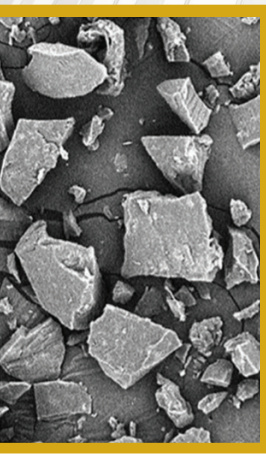
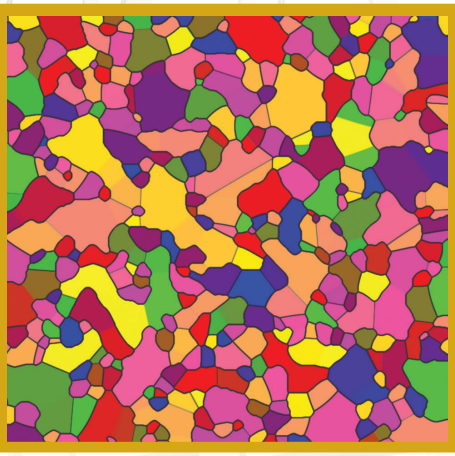
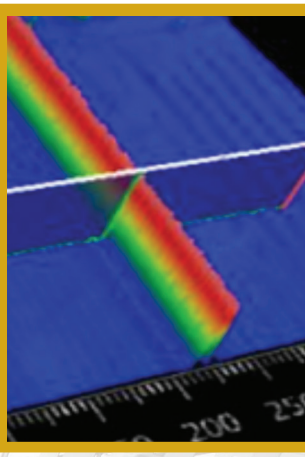
Materials Matter @Purdue

2019 Annual Newsletter



You Can't Make it Without Materials

Student highlights

Cutting-edge, faculty-led research

Alumni teams and successes

PURDUE UNIVERSITY

Materials Engineering

A Message from the Head

inside

Boilermaker MSE's,

I'm guessing you don't go back and read last year's Head's letter in the newsletter, so in one way that's good, since I could recycle almost everything in it. There are basically no metrics that wouldn't yet again be a record. We have over 170 graduate students enrolled, 66 BS MSE degrees were granted in 2019, and we crossed $20M in research expenditures this year. New faculty were hired, new staff members are on board to provide leadership in industrial impact and to ensure we're operating in a safe manner, and our operations continue to improve to meet our booming enrollment and research enterprise. New facilities have opened up; the MSE Laboratory for Advanced Materials and Processing at the Engineering Research Labs at Kepner had its grand opening in May 2019 (if you would like to name that building so we can have a catchier name please let Robyn know), several MSE faculty have added lab space in the new FLEX lab at the south end of campus in Discovery Park, and new facilities continue to grow at the Indiana Manufacturing Institute in the Purdue Research Park.

So this year let me come back to something from a couple years ago… *"building the materials community."* We believe Purdue MSE should play an important role in shaping the materials engineering community on campus and around the country. We should do that through the discoveries we make, and often we try to move these discoveries to have impact outside the university. That impact may take place in an existing industry, through entrepreneurial activities, or in practices that impact government or industry standards and processes. We should impact the educational processes for our students, from our ever-evolving credit-based curriculum, such as new classes on polymers and lean manufacturing of materials, to an all-online short course on Additive Manufacturing, to being the college leader in extending our undergraduate courses to off-campus co-op and interns in the summer (that's Purdue Online, not Purdue Global, just FYI). And we should develop educational tools for the nation; with incorporating computational tools from our intro to senior courses using the world-class nanoHUB platform that runs on Purdue's supercomputers. Finally, in addition to doing research and teaching, we serve, because we are a land grant school after all. As you can see from our student highlights and awards we recognize the ways our students help each other, help other students, and help the community.

Please let us know if you're coming to campus, and follow us on social media for events on and off campus (see you in Portland at MS&T in late September!) So, as the 150th celebrations slowly wind down (with one last burst at homecoming from MSE), we continue to try to always show *"You can't make it without materials"*…

Hail Purdue!

Dr. David F. Bahr
Professor and Head
of Materials Engineering

SCHOOL OF MATERIALS ENGINEERING

The John A. Edwardson Dean of the College of Engineering and the Roscoe H. George Professor of Electrical and Computer Engineering • **Dr. Mung Chiang**

Head • **Dr. David F. Bahr**

Chief Development Officer • **Robyn Jakes**

www.engineering.purdue.edu/MSE

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We welcome your comments, opinions, and questions. Please send them to the following address:

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PURDUE UNIVERSITY | Materials Engineering
COLLEGE OF ENGINEERING

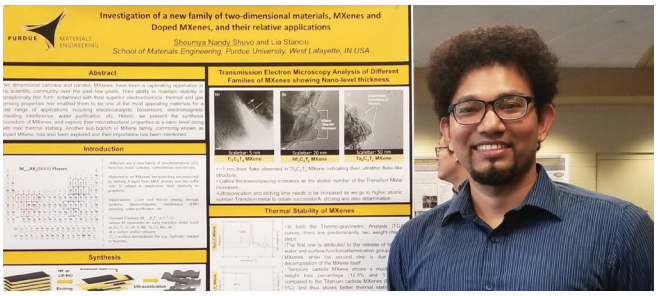
Surface Engineering and Advanced Materials Processing Conference

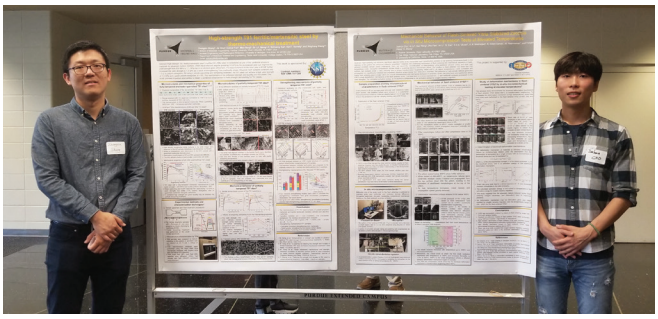
On May 29-30, 2019, the School of Materials Engineering hosted more than fifty attendees from over thirty companies on the Purdue campus for a Surface Engineering and Advanced Materials Processing Conference. During this interactive event, participants had the opportunity to engage with some of Purdue Engineering's world-class faculty and commercial and governmental partners, while simultaneously learning about Purdue's advanced capabilities and current research in the areas of surface engineering and materials processing. In addition, information was provided about the Center for Surface Engineering and Enhancement (CSEE) which will focus on surface engineering techniques such as heat treating, shot and laser peening, coatings, surface modeling, and thin films.

The conference also served as the grand opening for the new Laboratory for Advanced Materials & Processing (LAMP), an innovation center for applied research in advanced materials processing. This innovative laboratory facility is located off-campus in Lafayette, Indiana. Current technologies include, but will not be limited to high temperature materials processing, ceramics and superalloys as well as coatings and castings.

As part of the conference, ASM (Indianapolis Chapter) co-sponsored a networking session and graduate student poster session. Congratulations to MSE graduate students: Shoumya Nandy Shuvo, Jaehun Cho, and Zhongxia Shang who received the top three poster awards.

If you were unable to attend the conference, but would like to learn more about membership in CSEE or LAMP, please contact the Managing Director for Industrial Consortia, Mark Gruninger at mgruninger@purdue.edu or Chief Development Officer, Robyn Jakes at rnjakes@prf.org.





Recent Faculty Awards & Recognition

Srinivasan Chandrasekar
2019 Milton C. Shaw Manufacturing Research Medal from American Society for Mechanical Engineers (ASME)

Matthew J.M. Krane
Reinhardt Schuhmann, Jr. Best Undergraduate Teacher Award

Ernesto Marinero
Chair, American Physical Society Group on Energy Research and Devices

Strategic Advisory Board of Polyplus Battery Company

Lia Stanciu
Editor, Materials Chemistry and Physics Journal, published by Elsevier

Alejandro Strachan
Richard E. Grace Best Faculty Research Grant

Michael Titus
NSF (National Science Foundation) Career Award

2019 Outstanding Faculty Mentor (Purdue University)

Haiyan Wang
Fellow of the Materials Research Society (MRS)

Janelle Wharry
NSF (National Science Foundation) Early Career Development (CAREER) award

Xinghang Zhang
2018 TMS (The Minerals, Metals & Materials Society) Brimacombe Medalist

Argonne National Lab – IVEM Facility National Scientific User Committee Advisor

Metallurgical and Materials Transaction A, Key Reader

Science Advances, Associate Editor

Welcome Mark Gruninger

In December 2018, MSE welcomed **Dr. Mark Gruninger** as the Managing Director for Industrial Consortia. In this role, Dr. Gruninger will manage the industrial centers within the School of Materials Engineering, including fostering relationships with corporate, academic and government partners. Prior to joining Purdue University, Dr. Gruninger spent most of his industrial career with Praxair and its subsidiary Praxair Surface Technologies in a variety of management positions, concluding his 25 year career with the company as President, Praxair Surface Technologies and President, Electronic Materials. Dr. Gruninger holds a BS, MS and PhD in Ceramics Engineering from Rutgers University as well as an MS in Management from Purdue's Krannert School of Business.

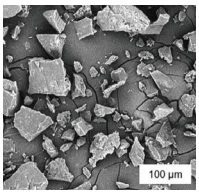
Howarter to Lead Engineering Undergraduate Research

In addition to his role as Associate Professor in Materials Engineering and Environmental and Ecological Engineering, **Professor John Howarter** has been named Director of Undergraduate Engineering Research for the College of Engineering. As Director, he will run the Summer Undergraduate Research Fellowship (SURF) program, which encourages and fosters undergraduate research and serves an important way to recruit graduate students to Purdue Engineering.

Seasoned Industry Leader Joins MSE Faculty

Paul R. Mort III recently joined Materials Engineering faculty as a Professor in support of Purdue's Center for Particulate Products and Processes (CP3). He is a 24-year veteran of the Procter & Gamble Company and is globally recognized as an expert in particulate processing and powder technology. He has a demonstrated history of product innovation and driving process efficiency in the consumer goods industry. Dr. Mort is an Editor for Powder Technology journal and a consultant with the International Fine Particle Research Institute (IFPRI), working to develop a pipeline of perspective articles for the journal. He is active in linking particle technology with adjacent technical communities including pharmaceutical processing, materials science and engineering, and process control.

Faculty Research Highlights

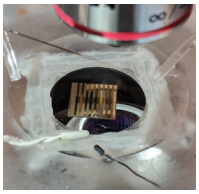


Synthesis and characterization of polymer-silica composite hydrogel particles and influence of hydrogel composition on cement paste microstructure

Dr. Kendra Erk and graduate students, Krafcik and Bose, created water-swollen polymer hydrogel particles that act as internal curing agents in high performance concrete. Hydrogel particles which contained nanosilica were observed to catalyze the growth of strong inorganic phases within void space previous occupied by the swollen particles, ultimately yielding concrete with improved strength and durability. *Advances in Civil Engineering Materials*, 2018. Learn more: bit.ly/hydrogelparticles

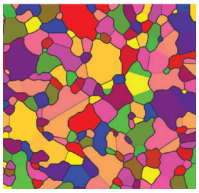
Cellulose nanocrystal (CNC) coatings with controlled anisotropy as high-performance gas barrier films

Dr. Jeffrey Youngblood and a team of Purdue researchers, have developed a new manufacturing process that uses cellulose nanocrystals (CNCs) to provide advanced barrier coatings for food packaging. This can improve food packaging and keep groceries fresh longer. *ACS Applied Materials & Interfaces,* 2019. Learn more: bit.ly/YoungbloodACSAMI



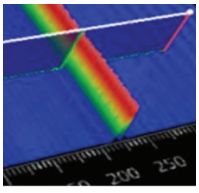
Perovskite nickelates as bio-electronic interfaces

Dr. Shriram Ramanathan and co-workers have discovered that perovskite nickelates, a class of quantum materials can function as ultra-sensitive biosensors that may in the future be useful for early stage disease detection. *Nature Communications*, April, 2019. Learn more: bit.ly/ShriramRamanathan



Charged grain boundary transitions in ionic ceramics for energy applications

Dr. Edwin García, and doctoral student, Suryanarayana Karra Vikrant, have developed a new theory that could allow industry to improve the performance of ionic ceramics for rechargeable batteries, fuel cells and other energy applications. NPJ *Computational Materials*, February, 2019. Learn more: bit.ly/betterbatteries

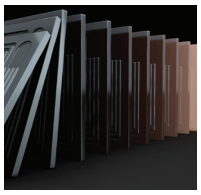


Polymer thin film adhesion utilizing the transition from surface wrinkling to delamination

Hyeyoung Son in the Davis Research Group developed a new method to simultaneously measure polymer thin film modulus and adhesion to a flexible substrate. This work utilizes the transition from wrinkling to delamination. *RSC Soft Matter*, July 2019. Learn more: bit.ly/polymerthinfilmadhesion

Evaluation of the physical, chemical, mechanical, and thermal properties of steam-cured PET/polyester cured-in-place pipe

Dr. John Howarter, along with a team of civil, materials and environmental engineers, measured the durability and potential for hazardous chemical release for cured in place pipes, which are an innovative low cost method to rehabilitate failed sewer pipes. *Journal of Composite Materials,* April, 2019 Learn more: bit.ly/HowarterCIPP

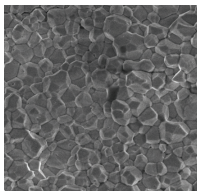


Ceramic–metal composites for heat exchangers in concentrated solar power plants

Dr. Kenneth Sandhage, Reilly Professor of Materials Engineering and his research group have created new advanced composite materials for high temperature heat exchangers, to enable lower cost electricity generation by Concentrated Solar Power plants. *Nature* (2018) 562: 406-409. Learn more: bit.ly/SandhageNature

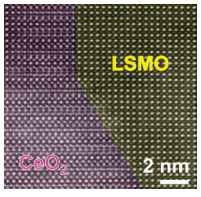
Laser-enabled fabrication of flexible and transparent pH sensor with near-field communication for in-situ monitoring of wound infection

Dr. Rahim Rahimi's research group reports on the development of a low-cost smartphone-based pH sensing platform that consists of a disposable, flexible, and transparent pH sensor interfaced with reusable near-field communication tag that can help early diagnosis of wound infection. *Science Direct*, August 2018. Learn more: bit.ly/RahimipHsensor



High temperature deformability of ductile flash-sintered ceramics via in-situ compression

The first in-situ microcompression test on flash sintered YSZ performed inside SEM at elevated temperature (~ 600 degree C) revealed that a high density of dislocation generated during flash event facilitates a ductile behavior at intermediate temperature (400 degree C). *Nature Communications*, 2018. Learn more: bit.ly/Zhangflashcenteredceramics



Strain-driven nanodumbbell structure and enhanced physical properties in hybrid vertically aligned nanocomposite thin films

Dr. Haiyan Wang, Basil S. Turner Professor of Engineering, and her research group, have constructed a novel nanocomposite epitaxial thin film with a strain-driven nanodumbbell structure and tilted heterointerfaces, enabling higher efficiency in strain tuning and property improvements. *Applied Materials Today*. Learn more: bit.ly/Wangthinfilms

Staff Awards

Congratulations to MSE staff member, **Rosemary Son** on being a finalist for the Clerical/Service Customer Service Award. Rosemary was nominated for her consummate understanding and natural leadership of diverse graduate students through the recruitment and admission process within the School of Materials Engineering ensuring the best and brightest excel in their research opportunities.

Vicki Cline Celebrates 40 Years of Service to Purdue

Vicki Cline with Provost Jay Akridge

Welcome New Staff

MSE is pleased to welcome **Lisa Stacey** back to Materials Engineering. Ms. Stacey worked in the School as a Secretary/ Development Assistant from 2012 - 2014 before accepting a position as an Administrative Assistant with the Purdue University's Regenstrief Center for Healthcare Engineering (RCHE). In this role she provided administrative support to center directors and staff scientists, and served as the internal/external liaison between RCHE's affiliated faculty, clinicians, EVPRP, and the Regenstrief foundation. In her new role with MSE, she will serve as the Lead Administrative Assistant to MSE Head, Dr. David Bahr.

MSE is pleased to welcome back **Jennifer Fifer** as the School's Safety and Mechanical Testing Technician. Ms. Fifer earned her BS degree in Materials Engineering from Purdue University in 2017, and prior to joining MSE, she served as a Materials and Process Engineer at Butler Aerospace in the Purdue Research Park. In her new role, Ms. Fifer will focus on safety and training program development to ensure that the School continues to meet and exceed safety standards.

The School of Materials Engineering is pleased to welcome **Darren Pauly** as a Laboratory Technician. In this role, Mr. Pauly will ensure that laboratory equipment is well-maintained and that undergraduate and graduate students are properly trained to use equipment. Prior to joining Purdue University, Mr. Pauly served as a Production Analyst at ZF as well as a Tool Crib Attendant at Keystone RV. In addition, Mr. Pauly spent seventeen years in the military, including service in the United States Navy, and United States Air Force Reserve.

Students Make Design Team Progress in 3-D

With a Little Help from Friends



By William Schmitt

Additive manufacturing, known to the general public as 3-D printing, has produced a success story at Purdue's School of Materials Engineering where the benefits of friendship come in threes—for students, alumni, and a community of problem-solving collaboration.

Success is coming through "AM" innovation, but more immediately it's enabled by teamwork that bridges past and present. A trio of eminent materials engineering graduates who learned and lunched together in the 1990s, and then stayed in contact about their accomplishments and aspirations, has reassembled to help today's seniors build the future.

David Bahr, head of the school, realized last year how one of the capstone projects tackled by senior design teams could yield cutting-edge insights for students and their mentors alike. He asked two old friends, John Barnes and Peter Tortorici, who were eager channels of corporate and personal support for education at Purdue, to revisit campus—to share what they know and what they still want to know.

"This was a win-win-win for everybody," Bahr said of the design project that took shape in the 2018-2019 academic year. A second phase of the project this fall will build on the preliminary discoveries, engaging a new team of several seniors and the same cadre of friends as expert guides.

"I'm always excited when we have an opportunity for students to work with professionals. If they're professionals I happen to have gone to school with, hey, that's great."

Here's more background on the people and the purpose behind the story.

Barnes was Bahr's grad-school roommate. He is also founder and managing director of The Barnes Group Advisors, the largest independent consultancy and training firm in additive manufacturing engineering. Tortorici is senior manager in the Minneapolis headquarters of Medtronic, the medical technology leader which develops, among many other devices, state-of-the-art pacemakers for heart patients.

The three materials engineers (whose friendship started when Barnes and Bahr were earning their Purdue master's degrees and Tortorici was pursuing his PhD) started finding common cause in early 2018. They discussed a vision of developing AM applications to produce the titanium shields that encase pacemakers. These discussions eventually helped bring Barnes and Tortorici back into campus life.

Medtronic knows additive manufacturing could substantially improve upon conventional methods of forming those titanium containers, Tortorici explained. The multiple skill sets used in AM—to find the ideal combination of 3-D printers and processes, materials to be used, and final products with the necessary attributes—might someday reduce the time and expense for making pacemaker prototypes and enhance customization of devices' size, shape, and battery life.

"This is important stuff that's not urgent," as Tortorici put it. If a project were urgent, Medtronic would focus on it internally, but instead preliminary design issues in AM can be addressed through partnerships with trusted sources of expertise outside the company.

Medtronic has built a relationship of trust with Purdue by funding senior design teams in prior years. And it wants the materials engineers emerging from those teams to consider careers in medical technology. These factors fed consideration of a venture in medical AM research, Tortorici said: "This is the perfect alignment for a student project."

Alignment was also perfect with The Barnes Group Advisors. Prior to founding his consulting firm, Barnes led complex engineering endeavors at major aerospace companies and Australia's national science agency. He built a reputation of leadership at the intersection of titanium metallurgy and additive manufacturing when the latter was still new.

"Twenty-some years later, it's now all the rage," Barnes said, noting AM is appropriately of great interest to students as well as Medtronic. Meanwhile, he wants his firm better connected to the growing medical services industry and believes in supporting Purdue's College of Engineering as a training ground for team-players who "get on with it" to solve problems with a Boilermaker zeal.

Bahr sealed together the synergies of Barnes' firm and Medtronic by pointing out a third set of beneficiaries. He invited his friends to guide and evaluate the work of four materials engineering students who also appreciated the mission. These seniors would delve into a design team project, exercising the multiple AM skill sets mentioned above.

Looking back on those design team members who graduated this year, "they all did a really good job," said Barnes.

Everyone was open to a lot of learning. The capstone class, which collected and presented masses of data, along with conclusions and recommendations, for evaluation by Barnes and Tortorici, gained from a teachable moment of collegial candor. Barnes (whom the school honored as an Outstanding Materials Engineer in 2014) noted one of the students' concerns would be easily addressed in post-AM processing to minimize porosity.

Tortorici said this was a meaningful educational experience showing the

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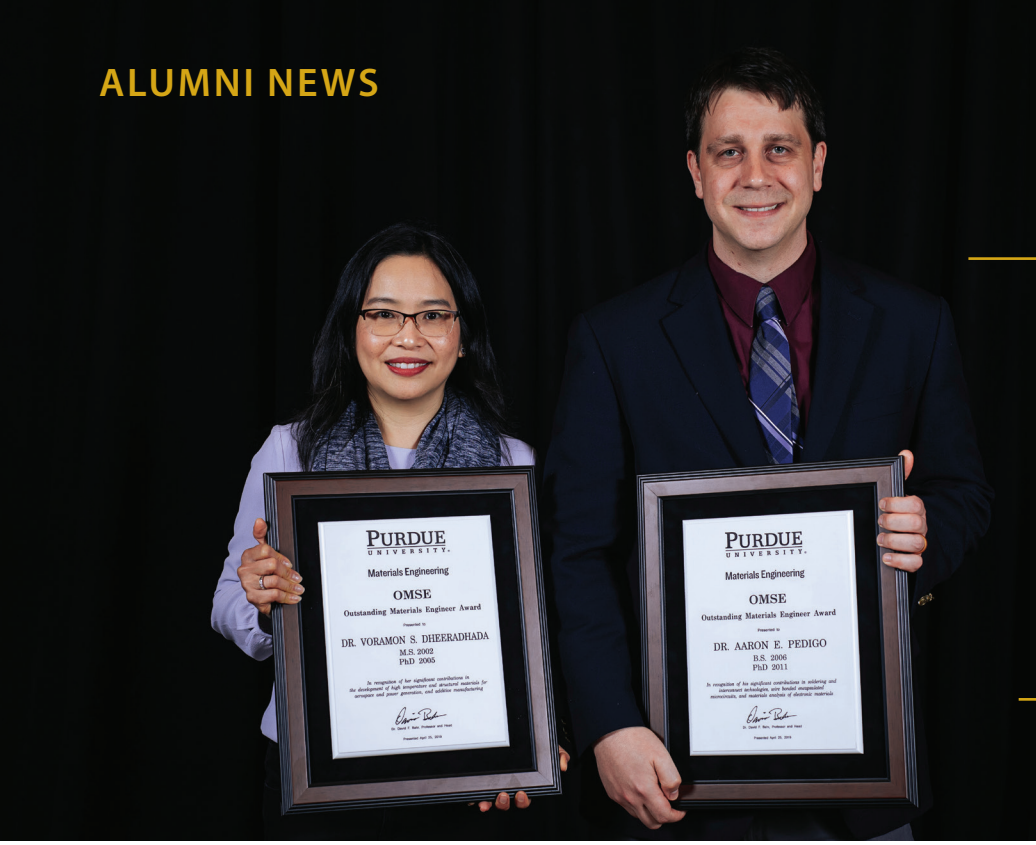


Outstanding Materials Engineer Awards

Dr. Voramon Dheeradhada

Senior Materials Scientist
GE Global Research

Dr. Voramon Dheeradhada is currently a senior materials scientist at GE Global Research with over 15 years of experience in material developments especially in alloy and metallic coating for structural applications focusing on environmental degradation. Her areas of expertise include but not limited to high temperature structural materials for aerospace and power generation, additive manufacturing, alloy design, processing-microstructure-property relation, thermodynamic, metallic coatings, characterization, and machine learning. She has worked on several alloy systems (nickel superalloy, cobalt alloys, titanium, titanium aluminide, etc.) as well as refractory intermetallics (molybdenum, niobium silicides. etc.)

At GE, Dr. Dheeradhada leads and works with an interdisciplinary team of engineers, scientists, and technicians advancing materials science research. Her current focus includes alloy development for additive manufacturing, parameter development for hard-to-weld alloys, and development of in-situ repair technology for metallic components in gas turbine. Her current project highlights include the use of machine learning to accelerate development cycle of build parameters for powder bed fusion metal printing. Additionally, she serves as a materials expert with an emphasis on corrosion in materials for supercritical CO2.

Prior to joining GE, Dr. Dheeradhada received her MS (2002) and PhD (2005) in Materials Science from Purdue University. She is a holder of three granted patents and five patent publications. She also has several patent applications in the topics of machine learning and repair technology in progress.

Dr. Aaron Pedigo

Materials Engineer
Naval Surface Warfare Center,
Crane Division, (NSWC Crane)

Dr. Aaron Pedigo earned a bachelors and doctorate degree from the School of Materials Engineering at Purdue University. He has been a civilian employee of the Naval Surface Warfare Center, Crane Division (NSWC Crane) since 2009. His work with Crane includes experience supporting the Navy's Miniature & Microminiature (2M) electronic repair program and service as a senior analyst in Crane's Failure and Material Analysis Laboratory. The common thread throughout his tenure has been analysis and mitigation of risks posed by circuit board and electronic component packaging interconnects on high-reliability military systems using core materials engineering principles. His expertise in lead-free (Pb-free) solders and finishes, gold embrittlement of solder joints, and copper bond wire interconnects has allowed him to support every service within the Department of Defense (DoD) as well as the Office of the Secretary of Defense (OSD) and Missile Defense Agency (MDA). Dr. Pedigo resides in Bloomington, IN where he enjoys spending time with his family, gardening, and woodworking.

Ms. Alison Park

Program Manager for Advanced Manufacturing and Materials,
Aerojet Rocketdyne

Ms. Park was unable to attend the 2019 awards ceremony. She plans to accept her award in 2020.

Alumni Awards

MSE alumnae, Dr. Milea Kammer Receives Rising Star Award from IPC

BS Materials Engineering '08
PhD Materials Engineering '14

Congratulations to MSE alum, Milea Kammer for receiving the IPC (the Association Connecting Electronics Industries) Rising Star Award. "This recognition is bestowed upon IPC members who have taken leadership roles and provided support to IPC standards, education, advocacy and solutions to industry challenges. Their contributions have made significant impact upon IPC and industry within the past five years and will continue to have a lasting impact for many years to come."

MSE alumnus, William Jaorskinski inducted into 2018 Class of ASM Fellows

"For recognition of continuous development of advanced powder processing technologies and coating solutions for enhanced wear and corrosion resistance throughout numerous industries."

Mr. William J. Jarosinski, FASM
BS ('90) and MS ('95)
Associate Director, Materials
Praxair Surface Technologies, Inc.
Indianapolis, IN

Rick Sisson, PhD 1975

Dr. Richard Sisson was named a Fellow of the American Ceramic Society and a Fellow of the International Federation for Heat Treatment and Surface Engineering and the American Ceramic Society.

PURDUE UNIVERSITY

Materials Engineering

Students Make Design Team... continued from page 7

advantages of hands-on, long-term experience. Barnes' criticism of the missing knowledge did not in any way imply incomplete or lax efforts by the team.

Students want their work to make a tangible difference with real-world challenges, Tortorici said. That's why the 2019-2020 phase of the AM project will not merely repeat phase one. It will be informed by answers to a survey taken among last year's class as its work concluded: "What questions arose that you would still want to answer going forward?"

Bahr pointed out additional lessons learned by the students. These included seeing the motivation of their mentors to bring together different perspectives and areas of knowledge; new understanding can always be generated, even among seasoned experts. Students also saw the importance of keeping in touch over time with classmates, alumni, and others in the field, Bahr said: "One of the things we hope students learn is that networking is important."

Barnes and Tortorici, brought back to Purdue after years pursuing different avenues of career success, agreed they have seen the value of networking for continuous learning amid constant change.

"It's fun to be back working with two old classmates," said Tortorici. "Everybody's at a different stage of their lives" after having established families as well as careers, but past experiences and new opportunities keep converging.

The School of Materials Engineering has been a setting of substantial growth and change since the 1990s, according to Bahr. Indeed, the discipline itself is evolving so much that the AM design team idea instituted by the three friends centers on "a technology that didn't exist at the time of their graduation."

The best response, said Bahr, is for the school to continue connecting students, faculty, and alumni as a community on the move. That's the momentum he sees in Barnes and Tortorici. "We want people who like advancing the field."

It's also the momentum he sees in seniors probing multiple dimensions of a problem as they envision strides in materials and manufacturing to serve others in diverse areas of life—helping heart patients, for example. All the school's 17 design teams last year composed an overarching success story Bahr expects will be told again and again: "the experience of keeping the ball moving forward."

2019 Distinguished Engineering Alumni Award
JEFFREY GRAVES

For strong corporate and global leadership and management practices in the materials engineering industry by contributing to worldwide technology growth, improved operational efficiencies, manufacturing productivity, and the higher performance of metals and composites.

The unique determination that Jeff Graves brings to his professional life is clearly evident in his consistent success throughout a 30-year career. In the past six years at MTS Systems Corp., Graves led 3,000 employees to a 48 percent increase in revenue that included a threefold increase in profitability for the corporation's sensor components businesses.

"True success, in a career or in your personal life, is not a result of heroic, short-term efforts, but, rather, consistent, day-to-day focus and drive for progress," Graves says, in offering advice to Purdue undergraduates. "Before you know it, you will look back and realize you have climbed the mountain, and the view is even more beautiful than you imagined!"

The view that Graves sees today includes a resume of successful full-time leadership in five companies as well as membership on the boards of directors for others. He has been honored for his distinguished career by Purdue and the University of Wisconsin as well as by the American Society for Metals. He also received the Howmet Award for Excellence in Metallurgy very early in his career.

Graves modestly admits that his success did not come without some failure very early on. "After a dismal academic performance my freshman year, I had to decide if I was really committed to becoming an engineer," he recalls.

After leaving "chagrined" from a meeting with a pessimistic academic advisor who advised him to just get through his sophomore year, Graves says he got very serious about his future. "I reflected on the prior 12 months; thought about my goals in life and decided that I really did want to be an engineer, and have the option for a career in research," he says. "From that day onward, I focused each day on simple, fundamental execution ... going to class, taking good notes, reviewing them, completing assignments on time and to the absolute best of my abilities."

Graves says the momentum of his resolve resulted in a GPA strong enough to give him several options for graduate school.

"I left Purdue with not only an excellent academic grounding but also an ability to write and speak in public forums," he says. "That helped a great deal in building and leading teams later in life."

CAREER HIGHLIGHTS

2012-present
President, Chief Executive Officer and Director, MTS Systems Corporation

2005-2012
President, Chief Executive Officer and Director, C&D Technologies Corporation

2003-2005
Chief Executive Officer and Director, KEMET Electronics Corporation

2001-2003
President and Chief Operating Officer, KEMET Electronics Corporation

1996-2001
Various management positions, General Electric Company, GE Power Systems

1994-1996
Program Manager, Physical Metallurgy Lab, General Electric Company, Corporate Research and Development Center

1990-1994
Program Manager, Materials Science, Science Center, Rockwell International Corporation

1989-1990
Manager, Advanced Metals and Composites, Howmet Corporation

1987-1989
Staff Scientist, Materials Science, Science Center, Rockwell International Corporation

EDUCATION

1983
BSMetE, Purdue University

1985
MSMetE, University of Wisconsin-Madison

1987
PhD MetE, University of Wisconsin-Madison

"Everyone has setbacks, failures and occasional tragedies in their lives. Be strong in your faith, clear in your priorities and drive forward with determination each day. You will ultimately prevail." — Jeffrey Graves

Undergraduate Research that Sticks

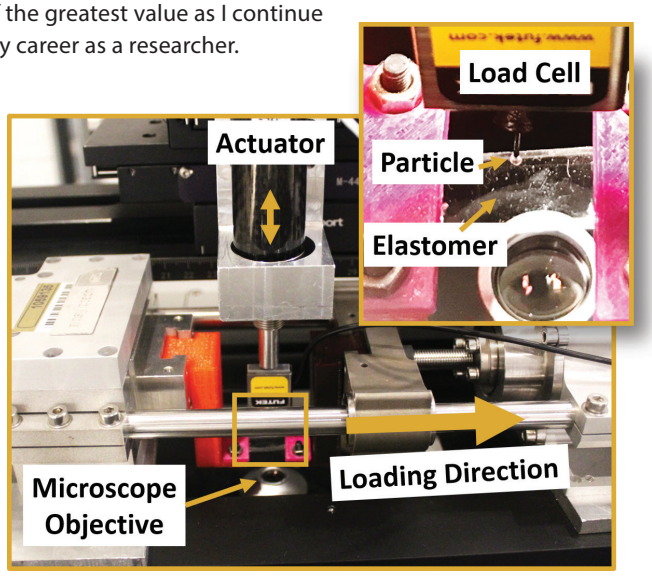
Elina Ghimire

I am a rising senior studying Polymer Science at the University of Southern Mississippi (USM). For the past two years at USM, I have worked in Professor Simon's research group investigating the coassembly behavior of linear amphiphilic triblocks in the fabrication of polymer vesicles. Having worked in a polymer synthesis lab, I wanted to explore the bulk properties of polymers through an engineering focused research. My interests seemed a natural fit for the summer undergraduate research fellowship (SURF) program in the School of Materials Engineering at Purdue University. This summer, I am studying the debonding mechanisms of rigid microparticles from elastomeric substrates under the mentorship of Professor Chelsea Davis and Professor David Bahr. While I am not technically a Purdue MSE undergrad, I have been enjoying the opportunity to get to know the School from an outsider's perspective while I learn more about engineering research.

My SURF project is focused on understanding how to control the adhesion and detachment of rigid microspheres to soft polymer substrates. The insights gained from this project will benefit industries that require precision in powder and particulate handling. Energetic materials and active pharmaceutical ingredients are often manufactured and processed in small quantities of particles, so developing new methods for immobilizing them on a substrate, transporting them, and then releasing them in a controlled manner are necessary. I am studying the effects of applying a tensile deformation to the elastic substrate on the adhesion of a spherical particle to the substrate. With guidance from my graduate mentor, Naomi Deneke, a PhD candidate in Professor Davis's group, I have built an experimental setup that is comprised of an optical microscope, a micromechanical tensile load frame, and a contact adhesion testing device. My experiments allow me to monitor the change in contact area between a spherical glass bead and a poly(dimethylsiloxane) (PDMS) substrate as the PDMS experiences a lateral strain. I measure the normal load and displacement of the bead as it is pushed into contact with the substrate and then pulled away. From this data, I can compare the work of adhesion values when PDMS is stretched to different strains. I am also investigating effects of the substrate modulus and the size of the particle on adhesion. So far, we have figured out that the work of adhesion decreases when we increase the amount of strain in the elastic substrate. Also, we have observed that the shape of the contact area changes when the substrate is stretched. These early fundamental results are teaching us exciting new approaches for how to manipulate particles simply by controlling the deformation of the adhesive substrate.

Besides these scientific insights, by working on this project, I have learned a new approach to conducting research. My problem-solving skills have been strengthened as I worked to discover the best method of organizing and assembling several instruments to get useful data. Overall, I have gotten an experience of what life is like as a graduate student, working as a full-time researcher this summer. I have relished my time as a SURF student at Purdue this summer and am excited to continue this path ahead. After my graduation in May 2020, I would like to pursue a doctoral degree in Materials Engineering, particularly studying polymers.

Spending my summer at Purdue has not only given me the opportunity to do hands on experiments, but also has made me realize the vast array of research topics and how science can impact our lives. I was awestruck to hear Professor Kendra Erk talk about the usefulness of incorporating something as delicate as hydrogels into concrete as an internal curing agent, leading to a tougher structural material. One of the graduate students in the Davis research group demonstrated the formation of perfect wrinkles in a glassy thin film by subjecting it to varying stress environments, utilizing fundamental buckling mechanics to guide her experiments. Needless to say, my own project captivated me when I realized that multiple phenomena come into play when I simply bring two objects into contact with each other. This summer, I have learned to think and to expand my horizon of curiosity, which I believe will be of the greatest value as I continue my career as a researcher.



Undergraduate Student Profile

Brandon Wells • Cary, North Carolina

What attracted you to Purdue University and specifically, Materials Engineering? Purdue was attractive to me because they did a great job of reaching out to prospective students through groups like the Minority Engineering Program (MEP). I participated in an MEP summer camp which allowed me to work on engineering challenges, interact with Purdue students and learn from professors. MSE stood out to me because the professors were accessible and passionate about what they do. I decided on MSE after I met with Professor Trice during my first visit to Purdue.

What has been your greatest achievement during your time in the School of Materials Engineering? My greatest achievement was winning my division in the Undergraduate poster competition at the 2019 TMS Annual Meeting and Exhibition. I have been working in Professor Carlos Martinez's soft materials lab for 3 semesters to develop a vibration assisted droplet generation system that fabricates alginate microparticles at flow rates orders of magnitude above current microfluidic methods. It's humbling to know that I only started a year ago and went from knowing very little about the field to training a new undergraduate student who joined the group. Working in the Martinez group has been one of my most rewarding learning experiences because they challenged me to learn new skills, apply concepts I had been introduced to in class, and present updates during group meetings each week.

What has been your favorite MSE course; why? My favorite course has been MSE 367: Materials Processing Laboratory. It is the class I've spent the most hours on, but the course is structured in a way to give you lots of areas to improve. MSE 367 is different from most undergraduate labs in that the projects span multiple weeks, you work in the same group for the entire semester and the lab reports are much more in depth. This kind of structure makes me more confident about my technical writing and gave me hands on experience making materials with specific properties.

Please briefly discuss any participation in study abroad and how the experience was beneficial. I studied abroad with the Purdue Jazz Band during the spring break of my freshman year. We traveled to Lisbon, and the Algarve regions in Portugal and played a concert at each stop along the way! I was nervous at first because I had never been abroad before, but being immersed in this kind of environment challenged me to adapt and communicate in ways I haven't before.

Please discuss any participation in co-op or internship programs and how the experience was beneficial. My first internship was at GE Aviation near Cincinnati in the Ceramics Matrix Composites (CMC) Fastworks Lab. I performed different forms of destructive and nondestructive analysis on CMC parts to verify dimensional and mechanical property specifications. Even though I hadn't taken any MSE classes at the time, I pushed myself to find other ways to add value by creating templates that made visual representations of the data. My second internship was at 3M as a Transportation Safety Division R&D intern helping to develop pavement markings for their connected roads initiative. This opportunity was really exciting for me because I was helping to test and study products that I encountered every day. Working on this project taught me how to characterize the optical performance of pavement markings through direct measurement and image processing. By the end of the assignment, I became certain that I wanted to pursue a graduate degree in order to work in an environment like 3M in the future. In the summer of 2019, I started at Lawrence Livermore National Lab, and I am excited to see how government and universities work together.

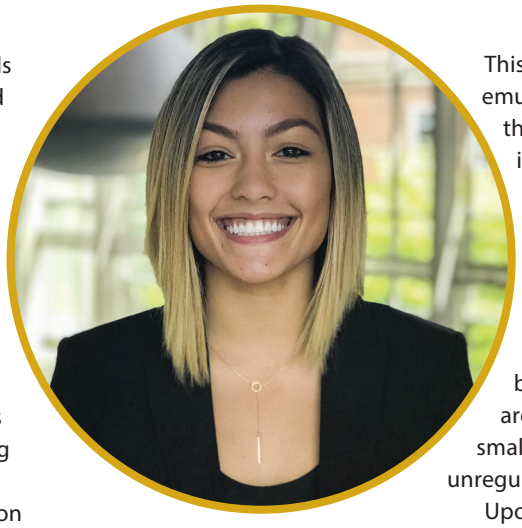
Have you been involved in any student organizations while at Purdue? If so, which ones? I've played trumpet in the Purdue Jazz Band since my freshman year. We usually perform once a month, but the biggest performances are in the spring semester when we host the Purdue Jazz Fest in January and when we travel to the Elmhurst Jazz festival in February. I also have worked for 2 years as the academic excellence chair for the Purdue chapter of the National Society of Black Engineers. While many students think that GPA determines their excellence, I hope to expand that definition to include a student's ability to display integrity, resilience and tenacity throughout the learning process.

Why would you recommend this department to others who are still deciding on an area of study? I would recommend materials engineering because the field is broad enough for students to pursue their interests in almost any industry. The environment amongst students also feels more like we are working together to achieve a goal instead of competing for the highest mark.

How do you plan to use your knowledge and experience gained at Purdue University in the future? After becoming accustomed to Purdue's workload, I feel much more confident in my ability to a research career without having to give up my passion for music. I am more self-motivated to learn than when I arrived, and MSE professors have equipped me with the resources and tactics to break down complex problems into manageable pieces. I plan to use the fundamental concepts I've learned from my classes to make more confident data driven decisions, but I also am more aware of when I need to ask for help.

"SURF"ing in the Bilge Water

Rina Sabatello



When I first entered the school of Materials Engineering at Purdue as a sophomore, I did not know that undergraduate research opportunities were available. As I took MSE courses, specifically teaching-lab courses, I was intrigued at how hands-on materials engineering is. It was not until the fall of my junior year where my advisor, Professor Martinez, asked me if I was interested in working on his project. Being eager to deepen my experience in the laboratory, I accepted the position in his group and applied for MSE 499 the following spring. The project focused on fabricating monodisperse hydrogel capsules via vibration through a nozzle. Alginate, a naturally occurring hydrogel, crosslinked with calcium chloride provides the ability to create capsules for the delivery of materials in agricultural, pharmaceutical, and cosmetic applications. Alginate was dispensed through a nozzle at different flow rates and vibrated at specific frequencies to ensure monodisperse drops. Most of our work was to optimize the generation of monodisperse droplets by applying an optimum frequency. We spent the semester optimizing the drop generation conditions and comparing the results to theoretical calculations.

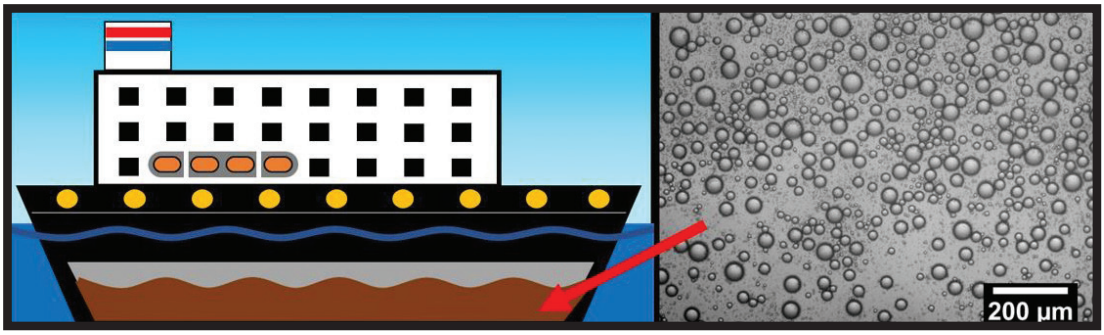
During this spring semester, I took a course on soft material where I learned about particle interactions, suspensions, rheology, hydrogels, emulsions, etc. This course kickstarted my interest in soft materials because I also have a passion for cosmetics, which are made from emulsions. It also made me more interested in pursuing a higher education in soft materials after my undergraduate degree. Knowing this, Professor Martinez advised me to apply for the summer undergraduate research fellowship (SURF) and explained that this was an opportunity for me to experience what graduate school is like. He asked if I was interested in working on a new project with himself, Professor Erk and Professor Howarter.

This project focuses on oil-in-water (O/W) emulsions found in the bilge of US Navy vessels that impose a threat to the oceans due to inefficient cleaning and separation of the oily wastewater. A combination of oils from engine lubricants, surfactants from on board cleaning, and seawater. The oil forms micron sized droplets that are stabilized by the surfactants and are not easily separated via gravity. Ships attempt to filter bilge water before discharging it into the ocean and are unsuccessful in removing and detecting small oil droplets, polluting the oceans with unregulated oil.

Upon being accepted into SURF, I focused on testing the impact of surfactant concentration and type of model bilge water emulsions. My duties in the laboratory include preparing O/W emulsions and characterizing the emulsions oil drop size over time in static and dynamic conditions using laser scattering techniques. I also conducted interfacial tension experiments via pendant drop method to calculate the surface excess concentration, and minimum drop size formed at a given surfactant concentration.

During SURF, I was assigned a graduate mentor Cole Davis, and a faculty mentor Professor Martinez where I would continue to build relationships similar to those in graduate school. My mentors guided me through the bilge water project and helped me develop my research skills. SURF also had mandatory professional development seminars and research seminars that highlighted information such as, tips for the GRE and applying to graduate school, funding and fellowships, etc. What I enjoyed most about being in SURF is that I got to present a poster at the end of the summer, as well as publish a technical paper.

I must acknowledge my advisor, Professor Martinez for supporting me throughout my studies in MSE and encouraging me to pursue a doctorate program. I highly suggest students who are indecisive about graduate school to apply to SURF.



Graduate Student Profile

Caitlyn Clarkson • Albuquerque, New Mexico

How did you first hear about Purdue University? I was an undergraduate intern at Sandia National Labs when I learned about Purdue. Several of the staff members I worked with highly recommended it.

What attracted you to Purdue University's graduate programs? I decided to apply to Purdue after it came personally recommended to me by my mentors at Sandia National Labs. What really convinced me to pick Purdue was the sense of family and of connectedness within the department that I felt when I visited in February 2015. Everyone was so friendly and inviting on top of having excellent facilities for research and learning. I knew I would be happy here.

What has been most rewarding about your time in Materials Engineering? I have had several rewarding experiences over the course of my graduate career at Purdue, however, my most rewarding experience at Purdue was the NSF Interdisciplinary Graduate Education and Traineeship (IGERT) Sustainable Electronics Program of which I am a fellow. This two-year program was comprised of several industrial visits, professional development workshops, and interdisciplinary classes which have defined my graduate experience. My personal highlights from this program were the trip to India to visit companies in the electronics supply chain and learn about the challenges they face and the student-led seminar which my cohort pioneered in our final year. This program taught us about the interdisciplinary nature of the electronics life cycle and gave us the opportunity to apply our knowledge to create research collaborations and develop a curriculum and class ourselves.

What is your area of research? Broadly speaking, my area of research is polymer processing and characterization. Specifically, I have been investigating nanocellulose/polymer composite systems. Nanocellulose is an abundant, inherently renewable nanomaterial that can be synthesized from a wide variety of biomass. In the Youngblood research group, I look at how these nanoparticles can be used to reinforce or nucleate polymers like poly(lactic acid), nylon 6, and acrylic. The challenge is in dispersing the nanoparticles into the polymer matrix while minimizing solvent use, agglomeration, and destruction of the nanoparticles.

Have you been involved in any student organizations or community activities while at Purdue? If so, which ones? Yes. I have been involved with the Women in Engineering Program (WEIP) which hosts science, technology, engineering, and technology (STEM) outreach events year-round as well as professional development for women. I am also a member of the Engineering Academics club which provides professional development for people who plan on becoming professors. Additionally, within the department, there is the MSE graduate student association of which I was the STEM outreach coordinator; we organized the department's participation in campus-wide events like Space Day and Nanodays. As graduate student, I have also participated in the TMS Congressional Visit Day in Washington D.C. There is also ample opportunity to work with national organizations within your discipline during graduate school and I worked with TAPPI Nano.

Why would you recommend this department to others who are still deciding on an area of study? I would recommend this department for two primary reasons. Firstly, that the faculty's disciplines are very diverse and there is a generous amount of collaboration and co-advising opportunity between professors. MSE has really developed expertise across the ceramics, metals, polymers, and composites fields. Secondly, you don't have to pick right away! The graduate advisor pairing process gives students enough time to meet with various professors and their group after they have already been accepted to the program so there is low pressure to pick an advisor right away.

How do you plan to use your knowledge and experience gained at Purdue University in the future? My training through the NSF IGERT Sustainability in Electronics program at Purdue has shaped my idea of what I'd like to pursue as a professor. As a professor, I want to create a program like the one I have participated in which provides phenomenal student experience and education opportunities such as industry tours, international experiences, and interdisciplinary courses. I think the program could also include a graduate mentorship program and summer research experience or learning experience for high school and undergraduate students.

Why did you choose grad school as opposed to going straight into the workforce? I chose grad school because I wanted to be a professor. My teachers and professors have been the most influential people in my career. I wanted to join their ranks so that I could lift up other students and provide them unique opportunities whether in research or education while having the freedom and agency to explore technological problems related to my own interests.

If you could give one piece of advice to undergraduates considering graduate school, what would it be? Talk to your professors and grad students you know about why they went to grad school. People have taken a bunch of different paths to grad school like working in industry beforehand or going straight to grad school or serving in the military first. There isn't just one path that leads to grad school and learning about different people's stories may help you figure out whether grad school is something you want as well as clear up any misconceptions you might have about the process, people, or what you stand to gain from grad school.

MSE Senior, Hugo Arribas, receiving the inaugural Donna Bystrom Undergraduate Service Award. (Pictured with Donna Bystrom and David Bahr)

2018-2019 Student Award Recipients

INTERNAL STUDENT AWARDS:

Baishakhi Bose
Xin Li Phuah
Jessica Sargent
Briney Achievement Award

Qiang Li
College of Engineering Outstanding Graduate Student Researcher

Megan Forshey Zhongxia Shang
Estus H. and Vashti L. Magoon Graduate Teaching Award

Yifan Zhang
College of Engineering Outstanding Graduate Student Service Award

Hugo Arribas
Donna Bystrom Undergraduate Service Award

Allison Chau
Fiona O'Dowd
Joseph Okkema
Hunter Vaught
John L. Bray Memorial Award

Allison Chau
Outstanding Graduating Undergraduate Research Award

EXTERNAL STUDENT AWARDS:

Alejandro Figueroa
Nuclear Regulatory Commission Graduate Fellowship

Cuncai Fan
Bilsland Thesis Fellowship (2018-2019)

Allison Chau
Industrial Scholarship (Purdue Engineering Student Council)

General Motors Equal Employment Opportunity Commission Endowed Scholarship

Summer Undergraduate (SURF) Research Fellowship

Nia Hightower
Published "Effects of the Shielding Argon Gas Flow on the Mechanical and Physical Properties of Selective Laser Melted Ti-6Al-4V Solid Material"

Johnson & Johnson Encore Award

Brandon Keuneke
Purdue Student Activities and Organizations (SAO) Emerging Leader Award

Nelyan Lopez-Perez
France A. Cordova Leadership in Action Award

Shikhar Misra
Bilsland Graduate Fellowship (2019-2020)

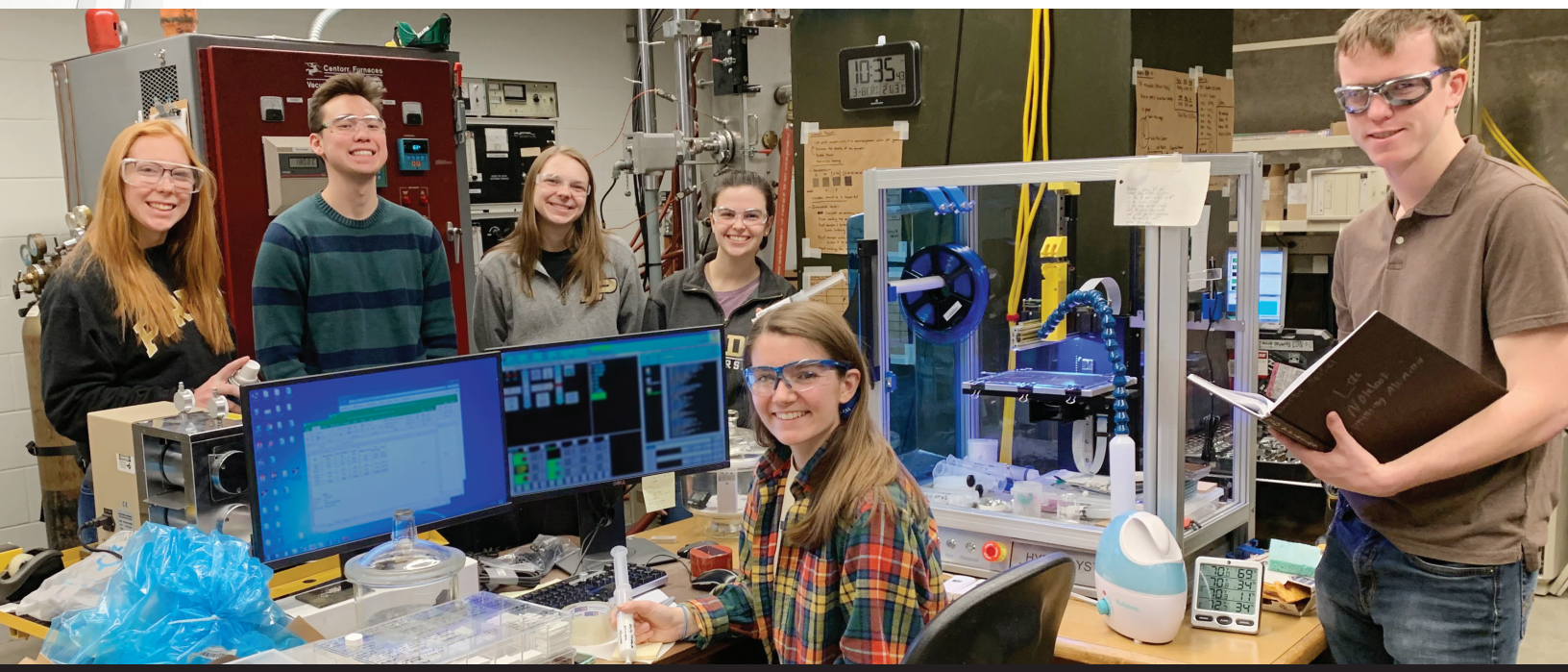
Anythony Pupillo
2018 AIST Steel Intern Scholarship

Tongtong Shen
3rd place in Student Research Presentation Competition, Chinese American Chemical Society, Great Lakes Chapter

Armen Yildirim
1st place, Birck Science Shark Tank Science Communication Award

MaterialsMatter @Purdue

School of Materials Engineering
Neil Armstrong Hall of Engineering
701 West Stadium Avenue
West Lafayette, IN 47907-2045



MSE undergraduates in the research lab

EVENTS *Mark Your Calendar!*

MSE Current Student and Alumni Mixer

Thursday, September 12
5:30 pm - 7:00 pm

Mackey Arena, Spurgeon Club

Cost: *Free* **RSVP:** rnjakes@prf.org

Mingle with undergraduate and graduate students, faculty, staff and other alumni in a casual setting.

MSE Alumni Reception at MS&T Conference

September 30, 2019
6:00 pm - 8:00 pm

Spirit of 77
500 NE MLK Jr. Blvd.
Portland, OR 97232

Cost: *Free* **RSVP:** rnjakes@prf.org

If you live in the Portland area or will be attending the MS&T Conference, please join us for hors d'oeuvres, drinks and conversation with alumni, students and faculty.

For additional information about these events or to rsvp, please contact Robyn Jakes at 765-494-4094 or rnjakes@prf.org.