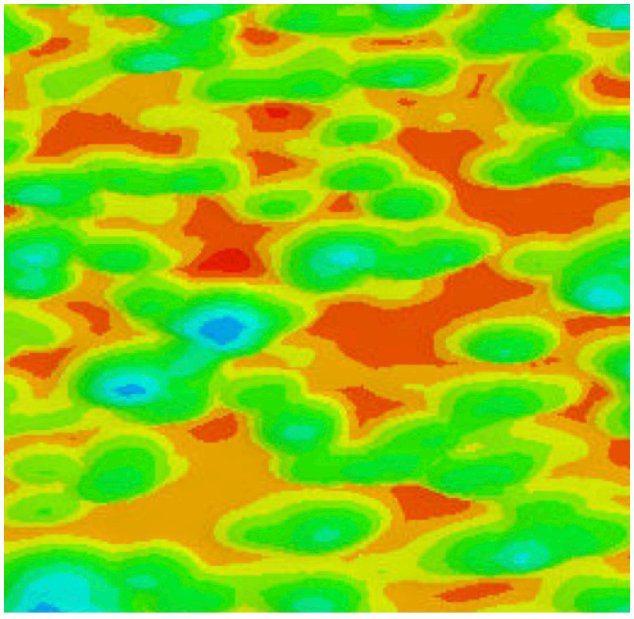
MATERIALS MATTER @Purdue

2020 Annual Newsletter

Student highlights | Cutting-edge, faculty-led research | School updates



PURDUE UNIVERSITY | School of Materials Engineering

A MESSAGE FROM THE HEAD

Dear Purdue MSE Family,

I hope this note finds you and your family safe, healthy, and well. In 2019, I almost seemed to be complaining that there wasn't much different to write about for the newsletter; another record year of funding, student enrollment, and successes in the School. I guess I won't have that problem this year. In mid-March, Purdue moved to online classes, and faculty had about one week to transition to online classes. Our spring 2020 TA's did video capture of key labs to allow students working remotely to see the processes that generated the data they had to evaluate. Staff came in to complete critical research experiments that had been ongoing for weeks. I'm so proud that even as we were separated, the faculty, staff and students pulled together to successfully complete the Spring semester in true Boilermaker spirit, and we're very proud of our graduating class of 57 undergraduates who obtained their degree in Materials Engineering during extraordinary circumstances!

In MSE, the pandemic offered an opportunity to reflect upon our current policies and to seek out opportunities for improvement. We hosted the first of many virtual PhD defenses, and the positive response was overwhelming. While we will someday likely return to in-person defenses, we will continue to offer the presentations in a streaming format so families, friends, and former group members can be present during this milestone. With 27 PhD's and 6 MS students on track to graduate in Spring and Summer 2020, we've had more online defenses this year than the number of defenses we had in all of 2019. Similarly, online webinars for our senior design projects allowed our corporate partners to include larger numbers of engineers and managers in the end-of-year reports, benefiting our students and our partners in information exchanges.

COVID-19 was not our only concern this summer. The school is examining our policies, procedures, and climate to better represent our constituents and our mission to serve all students. Increasing the opportunities and providing tools for success for students of color needs to be forefront in our minds. In an effort to be more inclusive, we have removed the GRE exam as a requirement for acceptance into our graduate program, based on evidence of racial bias within the GRE exam for domestic students in the physics and life sciences. We cannot, and will not, perpetrate policies that make us anything less than inclusive to all students, faculty and staff. We welcome any thoughts and discussions on how to ensure we do a better job making Black, Indigenous, and People of Color thrive in Materials Engineering.

We are so grateful that we have been able to connect with many of you during the pandemic, and while we wish we could say that we'll be visiting you in person, University travel restrictions will likely limit our travel as well as visitors to campus. Therefore, we will be reaching out to ask you to meet with us virtually via video calls on WebEx, Zoom, our new YouTube channel, or even just an old-fashioned phone call. We look forward to catching up with you, and thank you for being part of the MSE family.

Stay safe, healthy, and Hail Purdue,

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

inside

PURDUE UNIVERSITY

School 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

Materials Matter@Purdue is published by the School of Materials Engineering at Purdue University for alumni, faculty, students, corporate partners, and friends.

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

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701 West Stadium Avenue
West Lafayette, IN 47907-2045

To make a gift to the School of Materials Engineering, please contact:

Robyn Jakes
Chief Development Officer
765-494-4094
rnjakes@prf.org

Or click the "Giving" link on our homepage.

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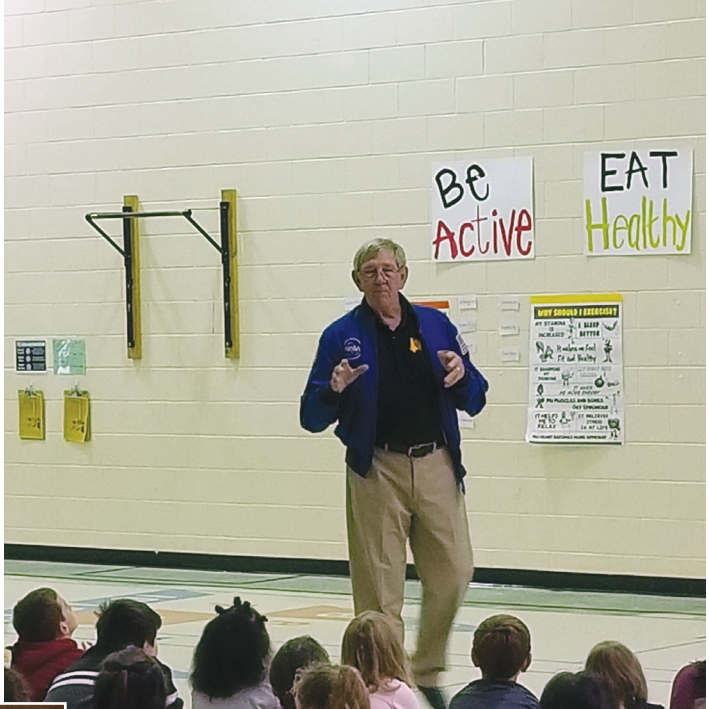
Watch Purdue Materials Engineering on YouTube: bit.ly/PurdueMSE_YouTube

MSE NASA Astronaut Visit

As part of the celebration to conclude Purdue's sesquicentennial, "150 Years of Giant Leaps, 13 Purdue astronauts were reunited on October 10, 2020. **NASA astronaut and MSE alum, Michael J. McCulley** returned to campus, and spoke to students in MSE 690. In addition, he also visited Oakland Elementary where he shared his experiences in space with first through fifth graders!



Professor Mike Titus and a group of MSE undergraduate students spent Saturday, February 15, 2020 at the Klondike Elementary School Carnival teaching students in grades K-5 how to cast pewter medallions featuring the school's logo.

On June 26, 2020, **MSE Professor and Vice President Emeritus, Dr. Richard E. Grace** celebrated his 90th birthday. He and Connie are enjoying retirement in West Lafayette.

FACULTY AWARDS & RECOGNITION

Anter El-Azab
Chair-elect of the Technical Thrust Area on Nanotechnology and Lower Scale Phenomena of the U.S. Association of Computational Mechanics (USACM).

Vice Chair, Professional development committee, The Minerals, Metals & Materials Society (TMS)

Michael Manfra
Distinguished Professor of Purdue Physics and Astronomy
bit.ly/Manfradistinguishedprof

Ernesto Marinero
Chair-elect for AAAS - The American Association for the Advancement of Science's section on Industrial Science and Technology

Shriram Ramanathan
Richard E. Grace
Best Faculty Research Grant

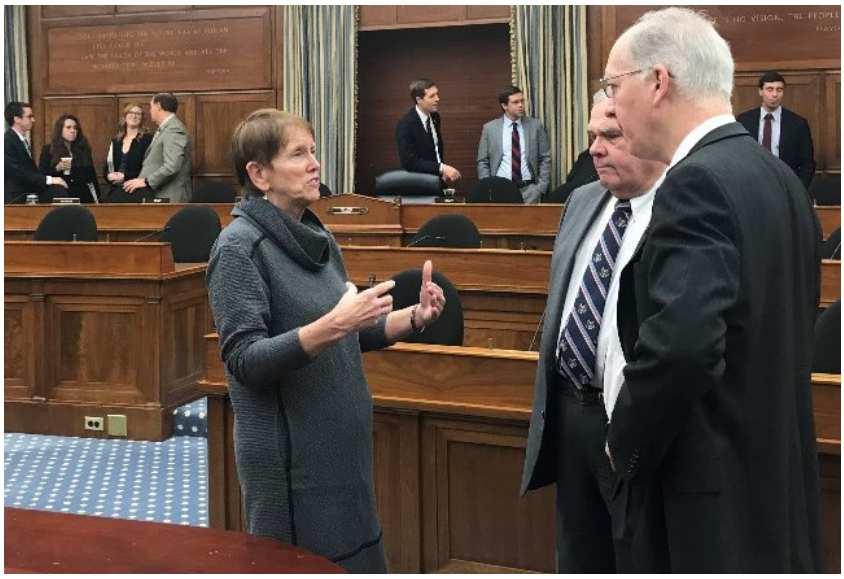
Elliott Slamovich
Reinhardt Schuhmann, Jr. Best Undergraduate Teacher Award

Michael Titus
2020 TMS-Japan Institute of Metals and Materials Young International Scholar bit.ly/Titus_JIM

Janelle Wharry
2020 American Nuclear Society's Landis Young Member Engineering Award bit.ly/Wharry_ANS

DOE Early Career Research Program (ECRP) - $750,000

Jeffrey Youngblood
College of Engineering - Outstanding Faculty Mentor



Purdue MSE Professor Testifies to Congress

Professor Carol Handwerker, Reinhardt Schuhmann Jr. professor of Materials Engineering, fellow of TMS, The American Ceramic Society, and ASM International, testified to Congress at the U.S. House of Representatives Committee on Science, Space, and Technology hearing on Research and Innovation to address the Critical Materials Challenge.

Watch the testimony here:
bit.ly/Handwerker Congress

Trice Receives ACerS Fellow

Professor Rod Trice has been named a 2019 Fellow of the American Ceramic Society (ACerS). This award was presented at the ACerS Honors and Awards Banquet on September 30, 2019 in Portland, Oregon.
bit.ly/TriceACerSFellow

WELCOME *NEW FACULTY*

Nikhilesh Chawla

The School of Materials Engineering is pleased to welcome Nikhilesh Chawla as the Ransburg Professor of Engineering. Professor Chawla hails from Arizona State University where he served as Director for the Center for 4D Materials Science and was the Fulton Professor of Materials Science and Engineering. Professor Chawla received his PhD in Materials Science and Engineering from the University of Michigan in 1997. Before joining Arizona State University in 2000, he was a postdoctoral fellow jointly at Ford Motor Company and the University of Michigan, and a senior development engineer at Hoeganaes Corporation.

Professor Chawla's research is in the area Four-Dimensional (4D) Materials Science with a particular emphasis on the deformation behavior of advanced materials at bulk and small length scales. He has co-authored over 265 refereed journal publications (Web of Science h-index of 46; Scopus h-index of 50; Google Scholar h-index of 57) and over 500 presentations in these areas. He has close to 12,000 citations to his work. He is the author of the textbook Metal Matrix Composites (co-authored with K.K. Chawla), published by Springer. The 2nd edition of this book was published in 2013.

Professor Chawla is a Fellow of ASM International and past member of The Minerals, Metals, and Materials Society (TMS) Board of Directors. He is the recipient of the University of Michigan, Department of Materials Science and Engineering Distinguished Alumnus Award for 2018, Acta Materialia Silver Medal for 2017, and New Mexico Tech Distinguished Alumnus Award for 2016. In addition, he was named 2016 Structural Materials Division Distinguished Scientist/Engineering Award, as well as the 2016 Functional Materials Division Distinguished Scientist/Engineering Award, both from TMS; 2013 Brimacombe Medalist Award from TMS; 2011 Distinguished Lectureship given by Tsinghua University, China; 2004 Bradley Stoughton Award for Young Teachers, given by ASM International; and the 2006 TMS Young Leaders Tutorial Lecture. He has also won the National Science Foundation Early Career Development Award and the Office of Naval Research Young Investigator Award.

Professor Chawla is editor of *Materials Science and Engineering A,* published by Elsevier (2019 Impact Factor of 4.7). He also serves on the Editorial Boards of Materials Characterization and Materials Chemistry and Physics. He has served or is serving on several external advisory boards, including that of Naval Research Laboratory, the Advanced Photon Source at Argonne National Laboratory, and New Mexico Tech.

Janelle Wharry

In January 2020, we welcomed Professor Janelle Wharry to MSE as an Associate Professor. Dr. Wharry first joined the school in 2017 with a courtesy appointment while a part of Purdue's School of Nuclear Engineering.

Dr. Wharry's research aims to understand structure-property-functionality relationships in irradiated materials, with an emphasis on deformation mechanisms and mechanical behavior at the nano/microscale. She also manages Department of Energy (DOE) contracts to code-qualify electron beam welding and powder metallurgy with hot isostatic pressing (PM-HIP) processing of structural materials for nuclear applications. She has published more than 60 peer-reviewed journal articles and refereed conference papers, and is Editor of Materials Today Communications. She is the recipient of the DOE Early Career Award, National Science Foundation CAREER Award, and ORAU Ralph E. Powe Junior Faculty Award. She currently serves as Chair of ASTM Subcommittee E10.08 on Procedures for Radiation Damage Simulation; previously, she was General Chair of the inaugural 2019 Materials in Nuclear Energy Systems (MiNES) Conference and Chair of the American Nuclear Society (ANS) Materials Science & Technology Division.

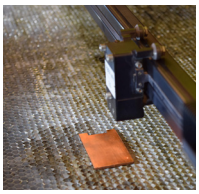
Arun Kumar

In January 2021, Dr. Arun Kumar Mannodi Kanakkithodi will be joining MSE as an assistant professor. Dr. Kanakkithodi received a Bachelor of Technology in Metallurgy and Materials Engineering from the Indian Institute of Technology, Roorkee in 2012, and a PhD in Materials Science and Engineering from The University of Connecticut in 2017. Dr. Kanakkithodi currently serves as a Postdoctoral Researcher at Argonne National Laboratory and his research is focused on quantum mechanics-based materials modeling and machine learning.

PURDUE UNIVERSITY

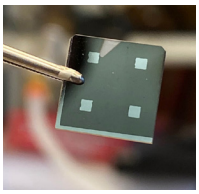
School of Materials Engineering

Faculty Research Highlights



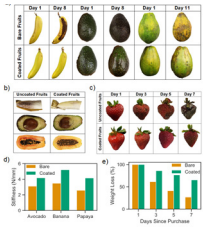
Killing Bacteria

MSE professor, Rahim Rahimi is leading a team that has created a laser treatment method that could potentially turn any metal surface into a rapid bacteria killer – just by giving the metal's surface a different texture. Learn how it works: bit.ly/Rahimi_antimicrobialcopper



Cloaking Heat Signatures

Infrared cameras detect people and other objects by the heat they emit. Now, Purdue MSE professor, Shriram Ramanathan is part of a team of engineers and collaborators that has demonstrated a quantum material that can hide a target by masking its heat properties. bit.ly/IRCamouflage

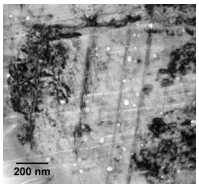


Edible Coating Preserves Produce to Lengthen Shelf-Life

MSE Professor, Jeffrey Youngblood, has partnered with a team of researchers from Rice University to use eggs and cellulose nanocrystals that would normally be wasted as a coating to help preserve fresh produce! bit.ly/Youngblood_egg_based_coatings

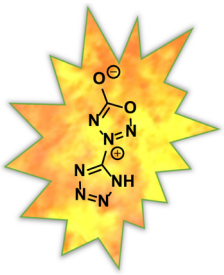
Microstructure Evolution and Degradation in Rechargeable Batteries

Recent MSE graduate, Aniruddha Jana (PhD 2019), and MSE Professor, R. Edwin García have developed a theory that combines the effects of chemical diffusion, electrodeposition, and plastic deformation to understand Li-dendrite growth, as a stepping stone to develop safer, advanced batteries. The work is published in the Journal of Energy & Environmental Science (DOI: 10.1039/C9EE01864F). bit.ly/Garcialithiumdendrite



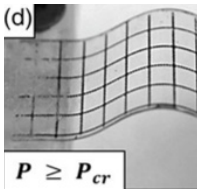
How do we reduce costs of building nuclear power plants?

MSE professor, Janelle Wharry, proposes a new design to save time and money. The presence of cavities can mediate deformation modes in irradiated steels used in nuclear power plants. bit.ly/WharryDeformationCavities



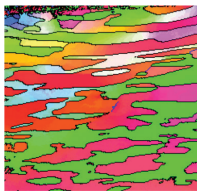
New Lead-Free Explosives

Current primary explosives contain lead which is an environmental hazard and personal safety risk. Professor Davin Piercey has developed new materials that avoid the use of lead and are prospective environmentally-friendly replacements. bit.ly/lead-free_explosives



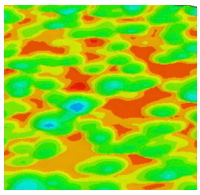
New Polymer Film Modulus Measurement Technique

Doctoral student, Mitchell Rencheck, in the Davis Research Group has developed a novel buckling technique to measure the modulus of brittle polymer films. In collaboration with the Youngblood Research Group, this new characterization tool was applied to nanocellulose films and yielded highly accurate results. bit.ly/film_buckling_modulus



Hybrid Technique Aims to Produce Stronger, Corrosion-Resistant Nickel

Professor Xinghang Zhang is leading a research team that has created a technique to produce stronger, corrosion-resistant nickel for use in auto, medical and manufacturing industries! Learn more: bit.ly/corrosionresistantnickel

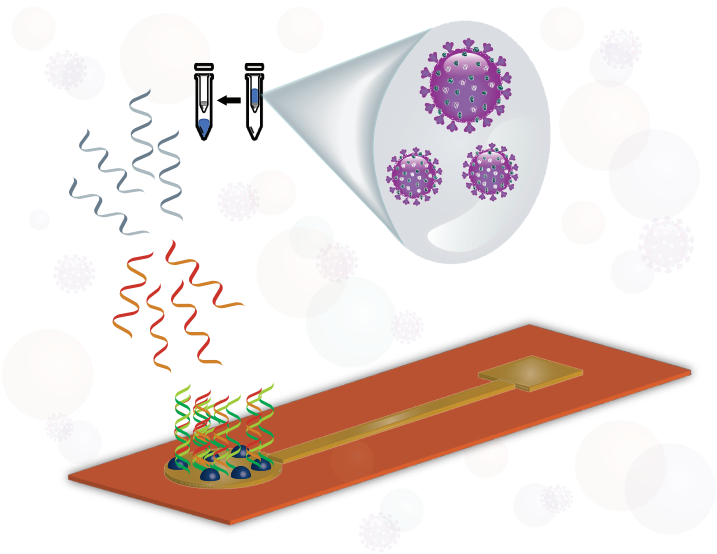


Predictions of Decreased Surface Roughness After Shot Peening Using Controlled Media Dimensions

Professor David Bahr and recent PhD, Siavash Ghanbari, propose a method for decreasing roughness and increasing residual stress concurrently using a distribution of shot sizes in a single shot peening passage based on finite element modeling that has been calibrated using by experimental results. bit.ly/shotpeenroughness

MSE's COVID-19 Research Response

MSE Professor, **Lia Stanciu**, is leading a research project focused on developing an electrochemical field deployable testing device that can diagnose COVID-19 from nasal swabs within 30 minutes. This project is being funded by the National Science Foundation (NSF) Rapid Award CBET 2027554. Professor Stanciu's research is supported by graduate students, Ana Ulloa and Winston Chen, as well as the postdoctoral researcher, Dr. Amit Barui.



Professor **Mukerrem Cakmak**, Reilly Professor of Materials and Mechanical Engineering, is part of a Purdue team that has partnered with 3M to produce thousands of pieces of personal protective equipment to help healthcare facilities during the COVID-19 pandemic. **bit.ly/Cakmak_3M_PPE**

STAFF

Son Promoted to Graduate Advisor

In response to the MSE graduate enrollment almost tripling over the last five years, MSE is pleased to announce that we have added a new graduate advisor: **Rosemary Son**. Rosemary previously served as the administrative assistant/graduate coordinator in MSE and after recently completing her master's degree in higher education from Purdue University Global, she will now assume advising duties for our graduate program.

Welcome New Staff Members

Aury Ku joined MSE as an Administrative Assistant in September 2019. In this role, she will provide administrative support to faculty, staff, students and external guests. Prior to joining Purdue, Ms. Ku worked with Starbucks from 2015-2019. We are pleased to welcome her to the MSE family.

Cathy Noerenberg joined MSE as an Administrative Assistant in January 2020. Cathy holds an Associate's degree from Ivy Tech Community College, and her career at Purdue University spans 14 years. During her tenure, she has worked in the College of Engineering, Veterinary Medicine, and the Polytechnic Institute.

PURDUE DAY OF GIVING 09|09|20

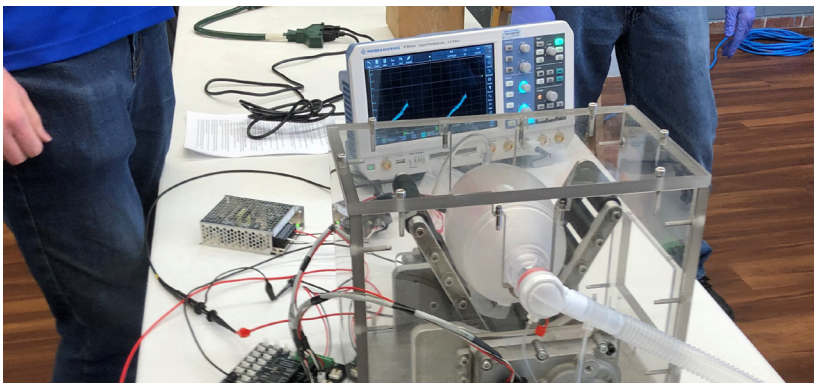
Over the past five years, the MSE community has come together to help us do amazing things through Purdue Day of Giving, and this year we have some exciting initiatives!

- **MSE Online Education**
- **K-12 Outreach**
- **MSE Laboratory Upgrades**
- **Student Travel and Clubs**

dayofgiving.purdue.edu

ALUMNI NEWS

MSE alumnus, **Steve Ferdon**, led a group of about 40 volunteers with Mission Columbus. This group designed, tested, and manufactured ventilators, PAPRs (respirators), and hoods which were distributed to medical providers in the Columbus, Indiana area. The team is comprised of engineers, machinists, supply chain experts and current and retired medial professionals and is about a third Boilermakers!



Jacob Jones named Distinguished Professor at North Carolina State University.

Michael Brant (BS 2013), appointed to the ASM Heat Treat Society Board of Directors. He will serve as an Emerging Professional for the 2019-2020 term.

MSE alum and advisory committee member, **Kyle Hummel** named to Heat Treat Today's 2019 Class of 40 Under 40! Learn more: **bit.ly/Hummel40under40**

Tresa Pollock – Distinguished Lecturer

The College of Engineering was pleased to welcome MSE alumna, Dr. Tresa Pollock, the Alcoa Distinguished Professor of Materials at the University of California, Santa Barbara, back to campus on October 24, 2019, as part of the Distinguished Lecture Series. Dr. Pollock's presentation entitled, "At the Crossroads of Additive Manufacturing, Analytics and Advanced Materials can be viewed at **bit.ly/Pollock_distinguished_lecture.**

MSE Alumnus, Dr. Peter Tortorici Inducted into Professional Practice Hall of Fame

EDUCATION

BS 1990, Metallurgical Engineering, Purdue University ▪ MS 1993, Metallurgical Engineering, Purdue University ▪ Doctorate 1997, Materials Engineering, Purdue University

CO-OP ALUMNUS

Peter Tortorici completed four Co-op rotations with Delphi Energy (formerly known as Delco Remy Division GMC). Here he worked in the initial development of neodymium-iron-boron (Nd-Fe-B) permanent magnets and conducted a variety of materials testing (aging, corrosion, heat treatment) on cold-pressed and hot-pressed permanent magnets.

PROFESSIONAL CAREER

Peter Tortorici has been employed with Medtronic, the world's largest medical device company, for more than 18 years. Since 2016, he has served both as the Senior Engineering Technology Manager in Advance Manufacturing Engineering and as the Technology Collaboration Leader. In this role, he provides technical expertise to drive technology development and adoption in order to improve quality, reliability and meet cost-reduction goals. He is currently leading a group developing manufacturing technologies for cardiac and neurological implantable medical devices.

In light of his outstanding career, Dr. Tortorici has received multiple recognitions from Medtronic as he was awarded the 2011 Medtronic Star of Excellence, named 2014 Medtronic Tempe Campus Technical Guild, and 2017 Medtronic Technical Fellow. Peter has published eight papers in highly regarded professional journals and has been awarded two patents.

Peter Tortorici (center) pictured with Eckhard Groll (left) former Director of the Office of Professional Practice, and Eric Nauman (right), Director of the Office of Professional Practice.

Outstanding Materials Engineer Awardees

Carlotta M. Arthur

Carlotta M. Arthur, PhD, is Director of the Henry Luce Foundation's Clare Boothe Luce (CBL) Program, the nation's most significant funder of women in STEM higher education, having awarded over $200M in grants to support 2,500+ women at 200 institutions. Dr. Arthur co-leads the crafting of the Luce Foundation's diversity, equity and inclusion (DEI) strategy, and has worked to significantly increase the number of minority-serving institutions supported by the program. Carlotta also provides strategic leadership in identifying initiatives with the potential to transform STEM higher education, such as the National Academies of Sciences, Engineering, and Medicine's Sexual Harassment of Women study; STEM diversity in the innovation ecosystem; and STEM ethics and society. Prior to joining Luce in 2012, Dr. Arthur directed the Mellon Mays Undergraduate Fellowship and Diversity Initiatives Programs at the Andrew W. Mellon Foundation.

Carlotta was the first African American woman to earn a BS in Metallurgical Engineering from Purdue University. Following nearly a decade in the aerospace and automotive industries, she went on to complete a PhD in Clinical Psychology (Psychophysiology emphasis) at SUNY Stony Brook. Dr. Arthur was a member of the inaugural cohort of W.K. Kellogg Scholars in Health Disparities at the Harvard School of Public Health, examining psychosocial determinants of health with a focus on translation of research to policy and practice. She has also served as an Assistant Professor at Meharry Medical College, an Historically Black College in Nashville, TN; and as an Adjunct Assistant Professor at the Dartmouth Geisel School of Medicine.

Dr. Arthur is a Licensed Psychologist and founder of a professional LLC that provides strategic expertise and guidance on psychosocial determinants of, and life course perspectives on, inequity. She also advocates for diversity among youth in STEM, and is a budding children's book author. Her middle grades book manuscript STEAM Crew Kids: The Secret of Project MAG, whose main characters are from underrepresented groups, was a finalist in a 2018 WeNeedDiverseBooks.org contest.

In addition to serving on the Society of Women Engineers Research Advisory Committee, Carlotta is a member of the Council on Competitiveness, National Commission on Innovation and Competitiveness Frontiers Working Group; a member of the American Psychological Association Leadership Institute for Women in Psychology Advisory Committee; and a member of the Board of Trustees of the Helene Fuld College of Nursing in Harlem, NY.

Jacob Jones

Dr. Jacob Jones is a Distinguished Professor of Materials Science and Engineering at NC State University, Director and Principal Investigator of the Research Triangle Nanotechnology Network (www.rtnn.org), and Director of the Analytical Instrumentation Facility (www.aif.ncsu.edu). Jones' expertise is in developing structure-property-processing relationships in functional materials such as piezoelectrics and ferroelectrics, primarily through application of advanced X-ray and neutron scattering tools. Jones participates in and leads many interdisciplinary teams and projects on topics utilizing concepts in nanotechnology, crystallography, or functional materials. Representative projects include collaborations with statisticians and mathematicians in applying Bayesian inference to crystallographic structure refinement and the use of nanotechnology and materials science in environmental remediation and water treatment. Jones is known for promoting international science and engineering initiatives. He has been Principal Investigator on three NSF awards to provide international research experiences to U.S. students at foreign research laboratories. Using these programs, Jones has enabled over 50 U.S. students to obtain international research experiences overseas and has hosted a multitude of foreign students at U.S. institutions.

Jones has published over 240 peer-reviewed research papers and delivered over 130 invited lectures since 2004. He is a Fellow of the IEEE Society and the American Ceramic Society and has received numerous awards for his research and education activities, including a Presidential Early Career Award for Scientists and Engineers (PECASE), an NSF CAREER award, the IEEE Ferroelectrics Young Investigator Award, the 2019 NC State Alumni Association Outstanding Research Award, and the 2016-2017 NC State College of Engineering George H. Blessis Outstanding Undergraduate Advisor Award. At NC State, he is an elected member of the Research Leadership Academy, the faculty-driven epicenter of research leadership and faculty mentoring to enhance NC State's research culture.

Jones received his PhD from Purdue University in 2004, after which he completed an international postdoctoral fellowship from the National Science Foundation at the University of New South Wales (UNSW) in Sydney, Australia. He was an Assistant and Associate Professor in the Department of MSE at the University of Florida from 2006-2013 and joined NC State in August of 2013.

Early Steps Toward Purdue Research
SHAPE A HIGH SCHOOL LEGACY

By William Schmitt

Jefferson High School in Lafayette, IN, recently said farewell to a retiring teacher whose legacy continues to expand, thanks to his zeal for motivating STEM students and his outreach to the school's nearby neighbor, Purdue University.

Through partnerships with world-class researchers and mentors, including a professor in the College of Engineering, young people say they are discovering new career paths, and the world of K-12 education is seeing new possibilities in a panorama of collaboration.

Joe Ruhl, who retired this spring after 42 years as a biology teacher—and a force of nature—at Jefferson High, has helped to forge many rewarding paths not only for his students, but for his school and for faculty members on the Purdue campus across the Wabash River in West Lafayette.

His own journey has earned rewards, too. Among them, he was named Indiana's recipient of the Presidential Award for Excellence in Science Teaching in 1989. He returned to the White House in 2017 as one of five educators inducted into the National Teachers Hall of Fame. Ruhl, who holds both a BS in biology (1977) and an MS in biology education (1980) from Purdue, plans to continue his sideline efforts as a motivational speaker.

"I like to share ideas with teachers on how to inspire students," he said in an interview. The key is fostering a network of caring relationships among the young people themselves, as well as "feedback loops" where they energize their teachers and vice versa. Since 1997, when he initiated an independent science research course, he has extended the radius of encouragement—pairing up "passionate" students with the laboratory-based endeavors of Purdue professors advancing knowledge in similar fields of interest. Those endeavors, allowing high school juniors to do a year's worth of hands-on work, tied to the high-stakes research and a professor's personal mentoring

Ruhl

Trice

(alongside the lab's team of graduate students), initially focused on the sciences. They tapped into Ruhl's identification of promising performers in his ninth-grade biology honors course and his pursuit of local friendships with outreach-prone faculty members at his renowned alma mater.

In 2002, the students' options grew to include cutting-edge experience in engineering, too—"something that most kids in high school had never experienced," says Prof. Rod Trice, PhD, a materials engineer developing manufacturing techniques for heat-resistant ceramic materials in aviation. A grant he had received from the National Science Foundation proposed involving high schoolers in his research. He contacted Ruhl after learning of his reputation for matching young people's talents to real-world projects.

That was the start of another set of great relationships. During nearly two decades, Trice has welcomed into his lab many different Jefferson High students whom Ruhl had carefully vetted for their talent, diligence, and interest in engineering. Aligned with the structure Ruhl created for the independent research course, juniors could spend significant, supervised hands-on time in Trice's lab; their collection of data and overall insights—plus immersion in journal articles and development of communication skills—would lead to a detailed presentation for that year's Indiana regional science fair competition.

Their efforts could begin with a paid internship during the summer prior to junior year and could even extend into senior year if justified by their progress. Along with science-centered members of Ruhl's class (exploring botany, biochemistry, veterinary science, and much more), those preparing engineering presentations could advance to statewide—and even international—science fairs.

Trice recalls how impressed he became early on—not only with students who established small but substantial niches of competence within the outstanding lab research teams, but with Ruhl. Between 1997 and 2020, Ruhl has cultivated more than 300 young people ready for fast-tracked learning—many of them representing Jefferson High's diverse student body.

"I don't know how he does it," Trice says, calling Ruhl an educator who's "one in ten million."

Ruhl returns the compliment. "Rod Trice has been one of the star mentors," he says. Trice and his lab associates "have done a wonderful job inspiring students" by welcoming them into relationships marked by respect and a persistent drive for excellence. Trice also exemplifies the "gracious" spirit of cooperation he has found at Purdue; the course is not a formal K-12/university program, Ruhl explains. He cobbled together affiliations to support an initiative that has no budget to pay mentors.

The students directed toward campus experiences across the river are a diverse bunch in all ways, reflecting the large public high school as "a complete cross-section of society," Ruhl confirms. "I've made a conscious effort to reach out to under-represented groups," he says. A majority of the juniors who apply and are accepted into the independent research course have been female. Trice says young women have constituted 75 percent of the students working in his lab.

Joe Ruhl engaging with his students.

> ***"I like to share ideas with teachers on how to inspire students"***
>
> **— Joe Ruhl**

Stories of impact on career pursuits and accomplishments in science and engineering abound when Ruhl and Trice summon their memories.

There's a student who took Ruhl's class in both her junior and senior years, conducting entomology research with Prof. Christian Krupke, PhD, and rising in science fair competitions; in 2015, she received a $1,000 third prize in the International Science and Engineering Fair when she became Jefferson High's thirteenth student to reach the global competition. She is now earning her PhD in Pharmacology at the University of North Carolina, working on improved chemotherapy for cancer patients (see the photos of Sarah Cooper).

A young man worked in Trice's lab last summer and returns to Jefferson as a senior in 2020-2021, having enjoyed a personal epiphany about materials engineering. Various graduates have launched into different engineering fields as they enrolled in college. A while back, a young man who sampled nuclear engineering in Ruhl's class carried that interest all the way to a PhD degree and now has returned to Purdue to pursue giant leaps in the same lab where his journey began.

One young woman showed promise as a 15-year-old and followed up on an engineering lab opportunity with Trice; transformed perspectives prompted her to rejigger her junior and senior class load. She seized Jefferson's much-expanded resources in that field. Now 18, she is entering Purdue's College of Engineering this fall (see the Laney Houston story at engineering.purdue.edu/MSE).

Ruhl, like his students, sees the independent research partnerships he helped form with Purdue professors as only the beginning. He acknowledges he is hardly the only K-12 educator in the United States who has helped form collaborations with university science professors. But such innovations take extra work, and Purdue professors made it easier.

He does not want his retirement to be the end of his motivational efforts. He offers guidance on duplicating the science research initiative when he speaks to the Hoosier Association of Science Teachers, Inc.

And he hopes his schedule of public speaking will offer encouragement to teachers nationwide. As seen in a 2015 TED Talk, he says "the power of love" within a network of respectful relationships can give STEM students more confidence and career choices.

"I would love to train teachers who are interested in doing this," he says, referring to the startup of inclusive groupings making students' engagement more intentional.

Ruhl already has found a Jefferson High teacher who will continue the research course for juniors this fall. He says Purdue professors are already saying they will continue the collaborations.

One of them is Trice, who says the development of skills he sees in the high schoolers—and the driven teamwork he sees spread among teenagers, graduate students, and professors alike—contribute to his enjoyment of mentoring.

"I absolutely will continue with the course," he says. It's a win-win for Purdue's lab research leadership in "real programs that actually have an impact" on-campus, regionally, and beyond.

UG researcher Brynna Kelly turns up the heat

WORKING WITH HIGH TEMPERATURE METALS

By my first day of Materials Engineering classes as a sophomore at Purdue, I knew that I wanted to experience undergraduate research. The Honors College always encouraged undergraduate research in the freshman engineering classes and after hearing my materials engineering classmates in MSE 230 talk about their research positions on the very first day made me want to experience undergraduate research myself.

During the last week of the first hands-on laboratory class in the MSE curriculum, MSE 235 Materials Processing Laboratory, Dr. Titus alerted the class to a few open positions in his research group. After speaking to Dr. Titus about my experience and the projects he was working on, I joined his research team. The summer after my freshman year at Purdue, I had started a position as a Metallurgical and Process Engineering co-op student at Moog, Inc., where I learned many hands-on skills that were extremely beneficial for my research work. My experiences at Moog and in MSE 235 prepared me for my first project with Dr. Titus regarding the characterization of aluminum-copper alloys.

In this project, my partner and I were tasked with quantifying the microsegregation and primary and secondary dendrite arm spacing in different horizontally-solidified aluminum-copper castings. This research was being performed in order to replicate a previous experiment that studied interdendritic fluid flow in aluminum-copper castings. The first step of this project involved sectioning samples out of the ingot at the thermocouple locations using a Flow waterjet cutter at the Bechtel Innovation Design Center (BIDC). Using this machine allowed me to experiment with the design of the cutting path and learn from the challenges of sectioning the wedge-shaped ingots. The image shows the final sectioning design. The catalogued samples were prepared and analyzed with optical microscopy, scanning electron microscopy, and X-ray diffraction. My favorite parts of this project included connecting with other undergraduate researchers in MSE and learning more about machining through my experience at the BIDC. My experience working on this project, coupled with my junior-year MSE courses helped to develop my ongoing passion for manufacturing.

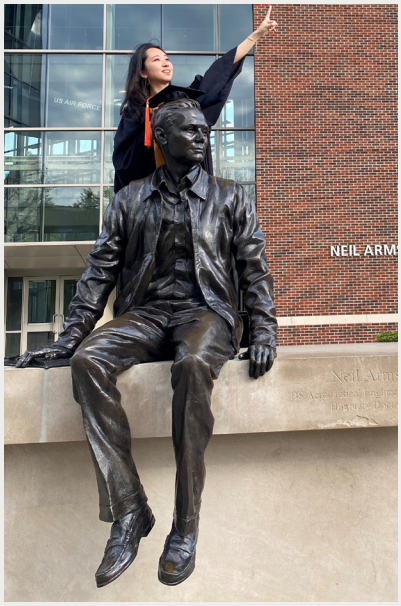
While I was working on this project, I completed the Purdue MSE laboratory sequence and finished another co-op block at Moog. During my third semester researching with Dr. Titus, I had the opportunity to transfer to another project within his research group, focusing on the precipitation and growth kinetics of Haynes® 244®, a nickel-based superalloy used in high-temperature gas turbines. My experience working on this project included carrying out heat treatments, testing microhardness, and writing a program that identifies the minimum creep rate from a creep curve. The part that I enjoy most about this project is the complexity of the Haynes® 244® system because I have learned a great amount from literature reviews that I have completed outside of the lab.

I am extremely grateful to acknowledge my advisor, Dr. Titus, for these research experiences over these past three semesters and providing many department engagement opportunities, both of which have helped me to grow as a student.

Molten aluminum alloy waiting to be cast into an ingot.

Aluminum ingot sectioned and cut into small cubes for optical and electron microscopy analysis.

2020 Student Award Recipients



Internal Student Awards:

Bray Award
Peter Hong, Tyler Lucas

Outstanding Graduating Undergraduate Research Award
Nolan Miller

Donna Bystrom Undergraduate Service Award
Peter Hong

Undergraduate Student Leadership Award
Ashley Wissel

Outstanding Graduate Student Service Award
Xin Li Phuah

Outstanding Graduate Student Researcher
Xuejing Wang

Estus H. and Vashti L. Magoon Graduate Teaching Award – Purdue Online
L. Susana Diaz-Amaya

Estus H. and Vashti L. Magoon Graduate Teaching Award
Thomas Mann, Sae Matsunaga

Briney Achievement Award
Jesse Grant
Brenden Hamilton
B. Stiven Puentes Rodríguez

External Student Awards:

2019 Best Post Award at Microelectronics Integrity Meeting, Indianapolis
Yaohui Fan

2nd Place Poster at the SMART Films Workshop, Birck Nanotechnology Center
Jesse Grant

Nucor Steel Foundation Scholarship and the AIST Steel Intern Scholarship
Amanda Guyre

1st Place Poster in the Graduate Structural Materials Division at TMS
Thomas Mann

2020 TMS Graduate Student Best Paper Award
Keyou Mao

2nd Place 2019 DOE Nuclear Science User Facilities Users' Committee
Keyou Mao

Office of Undergraduate Research Fellowship
Nolan Miller

Best Poster at 2019 Materials Research Society, Fall Meeting in Boston
Shikhar Misra

Dean's Teaching Fellowship College of Engineering
Mitchell Rencheck

Early Career Representative from the DOE Energy Frontier Research Centers - Center Thermal Energy Transport Under Irradiation
Amrita Sen

First Place in the Poster Competition, 2019 Surface Engineering and Advanced Materials Processing Conference, ASM Indianapolis Chapter
Shoumya Nandy Shuvo

Additional Awards:

II-VI Foundation Scholarship
Tyler Lucas

Roland Snow Award, MS&T
Xin Li Phuah

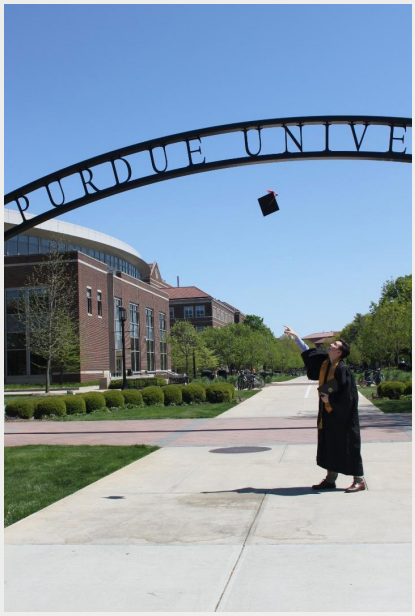
Goldwater Scholarship
Mackinzie Farnell

Lord Bagri Scholarship, The Copper Club
Paul Mather

National Science Foundation (NSF) Graduate Research Fellowship
Alejandro Figueroa Bengoa

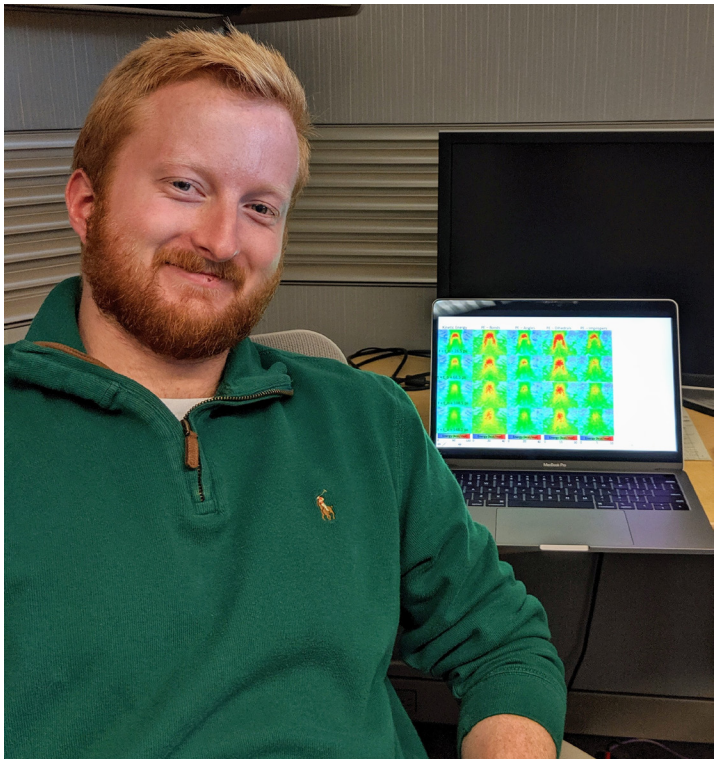
2020 National Science Foundation (NSF) Graduate Research Fellowship (GRF)
Joseph Yount

1st place, Poster Session, Undergraduate Functional Materials Division at the TMS conference
Sookyoung Jeong



From Atoms to Explosions:
Simulating Nanoscale Chemical Initiation

Brenden W. Hamilton

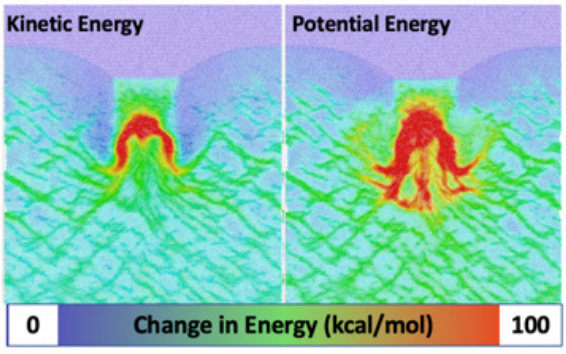


Brenden is a 3rd year PhD student under the advisement of Professor Alejandro Strachan. He is also an alumnus of Purdue, with bachelor's degrees in both Materials Science and Engineering and Applied Physics. As both an undergraduate and graduate student in Dr. Strachan's group, Brenden's research has attempted to better unravel the processes through which high-velocity impact can lead to chemical initiation and detonation of explosive materials. These works rely on the use of theoretical and predictive simulations with atomic resolution, namely molecular dynamics. MD simulations follow the evolution of individual atoms and, using some of the largest supercomputers in the world, Brenden tracks tens of millions of atoms.

The exact events to take an explosive from shock compression to full detonation are still an open question in science, it all happens on scales that are too fast and too small to probe experimentally. The main hypothesis is the formation of hotspots, where impact energy localizes, that eventually react, grow and agglomerate to form a detonation. These hotspots form when the shockwave interacts with the microstructure or defects in the material. Thus, understanding the initiation of detonation in solid explosives bring together materials science, shock physics, and chemistry. A predictive understanding of the relationship between an explosive's microstructure and how it initiates will enable tailoring materials for specific properties such as insensitivity and safety, as well as performance.

To date, hotspots have been solely described by their temperature field. Brenden's recent work, in collaboration with researchers at Lawrence Livermore National Laboratory, a missing piece in current models. He found an increase in potential energy (PE) that cannot be inferred from the temperature, as has been assumed. The additional rise in PE is mainly due to extreme deformations and strains of individual molecules. These intra-molecular deformations store significant energy directly in chemical bonds that can be readily used to initiate chemical reactions. This can lead to rapid mechano-chemistry and non-equilibrium reactions that are currently not captured in macroscopic detonation models. Brenden's ongoing work is focusing on better understanding how these strained molecules and non-equilibrium states influence chemical kinetics. This work aims to build tools to predict the state of the hotspot formed from various microstructural defects and shock strengths, without simulating the full defect, saving computational costs.

Brenden plans to continue research on explosive materials and shock compression of matter, not only due to its impact on our country's defensive capabilities, but because it also allows for the study of numerous basic science principles for materials, physics, and chemistry. These principles include the properties of solids under extreme temperature and pressure conditions, plasticity and shear banding in molecular solids, mechanical and chemical properties of amorphous materials, and non-equilibrium processes in materials.



Localized Kinetic and Potential energy from the shockwave induced collapse of a void in the solid explosive TATB

GRADUATE STUDENT PROFILE

Ana Maria Ulloa Gomez · Bogotá, Colombia

What attracted you to Purdue University's graduate programs?
During the six months in the UREP-C program, I had the opportunity to be part of Professor Stanciu's group and was able to conduct research under the mentorship of Sabrina Huang (a former graduate PhD student). The work performed during those months was very enriching. That said, having experienced the level of research done at Purdue, I decided to pursue a graduate engineering program instead of a dental clinical specialty in Colombia.

What has been most rewarding about your time in Materials Engineering?
Ever since I came here, I have had numerous rewarding experiences. However, being part of SMART Films group at Birck has been the most rewarding one because I have had the opportunity to work with faculty and graduate students for many disciplines (chemical, electrical, biomedical, materials, and mechanical engineering) to develop sensors which are viable for industrial use.

What is your area of research?
Back in 2017, as an undergraduate I started working in the enhancement of bioresorbable metals for medical applications but for the past two years I have been working in the development of sensors for the detection of contaminants in food. These sensor are intended for the agricultural industry with the goal of maintaining environmental safety. Currently, my research goal is to develop a zirconia-based electrochemical sensor for the detection of nitroaromatic organophosphorus pesticides.

Have you been involved in any student organizations or community activities while at Purdue? If so, which ones?
Yes, I am the Vice President of the Colombian Students Association at Purdue (CSAP).

Since Colombian students constitute the largest Latin-America population enrolled at Purdue, CSAP is intended to integrate our community, share the culture of our country across the campus as well as sponsor professional development events for both undergraduate and graduate students.

Why would you recommend this department to others who are still deciding on an area of study?
Even thought materials engineering is conventionally associated with ceramics, metals and polymers research, this department at Purdue also conducts research in other areas such as biological and electronic materials, computational modeling, and many others. So the field is broad enough for students to pursue their interest in diverse fields. Furthermore, MSE faculty work in collaboration with several engineering departments, and this represents a great opportunity to get involve in multidisciplinary projects.

How do you plan to use your knowledge and experience gained at Purdue University in the future?
Having first hand experience about the needs of the healthcare professionals and patients, I would like to serve as a bridge in industry to connect two disciplines, health science and materials engineering.

You are a licensed dentist. Why did you decide to pursue a graduate degree in Materials Engineering?
As I mentioned previously, being part of the UREP-C program contributed significantly to this choice. The majority of dentistry schools train and provide an advanced set skills intended for professionals which will be in clinical environments. Additionally, most graduate programs in dentistry involve the use of different kinds of materials, but there is a knowledge gap between the application and the design or development of new materials. Hence, there is not enough room to get involved in the investigation or research-side of things. Through a graduate degree in materials engineering, I am able to learn the necessary research tools and gain understanding of the dependence between the materials' properties, structure, and processing and their performance for different health science applications. "You can't make it without materials."

If you could give one piece of advice to undergraduates considering graduate school, what would it be?
If you want to develop new skills, love learning and creating new knowledge, probably this a good choice independently the path you want to pursue (academic or industry). However, if you haven't been involved in graduate school before, I recommend you to get advice from graduate students and professors about their experiences and their work. Also, evaluate your career prospects "Does your dream career require a graduate degree?" If you are still unsure of what you want to do, I also recommend you to try to get both a summer internship in industry and maybe take a semester to do research. This way you can make more solid decisions.

MATERIALS MATTER @Purdue

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

120TH ANNIVERSARY

MSE is pleased to help Purdue's College of Engineering celebrate its 120th anniversary! This podcast (2 episodes) will allow you to hear from some of your favorite MSE faculty about where we are today, and why "you can't make it without materials."

Listen now:
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bit.ly/MSEPodcast_episode2