MICHIGAN STATE UNIVERSITY COLLEGE OF ENGINEERING • FALL 2012

THE BOND

DEPARTMENT OF CHEMICAL ENGINEERING & MATERIALS SCIENCE

Innovative Reactor Set to Harvest Alternative Fuel

Take proven biochemical engineering practices and add innovation. The result is a reactor that will be able to produce the next generation of alternative fuels.

CHEMS professor R. Mark Worden is part of a research team that received $1.7 million from the U.S. Department of Energy Advanced Research Projects Agency-Energy to build a reactor system for *Ralstonia eutropha*, a bacterium that scientists are engineering to metabolize hydrogen and carbon dioxide to produce isobutanol, a fuel that can be used as a replacement for gasoline.

Anthony Sinskey, professor of biology at Massachusetts Institute of Technology, leads the genetic engineering team.

"Sinskey is a leader in metabolic engineering," says Worden. "His research group is focused on the biology of the bacterium and engineering it to produce isobutanol. To make the bacterium produce the biofuel we are working on, Sinskey and his research team have successfully altered the genetics of the bacterium, also called a microbe, by adding new DNA that allows the cell to produce isobutanol."

Worden's role in this project is to build a reactor system for the fermentation system. A prototype reactor has been designed and built, and it is currently being tested. Getting to this point, however, was not easy.

"Developing the reactor is a complex project," says Worden, who had had experience designing reactors. "This one is different from a normal bioreactor because the food the microbe eats is hydrogen gas, oxygen gas, and carbon dioxide gas. With other fermentations, the food the microbes eat dissolves easily in water. In this case, the hydrogen and oxygen don't

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R. Mark Worden (left) with PhD student Yangmu (Chloe) Liu.

Materials Discovery Charging Up the Auto Industry

Jeff Sakamoto

What does research on batteries, thermoelectrics, and biomedical materials have in common? For CHEMS assistant professor Jeff Sakamoto all three fall under one umbrella of fundamental materials discovery and the translation of those discoveries into technological innovations.

"I'm a ceramicist by trade," says Sakamoto, who came to MSU from NASA's Jet Propulsion Lab (JPL) in 2007. "I work on ceramic material synthesis and design the materials at the atomic scale."

His expertise in all three areas, but especially his work with batteries, has received national attention. Sakamoto recently was an invited speaker at the National Academy of Engineering's 2012 U.S. Frontiers of Engineering Symposium on Vehicle Electrification held September 13-15 at the General Motors Tech Center in Warren, Michigan. Out of 400 nominees, approximately 100 participants were invited and 16 were invited to present. Sakamoto's presentation was entitled "Keeping Up with the Increasing Demands for Electrochemical Energy Storage." Additionally, his paper from that presentation was one of four papers selected for publication in the December issue of *The Bridge*, a publication of the NAE. Sakamoto also made a presentation at the 2011 National Academy of Sciences Indonesian-American Symposium in Bogor, Indonesia.

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MICHIGAN STATE UNIVERSITY

from the Chair

MARTIN HAWLEY

Greetings to all as I write this on a beautiful fall day in East Lansing. The 2012-13 academic year is off to a fast start and I am excited about all that is happening in our department.

Our faculty members, along with the students who will join them in the workplace, are making the world better. Look at the accomplishments of R. Mark Worden and Jeff Sakamoto (featured on page 1) as examples of the innovative research being done in our department that will have an impact on the world. You can read about other research and honors that our faculty members are receiving inside this newsletter.

In this environment our students also flourish. I am extremely proud that we have continued a long-standing tradition of taking the top prizes in the AIChE Student Design Competition – and 2012 was no exception. Congratulations to Chris Beuerle who took first prize in the individual category of the 2012 competition. He's now an engineer with Shell Oil Company. We also welcome a Von Ehr Scholar this year, one of several who have selected CHEMS as their major over the years. Also, Diandra Rollins won an impressive NASA fellowship to advance her PhD work under the mentorship of professor Lawrence Drzal.

Our alumni also are helping to make the world a better place. A good example is Kim de Groh who was the recipient of our 2012 Red Cedar Award for distinguished service to the profession and outstanding commitment to the community. Her work in the Space Environment and Experiments Branch at NASA Glenn Research Center in Cleveland, Ohio, is outstanding, as are her community projects—especially her interest in mentoring young women interested in science, engineering, and math.

By holding fast to three research themes for the department—energy and sustainability, nanotechnology and materials, and biotechnology and medicine—I see a brighter world ahead. As always, I wish each of you the very best.

2012 Red Cedar Award in Chemical Engineering and Materials Science

Kim K. de Groh (van den Ende) (BS '85, MS '87 Materials Science) received the 2012 Red Cedar Circle Award in Chemical Engineering and Materials Science at the annual College of Engineering Alumni Awards Banquet in May. Initiated in 2000, this award recognizes MSU chemical engineering and materials science alumni for their distinguished service to the profession and outstanding commitment to the community.

De Groh is a senior materials research engineer in the Space Environment and Experiments Branch at NASA Glenn Research Center in Cleveland, Ohio, where she has conducted research and mentored students for the past 23 years.

Currently, de Groh is the co-principal investigator for the Materials International Space Station Experiment-X (MISSE-X) project. Her interest in the space program began at an early age. Her father, Hendrik van den Ende, a biomedical engineer at Henry Ford Hospital in Detroit, ran medical tests for NASA during the early space program. De Groh recalled: ". . . our family watched Neil Armstrong take the first step on the moon on July 21, 1969. We watched him on a little black and white TV up at our cottage on Lake Michigan. It was 9:56 p.m., and the moon was bright and visible, and we ran back and forth between the TV and outside on the deck to look at the moon."

In 1986, while attending MSU, de Groh earned a summer internship at NASA Glenn Research Center, where she met her future husband, Henry de Groh III. By 1987 Kim had graduated from MSU with a master's degree in materials science and moved to Ohio. She and Henry were married the following year.

In 1989 de Groh became an employee of NASA. She is now internationally known as a technical leader in areas relating to the environmental durability of spacecraft materials. She is the principal investigator for 13 International Space Station (ISS) experiments. Her research has directly impacted the Hubble Space Telescope and ISS and is influencing spacecraft material design choices made by NASA and the nation's space industry. De Groh has participated in shuttle flight experiments and Russian space station Mir experiments. Through experiments in space and ground-laboratory experiments, she assesses how the space environment affects spacecraft materials.

She is currently writing a NASA Technical Standards Handbook for spacecraft designers based on her ISS flight data.

Since 1998, de Groh has been the on-site mentor and team leader for 26 young women involved with the PEACE project—the Polymers Erosion and Contamination Experiment—a collaboration between Ohio's Hathaway Brown preparatory school students and engineers at NASA's Glenn Research Center. She has also mentored university students. In addition to mentoring, de Groh actively participates in NASA and community outreach activities in an effort to get students, and in particular young girls, interested in science, technology, engineering, and math (STEM) fields.

Martin Hawley, chair of the Department of Chemical Engineering and Materials Science, presents the 2012 Red Cedar Circle Award to Kim K. de Groh.

She has received many awards and accolades for her scientific and mentoring contributions, including two of NASA's highest honors—the NASA Exceptional Achievement Medal and the Space Flight Awareness Honoree Award. In 2009 she was inducted into the Ohio Women's Hall of Fame by Governor Ted Strickland.

De Groh and her husband, who is also a materials engineer at NASA Glenn, have two boys—Henry and Daniel. They have resided in Hinckley, Ohio, since 1991.

Innovative Reactor (continued from page 1)

like to dissolve in water. They are sparingly soluble, meaning that it is difficult to dissolve the hydrogen and oxygen as fast as the microbes can eat them."

Worden points out that this problem of getting gases into water is the same problem that started the biochemical engineering discipline back in the 1940s.

"There was a need back then to produce penicillin from a fungus," he explains. "Scientists could produce it on Petri dishes, but that is not a good way to make a lot of the product. They learned to grow the fungus in a tank of water but then were initially not able to get oxygen into the water fast enough so that the fungus could produce the penicillin at a high rate. The biochemical industry field was formed to solve that mass transfer problem, so this idea of designing reactors to enhance gas mass transfer in water is a pioneering problem of our industry, and we are well-equipped to deal with it."

The typical way to get these gases into the water faster is to use smaller bubbles because the smaller the bubbles, the more surface area they have.

"We took this approach to an extreme by making microbubbles, which helps to dissolve the gas fast enough to meet the need," Worden says. This project, however, presented several new challenges.

"The gas that consumed the most—measured in moles—is hydrogen gas, and hydrogen is less soluble than oxygen," Worden says. "That is part of the problem—high demand for a gas that is not very soluble."

Another major problem is that hydrogen and oxygen cannot be bubbled together in the same liquid because, when these gases mix, they are explosive. This created a huge safety issue that was a challenge in designing the reactor.

The result of Worden's work is a new reactor design called Bioreactor for Incompatible Gases, for which MSU Technologies submitted and received a provisional patent.

Worden and his research team are considering two ways to remove the isobutanol during the fermentation process.

"In the first, we have the isobutanol stick to little plastic spheres and then later release the isobutanol and recover it," Worden says. "Our other strategy is using a gas such as hot air to evaporate the isobutanol out of the water. Isobutanol is more volatile than water, so it comes out faster and we can selectively remove it from the water during fermentation."

The prototype reactor is now being tested.

"We recently put all of the components together and developed a complicated control process to automate the reactor so that it can detect what's needed and take corrective action without an operator having to be there to do it manually," Worden says. "The control system has been a challenge because different pieces of equipment talk different languages. We have had to use electronic translators to get the signals from different instruments into a compatible format so that all the data and signals can be analyzed at the same time."

Worden recently received a new strain of the microbe from the

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Russian Scientists Visit MSU to Receive Training in Fermentation Pilot Plant Methods

Five Russian scientists spent three weeks in July at Michigan State University and the Michigan Biotechnology Institute (MBI) learning about fermentation pilot plant operations. CHEMS professor R. Mark Worden took the lead on the MSU component of the project.

The scientists, from the Production Association Sibbiopharm Ltd., based in Berdsk, the Russian Federation, were accompanied by two translators.

Sibbiopharm is currently one of the leaders of bioindustry in Russia, with more than 45 years of experience in manufacturing enzymes and biotech products for the food and agricultural industries, and for environmental protection applications.

The goal of the MSU and MBI program was to train Sibbiopharm staff to use new equipment that was provided to their company during a Production Upgrade Project supported by a 2006-2010 grant from the BioIndustry Initiative (BII) Program of the U.S. Department of State.

The training included a week of focused studies in an MSU biochemical engineering laboratory, followed by two weeks of learning about Pilot Plant operations at MBI, a company that partners with MSU, other research institutions, and end-user companies to bridge the gap between early innovations and commercial applications. MBI has 25 years of experience in fermentation technologies and process scale-up.

"The MSU component of the training program focused on fermentation optimization and scale-up methods. A combination of lectures, laboratory experiments, and computer-based exercises were tailored to the backgrounds of the students," according to R. Mark Worden, MSU AgBioResearch scientist and professor in MSU's Department of Chemical Engineering and Materials Science.

"The program at MBI was focused on the practical aspects of designing, operating, and maintaining a modern fermentation pilot plant," says David Senyk, vice president of engineering at MBI. "Demonstration of the scale-down and scale-up of an existing Sibbiopharm process was used as the basis for the training."

The training program was organized by CRDF Global—an implementing partner of the U.S. Department of State and independent nonprofit organization that promotes international scientific and technical collaboration through grants, technical resources, training, and services. The organization is based in Arlington, Virginia, with offices in Moscow, Russia; Kyiv, Ukraine; Almaty, Kazakhstan; and Amman, Jordan.

"This training simulated, as closely as possible, the production conditions that exist at the Russian company," says Jim Wolfram, an independent consultant supporting the CRDF implementation of the BII Program. "A permit was secured to allow their non-pathogenic organism to be transported to the United States. Therefore, the conditions of the fermentations and assays were familiar to the trainees.

"During the training, a new process control variable was tested. The result yielded a 50 percent gain in production of the product per unit volume. A positive increase like this, if reproducible at the Russian plant, could be financially significant in their sustainability," Wolfram says.

— Laura Luptowski Seeley

Faculty Bond

New Staff

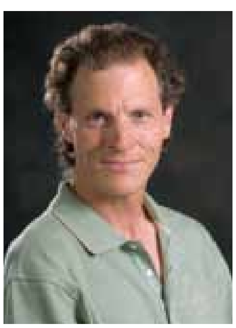
The CHEMS department welcomes **Maddalena Fanelli** to its staff as an academic teaching specialist. Fanelli teaches or coordinates a number of undergraduate laboratory courses, including Laboratory Practice and Statistical Analysis, and the experimental components of Composite Materials Processing, Biochemical Engineering, Introduction to Materials Science, and the majors laboratory materials course.

"For students, the hands-on experience of these labs is critical to making the theoretical learning more understandable and concrete," says Fanelli. "The practical connection made through these courses cannot be matched by the ever growing number of virtual learning options. In many cases, it sets us apart from universities abroad."

Fanelli came to MSU because she loves teaching and learning, the freedom to think, and sharing and bringing new ideas to life. Prior to coming to MSU, she worked in research and development for a number of companies, including Draths Corporation, Velocys, and Schmalbach-Lubeca.

Fanelli has a PhD from Case Western Reserve University in Cleveland, Ohio, and earned her BS and MS degrees at the University of Toledo, in Ohio. She is a member of the American Institute of Chemical Engineers, the American Chemical Society, and the American Society for Engineering Education.

TMS Awards



Professor **Thomas R. Bieler** has been honored with two awards from TMS (The Minerals, Metals and Materials Society) Materials Processing and Manufacturing Division (MPMD). He is the recipient of the 2013 Distinguished Service Award as well as the Distinguished Scientist/ Engineer Award. The awards will be presented in March 2013 at the TMS Annual Meeting in San Antonio, Texas.

The Distinguished Scientist Award recognizes an individual who has made a long-lasting contribution to design, syntheses, processing, and performance of engineering materials with significant industrial applications. Bieler was nominated for this award by S. Lee Semiatin, a research leader with the Air Force Research Laboratory at Wright-Patterson Air Force Base in Ohio. The Distinguished Service Award recognizes an individual whose dedication and commitment to TMS-MPMD has made a demonstrable difference to the objectives and capabilities of the division and the society. He was nominated for this award by James W. Sears, director of additive manufacturing at the South Dakota School of Mines & Technology and executive director of the Quad Cities Manufacturing Laboratory, and by James C. Foley, the research and development manager at Los Alamos National Laboratory.

Bieler's research focuses on mechanical deformation of metallic materials, texture and microtexture damage nucleation, and crystal plasticity finite element simulations of deformation in titanium alloys, solders, intermetallics, and refractory metals. He came to MSU in 1989 after earning his PhD in materials science at the University of California, Davis. Prior to his doctorate work, Bieler worked in the Experimental Mechanics Division at Sandia National Laboratories in Livermore, Calif.

His recent research on lead-free solder joints that has used synchrotron x-ray sources at the Advance Photon Source (APS) at Argonne National Laboratory will be highlighted in the next APS annual report.

Bieler was also recently appointed the section editor for the *Journal of Electronic Materials*, and serves as a key reader for *Metallurgical and Materials Transactions A.*

Bieler is primarily active in TMS, but is also a member of the Materials Information Society International, the American Society of Engineering Education (ASEE), and an intermittent member of Materials Research Society (MRS).

Thermodynamics Textbook

The second edition of a textbook co-authored by Professor **Carl Lira** was published in February. *Introductory Chemical Engineering Thermodynamics* is widely used throughout the world.

The textbook, designed primarily for undergraduate chemical engineering students, provides coverage of molecular concepts, energy and entropy balances, equations of state for thermodynamic property calculations, and activity models.

The text is offered in a hard-cover version, an e-book version, and an international version. It is part of the prestigious Prentice-Hall International Series in the Physical and Chemical Sciences. The co-author is J. Richard Elliott, professor of chemical engineering at the University of Akron.

The Cahn Prize

Melissa Baumann

Eldon Case

Professors **Melissa Baumann** and **Eldon Case,** along with Xudong Fan, a teaching specialist with the MSU Center for Advanced Microscopy, are the co-authors of a paper that is one of 12 finalists for the first *Journal of Materials Science* (JMS) Robert W. Cahn Best Paper Prize. The award is named in honor of the journal's founding editor, the late Robert Wolfgang Cahn. The annual prize recognizes an exceptional original research paper published in the journal in a particular calendar year. Baumann, Case, and Fan are the co-authors of a paper titled "The Effect of Indentation-Induced Microcracks on the Elastic Modulus of Hydrozyapatite." It appeared in JMS in September. The paper that wins the award will be announced at the 2012 fall MRS meeting in Boston.

Powerful New Approach to Attack Flu Virus

An international research team that includes assistant professor **Tim Whitehead** has manufactured a new protein that can combat deadly flu epidemics.

A paper, featured in a recent issue of *Nature Biotechnology*, demonstrates ways to use manufactured genes as antivirals, which disable key functions of the flu virus.

"Our most potent design has proven effective on the vulnerable sites on many pandemic influenza viruses, including several H1N1 (Spanish flu, Swine flu) and H5N1 (Avian flu) subtypes," says Whitehead, the paper's co-lead author. "These new therapeutics are urgently needed, so we were especially pleased to see that our design neutralizes H1N1 viruses with potency."

This research also laid the groundwork for future treatments of all flu viruses, as well as other diseases such as smallpox, Whitehead adds.

The research was funded by the Defense Research Projects Agency, the Defense Threat Reduction Agency, the National Institutes of Health, the National Institute of Allergy and Infectious Diseases, and the National Institute of General Medical Sciences.

Tim Whitehead

Tex Frazier Lecture

Ramani Narayan, University Distinguished Professor of chemical engineering and materials science, was invited to give the Tex Frazier Lecture at the 2012 American Society for Horticultural Science (ASHS) annual conference in July in Miami, Florida.

The title of Narayan's lecture was "The Promise of Bioplastics: Understanding Value Proposition of Biobased and Biodegradable Plastics for Reducing Carbon Footprint and Improving Environmental Performance.

The Tex Frazier Lecture series was named in honor of William A. ("Tex") Frazier, an eminent member of the faculty at Oregon State University. The intent of the lecture series is: "to foster and promote reciprocal liaisons between ASHS and other professional groups; to recognize distinguished scholars and to bring their point of view to ASHS members; and to encourage the development of a holistic philosophy within the horticultural science profession so that ASHS members and students can enjoy the benefits of a broader perspective provided by an understanding of the interrelationship of seemingly diverse disciplines."

Narayan was also presented with honorary membership in ASHS.

In Memoriam—Alumni

Michael Dennos (BS CHEMS '43), the retired CEO of Chef Pierre and a founder of the Dennos Museum Center in Traverse City, Mich., died June 28, 2012, at the age of 92.

Michael Howard Dendrino was born on May 16, 1920, in Muskegon, the first of eight children born to Christos and Katherine (Holder) Dendrino. His father hailed from the Ionian island of Kefallonia, coming to the U.S. from Corfu, Greece, by himself at the age of 14. His mother was born in a sod hut on a North Dakota prairie.

On the day after Italy invaded Greece in 1940, Michael's father, Christos, went down to the courthouse to restore the "s" to the end of his surname, thus changing it back to the original Greek "Dendrinos" from the Italian-sounding "Dendrino" doled out to him when he came through Ellis Island. With their father's permission, each of his sons adopted his own preference for a surname, with Michael choosing a shorter version–Dennos.

Dennos began working at the age of 12 for Sunrise Pies, his father's North Muskegon bakery. A graduate of Muskegon High, Michael became the first in his family to attend college when he won a scholarship to Michigan State University, where he studied chemical engineering so that, in his words, he would "never have to make another pie again."

Michael married his high school sweetheart and fellow MSU student Barbara Mae Hansen, on Sept. 25, 1941. After graduating from MSU, Dennos served in the U.S. Navy during World War II. Following up his training at the Great Lakes Naval Training Station and officer's school at Columbia University, Lt. Dennos was assigned as a communications officer to the battleship USS *Wisconsin*, where he spent much of his time making pies for the captain.

After his service ended in 1946, Michael moved his young family east where he worked for 20 years at Schenectady Chemical Co. Dennos moved back to Michigan in 1962 to help run the family pie business that had been started by his father in 1922 and moved to Elk Rapids by a brother, Peter Dendrinos. They moved the pie company, which was rechristened Chef Pierre, to Traverse City in 1963, where it became the largest employer in Traverse City and the No. 1 provider of pies to the U.S. food service industry. Dennos became president of Chef Pierre in 1973 and CEO in 1981, after merging Chef Pierre with Consolidated Foods, the parent company of Sara Lee, in 1980. Michael retired in 1986 as vice president of Consolidated Foods.

In 1973, Dennos endowed the M. Larian Scholarship Fund for deserving chemical engineering students at Michigan State in honor of his chemical engineering professor, Doc Larian. Dennos was a recipient of the Lifetime Achievement Award from the American Hellenic Institute in Washington, D.C., and the Claud R. Erickson Award from Michigan State University.

Materials Discovery (continued from page 1)

The prototype ceramic that Sakamoto is working on is an electrolyte and could have uses in electric car batteries. This ceramic electrolyte is based on a ceramic oxide that exhibits a combination of high ionic conductivity and chemical stability against metallic lithium, meaning it will not degrade when placed in contact with lithium, a property few ceramics exhibit. Examples of technologies that could be enabled by this class of electrolyte include: solid-state lithium-ion batteries that are non-flammable and do not require hermetic packaging, lithium-air semi fuel cells, and lithium-sulfur batteries.

"Lithium-ion battery technology has advanced significantly in the last two decades," says Sakamoto. "However, future energy storage demands will need to be safer, cheaper, and have higher performance electrochemical energy storage. While the primary strategy for improving performance has focused on electrode materials, the development of new electrolytes has been overlooked as a potential means to revolutionize electrochemical energy storage."

Advancing battery technology in electric vehicles is important for two reasons. One is "range anxiety," or how far an electric vehicle can go before it needs recharging. The current lithium-ion battery being used in electric vehicles can go about 100 miles before it needs to be recharged, a process that is slow. "It's not like you go to the gas station and recharge in the same amount of time it would take to fill a car with gasoline," says Sakamoto. In fact, the recharge will take several hours and work best from a high voltage electrical outlet that most owners will install at their own homes.

The second thing is, of course, cost. Finding a cost-efficient battery for electric vehicles is the quest of many researchers. The battery packs used in current electric vehicles make up a significant portion of the total cost of the vehicle. In electric vehicles, the battery capacity is measured in kilowatt-hours, which leads to a dollar rating of the cost per kilowatt-hour. Currently, the lithium-ion batteries are about $600 per kilowatt-hour.

"The goal is that the battery for an electric vehicle has to be about the same cost as a conventional drive train in gasoline vehicles, so that number has to come down to about $150 per kilowatt hour to be commercially viable and to be considered for widespread adoption. In order to do this, there has to be a change in technology, and that probably means a different way of producing the battery," explains Sakamoto.

The U. S. Department of Energy is pushing for results with electric vehicles and is funding research on batteries. The department also has created milestones for achievements. The first, which is just around the corner, is 2015, when the current technology is to be optimized. The next milestone is 2020, when there should be some new materials breakthroughs with batteries. "It should be the best that conventional lithium-ion batteries can do, but it still may fall short of the $150 per kilowatt-hour target."

The third milestone, the one Sakamoto is working toward, is 2030, when there needs to be a significant materials breakthrough, something other than a lithium-ion battery. "There are two possible solutions that I think are feasible—Li-S (sulfur) and Li-air semi fuel-cells," says Sakamoto. "The cost of either one of these is much less than the cost of the current battery and the range is comparable to a gas engine." His ceramic electrolyte could fit in with either of these two solutions.

The Li-S battery is a rechargeable cell with a very high energy density. By virtue of the low atomic weight of lithium and the moderate weight of sulfur, Li-S batteries are relatively light. Their primary appeal in electric vehicles is their high energy density and the low cost of sulfur.

The Li-air semi fuel-cell (or Li-air battery for brevity) battery chemistry uses the oxidation of lithium at the anode and the reduction of oxygen at the cathode to induce a current flow. The major appeal of the Li-air battery is its extremely high energy density, which rivals that of traditional gasoline-powered engines, because it uses oxygen from the air instead of storing an oxidizer internally.

"The lithium-air battery could provide ultra high performance, but it isn't going to happen anytime soon," explains Sakamoto. "Air is free, but there are a lot of engineering challenges. One example is how to build the battery so it will recharge. When the lithium oxidizes, it wants to stay that way, so this kind of battery is difficult to recharge. That's why I like to talk about the ceramic we developed–it would be good in both technologies."

However, Sakamoto is not totally focused on 2030 solutions. He is working with researchers at Ford Motor Company on materials processing, trying to optimize existing materials and the way they are processed.

Obviously, an industry that is working toward solutions to problems in 2030 is going to need talented, newly educated researchers and engineers to continue to move the industry forward. Sakamoto works with PhD and undergraduate students, and also teaches MSE 370–Physical and Chemical Processing of Materials and MSE 875–Graduate Ceramics.

"Students are aware of the national and local challenges in the automobile industry and other industries," says Sakamoto. "They want to do something about it and that keeps them inspired. I don't have to inspire them—and I like that."

–Jane L. DePriest

Fast Facts about the Frontiers of Engineering

The National Academy of Engineering's 2012 U.S. Frontiers of Engineering Symposium that was held in Warren, Mich., in September brought together 100 outstanding engineers under the age of 45 to discuss pioneering technical and leading-edge research in various engineering fields and industry sectors.

The goal was to bring together engineers from all disciplines and from industry, universities, and federal laboratories to facilitate cross-disciplinary exchange and promote the transfer of new techniques and approaches to sustain and build the innovative capacity of the United States.

Innovative Reactor (continued from page 3)

Massachusetts Institute of Technology and is working on a test run with the actual microbe.

One of the big advantages of isobutanol is that it is a direct substitute for gasoline. Ethanol, another alternative fuel, can be added to gasoline only in low concentrations. That's one of the reasons for the emerging interest in isobutanol as an alternative fuel, according to Worden.

This project has spawned an initiative with the Michigan Biotechnology Institute (MBI).

"MBI realizes that this kind of fermentation, where hydrogen is fed to microorganisms, could be a growing area of research," Worden says. "MBI can scale up a reactor that is bigger than the one we can make at MSU. Ultimately, we want to be the focal point for the development of these gas-intensive fermentations. MBI is the perfect partner because scaling up fermentations is what they do."

For Worden, the project has other ultimate rewards.

"As an educator, we tell the students that if they apply the engineering principles we teach, they can deal with systems," he says. "This is a great example of that. We integrated well-established principles in a creative new way to address challenges in a novel fermentation process. "

— Jane L. DePriest

Student Bond

2012-13 Von Ehr Scholars

Chemical engineering freshman **Carson Laurenz** is one of three incoming students who have been selected to receive Von Ehr Scholarships for the 2012-13 academic year.

A $1 million endowed scholarship fund was established in 2006 by James R. Von Ehr II, a 1972 computer science graduate and successful entrepreneur who has long demonstrated his commitment to MSU and the college through service and philanthropy. The intent of the scholarships is "to provide financial assistance to outstanding undergraduate students who come from humble backgrounds, as I did," says Von Ehr.

Qualified prospective students—those scoring in the 90th percentile and above on national placement exams and who have a proven financial need—are invited to apply for the scholarships, which are renewable for four years. Incoming freshman applicants are required to write a brief essay that describes their idea of the meaning of "free enterprise," "liberty," and "open world markets," and relate how these principles help to promote creativity and the transmission of technological benefits to different world cultures and society in general.

"I chose engineering because I love solving challenging problems that involve math and science. Obtaining an engineering degree would open a lot of doors in my life," says Laurenz, who is from Midland, Mich.

To him, the scholarship is "a huge deal." "Not only does it help me out financially, but it also gives me an opportunity to gain experience in the College of Engineering. I am truly thankful for Mr. Von Ehr making an investment in my education," says Laurenz, the son of Brenda Guest and Scott Laurenz.

Also receiving the scholarship are Kathleen Haynes of Dimondale, Mich. (environmental engineering), and Kyle Swinkin of Livonia, Mich. (computer science and engineering).

AIChE 2012 Student Design Competition

Chris Beuerle continued the department's tradition of winning awards in the AIChE Student Design Competition. Beuerle, who graduated in May 2012, won first prize in the 2012 competition. The award was presented at the AIChE annual meeting in Pittsburgh in October.

The CHEMS department has the best record in the nation for placing in this national contest since it started in 1967. In 2010, MSU took top honors in both the team and individual competitions. The projects that the students entered into the competition were originally assigned as projects in an MSU spring semester course in process design and optimization. Beuerle's project was "Production of Non-Alcoholic Beer Using a Reverse Osmosis Membrane Process."

Beuerle is now a process engineer with Shell Oil Company in Houston, Texas. "I didn't know that I really wanted to major in CHEMS for sure until I took the Separations course and completed an internship. That's where I really got some hands-on work and realized I wanted to go into a profession where I didn't just sit at a desk, but could go out into the field and get my hands dirty."

He is the son of Ed and Cory Beuerle.

NASA Space Technology Research Fellowship

CHEMS doctoral student **Diandra Rollins** received a NASA Space Technology Research Fellowship for the 2012-13 academic year. The fellowships are given to researchers who show significant potential to contribute to NASA's strategic goals and missions. The paper Rollins submitted for the fellowship is titled "Multifunctional Graphene Nanocomposite Foams for Space Applications."

Originally from Iowa, Rollins obtained her BS degree in materials science engineering from Ohio State University, with a specialization in ceramics in June 2009. She hopes to complete her PhD by spring 2014. CHEMS Professor Lawrence Drzal is her adviser. In addition, NASA will pair Rollins with a technically relevant and community engaged researcher who will serve as her professional mentor.

Rollins is already thinking ahead to what she might like to do next. "Before starting my career I would like to do volunteer work that would use my engineering background to provide creative solutions to problems in Third World countries."

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Department of Chemical Engineering & Materials Science
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East Lansing, MI 48824

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CHAIRPERSON Martin Hawley

TEL (517) 355-5135
E-MAIL chems@egr.msu.edu
WEB www.chems.msu.edu

EDITOR Jane L. DePriest

PUBLICATIONS DIRECTOR
Laura Luptowski Seeley

PHOTOGRAPHERS
Harley J. Seeley
Kurt Stepnitz

Five Russian scientists spent three weeks in July at MSU and the Michigan Biotechnology Institute (MBI) learning about fermentation pilot plant operations. See story on page 3.

As isobutanol is created, it can be lethal to the bacterium producing it. Microwell plates are used to periodically collect samples to see how the bacterium is faring. See story on page 1.