COLLEGE OF ENGINEERING & APPLIED SCIENCE

UNIVERSITY OF WYOMING

Chemical Engineering

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Chemical Engineering Newsletter October 2017

Message from the Head:

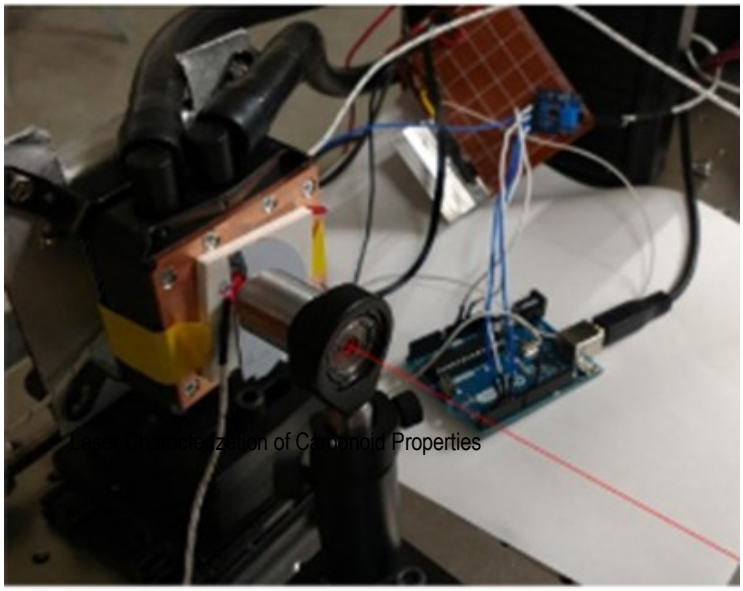
It has been roughly a year since we published our first Department of Chemical Engineering (CHE) newsletter. Personally, I have learned quite a bit since becoming head of this outstanding group of students, staff and faculty. Our partners, such as our growing industrial advisory board and research collaborators, are part of our extended family. Our efforts have borne fruit. For instance, our undergraduate student enrollment has stabilized close to 210 undergrads, while the graduate program continues to grow, approaching a total of almost 40 graduate students. Several nascent initiatives continue to evolve successfully. I am thrilled to report that the Materials Science and Engineering PhD program under construction is now housed in Chemical Engineering with commensurate contributions from our partners in various departments, including Chemistry, Physics, Geology and Geophysics, Mechanical Engineering, and Electrical and Computer Engineering, among others. Some of the highlights include our strong research participation of UW's Carbon Engineering program (read article in this number for details of this program and visit the website at http://www.uwyo.edu/ser/research/carbon-engineering/index.html) funded by the State of Wyoming and coordinated by the School of Energy Resources. A considerable number of patents and publications are coming out of this exciting initiative. A recently awarded grant from NASA will allow testing of new materials to mitigate ice adhesion problems in aerospace applications. Additional projects continue to strengthen our representation in these key areas that aim at WY's economic diversity.

The department successfully secured space for a teaching and research bioengineering lab, handsomely supported by the College of Engineering and Applied Science. This lab will be a jewel in our program and a matter of pride for our department. Dr. Wawrousek has made this a priority and her efforts are paying off. With a bit of luck, we will hold a ribbon-cutting ceremony this semester. Students will greatly benefit from elective courses that by construction will provide active learning (hands-on) opportunities. Research in this area continues to thrive and large proposals to the National Institute of Health (NIH) and other agencies are underway. The future certainly looks bright in this area. A partnership with the Department of Civil and Architectural Engineering (CAE) has led to revamping of the Environmental Engineering MS program. CAE and CHE coordinate this program as equal partners, offering unique training opportunity, also available to qualified undergraduate students through elective courses (for details, check the website at http://www.uwyo.edu/chemical/graduate/prospective/environmental/index.html). Our faculty and staff remain dedicated to our primary functions, keeping students' success as our utmost priority. More is to come and I foresee many wonderful surprises in the immediate future from efforts from our dedicated staff and faculty. Our students will continue to enjoy an ever-improved program and an unforgettable educational opportunity. We envision an exciting new academic year and welcome interest in choosing us as your academic program. Enjoy our Newsletter!

This Issue Contains:

- *Materials Science & Engineering*
- *Environmental Engineering*
- *Susan McCormack Center for Student Success*
- *Nanomaterials & Separation Technologies—Dr. Dongmei Li*
- *AIChE Update*
- *Carbon Engineering & Science Initiative*
- *CHE Student Success*

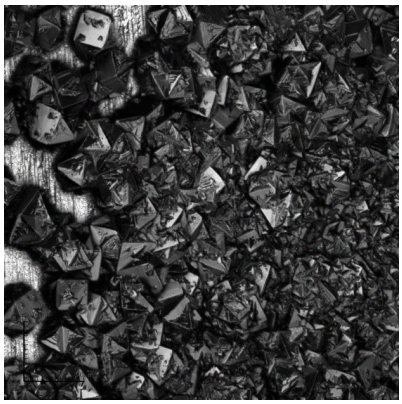
Materials Science & Engineering



In early 2017, the Chemical Engineering department became the official lead for the Materials Science & Engineering program. This program draws together experts from within the department and other disciplines, including Physics, Chemistry, Mechanical Engineering, Electrical Engineering and Geology to create a Center of Excellence for studies of solid materials. The MSE program will formalize instruction for solid state sciences, promote interdisciplinary research between UW collaborators, interface with other institutions for advanced studies, and develop products to promote the Wyoming economy.

One program of current study, funded by the Wyoming School of Energy Resources, is the preparation of carbon based solids and the investigation of their physical properties. The team of Patrick Johnson (CHE), William Rice, (Phys), Jinke Tang (Phys), TeYu Chien (Phys) and J.F. Ackerman (CHE) are particularly interested in the chemical conversion of coal to diamond, graphene and carbon nanotubes. Each of these carbanoids has unique physical properties which make them highly desirable in technical applications. Indeed, the highest hardness, lowest coefficient of friction, highest tensile strength, lowest electrical resistance and highest thermal conductivity of all known materials are found in these carbonoids. With such superior properties, high purity forms of the carbanoids can be used to produce a variety of high value devices including: high frequency/high temperature transistors and integrated circuits, chemical and biological sensors, flexible color displays, solar cells and high energy density batteries. In addition, even as bulk polycrystalline solids, they can be added to polymeric and ceramic composites to enhance their electronic, thermal, and mechanical properties.

The two challenges facing the UW researchers are 1) to produce these carbanoids at large quantities without sacrificing the desirable physical properties and 2) to convert their standard production feedstocks from refined methane and graphite to coal. The UW approach to the problem has been to investigate two approaches to their synthesis. The first is a refined thermal and electrical discharge technique that creates methyne radicals in the gas phase. By controlling the diffusion distance from the arc to a substrate and the substrate temperature, specific carbanoids can be selectively deposited. The second utilizes highly oxidative treatments of carbonaceous solids, followed by cyclic high pressure and high temperature exposure while in contact with nanodots or sheets of metal catalysts. To date, the team has produced both diamond films and graphene sheets that have comparable properties to commercially available materials. Future experimentation will focus on chemical functionalization of the carbanoids to improve optical and electronic properties and to make them more compatible with co-polymerization into polyurethanes and polyamides.



Diamond Film Grown at UW Using Gaseous Thermal Techniques

Environmental Engineering

Environmental Engineering

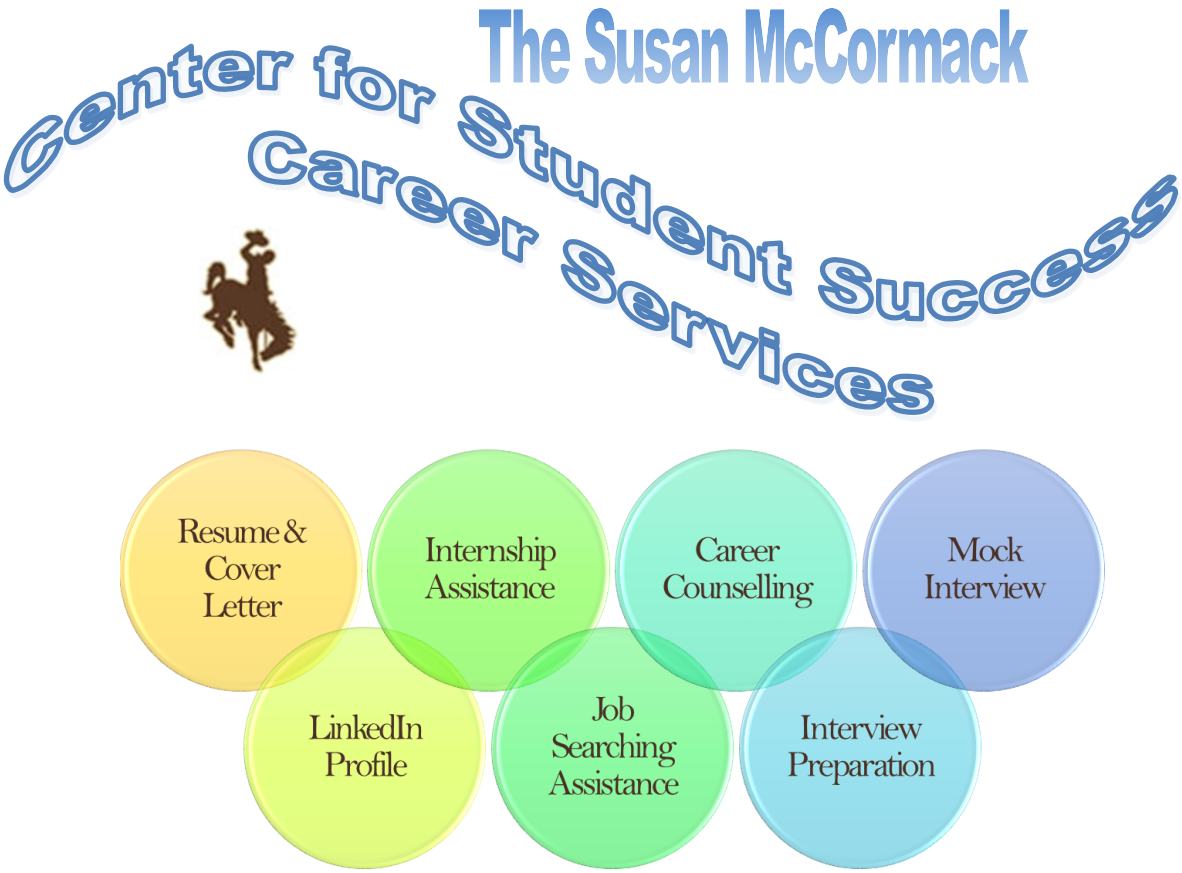
Environmental engineering started as a subset of civil engineering called sanitary engineering. Environmental engineers designed, constructed and operated infrastructure to produce and distribute safe drinking water and to collect and treat wastewaters for safe discharge to the environment. The scope of environmental engineering expanded as additional human impacts to the environment were identified. Solid waste management and disposal (including landfill design, construction and operation) and hazardous waste remediation, especially to protect and remediate groundwater resources, became major areas of importance. Environmental engineering also began examining air pollution challenges. During this time, environmental engineers often focused on "end of pipe" challenges, in other words, they tried to keep pollutants from entering the environment.

Environmental engineering has since evolved into an interdisciplinary field that still focuses on the environment, but now does so within the framework of sustainability. Keeping pollutants out of the environment (water, air, land) remains the key goal and "end of pipe" treatment remains important, but environmental engineers now also examine how to avoid pollutant production in the first place, and especially consider how to recover economic value from waste materials to keep them from becoming pollutants. Environmental engineering now attracts engineers from many fields but because of the broad scope of knowledge required, undergraduate degrees solely in environmental engineering remain rare.

A bachelor's in chemical engineering provides an excellent background for environmental engineering. At the University of Wyoming, chemical engineering undergraduates may complete their technical requirements with a concentration in environmental engineering. Consistent with the interdisciplinary nature of environmental engineering, the three required courses are from Atmospheric Science (ATCS 2100 Global Warming: The Science of Humankind's Energy Consumption Impacting Climate); Civil Engineering (CE 3400 Introduction to Environmental Engineering); and Chemical Engineering (CHE 4000 Environment, Technology and Society). Students also take one of the biological engineering courses offered in Chemical Engineering (CHE 3100 Fundamentals of Bioengineering or CHE 4100 Biochemical Engineering) and two additional courses from an approved list. Chemical engineering students who complete the concentration in environmental engineering are well prepared to work in the field.

To further deepen their knowledge and skills, qualified students can pursue a Master's of Science in Environmental Engineering. This program is a joint venture between the Department of Chemical Engineering and the Department of Civil and Architectural Engineering and has recently been rejuvenated. To enhance their ability to address environmental sustainability efforts ranging from water management to energy production, students in the M.S. in Environmental Engineering program gain greater depth in key areas including sustainability, environmental microbiology and chemistry, advanced process design and operation, and pollutant transport and remediation. The Department of Chemical Engineering sees the M.S. in Environmental Engineering as an excellent addition to its program offerings. For more information about the program, visit the website: http://www.uwyo.edu/chemical/graduate/prospective/environmental/index.html

The Susan McCormack Center for Student Success unit is dedicated to assisting College of Engineering and Applied Science students with career planning processes, from freshman through graduation. Professional staff members assist with the ongoing process of career planning which includes the development of a career road map to follow for accomplishing yearly career goals, leading to career success beyond graduation. The Career Services office provides assistance with resume and/or cover letter writing for job and internship applications, LinkedIn profile reviews, job interview preparation and, organizing and facilitating career and employer events to help prepare students with necessary career readiness tools. We use E.P.I.C. which currently consists of approximately 100 instructional milestones to guide students through their decision on selecting a major to understanding the full-time employment job search; this system is an on-line, self-paced, system accessible for any UW student with a typical UW username and password https://epicwyo.tuapath.com/. In conjunction with the Center for Advising and Career Services, we maintain the online job and internship platform *Handshake* to keep employers and students connect. Any type of career preparation appointment can be made with a career services professional; go to http://www.uwyo.edu/ceas/resources/studentservices/jobs/index.html for more information. We look forward to helping CEAS students move forward on their road to career fulfillment.



SCHOLARSHIPS

The College of Engineering and Applied Science is committed to student success. The Susan McCormack Center for Student Services is a one-stop-shop to help students develop their full potential. Our mission encompasses a variety of approaches, for a variety of students. We focus on advising and academic issues, retention, career services, recruiting, and K-12 outreach.

One of our most important responsibilities is to award scholarships for the College of Engineering and Applied Science. Most of the scholarships have been funded by our very generous private donors, and are awarded based on academic merit. All of our students are automatically considered for college scholarships- no application is required. Current students are ranked by their UW GPA and class standing; incoming freshmen are ranked using their high school unweighted GPA, ACT Composite Score, and ACT Math Score; and incoming transfer students are ranked using their transfer GPA and class standing.

We also offer the competitive Engineering Undergraduate Research Scholarship for incoming students. Our top performing students receive $6,000 of annual funding to help cover the cost of tuition, room and board and associated fees. The award is renewable for three additional years for a total scholarship of $24,000. These students are also automatically accepted into the prestigious Undergraduate Research Scholars Program which includes:

- Research lab observation series, which connects students to cutting-edge researchers in the College of Engineering and Applied Science
- Professional development workshops focused on enhancing student research skills and advancing understanding of the breadth of research opportunities

Wyoming students that receive the University Trustees Award are also invited to participate in the Undergraduate Research Scholars Program.

For the 2017-18 academic year, we have awarded nearly $875,000.00 to new and continuing undergraduate students. We are proud to have such a strong scholarship program in the College of Engineering and Applied Science to help students achieve their goals.

Nanomaterials & Separation Technologies—Dr. Dongmei Li

Dr. Li received her Ph.D. under the guidance of Professors Bill Krantz, Bob Sani and Alan Greenberg at University of Colorado, Boulder, with a focus on modeling and experimental study of effects of process parameters on polymeric membrane morphology. In a collaboration with industry and a national laboratory, she then worked on a hydrogen sensor project for her postdoctoral work with Professor Will Medlin at CU-Boulder. In 2006, she became a team lead in 193nm photolithography module at Intel Corporation and in 2007 a Senior New Product Development engineer at DRC Metrigraphics. In fall 2011, she joined the faculty of the University of Wyoming Department of Chemical Engineering. Her research program at UW focuses on ***nanomaterials and separation technologies***, with ongoing research topics being described as follows.

Membrane materials and processes for industrial waste water treatment

The Li lab addresses challenges associated with complex water chemistries, different reuse standards, and economics by integrating catalytic nanoparticles into commercial membranes that can decompose dissolved organic compounds (DOC) into water and carbon dioxide without the need to identify the DOC.

Molecular Separation Methods for Ionic Liquids Recycling from Carbon Feedstock

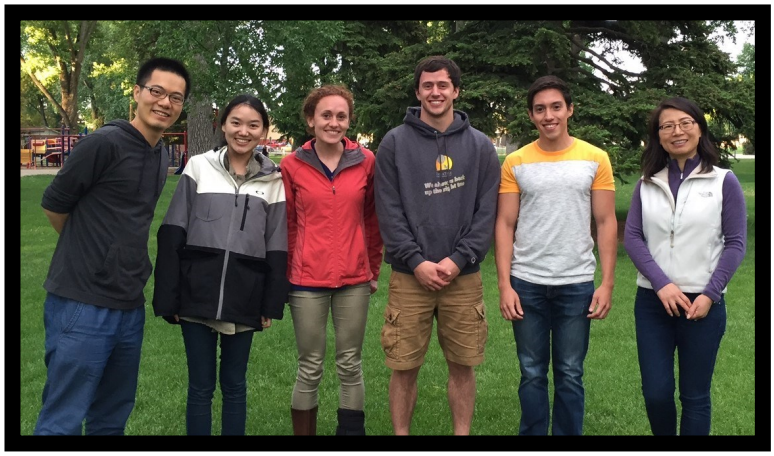
Given the high cost of most ILs, the recovery/recycling of ILs will be a crucial component of extracting valuable fuels/chemicals from carbon feedback, especially for industry-scale operations. Collaborating with national laboratory partners, separation/recovery processes will be assessed and selected using existing and to-be-developed understanding of molecular weight range and crystal structures of extracted compounds of carbon feedback. Information on extract crystalline structure will provide insight on which separation technology/process is optimal.

Hydrogel nanoparticles for the encapsulation and delivery of diagnostic and therapeutic molecules

Polyethylene glycol (PEG) hydrogel-based nanoparticles are a compelling delivery vehicle because they can be far more easily designed and tuned to specific therapeutic needs than existing materials. However, there exist no reliable methods to prepare PEG particles on nanometer length scales with narrow size distributions and well-defined loading. Polymerization kinetics, combined with specific droplet formation techniques, was employed to address this challenge by exquisitely controlling particle size and uniformity and facile tunability of the macromolecular network.

Bottom-up design and synthesis of nanocatalysts via atomic-level surface modification

The Li lab is investigating catalyst platforms consisting of nano-scale, phase-pure transition metal carbide (TMC) supports and metal nanoparticles (< 3 nm) deposited by vapor phase atomic layer deposition (ALD). Taking advantage of the atomic level control of deposited metal nanoparticles, we aim to probe the synergetic effect between supported metal catalysts, such as platinum, and underlying TMC supports, via surface characterization and device performance. Such understanding helps further reduce noble metal catalyst loading in applications including fuel cells and, more importantly, sheds light on future catalyst designs that enable replacing noble metal catalysts with more economical catalysts such as TMC. **Nanoscale rare earth element (REE) catalysts.** The central hypothesis that motivated this area of study is that unique morphology and reduced size may enhance catalytic activity of REE-based catalysts, such as lanthanide oxysulfides/oxysulfates, without compromising their unique sulfur tolerance. In addition, the reduced size may allow an alternative membrane reactor configuration (a.k.a. catalytic composite membrane micro-reactors, or CMMR), which may further increase catalyst activity and durability, while beneficially shifting equilibrium toward product generation.



Shuai Tan, Jiashi Yin, Audra DeStefano, Trey Herrera, Daniel Debroy, Dr. Dongmei Li

Sponsors of our research include Wyoming National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR), University of Wyoming School of Energy Research (SER), Wyoming NASA Space Grant Consortium, University of Wyoming.

COLLEGE OF ENGINEERING & APPLIED SCIENCE

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AIChE Student Chapter Update

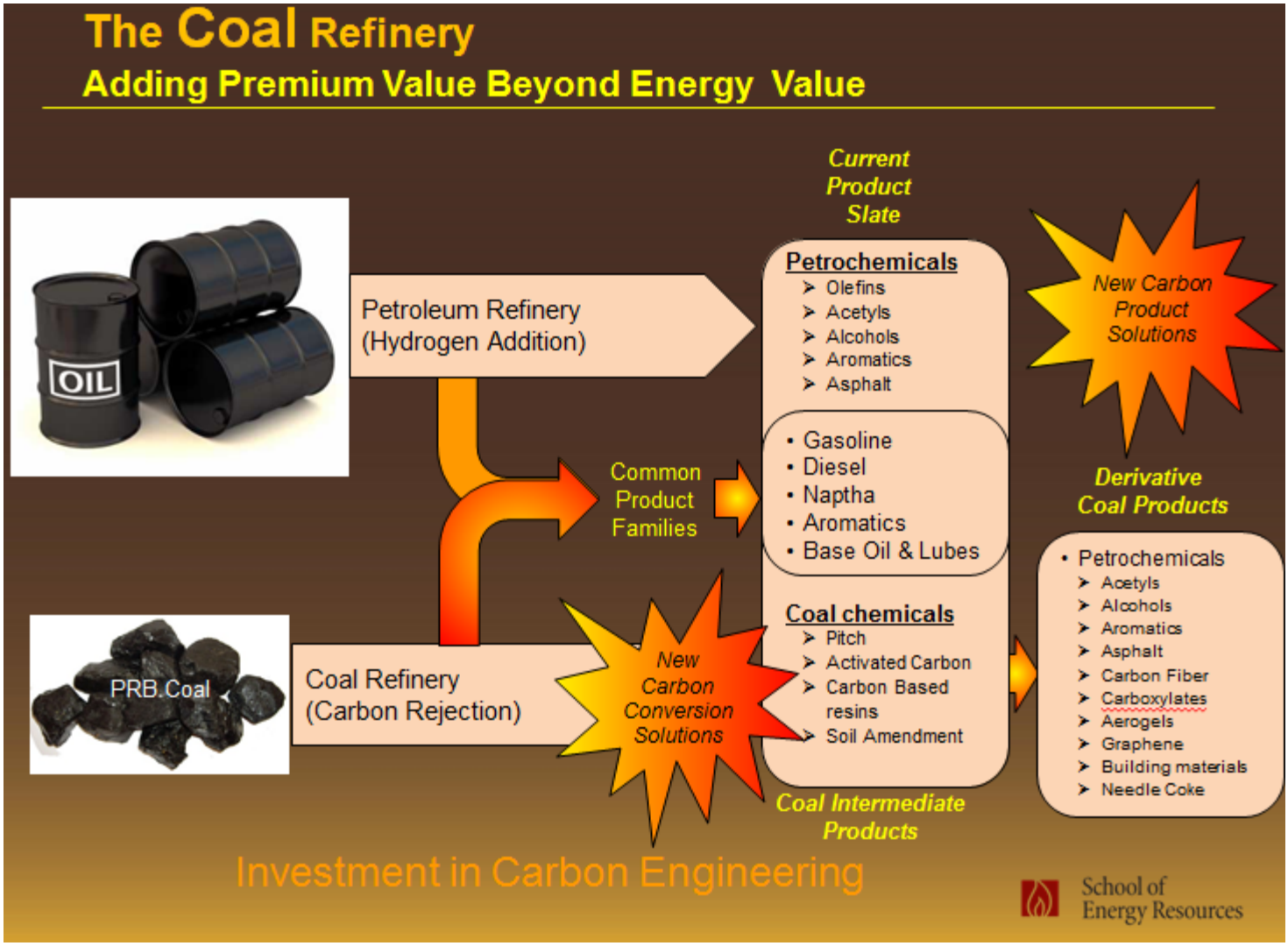
Recently, AIChE has participated in many events and attended multiple conferences. Last semester, AIChE traveled to San Francisco for the Annual Student Conference. At the conference we attended many workshops, watched ChemE Car and ChemE Jeopardy competitions and attended networking events. One workshop we attended was an industry leaders panel where distinguished employees from companies such as Chevron, ExxonMobil, and some various food companies answered questions from the audience. We were able to meet individually with some of the people afterwards. Another networking opportunity was the Graduate Fair. One of our members talked with a school for a graduate program that she has since applied and been accepted to. This semester AIChE attended the Rocky Mountain Regional Conference where we competed in ChemE Jeopardy and gathered ideas for the ChemE Car that is currently under construction. The AIChE student chapter is extremely fortunate to have the support of the Chemical Engineering Department as well as the UWEFE Board as sources of funding to attend these events.

Left to right: Thomas Christensen II, William Duncan, Christian McWorkman, Seth Bassham, Katie Nelson, Emily Lynch, Sarah Kamphaus

AIChE has also been involved in many on campus events this year as well. In the Fall, a group participated in the BIG Event which is a chance for UW students to give back the community with various community service projects. We also participated in Safe-Treat where a safe environment for trick-or-treating is established for kids in the community. This semester, a group from AIChE toured the Budweiser brewery in Fort Collins, CO. Afterwards, we met with a current engineer and had spent an hour or so answering any questions we had about working at a brewery and what kind of jobs Budweiser has to offer. In the future, we have been arranging a tour of New Belgium Brewery as well. We also have been arranging for Trihydro, a Laramie, WY based company, to come to an AIChE meeting and discuss the company and type of work that a chemical engineer experiences at Trihydro.

The officers for the remainder of this school year are William (Sandy) Duncan (President), Katie Nelson (Vice President), Emily Lynch (Treasurer), Sarah Kamphaus (Secretary), Bridger Martin (ChemE Car Leader), Katie Hopfensperger (JEC Rep), Holly Ramseier (JEC Rep) and Christian McWorkman (UWEFE Rep).

Carbon Engineering & Science Initiative



Carbon Engineering and Science Initiative

Funded over two-years by the Wyoming legislature, the carbon engineering and science initiative, began in July 2016, with the objective of understanding the feasibility of using Wyoming coal as a feedstock to make advanced materials and performance chemical products. Early emphasis has been on developing techno-economic apprais-als of various coal conversion processes and the products that might be made from coal. It is anticipated that multiple processes will be combined to form a coal refinery making a wide range of products, first by producing intermediate liquids and solids that can either be used to make chemical building block commodity products or can be further transformed into more valuable non-fuel-based products.

The Carbon Engineering and Science Initiative is currently seed funding some 15 projects focusing upon low tem-perature conversion processes using solvent extraction and low temperature thermal approaches and investigat-ing product manufacturing opportunities that include intermediate low cost paving, building and construction mate-rials and agricultural products and derivative high performance advanced composite materials, carbon fibers, graphite and graphene products.

A significant contribution to carbon engineering embraces Faculty, researchers and students in Chemical Engi-neering, Civil and Architectural Engineering, Mechanical Engineering, and Petroleum Engineering Departments within the College and Engineering and Applied Sciences.

Within Chemical Engineering, there is a current emphasis on understanding the fundamental science, characteri-zation of the deliberate decomposition of coal, and the molecular chemistry of intermediate and derivative coal products. Wyoming Powder River Basin coal largely consists of poly-aromatic structures and has a high oxygen content. In turn, systems engineering modelling has started to provide definition of possible coal conversion path-ways and configurations for a manufacturing complex fed with Wyoming coal producing non-energy and fuel prod-ucts. Appreciating optimal yields of possible and potential coal-liquid and solid conversion products is a specific challenge being addressed at this time. Such information will be used subsequently to feed techno-economic studies that will be used to assess the feasibility of building such a facility in Wyoming.

Chemical Engineering faculty member David Bell and his research team are investigating a range of solvent ex-traction techniques to maximize the liquid intermediate product yields from Wyoming coal, while Patrick Johnson and John Ackerman are using solvent extracted coal liquids to make polymers and carbon materials that together can from composite material solutions. Maohong Fan and his research team are focusing on manufacture of coal based fiber materials

For more information about the Carbon Engineering and Science Initiative, contact Richard Horner, Director of Special Projects and Technology, rhorner@uwyo.edu.

COLORADO SPRINGS, Colo. – Wyoming senior steeplechase standout Audra DeStefano has been named the Mountain West Women's Outdoor Track Athlete of the Week, the conference office announced Tuesday. The reigning MW champion in the 3,000-meter steeplechase started her final outdoor campaign with a bang at Saturday's Jerry Quiller Classic in Boulder, Colo., winning the steeplechase with an altitude-adjusted time of 10 minutes, 34.38 seconds.

DeStefano was victorious by nearly 45 seconds in Boulder as she began her chase for a second consecutive conference title in the event. Her adjusted time currently leads the conference by a wide margin and ranks second in the NCAA behind BYU's Courtney Wayment. DeStefano leads Illinois' Valerie Bobart, the nation's third-ranked athlete in the event, by nearly 10 seconds.

The weekly accolade comes as the third of DeStefano's illustrious outdoor track & field career. She has now collected a weekly honor from the conference in each of the last three outdoor seasons and has earned three of the Cowgirls' last five weekly outdoor honors from the Mountain West. In 2016, McKenzie Brogan joined DeStefano as the only Cowgirls to receive a Women's Outdoor Track Athlete of the Week award from the conference.

DeStefano, a native of Gillette, Wyo. and a six-time all-conference honoree, holds the University of Wyoming record for the women's 3,000-meter steeplechase with a time of 10:07.35 that earned her a conference championship in the event in 2016. It was the third-fastest time in MW championship meet history and gave the Cowgirls their first title in the event since Emily Higgins took top honors in 2009.

Chemical Engineering

Graduate Student

Mountain West

Outdoor Track Athlete of the Week!