2011

2011-2012 ChE Newsletter

Department of Chemical Engineering, Michigan Technological University

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2011-2012

Spotlight:
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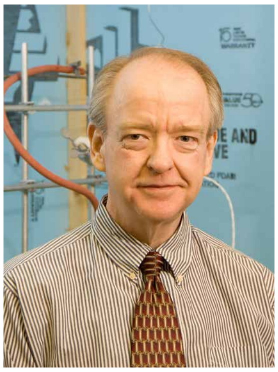
Please contact Komar Kawatra skkawatr@mtu.edu if you have any questions.



Dear Friends,

Welcome to another newsletter designed to fill you in on the many exciting events happening in the Department of Chemical Engineering at Michigan Tech. We continue to be very proud of our students as they learn, mature, and participate in solving problems important to society.

There are three distinctive features of the student experience: 1) a welcoming and supportive atmosphere, 2) intensive career preparation, and 3) unique learning and research opportunities. The department's External Advisory Board works with us to keep our curriculum up-to-date and relevant to employers. As a result, our students leave confident and ready to work, whether their final destination is industry, graduate school, or government.

In this newsletter, we have featured bioengineering research efforts in our department. You will meet the faculty doing this work and read about the students, both undergraduate and graduate, who are involved in bioengineering research along with them. We are proud of the extent to which undergraduates participate in all of our research activities. Fully 50 percent of our 2011 graduated seniors had a research experience while at Michigan Tech. One example is Amna Zahid, a junior who won best student poster in the Separations Division at the 2011 AIChE Fall meeting in Minneapolis. Amna's poster can be seen on page 16.

Through participation in the Michigan Tech Enterprise Program, students are taking on real leadership roles. They interact with industry sponsors, manage project budgets, and produce results. This is active learning at its best. Our department hosts two Enterprise teams, Consumer Product Manufacturing and Alternative Fuels Group, featured on page 17.

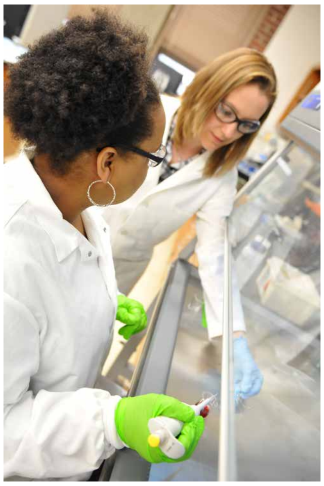
You will also read in these pages about our outstanding AIChE student chapter. Through AIChE, students are volunteering their time and effort to make the department better and help each other succeed.

Whenever you are on campus, we invite you to stop in for a visit and meet some of our outstanding students.

Tony N. Rogers

Tony Rogers
Interim Chair
Department of Chemical Engineering

Contents



Adrienne Minerick (r), is pictured with PhD student Tayloria Adams (l) in the Medical Micro-Device Engineering Research Lab. Minerick is winner of the 2011 Fahien Award from the Chemical Engineering Division of ASEE. See page 21.

About the Department

The Department of Chemical Engineering at Michigan Tech is among the world's leaders in providing quality education and research. As of April 2012, we have eighteen faculty, six staff, 381 undergraduate students, and 59 graduate students—including 39 PhD students.

We are housed in the Chemical Sciences and Engineering Building at the center of Michigan Tech's campus in Houghton. We offer programs leading to the Bachelor of Science in Chemical Engineering, Master of Science in Chemical Engineering, and the Doctor of Philosophy (PhD) in Chemical Engineering.

Our mission is to provide a high-quality educational experience which prepares graduates to assume leadership roles within the chemical and associated industries; to foster the pursuit of new knowledge and innovative scholarship in the chemical sciences and engineering; and to provide leadership to the chemical engineering profession through scholarship, teaching, and service.

Our facilities—including the Process Simulation and Control Center, Hazards Laboratory, and Carbon Technology Center—are state-of-the-art. Our BASF and Kimberly-Clark classrooms offer multimedia equipment, videoconferencing, and audiovisual technology.

Our Faculty

Our world-class faculty have published nationally recognized textbooks on safety, environmentally sensitive engineering, rheology, and polymer engineering. They have won numerous honors for their achievements in research and teaching, including the A.M. Gaudin Award for Mining, Metallurgy and Exploration from the American Institute of Metallurgy, the Norton H. Walker Award from the American Institute of Chemical Engineers, and Michigan Tech's Distinguished Teaching Award.

Faculty research areas include chemical process design, polymers, advanced process control, chemical process safety, minerals processing engineering, catalysis and particulate processing, environmental engineering, polymer rheology, biochemical engineering, as well as alternative energy and sustainability. We also offer one of the only dedicated technical communication courses for chemical engineering in the US.

Pictured: Michigan Tech's new Great Lakes Research Center (far right). For more info visit http://greatlakes.mtu.edu

Chemical Engineering Faculty

Gerard T. Caneba, PhD
University of California-Berkeley
Carbon nanotube/polymer composites
precipitation polymerization

M. Sean Clancey, PhD
Michigan Technological University
Technical communications

Tomas B. Co, PhD
University of Massachusetts
Process integrity, process modeling,
plant-wide control

Daniel A. Crowl, PhD
Herbert H. Dow Professor
for Chemical Process Safety
University of Illinois
Chemical process safety

Timothy Eisele, PhD
Michigan Technological University
Metals extraction, CO2 sequestration

Caryn Heldt
North Carolina State University
Biosensors, design of biomolecules

S. Komar Kawatra, PhD
University of Queensland, Australia
Iron and steel making, particle technology

Julia A. King, PhD
Mechanical Engineering, University of Wyoming
Thermally and electrically conductive resins, composites

Wenzhen Li, PhD
Chinese Academy of Sciences
Electrocatalysis, fuel cells, nanostructured materials

Adrienne Minerick, PhD
University of Notre Dame
Electrokinetics, biomedical microdevices

Faith A. Morrison, PhD
University of Massachusetts
Rheology of complex systems,
chemical engineering education

Michael E. Mullins, PhD
University of Rochester
Environmental kinetics and thermodynamics,
engineered nanostructures

Ching-An Peng, PhD
James and Lorna Mack Endowed Chair
University of Michigan
Drug/gene delivery, nanobiotechnology,
cellular/tissue engineering

Tony N. Rogers, PhD
Michigan Technological University
Environmental thermodynamics, process
design and simulation

John F. Sandell, PhD
Michigan Technological University
Fire protection and environmental engineering

David R. Shonnard, PhD
Richard and Bonnie Robbins Chair
in Sustainable Materials
University of California, Davis
Biological engineering, alternative energy, sustainability

Wen Zhou, PhD
University of California, Los Angeles
Computational systems biology and bioinformatics

Visiting Scholars

Nasrin Salehi
Assistant Professor, Department of Pathobiology
University of Tabriz, Tabriz, Iran
Molecular Biology, Protozoan diseases, new methods in diagnosis
and treatment of infection diseases

Fang Wang
Lecturer, College of Life Science
Tarim University, Xinjiang, China
Electroreduction of CO2 to fuels

Xusheng Zhao
Associate Professor, College of Chemistry and Life Science
Qinghai University for Nationalities, Qinghai, China
Novel electrocatalysts, electrocatalytic processes and electrolysis cells

Gang Tao
Associate Professor, College of Urban Construction
and Safety Engineering
Nanjing University of Technology, Nanjing, China
Combustion data analysis

Hector Moncada-Hernandez
PhD Candidate and Member, BioMEMS Research Chair
Tecnológico de Monterrey, Monterrey, Mexico
Microparticle dielectrophoresis, microdevice separations,
COMSOL modeling

Ching-An Peng

HUMAN HEALTH

Biomaterials and Bionanotechnology

Ching-An Peng

PhD student Alicia Sawdon (l) with Dr. Nasrin Salehi (r), a postdoc research associate

CANCER IS A LEADING CAUSE of death worldwide. Despite considerable advances in surgical and adjuvant therapies, many forms of cancer still show resistance to treatment. One way researchers are combating cancer is through suicide gene therapy. In such an approach, the suicidal gene and corresponding prodrug are administered in a two-step process. That is, first the gene is introduced into the targeted cancer cells, expressed and released into the cytosol and then the prodrug is administered. The prodrug is activated by the gene-expressed enzyme and converted to its cytotoxic form.

Professor Ching-An Peng is designing and synthesizing functionalized nanomaterials to augment the anticancer effectiveness of suicide gene therapy. Peng and his research team use polymer-based nonviral vectors as nanocarriers to ferry gene and prodrug simultaneously into the malignant cancer cells in one-step dosage rather than the convectional suicide gene therapy conducted by separate routes.

HPLC is used to determined the concentration of prodrugs released from polymeric micellar nanocarriers.

Acyclovir, a guanosine-based prodrug, has been used as the initiator directly in ring-opening polymerization of epsilon-caprolactone to form hydrophobic acyclovir-poly (epsilon-caprolactone), which is grafted with hydrophilic chitosan of various molecular weights to form amphiphilic polymers for the preparation of stable micellar nanoparticles. The cationic chitosan deployed on the outer surface of nanoparticles is employed to form complexes with herpes simplex virus thymidine kinase gene encoded plasmids. PhD student Alicia Sawdon is investigating multifunctional gene/drug nanocarriers for their efficacy in killing brain cancer cells.

Another gene/prodrug system used for the treatment of colorectal cancer cells is thymidine phosphorylase/doxifluridine, which is delivered by polymeric nanocarriers designed and synthesized by PhD student Jason Wang, who has a PhD in physics and is pursing his second doctoral degree in chemical engineering.

Maintaining sufficient blood-circulating time of drug carriers for targeting cancer cells and releasing drugs is another challenge for achieving therapeutic effectiveness. CD47-streptavidin with anti-phagocytic feature is produced by recombinant DNA methods and will be bound on gene/drug nanocarriers to examine the interaction with macrophages and alpha(v)beta(3) integrin-bearing cancer cells. Dr. Nasrin Salehi, a research associate, is working on this topic. Finally, PhD student Sushil Pachpinde is working on the team to functionalize gold nanorods and gold nanoparticles as theranostic agents for caner cell detection and treatment.

HONORS AND AWARDS

Ching-An Peng holds the James and Lorna Mack Endowed Chair in Bioengineering. He was awarded a Strong Communities, Strong Cities (SC2) Fellowship in 1998, and was a Zumberge Fellow from 1998-2000. He served the scientific advisory committee of Los Angeles Tissue Engineering Initiative from 2004-2006, and is on the editorial advisory board of the *Open Biotechnology Journal.* His research has been supported by the National Science Foundation, the National Institutes of Health, the National Science Council (Taiwan), the National Health Research Institutes (Taiwan), and a number of domestic and foreign foundations.

Caryn L. Heldt | HUMAN HEALTH

Bioseparations and Molecular Recognition

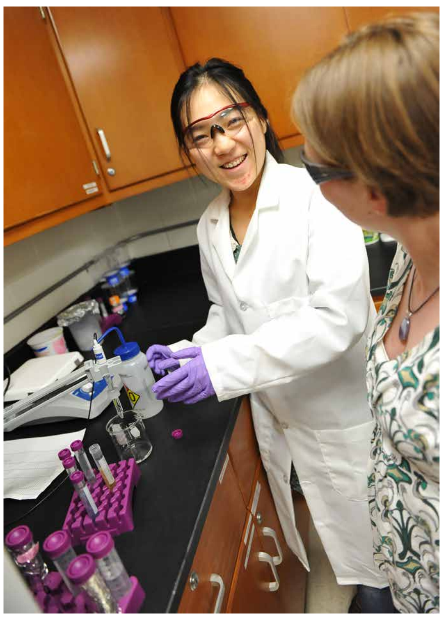
Caryn L. Heldt

BIOSEPARATIONS INVOLVE the partitioning of biological molecules to remove impurities and create a pure product. These biological products can be anything from enzymes for laundry detergent, new drugs to treat cancer, or viral vaccines. Assistant Professor Caryn Heldt and her research group are using specific molecular recognition to separate and detect pathogens and disease-causing proteins with the overall goal of improving human health. By using the engineering principles of kinetics, mass transport and colloidal science, Heldt and her team are trying to solve difficult separation problems. They are particularly interested in separating small viruses using affinity techniques. They have recently found small affinity ligands that bind to parvoviruses and are now applying them to different removal techniques to purify water, blood, and biotherapeutics.

Another focus is discovering the source of toxicity and disease progression in amyloid diseases, such as Alzheimer's and Parkinson's disease. "The identification of the toxic aggregate species will bring us closer to finding a therapy to slow or stop the progression of these debilitating diseases," says Heldt. "This can be approached as a separation problem due to the heterogeneity of the aggregate species formed in these diseases."

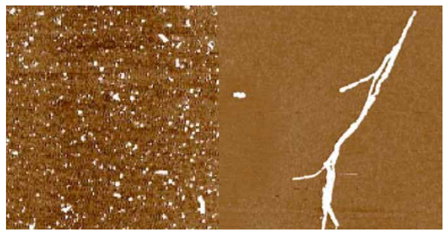
Graduate and undergraduate students are working on many projects to accomplish these goals. One group of students is focusing on finding new methods of removing small viruses. Small viruses cause illness outbreaks on cruise ships, hepatitis outbreaks in food and can be difficult to remove due to their small size and robust chemical nature. Master's student Bingyu Bai is using functionalized chitosan electrospun membranes to remove small viruses from water as an alternative water purification method in remote areas. Two PhD students, Maria Tafur and Khrupa S. Vijayaragavan, with the help of undergraduate Amna Zahid, are removing viruses from biotherapeutics to reduce costs and improve the safety of expensive biological therapeutics. They are using standard protein separation techniques, including chromatography, precipitation, and extraction and applying them to pathogen removal. Undergraduate Max Regner, a member of the Honors Institute at Michigan Tech, is separating amyloid proteins that cause human diseases. He is attempting to identify the protein aggregate species that is the source of cellular toxicity in degenerative amyloid diseases.

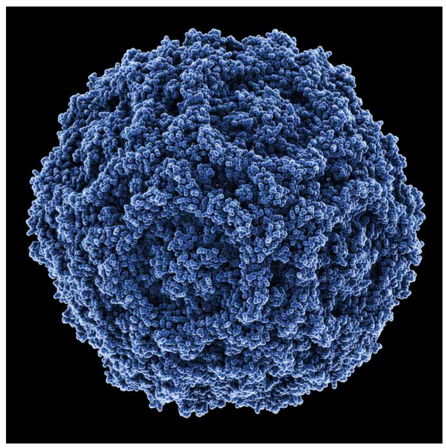
"The integration of graduate and undergraduate training in the lab enhances research and education at Michigan Tech," notes Heldt. "We will continue to integrate education at all levels to inspire and guide the next generation of engineers as our research team continues to grow."



HONORS AND AWARDS

Heldt won first place at the Schoenborn Competition for best oral presentation of PhD research at North Carolina State (2008) and was the recipient of the NIH/NCSU Biotechnology Training Fellowship (2004-2006). Undergraduates under her advisement have also won third place (2006) and first place (2011) in the Student Poster Competition, Separations Division, AIChE National Meeting, as well as a first place oral presentation in the Undergraduate Research Symposium, Rensselaer Polytechnic Institute (2010). Her recent work on amyloid fibril growth was also highlighted in *Science and Technology Concentrates in Chemical and Engineering News,* Nov. 8, 2010.





TOP Formation of insulin fibrils from small aggregates (l) to mature fibrils (r) as a model of amyloid disease ABOVE Parvovirus particle, molecular model LEFT Heldt (r) with graduate student Bingyu Bai (l).

Adrienne Minerick

HUMAN HEALTH

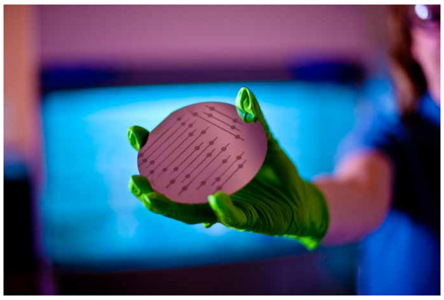
Biomedical Electrokinetics in Microdevices

Adrienne Minerick

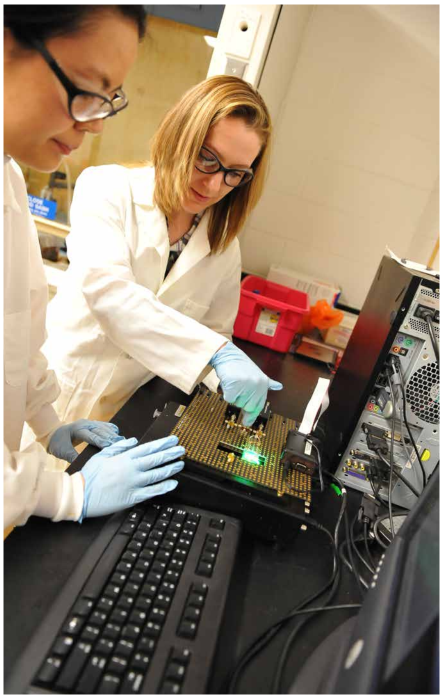
POINT OF CARE MEDICAL DIAGNOSTIC devices are in their infancy, but have the potential to address many of the grand challenges in global health. Associate Professor Adrienne Minerick and her research team are focused on nonlinear electrokinetics in microdevices to discern cellular responses at the micron length scale. This technology is a precursor to portable medical diagnostic devices because within a single drop of blood, electric fields can discern blood type. Minerick aims to be able to discern cellular blood diseases and quantify infected/unhealthy cells relative to healthy cells—all within a single drop of blood loaded into a portable handheld device powered by a battery.

Minerick and her research team specialize in dielectrophoresis, non-uniform alternating current (AC) electric fields that can polarize neutral cells. The polarization and thus motion induced at the micron length scale is dependent on properties of the cell membrane and the cytosol. Molecular expression or structure is altered in diseased cells such that the altered dielectric properties elicit a different motion in dielectrophoretic fields.

Recent PhD graduate Soumya K. Srivastava, now an assistant research professor at Washington State University, designed and optimized a direct current insulation dielectrophoretic (DC-iDEP) microdevice constructed using soft photolithography to continuously sort ABO-Rh blood types. Her device achieved recognition of A+ and B- from all other blood types (all 8 could be distinguished from at least 3 others) at confidence levels in excess of 99.993 percent. Kaela M. Leonard, a PhD student in her final year of study, was able to identify a resonant AC frequency to rupture red blood cells rapidly in a microdevice so that downstream protein electrophoresi can be performed in one integrated chip. She has also optimized a galactosidase enzyme, which digests away the ABO antigens from the membrane of red blood cells. The dielectrophoretic signatures of the cells change after the digestion, providing insights into whole cell electrokinetic detection of molecular expression. Tayloria Adams is a beginning PhD student examining the dielectrophoretic signatures of cardiac-biased stem cells while Chungja Yang is a third year PhD student systematically studying the dielectrophoretic signatures of liposomal core-inorganic shell nanoparticles to rapidly arrange the particles into a three dimensional pattern to transform light into coherent color. Another PhD student, Aytug Gencoglu, who will defend summer 2012, has been particularly effective at elucidating the effects of electrochemical reactions at electrode surfaces that impact the nanoliters of fluid within the diagnostic microdevices. These projects together provide foundational knowledge for advancement of microscale electrokinetics for widespread use in portable medical diagnostic devices.



Soft photolithographic techniques are used to create microscale relief patters on silicon wafers for the custom microdevices.



PhD Candidate Chungja Yang and Minerick discuss the microvolume process components and fluorescence optics that interface with the dielectrophoretic microdevice.

HONORS AND AWARDS

Minerick has received a National Science Foundation CAREER Award (2007), the Raymond W. Fahien Award from the American Association for Engineering Education (2011), the Fredrick D. Williams Instructional Innovation Award from Michigan Tech (2012), the Ralph E. Powe Junior Faculty Award from Oak Ridge Associated Universities (2004), and an ASEE Southern Section New Faculty Research Award. She won the Thomas C. Evans Instructional Paper Award twice, and three other paper awards, as well. Her research and education projects have been supported by the National Science Foundation, US Department of Energy, the National Institutes of Health, and state and national foundations.

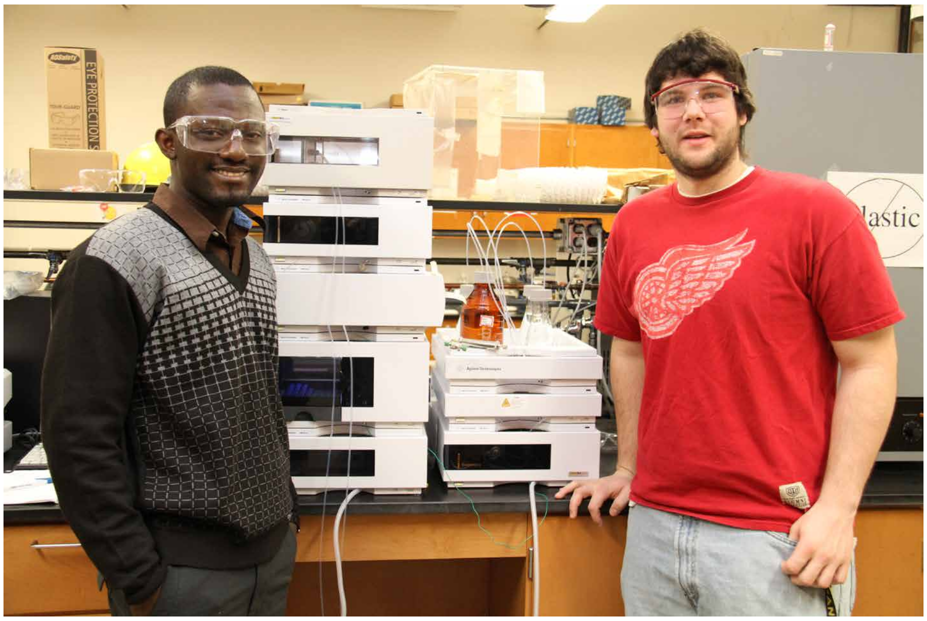
David R. Shonnard

ENERGY

Biofuels and Sustainability

David R. Shonnard

A SUSTAINABLE ENERGY SUPPLY is one of the grand challenges of chemical engineering in the 21st century. Realizing the large potential of woody biomass to satisfy energy and transportation fuel needs in an environmentally beneficial way is the goal of Professor David Shonnard's research program. Woody feedstocks include forest logging residues, energy crops, and industrial waste streams from the Upper Midwest region of the US. Graduate and undergraduate students in Shonnard's research team are using a variety of conversion platforms to produce value-added intermediate biofuel compounds. One platform targets production of sugars from the carbohydrate fractions of wood, which can be fermented to alcohol and hydrocarbon fuels using specialized microorganisms. Currently the team seeks to improve its mechanistic understanding of dilute acid hydrolysis reactions for deconstruction of hemicellulose using experimental and modeling approaches. Cellulose deconstruction reactions are facilitated by specialized enzymes, or biological catalysts, which work in concert to break down cellulose polymers to smaller fragments and ultimately to glucose, the most common sugar on the planet. One PhD student, Michael Brodeur-Campbell, and MS candidate Zainab Alshoug are using recombinant DNA techniques to improve characteristics of natural enzymes to make them more active in the presence of changing reaction conditions. In partnership with a Michigan startup company, PhD student Felix Adom is working with these sugar platform conversions to process a waste stream from the corn ethanol industry into fermentable sugars and amino acids for high value biochemical production. PhD student Jifei Liu's project involves wood-containing wastewater from a forest products facility in Michigan, which is converted to sugars for ethanol production with a co-product road deicer. PhD candidate Jordan Klinger is investigating fast pyrolysis of forest feedstocks from Michigan. Other projects include modeling the greenhouse gas emissions from forest feedstock supply chains in Michigan (Dr. Robert Handler, postdoctoral researcher), modeling life cycle environmental impacts for pyrolysis-based hydrocarbon biofuels (Jiqing Fan, PhD candidate), and modeling environmental impacts of biofuels from more diverse feedstocks including guinea grass, jatropha from Yucatan-Mexico, sugar cane bagasse, corn stover, logging residues, and macroalgae/microalgae (Edwin Maleche and Matt Mihalek, MS candidates). Each year Shonnard's research team also includes several supported undergraduate researchers, and high school students and science teachers gain research experiences in his laboratory during the summer semester.



PhD student Felix Adom with undergraduate researcher Jamie Davis in the Hydrolysis Lab

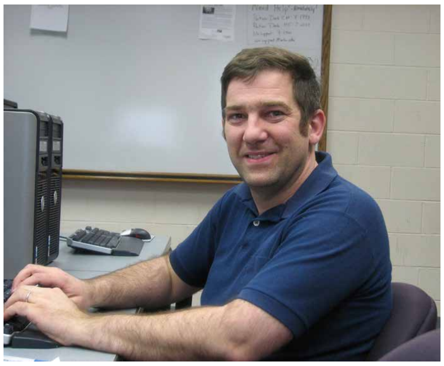
HONORS AND AWARDS

In recognition of research and education accomplishments in sustainability and green engineering, Shonnard has been awarded the Richard and Bonnie Robbins Chair in Sustainable Use of Materials (2008). He has also received the Ray Fahien Award from the American Association for Engineering Education (2003), an NSF/Lucent Technologies Foundation Industrial Ecology Fellowship (1998), and the department's Research Award (2011 and 2012). His research and education projects have been supported by the National Science Foundation, the US Department of Energy, the Michigan Economic Development Corporation, and several domestic and foreign industrial partners.

Timothy C. Eisele

IRON & STEEL

Microbially-Assisted Metal Extraction



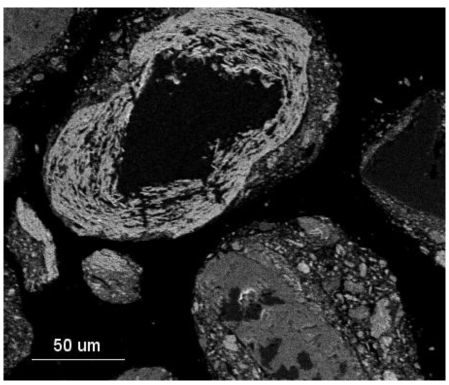
Timothy C. Eisele

THE PREVAILING TECHNOLOGY for production of many metals from ore is environmentally objectionable and consumes a tremendous amount of energy. In particular, the production of iron requires processing temperatures as high as 1500°C, achieved by combustion of fossil fuels, primarily coal. Fossil fuels are also needed to act as reducing agents to convert iron oxide to metallic iron. Making metals extraction environmentally benign requires the development of completely new approaches that can be carried out at low temperatures and use renewable reducing agents.

Assistant Professor Tim Eisele and his research team are investigating just such a new approach to iron production. PhD students Kristen Gabby and Jithendar Gujja are working with iron-reducing bacteria isolated from anaerobic bogs. These organisms can solubilize iron by chemically reducing it from the insoluble Fe^{+3} state to the soluble Fe^{+2} state, as a part of their anaerobic metabolism of carbohydrates and organic acids. The action of these bacteria on any of the common iron-bearing minerals results in dissolution of the iron without the need for high temperatures, strong acids, or other aggressive, energy-intensive, non-sustainable processes. Their objectives include determining the types of organisms that are most effective for chemically reducing iron; developing protocols for cultivating the organisms in the laboratory so that they can produce consistent levels of dissolved iron over long periods of time; maximizing the concentration of dissolved iron that these organisms can achieve; determining the chemical makeup of the solutions generated; and, ultimately, designing large-scale processing schemes that can be used to extract iron on an industrially-significant scale.

Once the iron is dissolved in the form of Fe^{+2}, it is suitable for electrochemical recovery directly from solution at room temperature ("electrowinning"). A combined bacterial dissolution/electrowinning process will achieve the goal of producing metallic iron with no high-temperature processing steps at all. Two undergraduate students, Chase Stevens and Jon Singleton, have worked on developing a semi-continuous iron electrowinning process that will be compatible with the bacterial dissolution process.

In addition to direct extraction of iron, the action of iron-reducing microorganisms can be used to control the reduction/oxidation potential of solutions. Eisele and his team are applying this to a new project with a goal of preventing mercury pollution as a result of precious metals extraction. The current technology for gold and silver extraction results in the simultaneous recovery of mercury, which then contaminates the precious metals. Refining of the gold and silver to remove the mercury then results in unintentional mercury releases—a severe environmental problem. Work being done by Eisele and PhD student Kristen Gabby will make it possible to control the reduction/oxidation potential during leaching so that the precious metals can be recovered while leaving mercury immobilized in a harmless form in the remaining ore.



ABOVE Eisele with PhD student Jithendar Gujja LEFT Electron micrograph of a very fine-grained iron ore suitable for extraction by bacteria

AWARDS

Eisele's research has been supported by the Department of Energy. Work relating to precious metals extraction has been supported by Newmont Mining Corp.

S. Komar Kawatra

IRON & STEEL

Green Technology of Ironmaking

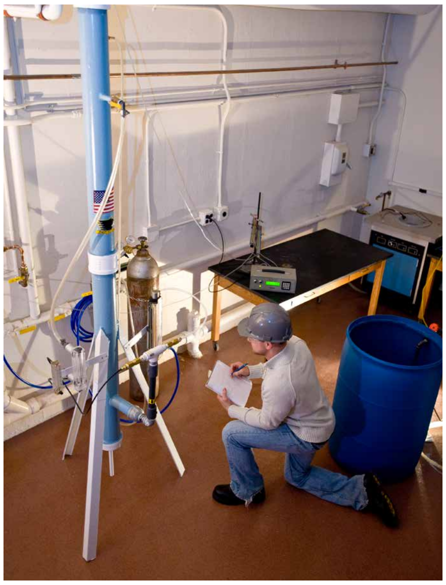
S. Komar Kawatra

IRON AND STEEL INDUSTRIES have been struggling for decades to reduce CO_2 emissions and energy consumption. Tremendous efforts have been made by researchers to reduce emissions, however the iron and steel remain among the most energy-intensive industries and are still known for huge CO_2 emissions.

Professor and Chair S. Komar Kawatra came up with a very unique approach to this problem, which has never been used by any researcher before. In any reaction, product generation depends on the reactants. Currently in the iron-making process, fossil fuel-derived, non-sustainable reducing agents such as high grade metallurgical coke, coal and natural gas are used to reduce iron oxide into metallic iron. In order to reduce iron oxide, carbon and hydrogen are required; carbon and hydrogen are also stored in the form of carbohydrate in many types of biomass. Biomass is sustainable and environmentally friendly—unlike nonsustainable reducing agents it removes CO_2 from the atmosphere and converts it into carbohydrate. Kawatra and his research team intend to use this carbohydrate to produce iron. "In combustion of any carboneous material, generation of CO_2 depends on the hydrogen/carbon ratio: the higher the ratio. the lower the CO_2 emission," Kawatra explains. "Compared to current reducing agents, biomass has a higher ratio of hydrogen to carbon, which means lower emissions of CO_2, and, due to the stored carbohydrate it is equally capable of reducing iron oxide into metallic iron." PhD student Urvashi Srivastava and Assistant Professor Tim Eisele successfully produced high quality metallic pig iron by using biomass alone as a reducing agent. To cover a wide variety of biomass, different types of biomass were used at different experimental conditions and pig iron nuggets were successfully produced at all the conditions.

When biomass is used for ethanol or biofuel production, several steps are involved before processing the biomass, such as pretreatment and enzymatic hydrolysis. Biomass utilized as a reducing agent to produce iron does not require any processing; it only needs to be ground. Ground biomass and iron oxide can just simply be mixed together to produce self-reducing composite iron oxide biomass pellets. These pellets can be fired at high temperature to produce molten pig iron.

Reducing CO_2 emissions in the iron and steel making industry is one of the many investigations conducted by Kawatra's research team. Two other projects—the reduction of dust generation from iron ore pellet plants, conducted by PhD student Joe Halt, and the capture and sequestration of CO_2 from iron production, conducted by PhD student Brett Spigarelli—will also help make the environment a better place.



PhD student Brett Spigarelli monitors a CO_2 Scrubber designed and built by students. Their group has applied for a patent and hopes to build a pilot plant in cooperation with Carbontec Energy Corp.

Sustainable Iron & Steel

THE ADVANCED SUSTAINABLE Iron and Steel Making Center (ASISC) was established by S. Komar Kawatra in 2008 to conduct research leading to increased sustainability in the iron and steel industry, including ironmaking, steelmaking, slag management, and feed preparation (grinding, separation, and pelletization). ASISC promotes fundamental industry-sponsored research, and provides educational opportunities for engineering students.

The 2012 ASISC Conference will take place August 6-10 on the Michigan Tech campus in Houghton, MI. To find out more, please email ASISC@mtu.edu, or visit www.chem.mtu.edu/asisc

HONORS AND AWARDS

S. Komar Kawatra has an outstanding track record of working on research projects related to environmental sustainability. His project, "Production of iron using environmentally-benign renewable or recycled reducing agents," was applied for patent publication date 09.27.2007. He has received numerous honors and awards, including the 2000 Robert H. Richards Award from the American Institute of Mining and Metallurgy, the Taggart Award from the Society for Mining, Metallurgy and Exploration, and the 2002 Frank F. Aplan Award from the American Institute of Mining, Metallurgical, and Petroleum Engineers.

Wen Zhou

COMPUTATIONAL MODELING

Systems Engineering and Biology, and Bioenergy

Wen Zhou

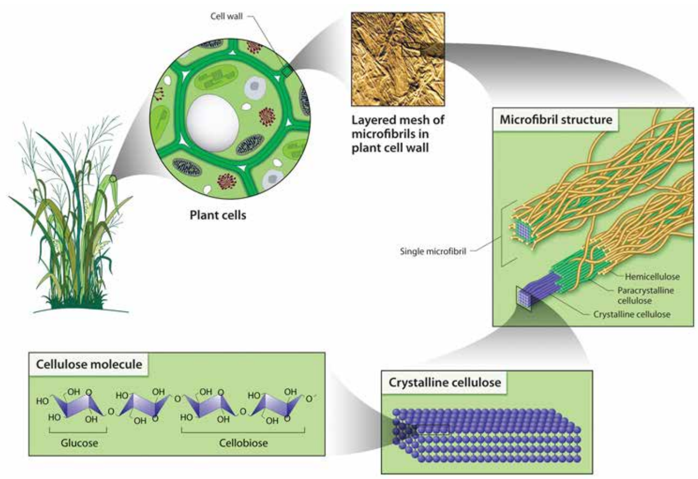
ASSISTANT PROFESSOR WEN ZHOU uses and advances computational systems biology and engineering in order to better understand and further improve complex biochemical processes that can address bioenergy and environment related problems based on first-principle mechanisms.

The complexity of system networks when advancing biotechnologies and bioprocesses for bioenergy production and environmental protection, on the mesoscopic scale within living microbial cells, and on the macroscopic scale within industrial processes, necessitates the application of computational systems biology and process systems engineering. Zhou's research team is advancing computational technologies in both systems biology and systems engineering, and equally importantly, the interface of these two. Their ultimate goal is to generate computational tools that can be used to aid the analysis and design of corresponding biochemical systems.

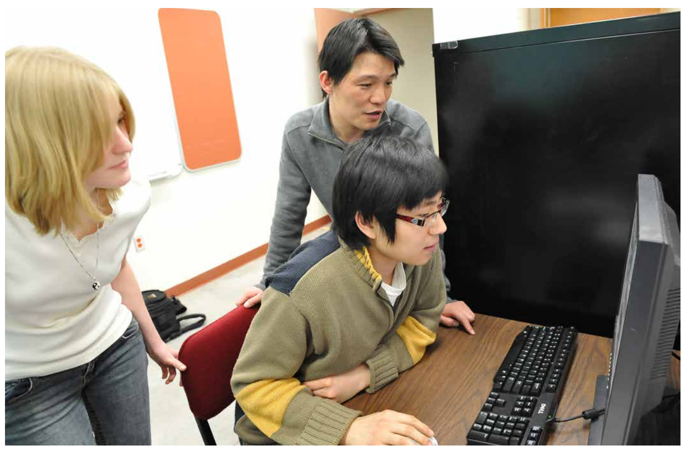
Zhou's team is addressing bioenergy production processes through biochemical or thermochemical conversion approaches, using lignocellulosic biomass as the energy source. Lignocellulosic plant biomass has long been recognized as a potential low-cost and sustainable source of mixed sugars for production of biofuels and other value-added chemicals, because of its availability in large quantities and its renewability. Lignocellulosic biomass comes from plant cell wall, which is a composite structure with crystalline cellulose, hydrated hemicellulose, and lignin as major components. The plant cell wall has evolved superb mechanisms for resisting assault on its structural sugars from the microbial and animal kingdoms, collectively known as biomass recalcitrance. Current technologies for the biochemical conversion of lignocellulosic biomass generally include pretreatment, enzymatic hydrolysis, and fermentation. However, this process needs to be more efficient and less costly to commercialize. In order to ensure a successful transition from existing to 2030 technologies, pursuing knowledge-based solutions to major barriers is critical. One PhD student, Yang Zhang, is working on improved modeling capability of lignocellulosic biomass hydrolysis process, where all of major biomass components (i.e. cellulose, hemicellulose and lignin) and their morphologic changes along the hydrolysis are taken into consideration. Such modeling framework could provide useful predictive capability for hydrolysis process optimization and hydrolytic enzyme design. Another Ph.D. student, Vinay Patil, is working on systematically analyzing biochemical cellular networks within one promising bioenergy production microbe, Clostridium thermocellum, for improved process tolerance. This work could provide insights into how microbes can be manipulated for better performance in bioenergy production.

HONORS AND AWARDS

Wen Zhou has received a Beedle fellowship (2005), an ARCO fellowship (2003, 2004) and a UCLA Chemical Engineering Departmental Fellowship (2002). He is also a recipient of the Guang Hua Scholarship (1999), Excellent Student Scholarship (1996, 1997), Li Qing Wen Jiao Scholarship (1995) and Li Xue Scholarship (1994), all from Tsinghua University. Zhou has been on the editorial board of *Journal of Chemical Engineering & Process Technology* since 2010.



Cellulose crystalline structure in plant cell wall



PhD student Yang Zhang and undergraduate Sarah Piccard discuss questions with Dr. Zhou.

Samantha Neirby Selected for Navy Submarine Training

DAVE WALLIS/THE FORUM

Samantha Neirby

SAMANTHA NEIRBY HAS GONE where mostly men have gone before. The US Navy has chosen Neirby—who finished her chemical engineering degree last spring at Michigan Tech—to train to serve on a nuclear submarine. She is just the third woman Naval officer ever recruited from a college or university to serve on a sub.

Neirby passed the final hurdle—an interview with Admiral Kirkland H. Donald, director of Naval nuclear propulsion and deputy administrator of the National Nuclear Security Administration—in Washington, D.C. in February 2011. Upon graduation in April 2011, she went to the Navy's Officer Candidate School in Newport, Rhode Island to be commissioned, and then entered a one-year nuclear power training program in Goose Creek, South Carolina.

Neirby, who is on the Dean's list at Michigan Tech, served in the Navy's Nuclear Power Officer Candidate Program (NUPOC) for two years. Initially she expected to serve on a nuclear carrier, but when her Navy recruiter suggested that she try for a nuclear submarine assignment, she didn't hesitate. "I just can't tell you how excited I am," Neirby exclaimed. "Working in nuclear power has been my dream since about my second year in high school."

"I think chemical engineering is one of the hardest majors at Tech," added Neirby. "It taught me to deal with stress, to expect the unexpected and to keep at problems until you find a way to solve them." She has impressed her professors at Michigan Tech as much as she has impressed the Navy.

"Samantha's experience in the chemical engineering department shows what a good student with drive can accomplish," said Associate Professor Tony Rogers, one of Neirby's senior deign instructors. "Her senior design team accepted the challenge of designing a commercial process for charcoal production in Panama, while sustaining the mangrove tree raw material and reducing harmful air emissions. Samantha has become known at Michigan Tech as a student who pushes the envelope, exceeds expectations and is not afraid to try new things. She is proving that chemical engineering opens a lot of doors to students willing to walk through them."

The nuclear powered attack submarine, USS Albany (SSN 753) transits the Chesapeake Bay as it returns from a scheduled six-month deployment *(Credit: US Navy)*

The daughter of the late Jeffrey Neirby and Rita Schmidt of Fargo, N.D., she attended Moorhead Senior High School in Moorhead, Minn., where she was raised by her grandmother, Ilene Neirby and her older brother, Adam Neirby. " I know without their support, I would never have made it this far," she said.

Spigarelli and Haselhuhn Rise to the Top at SME Poster Session

SME
Society for Mining, Metallurgy & Exploration

STUDENTS IN THE Department of Chemical Engineering showcased their latest research at the 2012 Society for Mining, Metallurgy and Exploration (SME) annual meeting held February 11-16 in Seattle, WA. This year, graduate students took first and third place at the minerals processing division student poster competition. SME members working in the mining industry judged the posters. Brett Spigarelli, a third-year PhD candidate, presented the first place poster, "An Equilibrium Analysis of Carbon Dioxide Absorption in Alkali Solutions". Howard Haselhuhn, a second-year PhD candidate, presented the third place poster, "Water Chemistry Effects on Zeta Potential of Concentrated Hematite Ore". Both Spigarelli and Haselhuhn work under Dr. S. Komar Kawatra.

PhD students Brett Spigarelli (l) and Howard Haselhuhn (r)

AIChE 2011
NORTH CENTRAL
REGIONAL CONFERENCE
AT MICHIGAN TECHNOLOGICAL UNIVERSITY

AIChE STUDENT CHAPTER UPDATE

MICHIGAN TECH IS FORTUNATE to have a very active and nationally respected student chapter of the American Institute of Chemical Engineers (AIChE). The Chapter's peer-mentoring program and social activities help to create a welcoming environment for students. Invited speakers connect students with future employers and discuss available career opportunities. By participating in regional and national AIChE conferences, competing in the Chem-E-Car competition, and doing local volunteer work, the Michigan Tech AIChE Student Chapter promotes service to the chemical engineering profession and the community at large.

The AIChE student chapter, pictured here in the cosmetics mixing department, enjoys an Amway plant tour.

Michigan Tech Hosts Regional AIChE Conference

Michigan Tech was a proud host of the 2011 AIChE North Central Regional Conference. L to R: Michigan Tech's AIChE President Kelly-Anne Zayan; keynote speaker Tara Tolly, Category Leader, Chemicals Global Procurement, Archer Daniels Midland; and Michigan Tech AIChe Vice President, Janelle Paddock

AIChE students celebrate K-Day at McLain State Park with complimentary ooblek for all takers!

CPM President Bobby Parker Wins Cote Award

THE 2011-2012 James '61 and Monica Cote Endowed Scholarship Award was presented to Robert J. Parker for his high academic achievement during the past school year. Parker is a member of the Theta Tau Fraternity and a junior majoring in Chemical Engineering. The award is $1,000 and is given annually to a Theta Tau member who has achieved excellence in academics studying engineering. Last semester Parker achieved a 3.9 GPA and has maintained a 4.0 departmental average. He also serves as president of the Consumer Product Manufacturing Enterprise at Michigan Tech.

Parker receives the Cote award from Civil and Environmental Engineering Professor and Chair David Hand.

First Place: Chem-E-Car 2012

MICHIGAN TECH'S INGENIOUS Chem-E-Car took first place and nabbed honors for creativity at the North Central Region Chem-E-Car Competition, held April 21 at the University of Akron. The event is sponsored by the American Institute of Chemical Engineers and Chevron.

Chem-E-Car entrants build small cars, about the size of a shoebox, and power them using chemical reactions. About an hour before the competition, they are told the length of the course and the weight of the payload. Then, they configure their vehicles to roll as close as they can to the finish line.

This year, the course was 71 feet long, and the payload was 300 grams. The Michigan Tech car, named "Paradise Lost," halted just six inches shy of the finish line. The next-closest competitor, Purdue University, was 11 inches away.

"We had a fantastic weekend," said Ross Koepke, team coleader and a junior majoring in chemical engineering. "We put a lot of time in before the competition, and it paid off. Coming away with these awards is outstanding."

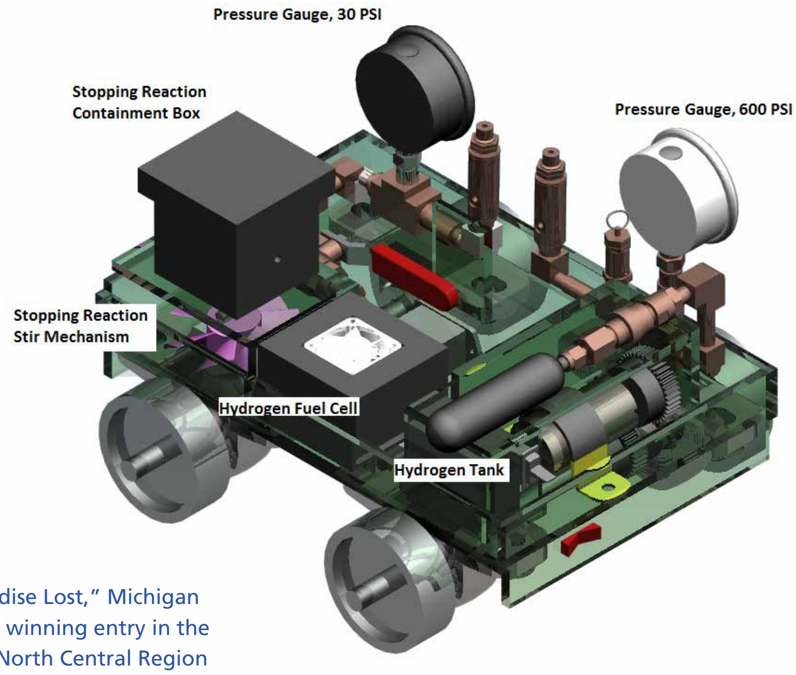
The car relied on two chemical systems. Electric power was provided by a hydrogen fuel cell that drew hydrogen gas from a metal hydride cylinder. "Hydrogen molecules are so small they can migrate into metals and form an alloy," Koepke said. "What this allowed us to do was store more hydrogen in a smaller volume at less pressure. Last year's Chem-E-Car team developed this technology, and it was a key part of our success."

A different, two-part chemical reaction stopped the car. The first part created chemicals that turned a solution deep purple. The second reaction removed those purple chemicals, keeping the solution transparent.

A photodiode kept an eye on the solution, and as soon as the solution darkened to purple, the photodiode flipped a switch to stop the motor. Timing the appearance of the purple was key to making the car travel the length of the course.

Yes, Koepke said, it's pretty cool, but that's only part of the story. When the team was developing the car, it wasn't stopping consistently, because the chemicals weren't dispersed evenly in the solution. "So we installed a stirring mechanism," he said. "There were two magnets, one inside the reaction vessel and one beneath it. The one beneath is connected to a modified computer fan.

"Basically, the fan would spin the magnet outside, which would spin the magnet inside, which stirred the solution." Soon they had their car stopping on a dime. However, they earned their creativity prize for something other than their creative use of chemicals. "We had an obsessive focus on safety," Koepke said. The team replaced chemicals that posed a hazard with very benign substances, like ascorbic acid, or vitamin C.



"Paradise Lost," Michigan Tech's winning entry in the 2012 North Central Region Chem-E-Car Competition

Chemical Engineering Department Scholar Announced

Amanda Taylor

EACH YEAR, the Department of Chemical Engineering recognizes one student as its 2012 Department Scholar. Amanda Taylor has been given the honor this year. Taylor will receive a $200 cash award from the university.

According to Professor Tony Rogers, interim department chair, Taylor is one of the department's most accomplished undergraduates with superb communication skills, impressive work ethic, and exceptional leadership qualities. "It is our observation that Amanda possesses a high degree of intellectual ability along with a desire to serve her campus and community."

Taylor is active in undergraduate research in alternative energy. The prospect of teaching and energy research has led her to make future plans to become a university professor. She hopes to take an active role in the national effort to make alternative energy sources practical and sustainable for future generations.

HYDROPHOBICITY COMPARISON: Amna Zahid Wins First Place in AIChE Poster Competition

UNDERGRADUATE RESEARCHER Amna Zahid, together with Dr. Caryn Heldt and graduate student K. Saagar Vijayaragavan, have spent months working on a hydrophobicity comparison of a nonenveloped virus with blood and host cell proteins. Zahid created a poster about their work together, and presented it in Minneapolis at the Fall 2011 AIChE Meeting, winning first place in the Separations Division of the undergraduate poster competition.

Q. Please describe your project for us—what exactly are you working on, and what is its function/purpose?

A. The project I'm working on is basically testing a hypothesis that viruses are more hydrophobic than typical blood cell proteins. The relative difference in the hydrophobicity of viruses and proteins can potentially help our group to create novel virus removal techniques. This will have many applications. For example, it can potentially help in removal of virus from biotherapeutic products reducing the number of infections/deaths caused. We have used both experimental and computational methods to test this difference and demonstrated that there is a hydrophobicity difference between our model non-enveloped virus and proteins.

Q. What have been the most difficult or challenging aspects of the work thus far?

A. The most challenging aspect I'd say would be time management. Lab work requires time and commitment. During the semester when I took three research credits, I was also working two part time jobs on campus and maintaining a full-time student status. Juggling everything was pretty stressful but I had no option as I have to earn to pay for my expenses. However, I do not regret anything as I've learned so much from all the part-time jobs I've done on campus since I came to Michigan Tech.

Q. What have been the most rewarding aspects?

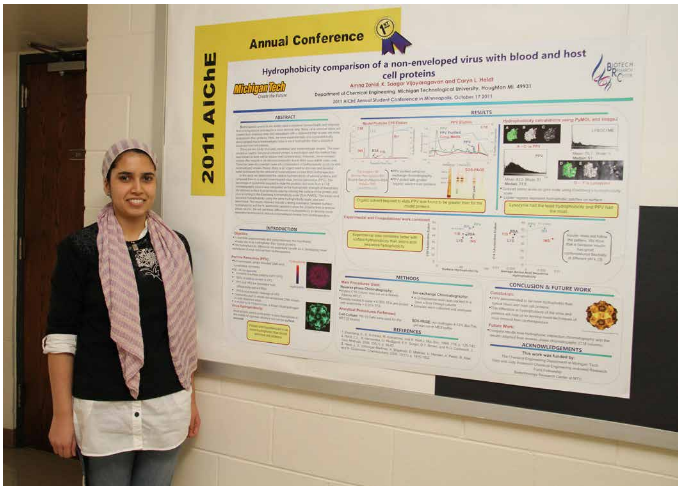
A. The most rewarding aspect for me is being a small part of a project that can potentially help people around the world. I really hope this project becomes successful and makes a positive difference in people's lives. For me, nothing can beat this feeling! The graduate students in our group will use the hypothesis to create the novel separation techniques.

Q. What are the most important lessons you have learned along the way? Or—what do you hope to learn or accomplish?

A. I know it sounds trite but it's true, I learned that nothing is impossible as long as you believe in yourself, work hard and have sincere intentions. I think I've learned more from my failures than the successes along the way. I also learned to appreciate diversity more; the best thing I like about our bioseparation group is its diversity. I think our bioseparation group is a great example of a good team and a great team leader (Dr. Heldt). There's no discrimination in our group, everyone's friendly and we all go out of the way to teach and help each other whether it's related to our projects or not. I've really enjoyed a lot working with this group and I'm grateful to all of them for this great experience. It has definitely been one of the highlights of my time at Tech.

Q. What do you hope to do upon graduation?

A. I plan to apply for jobs and for graduate schools to keep my options open. I will go with the flow, just as I've done so far depending on what I find along the way. Further studies are extremely expensive and I'm already having a hard time paying for my undergraduate degree but I'll still apply. This summer I'll be going for an internship as a chemical engineer, which is another thing that is on my list. I love to learn new things and I enjoy hands-on work, I hope I do well there.



Amna Zahid, a chemical engineering junior, won 1st place in the Undergraduate Poster Competition for the Separations Division at the Fall 2011 AIChE Meeting in Minneapolis.

Q. How long have you spent working on the project? How did you get interested/involved?

A. I've been working on this project since January 2011. I wanted to get one semester of research experience so I decided to take three credits of undergraduate research, which also count towards my bachelor's degree. Dr. Heldt was looking for undergraduate students for her projects so I contacted her; she called me for an interview and later I was selected. The project went well in the spring semester and she offered me work in the following summer semester, for which I received the Gary and Judy Anderson Chemical Engineering Endowed Research Fund Fellowship. This semester I'm working as a student researcher in the lab.

Q. Any other details you'd like to share?

A. For a person to whom public speaking was equivalent to death at one point in time (no kidding!), winning a place in a poster presentation competition is definitely encouraging. Tech has played a big role in helping me fight my public speaking phobia. Studying abroad and coming to Tech to study has definitely been one of the big turning points in my life. I've generally found the people here welcoming, kind and helpful.

Enterprise Team Updates

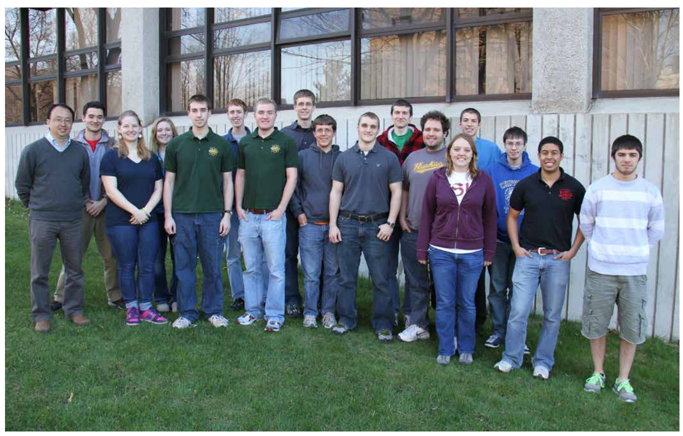
CONSUMER PRODUCT MANUFACTURING

ADVISORS: Tony Rogers and Sean Clancey
SPONSORS: Keweenaw Brewing Company (KBC), Dow Corning Corporation, nanoMAG, and the Village of Lake Linden

OVERVIEW: CPM is a student-led organization run much like a small business. Multidisciplinary teams of students work to create innovative product and process solutions that address the needs of commercial and governmental sponsors. Projects are aimed at increasing an existing product's profitability or market potential, solving process bottlenecks, and creating new or improved products. Working with a variety of clients allows students to develop outstanding teamwork and communication skills. CPM students are currently designing a hydroponics system for fresh produce in the UP, creating sports protective equipment with new materials, developing alternate bulk shipping methods for Dow Corning, and optimizing large-scale manufacturing processes. With many leadership opportunities, active, hands-on advisors, and the help of top companies, CPM gives students experiences that will help them succeed in industry after graduation.

CPM students safely dissect a commercially-available intermediate bulk container (IBC) to test the material properties of each component. These tests, among many others, will be used in the development of a custom IBC that meets the specified needs of Dow Corning.

ALTERNATIVE FUELS GROUP



ADVISOR: Wenzhen Li
SPONSORS: Ford Motor Company Fund

OVERVIEW: AFG is devoted to researching new and innovative alternatives to today's fossil fuels. The team is committed to providing viable solutions to world energy problems, with five active projects: a direct methanol fuel cell production facility; solid oxide fuel cell cogeneration; biodiesel production for a street sweeper; a solar car; and stationary solar energy analysis.

AFG's solar car team creates a scale model of solar car chaise.

Technical Communication for Chemical Engineers

Sean Clancey evaluates a student presentation in CM 3410

MICHIGAN TECH OFFERS ONE of the nation's only technical communication courses specifically designed for chemical engineering, CM3410.

Chemical Engineering lecturer Sean Michael Clancey, winner of the 2009 Michigan Tech Distinguished Teaching Award, teaches the course.

"When engineers go out into the world, they learn that the ability to communicate technical information is absolutely essential to their careers," says Clancey. "They're rated heavily on their communication skills.

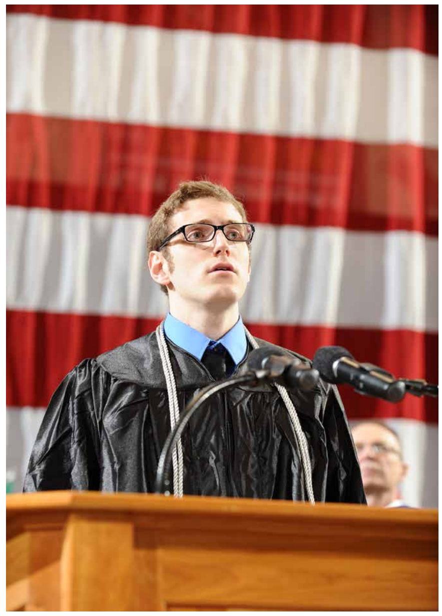
In CM 3410, each student is required to give three talks, which are videotaped. Extra credit is given to students who turn in memos that analyze their own speech performance. During a typical class period, students revise samples of writing found in the genre of chemical engineering and defend their edits.

Clancey has his students focus on techniques used to communicate technical information, both written and oral. "The idea is to apply these techniques to documents that chemical engineers would be likely to write—everything from sentence-level structures to paragraph structures to whole documents."

Students are asked to produce at least three pieces of writing: a resume and cover letter, a memorandum, and a set of abstracts and an executive summary. They also form small groups to produce a more extended piece of technical writing. Writing materials are placed in a portfolio handed in at the end of the semester.

CM3410 has been offered at Michigan Tech for nearly 20 years. Clancey "inherited" the class in the mid 1990s from former faculty member Betsy Aller, who is now an associate professor at Western Michigan University.

Each year, Clancey selects two studens from CM3410 to win the Kimberly-Clark Communications Award, and the Kimberly-Clark Ethics Award. "We promote, value and emphasize communication and ethics strongly in the Department of Chemical Engineering," notes Tony Rogers, professor and interim chair. "We are dedicated to rewarding students for developing themselves in these areas." Winning in 2011 were Spencer Doyle for Ethics, and Alex Ash for Communication. Winning in 2012 were Gregory Knauf for Ethics, and Philip Kaiser for Communication.



Chemical Engineering graduating senior Kyle Andrews sings the national anthem at Michigan Tech Commencement. Andrews, an honors student, received three scholarships during his years at Michigan Tech: the Mackie Endowed Scholarship, the 3M Endowed Scholarship, and the James & Alma Van Camp Endowed Scholarship.

Linda's McInally's Simple 7 to Maximize your Success!

Linda McInally, retired Dow Corning Vice President of Manufacturing for the Specialty Chemicals Business, shared invaluable insights and advice as Keynote Speaker at the 2012 Convocation:

1. Always put safety first.
2. Respect those around you. Listen then act.
3. How you present your work is as important as the work itself.
4. Always be professional, simplify your messages and know your audience.
5. Prioritize your work. Spend your time on the highest impact projects that deliver that impact the fastest.
6. Leverage your generational advantages. Use your keen sense of computing as well as your strong network to help you solve problems faster.
7. Develop your business and leadership acumen.
8. Pace yourself and enjoy the ride!

Gregg Zank is Keynote Speaker at 2011 Convocation

S. Komar Kawatra and Dow Corning's Gregg Zank

GREGG A. ZANK, Chief Technology Officer, Senior Vice President and Executive Director of Science and Technology for the Dow Corning Corporation, spoke to a packed classroom of chemical engineering undergraduates about career and life choices in a keynote speech at the 2011 Awards Convocation for the graduating class.

Zank joined Dow Corning in 1985 and is a recognized leader in the scientific community as well as a pioneer in technological development. He holds thirty patents for innovations, including advanced monolithic and composite ceramics, rechargeable batteries, and high-temperature thermosetting plastics. Now, Zank leads Dow Corning's innovation efforts, which include a unified approach to advancing and managing innovation for maximum future growth based on global megatrends. He also oversees the company's development of new ideas and solutions, including a business and technology incubator.

Dow Corning Corporation, with support from Zank, has partnered with Michigan Tech over the past twenty years to elevate the Chemical Engineering Unit Operations Laboratory to be the best in the nation. Generous donations have created a polydimethylsiloxane (PDMS) pilot plant that showcases Dow Corning's silicone chemistry and allows students to operate a one-of-a-kind, fully-instrumented facility.

Students in attendance at the Awards Convocation had been trained in this excellent pilot plant, and they heard Zank speak about college, entering the workforce, and making a difference in science. "I have a lot of respect for you," he said. "You've already accomplished a lot and you're going to accomplish even more. My hope is that you take on challenges as you go forward." Zank urged students to make the world a better place than it is today, and to lead. According to Zank, chemical engineers work to solve key world problems, including energy, the environment, the availability of clean water, the human body/chemistry interface, and the education revolution. "You will play a vital role—you will be involved in the application of science," he told the students.

Linda McInally is Keynote Speaker at 2012 Convocation

2012 CONVOCATION KEYNOTE speaker Linda McInally is recognized within Dow Corning for her deep knowledge of people and processes around the world, for enabling strong leadership, and for significant financial contribution and quality improvements to business. McInally graduated from Michigan Tech with a BS in Chemical Engineering in 1979. She worked two years with IBM before joining Dow Corning in 1981. Her career at Dow Corning has been centered on operations, with positions in process engineering, product development, finance and most recently, several roles in manufacturing leadership.

From 1997 to 2002, McInally worked for Dow in Seneffe, Belgium, first as Manager of the Global Process Engineering & Tech Center and then as Site Manager. McInally was named to the list of top 20 most powerful women in the US, and then named Vice President of Manufacturing for the Specialty Chemicals Business in 2008, responsible for manufacturing plants across Asia, Europe,

Linda McInally

and North and South America. She also led the Global Manufacturing Automation Group, responsible for implementing a vision for improving productivity through automation until her retirement at the end of 2011. In addition, she has served as a career development coach and mentor at Dow Corning for those starting out, helping them to achieve their potential while balancing professional and personal life.

Governor Appoints Julie Fream '83 to Michigan Tech Board of Control

Julie Fream

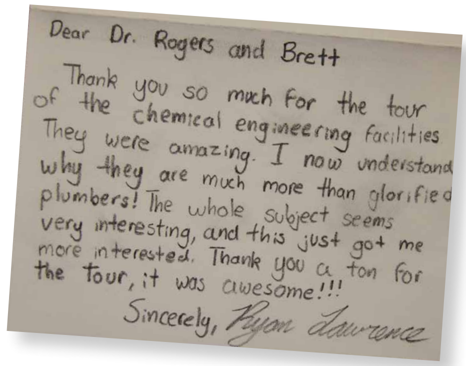
GOVERNOR RICK SNYDER has appointed chemical engineering alumna Julie Fream, vice president of Visteon's North American customer group, global strategy and communications to the Michigan Tech's Board of Control.

Fream graduated in 1983 from Michigan Tech with a bachelor's degree in chemical engineering and earned an MBA from the Harvard Business School in 1987. She began her career at Visteon in 1998 and previously worked for General Motors, Ford Motor Company and TRW.

In 2002, Fream appeared on Crain's Detroit Business's "40 under 40" list for her sales leadership at Visteon. In 2005, she earned the Anti-Defamation League's Woman of Achievement Award for fostering an inclusive and diverse work environment at Visteon.

Fream, of Birmingham, is a member of the University's Distinguished Academy of Chemical Engineering. She received Michigan Tech's Outstanding Young Alumni and Outstanding Service Awards and was the featured speaker at Midyear Commencement in 2003.

"Michigan Tech has a key role in educating Michigan's future engineers and leaders," said Fream. "I'm honored to serve on the Board and support the University as it moves forward in the coming years."



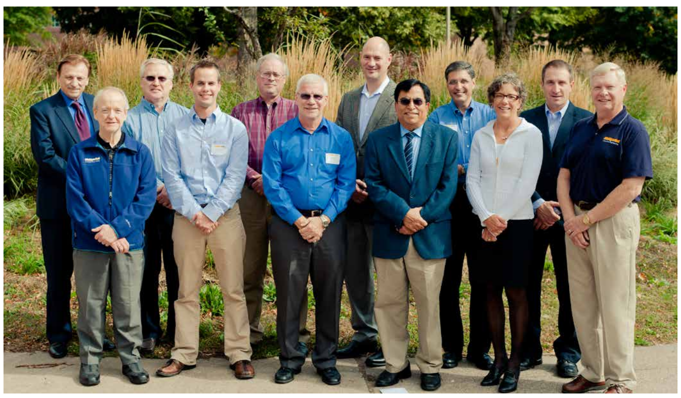
Dear Dr. Rogers and Brett

Thank you so much for the tour of the chemical engineering facilities. They were amazing. I now understand why they are much more than glorified plumbers! The whole subject seems very interesting, and this just got me more interested. Thank you a ton for the tour, it was awesome!!!

Sincerely, Ryan Lawrence

Julie's son, Ryan, (12 years old, 7th grade) visited the Department in October 2011.

2011 Chemical Engineering Advisory Board Meeting Attendees



Attendees of the External Advisory Board meeting, Fall 2011

Mark Mieziva

James Sanderson

Gene Chamberlin

Linda McInally

Ryan Stoeger

Glenn Lawrence

Brad Rick

Donald Dixon

Chris Gosling

Daniel Beatty

Adrienne Minerick Wins ASEE Fahien Award

Adrienne Minerick

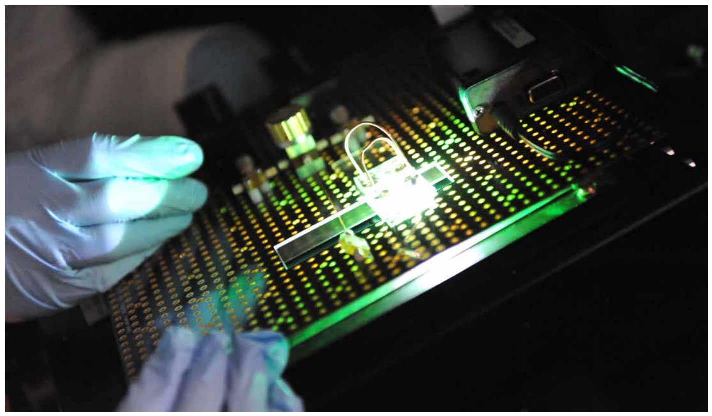
THE DEPARTMENT OF CHEMICAL Engineering is proud to announce the significant achievement of Assistant Professor Adrienne R. Minerick, winner of the 2011 Ray W. Fahien Award from the Chemical Engineering Division of the American Society for Engineering Education.

The Fahien award was given to Minerick for her outstanding educational scholarship and teaching effectiveness. Of special note is her effort to involve underrepresented minorities in undergraduate research opportunities.

The award honors Raymond W. Fahien, who was editor of the archival journal, *Chemical Engineering Education,* from 1967 to 1995. It is based upon two equally weighted criteria: outstanding teaching effectiveness in the training of undergraduate and/or graduate students and educational scholarship through significant contributions to education in the field of chemical engineering.

The Fahien Award has been given by the society since 1997. Minerick is the fourth chemical engineering faculty member at Michigan Tech to receive this award. Previous award winners include Kirk Schulz (1997), David R. Shonnard (2003) and Jason Keith (2008).

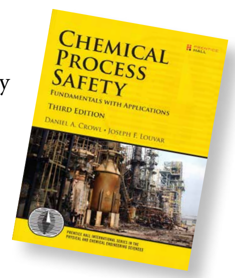
Minerick received her BS in Chemical Engineering from Michigan Tech and her MS and PhD in Chemical Engineering from University of Notre Dame. Minerick has won numerous awards for both teaching and research, including a NSF CAREER Award, an ASEE Southern Section New Faculty Research Award, the Fredrick D. Williams Instructional Innovation Award, and is twice winner of the Thomas C. Evans Instructional Paper Award. Her research interests are in nonlinear electrokinetics in microdevices with applications in medical diagnostics.



Minerick's passion is research instruction of microscale devices shown here mounted on a video microscope stage.

Dan Crowl Wins Merit Award

Dan Crowl (r) receives the Merit Award for teaching and lifetime achievement in process safety.



CHEMICAL ENGINEERING Professor Dan Crowl has won the Mary Kay O'Connor Process Safety Center Merit Award.

Presenting the award was Dr. M. Sam Mannan, director of the Mary Kay O'Connor Process Safety Center, which is located at the Texas Engineering Experiment Station at Texas A&M University.

The Merit Award recognizes an individual who has made significant contributions to the advancement of education, research, or service activities related to process safety concepts and/or technologies. Crowl is the coauthor (with Joe Louvar) of the leading process safety textbook in the world, "Chemical Process Safety, Fundamentals with Applications." The third edition was published in May 2011. Crowl has been a leader in process safety education since 1985.

The Mary Kay O'Connor Process Safety Center was established in 1995 in memory of Mary Kay O'Connor, an Operations Superintendent killed in an explosion on October 23, 1989 at the Phillips Petroleum Complex in Pasadena, TX. Mary Kay O'Connor graduated from the University of Missouri-Columbia with a degree in Chemical Engineering and received a MBA from the University of Houston-Clear Lake.

More info at http://psc.tamu.edu/

New Flow Measurement and Control Experiment

THE DEPARTMENT OF CHEMICAL ENGINEERING has added a new Flow Measurement and Control experiment to the Unit Operations Laboratory, replacing an older unit built in the 1960s. Rosemount, Micro Motion, and Fisher Valve—all Emerson Process Management companies—as well as Novaspect, Inc. provided substantial educational discounts and design assistance for the project.

"It's critical that we introduce our students to the best and latest technologies in our laboratory courses," noted Dave Caspary, chemical engineering lab facilities manager. "Without the help of our industrial friends we wouldn't have the resources to do this type of thing. In this case, Emerson Process Management and Novaspect, Inc. provided the technical support and substantial educational discounts to make this a reality."

It's critical that we introduce our students to the best and latest technologies in our laboratory courses.

Two years ago a team of chemical engineering seniors designed the new experiment along with help from Casey Hanlon (ChE '08), a sales engineer at Rosemount. The students, all 2009 grads were Anwar Aglan, Colin Crabb, Dan Rosenberg, and Joe Stein.

The experiment features four different flow measuring technologies: a Coriolis Flowmeter, an Integral Orifice Flowmeter, a Vortex Flowmeter, and a Magnetic Flowmeter. Unit Operations Lab students will compare the accuracy of each flow meter over its full range, learn about the technologies and how they are best applied in the chemical process industries.

Because most fluid flow applications also need to be controlled, it was decided to add a control valve characterization feature to the experiment. Working with Dennis Bialecki of Novaspect, and the folks at Fisher Valve, Michigan Tech added two Fisher control valves, complete with digital positioners. The two valves are similarly sized but one has what is called a linear trim while the other has an equal percent trim. Students will explore what is known as the installed characteristic response of two similarly sized valves with different internal valve trim configuration.

The experiment was fabricated on site by research associate Tim Gasperich and master machinist Jerry Norkol of the chemical engineering department. Additional assistance for this project also came from Terry Worm of Rosemount Inc.

The new Flow Measurement and Control Experiment was commissioned on October 4, 2011. L to R: Jerry Norkol, Dave Caspary, Dr. Tony Rogers, Casey Hanlon, Terry Worm and Dennis Bialecki.

Sustainable Futures Institute Wins NSF Grant

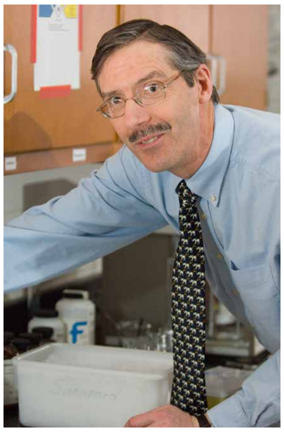
The SFI mission: to enhance knowledge, develop technologies, and expand capabilities in working towards a sustainable future.

THE SUSTAINABLE FUTURES Institute (SFI) will receive $749,996 from the National Science Foundation (NSF) to develop a research road map on biofuels and bioenergy sustainability in the Pan-American region, as well as a graduate course in biofuels/bioenergy sustainability, to be offered over the Internet to US and international partner universities.

The three-year grant is one of 11 nationwide totaling $8 million. It is part of NSF's Science, Engineering and Education for Sustainability (SEES) efforts in its Research Coordination Networks (RCN) program.

"This award continues the long record of sustainability research and education at Michigan Tech and significantly increases the visibility of the University and the Sustainable Futures Institute in international sustainability discussions," said David Shonnard, Robbins Chair Professor in Chemical Engineering and SFI director.

SFI is leading the preparation of a larger NSF proposal addressing the same topic: Pan-American Biofuels/Bioenergy Sustainability.



David R. Shonnard

Carbon Foam Plays Promising New Role in a Sustainable Battery/Capacitor

A LIGHTER, GREENER, CHEAPER, longer-lasting battery. Who wouldn't want that?

Tech researchers are working on it. Actually, their design is a twist on what's called an asymmetric capacitor, a new type of electrical storage device that's half capacitor, half battery. It may be a marriage made in heaven.

Capacitors store an electrical charge physically and have important advantages: they are lightweight and can be recharged (and discharged) rapidly and almost indefinitely. Plus, they generate very little heat, an important issue for electronic devices. However, they can only make use of about half of their stored charge.

Batteries, on the other hand, store electrical energy chemically and can release it over longer periods at a steady voltage. And they can usually store more energy than a capacitor. But batteries are heavy and take time to charge, and even the best can't be recharged forever.

Enter asymmetric capacitors, which bring together the best of both worlds. On the capacitor side, energy is stored by electrolyte ions that are physically attracted to the charged surface of a carbon anode. Combined with a battery-style cathode, this design delivers nearly double the energy of a standard capacitor.

Now, Tech researchers have incorporated a novel material on the battery side to make an even better asymmetric capacitor.

Their cathode relies on nickel oxyhydroxide, the same material used in rechargeable nickel-cadmium or nickel-metal hydride batteries. "In most batteries that contain nickel oxyhydroxide, metallic nickel serves as a mechanical support and a current collector," said chemistry professor Bahne Cornilsen, who has studied nickel electrodes for a number of years, initially with NASA support. A few years ago, the team had a chance to experiment with something different: Cornilsen suggested replacing the nickel with carbon foam.

Deposited nickel-carbon foam electrode

Carbon foam has advantages over nickel. "It's lighter and cheaper, so we thought maybe we could use it as a scaffold, filling its holes with nickel oxyhydroxide," said Tony Rogers, associate professor of chemical engineering.

Carbon foam has a lot of holes to fill. "The carbon foam we are using has 72 percent porosity," Rogers said. "That means 72 percent of its volume is empty space, so there's plenty of room for the nickel oxyhydroxide. The carbon foam could also be made of renewable biomass, and that's attractive."

But how many times can you recharge their novel asymmetric capacitor? Nobody knows; so far, they haven't been able to wear it out. "We've achieved over 127,000 cycles," Rogers said.

Other asymmetric capacitors have similar numbers, but none have the carbon-foam edge that could make them even more desirable to consumers.

"Being lighter would give it a real advantage in handheld power tools and consumer electronics," said Rogers. Hybrid electric vehicles are another potential market, since an asymmetric capacitor can charge and discharge more rapidly than a normal battery, making it useful for regenerative braking.

The group has applied for a patent on its new technology. Chemical engineering professor Michael Mullins is also a member of the research team. Graduate students contributing to the project are PhD graduate Matthew Chye and PhD student Wen Nee Yeo of the chemical engineering department and MS student Padmanaban Sasthan Kuttipillai and PhD student Jinjin Wang of the chemistry department.

The research is funded by the US Department of Energy, the Michigan Universities Commercialization Initiative, the Michigan Tech Research Excellence Fund and the Michigan Space Grant Consortium.

New Solar Research Center at Michigan Tech

MICHIGAN TECH'S NEW Solar Photovoltaic Research Facility features a complete AC module system—including solar panels, microinverters and monitoring system—and represents a new way to harvest solar energy that is making solar more affordable, productive and reliable.

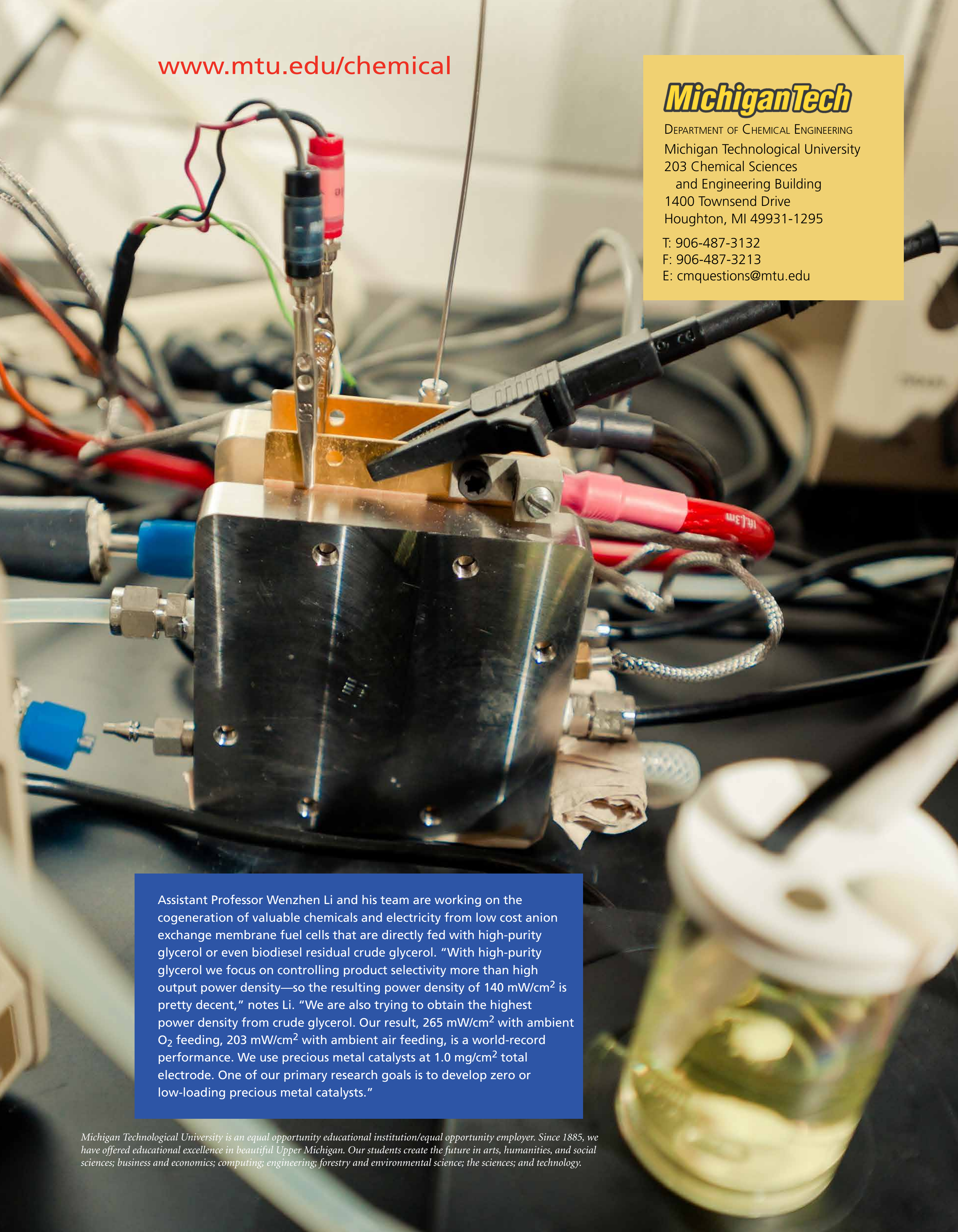
The two-kilowatt facility is located at the Keweenaw Research Center (KRC) near the Houghton County Memorial Airport. It will be used primarily to advance solar-energy research and education.

L to R: Solar panel donors include mechanical engineering alum Steve Trombley '89, Hemlock Semiconductor; chemical engineering alums Bill Huss '83 and Mary Fogelsinger Huss '83, Dow Corning; and Dave Kraycsir '86, Hemlock Semiconductor.

SolarBridge Technologies, of Austin, Texas, provided 10 state-of-the-art microinverters, as well as equipment and software for managing and monitoring the system. Dow Corning and Hemlock Semiconductor donated the facility's solar panels, which were made by a number of manufacturers. Dow Corning produces the silicones used in making the panels. Hemlock Semiconductor manufactures polycrystalline silicon, the black, glass-like material on the panels' surface that absorbs sunlight.

"We're proud and happy this has worked out so well," said Bill Huss, global productivity manager for Dow Corning and a 1983 chemical engineering graduate.

Undergraduates in Michigan Tech's Alternative Fuels Group Enterprise, advised by Chemical Engineering Assistant Professor Wenzhen Li, will be among the first to get involved in the new research facility. KRC has a small weather station at the site, and the students will correlate the solar cells' output with the local weather, monitoring how they behave under varying conditions.



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Assistant Professor Wenzhen Li and his team are working on the cogeneration of valuable chemicals and electricity from low cost anion exchange membrane fuel cells that are directly fed with high-purity glycerol or even biodiesel residual crude glycerol. "With high-purity glycerol we focus on controlling product selectivity more than high output power density—so the resulting power density of 140 mW/cm^2 is pretty decent," notes Li. "We are also trying to obtain the highest power density from crude glycerol. Our result, 265 mW/cm^2 with ambient O_2 feeding, 203 mW/cm^2 with ambient air feeding, is a world-record performance. We use precious metal catalysts at 1.0 mg/cm^2 total electrode. One of our primary research goals is to develop zero or low-loading precious metal catalysts."