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Fall 2018

Department of Materials Science and Engineering

DEPARTMENT NUMBERS

- ***30 tenure-line faculty***
- ***200 graduate students***
- ***395 undergraduate students***
- ***80 research associates/ postdoctoral scholars***
- ***$16,318,449 annual research expenditures***

Clockwise from top left: Katina Posney, Laura Tetrault, Eric Sagmuller, Meg Abplanalp, and Scott Henninger working in the Steidle Building.

DEPARTMENT LIFE

FACULTY, STUDENT, & ALUMNI NEWS

RESEARCH UPDATES

Close connections help MatSE staff, faculty achieve growth, great things

Meg Abplanalp, an academic adviser and recruiter, oversees undergraduate students until they turn their tassels, and oftentimes, after that.

"I'm their MatSE mom through new student orientation, TOTEMS, and their entire undergraduate experience, and remain close after. We're not just creating Penn Staters. We're creating a Penn State family."

Abplanalp is one piece in the network of staff members making the department a welcoming place for students, a productive environment for researchers, and a place where energy and camaraderie drive innovation and success.

'It's a first name basis'

Katina Posney, administrative support coordinator, oversees budgets, staff, grants and endowments, and salaries. She's also frequently in contact with alumni. She's been with the department for seventeen years and has watched it grow more than 150 percent in the past decade.

Posney said the camaraderie allows the staff to manage that growth.

"Hands down I love the people," Posney said. "MatSE creates such a family environment with their faculty. It's a first name basis."

Focus on research

Laura Tetrault says that if she does her job correctly it gives researchers more time to focus on solving problems that make a difference.

As a proposal and grant assistant, Tetrault's job is preparing, submitting, and tracking grants. That's a task made even more difficult by a spate of recent faculty hires and high-profile research projects. For this year, approved research funding is up 400 percent over last year.

"I always like to see winning proposals," Tetrault said. "It is fascinating and inspiring to know the research our faculty do. They're passionate about bettering society. That's what makes me want to make their jobs easier."

That research doesn't get off the ground without the help of Scott Henninger, facilities representative, and Eric Sagmuller, research support technologist. Henninger is responsible for building and laboratory safety and Sagmuller handles equipment maintenance and some repairs. With more than 27,000 square feet of laboratories open to undergraduate, graduate, and faculty researchers, that's no easy task.

As a member of the safety committee, Henninger is focused on improving lab safety and safety education for students.

In a method implemented in 2015, he helped roll out a plan that covers both. Selected graduate students, who are most often in the lab, are trained on lab safety and spread their knowledge to others. This, said Henninger, opens a two-way channel of communication where these students learn and train using expert advice while in frequent contact with him and other lab safety managers.

Sagmuller, who has worked for the department for twenty-five years, also keeps equipment running smoothly.

'The possibilities are endless'

From biomedical to energy harvesting, Posney said cohesion is what allows the staff and faculty to work together to find solutions for society's most pressing problems.

"Our increased funding is going to support so many great research endeavors," Posney said. "Materials science is on the forefront of so many things. The possibilities are endless."

A Note from the Department Head

Welcome to the fall newsletter! University Park is teeming with students after the relative quiet of the summer term and there is a great sense of excitement and anticipation for the semester ahead. MatSE continues to grow and we welcome our largest group of students ever, with 395 undergraduate students and 200 graduate students! Steidle Building is back to its lustrous self after the flood at the start of the calendar year, and our students, faculty, and staff continue to enjoy the amazing space. I am also happy to announce that the MatSE website has undergone a complete redesign and I encourage you to check it out when you have a few minutes.

In this newsletter you will read about the MatSE staff who work with our students as they work towards graduation, always ensure that the laboratory equipment functions at its best, pay the bills on time, help put together contracts and proposals, and enable the production of this newsletter! You will also read about some of the significant accomplishments of our faculty and students, including the production of wearable energy harvesting devices, the improvement of the injection molding of polymers to the benefit of industrial partners, and the development of medium-band infrared sensors. Our featured alumna is the newest member of the MatSE External Advisory Board. Dr. Titilayo (Titi) Shodiya applies her expertise in materials science and engineering as a program manager at NIST and co-produces an award-winning podcast that focuses on the interplay between science and pop culture.

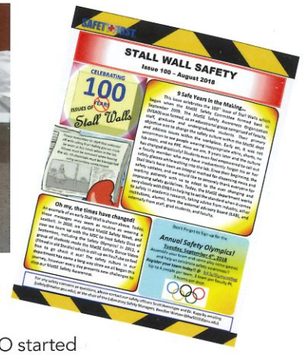
As always, I look forward to hearing from alumni and friends of MatSE at sinnott@matse.psu.edu and 814-863-3117. Do not hesitate to drop me a line to share your story or to let me know when you will be in State College; I will be happy to arrange for you to tour Steidle Building or the Millennium Science Complex.

Susan B. Sinnott

Susan B. Sinnott
Department Head and Professor of Materials Science and Engineering

Our first Steidle Café was held September 20th 'mixing one faculty, one staff, and one student'. Clara Capparelli, Ph.D. student in chemical engineering (shown above), Professor Enrique Gomez, and Katina Posney, administrative support coordinator, were presenters. The Steidle Café will be held monthly throughout the year.

Student attempts to beat the best time at the speed gowning station during this year's Safety Olympics at the Millennium Science Complex.



Focus on Department Safety

August marked the 100th issue of the Stall Wall safety flyer that began nine years ago in September 2009. Also that year, the MatSE Safety Committee met for the first time and formed the MatSE Safety Awareness Organization (MSAO) as an educational group comprised of faculty, staff, and students. Their primary objective was to change the safety culture within the MatSE department. Since their beginning, the Stall Walls have been an integral method for dispersing news and safety updates.

In 2010, MSAO started MatSE Safety Week, and now teams up with the Millennium Science Complex to host Safety Days of September, including the Safety Olympics. This year, MatSE won the Safety Olympics!

The safety culture in our department has come a long way since we all began this journey; however, every day presents new challenges to MSAO.

LEADERS CHANGING THE WORLD

Professor Zi-Kui Liu Nominated for ASM VP

Professor Zi-Kui Liu, FASM, was nominated for vice president and trustee of ASM International for a term of one year. The nominees will be confirmed at the ASM Annual Business Meeting on October 15, during MS&T18 in Columbus, Ohio. Once elected, the vice president will automatically become the ASM president for 2019-20.

"I would like to thank the nominating committee members for their trust," said Liu. "I am grateful for this opportunity to serve ASM International who has supported our profession tremendously. I will do my best to work with the society members, leaderships, and various stakeholders to further strengthen ASM International, enhance its impact to academy, research institutions, and industry, and make the world a better place."

Professor James Adair Named Inventor of the Year

Professor James Adair receives the 2018 Invent Penn State "Inventor of the Year" award for his work on cancer treatment and delivery from Vice President for Research Neil Sharkey.

First Ever Poster Session for MatSE Accelerated M.S. Students

The inaugural poster session was held on Tuesday, July 31, in the Steidle Building Atrium. The iMatSE Accelerated M.S. students presented their research to fellow graduate students, faculty, and staff at the event.

Celebrating the retirement of Professor Jim Runt

Above, Professor Jim Runt (second from left) stands with his family. On Friday, August 31, the department held an event to honor his legacy. Faculty, staff, and alumni regaled the crowd with their stories and experiences of working with Runt.

INVENTING TOMORROW: FOCUS ON MATERIALS RESEARCH

Device harvests energy from low-frequency vibrations

A wearable energy harvesting device could generate energy from the swing of an arm while walking or jogging. The device, about the size of a wristwatch, harvests enough power to run a personal health monitoring system.

In this work, Professor Susan Trolier-McKinstry and her former doctoral student, Hong Goo Yeo, used a well-known piezoelectric material, PZT, and coated it on both sides of a flexible metal foil to a thickness four or five times greater than in previous devices. Greater volume of the active material equates to generation of more power. By orienting the film's crystal structure to optimize polarization, the performance—known as the figure of merit—of energy harvesting was increased. The compressive stresses that are created in the film as it is grown on the flexible metal foils also means that the PZT films can sustain high strains without cracking, making for more robust devices.

Collaborators at the University of Utah and in Penn State's Department of Mechanical Engineering designed a novel wristwatch-like device that incorporates the PZT/metal foil materials.

In future work, the team believes they can double the power output using the cold sintering process, a low-temperature synthesis technology developed at Penn State. In addition, the researchers are working on adding a magnetic component to the current mechanical harvester to scavenge energy over a larger portion of the day when there is no physical activity.

The National Science Foundation Nanosystems Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies funded this project.

Hong Goo Yeo, Tiancheng Xue, Shad Roundy, Xiaokun Ma, Christopher Rahn, Susan Trolier-McKinstry, "Strongly (001) Oriented Bimorph PZT Film on Metal Foils Grown by rf-Sputtering for Wrist-Worn Piezoelectric Energy Harvesters" Advanced Functional Materials, 2018, 28 (36), pp 1801327 DOI: 10.1002/adfm.201801327

Fantastic plastics: reshaping injection molding

A professor researching ways to enhance outdated injection molding technology teamed up with a rheology expert and a theoretical polymer physicist and together they opened a new chapter on polymer crystallization.

Professor Ralph Colby, the department's expert in rheology partnered with Professor Alicyn Rhoades, associate professor of engineering at Penn State Behrend and Professor Scott Milner, the William H. Joyce Chair Professor in the department of chemical engineering, to get a better basic understanding of how plastics cool from a liquid to solid in injection molding.

The goal of injection molding is to get polymers to orient themselves and crystallize in a specific way. It's not as simple as just heating and cooling the material; rather, it requires the right amount of pressure and temperature to make individual molecules play nicely with one another and get into the right order.

Their work, which involves some new techniques, is already helping industry partners. The team has been working closely with two major players in the plastics industry: GM, from the automotive industry, and SKF, from the aerospace industry. Some of their work is already being fed into injection molding software so that it more accurately predicts how the product will behave.

Alicyn M. Rhoades, Anne M. Gohn, Jiho Seo, René Androsch, and Ralph H. Colby,"Sensitivity of Polymer Crystallization to Shear at Low and High Supercooling of the Melt"Macromolecules, 2018, 51 (8), pp 2785–2795 DOI: 10.1021/acs.macromol.8b00195

Infrared light is impossible to see with the naked eye, but in it researcher Jon-Paul Maria sees endless possibilities.

Professor Jon-Paul Maria, who joined Penn State as a professor in January 2018, is investigating medium wave infrared light, which is best at seeing through obscurants in imaging, sensing, and communication applications.

The technology can be useful in a range of areas including the military, automotive, first responders, and even the food industry helping them see through clouds, smoke, fog, dust, and even food spoilage.

Currently, medium band infrared sensors are costly to build because they are made from materials that are expensive, difficult to process, and require cryogenic cooling. This makes the operation and deployment more expensive than the sensor itself.

Maria's approach, using the degenerate semiconductors cadmium oxide (CdO), indium nitride (InN), and gallium nitride (GaN), looks at creating optical elements and sensors using materials that can be operated at room temperature. This works by tuning them so that when they couple strongly with IR light, it's not only very efficient but also allows the engineering of plasmon-polaritons, or resonating dipoles created by oscillating electrons.

Maria and his group want to engineer a material so that it absorbs incoming infrared light, excites a large population of plasmon-polaritons, which in turn creates "hot electrons." If the carriers get hot enough they can be filtered from all others and collected as a voltage or a current. It's essentially an infrared solar cell. The hotness of these excited carriers makes them stand out against the thermal background so the device does not need to be cooled and can operate at room temperature.

"The bulk of our work," Maria said, "is based on degenerate semiconductors. We focus on preparing these semiconductors with the highest combinations of carrier concentration and mobility with a technique called pulsed plasma sputtering."

Pulsed plasma sputtering creates thin layers of these degenerate semiconductors within a very reactive environment due to very high power densities that can be sustained.

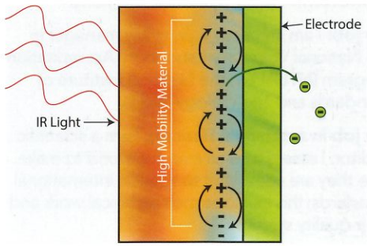


Illustration of pulsed plasma sputtering

Because of this special environment, it is possible to control composition, morphology, crystallinity, and defect chemistry to a better degree as compared to conventional approaches. This enables us to make oxide and nitride semiconductors with extremely high carrier concentrations while maintaining high mobility.

An expert in new materials, Maria's research focuses on replacing existing materials with alternatives that have better properties, are easier to manufacture, and are inspired by technology opportunities.

Evan L. Runnerstrom, Kyle P. Kelley, Edward Sachet, Christopher T. Shelton, and Jon-Paul Maria,"Epsilon-near-Zero Modes and Surface Plasmon Resonance in Fluorine-Doped Cadmium Oxide Thin Films" ACS Photonics, 2017, 4 (8), pp 1885–1892 DOI: 10.1021/acsphotonics.7b00429

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The Department of Materials Science and Engineering biannual newsletter

Alumna Spotlight: Dr. Titilayo (Titi) Shodiya, '10 joins the EAB

Hometown: Upper Marlboro, Maryland

My job: I am currently a program manager in the National Voluntary Laboratory Accreditation Program (NVLAP) at the National Institute of Standards and Technology (NIST).

My job in a nutshell: Basically, I am a scientific auditor. I assess labs all over the world to make sure they are compliant to specific international standards; this includes their technical work and their quality systems.

Through my career I hope to: make an impact on the international scientific community that is greater than the work I have done at the lab bench. I want to increase diversity in STEM majors and careers, and improve the scientific literacy of all people.

Why I chose Penn State: Penn State was the only university I visited that felt like home. And I knew the Penn State name would open doors for me, and it definitely has!

The professors that had the biggest impact on me/the professor I will never forget: Dr. Allen Kimel is a HUGE reason I have been able to be successful as an engineer. He wasn't my official academic adviser, but his mentorship during my time at Penn State was life changing. He is such a great asset to the MatSE program because he truly cares.

Fun fact about me: I was recently featured in *ELLE* magazine online for winning a podcast competition with Spotify. I have a podcast with one of my good friends from graduate school called "Dope Labs," where we show the intersection of science and pop culture. Our pilot should be out this fall so keep your eyes and ears peeled!

You might be surprised to know that: I hiked 110 miles through the Italian, Swiss, and French Alps for my honeymoon.

The teams I always cheer for: The Nittany Lions! (of course), the Duke Blue Devils, and the Michigan Wolverines.

I'm always up for watching: Judge Judy…I've never loved someone so rude so much.

The holiday I most look forward to is: SHARK WEEK on Discovery Channel. That's a holiday for me!

My advice to graduating students: The PSU network after graduation is an amazing resource, so always reach out. Also, always reach back to help people as you are advancing in your career.

Dr. Titi Shodiya is the newest member of the MatSE External Advisory Board (EAB).

ALUMNI SPOTLIGHT

Our alumni lead extraordinary careers, and celebrating their success is our priority. Please write to us anytime; we want to stay in touch. Contact: multimedia@matse.psu.edu