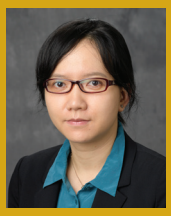
Materials Matter @Purdue

2016 Annual Newsletter





The School of Materials Engineering is pleased to welcome

EIGHT NEW FACULTY MEMBERS

PURDUE™ MATERIALS ENGINEERING

A Message from the Head

inside

MSE Alumni, Students, and Friends!

The 2016 academic year has just started, and already we are off to another record year of "mosts:" most incoming sophomores (68); most graduate students (142, with 135 PhD); most faculty hired in a single 18-month time span, and the highest total number of faculty in the history of the School. If you aren't on campus, this might sound like a broken record each year, but this is the most exciting time I think our School has ever seen since it's founding in 1959.

Our challenge going forward is to not just be bigger, but better. As Dean Leah Jamieson has said many times, if at the end of the Engineering Expansion all we are is bigger then we have wasted an opportunity. So, over the next year, our focus is shifting from not only how to grow and keep our family-like atmosphere within Purdue, but also to answer the question, "How do we **build the materials community**?" This is a multi-dimensional problem; we are looking for how to shape our students into the MSE's of the future, how to make materials research on campus more cohesive and team based, and how to create new educational paradigms that other schools adopt (and determine where we should adopt others' best practices). In addition, we must decide how we increase our entrepreneurial activities, and how we make Purdue MSE one of the go-to partners for materials research around the world. In preparation for the next stage of the School, we have introduced programs like the Institute for Advanced Composites Manufacturing Innovation (IACMI) funded by the National Network for Manufacturing Innovation(NNMI). MSE is taking the lead on center proposals from Purdue to the National Science Foundation (NSF), and linking applied and fundamental work for the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E). We have the right people in place, we are players in all sectors of materials engineering (from metals to semiconductors and biomaterials), and with your help, we are revitalizing our facilities.

I'm excited to be a part of this stage of the School's history. It's hard work, but it's going to be fun too. I hope you'll join us in building the materials community. Making and building… that's what Boilermakers do.

Hail Purdue,

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

On the Cover
The School of Materials Engineering is pleased to welcome eight new faculty members (L to R): Dr. Mukerrem Cakmak, Dr. Chelsea Davis, Dr. Tomás Díaz de la Rubia, Dr. Peilin Liao, Dr. Jan-Anders Mansson, Dr. Maria Okuniewski, Dr. Haiyan Wang, and Dr. Xinghang Zhang

PURDUE UNIVERSITY

PURDUE MATERIALS ENGINEERING

SCHOOL OF MATERIALS ENGINEERING

John A. Edwardson Dean of Engineering • **Leah H. Jamieson**

Head • **Dr. David F. Bahr**

Director of Development • **Robyn Jakes**

www.engineering.purdue.edu/MSE

Join the Purdue Materials Engineering LinkedIn Group: Purdue Materials Engineering. LinkedIn

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

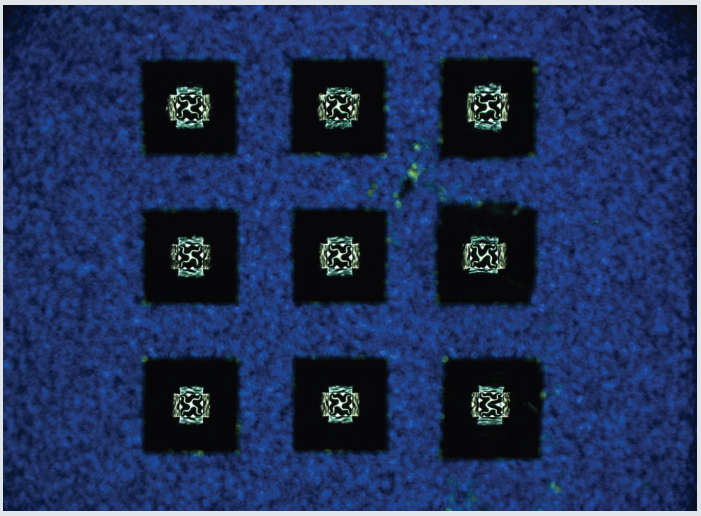
Robyn Jakes
Director of Development
765-494-4094
rnjakes@prf.org
Or click the "Giving" link on our homepage.

Discovery of new solid state materials for applications in physics and technology

Growing demand in low power, light weight, and increased performance for many cutting edge technologies is driving research into new materials with unique physical properties. Today, special emphases are made on discovering properties of materials, growing materials of high structural quality, and roles of defects in dictating the physical properties of materials.

This is the pivot of research done by Professor Shriram Ramanathan of the School of Materials Engineering. Since his arrival at Purdue in 2015, he, along with his multi-disciplined group of physicists, electrical engineers, and materials scientists, have continued to investigate ceramic oxides, because of their unique electronic properties, with special focus on electrical conductivity, ionic transport, structural quality, and impact of microstructure on performance.

In the group's research, device fabrication remains an indispensable method as it makes for testing of properties of these advanced materials that are being investigated. As such, in a bid to discover desired properties with applications in Photonics and Autonomous Systems, new materials are being synthesized in projects relating to fuel cells and low power switches. Results in this research area, will open up new areas connecting advanced materials to previously unexplored topics of relevance to society. It is certainly a good growth opportunity where research in Material Science can have impact in Future Technologies.



Array of chip scale micro-fabricated fuel cell membranes

http://www.nature.com/nature/journal/v534/n7606/full/nature17653.html.
http://shriram-ramanathan.org/

Faculty awards:

David Bahr
2016 American Association for the Advancement of Science (AAAS) Fellow, The Minerals, Metals and Materials Society (TMS) Brimacombe Medalist

Mysore Dayananda
2015 ASM-IIM (Indian Institute of Materials) Visiting Lectureship

John Howarter
Society of Environmental and Ecological Engineering Instructional Excellence Award

Elected to the Minerals, Metals and Materials Society (TMS) Board of Directors, Chair of the Public and Governmental Affairs Committee

Volkan Ortalan
Office of Naval Research Young Investigator Award

Hiayan Wang
2016 American Association for the Advancement of Science (AAAS) Fellow

Faculty promotions:

Dr. Lia Stanciu
promoted from associate professor to full professor.

Dr. R. Edwin Garcia
promoted from associate professor to full professor.

Welcome New Faculty Members

Dr. Mukerrem Cakmak

Reilly Professor of Engineering
Materials Engineering/Mechanical Engineering

Dr. Cakmak received his BS in Chemical Engineering from the Technical University of Istanbul and his MS and PhD in Polymer Engineering from University of Tennessee, Knoxville. He co-founded the Polymer Engineering Department at the University of Akron where he was named Harold A. Morton Chair and Distinguished Professor of Polymer Engineering. Dr. Cakmak's area of expertise is on identification, modeling and simulation of complex structural mechanisms taking place during the course of polymer processing operations including film casting, uni- and biaxial stretching processes. He is actively developing novel processes to address the needs of emerging markets. This includes hybrid roll to roll process to embed conductive electrospun nanofibers in substrates for transparent conductive films. More recently, he focused on nanomanufacturing to organize and align nanoparticles in polymer films with external fields on a pilot scale machine. He developed a number of unique metrology tools including an instrumented drying system that measures weight, thickness, birefringence of cast liquids during the course of their solidification. To assess the functional properties in use conditions, a heavily instrumented film stretching process simulator was developed. This simulator tracks true stress, strain, birefringence and electrical conductivity during all stages of film stretching operation in order to understand molecular mechanisms that take place during the course of film processing operations. His most recent development is a metrology tool that combines ultrafast IR spectroscopy abd optical birefringence with stretching system to investigate orientation/relaxation/crystallization processes that take place in multicomponent polymer systems undergoing heating, stretching, cooling. He is currently developing roll to roll pilot lines for functional flexible polymer films and freeze drying of food and pharmaceuticals. He has authored and co-authored more than 200 refereed publications and patents.

Dr. Chelsea Davis

Assistant Professor

Dr. Chelsea Davis received a BS in Textile Engineering from North Carolina State University in 2005. She obtained her MS and PhD in Polymer Science and Engineering from the University of Massachusetts (UMass) Amherst in 2007 and 2012, respectively. While at UMass, Dr. Davis's work was supported through an NSF Integrative Graduate Education and Research Traineeship. Her doctoral dissertation focused on the use of surface instabilities for adhesion control. From 2012-2013, Dr. Davis was a Michelin Postdoctoral Research Fellow at the ESPCI ParisTech working on the development of an adhesion testing device to probe the impact of dwell time on polymer-polymer adhesion. She went on to complete a National Research Council Postdoctoral Fellowship in the Polymers and Complex Fluids Group at the National Institute of Standards and Technology (NIST) investigating methods to visualize interfacial failure of composites and nanocomposites from 2013-2015. Dr. Davis is currently a Materials Research Engineer within the Materials Science and Engineering Division at NIST continuing her work on damage-sensing interfacial molecular probes in polymer composite systems.

Dr. Davis's research focuses on the molecular visualization of interfacial mechanics. Adhesion, friction, and wetting mechanisms are critical surface problems that must be addressed and understood to enable innovations in polymer surfaces and coatings technologies. Utilizing custom-built mechanical testing devices in situ with optical microscopy, she is developing new insights into polymer interfacial phenomena.

Dr. Tomás Díaz de la Rubia

Professor
Director and Chief Scientist, Discovery Park

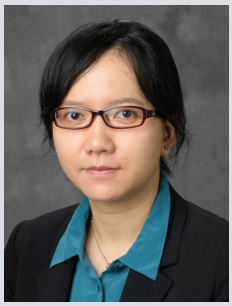
Dr. Tomás Díaz de la Rubia is Purdue University's chief scientist and executive director of Discovery Park. In this position, his responsibilities include building upon Discovery Park's foundation of excellence which has enabled high-impact research that crosses traditional academic boundaries. He is also a professor of Strategic Management (by Courtesy) in the Krannert School of Management.

Before coming to Purdue, Dr. de la Rubia served as innovation leader and a director in Deloitte's energy and resources industry practice in Washington, D.C., working with Fortune 500 energy and manufacturing companies to identify and capitalize on business opportunities arising from potentially disruptive, innovative new technologies.

Prior to joining Deloitte, Dr. de la Rubia was the chief research officer and deputy laboratory director for science and technology at the Lawrence Livermore National Laboratory (LLNL) in California, where he was responsible for the long-term health of the science and technology foundations of the laboratory's $1.6 billion research program. In this capacity, he oversaw a $300M program of basic and applied research, and was responsible for the Laboratory's industrial partnerships and technology commercialization. From 2002-2009, he was an associate director at LLNL, leading its chemistry, materials science, life sciences, and energy and environmental sciences organizations, as well as its $60 million basic materials science, chemistry and biology programs with the Department of Energy's Office of Science.

Dr. de la Rubia has published more than 150 peer-reviewed articles and has co-edited several books and conference proceedings. He is a fellow of the American Physical Society and of the American Association for the Advancement of Science and served as an elected member of the board of directors of the Materials Research Society, and vice-chair of the division of computational physics of the American Physical Society. He holds a bachelor's degree (summa cum laude) and a doctorate in physics from The State University of New York, Albany.

Dr. Peilin Liao



Assistant Professor

Dr. Liao obtained her PhD in Chemistry from Princeton University in 2012, and BS in Chemistry from Peking University, China in 2006. During graduate school and postdoctoral training, she worked on developing and applying first-principles electronic structure theory to understand and improve oxide based solar cells and catalysis on metal-organic frameworks (MOFs). Her research interests are in first-principles computational study of the physics and chemistry of materials, in the areas of renewable energy research and catalysis. Prior to joining Purdue University, Dr. Liao was a postdoctoral fellow at Northwestern University, a postdoctoral research scientist at Columbia University, and a postdoctoral research associate at Princeton University.

Dr. Jan-Anders Mansson

Professor
Materials Engineering/Chemical Engineering

Dr. Jan-Anders E. Mansson, has his PhD from Mechanical Engineering at Chalmers University of Technology in Gothenburg, Sweden. After 5 years as head of the R&D department at a Swedish polymer and composite manufacturing company, he moved to an academic position at the University of Washington, where he was a Professor of Chemical Engineering. Later he moved to the Royal Institute of Technology, Stockholm, Department of Polymer Technology and Aeronautical and Vehicle Engineering.

In 1990, Dr. Mansson joined the Ecole Polytechnique Fédérale de Lausanne (EPFL) as Professor and Director of a newly created chair in Polymer and Composite Technology (LTC) at the Institute of Materials. His research at EPFL-LTC is focused on novel cost-effective materials and manufacturing methods as well as unique additional functionalities, beyond the classical performance characteristics of composite materials. Scaling strategies and manufacturing principles for industrial implementation have been a focus since the beginning. The research partners are primarily in the Automotive, Aerospace, Chemical, Medical and Sport industries. The research has led to over 600 scientific publications and a number of patents and patent applications.

Besides his research, Professor Mansson has during the period 2004-2008, been Vice-president at the Ecole Polytechnique Fédérale de Lausanne, responsible for a newly created vice presidency in innovation and technology transfer, with a mission to build-up a dedicated innovation strategy and tech-transfer interface at EPFL. He served as Swiss Focal Point, under the Swiss Government for the cooperation in Science and Technology with the Republic of Korea. Since 2008, Professor Mansson has served as President of the International Academy of Sports Science and Technology, AISTS, an International Olympic Committee (IOC) co-founded organization linking Academic Institutions in Sport Management and Technology. Mansson is a member of The Royal Swedish Academy of Engineering Sciences (IVA) and the Swiss Academy of Engineering Sciences (SATW).

Mansson is the founder of the composite companies, EELCEE Ltd. and QEESTAR Co. Ltd. active in the field of High-Volume Composites and Additive Manufacturing. The two companies have their main operations in Korea and Europe.

Dr. Maria Okuniewski

Assistant Professor

Dr. Maria Okuniewski received her MS and PhD degrees in Nuclear Engineering at the University of Illinois at Urbana-Champaign in 2004 and 2008, respectively. She received her BS degree from the University of Tampa. Prior to joining Purdue University in January 2016, Dr. Okuniewski was a staff scientist and engineer at Idaho National Laboratory for almost eight years in the Nuclear Fuels and Materials Division. Dr. Okuniewski was also an adjunct faculty member at Idaho State University in the Department of Nuclear Engineering and Health Physics. She was also a charter member of the World Nuclear University fellows in 2005. She was the recipient of the Department of Energy, Fuel Cycle Research & Development Excellence Award in 2013.

The over-arching goals of Dr. Okuniewski's research focus on understanding the connections between the microstructure of nuclear materials and fuels and their mechanical properties. This research aims to connect phenomena that span multiple spatial (atomistic to mesoscale) and temporal (picoseconds to seconds) scales. Her research utilizes both experimental and modeling techniques in a complementary fashion. She has also been instrumental in developing new techniques and expanding the capabilities of existing techniques to apply to the characterization of nuclear fuels and materials such as positron annihilation spectroscopy, nanoindentation, synchrotron X-ray diffraction and tomography, neutron diffraction, and focused ion beam/scanning electron microscopy applications.

Dr. Haiyan Wang

Basil S. Turner Professor of Engineering
Materials Engineering/Electrical and Computer Engineering

Dr. Haiyan Wang hails from Texas A&M University. Her tenure at the University began in 2006, and she held the positions for assistant, associate and full professor. From 2013-2015, she served as a program director in the Division of Materials Research at the U.S. National Science Foundation. From December 2002 to January 2006, Dr. Wang was on the staff of the Los Alamos National Laboratory, first as a director-funded post-doctoral fellow, and then as a permanent technical staff member. She received her PhD in materials science and engineering from North Carolina State University in 2002, her MS degree from the Institute of Metal Research in 1999, and BS from Nanchang University in 1998.

Dr. Wang specializes in nanostructured functional ceramics for multifunctional hybrid materials, microelectronics, optoelectronics, high-temperature superconductors, solid oxide fuel cells, ferroelectric and ferromagnetic applications, and radiation tolerance materials. She has published over 350 journal articles and presented 180 invited and contributed talks at various international conferences. Dr. Wang holds eight patents in the areas of thin film processing and architectures.

She is a fellow of American Association for the Advancement of Science (AAAS), ASM International, and ACerS. Her major awards include O'Donnell Award in Engineering from The Academy of Medicine, Engineering and Science of Texas (TAMEST) 2015, Distinguished Research Achievement Award from Texas A&M AFS 2015, ASM Silver Medal Award 2011, NSF CAREER 2009, ONR-YIP 2008, PECASE 2008 and AFOSR-YIP 2007.

Dr. Xinghang Zhang

Professor

Dr. Xinghang Zhang joined the School of Materials Engineering in Fall 2016. After receiving his PhD in 2001 from North Carolina State, he was a director-funded postdoctoral fellow at Los Alamos National Lab until joining Texas A&M University in 2005. Professor Zhang's research interests are in nanostructured metallic systems (thin films and bulk); radiation damage in nanostructured metallic materials; nanotwinned metals, and hydrogen storage in nanostructured metals. He couples materials processing with characterization and nanomechanical testing on a wide range of nanostructured metals in both ambient and harsh environments. His research, over 160 papers, and descriptions of his group activities can be found at https://sites.google.com/site/xzhanggroup/.

ZF TRW Utilizes Purdue Research Team for Residual Stress Study

Student Researchers: Doug Blomeke, Cayley Dymond, Hojung Kim, Xiaomeng Zhang
Faculty Advisor: Dr. David Bahr **Industrial Sponsor:** Mark Herter, Program Manager with ZF TRW

The ZT TRW branch in Lafayette, Indiana produces power steering systems for the heavy-duty trucking industry. To meet performance and safety standards for their customers, ZF TRW uses shot peening to increase the fatigue life of their products. Mark Herter, Program Manager with ZF TRW, engaged the services of the research team with Purdue Materials Engineering to provide guidance on which parameters are the most important in the shot peening process and how modifying these parameters affects the microstructure, residual stress, and hardness.

PROJECT BACKGROUND

The research team set out to tell TRW how much room they have in their peening process to change parameters without negatively affecting the performance of their THP60 rack pistons. There are three concepts that are fundamental to this project: shot peening, residual stress, and fatigue.

EXPERIMENTAL PROCEDURE

The picture of the as-received THP60 rack piston is shown to the right. The sample preparation procedure followed the ASTM standards. Synthetic chemotextile hard napless polishing cloth and glass filled epoxy powder were used to improve edge retention. The etchant was nital which contained 2% nitric acid and 98% ethanol. Parts for the Design of Experiments were named with a two-number convention. The first number is the peening air pressure, and the second number is the percentage of the normal peening time that was used.

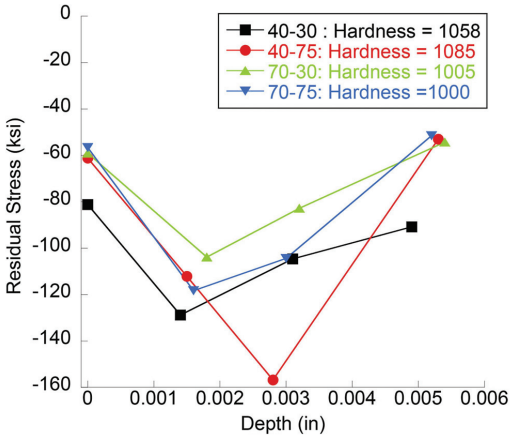
RESIDUAL STRESS MEASUREMENT BY XRD

To measure the residual stress at the surface of the parts from the current process, the team used the XRD Debye-Scherrer Ring method. The depth profiles were created for the other parts using the $\sin^2\Psi$ method.

Since austenite had a different crystal structure from martensite and other phases of iron, the resulting diffraction pattern would be different. The amount of retained austenite could be estimated by comparing the intensities of diffraction peaks arising from each of the phases. In the absence of significant undissolved carbides and preferred orientation, there was a correlation between the intensity ratio and the volume fraction of retained austenite. Two standards (ASTM E975 and SAE SP-453) for austenite measurements were used. Both assumed that the material had a nearly random orientation and few carbides.

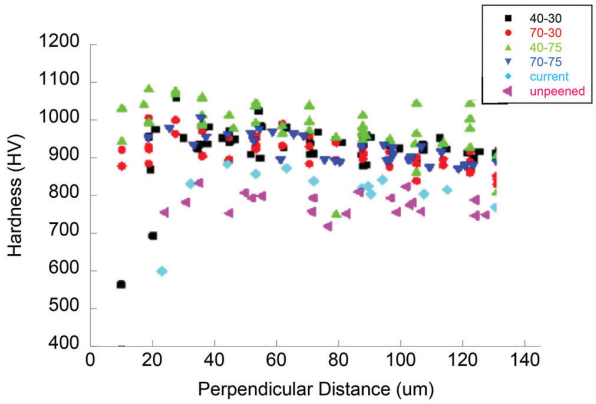
RESULT

Residual Stress



The residual stress profiles and the maximum hardness value and location for the four experimental samples. 40-75 shows the greatest residual stress at the deepest location along with the highest hardness value.

Hardness



Hardness values near the surface for the four experimental samples, the current process, and an unpeened region. The 40-75 sample showed the highest average hardness and the unpeened sample showed the lowest average.

Presence of Cementite

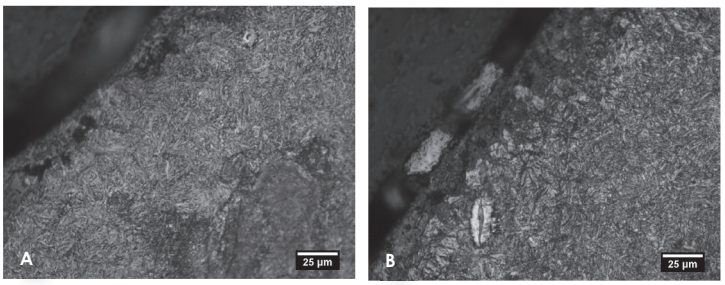


Image A shows the microstructure near the surface of the peened region for 40-30. Image B shows the same region for 40-75. All samples had microstructures comprised of tempered lath martensite. Small, semi-circular white areas reveal the presence of cementite, more heavily present in Image A than in Image B.

Cementite Volume Percentages

Current Unpeened	Current Peened	40-30	40-75	70-30	70-75
4.85	2.30	1.87	1.28	1.79	1.79

Surface Retained Austenite

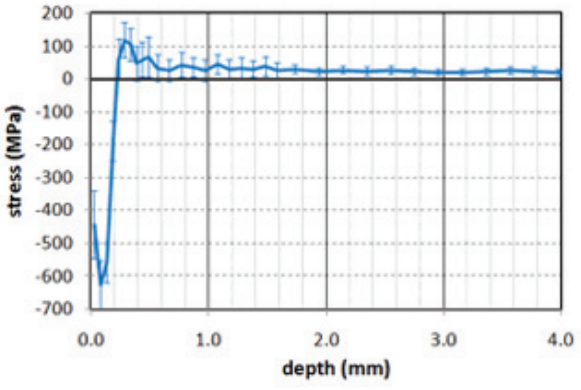
Three of the samples had similar levels of retained austenite, around 0.3 percent. The 40-30 sample had a higher level of retained austenite but was still relatively low at only 1.10 percent. This could cause a slight effect in the observed hardness and residual stress.

Retained Austenite Volume Percentages

40-30	40-75	70-30	70-75
1.10	0.27	0.25	0.33

DISCUSSION

The figure below shows a typical residual stress depth profile for a shot peened metal. The maximum compressive stress is reached within 100 µm and then drops until a tensile residual stress is reached deeper in the part, a necessary force balance as the part is unmoving. Because we took measurements at four discrete depths, it is possible we did not accurately capture the peak compressive residual stress in each part.



Typical residual stress depth profile for a shot peened metal. Image is property of Los Alamos National Laboratory.

The 40-75 part had the largest compressive residual stress and the deepest maximum, but its third measurement was taken more shallowly than in any other sample. Because the other measurements align so closely, it seems likely that for the other three samples, the true peak compressive residual stress was missed as it occurred between the second and third measurement depths.

The 40-30 sample had the greatest compressive residual stress at the surface at roughly -80 ksi while the other three samples were all around -60 ksi. The 40-30 sample also had a much greater compressive residual stress deeper into the part. At 0.005 inches from the surface, the residual stress in the 40-30 sample was -91 ksi while the other three samples showed residual stresses at this depth of only about -52 ksi. The 70-30 sample exhibited lower residual stress readings in two locations than any other sample. Collectively, the results demonstrate that peening with a greater velocity induced less residual stress into the part.

Near the surface, the 40-75 sample showed slightly higher hardness values overall. The 40-75 sample exhibited the least cementite at 1.28%. Its retained austenite measurements were similar to both the 70-30 and the 70-75 samples. Hardness would be expected to be lower with more cementite and more retained austenite since these are softer phases. However, there is no correlation between retained austenite and hardness supported by the data. The unpeened tooth showed on average lower hardness values than all of the other samples, demonstrating that the shot peening process does affect hardness.

CONCLUSIONS

Peening at a lower velocity produced a deeper and greater residual stress field. These results showed it is possible to peen the part at too high a velocity, causing a negative effect on the imparted residual stress. The residual stress curves showed no peening time effect, indicating that the current process runs longer than is necessary to reach the saturation point where no additional benefit is achieved. All of the peened parts were harder than the unpeened parts, but all peened parts were not significantly different in hardness from each other.

"The research finding most interesting to us was regardless of the peening time, we had roughly the same surface residual stress. This is of course something we are going to explore further in the near future when we review the processes and make upgrades in the THP60 rack piston production line. The shot peening operation has not created bottlenecks for us, but longer cycle times are harder on the equipment and could lead to more down time," said Mr. Herter.

FOR MORE INFORMATION

Companies interested in utilizing the research capabilities of Purdue Materials Engineering should contact Robyn Jakes at 765-494-4094 and rnjakes@prf.org.

Reprinted with permission from
The Shot Peener magazine, Fall 2016.

New employee:

The School of MSE is pleased to welcome **Rosemary Son** as the School's Graduate Secretary. Rosemary has Associate's degrees in Accounting and Business Administration from Stevens Henager Business College and a Bachelor's Degree in Political Science from Bringham Young University. Prior to joining Purdue University, she taught English in public schools in New Mexico, Pennsylvania, and Indiana. Rosemary will serve as the primary contact for all aspects of the graduate admissions process within the School of Materials Engineering.

ALUMNI NEWS

2016

Outstanding Materials Engineer Award RECIPIENTS

PURDUE MATERIALS ENGINEERING

Mr. William Shelley II
Founder, Chief Technology Officer CarbonGistics, Ltd.
Dublin, Ireland

Founder, Chief Technology Officer of Piezocera, LLC
Louisville, KY

In recognition of his demonstrated excellence in the areas of transitioning advanced ceramics materials to novel applications; the R&D of piezoelectric actuators for fuel injectors, piezoelectric ceramic composition development, and actuator development as well as design and testing of prototypes and scale up to production.

William F. Shelley II graduated from Purdue University with a BS and an MS in Materials Engineering in 1997 and 1999, respectively. His experience has included involvement in R&D of piezoelectric actuators for fuel injectors, piezoelectric ceramic composition development, 1-3 composite development, and unimorph and bimorph actuator development as well as design and testing of prototypes and scale up to production.

Currently, he is serving as Co-founder and Chief Technology Officer (CTO) of CarbonGistics, Ltd, a startup based in Dublin, Ireland. CarbonGistics is developing technologies for large-scale carbon harvesting for the production of carbon allotropes (graphite, graphene, carbon fiber) and gaseous hydrogen for zero-carbon emissions fuel. In addition, Mr. Shelley is also the Co-founder and CTO of a piezoelectric ceramic R&D and manufacturing startup company based in Louisville, currently pending legal formation.

Prior to his current position, Mr. Shelley served as CTO for Advanced Green Innovations (AGI) based in Arizona. In this position, he oversaw R&D of gaseous fuel injectors, sensing and feedback technologies, carbon allotropes (carbon nanotubes, carbon nanofibers, graphene), thermochemical reactors, anaerobic digesters, microbial electrolytic cells, advanced glass-ceramics, combustion strategies, and ignition circuits and managed the intellectual property portfolio of U.S. and foreign patents, trademarks, and trade secrets. In addition, he managed over 180 grants and more than 500 pending patent cases as well as internal and external IP counsel while simultaneously managing a team of 23 scientists, engineers, technicians, mechanics and machinists. At AGI, Mr. Shelley also served as Vice President, Advanced Materials and Technology, and Vice President, Engineering, and Advanced Development Materials Engineer. He has authored four state and federal grant proposals, with three being funded for a total of $2.6M.

The School of MSE is proud of its alumni and their accomplishments.

If you have recently received an award, promotion or other recognition, please email Robyn Jakes at rnjakes@prf.org so we can acknowledge your success in a future newsletter or on our website.

Dr. Yongho Sohn *PhD, Fellow ASM*
UCF Pegasus Professor
Department of Materials Science and Engineering
Associate Director for UCF Materials Characterization Facility
University of Central Florida

In recognition of his demonstrated excellence in fundamental materials properties measurements and microstructural characterization of advanced materials and nuclear-related systems that directly impacts Materials Genome/Computational Materials Engineering database development, as well as developments for materials in thermal barrier and oxidation resistant coatings for advanced gas turbine applications, ternary Heusler alloys and powder-derived metal-matrix and ceramic-metal structural composites.

Yongho Sohn received his BS degree in Mechanical Engineering and his MS degree in Materials Science and Engineering from Worcester Polytechnic Institute in 1991 and 1993, respectively. He earned his PhD in Materials Engineering from Purdue University in 1998. After working as a post-doctoral researcher at the University of Connecticut, he joined the MSE faculty at the University of Central Florida (UCF) as an Assistant Professor in 2001. Dr. Sohn is now a Professor in the Department of Materials Science and Engineering (MSE) at UCF. Since August 2006 he has also been serving as the Associate Director for the Materials Characterization Facility, a university-wide user facility that houses electron microscopes and many other major materials analysis instruments.

Dr. Sohn is an expert in the field of multicomponent diffusion and microstructural analysis. His research involvement covers a wide range, both theoretical and industrial, including thermal barrier and oxidation resistant coatings for advanced gas turbine applications, microstructural characterization of advanced nuclear fuels, ternary Heusler alloys for magnetic refrigeration, and powder-derived metal-matrix and ceramic-metal structural composites. He has advised or co-advised about 30 MS and 15 PhD students, presented over 100 invited talks and published over 130 articles in peer-reviewed journals. He is active in several professional societies including The Minerals, Metals, and Materials Society (TMS), American Ceramic Society (ACerS), American Society for Materials (ASM) International, and the American Society of Engineering Education (ASEE). He serves in leadership roles in the Gibbs Award Selection and Alloy Phase Diagram Committees with ASM International. He served as Executive Director and Vice President of Korean-American Scientists and Engineers Association (KSEA). He is a member of the Board of Review for Metallurgical and Materials Transactions, TMS's Nuclear Materials Committee and TMS's High Temperature Materials Committees. Currently Dr. Sohn also serves as an Associate Editor of Journal of Phase Equilibria and Diffusion.

Dr. Sohn has received several accolades including Distinguished Researcher Award (2005), Faculty Excellence Award (2011), Teaching Incentive Program Award (2007, 2013) and Research Incentive Award (2006, 2012) from UCF. In 2008, he received the National Science Foundation (NSF) CAREER Award from the Division of Materials Research, and in 2006, he received the Young Scientist Award from the National Institute for Materials Science in Tsukuba, Japan. He became an ASM Fellow in 2015, and, in 2016, was named UCF Pegasus Professor, the highest academic distinction given to a faculty member at UCF.

Mr. Brian Underwood
Serial Entrepreneur

In recognition of his demonstrated excellence in the entrepreneurship arena and leading innovative approaches to solving industrial and consumer problems in a wide range of industries.

Brian Underwood has co-founded and advised several start-ups in the last twenty years. While three of his start-ups have been in high-tech, his most recent venture is focused on agricultural development and almond processing.

Before undertaking almond ranch development, Mr. Underwood co-founded Silicon Image, which went public on Nasdaq in October 1999. Silicon Image created the technology behind DVI & HDMI that are now approaching five billion implementations worldwide. After Silicon Image, Mr. Underwood co-founded SideStep in 2000, which was purchased by Kayak in 2007 (now owned by Priceline). Underwood also was a part of Signalworks, a full-duplex speakerphone software company, which was acquired by Cisco in 2003.

Mr. Underwood is also a board member at Hillbrook, a private school in Los Gatos. He continues to dabble in high-tech startups.

Mr. Underwood holds an MS in Materials Engineering from UC Davis in 1991 and a BS in Metallurgical Engineering from Purdue University in 1989.

MSE Alumni Inducted into Co-op Hall of Fame

Written By: Chad E. Barker

Launched in 2010, the Cooperative Education Hall of Fame is an annual celebration honoring those who have made significant contributions to Purdue's Co-Op program or those alumni who have achieved excellence in their careers after participating in Cooperative Education during their time at Purdue. In essence, this event provides a lens through which current and future students can view the power of Co-Op as a means of drawing the map for one's future success. Previous inductees have included CEO's, politicians, lawyers, high ranking technical experts, and Purdue faculty with a passion for experiential learning. The 2015 class of inductees was no exception to this excellent pedigree. They included, Mary Lee Gambone (BS '82, Metallurgical Engineering), Jim Karl (BS '81, Materials Engineering), Candee Krautkramer (BS '90, Chemical Engineering), Steven Perry (BS '84, Chemical Engineering), and Janice Voss (BS '75, Aeronautical and Astronautical Engineering).

PURDUE™ MATERIALS ENGINEERING

Mary Lee Gambone

Dr. Mary Lee Gambone has garnered over 30 years of distinguished experience in the aerospace materials field. Since joining Rolls-Royce in 1998, she has had several roles, including Chief of Research and Technology Strategy and Manager of Critical Part Lifing. Her early career as a materials engineer was with Allison Gas Turbine Division of General Motors and she enjoyed several years with the U.S. Air Force as team lead for metal matrix composites research in the Air Force Research Laboratory, Materials Directorate.

In addition to her professional career, Mary Lee also serves on the Alumni Advisory Committee for Purdue's School of Materials Engineering, as well as the SAE Aerospace Committee and the AFRL Metals Affordability Initiative Executive Steering Committee. In 2013, Mary Lee received Purdue's Outstanding Materials Engineer Award.

Mary Lee is currently the head of the Rolls-Royce Materials Engineering organization in Indianapolis.

While at Purdue, Mary Lee was a co-op for Armco Steel (now AK Steel) in Middletown, Ohio. Working in the Research Center, she evaluated a broad diversity of products ranging from cast iron grinding balls to composite casket liners. "What I remember most vividly is the helpful encouragement and instruction I received from the technicians and engineers I worked with. I learned so much about working in a laboratory and how to get along with people in a team from my co-op experience; I know I would not have been as good an engineer without it!"

Photo by Grant Thompson

Jim Karl

Immediately following graduation from Purdue, Jim joined IBM at their Essex Junction, Vermont facility and continued to work out of that location until his retirement in June of 2011. During his 30-year career with IBM, Jim held numerous engineering and management positions throughout the Microelectronics Division's development and manufacturing organizations. After retiring from IBM, Jim was principal consultant for Idea-Ore Consulting, providing consulting services for the U.S. Aerospace, Defense, and Intelligence communities related to secure development and manufacturing of semiconductor components.

Throughout his professional career, Jim maintained an active relationship with Purdue. For many years, Jim was IBM Microelectronics' technical recruiting lead at Purdue. He and a fellow alumnus started the Purdue Alumni Club of Vermont. Jim was named Purdue's Outstanding Materials Science Engineer in 1998 and has served on the Materials Science Engineering Advisory Board.

At the time of this award, Jim was serving as the interim president and CEO of the Purdue Alumni Association, where he oversaw all engagement, communication, membership, marketing & sales, and data management activities for the association.

While at Purdue, Jim was a 5-session co-op with General Electric.

Are you a member of the R.B. Stewart Society?

If you have included Purdue University in your estate plans, we encourage you to let us know so that we can recognize you with membership in the R.B. Stewart Society. With this exclusive membership, you not only have access to the quarterly newsletter, but you will also be included in invitation-only R.B. Stewart Society events. Statements of support are used to help the School of Materials Engineering project future financial support and gift expectancies, and also count towards the goals for the Ever True campaign. Please contact Robyn Jakes at 765-494-4094 or at rnjakes@prf.org with any questions or to discuss your specific situation.

Carmine J. Spinelli
receives the College of Engineering DEA Award

FOR HIS EXEMPLARY SERVICE TO THE UNITED STATES FOR ENGINEERING SOLUTIONS THAT LOWERED COSTS OF NUMEROUS MILITARY SYSTEMS WHILE INCREASING SAFETY AND MANUFACTURABILITY

Carmine J. Spinelli
President
C Spin, Incorporated
BSMetE '58

Carmine Spinelli grew up in Raritan, New Jersey, a blue-collar town best known as the home of John Basilone, a machine-gun hero who won World War II's first Congressional Medal of Honor. Encouraged to pursue engineering as a profession by his father, an Italian immigrant factory worker with a fifth grade education, the young Spinelli looked west. He landed in West Lafayette, farther from home than he had ever ventured.

Today Spinelli jokes that his tuition for Purdue in the mid-1950s was twice as much as that of his in-state classmates. "I was paying $120 a semester," he says. "In-state students paid $60 a semester."

Even on unfamiliar turf, Spinelli made friends fast. Accompanying one roommate to Lebanon, Indiana, he tended cows and pitched in on farm chores in exchange for a Thanksgiving dinner. "You couldn't find nicer people," he says. "That was my general impression of campus. Everyone was so open and honest. It was a pleasant eye-opener for me."

During his senior year, he spotted a campus job posting for an entry-level position at Picatinny Arsenal, just a half hour from his hometown. In the four decades that would follow, Spinelli never left; he stayed and was promoted up the line — from intern to journeyman to technical director in charge of thousands.

That combination of Purdue kindness and a core understanding of metallurgical engineering served him well. "I tried to be tolerant and open-minded," Spinelli says of his leadership style. "There's more than one way to solve a problem. You surround yourself with good people, let them take the lead, and you just advise them."

Surrounded by engineers in research and development, Spinelli worked on teams responsible for all ranges of weaponry, from small bullets shot from pistols and rifles to tank ammunition and artillery systems. An early advocate of extensive modeling, simulation, and prototyping, he helped usher in an era of "smart ammunitions" that now save lives through pinpoint accuracy.

In a career distinguished by technical and leadership awards, Spinelli has gone above and beyond his role in civil service. He initiated a program to reduce battlefield lethality by developing "self-destructing" munitions. He also helped secure a collaboration between the United States, England, Germany, Italy, and France to standardize and develop a 52-caliber cannon.

On May 12, 2016, Mr. Spinelli was inducted into the U.S. Army Ordnance Corps Hall of Fame. The Ordnance Corps Hall of Fame was established in 1969 to recognize and memorialize persons who have made a positive, significant contribution to the U.S. Army Ordnance Corps

Beyond bombs or bullets, however, Spinelli is proudest of hiring and developing talented engineers. "In our business, you hire someone with the basic engineering skills and train them to be an armament engineer," he says. "It takes at least four or five years to help grow someone from a journeyman engineer to a design engineer."

Now in the consulting business, Spinelli works with a number of military systems manufacturers around New Jersey. He also serves on state and national advisory boards, sharing his expertise on manufacturing readiness for military applications.

Before receiving the Distinguished Engineering Award (DEA), he revisited Purdue only twice. The first time, shortly after graduation, with his future wife (and his mother as chaperone), was for a Boilermaker football game.

A few years ago, while attending a 50-year reunion to rub shoulders with a few of his 21 classmates, he rediscovered some of his old haunts, a few of which had not changed much. Entering Harry's Chocolate Shop, he was greeted by a doorman who joked that he looked old enough to get served. Spinelli confessed, "Fifty years ago, I got kicked out of this place because I was underage."

Undergraduate Student Profile

Theresa Saenz • Michigan City, IN

What attracted you to Purdue University and specifically, Materials Engineering? This is always a funny question for me. In high school, I was deeply determined to go to any school but the dreaded in-state school that is only two hours down a single road from my hometown: Purdue. My escape plans fell through, so I begrudgingly started at Purdue. I think it took me all of two days to fall in love with the place. I have always been amazed by the drive and talent of all Purdue students, and I appreciate Purdue's high academic standards. I was interested in solar energy research going into college, and I decided that MSE would be a good path to pursue that from. The School of Materials Engineering has always particularly impressed me with it's extremely high quality of teaching, friendly atmosphere, and commitment to undergraduate research.

What has been your greatest achievement during your time in the School of Materials Engineering? I have had quite a bit of success with big name scholarships. I was one of Purdue's nominees for the Goldwater scholarship as a sophomore, which is considered one of the more prestigious scholarships an engineering undergraduate student can receive nationally. This year, I received a full ride scholarship for my remaining time at Purdue through the Stamps Foundation and Purdue. Up next, I'm pursuing a Fulbright grant to do solar research in Germany after graduation.

What has been your favorite MSE course; why? I loved MSE 370, which is essentially our quantum mechanics and solid-state physics course. It seems as though it brought pain and suffering upon most of my classmates, but I couldn't have been much more excited about it. Quantum mechanics is about as fundamental as you can get in materials science, and that was quite an elegant idea to me.

Please briefly discuss any participation in study abroad and how the experience was beneficial. I write this at the University of New South Wales (UNSW) in Australia, where I'm taking a core MSE course and a couple of photovoltaic engineering courses as technical electives. As I've mentioned, I'm very interested in solar research, and UNSW is a world leader in both solar research and education. It's allowed me to take classes specific to my interests that Purdue simply doesn't have. While I've been here, I've had plenty of opportunity to travel. I went to New Zealand over our break to go trekking in the mountains, and I'm headed up to the Great Barrier Reef this weekend.

Please discuss any participation in co-op or internship programs and how the experience was beneficial. I have had two internships at the Colorado School of Mines and the National Renewable Energy Lab (NREL) and will have another at Caltech this summer. I think of them as being the core of my experience as an undergraduate. Internships put everything you are learning into perspective. The introductions we have to things like electron microscopy make a lot of sense when you find yourself looking at a solar cell in an SEM in a national lab.

Have you been involved in any student organizations while at Purdue? If so, which ones? Students Growing Sustainable Communities, Purdue Honors College, Purdue Outing Club.

Why would you recommend this department to others who are still deciding on an area of study? Materials engineering is a fascinating field that allows you to work on a huge variety of problems. I've also noticed that materials engineers at Purdue are consistently the most satisfied with their engineering major. Part of that, I think, is just because it's a interesting subject, but it also says a lot about the environment the School of Materials Engineering has created. More than any other department, you can expect to experience a department that really cares about you. Professors always have their doors open, classes are relatively small, and there is ample opportunity to do research as an undergrad.

How do you plan to use your knowledge and experience gained at Purdue University in the future? After I graduate, I am planning on taking a year off to do a Fulbright if I am chosen for it or another internship at NREL. Then, I am planning on starting a PhD at Caltech or Colorado School of Mines, where I'll be doing solar materials research. Eventually, I hope to become a staff scientist at NREL. My Purdue education will be base for everything I do moving forward, and it is a base I am very confident in.

Graduate Student Profile

Logan Kearney • North Chicago, IL

How did you first hear about Purdue University? My high school counselor.

What attracted you to Purdue University's graduate programs? The opportunity to work on globally relevant research problems with talented and ambitious faculty.

What has been most rewarding about your time in Materials Engineering? The most rewarding thing is seeing the community of peers that you mature with regularly achieving amazing things.

What is your area of research? I work on understanding the dynamic processes that effect the transport, chemical stability and anti-fouling properties in polymer thin film interfaces. We use highly controlled systems and measurement devices to study these nanoscale events. The knowledge gained from these metrological studies guides the design of advanced membranes and surfaces with optimized properties.

Have you been involved in any student organizations or community activities while at Purdue? If so, which ones? Our departmental graduate student association (MSEGSA) provides great opportunities to get involved in STEM outreach with young people that visit Purdue from all over the country. We have also worked with local community centers to interface with kids from the Lafayette area. In the last several years I have served on the MSEGA executive board and the outreach committees. Over that time, I have realized the importance of grooming the next generation of technical professionals through outreach and staying involved to develop my skillset outside of technical lab work.

Why would you recommend this department to others who are still deciding on an area of study? I would say that in the MSE world, and in this department in particular, you have a lot of mobility in terms of the specific topics you will study and work on. There are many opportunities within the graduate school environment to direct your experience and tailor your education to your continually evolving interests.

How do you plan to use your knowledge and experience gained at Purdue University in the future? In my time in graduate school I have learned how to start up research projects, execute them and communicate those results more effectively. Regardless of my next career, I know that I will lean on those skills to be a valuable contributor in the world of materials research.

Why did you choose grad school as opposed to going straight into the workforce? It was a tough decision for me because I wasn't sure that grad school was for me. However, I felt that I wasn't done learning and I eventually realized that my favorite parts of my bachelor's experience were due to participation in undergraduate research.

If you could give one piece of advice to undergraduates considering graduate school, what would it be? Place less emphasis on the specific project you want to work on and focus instead on who you want to work with. Mentorship is a huge part of your success in graduate school so it is critical that you find an advisor that you can work with effectively. Materials research is very diverse so you will find yourself working on many different things at various times in grad school.

2015-2016 Student Award RECIPIENTS

INTERNAL

Alexandra Bruce
College of Engineering Outstanding Graduate Student Service Scholarship
This award recognizes one student who provides outstanding service to the graduate student community, the School, the College, and the University.

Cayley Dymond
MSE Outstanding Graduating Senior
This award is given for service and activities within MSE, Purdue and the community as well as for technical and academic achievements.

Professor Kendra Erk
Reinhardt Schuhmann, Jr.
Best Undergraduate Teacher Award

Michael Heiden
Lisa Rueschhoff
Estus H. and Vashti L. Magoon Graduate Teaching Award
This award recognizes outstanding teaching assistants and instructors throughout the College of Engineering.

Benjamin Helfrecht
John L. Bray Memorial Award
This award recognizes the senior student(s) with the highest grade point average.

Mitchell Wood
MSE Outstanding Graduating Graduate Student
This award recognizes one student for service and activities within MSE, Purdue and the community as well as research endeavors.

Aytekin Uzunoglu
College of Engineering Outstanding Graduate Student Researcher
This award recognizes one student who demonstrates excellence and leadership in research through publications, participation in professional organizations and willingness to mentor others.

EXTERNAL

Nelyan Lopez-Perez
National Institute of Justice Fellowship

Michelle McKinney
Association for Iron and Steel Technology Steel Scholarship

Kathleen Reeve
2016 Charles Hutchins Educational Grant

John Rotella
National Defense Science and Engineering Fellowship

Theresa Saenz
Awarded 1 of 3 ASM Materials Education Foundation Outstanding Scholar Awards

Hannah Woods
TMS Light Metals Division Scholarship

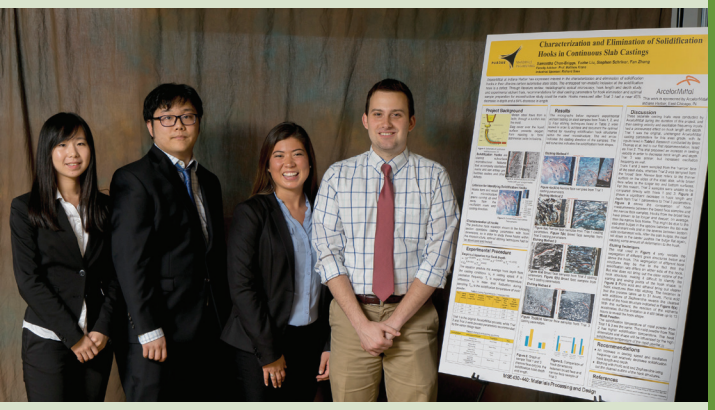
Kristen Adair, Sophomore
Xin Li Phuah, Junior
Nathan Spear, Junior
Logan Kroneman, PhD Candiate
Sam Reeve, PhD Candiate
Lisa Rueschhoff, PhD Candiate
ASM Indianapolis Chapter Best poster award

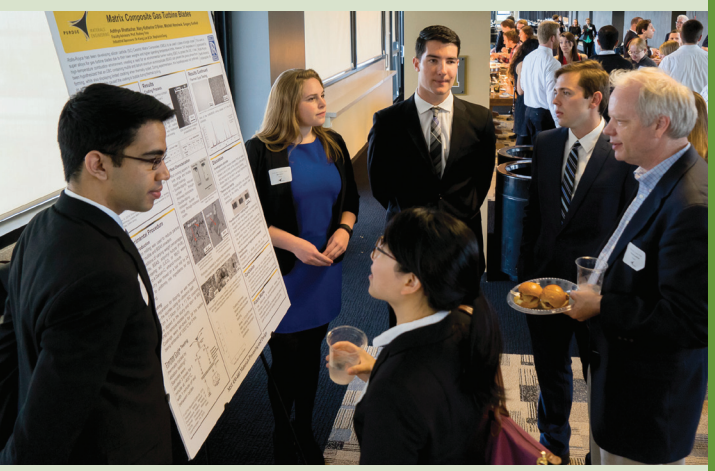
MSE Students Meet the Real World

The School of Materials Engineering prides itself in still being a place where students receive a hands-on education. One of the major components of hands-on learning comes during the students' senior year when they tackle an industry-sponsored senior design project. Student teams of 4-6 work closely with an MSE faculty advisor to solve a real-world industry problem through experiment design, modeling and simulation and critical analysis. Through this process, the students are able to develop and perfect communication, networking, business writing and team-building skills. The sponsoring companies not only have a team dedicated to working on their specific problem, but also gain solutions to high importance, low priority problems that never quite get finished. The senior design projects culminate with MSE Student Night in April where each project team presents a poster summarizing their research, conclusions and recommendations.

If you are interested in sponsoring a project, please contact Robyn Jakes at rnjakes@prf.org or by phone at 765-494-4094 for additional details.

Please visit our website: http://tinyurl.com/jexff57 to view posters from the 2015-2016 projects.





Alcoa Forgings & Extrusions
Analysis and Comparison of Ti-6Al-4V Billet for Forging Stock

ArcelorMittal (Indiana Harbor)
Study of Continuous Cast Slab Surface Solidification Hooks

Battery Innovation Center
High Power Battery Materials Performance Limits

Cummins Fuel Systems
Shot Peening and Residual Stress for High Pressure Diesel Fuel Injection Systems

IBC Coatings
Influence of Process Parameters and Electrolyte Composition on Phase Composition of PEO Coatings

IBC Coatings
Impact of Thickness & Modulus on Adhesion of Diamond-Like Carbon Coatings

John Deere
Residual Stress Levels of Carburized Gears

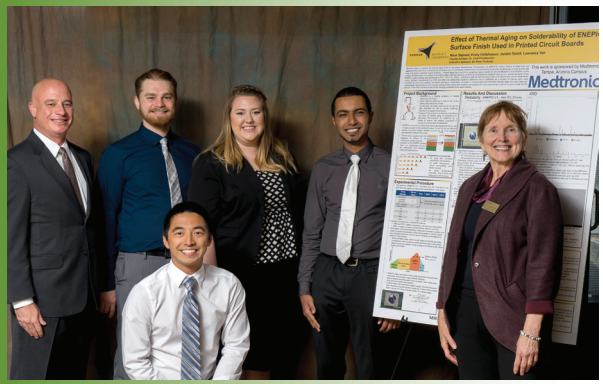
Juniper Network
Investigation of Microstructure Evolution in Advanced 3-D Memory Devices

Medtronic
Reliability of Semiconductor Interconnects in Medical Electronics: Reaction of NiV Underbump Metallization with Pb-free Solders

Rolls-Royce Corp
Development of Modified BSAS Coatings for SiC

TRW
Characterization of Steering System Shot Peening Processes

United States Steel Corporation
Residual Stress Evaluation of Heavy Gauge Hot Roll Coils



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EVENTS

Mark Your Calendar!

October 24, 2016

MSE Alumni Reception at MS&T Conference

6:30 – 8:00 pm

Squatter's Pub Brewery
1763 West Broadway (300 South)
Salt Lake City, UT 84115

Cost: Free

For additional information about this event or to rsvp, please contact Stacey Coar at 765-494-4100 or at scoar@purdue.edu.

PURDUE MATERIALS ENGINEERING

Professor Carol Handwerker, sophomore, Kristen Adair, and PhD candidate, Kathlene Reeve, celebrate a poster award.

ASM Student Night

The March 2016 Chapter Meeting for the ASM Indianapolis Chapter was held on the Purdue campus in partnership with the School of Materials Engineering. An undergraduate and graduate poster and networking session was held prior to dinner. The event was a great opportunity for Purdue MSE undergraduate and graduate students to meet and network with materials engineering professionals from all around Indiana. The evening concluded with a technical presentation by Purdue PhD candidate, Kathlene Reeve. Poster session prizes were awarded to the top three posters given by both undergraduate and graduate students.