2014

2013-2014 ChE Newsletter

Department of Chemical Engineering, Michigan Technological University

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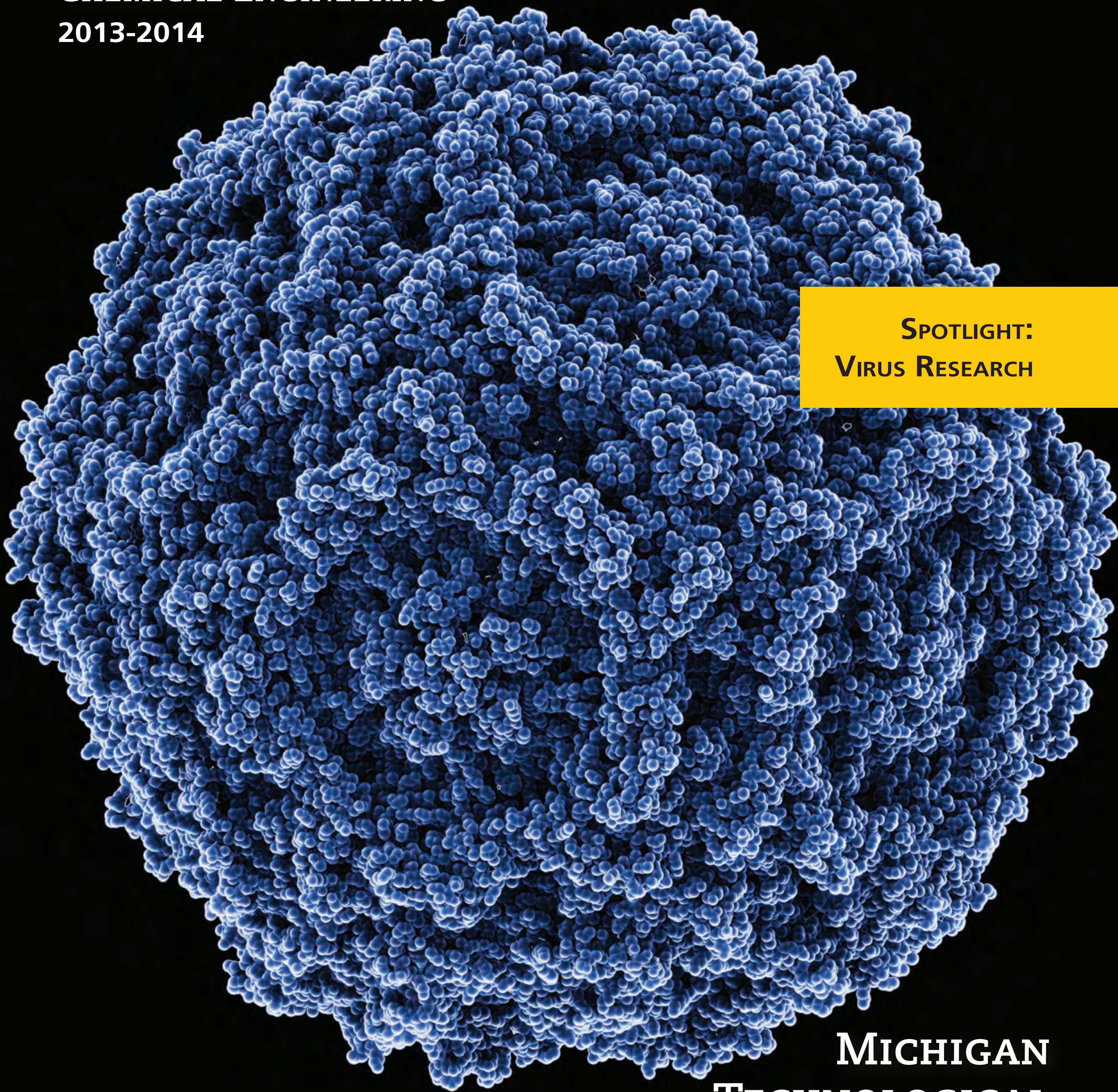

Spotlight: Virus Research

Michigan Technological University

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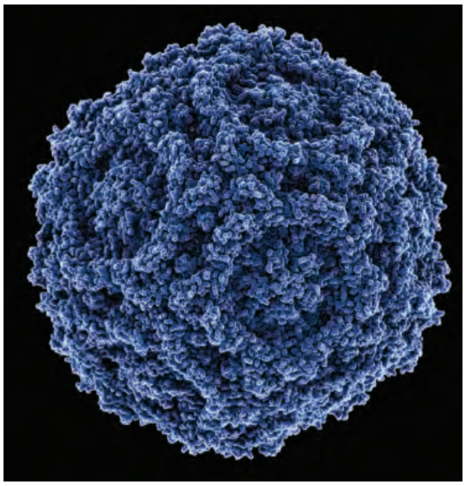
Giving Opportunities

We are grateful to the many corporations, alumni, and friends who have generously donated to our Unit Operations Endowment Fund. We use funds from this account to make sure that we have best Unit Operations Laboratory in the nation.

The department has several other endowment funds, and all of them are very important for our growth. The Chemical Engineering Outreach fund supports undergraduate students wherever the needs are greatest, including helping our students travel to national meetings and conferences. Similarly we have a Mineral Processing Outreach Fund. We have used funds from this account to maintain our undergraduate laboratories.

We have started a new fund, the Junior Professorship Endowment. This fund will be used to chair a young professor in chemical engineering. This fund will help a young faculty person to develop a strong teaching and a research program.

If you have any questions with any of our funds, please do not hesitate to contact Professor and Chair **S. Komar Kawatra** at **skkawatr@mtu.edu**



On the cover: Binding Peptides to Pathogens for Detection and Removal. See page 8.

Dear Friends,

This is an exciting time to study chemical engineering, and to be a chemical engineer. New challenges and opportunities continue to present themselves in industry and research, requiring the specific skills that a chemical engineer can provide.

Here at Michigan Tech, chemical engineering undergraduate and graduate programs supply the skills and know-how that industry and academia seek.

Our undergraduate program boasts one of the largest senior unit operations laboratories in the nation. The lab hosts three stories of applicable and practical experiments. This enables our students to hit the ground running when entering the workplace both during co-ops and internships and as graduates in full-time roles.

We also offer our undergraduate students four chemical engineering-specific minors: Minerals processing engineering, polymer science and engineering, bioprocess engineering, and alternative energy. Each of these minors incorporates specialized courses to enhance the knowledge base of each student. Courses are taught by professors who specialize in each respective concentration, with additional input from industry to ensure that each program is as applicable as possible to challenges encountered in the workplace.

Our graduate program is also on the rise. An advanced degree in chemical engineering can expand and refine problem solving skills and thought processes to tackle continuously changing problems in industrial processes and novel research. Research areas in our department include sustainable chemical processing, optimization of metal manufacturing, medical and bioprocessing, alternative energy, and chemical process design. These areas receive funding from numerous sources. National Science Foundation, National Institutes of Health, Department of Energy, Department of Education, Newmont Gold, and Cliffs Natural Resources are all major contributors.

Our areas of inquiry seek to answer questions driven by industrial needs as well as investigating the use of new technologies: How can the chemical industry operate more sustainably? Processes may be able to utilize alternative materials or reagents that are more environmentally benign and achieve the same if not better end results. What must be done to produce iron, steel and other metals more efficiently? Processes or concepts from other industries may be used to increase material production. What advancements do nanomaterials afford to the treatment of cancer, or the construction of fuel cells and alternative energy sources?

We are building all of our programs with the help of our alumni and friends. Your feedback is important to us. Please feel free to contact me directly anytime, at skkawatr@mtu.edu.

S. Komar Kawatra
Professor and Chair

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 December 2013, we have eighteen faculty, seven staff, 427 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

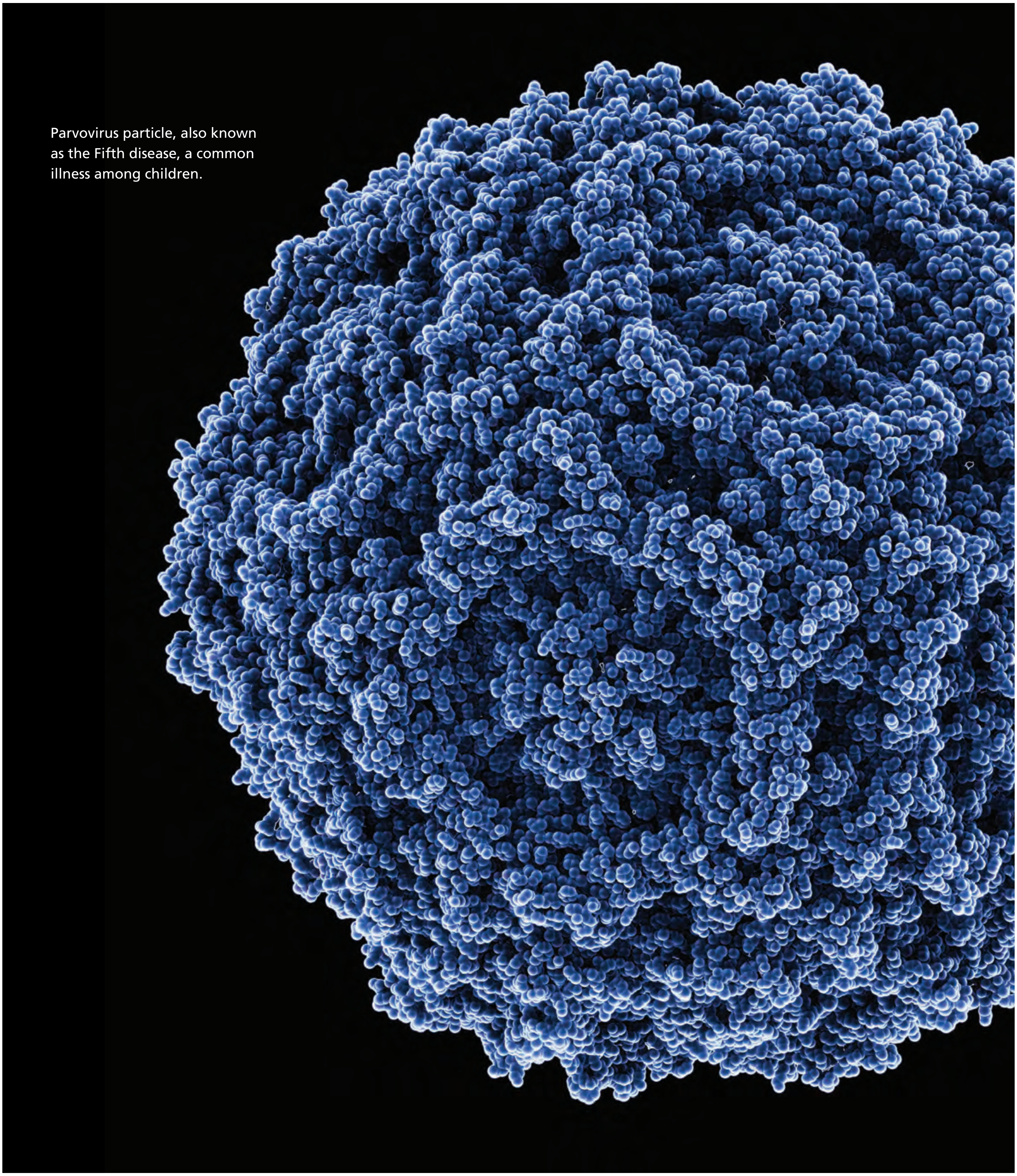
David R. Shonnard, PhD
Richard and Bonnie Robbins Chair
in Sustainable Materials
University of California, Davis
Biological engineering, alternative energy, sustainability

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

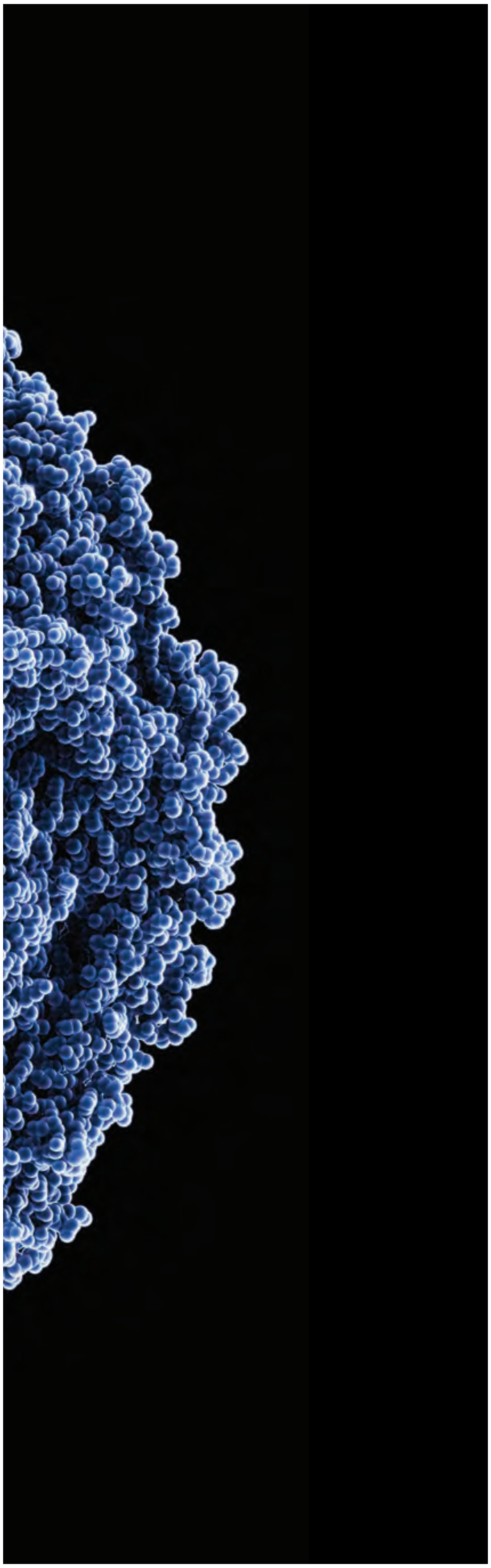
Post Doctoral Fellows

Jiqing Fan, PhD
Michigan Technological University
Use of a carbon budget model to calculate land use change greenhouse gas emissions associated with forest-based biofuels and bioenergy production in Michigan

Kaela Leonard, PhD
Michigan Technological University
Characterization of ABO blood type erythrocytes in an AC dielectrophoretic device



Parvovirus particle, also known as the Fifth disease, a common illness among children.



Infectious Diseases

Binding Peptides to Pathogens for Detection and Removal

MILLIONS OF PEOPLE DIE EVERY YEAR from infectious diseases. Illness such as AIDS or West Nile are caused by viruses. Bacteria, such as cholera or salmonella, can also be deadly. The incident of disease transmission, be it through contaminated water or food, touching a contaminated surface, or through a blood transfusion, could be reduced by the creation of specific and custom-tailored removal and detection devices.

Caryn Heldt is examining methods to bind peptides to pathogens. Her goal: To discover a better sensory element— an alternative to antibodies—that can be applied in a more economical device.

"Peptides are small pieces of proteins, like antibodies, but due to their small size, are more stable," she explains. The peptides under investigation are composed of the same twenty different naturally occurring amino acids as antibodies, giving them a similar diversity as antibodies to bind using multiple functional groups. Heldt and her team are not only interested in discovering new sensor peptide elements, but also hope to use these sensory elements in unique devices to remove and detect pathogens in a manner that is economical and environmentally sustainable.

"Many such devices today are based on specific antibodies that bind to pathogens for detection or removal," she notes. Pitfalls for such devices include a short shelf life, required refrigeration, and/or specialized laboratory equipment to analyze results.

Heldt is currently using porcine parvovirus as a model virus to test the removal and detection ability of different devices. Small peptides are being added to

Caryn L. Heldt

different membrane surfaces to create a virus filter that could purify water without the need for high pressure pumping—something that could potentially reduce the cost of producing clean water for personal use or for larger populations.

The team is also investigating the use of peptides as a specific sensor surface to create a low power device that can detect a virus in minutes instead of hours or days, reducing clinical delays. Other virus removal techniques are being pursued for more specialized applications, as well, such as the removal of viruses from biotherapeutics, including virus precipitation and extraction.

"All of these methods rely on the specific binding of small peptides to detect or remove viruses," adds Heldt. "These sensory elements could also be discovered for different pathogens and used to remove pathogens from the environment. We hope to reduce the number of deaths that are caused every year by infectious diseases."

Iron Ore—and More

Seeking Sustainability in Mineral Processing

Howard Haselhuhn

THE ASISC RESEARCH CENTER at Michigan Tech is a partnership of academic institutions and industry with interests in mineral processing. Members pool resources to address a diverse spectrum of interdisciplinary research questions. Their primary goal: to develop a new generation of sustainable, economical mineral processing technologies.

PhD student Howard Haselhuhn is an ASISC researcher focused on water chemistry. At an iron-processing facility, he recently studied the technology used to remove impurities from iron ore.

Depending on the time of year, almost all of the water used in an iron concentration plant is recycled. “This is not just important from an environmental standpoint; it is cost effective to conserve the thermal energy in the process water as well as the water quality within the plant,” explains Haselhuhn. “Iron ore concentration facilities depend on surface chemical interactions for many concentration operations; therefore, strict control of water chemistry is necessary. Most tap water is of insufficient quality for direct use within iron ore concentration plants,” he notes.

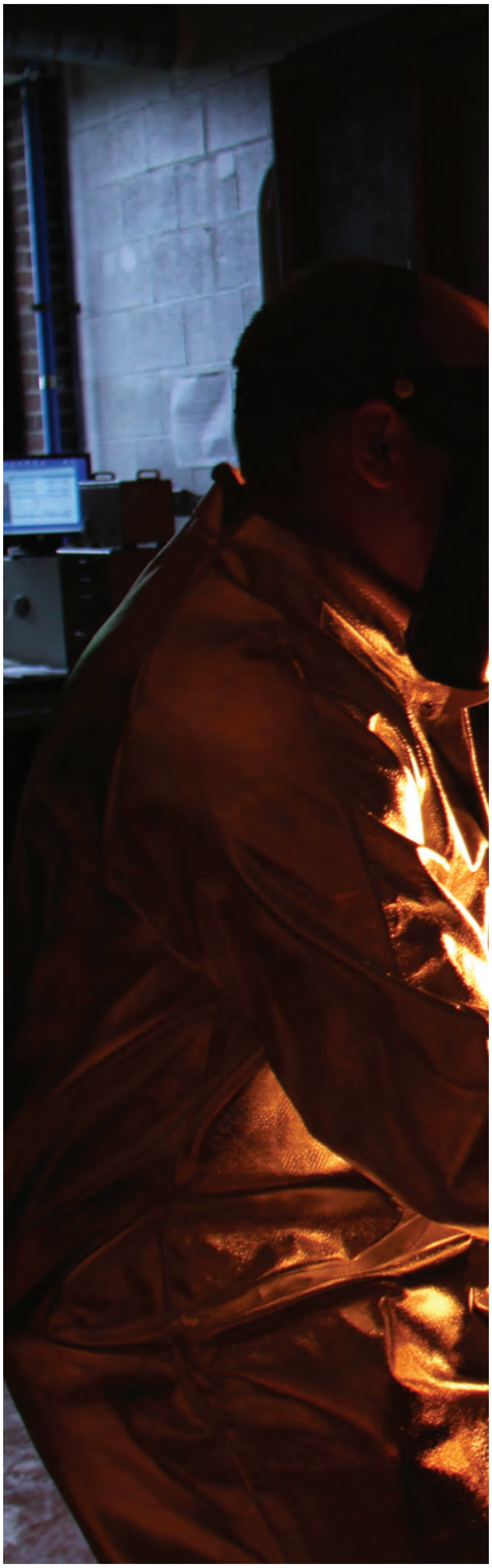
Iron ore is ground down into very small particles, which are mixed in water. Reagents are added to the mixture to flocculate iron oxide particles. These flocs, which contain more iron, settle quickly, leaving unflocculated particles, containing primarily silica, to remain suspended. However, Haselhuhn discovered, sometimes the raw ore and recycled water contain high levels of magnesium. In turn, that causes silica particles to cluster and settle out with the iron, rendering the separation process ineffective.

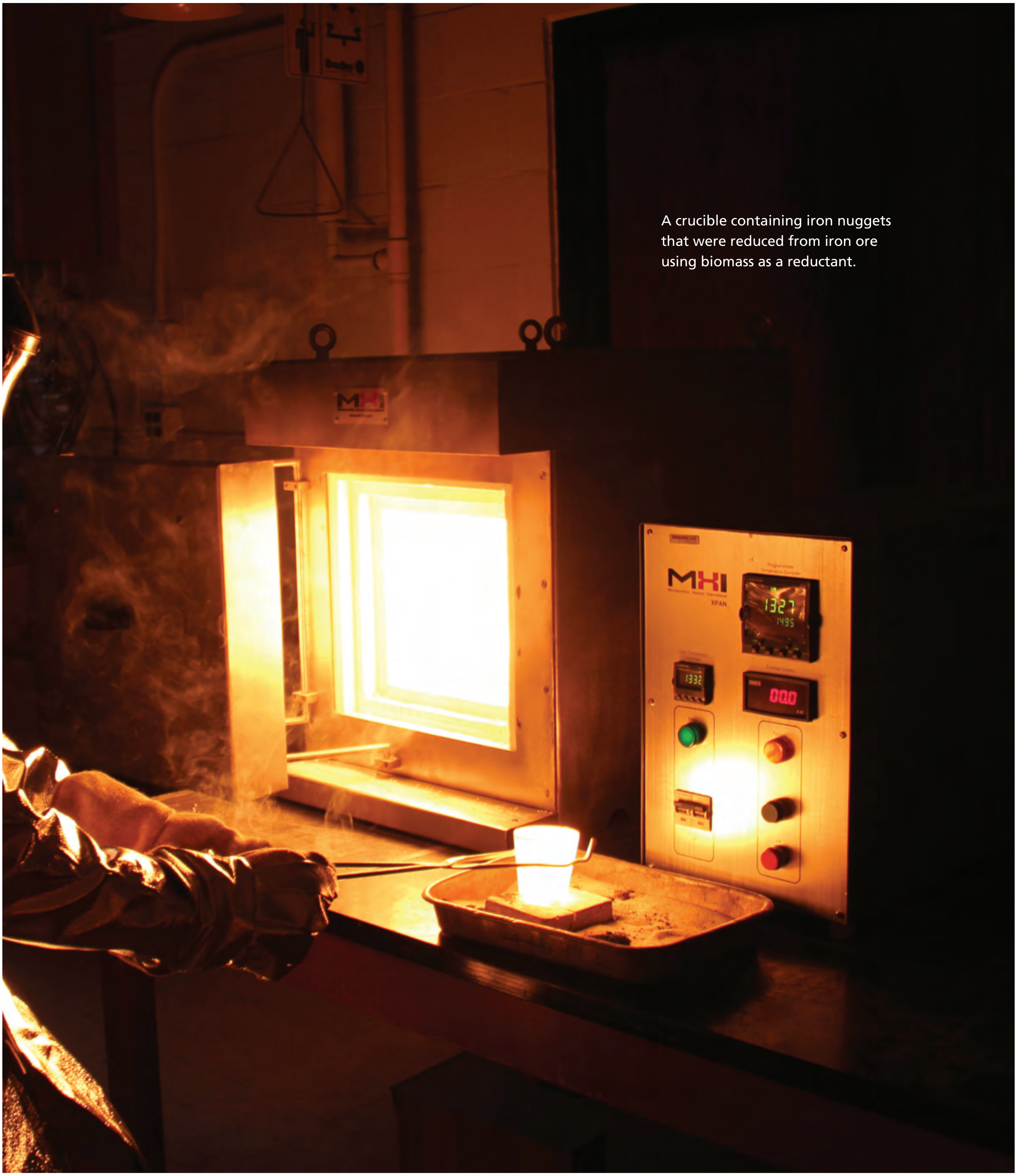
“By compensating for the excess magnesium, companies could reduce the loss of iron in their concentration process, something that could provide millions of dollars in potential savings,” he says. “We are fortunate enough to have an abundance of fresh water in the Great Lakes area, which makes iron processing easier. In many other parts of the world, the process water must at least partially come from the ocean, which is very high in magnesium. They can still process; just with different, more expensive methods.”

Once the ore is concentrated, it is in the form of an iron oxide. “Obviously, the oxygen must be removed before it becomes iron,” he adds. “This is typically accomplished by reacting it with a carbon source, typically coal. One direction ASISC has been exploring is replacing coal with a biomass-derived reductant. This decreases dependency upon non-sustainable natural resources.”

The mineral processing industry makes continuous improvements in technology, explains Haselhuhn. “Many of these improvements have been small and locale-specific, but once in a while there is a giant step forward that can bring about a new era in the industry. These dramatic improvements will be necessary to remain a sustainable industry. Unlike many industries, the feedstock (iron ore) is constantly degrading in quality. Eventually, it will not be feasible to process unless new methods are developed.”

“Repurposing waste will be key to reclamation of mining sites once the ore is gone,” he adds. “ASISC is committed to finding ‘zero-waste’ solutions to mineral processing.”





A crucible containing iron nuggets that were reduced from iron ore using biomass as a reductant.

Beyond Nanotubes

Synthesizing a Breakthrough Material

A UNIQUE FORM OF CARBON, graphene is the basic structural element of graphite. Essentially a single atom-thick honeycomb lattice of carbon atoms, a sheet of graphene can be rolled into 1D nanotubes or stacked into 3D graphite.

In 2004, physicists from the University of Manchester and the Institute for Microelectronics Technology in Russia isolated individual graphene planes by using Scotch tape on graphite crystals. In 2005 the same Manchester group, along with a research group from Columbia University, demonstrated that graphene electrons are massless Dirac fermions—giving graphene unique electronic and optical properties. These recent discoveries have led to an explosion of interest in graphene.

One major challenge: Graphene has previously only been produced in very small quantities, limiting how well it can be measured, understood and developed.

Michael Mullins is working to synthesize single graphene sheets in the lab. "Our goal is to make large enough quantities of graphene so that it can be shared with other researchers around the world who are studying it for future applications," he says.

Less than one nanometer thick, a graphene sheet is transparent. "Even several layers are still transparent," notes Mullins.

Graphene displays bipolar transistor effect, ballistic transport of charges, and large quantum oscillations. It can also transport electrons more quickly than other semiconductors, a quality called electron mobility.

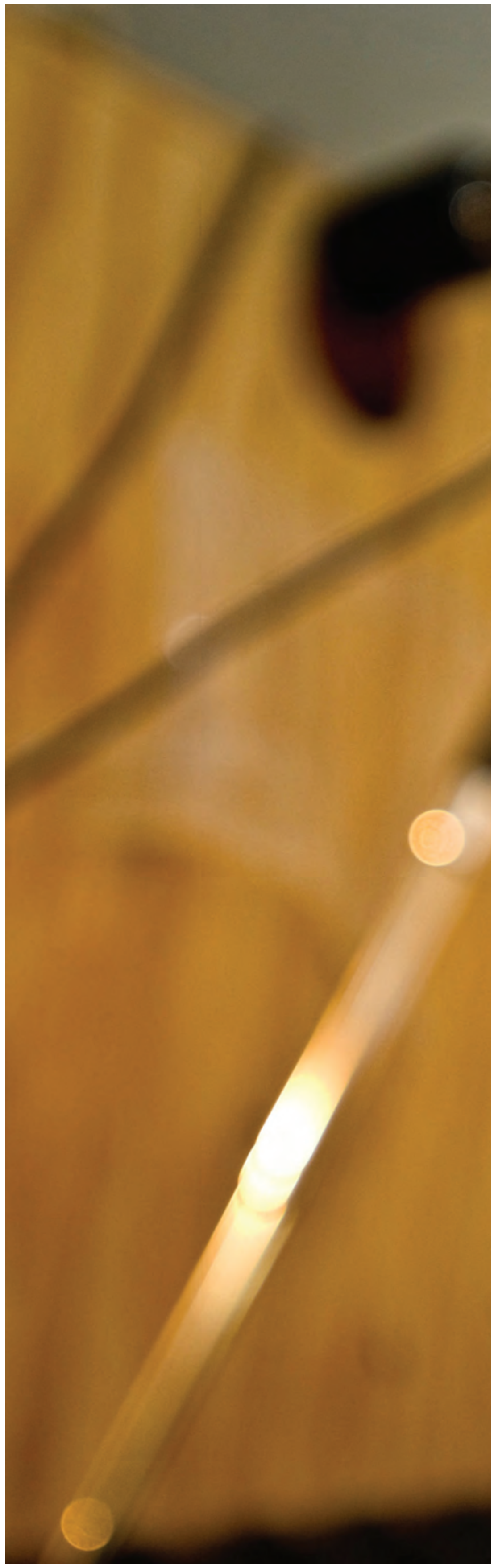
"It's clearly a breakthrough material," says Mullins. "Graphene possesses the highest strength of any material. It has among the highest heat and electrical conductivity of any material. It can be incorporated into a great number of applications. Graphene can be added to polymers for fuel cell dividers. It can be used in battery electrodes. It is an excellent conductor with a high surface area that can exceed, 2000 m2 per gram. A graphene sheet is the basic building block for many forms of carbon, including the nanotube. In fact, graphene is a next-generation material beyond the nanotube. But we need to make enough of the material to make it useful."

Michael Mullins

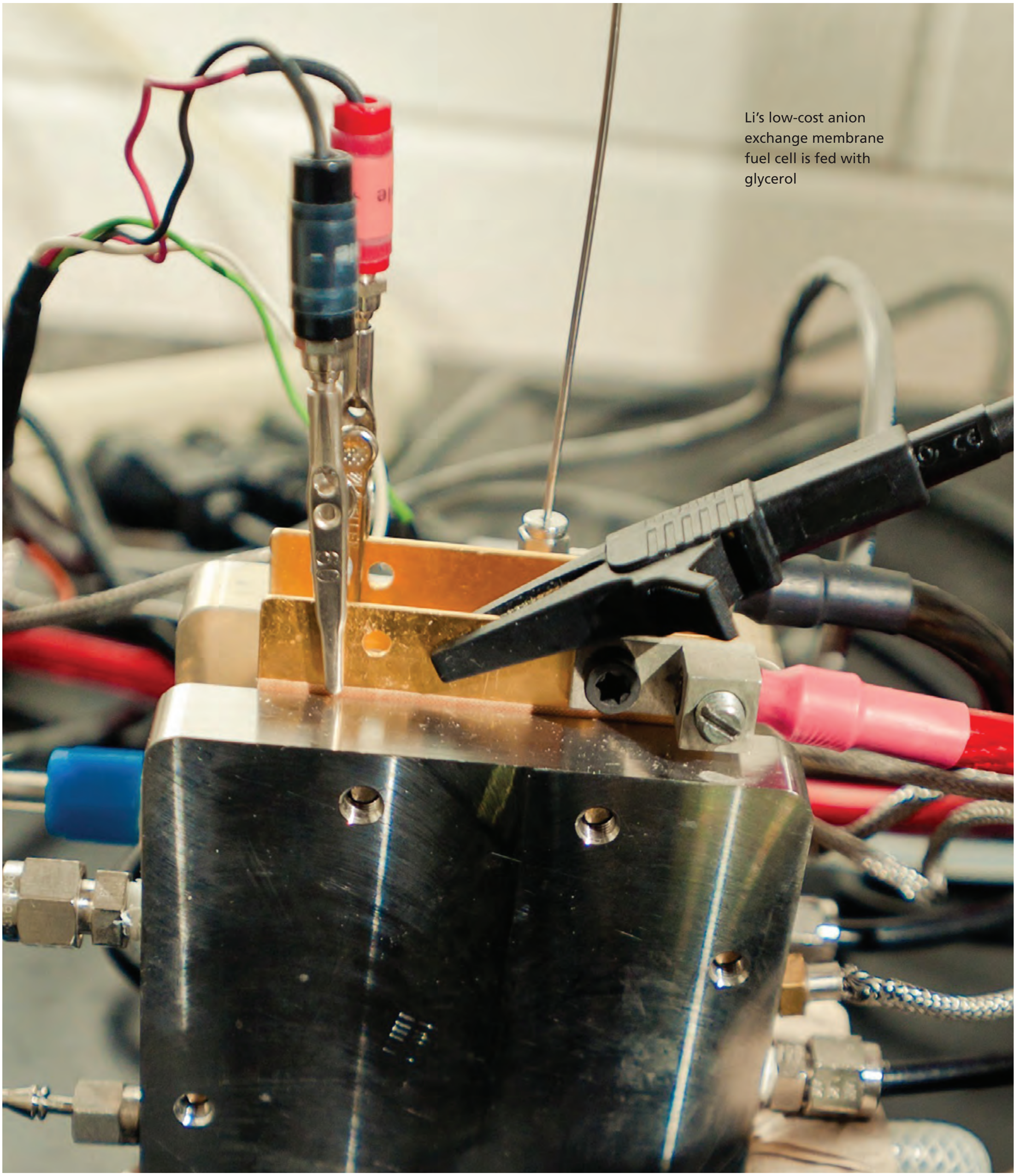
"Attempting to split bulk graphite into single sheets of graphene is not a very easy process. It can require extreme conditions," Mullins admits. His team is currently exploring two techniques. The first uses very strong acids followed by rinsing with an organic solvent. They run the mixture through an extremely fine filter to collect the sheets. The second uses supercritical carbon dioxide, which adsorbs between the graphite planes, expanding the sheets. This is followed by an injection of a surfactant material to hold the sheets apart so that they can be more easily separated in solution.

As the director of the Center for Fundamental and Applied Research in Nanostructured and Lightweight Materials (CNLM), Mullins has assembled the talents of several researchers working on a wide variety of projects—from heat-tolerant materials to replace the polymer electrolyte membrane in fuel cells to a nickel hydroxide battery electrode that can deliver more power than the batteries now in use at half the weight. Other projects include nanoencapsulation of pharmaceuticals, and nanofibers that are used as a lattice to regenerate nerve fibers.

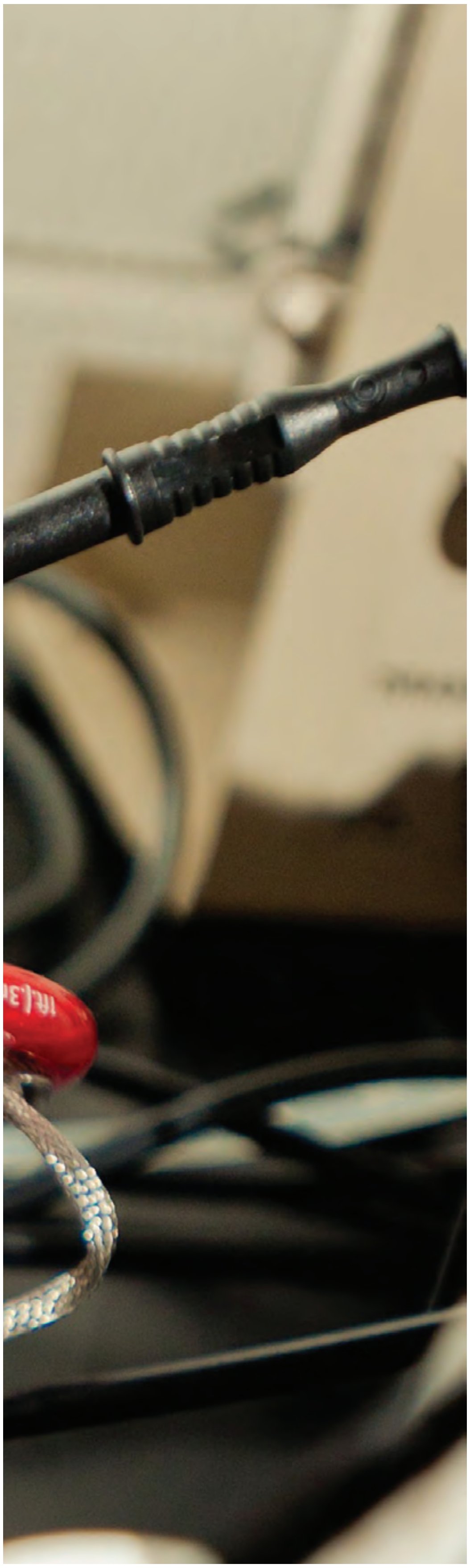
"The thing that ties all our research together is the engineering of hybrid materials at the nanoscale—polymers, ceramics and carbon."



A strong acid splits bulk graphite into single sheets of graphene



Li's low-cost anion exchange membrane fuel cell is fed with glycerol



It’s All About Catalysis

Cogenerating Electricity and Value-Added Chemicals from Biomass

BIOFUELS FROM LIGNOCELLULOSIC biomass can significantly reduce our dependence on fossil fuels and alleviate greenhouse gas emission. They are expected to be significant players in the future energy supply landscape. Biomass-derived compounds, i.e. polyols, sugars, and sugar-alcohols, will be mass-produced in biofuel productions and refineries. They also produce higher-valued chemical intermediates for polymers, foods, cosmetics, detergents and pharmaceuticals.

Catalysis is a major science behind the sustainable conversion of biomass feedstocks to biofuels and valuable chemicals. Catalysts can significantly influence the adsorption, desorption and activation energies—accelerating reaction rate (reactivity) and regulating reaction pathways (selectivity). However, at present it is still challenging for heterogeneous catalysts to selectively produce desired products, especially at the high reactant conversion rates needed for biofuel refineries.

Wenzhen Li and his research team are developing a novel anion exchange membrane fuel cell platform for electrocatalytic processing of biorenewable compounds. Their goal is to efficiently generate electricity and selectively produce value-added chemicals—not CO_2. This transformative research is expected to open up new avenues to maximize the utilization of biomass feedstocks. This knowledge can be widely used for catalysis, fuel cells, biofuels, biorefinery, electrolysis, chemical sensing and green chemical techniques.

“In a high pH anion exchange membrane fuel cell (AEMFC), the reaction kinetics and catalyst lifetime can be significantly enhanced,” Li explains. “Non-platinum group metals (PGM) such as Ag and Fe-N-C have shown competitive electrocatalytic activity and durability.” Li and his team have demonstrated that an AEMFC (Pt anode and Fe-N-C cathode) can generate eye-popping, high power density—over 140 mW/cm2—with glycerol fuel, and simultaneously produce value-added chemicals, such as glyceric acid, tartronic acid, and glycolic acid. “This power density is two to three orders of magnitude higher than the state-of-the-art enzymatic fuel cells, and could serve as power source for portable electronics or for self-sustainable chemical production,” notes Li.

Wenzhen Li

Li’s team is working to better understand relationships between potential catalyst structure and catalytic functions. They also hope to develop PGM nanocatalysts such as nanowires, nanoleaves, and core-shell structures, as well as non-PGM catalysts such as nickel and silver to efficiently generate both electricity and value-added chemicals from biomass feedstocks.

Boosting Conductivity

Discovering Synergistic Effects in Composites

THE PROTON EXCHANGE membrane fuel cell is one of the most promising alternative fuel technologies to power cars and buses. Bipolar plate technology plays a key role in fuel cell technology. The bipolar plate separates one cell from the next, carrying hydrogen gas on one side, and air (oxygen) on the other.

Julie King develops and models new thermoplastic-based materials containing several different carbon fillers to meet all the properties required for bipolar plates.

"Most polymer resins are thermally and electrically insulating," notes King. Using combinations of different carbon fillers, King has discovered new synergistic effects that greatly increase a composite's electrical conductivity and shielding effectiveness. Combinations of different fillers have a positive synergistic effect. King uses a combination of carbon fibers, carbon black, carbon nanotubes, and synthetic graphite particles, mixed with polymers including polycarbonate, nylon, polypropylene, and a liquid crystal polymer. By varying the combination of fillers and polymers King has been able to increase the thermal conductivity by a factor of 100, and decrease electrical resistivity by an astounding factor of 1018.

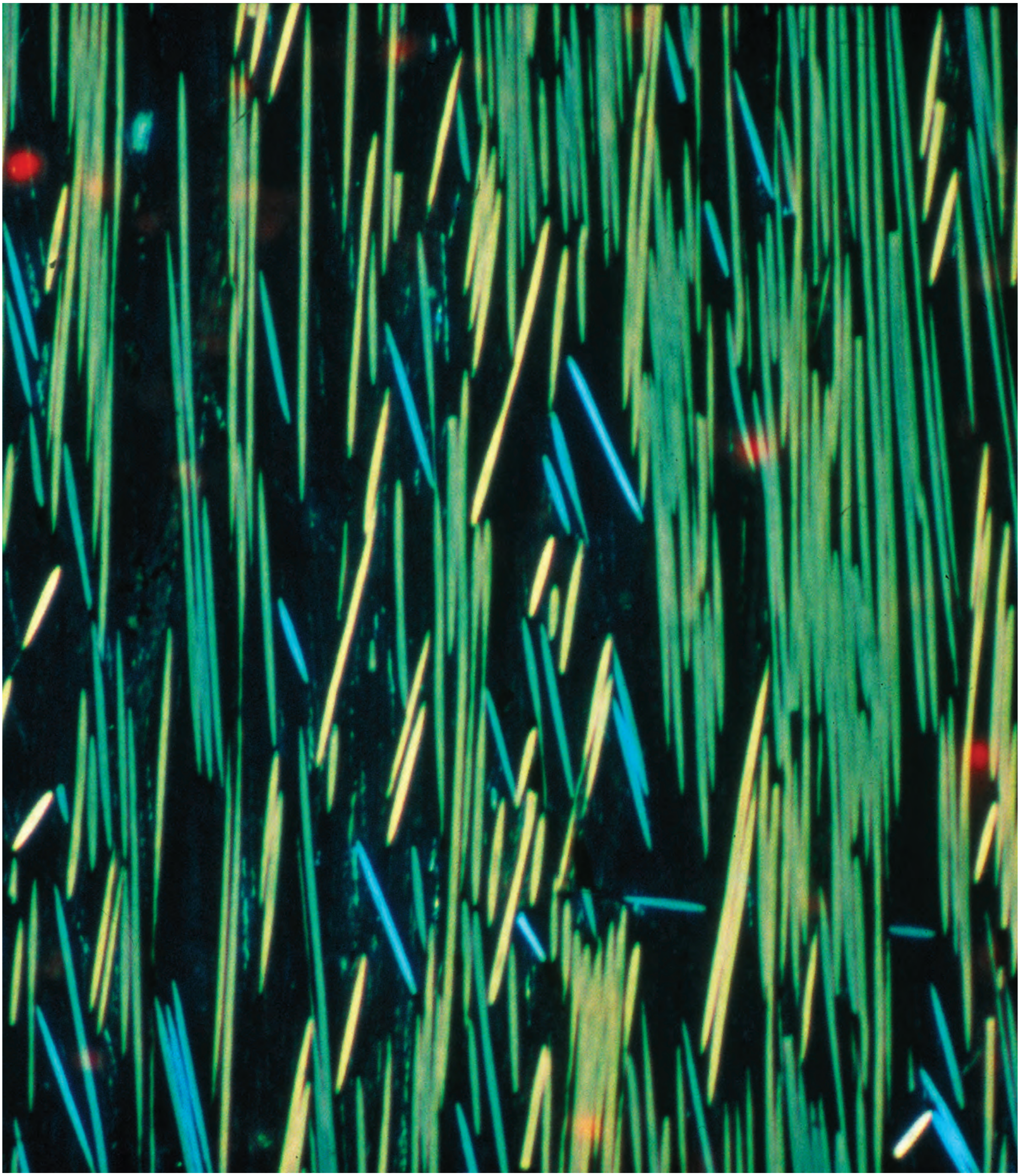
"It's possible that additional pathways form between the highly-branched, high-surface area carbon black, the thermocarbon particles, and carbon fiber—resulting in greatly enhanced electrical conductivity," King explains.

The voltage generated from one single cell is typically 0.7 volts. Since commercial electric motors often operate at 300 volts, the fuel cells are stacked in series. Often 430 bipolar plates are needed for a 300 V fuel cell assembly. "Thermoplastics can be formed into thinner bipolar plates," she adds. "Ideally bipolar plates should be as thin as possible to minimize electrical resistance and make fuel cells stack small."

Julie King

With many new technologies, cost can be a significant challenge. At present, a bipolar plate can run about $8, but the US Department of Energy has set a target of $2 per plate ($10 per KW) to facilitate affordable integration of fuel cell technology into public transportation. King's thermoplastic-based resins can be recycled, so used plates and any scrap generated in the manufacturing process can be remelted and used to produced new bipolar plates, bringing costs down further.

Micrograph of carbon fiber in a polymer matrix.



James Mack is Keynote Speaker at 2013 Convocation

THE CHEMICAL ENGINEERING Convocation was held in the Michigan Tech Rozsa Center on April 11, 2013. James Mack was the keynote speaker.

Over the years, James and Lorna Mack have been tireless supporters of Michigan Tech. Within the Department of Chemical Engineering, they have endowed the James and Lorna Mack Chair in Bioengineering to promote biotechnology research and education, currently held by Dr. Ching-An Peng.

James Mack has provided outstanding service to Michigan Tech since graduating with honors with a BS in Chemical Engineering in 1959. While a student, he was active with Tau Beta Pi, Sigma Rho fraternity, student government and Air Force ROTC. He also received an MBA from Western New England College and did graduate work in Chemical Engineering at the University of Toledo. He served 10 years as a trustee of the Michigan Tech Fund and as a member of the President's International Advisory Board. He received the Board of Control Silver Medal in 1999 and delivered the midyear Commencement address in 2000, when he also received an honorary Doctor of Engineering degree.

He recently retired as chairman, president and chief executive of Cambrex Corporation. The company has repositioned itself recently as a life sciences organization, manufacturing active pharmaceutical ingredients for over-the-counter and prescription drugs. He was selected as Entrepreneur of the Year in 2002 and 2003. Mack remains on the Board of Research Corp. Technologies, a venture gap firm.

Before joining Cambrex in 1990, he was a vice president of Olin Corp., president of Oakite Products and president/general manager of the Sherwin Williams chemicals division. Mack started his career as a Project Engineer with Monsanto.

Mack has been inducted into Michigan Tech's distinguished alumni academy in chemical engineering and is a life trustee of the Michigan Tech Fund. In 2004, he received the Distinguished Alumni Award.

James and Lorna have five children and six grandchildren and live in Westport, Connecticut. With retirement they are now able to enjoy more time with golf, fishing, sporting clays and raising thoroughbred horses.

L to R: President Glen Mroz, Distinguished Keynote Speaker James Mack, and Department Chair S. Komar Kawatra

"The Awards Convocation provides us an opportunity to thank faculty, staff and students for their hard work and dedication."
—S. Komar Kawatra, department chair

Dr. Tim Eisele won the Teacher of the Year Award, presented by AIChE President Elizabeth Skultety

Tim Rosetto (l) won the Kimberly Clark Professional Ethics Award, presented by M. Sean Clancey (center).

Dr. Caryn Heldt won the Research Mentor of the Year Award

Wil Brewer won the Outstanding TA of the Year Award

Chemical Engineering Class of 2013

William Paddock, Daniel Spencer, Amanda Taylor, and Edward Duda won the Dow Chemical Marriott W. Bredekamp Award

Robert Parker won the Kimberly-Clark Communication Award

Scott Kempainen, Kevin Osentoski, and Hans Sandholm won the UOP Davis W. Hubbard Plant Design Team Award

SUPPORT FROM MRS. KAREN HUBBARD, KIMBERLY-CLARK, DOW CHEMICAL, DOW CORNING, AND UOP MADE THIS YEAR'S CONVOCATION POSSIBLE.

Aquaponics Takes 3rd Place in Clean Energy Challenge

A TEAM FROM THE DEPARTMENT of Chemical Engineering, Aquaponics, has won Third Place and $10,000 in the Michigan Clean Energy Venture Challenge. Twenty-seven teams competed from across the state. Through the challenge, teams learned skills needed to start a successful company, through classroom and hands-on learning. The teams also met regularly with their on-campus mentors and venture capitalists to move their business forward.

Aquaponics features indoor farming using water instead of soil, with a fish tank providing nutrients to plants. Team members included Robert Handler, post-doctoral environmental engineer in the Sustainable Futures Institute; Josh Krugh, economics undergraduate; and Jacob Bray, chemical engineering undergraduate. "Aquaponics is a combination of aquaculture and hydroponics," Handler explains. During the challenge, the team examined the potential for business expansion in urban communities throughout the state. The six-month challenge was run by the University of Michigan Center for Entrepreneurship.

Read more about Aquaponics at http://goo.gl/cQu5h8.

Michigan Clean Energy Challenge

CPM Enterprise Students Help 3M Build a Better Taillight

MOST OF US TAKE PRIDE in being able to see the fruits of our labor, basking in a job well done. Brett Spigarelli can bask in the red glow of a taillight going into production for the 2013 model year of several cars. A PhD candidate in chemical engineering at Michigan Technological University, he serves as an advisor to the Consumer Product Manufacturing (CPM) Enterprise, and previously, as a student, he worked on a project with 3M to test how one of their new materials handled the process of thermoforming (shaping an object through heat and pressure), leading to the redesigned taillight on several 2013 model-year cars.

CPM and Blue Marble Security Enterprise tested 3M's Uniform Lighting Lens (ULL), investigating the optical properties of the material. Four years later, that material is now on the market and will be debuting on more cars in the near future.

The project was "a good example of getting students involved with problems of interest to industry," Spigarelli said. "It's a lot of what you do when you get out there on the job."

ULL is designed to better disperse the light of LEDs (light emitting diode), increasing effectiveness while still enjoying the same energy savings compared to halogen bulbs. The challenge was in applying ULL, a film, in industrial applications and ensuring it would hold up to the manufacturing process. This was where 3M asked Michigan Tech students to step in early in 2009.

The project ultimately involved more than 25 Tech students. According to Tony Rogers, faculty advisor to CPM, it is just one example of how the Enterprise Program brings industry experience to undergraduates.

"What impresses me most about CPM and the Enterprise experience are the opportunities for students to work directly with engineers and managers in industry," Rogers said.

CPM Takes Second Place at 2013 Undergraduate Expo

TEAM LEADERS: Robert Parker and Elaine Emerick, Chemical Engineering

ADVISORS: Tony Rogers and Sean Clancey, Chemical Engineering

SPONSORS: Kimberly-Clark Corporation, Dow Corning Corporation, nanoMAG LLC, Sustainable Futures Institute, The Pavlis Institute, and Kanwal Rekhi

Michigan Tech Sweeps SME Poster Competition

L to R: Paul Hagadone, Bret Spigarelli, Howard Hasselhuhn, and Katrina Swanson

FOUR MICHIGAN TECH Chemical Engineering students placed in the annual Minerals Processing division undergraduate and graduate poster competition during the Society of Mining, Metallurgy and Exploration (SME) Annual meeting in Denver on February 27, 2013. The annual poster competition showcases research from the top mining and mineral processing programs across the nation and is judged by some of the top engineers and scientists in industry and academia. It involved a five-minute oral presentation in a special session as well as a public poster display at a large SME gathering.

In the graduate student competition, Brett Spigarelli, a chemical engineering PhD candidate, took first place with his poster entitled "Increased Carbon Dioxide Absorption Rates in Alkali Solution by Addition of Surfactant." Howard Haselhuhn, a chemical engineering PhD candidate, took second place with his poster entitled "Dispersant Adsorption and Effectiveness during Iron Ore Beneficiation Operations." Both Spigarelli's and Haselhuhn's work have been locally, nationally and internationally recognized at many conferences over the past three years. Extended abstracts accompanying these two posters will be published in a special issue of Minerals and Metallurgical Processing Journal this spring.

Undergraduate winners included Katrina Swanson in first place, and Paul Hagadone II in second place.

"Congratulations, winners, and a big thank you to everyone who participated—your research is the future of this industry! ~SME

AIChE Student Update

AIChE student members are doing A LOT this year, including...

Industry Speakers

Susan Lewis from Dow, ChemDesign Products, Glenn Lawrence from Merck have been on campus, and AIChE will host more throughout the year including alumni from Bemis, Praxair, Chrysler, and more.

Tutor List

AIChe has created a tutor list to provide students with peer resources to help with classes. Tutoring is flexible—students can pick the times with the tutors or correspond via email.

Socials

In addition to the Department Picnic, AIChE is planning a paintball event, more faculty-student socials, some service events, and some team bonding experiences.

Plant Trips

Planning for many plant trips is currently in the works, including one to ChemDesign Products.

Presentations on Common Industry Concepts

Upcoming presentations include Six Sigma, how to conduct a business meeting, and project management.

ChemE Car Involvement

This is a great way for members to get involved in a lab and use their Chem Eng skills in a competition.

AIChE "Safety Moment" which occurs at the start of every weekly meeting

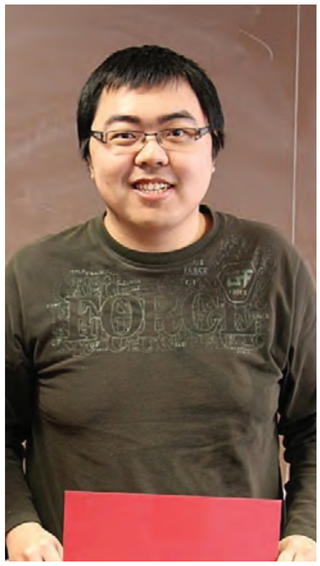
Safety Moments

Each AIChe meeting kicks off with a Safety Moment that explores a safety topic and discusses personal experiences with safety.

Chemical Engineering Graduate Research Forum

Alicia Sawden

Le Xin



Ji Qi

The 2nd Annual Chemical Engineering Research Forum—this time for both graduate and undergraduate students—will be held on Wednesday, January 22, 2014.

THE DEPARTMENT'S 1ST ANNUAL Chemical Engineering Graduate Research Forum was held on January 24, 2013.

Judges included:

- **Richard Donovan**—Senior Research Engineer (Chemical Engineering)
- **Jay Meldrum**—Director (Keweenaw Research Center)
- **Caryn Heldt**—Assistant Professor (Chemical Engineering)
- **Debra Charlesworth**—Assistant to the Dean (Graduate School)

Awards

ORAL PRESENTATIONS

1st Place—$500: **Alicia Sawdon**/*Guanosine Prodrug Incorporated Polymeric Nanocarriers for Suicide Gene Therapy*

2nd Place—$250: **Le Xin**/*Electrocatalytic Processing of Biomass-Derived Compounds: Efficient Production of Electricity, Valuable Chemicals and Hydrocarbon Fuels*

3rd Place—$100: **Ji Qi**/*Surface Dealloyed PtCo Nanoparticles Supported on Carbon Nanotube: Facile Synthesis and Promising Application for High Performance Anion Exchange Membrane Direct Crude Glycerol Fuel Cell*

POSTER PRESENTATIONS

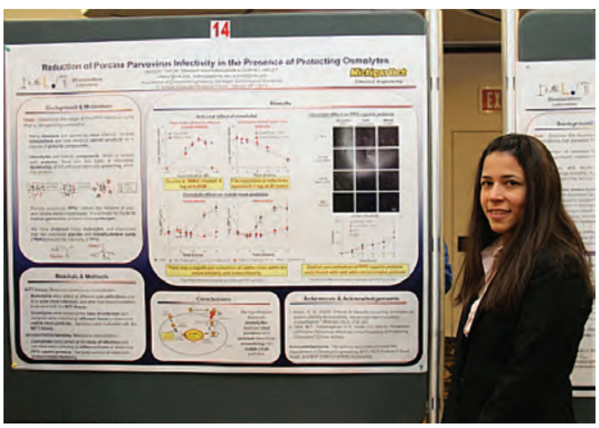
1st Place—$100: **Howard Haselhuhn**/*Water Chemistry Effects on Zeta Potential of Concentrated Hematite Ore*

Maria Tafur is ESC/BRC Student Research Forum Winner

THE ECOSYSTEM SCIENCE CENTER and the Biotechnology Research Center announced award recipients of the Ninth Annual ESC/BRC Student Research Forum, held March 27.

Two Grand Prize Awards and six Merit Awards were presented, selected from among the 59 posters and abstracts submitted by graduate students conducting research related to ecology, the environment and biotechnology at Michigan Tech.

Chemical Engineering PhD student Maria Tafur won a $500 Grand Prize Merit award for her poster, "Reduction of a Porcine Parvovirus Infectivity in the Presence of Protecting Osmolytes."



Maria Tafur

Additional $100 Merit Awards were presented to Tayloria Adams for her poster, "Characterizing the Dielectric Behavior of Human Mesenchymal Stem Cells," and to Ran An for "Micron-scale Ion Concentration Gradients in Nonuniform AC Electric Fields". Both Adams and An were advised by Associate Professor Adrienne Minerick.

Michigan Tech Collaborates on $4 Million Department of Energy Project

MICHIGAN TECHNOLOGICAL University is one of three colleges and universities that will collaborate with the biotech-based alternative fuels and chemical company LanzaTech on a $4 million research project. They will work to find ways to convert waste methane into low carbon fuels and chemicals.

Approximately 0.21 trillion standard cubic feet of natural gas is flared from production sites during crude oil extraction and coal mining in the US—close to 1 percent of the nation's natural gas, a significant amount.

Funding for the 3-year research project comes from the US Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E).

Chemical Engineering Professor David Shonnard will lead the research at Michigan Tech, with Robert Handler providing technical and program management support. Shonnard is director of the University's Sustainable Futures Institute (SFI) and holds the Richard and Bonnie Robbins Chair in Sustainable Materials. Handler is SFI operations manager.

Louisiana State University (LSU) and City College of New York (CUNY) are the other schools collaborating on the research.

LanzaTech's goal is to extend its core fermentation technology and produce fuels and chemicals more efficiently, economically and at a smaller scale. Michigan Tech's role is to work with LanzaTech engineers and scientists to determine the environmental impacts of a novel pathway for producing ethanol from stranded methane emissions.

"The Sustainable Futures Institute at Michigan Tech has worked with LanzaTech and many other innovative alternative-biofuels companies to assist in their research and development efforts, their pilot projects and commercial developments by providing a comprehensive understanding of their product systems from an environmental viewpoint," Shonnard said. "We look forward to this new project as one more in a long line of collaborations with LanzaTech."

LanzaTech will provide expertise in gas fermentation; the CUNY Energy Institute will offer reactor design with experimental reactor design expertise; and LSU will render reactor modeling capabilities.

The new design will enable the technology to be used with other carbon-rich waste resources, including carbon monoxide, carbon dioxide and hydrogen. It should enhance emission reduction capabilities across various industries.

The $4 million grant is part of ARPA-E's $34 million REMOTE (Reducing Emissions using Methanotrophic Organisms for Transportation Energy) program, aimed at upgrading transformational bioconversion technologies to produce transportation fuels cost effectively.

Pyrolysis Pilot Plant Funded by Two Foundations

THE PYROLYSIS PILOT PLANT was relocated from the Chemical Engineering Building to Michigan Tech's Advanced Power Systems Research Center building in mid-September 2013. Professor David Shonnard and his team of faculty and students are planning for a catalytic upgrading unit to attach to the outlet of the pilot plant unit to begin producing true hydrocarbon "drop-in" biofuel replacements for fossil fuels starting with woody biomass such as forest harvest residues, bioenergy crops, and other forms of biomass. This Pyrolysis Pilot Plant will be incorporated into work currently underway in the four-year National Science Foundation Sustainable Energy Pathways grant of $1.8 million awarded to Shonnard in 2012. The Pyrolysis Pilot Plant was also funded by the Rollin M. Gerstacker and Charles J. Strosacker foundations.

L to R: Nicholas Wimmer, Jordan Klinger, Bethany Klemetsrud, and David Shonnard

Banking on Innovation

Bringing Technology to Market with I-Corps

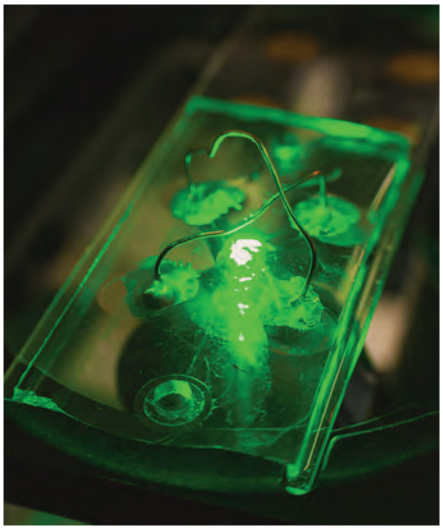
Adrienne Minerick

THE NATIONAL SCIENCE FOUNDATION Innovation Corps (I-Corps) program offers academic researchers and students an opportunity to learn firsthand about technological innovation and entrepreneurship.

Over a period of six months, each I-Corps team, with a principal investigator/entrepreneurial lead and an industry mentor, learns what it will take to achieve an economic impact with their particular innovation, answering questions such as: What are the required resources? What are the competing technologies? What value will this innovation add? Who cares?

> I-Corps taught us how to continuously gauge our market and adapt our business model in real time.

Michigan Tech's 2013 I-Corps team placed first among twenty-one teams in New York after a final presentation of their market analyses for new technologies. Principal investigator Adrienne Minerick led the team with postdoc Kaela Leonard, and Mary Raber served as team mentor. The technology they are looking to develop is a rapid, portable blood-typing device.



Fluorescent illumination of an microfluidic device. Wires serve as electrical contacts to manipulate cells within the microchannels.

"The real powerful aspect of the device is that it can discern different molecules on biological cell surfaces," Minerick explains. "For example, it can recognize blood type without the use of any chemical reagents." Blood banks are most interested in utilizing the device, which is being combined with other technology in the Minerick lab to simultaneously determine hematocrit of the blood.

"In general, lab-on-a-chip technology has the potential to replace costly centralized medical laboratory analysis with point-of-care diagnostic tests that could provide the patient with positive or negative results—along with quantitative information on disease status—in only a few minutes," says Minerick. "This has already been accomplished with blood glucose meters. Imagine having point-of-care technology for common blood chemistry panels, or even for early detection of diseases such as cancer.

I-Corps enabled Minerick's team to interview potential customers and assess their needs. "We talked to numerous hospital personnel, emergency medical technicians, and various medical labs in urban and rural areas before discovering a sector highly interested in our technology. I-Corps taught us how to continuously gauge our market and adapt our business model in real time. We have defined our next steps and are moving forward with commercializing our lab-on-a chip device," she adds. Minerick and Raber started a company called Microdevice Engineering, LLC in collaboration with Superior Innovations, a for-profit company that nurtures Michigan Tech startups.

An I-Corps team led by Ezra Bar-Ziv also placed first among twenty-four teams from across the nation in 2012. Their focus is torrefaction—turning low-rank biomass into high added-value biocoal. Bar-Ziv has put his ideas into practice by establishing an Israeli company, EB Clean Energy, that is now partnering with a northwestern utility to commercialize the process. And Amlan Mukherjee recently founded a start-up company called Life Cycle Solutions, LLC after receiving support through the NSF I-Corps program. (See page 8).

John Diebel, assistant director of technology commercialization at Michigan Tech, has worked with the I-Corps program as an industry mentor. He calls I-Corps training "transformative," not just for the participating teams, but also for the entire field of technology transfer.

Adrienne Minerick Named AAAS Fellow

ASSOCIATE PROFESSOR Adrienne Minerick was named a Fellow of the American Association for the Advancement of Science. She was recognized "for leading contributions to the field of nonlinear electrokinetics, particularly discernment of surface molecules with electric fields in microdevices, and for leadership in the field as the AES Electrophoresis Society president. Minerick was also elected to the American Society of Engineering Education's Board of Directors. She will serve as the Professional Interest Council I Chair.

Jay Meldrum—New Co-Advisor for Alternative Energy Enterprise

AS EXECUTIVE DIRECTOR of the Keweenaw Research Center (KRC), Jay Meldrum juggles numerous projects at any given time. KRC, a soft-money research arm of Michigan Tech, employs approximately thirty scientists and engineers to provide a wide range of applied research services to clients in government and industry with research expenditures of approximately $8 million each year.

Michigan Tech's Solar Photovoltaic Research Facility, located at the KRC, is one of those projects. The facility features a complete AC module system—including solar panels, micro-inverters and monitoring system. Undergraduates in Michigan Tech's Alternative Energy Enterprise (AEE) correlate the solar cells' output with the local weather, monitoring how they behave under varying conditions. Meldrum first served as a mentor to AEE team on the solar project, and recently, along with chemical engineering assistant professor Wenzhen Li, became the team's co-advisor. The AEE team is sponsored by the Department of Chemical Engineering.

The team's name was recently changed from Alternative Fuels Group. "The 'fuels' part of AFG was too limiting and people do not associate solar, wind, and geothermal with fuels," says the new co-advisor. Meldrum, Li, and the AEE team are now involved in many new projects throughout the Keweenaw as a result of the Enterprise's name change and overall focus.

One of the team's main projects involves the many abandoned mine shafts throughout Michigan's Upper Peninsula. "Since their closure, these shafts have filled with water," Meldrum explains. "The water is fairly warm, ranging from 45F to 60F in some locations. At the KRC's new building, we tapped the New Baltic #2 mine shaft, part of the Arcadia Lode that was mined between 1910 and 1930. The water is approximately 55F and abundant. We use this water to heat and cool our 15,000 square foot building. The system has run successfully for the past three years."

Jay Meldrum

The surrounding community is interested in tapping abandoned mine shafts for water, as well. "The city of Calumet has over 40 mine shafts filled with water, and currently uses only one. Calumet schools water their grounds and football field from this one shaft. The AEE team is looking at the feasibility of using additional water to provide geothermal heating and cooling for the schools.

"Geothermal heat pumps can take 45F degree water and create 70F heat. The pump can be reversed too, to provide cooling. We believe there is enough water in the Calumet mines to have a district heating and cooling system for several businesses to benefit at once," adds Meldrum.

As for the spring semester, the AEE team is already lining up plans for a new project. "The Michigan Tech library is now open 24/7 and needs to put up more signage. They have asked the team to design a way to light the sign using alternative energy. We are working on a combination solar panel/wind turbine design that would keep batteries charged enough to power LED's to light the new sign."

Meldrum is also the lead organizer and host for the SAE Clean Snowmobile Challenge (CSC), a Collegiate Design Series Competition that promotes the redesign of snowmobiles for lower emissions, lower noise output, and better fuel economy, hosted each year by Michigan Tech.

Caryn Heldt Wins Creative Canvas Course Contest

THE MICHIGAN TECH CENTER for Teaching and Learning's first Creative Canvas Course Contest saw students nominate more than 100 different courses from almost every department. The results are in. Nine faculty winners have graciously agreed to provide short "video course tours" so that others can see and learn from the design features of their well-received Canvas courses.

Congratulations to Chemical Engineering Assistant Professor Caryn Heldt, for her course, Fundamentals of Chemical Engineering 2 (CM2120).

Check out Dr. Heldt's video at http://goo.gl/ZMlmzc

Workshop on Chemical Engineering Challenges and Opportunities

COMPANY REPRESENTATIVES from Amway, Dow Chemical, Dow Corning, Kimberly-Clark, and Mosaic came to campus and talked to our students about challenges faced by their companies, and opportunities available for students who choose to work in the field. Our guests also offered suggestions and opinions to students in a casual setting. This workshop is always exceptionally well attended and much appreciated by students and sponsors alike.

Michigan Tech chemical engineering alumni offer advice to students

Chemical Engineering Academy Induction Ceremony 2013

MEMBERS OF THE Distinguished Academy are associates of the Michigan Tech Department of Chemical Engineering whose careers have been marked by extraordinary accomplishments or exemplary service to the profession.

Gregg A. Zank

Gregg Zank joined the Dow Corning Corporation after earning his doctorate in inorganic chemistry from the University of Illinois at Urbana in 1985. He later completed the Executive Development Program at

Gregg A. Zank

the Kellogg School of Management at Northwestern University in 2002. Through his years of industrial experience, he has shown a strong track record of scientific excellence. Zank is a recognized leader in the scientific community and a pioneer in technological development. He holds 45 patents for innovations including advanced monolithic and composite ceramics, photonic materials, rechargeable batteries and high-temperature thermosetting plastics. During his tenure at Dow Corning, Dr. Zank has significantly impacted Dow Corning's innovation efforts. While serving as director of Science and Technology, Zank established a unified approach to advancing and managing innovation for maximum future growth. This has included the establishment of a corporate Innovation Board and an internal Business and Technology Incubator, a unique format used to drive innovation for the company. He was named Chief Technology Officer in 2004 and senior vice president in 2009. In 2007 Zank was named the Charles D. Hurd lecturer at Northwestern University. In 2009 he received the Earle B. Barnes Award from the American Chemical Society for scientific leadership, invention, staff development and business impact. In 2011 he was awarded the Distinguished Alumnus Award from the University of Wisconsin-Superior, where he received his bachelor's degree in chemistry.

Daniel E. Somes

Daniel Somes joined Columbia Southern Chemical Company in Barberton, Ohio in 1957, a wholly owned subsidiary of Pittsburgh Plate Glass Company, after earning a BS degree in Chemical Engineering from Michigan Tech. He progressed from Process Engineer through the ranks to General Foreman. In 1965 he left PPG and joined Dundee Cement Company as Production

Daniel E. Somes

Manager of a green field Cement plant under construction in Clarksville, Missouri. This new plant was state-of-the-art, utilizing the largest cement manufacturing equipment in the world at that time. In 1965 Mr. Somes left Dundee to become Vice President of Operations at Penn-Dixie Cement Company. In 1974 he was recruited by Medusa Corporation to be Vice President of Operations in their Cement division. During his tenure he was responsible for converting the Charlevoix, Michigan plant from wet-to-dry process. The plant capacity was increased from 650,000 tons per year to 1.1 million tons. During the construction phase in 1979, Crane Co. acquired 93 percent of the outstanding shares of Medusa Corporation. After starting up the newly converted plant, Mr. Somes was promoted to President of Medusa Aggregates Company in 1981. In 1983 he was elected President and to the Board of Directors of Medusa Corporation. He expanded the distribution system on the Great Lakes for the Charlevoix plant by building new terminals in Owen Sound, Canada; Toledo, Ohio; Chicago, Illinois; and Ferrysburg, Michigan, and expanded the capacity of the Cleveland, Ohio terminal. To supply the expanded network, Medusa acquired a lake freighter and converted it to a self-unloading tug/barge with a capacity of 11,000 tons of cement. In 1988 Crane Co. spun off Medusa to its shareholders, and Medusa stock was then listed on the New York Stock Exchange. In 1992 Medusa acquired a cement plant from Lafarge Corp. in Demopolis, Alabama. In 1994 Mr. Somes retired from Medusa, having increased Medusa Corp. price per share by 3.5 times since the spin-off in 1998.

Robert E. Sloat

Robert Sloat joined Universal Oil Products Company after graduating in 1965, working in refinery process development and later in its patent law group while earning a Law degree from Chicago-Kent College of Law in 1972. In the patent group he worked with fluidized catalytic cracking and xylene separation refinery processes researchers. In 1975, he joined Amoco Corporation's Law group as a patent attorney in the chemical and refining areas. In 1977, Sloat was promoted to Director in Amoco's patent and technology licensing group and was involved in major chemical and refinery technology licenses in the US, Turkey, People's Republic of China and Japan. From 1982 to 1992, he managed Amoco's patent group covering refinery research and development. In 1992, he was promoted to Licensing Manager responsible for managing worldwide technology licensing activities of Amoco and was involved in major chemical process licenses in the US, South Korea and the PRC. From 1995 to 2003, Sloat managed its patent and licensing group covering crude oil exploration and production research. In 2003 he retired from BP Amoco after 28 years of service. From 2003 to 2008 he was an adjunct law professor at John Marshall Law School in Chicago teaching patent and technology licensing. He is a past member of the Licens-

Robert E. Sloat

ing Executive Society and the Intellectual Property Law Association of Chicago, and is a member of the Illinois Bar and a registered patent attorney. He is currently the Executive Officer of the Waukegan Sail and Power Squadron and active in boater education and safety programs. Sloat is one of the founders of the Sigma Phi Epsilon fraternity chapter at Michigan Tech and is a member of the Presidents Club.

James C. Simmons

James Simmons joined the American Steel Foundries Research laboratory as a Metallurgical Trainee and later a Research Metallurgist after graduating from Michigan Tech with a degree in Metallurgical Engineering in 1966. He worked on projects related to converting steelmaking facilities from Open Hearth Furnaces to Electric Arc Furnaces due to the 1970 Clean Air Act. He later worked as a Project Engineer, Process Engineer and Production Superintendent for Bucyrus Erie, Calumet Steel and CF&I Steel Corp. While at CF&I he began work towards an MBA at Regis College. In 1974 Simmons was nominated to the Electric Metal Maker's Guild (EMMG) and in 1978 he was awarded the Kelly Award by the AISE. In 1990 he joined Electric Metallurgy Company, later called EMC International, Inc. (EMCI) where he held the position of VP Sales and President. During his time at EMCI, Simmons developed a patent with Kobe Steel for the production of pig iron using DRI and HBI in an Electric Iron-making Furnace. EMCI was a subsidiary of MIDREX Corp. MIDREX was a subsidiary of Kobe Steel Ltd. MIDREX sold EMCI to Techint SPA in 2001 and through a succession of ownerships is now Tenova Core. During that time Simmons was Senior Vice President Business Development, Member Board of Directors and Vice President

James C. Simmons

Steelmaking. He was elected a Distinguished Member and Fellow of AIST in 2011. Simmons remains a Consultant to Tenova Core.

Susan L. Korpela

Susan Korpela joined the 3M Company after earning a bachelor's degree in Chemical Engineering in 1978. Korpela worked on adhesive products for industrial and automotive applications providing product/process development and technical service. This included worldwide manufacturing scale-up and training. She held various management positions starting in 1984, including supervisor for automotive tape products and lab manager for an acquisition manufacturing decorative automotive emblems with joint venture alliances in Japan. With her technical flexibility, she also managed new product opportunities for the automotive industry, including exploring electronic applications and mergers and acquisitions. A joint venture provided commercialization management opportunities in flat flexible cables and LED

Susan L. Korpela

lighting. This resulted in an automotive light management film lamination enterprise with Michigan Tech. In 2008 she joined the fuel cell components group and currently is the automotive project manager. Throughout her career her real passion was in K-12 STEM education, recognizing the importance the Michigan Tech Women in Engineering workshop had on her life in 1974. A role model speaker on many occasions, she has also secured 3M Foundation financial support for K-12 STEM education. At 3M, she has chaired the Technical Forum Academic Relations Committee, Visiting Women Scientist outreach and the AAUW Business Partner youth mentoring. At Michigan Tech she is a past member of the Chemical Engineering Industrial Advisory Board, and current member of the Presidential Council of Alumnae, the Corporate Advisory Board for Institutional Diversity, and the Presidents Club.

Meet the Administrator: Glenn Mroz, President, Michigan Tech

Glenn D. Mroz

GLENN D. MROZ became the ninth president of Michigan Technological University in 2004 after serving as Dean of the School of Forest Resources and Environmental Science for four years. He has served as a faculty member in the School since 1980. Mroz earned his BS and MS degrees in Forestry from Michigan Technological University and earned his PhD in Forestry from North Carolina State University in 1983.

President Mroz has introduced initiatives that support the academically talented and curious mindset of the University's students, including a first-year summer reading program, undergraduate research opportunities, Make a Difference Day, a global technological leadership institute, a hugely successful outdoor adventure program, new scholarship opportunities and an honors institute. On his watch, financial aid has increased by 250 percent.

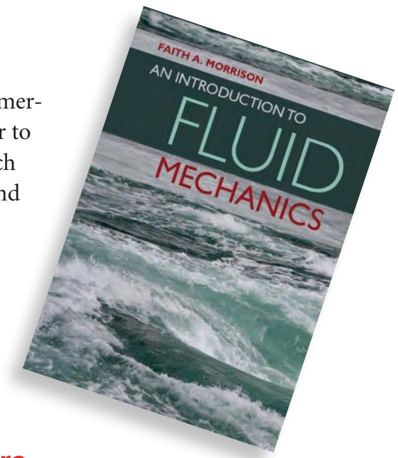
Under Mroz's leadership, Michigan Tech has more than doubled research expenditures, to more than $70 million. And the University raised more than $200 million in an intensive capital campaign, mostly to support scholarships, endowed chairs and professorships, academic programs and research.

Mroz is a member of the Citizens Research Council of Michigan, Chair of the Presidents Council, State Universities of Michigan, and Chair of the Great Lakes Intercollegiate Athletic Conference Council of Presidents. At the national level, he is one of thirty members of the Association of Governing Boards Council of Presidents, a member of the Science Coalition, and a former member of the American Council on Education Commission on Lifelong Learning. He is also a member of the Society of American Foresters, Xi Sigma Pi, Forestry Honor Society, and Soils Science Society of America.

New Books

An Introduction to Fluid Mechanics, by Faith Morrison

This is a modern and elegant introduction to engineering fluid mechanics enriched with numerous examples, exercises, and applications. The goal of this textbook is to introduce the reader to the analysis of flows using the laws of physics and the language of mathematics. The approach is rigorous, but mindful of the student. Emphasis is on building engagement, competency, and problem-solving confidence that extends beyond a first fluids course.



Cambridge University Press, 2013
ISBN: 9781107003538
Publication date: April, 2013
940 pages
520 black/white illustrations
40 tables/500 exercises

Benefication of Phosphate Ore, by S. Komar Kawatra and J.T. Carlson

Phosphate mining represents the fifth largest mining industry in the United States. The majority of this ore is used in the fertilizer industry. Decreasing ore quality presents new processing challenges. This book examines various methods for processing phosphate rock. An excellent reference and easy-to-read primer for students, engineers and researchers, it is also intended to useful for the professional with little or no knowledge of mineral processing. Benefication of Phosphate Ore is based on experience and funded research conducted at Michigan Tech.

Society for Mining, Metallurgy & Exploration
Publication date: February 2014
http://www.smenet.org/store/

Alums at the Society of Rheology in Montreal

AT THE 2013 SOCIETY of Rheology meeting in Montreal, Canada, Professor Faith Morrison met with James Eickhoff, Michigan Tech class of 2004, and Mark Cieslinski, Michigan Tech class of 2011.

Eickoff works for Anton Paar, a rheometer manufacturer. He travels all over the world. Cieslinski is a graduate student in Professor Don Baird's group at Virginia Tech, set to get his PhD in chemical engineering/rheology in two years. Both students took Professor Morrison's Polymer Rheology course while at Michigan Tech.

L to R: James Eickhoff, '04, Dr. Faith Morrison, and Mark Cieslinski, '11.

Of all the things Michigan Tech is known for, you might be surprised to know that incredible gardens top the list, thanks to Michigan Tech Master Gardener Lynn Watson. She strives to make her plants "happy." Since 2008, she has planted hundreds and hundreds of flowers at Michigan Tech; tucked among them are tomatoes, blueberries, rhubarb, chives, asparagus, chocolate mint, and much more.

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All Your News That's Fit to Print

Tell us your latest news: How has your Michigan Tech education helped you in your current position? Do you have any advice for our current students as they look forward to jobs in chemical engineering? Please submit your entry for the new Class Notes section of the Michigan Tech Chemical Engineering newsletter. Email your news and photos to **Chris Abramson** at **cmabrams@mtu.edu.** We look forward to hearing from you!