

MINES METALLURGICAL & MATERIALS ENGINEERING

A NEWSLETTER FOR FRIENDS & SUPPORTERS

ISSUE 1 - SUMMER 2017



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ISSUE 1 - SUMMER 2017

A Newsletter for Friends & Supporters of the Colorado School of Mines George S. Ansell Department of Metallurgical & Materials Engineering

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FROM THE DEPARTMENT HEAD

Welcome from Dr. Angus Rockett

Another Great Spring

It has been an outstanding spring at the George S. Ansell Department of Metallurgical and Materials Engineering, where faculty have won major research contracts, awards and teaching recognitions. We are looking forward to Prof. Sridhar Seetharaman joining the Department this fall. Sridhar has a long history of outstanding research in metallurgy, including extractive metallurgy, and will strengthen the capabilities of the Department in those areas. We will provide a full introduction to Sridhar in the next newsletter.

Teaching remains one of our greatest strengths. We have always had an outstanding metallurgical science and engineering program, and we continue to provide our traditionally excellent education with unique facilities such as the Foundry, where students get to mold liquid metal into custom shapes. The addition last year of Kester Clarke also strengthens the Department in the area of forging. To complement our metals facilities, we are adding a hot glass capability to allow students focusing on ceramics to work with glass in the lab. We are revising our curriculum to take advantage of these facilities and to provide the students more flexibility while retaining our traditional strengths.

Our student body is increasingly larger and more diverse with Spring enrollment of 160 undergraduates (11th overall nationally), 40 masters, and 63 PhD students. We are thrilled to report that for these three groups respectively, 36, 32, and 35% are women, so our gender balance continues to improve. There is more to do in this regard, but we are making progress. We are also working to increase numbers of students from traditionally under-represented socioeconomic and ethnic groups. Our fall enrollments have been consistently increasing by approximately seven students per year over the past four years. Our goal is to increase our undergraduate enrollment to 200 and to increase contact with the undergraduates at the freshman and sophomore levels. That will improve our ability to advise them and will make them part of our family earlier. We feel that this level, while a stretch for our lab facilities, will be sustainable. Our students remain in high demand and have no difficulty finding a job after graduation.

The Department continues to improve its level of research support with total expenditures last year exceeding \$7.7M, or nearly \$490k per faculty member. This puts us 13th overall among materials-



Dr. Angus Rockett
Department Head

related departments in expenditures per faculty member. Based on proposals funded to date, we expect expenditures in 2017 to exceed \$9M. The Department research effort continues to grow, supported by the overall enhancement of facilities across campus. We are particularly excited by the new building sponsored by CoorsTek, which will house the major campus-wide materials analysis instruments, including several new facilities.

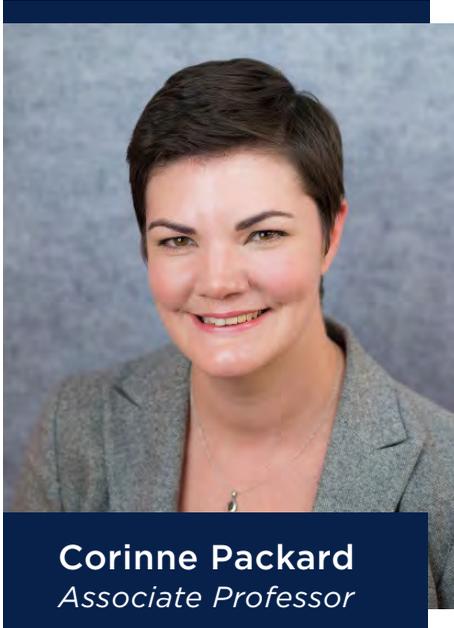
You will find below a number of highlights of the research accomplishments of our faculty. In the next newsletter we will have even more exciting news to report concerning awards won by the faculty, research accomplishments, and outstanding students. Feel free to write to me with any questions or comments you may have.

A handwritten signature in black ink, appearing to read "Angus A. Rockett".

Dr. Angus Rockett
arockett@mines.edu

AWARDS & ACCOLADES

MME's Packard wins TMS award for exceptional promise



Corinne Packard
Associate Professor

The Minerals, Metals and Materials Society has chosen a Mines associate professor of metallurgical and materials engineering to receive the AIME Robert Lansing Hardy Award, given annually to a younger member of the society who has shown exceptional promise for a successful career. Corinne Packard was selected “for exceptional promise in determining mechanical behavior of materials at diminishing length scales across the

spectrum of metals, ceramics and glasses.”

“Participating in TMS as a member and volunteer has had a huge impact on advancing my professional career,” Packard said. “The society and its meetings provide a great opportunity for interacting with others, from senior scientists all the way down to

the students in Material Advantage, where I first got my start in TMS.”

Packard holds a bachelor’s degree in materials science and engineering and a PhD in materials science from Massachusetts Institute of Technology. She joined Mines in 2010 and received an NSF CAREER Award in 2014. She holds a joint appointment at the National Renewable Energy Laboratory. Packard’s research interests include mechanical properties and behavior of materials, especially at micro- and nano-scales; pressure-induced phase transformation in ceramics; stress-driven failure in renewable energy materials; and nanomechanical testing at elevated temperatures and in situ electrical measurement.

The award, funded by the American Institute of Mining, Metallurgical, and Petroleum Engineers, was established by Dr. Arthur C. Hardy in honor of his son, a junior member of AIME who had great promise in the field of physical metallurgy but died suddenly at the age of 25. The award includes the Hardy Medal, an engraved plate and a cash award donated by Ford Motor Company.



Mines faculty honored at SME 2017 Annual Conference and Expo

Several Mines professors have been rewarded awards from the Society for Mining, Metallurgy and Exploration at their 2017 Annual Conference & Expo, held in Denver, Colorado on February 22, 2017. SME is one of the member societies under the umbrella of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

One of these professors includes Metallurgy and Metallurgical Engineering Research Professor Erik Spiller, who was one of three 2017 recipients of the SME Distinguished Member Award, given to individuals who demonstrated significant and sustained contributions to the minerals industry and to SME.



MME's Amy Clarke named to LIFT Expert Educator Team

A Colorado School of Mines associate professor in metallurgical and materials engineering has been named to a national team of expert educators charged with identifying the knowledge and skills workers will need to deploy new lightweighting technologies and materials being developed by industry.

Amy Clarke is one of six named to the Expert Educator Team (EET) by Lightweight Innovations for Tomorrow, the Association of Public and Land-grant Universities and the National Center for Manufacturing Sciences. The team members were selected from APLU's member universities and LIFT research partners for their significant knowledge of manufacturing technologies and experience within the manufacturing industry.

"I hope to learn more about ongoing LIFT projects and how our team can help to facilitate collaborations and workforce development," Clarke said. "It is my hope that our team will focus on best and future practices to promote diversity and inclusion and a workforce that includes exposure to and the adoption of state-of-the-art materials processing across a variety of sectors."

Before joining Mines in June 2016, Clarke was a scientist at Los Alamos National Laboratory for seven years, and spent a year at Caterpillar Inc. as a senior engineer. She is the site director for the Center for Advanced Non-Ferrous Structural Alloys and affiliated with the Advanced Steel Processing and Products Research Center at Mines.

"These experiences have enabled her to understand the challenges and opportunities that exist in academia, government laboratories and industry and have prepared her to serve on the EET," said Michael Kaufman, dean of the College of Applied Science and Engineering, who nominated Clarke for the team. "I believe she is one of the most successful young scientists in the field today."

The team will begin its work at a kickoff meeting February 23-24 in Detroit with LIFT's technology project leaders. The teams will review several technology projects underway and begin to determine where gaps in curricula exist. Closing these gaps will provide students with the right knowledge and skills needed for jobs working with



Amy Clarke
Associate Professor

new technologies. In addition to identifying in-demand skills, the team will work to develop recommendations for effective technology-aligned education strategies and will review the LIFT technology portfolio to recommend additional education and workforce development initiatives.

LIFT, operated by the American Lightweight Materials Manufacturing Institute, is a Detroit-based public-private partnership that seeks to develop and deploy advanced lightweight materials manufacturing technologies and implement education and training programs to prepare the workforce.

APLU is a research, policy and advocacy organization dedicated to strengthening and advancing the work of public universities in the U.S., Canada, and Mexico. The National Center for Manufacturing Sciences is the largest cross-industry collaborative research and development consortium in North America and is dedicated to driving innovation in commercial, defense, robotics and environmentally sustainable manufacturing.



AWARDS & ACCOLADES

Mines students show materials knowledge, bladesmithing skills



Colorado School of Mines students demonstrated both their materials expertise and practical skills at TMS 2017, taking second place in the Materials Bowl and finishing third in the Bladesmithing Competition. During the annual meeting of The Minerals, Metals and Materials Society, held February 26 to March 2, 2017, in San Diego, California.

Undergraduate students Jordan Carson and Rachel English and PhD candidates Andrea Bollinger and Brian Kagay competed in the Materials Bowl, a materials-themed knowledge and trivia competition. Mines won the contest in 2015, and also took first place in 2009, 2010, 2012 and 2013.

For the Bladesmithing Competition, a group of undergraduate and graduate students forged and crafted a straight razor with a Damascus pattern,

with some material coming from Clear Creek in Golden.

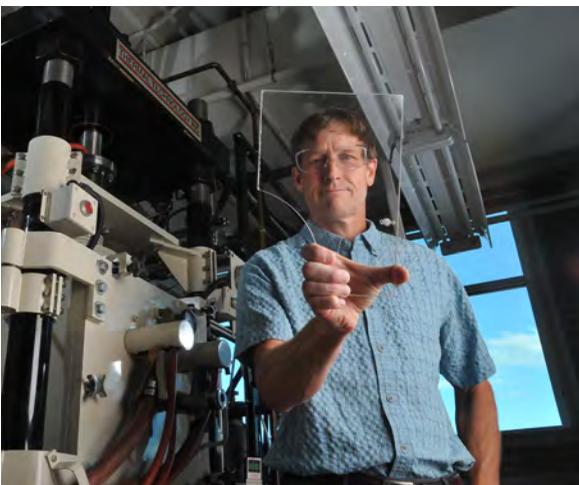
“The rubric stated that the blade should be of historical significance,” said undergraduate student Stuart Shirley, himself a blacksmith and one of the team leaders. “Our team decided to make a straight razor—this is a knife blade that has played an essential role in daily life,” he explained. The straight razor also transcended economic status, and is now making a comeback for those looking for the best shave.

Shirley and fellow undergraduate student Michelle Hoffman learned techniques from Denver knife maker Owen Wood and put them to use in blacksmith Dan McNeil’s Golden shop. They also conducted several thermite burns to create hunks of iron, with the original ore coming from the iron-rich sand in Clear Creek. “A piece of the smelted iron was used as the handle spacer, a critical component that allows the blade to open and close properly,” Shirley said.

Also helping to forge the blade and make the steel were undergraduates Marshall Boyton, John Copley and Chanise Hoffman and graduate students Alexandra Anderson, Tom Boundy, Brett Carlson and Hunter Sceats.



Reimanis honored by ACerS



Colorado School of Mines Metallurgical and Materials Engineering Professor Ivar Reimanis has been honored by the American Ceramic Society for exceptional volunteerism and raising the organization’s global profile to new heights, and has been named an ACerS global ambassador. The Global Ambassador Program recognizes ACerS volunteers worldwide who demonstrate exceptional leadership and/or service that benefits the society, its members and the global ceramics and glass community.

Reimanis is the Herman F. Coors Distinguished Professor of Ceramic Engineering, an ACerS fellow and a former director of the society. He was recognized at the 12th Pacific Rim Conference on Ceramic and Glass Technology, held May 21-26 in Waikoloa, Hawaii.

Ceramic society recognizes MME's O'Hayre

Colorado School of Mines faculty and researchers in the Metallurgical and Materials Engineering Department—a team led by Professor Ryan O'Hayre—are being honored by the American Ceramic Society.

O'Hayre and his team will receive the American Ceramic Society's Ross Coffin Purdy Award for a paper that appeared in the September 18, 2015, edition of Science.

The paper, titled "Readily Processed Protonic Ceramic Fuel Cells with High Performance at Low Temperatures," was based on more than five years of research to develop a new, higher-performance ceramic-based fuel cell device that might eventually be used to generate both electricity and hot water for residential households from natural gas. In addition to drastically increasing efficiency through reducing transmission losses, such a reliable, environmentally friendly distributed power technology would help guarantee greater energy security while also reducing energy costs for consumers.

"We are continuing to study the long-term durability of these cells when operating on different fuels, and so far our results have been exciting," O'Hayre said.

The research team, which includes Mines graduate student Chuancheng Duan, former research professor Jianhua Tong, former postdoctorate researcher Meng Shang, former graduate student Stefan Nikodemski, research faculty Michael Sanders and Sandrine Ricote, as well as Ali Almonsoori of the Petroleum Institute in Abu Dhabi, is still actively pursuing follow-up research, and hopes to present another high-impact paper in the near future.

"I'm excited about this honor for my students and colleagues, including Chuancheng, who works tirelessly in the lab on this research," O'Hayre said.



Ryan O'Hayre
Professor



"It is great to see it pay off for him and our entire team."

"We are continuing to study the long-term durability of these cells when operating on different fuels, and so far our results have been exciting," O'Hayre said.

The team will receive the award at the American Ceramic Society's Honor and Awards Banquet in Pittsburgh this October. In addition to accepting the award, O'Hayre has also been invited to give a talk at the society's conference.

De Moor receives educator award from SAE International



Colorado School of Mines Assistant Professor of Metallurgical and Materials Engineering Emmanuel De Moor has received the Ralph R. Teetor Educational Award from SAE International, a global association of

engineers and experts in the aerospace and automotive industries.

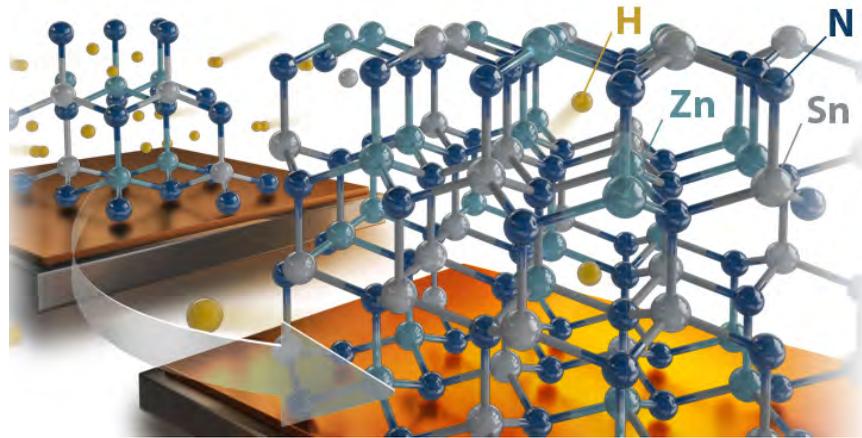
De Moor was one of seven to receive the award in ceremonies held April 3, 2017, during the SAE World Congress in Detroit.

The award, named after the 1936 SAE International president, is awarded to engineering educators with more than three but fewer than 10 years of full-time faculty experience. They are selected based on their contributions to teaching and curriculum development, their research and publications related to SAE International's interests, among other criteria.

De Moor joined Mines as a research assistant professor in 2010, and was named assistant professor in 2014. He holds a bachelor's degree in applied science and master's and doctoral degrees in materials science from Ghent University in Belgium. He is a member of the Advanced Steel Processing and Products Research Center and is focused on the effects of heat treating on the microstructural development and mechanical properties of steel.

In addition to a trip to a major SAE International meeting—either the World Congress or the SAE AeroTech Congress and Exhibition—and specialized tours with auto manufacturers and aerospace corporations, Teetor Award winners receive a framed certificate and two years of SAE International membership.

Materials researchers achieve breakthrough for solar cells



A Colorado School of Mines PhD candidate in materials science is the lead author of a paper featured on the cover of *Advanced Electronic Materials* that details a breakthrough in the development of a material for solar cells.

Angela Fioretti's "Solar Cells: Effects of Hydrogen on Acceptor Activation in Ternary Nitride Semiconductors" was published in the March 2017 issue of the journal. Coauthors were metallurgical and materials engineering postdoctoral researcher Adam Stokes, Physics Teaching Professor Matt Young, Physics Assistant Professor Eric Toberer—Fioretti's advisor, Physics Research Assistant Professor Adele Tamboli and Andriy Zakutayev of the National Renewable Energy Laboratory.

The vast majority of solar panels are based on elemental silicon, which is a fundamentally inefficient light absorber. "Development of new semiconductors that absorb light better is therefore necessary for solar energy technology to reach its full

potential," the researchers said.

The researchers focused on a ternary nitride semiconductor known as zinc tin nitride, which absorbs sunlight much better than silicon but does not have well-controlled electrical properties. They found that by exploiting the presence of hydrogen during synthesis and removing it afterwards, they could control the electron concentration in the material, which is critical to solar cell design. The team also discovered that the technique was most effective in samples that contained excess zinc, as opposed to the usual method using equal amounts of zinc and tin.

This method of controlling electron concentration was inspired by a similar technique in binary nitrides, which are used in blue LEDs. "This shows that well-known processing tricks can be applied to shorten the development time of new nitride-based solar cell technologies," the researchers said.

IN THE FIELD

Metallurgy students' yearly trip to Finkl, a vital rite of passage



Colorado School of Mines students in the Department of Metallurgical and Materials Engineering's Forging & Forming class visited Finkl Steel this spring for the 16th time in the past 17 years, in what has become an annual highlight and a rite of passage for metallurgy students.

The full-day visit, known as the Finkl Forging Forum, and led by Metallurgical and Materials Engineering Assistant Professor Kester Clarke, consisted of in-class instruction led by experts in each individual process and coordinated with tours on the shop floor. The instruction and tours took students through the entire manufacturing process on-site, including scrap recycling, steelmaking, vacuum degassing, casting, open die forging, heat treating, machining and nondestructive inspection of final products.

Students who have participated on the tour over the years have invariably expressed their enthusiasm, and this year was no different. Senior Christopher Finrock noted that "seeing the forging process performed at such a large scale illuminated the importance of understanding the science and techniques of forging and forming. The trip was a captivating culmination of my learning in MME."



FINKL STEEL

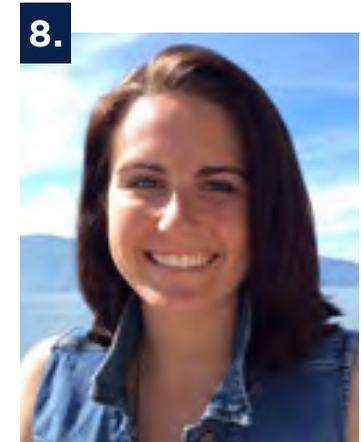
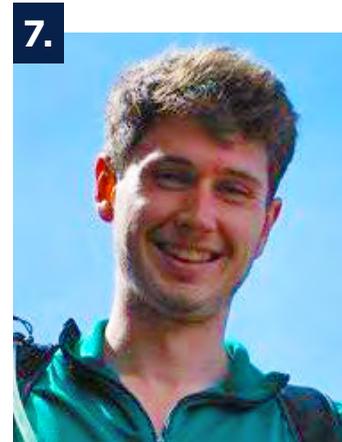
SCHMOLZ + BICKENBACH GROUP

Senior Austin Miller added, "I did really enjoy seeing the industry side in action and on such a large scale compared to what we've done in classes," which reinforces the use of real-world examples to better put classroom and small-scale laboratory work into a wider context.

"Finkl is proud to partner with the FIA and Colorado School of Mines in order to bring the manufacturing experience to the university curriculum," said Elizabeth Bilitz, technical product manager with Finkl. As the 20th year of this Forum draws closer, we look forward to working closely with Prof. Kester Clarke, a former Mines Finkl Forum participant himself."

STUDENT RECOGNITION

MME 2016-17 student awards & scholarships



1. Cheryl Hawk

2016 American Welding Society Section 039 Meritorious Award

2016 American Welding Society Student Chapter Member Award

2. Devon Gonzales

2016 American Welding Society Section 039 Meritorious Award

2016-17 AWS Section 146 District Scholarship

2016-17 Past Presidents National Scholarship

2016 AWS Professional Program Poster Session - 3rd Place Graduate Engineering

3. Virginia (Ginny) Judge

2017 AIST Smith Graduate Scholarship (AIME)

4. Nathan Switzner

2016-17 American Welding Society Graduate Fellowship Grant

5. Drew White

2016 American Welding Society Section 039 Meritorious Award

6. Nicholas Lipski

2017 Newmont Scholarship

7. John Magnum

Microanalysis Society Goldstein Scholar Award

8. Alexandra Anderson

American Institute of Mining, Metallurgical and Petroleum Engineers Henry Dewitt Smith Scholarship

Spring 2017 graduation ceremony



“So think of the future, think of the cost
Think of the benefits, think ‘What could be lost?’
If you don’t think, if you don’t think deep,
Especially if you hate work and if you love sleep,
Time could pass you by, and time isn’t cheap
Time tends to fly, sometimes time tends to creep
So think of the future, think about next year
If you do what’s best, then there’s nothing to fear.”

Mr. Nathan Switzner (R) delivered the Student Address in the Graduate Commencement Ceremony.

**THE CLARK B. CARPENTER
AWARD: PAIGE STOCK**

**THE MARY AND CHARLES
CAVANAUGH MEMORIAL
AWARD: KERRY MCQUAID**

**OUTSTANDING
GRADUATING
SENIOR AWARD:
IAN BRUMMEL**



**TOP GPAS FROM THE
GRADUATING CLASS:
TREVOR BALLARD
ABIGAIL MATTERN
FAITH OEHLERKING
JOSHUA PELZ
ADAM POLIZZI
GRACE WEBER**

**H. L. HAZEN AWARD IN
PROCESS METALLURGY:
GISELLE KREBS**

**THE HENRY W.
KAANTA AWARD:
MARSHALL BOYTON**

**OUTSTANDING
MME TEACHING
ASSISTANTS:
TAYLOR JACOBS
JONAH KLEMM-TOOLE
HUNTER SCEATS
KEVIN TALLEY**

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