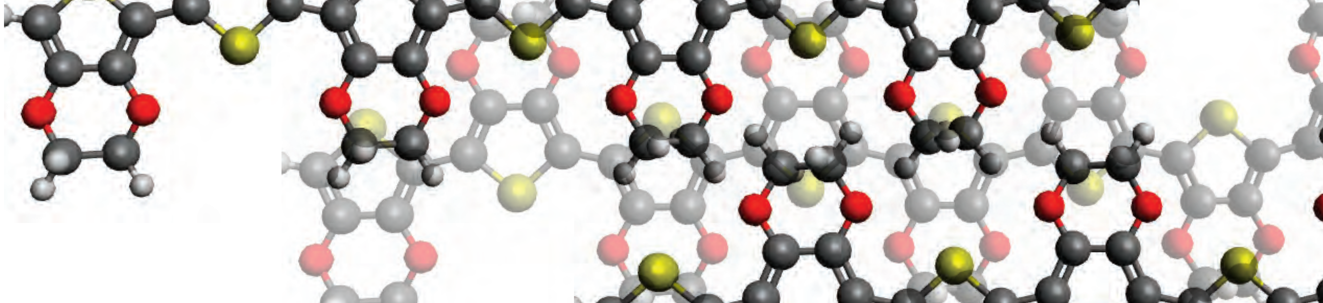
One approach the Epps group is taking is the use of nanoscale structures to improve both device performance and processing. To do this, they have developed high-throughput and combinatorial computational methods that allow nanoscale structures to be visualized with relatively low-cost optical techniques.

"Basically, this approach enables us to minimize the number of samples that need to be measured with expensive techniques such as atomic force microscopy and transmission electron microscopy," Epps says. The group also has developed universal design rules — that is, those that are applicable to a number of different types of surfaces and polymers — to understand key factors that link surface characteristics to nanostructure formation.

"These rules enable us to predict which polymers will work well with which surfaces, so, for example, we can create self-cleaning coatings that can resist fingerprint smudges on touchscreens," Epps says.

Epps is also leading an effort to do nanoscale patterning with block polymers as a low-cost alternative to lithographic approaches currently used to make electronic devices.

"With all of this work, I think the things that set us apart are the universal approaches, the inclusion of joint experiment and theory efforts, and our unique focus on combined chemistry, physics, and processing knowledge to accelerate materials design," he says.



MATERIALS BREAKTHROUGH

New approach to improving materials for interfacing neural tissue with electronic biomedical devices reported

Modern electronic biomedical devices are enabling a wide range of sophisticated health interventions, from seizure detection and Parkinson's disease therapy to functional artificial limbs, cochlear implants and smart contact lenses.

An effective direct interfacing material is essential to communication between these devices and neural tissue, which includes nerves and the brain.

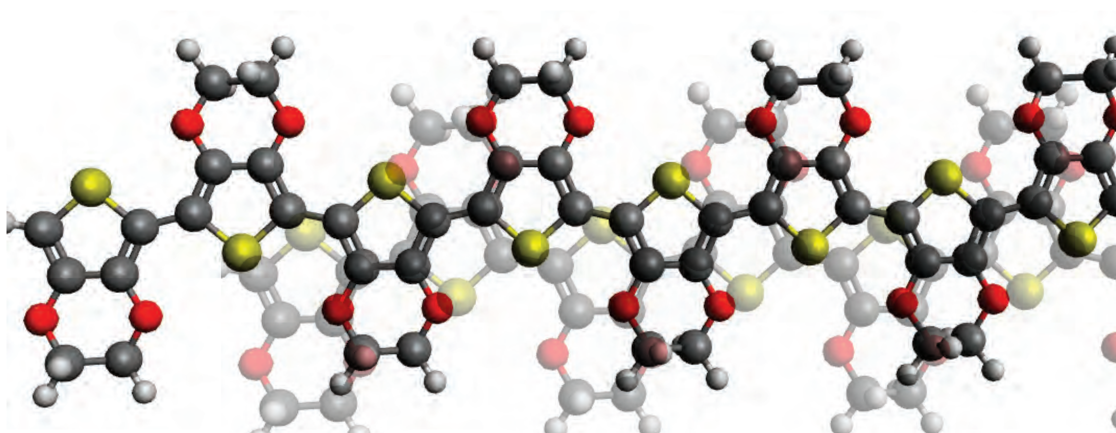
In recent years, a conjugated polymer known as PEDOT — widely used in applications such as energy conversion and storage, organic light-emitting diodes, electrochemical transistors, and sensing — has been investigated for its potential to serve as this interface. In some cases, however, the low mechanical stability and relatively limited adhesion of conjugated polymers like PEDOT — short for poly (3,4-ethylene dioxythiophene) — on solid substrates can limit the lifetime and performance of these devices. Mechanical failure might also leave behind undesirable residue in the tissue. Now, a research team led by David Martin, the Karl W. and Renate Böer Professor of Materials Science and Engineering, has developed an electrografting approach to significantly enhance PEDOT adhesion on solid substrates. The breakthrough is documented in a paper published in *Science Advances*.

Electrografting describes a process in which organic molecules are electrochemically oxidized or reduced, followed by the formation of metal-organic bonds at the substrate-polymer interface.

Compared to other methods, surface modification through electro-grafting takes just minutes. Another advantage is that a variety of materials can be used as the conducting substrate, including gold, platinum, glassy carbon, stainless steel, nickel, silicon and metal oxides.

The actual chemistry usually takes multiple steps, but Martin and his team have developed a simple, two-step approach for creating PEDOT films that strongly bond with metal and metal oxide substrates, yet remain electrically active.

"Our results suggest that this is an effective means to selectively modify microelectrodes with highly adherent and highly conductive polymer coatings as direct neural interfaces," Martin says.



STOPPING CANCER RECURRENCE

Susan G. Komen grant to support research on breast cancer recurrence

April Kloxin and doctoral student Lisa Sawicki study samples in UD's Colburn Lab

Although early detection and improved treatments have helped more women with breast cancer survive past the five-year mark, 20 percent of disease-free patients experience a recurrence five to 25 years later at a metastatic site — most often in the bone marrow or the lungs.

And their chances of surviving this secondary cancer are lower because it is often quite advanced before it is detected.

"There's a significant clinical need to understand the mechanism of late cancer recurrence to determine disease markers and improve treatment strategies," says April Kloxin, an assistant professor of materials science and engineering. "It has been hypothesized that late recurrences originate from tumor cells that disseminate to these other tissues in the body where they become dormant and are later re-activated."

Kloxin recently received a $450,000 grant from Susan G. Komen aimed at developing a better understanding of this dormancy and reactivation process so that ultimately recurrence can be prevented.

"While estrogen receptor positive tumors typically have better initial outcomes, late recurrences are a concern," she says. "If we can understand the mechanisms that drive the switch from dormancy to growth of this type of cancer, we can identify predictive biomarkers that may indicate which women are at risk and lay the foundation for the development of more effective treatment."

Kloxin's team plans first to create materials that mimic various metastatic sites and then identify key signaling pathways in cancer dormancy within these 3-D microenvironments. Second, they will focus on determining what regulates re-activation of the cancer cells within this cultured system. Finally, they will establish commonalities of dormancy or activation of patient-derived tumor cells in the culture model.

"This last goal is where we're really excited about our collaboration with the Helen F. Graham Cancer Center and Research Institute in the Christiana Care Health System," Kloxin says.

"Evaluating cells from actual patients will provide us with the heterogeneity of real cases and enable us to compare our findings with the traditional markers observed by clinicians."

The funding is part of a $32.7 million package of research grants recently announced by Komen, including more than $16 million to early-career investigators like Kloxin awarded through the organization's Career Catalyst Research Grants.

These grants are intended to foster promising young breast cancer researchers by providing them with support for up to three years for research career development under the guidance of a mentor committee.

"Komen's goal is to end breast cancer forever," Kloxin says. "It's exciting to be part of the global research community working to make this happen by using a variety of approaches and calling on the expertise of a broad range of people."

LITTLE HYBRIDS

NSF grant supports research on assembly of complex hybrid nanomaterials

An old saying suggests that great things come in small packages, but when "small" means nanoscale, putting those packages together can be a challenge—particularly when they involve diverse components.

"The intimate combination of inorganic nanoparticles and organic polymers within nanoscale packages of controlled sizes and shapes presents challenges in terms of production, while also offering opportunities for unique material properties," says Arthi Jayaraman, an associate professor in materials science and engineering and chemical and biomolecular engineering.

Funded by a four-year grant from the National Science Foundation, Jayaraman — along with UD's Darrin Pochan, William Johnson from the University of Utah and Karen Wooley from Texas A&M — will address those challenges so that the potential of these materials can be realized in a broad range of applications.

The research is aimed at developing computational and experimental tools that will guide the discovery and manufacture of hybrid inorganic-organic nanostructured objects, or HIONs.

Pochan explains that new polymer nanomaterials are typically designed at the molecular level and then placed in solution to see how they behave.

"We'd like to bring a more predictive and less empirical approach to this process," he says. "The computational tools that Arthi and Bill are bringing to this work will enable us to do that."

According to Jayaraman, computer-based assembly of polymers is usually accomplished in a stationary manner, but in the proposed work these hybrid materials will be assembled using a more dynamic approach. Pochan and Jayaraman liken this sequential process to building a shopping cart at the grocery store, then filling it in a prescribed, ordered way — for example, meat, vegetables, dairy, baked goods — and finally unloading it in the reverse order.

"As the material is built, the molecules move along a surface and collect various particles in a sequential manner, introducing new chemistries along the way — for example, hydrophobic, hydrophilic, and charged, in that order," Jayaraman says. "At the end, we have a new material with properties designed in layers, each layer intended for a specific role in the eventual application."

These hybrid materials can interact with complex natural materials like soils and water, so one potential application is pollution remediation, as HIONS can be designed to collect pollutants left behind by processes like fracking that take place in porous rock.

"Our ultimate goal is to enable high-throughput, tunable manufacturing of complex HIONs that exhibit compositions, structures, morphologies and properties for diverse technological applications," Jayaraman says. "We've already started to incorporate these concepts into our upper-level undergraduate and graduate-level polymer course in chemical engineering and materials science at UD."

Named Professorship Granted

Photos clockwise from left:

1. Kristi Kiick, deputy dean of the College of Engineering, Blue and Gold Distinguished Professor of Materials Science and Engineering

2. John Rabolt, David Martin, Kristi Kiick, Darrin Pochan (left to right)

3. Kristi Kiick and Babatunde A. Ogunnaike

Kristi Kiick, deputy dean of the College of Engineering and professor of materials science and engineering, has been named Blue and Gold Distinguished Professor of Materials Science and Engineering.

"Kristi is a distinguished leader in the field of biomaterials, an outstanding citizen of the community, and a true changemaker at this university, inspiring others to engineer solutions to challenging problems," said Babatunde Ogunnaike, dean of the College of Engineering.

Kiick joined the UD faculty as an assistant professor in materials science and engineering in 2001 and has been deputy dean since 2011.

Kiick's research focuses on the synthesis, characterization, and application of protein, peptide, and self-assembled materials for applications in tissue engineering, drug delivery, and bioengineering, with specific research in cardiovascular, vocal fold, and cancer therapies.

She has published more than 120 articles and book chapters, and has delivered over 150 invited and award lectures. She holds 21 patents.

Kiick received her bachelor of science in chemistry from UD as a Eugene du Pont Distinguished Scholar, where she graduated summa cum laude. She then received a master of science in chemistry as an NSF graduate fellow at the University of Georgia, followed by master of science and doctoral degrees in polymer science and engineering at the University of Massachusetts Amherst as a recipient of a National Defense Science and Engineering Graduate (NDSEG) fellowship. She received the Camille and Henry Dreyfus New Faculty Award in 2001, and an NSF Career Award and an Arnold and Mabel Beckman Foundation Young Investigator Award in 2003. She has served as program and meeting chairs for the American Chemical Society and Materials Research Society, respectively, and has been a Fellow of the American Institute of Medical and Biological Engineering since 2012 and the American Chemical Society since 2014.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ISEB Clean Room Corridor 1
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ISEB Clean Room Corridor 2
ISEB Clean Room Chase 5
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ISEB Clean Room Chase 4
ISEB Clean Room Service Corridor N...
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17
ISEB Clean Room Service Corridor S.
ISEB Gas Room 1
22
ISEB Gas Room 2

A BIG MOMENT *FOR TINY TECH*

Work now underway in UD's new Nanofabrication Facility

You have to think small to do the kind of work now underway in the University of Delaware's new Nanofabrication Facility (UDNF).

But you have to think big, too, because what happens in the UDNF "clean room" – more on that later – won't stay in the clean room. It will ship out to the wide world of biology, chemistry, engineering, electronics, health care, manufacturing, energy, physics, and who-knows-where-else. →

> “The future of science is in the fab”

In 2016, UD officials, faculty, staff and students marked the opening of the $30 million "machine shop of the 21st century" with a keynote address by nanotechnology pioneer Harold Craighead of Cornell University and a ceremonial ribbon-cutting in a packed hallway on the first floor of the Harker Interdisciplinary Science and Engineering Laboratory.

The facility is equipped to produce devices that cannot be seen by the naked eye – materials that can be used in a wide array of applications from medicine to environmental sciences to solar energy harvesting. The equipment in the laboratory allows researchers to make devices as small as 10 nanometers. "This is a state-of-the-art facility that will allow faculty, staff, students, and collaborators from across campus and beyond to envision research at its smallest scale," said Charlie Riordan, deputy provost for research and scholarship. "There are tremendous opportunities to develop technologies at the atomic level. And we are very well poised for all disciplines to leverage this technology to address the grand challenges we face in society."

The facility was years in the planning and now is in the hands of co-directors Matthew Doty, associate professor of materials science and engineering, physics, and electrical and computer engineering, and John Xiao, Unidel Professor of Physics and Astronomy. Xiao specializes in spintronics, nanofabrication and magnetic materials. Doty studies and develops nanostructured semiconductors.

Entry to the 8,500-square-foot clean room, where all the work is done, requires training, credentials, painstaking protocols and coverage from the "gowning room" – including hair nets, face and head covers, jumpsuits, gloves, booties, safety glasses and hard hats.

The clean room is rated for two layers of clean – one is Class 100, which means that it has no more than 100 particles measuring 500 nanometers or more in a cubic foot of air, and the other is Class 1,000, which means it has no more than 1,000 such particles per cubic foot.

For reference, an ordinary room would register about 100,000 particles per cubic foot.

To keep the air this clean, the air in the room is constantly pushed through filters, changing the air up to 300 times an hour.

Such hyper-clean conditions are mandatory because work at nanometer length scales can be sabotaged by unwanted particles. Without such measures, Xiao said, it would be like trying to frost a wedding cake while someone is throwing basketballs at you.

The clean room has four separate bays for processes including lithography, deposition of thin films, etching, and thermal processing. "We're getting the tools up and running and they're helping us qualify the tools," said Scott McCracken, facility specialist. "They're starting to do some work as well, starting some of their own projects."

The nanofabrication technology makes the University more appealing to students and faculty with such interests, and George Watson, physicist and dean of the College of Arts and Sciences, said he is taking the opportunity to recruit new faculty.

"This is opening up new opportunities," he said.

Ira Winston, chief infrastructure officer at the University of Pennsylvania's School of Engineering and Applied Science, saluted UD's accomplishment and that of his former colleague, Iulian Codreanu, who is now operations director of UDNF.

"We thought we built the premiere facility," Winston said. "But they [UD] made some choices we didn't make. They have some things we don't. So I know some of our users will be coming here. Collaboration is going to happen. We have some things they don't and they have some things we don't."

Industry leaders have shown significant interest in the University's new capacity, too. It's expensive equipment – the electron beam lithography setup alone cost about $3 million. Jim Sharp, president of Carl Zeiss Microscopy, attended the ribbon cutting when the UDNF opened. The facility has several Zeiss instruments in it.

"The future of science is in the fab," Sharp said. "The science will go there."

It is because of nanoscale technology that sophisticated computing can be done on devices the size of a wristwatch or cell phone rather than the massive machines that once required entire rooms to do the work of a glorified calculator.

And now, UD's tiny tech machine shop is poised to deliver extraordinary new possibilities.

UNDERSTANDING THE 2016 NOBELS

Faculty experts explain laureates' prize-winning work

Stephanie Law, Clare Boothe Luce Assistant Professor of Materials Science and Engineering, lent her expertise to a UD faculty panel convened to discuss the 2016 Nobel Prize-winning work in depth.

Law detailed the work behind the prize in physics, awarded to David J. Thouless, F. Duncan M. Haldane and J. Michael Kosterlitz.

The three men did work in phase transition — the process, for example, in which liquid water is cooled and becomes solid ice — and topology, a branch of mathematics that describes properties that only change step-by-step, not abruptly.

Topology, Law said, had been considered an "impractical" mathematical field, but it turned out to have important applications in physics.

The three Nobel laureates, she said, "really created an entirely new way to think about and classify matter, beyond the three states of solid, liquid and gas." They worked with very thin electrically conducting layers and with chains of atomic magnets that are found in some materials.

Their work laid the foundation for studying unusual phases of matter and for predicting a variety of exotic states of matter, Law said. Applications include spintronics and computer chips — research that is taking place at UD.

UD's Nobel symposium explores the groundbreaking work often not fully explained in news coverage of the prizes. Along with Law's commentary on the physics prize, fellow panel members explained the Nobel prizes in the areas of literature, physiology, peace, economics and chemistry.

HPC SYMPOSIUM

Janotti Research Group discusses parallel processing at HPC Symposium

Assistant Professor Anderson Janotti and his research group kicked off the University of Delaware's 2017 High Performance Computing Symposium. Their presentation, "Materials by Computational Design – A Bottom Up Approach," addressed the role of computer modeling in the discovery and optimization of new materials. The group also presented on how advances in parallel processing and the development of new algorithms are changing the landscape of materials science. With the ability to predict materials' properties, researchers are able to experiment with physical phenomena that is difficult to probe at the atomic scale. This presentation was a continuation of a series of meetings designed for researchers using or interested in using the University's HPC clusters.

RISING STAR

Law wins DOE Early Career Award and NAMBE Young Investigator Award

Stephanie Law, Clare Boothe Luce Assistant Professor in materials science and engineering at the University of Delaware, recently received a Department of Energy Early Career Award to study optical excitations in topological insulators.

She will receive $750,000 in funding over five years.

Topological insulators are materials that conduct electricity only on their outer surfaces, unlike common conductive materials, such as copper wires, which carry current both inside and out.

"The electrons on the surface of topological insulators are very special," Law said. They have tiny masses — even for electrons — and move at "an appreciable fraction of the speed of light."

When these electrons are exposed to light, they spin and vibrate in unusual ways.

As a result, topological insulators are sensitive to light in the terahertz range, which falls between microwave and infrared radiation. Terahertz light is invisible to the human eye and penetrates some opaque materials. Eventually, topological materials and the terahertz light they respond to might be used for defense applications, such as detecting explosives or examining the contents of shipping containers, says Law.

For now, Law and her team are exploring exactly how topological insulators interact with light.

For her investigations, Law makes thin films with stripes of bismuth selenide, a topological insulator. The films are made using a molecular beam epitaxy, which allows material to be deposited one atomic layer at a time.

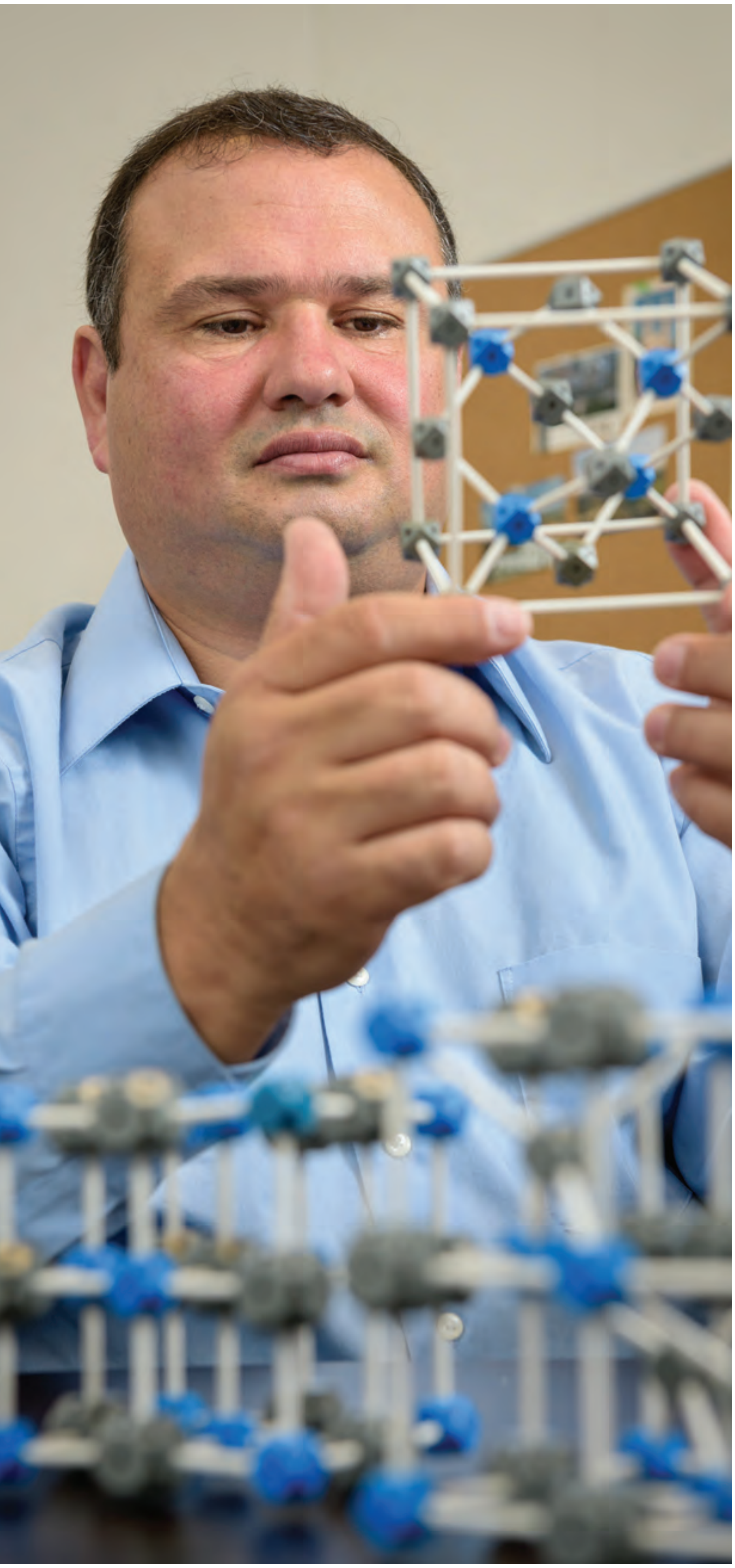
Then Law studies how the electrons on the surfaces of the stripes vibrate in response to light. The electrons behave differently depending on the thickness of the film or the width of the bismuth selenide stripes. Law will also make multi-layered films to see how electrons on one stripe interact with those on another.

Law is making waves in an emerging field. Topological insulators have only been around for about a dozen years.

"It's validating that the broader community is interested in my research ideas and willing to bet that I will produce results," she said.

Law is also a recipient of the North America Molecular Beam Epitaxy (NAMBE) Young Investigator Award for "contributions to the MBE growth of materials and devices that harness emerging physical phenomena, including topological insulators and plasmonics."

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. The widow of Henry R. Luce, Clare Boothe Luce was a playwright, journalist, ambassador and member of Congress. In her bequest establishing this program, she sought "to encourage women to enter, study, graduate, and teach" in science, mathematics and engineering.



DEFECTS THAT MATTER

Janotti wins NSF Career Award

Anderson Janotti has won a National Science Foundation Faculty Early Career Development Award to develop computational models of defects in materials that are used for energy, electronics, and optoelectronics applications.

The five-year grant was awarded through NSF's Division of Materials Research.

According to Janotti, assistant professor in materials science and engineering, the ability to control the type and number of defects present determines whether a given material will be suitable for device applications, so understanding and controlling defects is crucial to materials development.

Not surprisingly, defects can be detrimental to device performance, as is the case with those that limit the efficiency of solar cells.

On the other hand, they can also be manipulated to improve certain desirable characteristics.

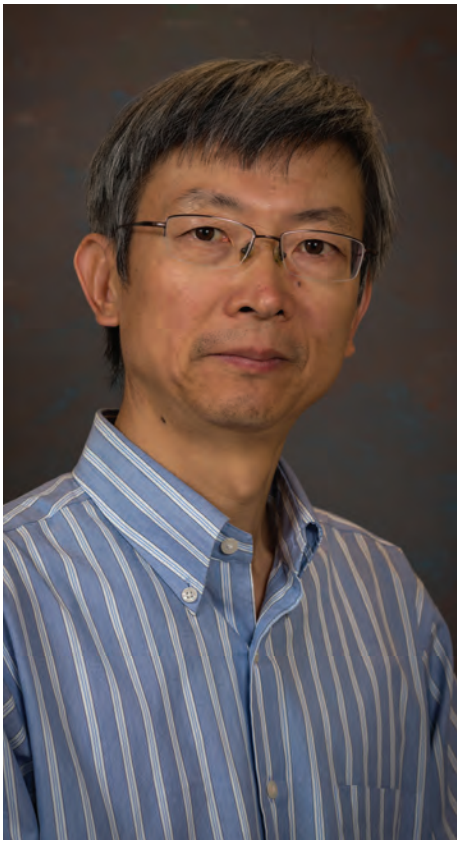
"For example, the electrical conductivity of semiconductors such as silicon and gallium arsenide can be drastically modified by adding minute concentrations of impurities, transforming a good insulator into an excellent conductor," Janotti says. "This technology is widely exploited in the microchips that are found inside our computers, smart phones, and tablets."

Computer modeling can play an important role in this effort, as it can complement experiments on materials by providing access to properties and phenomena that are difficult to probe at the atomic scale.

With the NSF support, Janotti will use advanced methods of electronic structure theory and supercomputers to investigate the role of defects in a series of complex materials that exhibit an array of physical properties. The research may enhance existing properties and could even lead to the discovery of new ones that can be used in novel device designs.

The funding will also enable the training of graduate and high school students. The graduate students will learn cutting-edge computational methods and advanced concepts in materials theory. They will also participate in an outreach program that involves teaching scientific programing to high school students. Through summer internships, the high school participants will develop data-manipulation tools that will help the graduate students with complex data visualization.

"Ultimately, we hope the work will identify defects that are detrimental to materials performance in devices and provide a basis to engineer defects, through doping or alloying, to enhance or broaden materials functionality," Janotti says.



Ni receives II-VI Foundation grant

Chaoying Ni, professor of materials science and engineering, has been awarded a grant from the II-VI Foundation to investigate "Thermal Transport in SiC and Diamond Based Composites." The one-year $95,000 award supports experimental and computational work aimed at elucidating the relationships among microstructural characteristics, thermal transport properties, and mechanistic essentials including interfacial and grain boundary behaviors of these composite systems. Applications for these materials include high-energy laser mirrors, armor, and semiconductor fabrication equipment due to their outstanding thermal, mechanical and environmental properties.

Additional Faculty Awards

Joshua Zide | 2017 | UD College of Engineering Outstanding Junior Faculty Award

David Martin | 2016 | MRS Communications Lecture Award (Inaugural winner)

MATERIALS SCIENCE AND ENGINEERING FACULTY

Robert W. Birkmire
Professor

Matthew F. Doty
Associate Professor; Co-Director of the UD Nanofabrication Facility

Thomas H Epps, III
Thomas and Kipp Gutshall Chaired Professor

John W Gillespie, Jr.
Professor; Director, Center of Composite Materials

Anderson Janotti
Assistant Professor

Arthi Jayaraman
Associate Professor

Xinqiao Jia
Professor

Kristi L. Kiick
Professor; Deputy Dean and Associate Dean for External Relations, College of Engineering; Blue and Gold Distinguished Professor of Materials Science and Engineering

April M. Kloxin
Assistant Professor

Kloxin, Christopher J.
Assistant Professor

LaShanda Korley
Distinguished Associate Professor

Stephanie Law
Clare Boothe Luce Assistant Professor of Materials Science and Engineering

Michael E. Mackay
Distinguished Professor of Materials Science and Engineering

David C. Martin
Karl & Renate Boer Chaired Professor of Materials Science and Engineering

Chaoying Ni
Professor; Director, W. M. Keck Center for Advanced Microscopy and Microanalysis

Robert L. Opila
Professor

Darrin J. Pochan
Professor; Department Chair

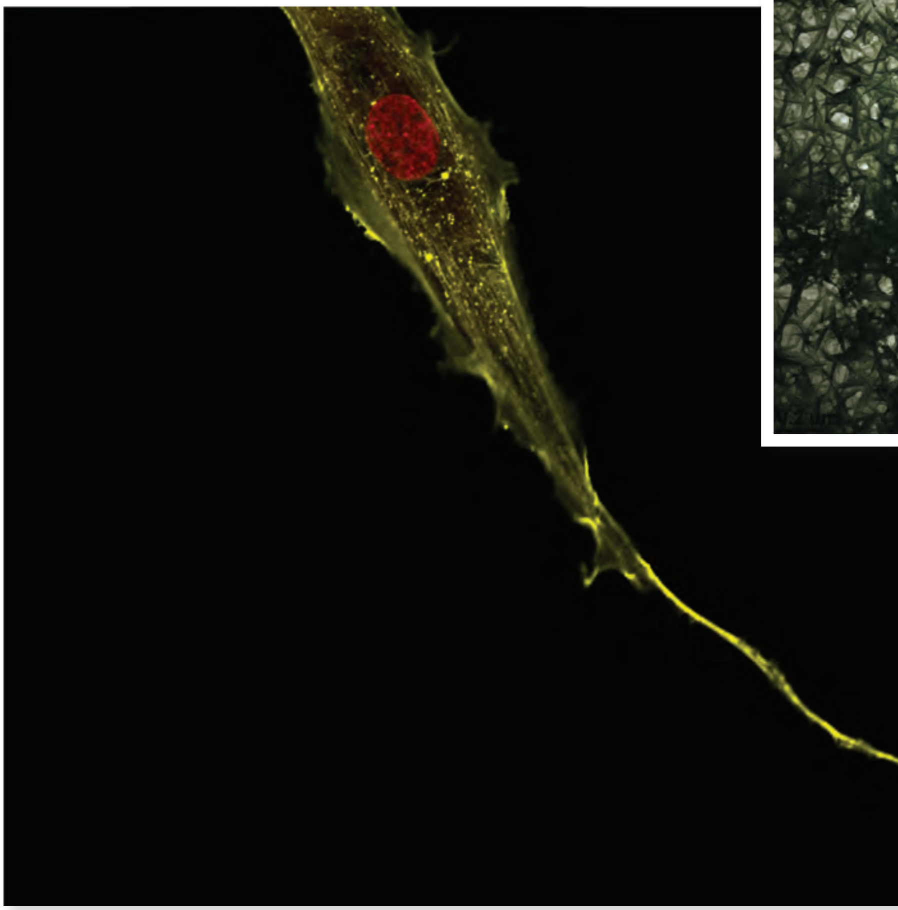
John F. Rabolt
Karl & Renate Boer Chaired Professor of Materials Science and Engineering

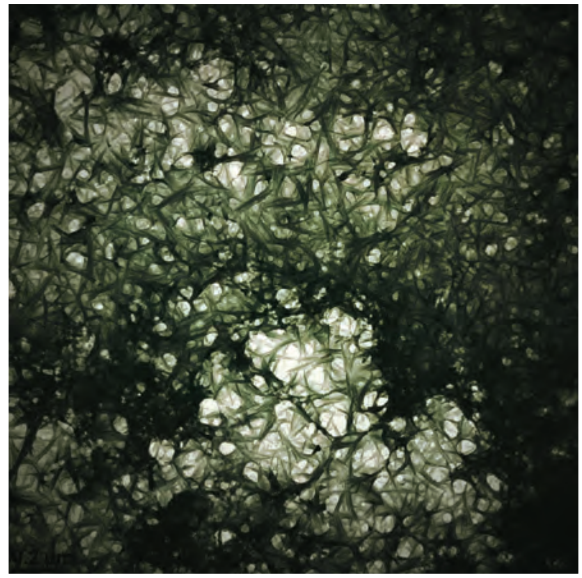
Syed I. Shah
Professor

Joshua M. O. Zide
Associate Professor

Affiliated Faculty

William Shafarman
Associate Professor; Interim Director, Institute of Energy Conversion

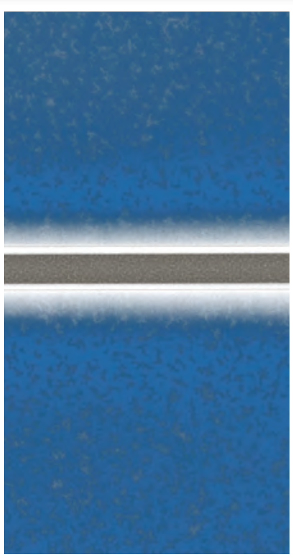


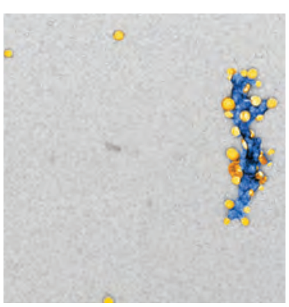


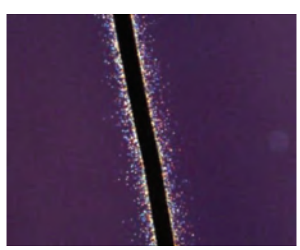
Art in Materials Awards

1st Place Winner, 2017
Sarah Geiger
"20,000 Nanometers Under the Skin"
Confocal microscope image of a human dermal fibroblast on a glass coverslip at 40x magnification.

2nd Place Winner, 2017
J. Harris
"Tangled Roots"
Webbed network of PLGA (poly(lactic-co-glycolic) acid) nanoparticles and CHRF cell membranes with TEM.







Additional Submissions

Bo Tew
"Welcome to Mont Blanc"
Dark particles (erbium and erbium arsenide) suspended on top of a liquid galium melt. This process is used for the growth of semiconductor thin films by Liquid Phase Epitaxy.

Sarah Geiger
"Seaway"
A colorized SEM image of a chalcogenide glass waveguide surrounded by residual Fluorine etch polymer at 50,000x magnification.

Chun-Yen (Nicolas) Hsu
"Incomplete Heart"
The incomplete heart composed of carbon nanotubes carpets presenting the natural of imperfection.

J. Harris
"Nano-Caterpillar"
Description TEM image of PLGA (poly(lactic-co-glycolic) acid) nanoparticles and CHRF cell membranes.

Vivik Subramanian
"The Wizard's Wand"
Description: Transmitted polarized light photomicrograph of oligomeric crystals of PEDOT crystallizing during the deposition on Gold.

STUDENT AWARDS

ASM & MSEG Poster Award

Eric Chen (Hard Materials | Doty)
"Morphology Control and Characterization of Upconversion Nanostructures for High-Efficiency Photovoltaics"

Sarah Geiger (Soft Materials | Jia)
"3D Photonic Sensor-Integrated Tissue Model for Force Sensing"

Departmental Awards

Chairperson's Outstanding Graduate Student Award
Matthew Lewis and Brian Sutherland

Outstanding Graduate Student Research Award
Tianshi Wang

Outstanding Graduate Student Teaching Award
James Hack

Outstanding Graduate Student Service Award
Tess Ginley

University & Graduate Awards

Bridges to the Doctorate Award
Zachary Sheffield

University Dissertation Fellowship Award
Eric Chen

Brandywine ASM Birchenall Paper Award
Hang Kuen Lau
"Aqueous Liquid - Liquid Phase Separation of Resilin-Like Polypeptide/Polyethylene Glycol Solutions for the Formation of Microstructured Hydrogels"

DENIN Poster Competition
Shuyu Xu
"Fabrication of Silver Coated Gold Nanorods Based Surface Enhanced Raman Scattering Substrates and Their Environmental Applications"

IGERT Award
Olivia George

NASA Delaware Space Grant College Program
Charles Jabbour

2017 Summer Internship
Eriq Gloria

2016 Electronic Materials Conference presenter
Cory Bomberger
"Growth and Characterization of ErAs Nanoparticles Epitaxially Embedded within GaBiAs"

MRS Officers 2017-18

Nicole Halaszynski, *President*
Jenna Harris, *Vice President*
Nick Valdes, *Secretary*
Olivia George, *Treasurer*
Michael Lloyd, *MA Rep*

CONGRATULATIONS
to our recent graduates

Steve Ackerman | MSSE 2015

Qi An | Ph.D. 2016
Thostenson
Electrophoretic Deposition of Ultrasonicated and Functionalized Nanomaterials for Multifunctional Composites

Mohamed Bah | Ph.D. 2017
Shah
Coercivity and Exchange Bias Study of Polycrystalline Hollow Nanoparticles

Nandita Bhagwat | Ph.D. 2015
Kiick
Novel Conjugates of Peptides and Conjugated Polymers for Optoelectronics and Neural Interfaces

Douglas Bishop | Ph.D. 2016
Birkmire
Fabrication and Modification of Defects in Cu2ZnSnSe4 Single Crystals and Thin Films

Cory Bomberger | Ph.D. 2016
Zide
Growth, Characterization, and Applications of Lanthanide Monopnictide Nanoparticles and Films in and on III-V Semiconductors

Seth Brynien | MMSE 2017

Yingchao Chen | Ph.D. 2015
Pochan
Construction and Characterization of Hybrid Nanoparticles Via Block Copolymer Blends and Kinetic Control of Solution Assembly

Ziran Chen | MMSE 2016
Pochan

Tai-Hsiang Chiu | MSSE 2017

Jonathan Church | Ph.D. 2015
Opila
Thin Film Subsurface Environments; Advanced X-Ray Spectroscopies and a Novel Bayesian Inference Modeling Algorithm

Pernell Dongmo | Ph.D. 2015
Zide
The Properties of Dilute Bismuthides and Rare-Earth Containing Materials for Applications in Thermoelectrics, Optoelectronics, and Terahertz Technology

Selim Ergen | MSSE 2017

Sean Fudger | Ph.D. 2017
Ni
Residual Stress Induced Mechanical Property Enhancement in Steel Encapsulated Light Metal Matrix

Liang Gong | Ph.D. 2017
Rabolt
Discovery of the β-Form Crystal Structure in Electonspun Nanofibers of Bio-Based Poly[®-3-Hydroxybutyrate-CO-®-3- Hydroxyhexanoate] and Its Implication on Properties

Jianbo He | Ph.D. 2015
Birkmire
Laser Processing in Fabrication of Interdigitated Back Contact Silicon Hetero-Junction (IBC-SHJ) Solar Cell

Chun-Yen Hsu | MSSE 2016
Ni

Xiaocao Hu | Ph.D. 2016
Hadjipanayis
Synthesis and Characterization of Magnetically Hard Fe-Pt Alloy Nanoparticles and Nano-Islands

Prathamesh Kharkar | Ph.D. 2016
Kiick & A. Kloxin
Design of Multimodal Degradable Hydrogels for Controlled Therapeutic Delivery

James Krajewski | Ph.D. 2016
Opila
Non- Destructive Depth Profiling Using Variable Kinetic Energy-X-Ray Photoelectron Spectroscopy With Maximum Entropy Regularization

Vinu Krishnan | Ph.D. 2015
Rajasekaran & Jia
Bioengineering Targeted Nanodrugs for Hematologic Malignancies: An Innovation in Pediatric Oncology

Chin-Chen Kuo | Ph.D. 2017
Martin
Optimizing the Performance of Neural Interface Devices with Hybrid Poly(3,4-Ethylene Dioxythiophene) (Pedot)
Chuyin Leng | MSSE 2015

Lan Li | Ph.D. 2016
Hu
Materials and Devices for Mechanically Flexible Integrated Photonics

Yingkai Liang | Ph.D. 2016
Kiick
Engineering Polymeric Matrices for Controlled Drug Delivery Applications: From Bulk Gels to Nanogels

Hongtao Lin | Ph.D. 2015
Hu
Chalcogenide Glass Mid-Infrared On-Chip Sensor for Chemical Sensing

Jinglin Liu | Ph.D. 2016
Martin
Structure and Properties of Conjugated Polymer Thin Films and Nanofibers

Wenwen Liu | Ph.D. 2015
Rabolt
Preparation and Characterization of Multi-Layer Biodegradable Nanofibers by Coaxial Electrospinning and Their Potential for Tissue Engineering

Tianzhi Luo | Ph.D. 2016
Kiick
Collagen Like Peptide Bioconjugates for Targeted Drug Delivery Applications

Thomas Mangan | Ph.D. 2015
Birkmire
Cu2ZnSn(S,Se)4 Photovoltaic Absorber Fabrication by Hydride Chalcogenization of Electrodeposited Precursors

Preston McDaniel | Ph.D. 2017
Gillespie
Nanoscale Morphology to Macroscopic Performance in Ultra High Molecular Weight Polyethylene Fibers

Christopher Leland McGann | Ph.D. 2015
Kiick
Resilin-Like Polypeptide-Poly (Ethylene Gylcol) Hybrid Hydrogels for Mechancially-Demanding Tissue Engineering Applications

Ngoc Nguyen | Ph.D. 2016
Mackay
Flow Induced/Refined Solution Crystallization of a Semiconducting Polymer

Okechukwu Ogbuu | Ph.D. 2016
Hu
High Index Glass Thin Film Processing For Photonics and Photovoltaic (PV) Applications

Andrew Olenderski | MSSE 2017

Krunal Parikh | MMSE 2017

Paul Parsons | MSSE 2016
Mirotznik & Opila
Development of Magnetodielectric Materials To Be Used in Additive Manufacturing Processes for High-Frequency Applications

Jing Qu | Ph.D. 2017
Martin
Electrochemically Deposited Conducting Polymers for Reliable Biomedical Interfacing Materials: Formulation, Mechanical Characterization, and Failure Analysis

Roddel Remy | Ph.D. 2016
Mackay
Thermal Characterization of Semiconducting Polymer Bulk Heterojunctions

Brian Sobieski | Ph.D. 2017
Rabolt
Characterization of a Bio-Based, Biodegradable Class of Copolymers, Poly[(F)-3-Hydroxybutyrate-CO-R-3- Hydroxyhexanoate], and Application Development

Sina Soltanmohammad | Ph.D. 2017
Shafarman
Advanced Precursor Reaction Processing For Ag-Alloyed Cu(In,Ga)Se2 Solar Cells

Brandon Stewart | MSSE 2017

Jessie Sun | Ph.D. 2015
Pochan
Hydrophobic Payload Encapsulation and Release Characteristics in Self-Assembled Peptide Hydrogels

Stephanie Varkas | MSSE 2015

Zhiqiang Wang | MSSE 2016
Shah
Cu2ZnSnSe4: Synthesis and Characterization

Bin Wei | Ph.D. 2016
Martin
Electrochemically Polymerized Conjugated Polymer Films: Stability Improvement and Surface Functionalization

Haocheng Wu | MSSE 2017
Kiick
Kinetics Study of Degradation of Maleimide-Thiol Conjugates in Reducing Environments

Peipei Xin | Ph.D. 2017
Shafarman
Alternative Buffer Layer Development in Cu(In,Ga) Se2 Thin Film Solar Cells

Danning Zhang | Ph.D. 2017
Gillespie
Void Consolidation of Thermoplastic Composites Via Non-Autoclave Processing

Wenluan Zhang | Ph.D. 2016
Mackay
Morphology Control of Polymer: Fullerene Solar Cells by Nanoparticle Self-Assembly

Xinran Zhou| Ph.D. 2015
Doty
Spectroscopic Properties of Self-Assembled Lateral Quantum Dot Molecules

Yi Zou | Ph.D. 2015
Hu
Novel Low-Symmetry Gratings for Ultimate Light Trapping Enchancement in Next-Generation Photovoltaics

University of Delaware

College of Engineering

Department of Materials Science & Engineering
201 Du Pont Hall
Newark, DE 19716-1501

MATERIAL SCIENCE 20TH ANNIVERSARY CELEBRATION

20th Anniversary Celebration
Saturday, May 12, 2018

Various events throughout 2018

FOR DETAILS AND TO REGISTER, VISIT: WWW.MSEG.UDEL.EDU

Department of
MATERIALS SCIENCE & ENGINEERING

1998-2018
20 YEARS