Fundamental Research Has Many Modern-Day Applications

Oops, I dropped my cell phone. Hey, it still works. That is thanks in no small part to the solder that is holding the electronic components together. "The entire modern world depends on reliable electronics and therefore on reliable solder joints," says Thomas Bieler, CHEMS professor. "Fifty to 70 percent of electronic failures are caused by problems with solder joints."

The traditional use of solder in electronics has been to make electrical contacts, such as two solid copper wires soldered to a terminal. In modern electronic systems, solder joints hold components (or packages) onto circuit boards, and serve as a mechanical attachment joint as well. Each electronic component used in a piece of electronic equipment—from cell phones and laptop computers to the computer modules in automobiles to equipment used for the Internet infrastructure—has hundreds of solder joints.

Bieler has been researching solder and solder joints since 1995 when he and CHEMS professor K. N. Subramanian started a research project with Ford Motor Company on ways to characterize lead-free "silver" solder. "With cars, the engine can get very hot when it is running and much colder when it is not, especially in winter. These cyclical extremes can deform the solder joints and cause problems. It's like bending a paper clip—dozens, hundreds, thousands of times."

Since 2006, solder has to be lead-free because in Europe and Japan electronic waste is burned, which leads to lead in the air. "Lead-tin solder was used for a long time and its properties continue on page 3...
Hats off to our CHEMS graduates! We are very proud of their accomplishments during their college careers and look forward to hearing about their achievements in the coming years. Our undergraduates are highly sought after in industry and for graduate research programs because of the strength of the department’s curriculum and the quality of students in our program. The future for today’s CHEMS graduates is bright.

Special congratulations to the students mentioned in this newsletter who have won awards, including Kendell Pawelec, a materials science senior, who has been named a 2010 CHEMS graduate is bright. Students in our program. The future for today's CHEMS graduates is bright. Several have recently received awards from the college and the university, and I want to offer my congratulations. The department is excelling in its research themes (energy and sustainability, nanotechnology and materials, and biotechnology and medicine), because these play such a significant roles in solving today's problems. Our research expenditures in these areas were almost $11 million this year.

In addition, we continue to expand our faculty to meet the needs of students and further develop our research areas. We are pleased to welcome Jason D. Nicholas as an assistant professor in the department. He received his PhD from the University of California at Berkeley and worked as a post-doctoral researcher at Northwestern University.

2010 Red Cedar Circle Award

Carl L. English (BS ’68, Chemical Engineering) received the 2010 Red Cedar Circle Award at the annual College of Engineering Alumni Awards Banquet in May. The award recognizes MSU chemical engineering and materials science alumni for their distinguished service to the profession and outstanding commitment to the community.

English is the chief operating officer of American Electric Power. Reporting directly to the chief executive officer, he is responsible for all of the company’s utility business operations and related business functions, including regulatory services, environment, safety, health, and shared services operations. He also holds positions on two energy industry boards—the United States Energy Association and the Association of Edison Illuminating Companies.

Prior to his current position, English was president of AEP Utilities. In that role, he was responsible for AEP’s commercial operations, regulatory services, electric transmission and distribution, and customer operations, serving more than 5 million customers in 11 states.

While at MSU, the Jackson, Mich., native was inspired by Martin Hawley, one of his professors, to participate in the national AIChE student design contest his senior year; his third place marked the first time an MSU student had finished in the final top three in that competition. Over the past 35 years, MSU continues to hold the nation’s best record for placing in the AIChE National Student Design Competition.

Immediately after receiving his MBA in 1969 from MSU, English began his career with Consumers Power Company (now Consumers Energy) and worked there for 35 years. He served as vice president of Gas Distribution and Customer Services, vice president of Electric Distribution, and president and CEO of the Gas Division.

Throughout his career, English has served on a number of industry boards and committees. He continues to be extremely active in his community today, serving as board chair of Directions for Youth & Families and the New Albany Community Foundation. In addition he serves on the boards of CompeteColumbus, the Columbus Association for the Performing Arts, the Wexner Center for the Arts Foundation Board, and the Columbus Symphony Board. He also serves on the Columbus Downtown Housing Investment Funds Board and is chair of the United Way of Central Ohio’s 2010 Campaign.

Carl and his wife, Linda, live in New Albany, Ohio. They have two daughters, Marcy and Jessica. Jessica resides in Birmingham, Mich.; she received her BS in supply chain management from MSU in 2002. Marcy and her husband, Grant Berakovich, live in Royal Oak, Mich.; they are both graduates of Albion College.

Carl English, far right, celebrates with his family at the awards ceremony. From left, his son-in-law and daughter, Grant and Marcy Berakovich; his wife, Linda; and daughter, Jessica.
**Fundamental Research**

(continued from page 1)

so they break down. However, you can’t predict how long a particular solder joint will last. They all appear to be different.”

That fact has lead to the current focus of Bieler’s research: the effects of crystal orientation on the deformation of solder. He and his research team are looking at early failures and how crystal orientation affects the failures. “A big goal would be to control the orientation, but that seems unlikely. We could also try to create poly crystal joints, but with thermal cycling, they may become single crystals anyway.

The third alternative is to live with reliability based on the worst case crystal orientation(s),” says Bieler.

One area with interesting results that Bieler and a PhD graduate student, Bie Zhou, are working on is to study how tin grain orientations change during cycling of thermally aged Plastic Ball Grid Array (PBGA) packages. Each selected package is polished to view the solder joints from the top by both Polarized Optical Microscopy and Orientation Imaging Microscopy. The color is correlated to the crystal orientations, and using a color code based on the direction that the short dimension of the crystal (unit cell) points, the red orientations are more likely to crack. “In one sample with 11 joints, all the red orientations cracked and the rest did not. The tendency for red orientations to crack varies depending on the package design,” says Bieler.

This project was originally funded by Cisco Systems, Inc., which produces electronic equipment that is used throughout the Internet communication system. “High reliability in Cisco’s electronic systems is crucial, and its performance affects us all,” says Bieler. Now the research team has received additional funding through an NSF Grant Opportunities for Academic Liaison with Industry (GOALI) to continue this work. The research team includes Bieler, MSU mechanical engineering professor Farhang Pourboghrat, and Tae-kyu Lee with Cisco Systems, Inc. in San Jose, Calif.

The hope is that the information gained in this research program will result in three-dimensional models that can be used by electronic system design engineers. “With reliable models, it will be possible to develop ways to predict the likelihood of damage without resorting to collecting large quantities of statistical data,” says Bieler.

For more information about Bieler’s work, visit www.egr.msu.edu/~bieler.

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**Senior Wins Prestigious Scholarship**

Hoping to help fill the gap of women in engineering, materials science senior Kendell Pawelec, of Howell, Mich., has been named a 2010 United States Gates Scholar and will pursue her doctorate at the University of Cambridge in Cambridge, England.

“During my search for the perfect graduate school, I became intrigued by the history and academic excellence offered by Cambridge,” says Pawelec, MSU’s third Gates Scholar and the only 2010 such scholar in the Big 10. There were about 800 U.S. applicants, according to Cambridge University.

“Without a doubt, the questions that interest me the most in my field are related to the way living systems interact with materials,” she said. “I am excited at the prospect of studying materials science at Cambridge, with its excellence in biomaterials research, as I obtain my PhD.”

The Bill and Melinda Gates Foundation established the scholarship in 2000 with a $210 million donation to allow postgraduates to continue studies at Cambridge University. The awards cover the full cost of graduate study—doctorate or master’s level. Since 2001, there have been 827 Gates Scholars from 85 different countries. The 2010 cohort of U.S. scholars includes 29 students from 20 states.

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**New Honors at Cambridge for CHEMS Grad**

The prestigious Cambridge International Scholarships are provided by the Cambridge Commonwealth Trust and the Cambridge Overseas Trust, charities established by the university to support international students. Friederichs was selected for the award as one of this year’s best overseas PhD applicants at the University of Cambridge. The NSF Graduate Fellowships recognize and support outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based master’s and doctoral degrees in the United States and abroad.

Friederichs says that college life in England is more independent and self driven than in the United States. “We have a lot of freedom in our research here, which allows us to really make a project our own,” says Friederichs in an e-mail from Cambridge. “Also the social side of college life in England is strongly encouraged through various formal dinners that bring together faculty and students. This is a great chance for networking outside of your research group or department.”

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Robert J. Friederichs, who graduated with a bachelor’s degree in materials science in May 2009, has been studying at Cambridge for almost a year. He recently received two scholarships—the Cambridge International Scholarship and a National Science Foundation Graduate Research Fellowship.
### Endowments

**American Electric Power Foundation Provides Leadership Gift**

The American Electric Power (AEP) Foundation has partnered with the Department of Chemical Engineering and Materials Science to establish the AEP Foundation Energy and Sustainability Endowment. The AEP Foundation is part of the American Electric Power Company, based in Columbus, Ohio. The goal of this endowment is to create a permanent fund to enhance the research and educational programs around the theme of energy and sustainability, which is a growing area in the department in terms of faculty, research, and graduate students.

Income from the endowment will be used to enhance recruitment of outstanding graduate students in the field of energy and sustainability by providing students with competitive fellowships; to support the development of faculty by providing funding to attend relevant conferences and workshops; and to encourage the development of new research by providing seed funding for appropriate scholarships and/or laboratory supplies.

A large number of MSU alumni are currently employed at or have retired from AEP, including CEO and chairman Michael G. Morris (Law), chief operating officer Carl English (CHEMS), and board member Linda Goodspeed (CHEMS). This commitment of support to the College of Engineering will help the university to continue training the next generation of engineers and leaders.

### 2010 Johansen-Crosby Lecture

F. Joseph Schork, professor and chair of the Department of Chemical and Biomolecular Engineering at the University of Maryland, delivered the annual Johansen-Crosby guest lecture on April 29. At a morning lecture he talked about his research, which focuses on the development of miniemulsion polymerization. During a lecture at lunch, Schork talked about chemical engineering education, a topic that he is very passionate about. “Will we go the way of mining engineering, textile engineering, metallurgical engineering, petroleum engineering, or will the next evolution of chemical engineering be as impressive as the previous ones?” says Schork. He believes that the education of new chemical engineers must change to fit the new paradigms.

Schork is the author of one book and nearly 90 archival journal papers. He is a member of the editorial advisory board of *Polymer Reaction Engineering* and has been the co-chair of the 1994 Engineering Foundation Conference on Polymer Reaction Engineering. He is the recipient of the Doolittle Award for the best paper in Organic Coating and Plastics Division of the American Chemical Society, the W. T. Ziegler Outstanding Teacher Award, and the Omega Chi Epsilon Outstanding Teacher Award. He received his bachelor’s and master’s degrees from the University of Louisville and his PhD from the University of Wisconsin.

The Johansen-Crosby Endowment honors the parents of professor Edwin Johansen Crosby, who received a bachelor of science degree in chemical engineering from Michigan State University in 1950 and continued his studies at the University of Wisconsin, completing his PhD in 1955. Professor Crosby spent his entire career as an inspiring educator and researcher in the Department of Chemical Engineering at the University of Wisconsin.

The speakers for the Johansen-Crosby lectures are selected based on their strong research track records while also demonstrating an investment in the continuing development of chemical engineering education, in particular through the integration of new fields and tools into the instruction of core chemical engineering disciplines.

### Research Forum 2010

The Department of Chemical Engineering and Materials Science held its seventh annual Research Forum on May 19. The forum showcased research advances that have taken place in the department in each of the three main research thrusts of the department—energy and sustainability, nanotechnology and materials, and biotechnology and medicine.

The one-day program, held at the University Club of Michigan State University, featured several presentations on MSU research, poster displays, and late-breaking results in nanotechnology, biomedical engineering, renewable energy, and advanced materials.

The program also included talks by three well-known scientists:

- Dr. Yet-Ming Chiang, co-founder of A123 Systems and professor of materials science and engineering at Massachusetts Institute of Technology, discussed energy storage and batteries.
- Dr. Michael G. Matturro, director of corporate programs at ExxonMobil Research and Engineering Company, explained the concept of making fuels from algae.
- T. Kevin Murphy, senior clinical director in Worldwide Medical at Pfizer, talked about the latest opportunities in pharmaceuticals.
Jason D. Nicholas recently joined the department as an assistant professor. He obtained his PhD in materials science from the University of California at Berkeley in 2007 for his work on the sintering and electro-chemical properties of doped cerium oxide, a common electrolyte material for Solid Oxide Fuel Cells (SOFC’s). As a post-doctoral researcher at Northwestern University from 2007-2009, he developed nano-structured SOFC electrodes. His BS degree is from Franklin & Marshall College in Lancaster, Pa., and he obtained a master’s degree in materials science from the University of Illinois at Urbana-Champaign. His current research interests focus on nano-structured SOFC electrodes, amorphous SOFC catalyst development, constrained ceramic sintering, and SOFC heterojunction property enhancements.

Professor Christina Chan was honored with a Withrow Teaching Excellence Award at the college’s annual awards luncheon in March. Chan is a dedicated and enthusiastic instructor who genuinely cares about the academic success of her students. “Dr. Chan is professional, focused, and willing to go the extra mile to make sure that students understand the material.” That includes stopping lectures every ten minutes to ask for questions, providing in-class practice problems, and seeking feedback from students in order to fine-tune her teaching style.

Students admire Chan’s expert knowledge (and her handwriting speed!) and feel well prepared for challenging assignments. To facilitate learning, Chan provides detailed lecture notes and gives in-class assignments and worksheets to ensure that all students understand the material before moving on. “I felt like she actually cared about me and my learning and made a hard class enjoyable and interesting.” “Her office door is always open for additional help and advice about careers and graduate school.” “Thank you, Dr. Chan, for all of your preparation for design!”

Assistant professor S. Patrick Walton received one of six Teacher-Scholar Awards from the university at a ceremony in February. The award is given to instructors, assistant professors, and associate professors who early in their careers have earned the respect of students and colleagues for their devotion to and skill in teaching. The purpose of the award is to recognize the best teachers who have served at MSU for seven years or less.

Walton received his bachelor’s degree in chemical engineering from Georgia Tech, and an MS (Chemical Engineering Practice) and ScD in the Department of Chemical Engineering at Massachusetts Institute of Technology (MIT). While at MIT, he was awarded a Shell Foundation Fellowship and was an NIH Biotechnology Predoctoral Trainee. Upon completion of his ScD, he joined the Stanford Genome Technology Center, receiving an NIH Kirschstein post-doctoral fellowship to support his research.

Since joining MSU, Walton has established a research group focused on nucleic acid biotechnology and recently graduated his first two PhD students, one of whom received multiple outstanding graduate student awards in the college and department. He has been a PI or other investigator on nearly $3 million in external research funding and has led the department’s efforts in the recruitment and retention of excellent undergraduate and graduate students.

The Dual-Beam FIB uniquely directs a highly focused ion beam for nano-scale milling, sectioning, and patterning of materials. In this mode, the FIB will be used widely for materials research and characterization studies, including automated serial sectioning for 3-D analysis, TEM sample prep from precise selected areas, and fabrication of a variety of nano-scale structured test specimens and MEMS devices. With the addition of high-resolution patterning of both conductors and dielectrics (facilitated by the field emission gun SEM column), the FIB will also allow prototyping of nano-scale electronic/magnetic/mechanical devices.

The instrument, which arrived at the Engineering Building in May, is located and maintained in the Composite Materials and Structures Center as both a research and user facility. “This ESEM/FIB will add capacity for new research initiatives at MSU,” says Drzal, who is the director of the center.
Student Bond

Outstanding Graduate Students

From left: Assistant professor Patrick Walton, Shengnan Xie, and Manoochehr Koochesfahani, associate dean for graduate studies and faculty development.

Shengnan Xie, a PhD graduate student in chemical engineering, and Xueling Fei, a PhD graduate student in materials science, were honored as the department’s 2010 outstanding graduate students at a reception in March.

Xie’s work is focused on the development of novel parallel analytical methods for the measurement of biological molecules. The analytical methods utilize genomics tools in the analysis of non-nucleic acid molecules through the use of aptamers, nucleic acid molecules that bind other types of molecules through structural interactions. As a part of her research accomplishments, Xie developed the dual aptamer analytical strategy for proteins.

She is doing her PhD work under the direction of Patrick Walton and helps manage Walton’s research group, taking responsibility for the daily operation of his laboratory. “Shengnan has become a truly independent scientist, which makes me very proud,” says Walton. “I have relied on her in many ways to help manage the group and lab operations.” Walton also says Xie is an exceptional “lab citizen,” and always brings a positive attitude to the lab and her interactions with her colleagues.

Fei is working under the guidance of professor David Grummon. “In his work on shape memory alloys he has conducted one of the most detailed and interesting experimental programs of any of my graduate students in the last decade,” says Grummon. The main result of Fei’s work has been the development of an indentation-planarization technique to achieve what is called “Surface Form Memory” (SFM) in which transitions between flat and highly non-flat surfaces are driven by small temperature changes.

In addition, Fei is an active supporter of Grummon’s efforts to commercialize NiTi joining technologies and was instrumental in developing a proposal that won funding from the MIIE to develop a reactive eutectic brazing process for shape memory materials. Besides personal research, Xueling has demonstrated his effectiveness as a leader and as a mentor to many undergraduate students who work in Grummon’s laboratory. He often takes the initiative to organize group discussions and is actively involved in training undergraduate researchers.

Engineering Excellence Service Awards

Raul Dacomba Torres and Megan Massa, both CHE seniors, received Engineering Excellence Service Awards for 2009-2010 for distinguished service to the CHEMS department, the college, and MSU. They received their awards during an April 27 reception.

Dacomba was nominated by CHEMS associate professor Daina Briedis. Dacomba is the president of Omega Chi Epsilon, the chemical engineering honor society. “Raul has been the most proactive president and leader of the group in the entire 27 years for which I have been the adviser for OXE,” says Briedis. Dacomba made contacts with industry to increase funding for OXE, and as a result Shell Oil Co. is now an established sponsor of the group’s outreach activities and Dow Corning sponsored the OXE Junior Competitive Exam.

Massa was recommended by CEE professor Susan Masten. “Megan took on numerous leadership roles in the Environmental Engineering Student Society (EESS), including serving as co-president this past year,” says Masten, who is adviser to the EESS. Massa was instrumental in the Girl Scout Water Wonders Badge workshops, in the Bumper Sticker contest run at several middle schools, and in preparing and staffing displays for the Engineering Open House, O-night at Wilson Hall, and River Cleanup.

Fitch H. Beach Award

Wei Chen received third place in the Fitch Beach Award competition. The topic of his presentation was: “Seeing Is Believing: The In-situ Study of the Tensile and Fatigue Behavior of Boron-Modified Titanium Alloys.” Associate professor Carl Boehlert is his adviser.

Chen received his PhD in materials science and engineering in May. He worked on new titanium alloys for jet engine applications in Boehlert’s research group. His PhD dissertation was titled “The Effect of Processing on the Physical and Mechanical Metallurgy of Boron-Modified Alpha/Beta Titanium Alloys,” in which he focused on the study of tensile, fatigue, and creep behavior of two titanium alloy systems at elevated-temperature.

Since joining the PhD program in 2006, Chen has published seven papers in peer-reviewed journals and given ten external presentations. He is currently working at the Oak Ridge National Laboratory as a postdoctoral research fellow.
**High-Achieving Student Recognition**

At the SWE awards banquet in February, students from various engineering departments were recognized for their academic efforts. For the CHEMS department this included:

Corey Anderson, chemical engineering
Dushyant Barpaga, chemical engineering
Justin Biega, chemical engineering
John Franklin, chemical engineering
Anthony Grillini, chemical engineering
Tyler Hackert, materials science and engineering
Maxwell Hartsell, chemical engineering
Robert Hasselbeck, chemical engineering
Logan Matthews, chemical engineering
Derek Miller, materials science and engineering
Kendell Pawelec, materials science and engineering
Shane Ung, chemical engineering
Jie Wen, materials science and engineering

**Trustees Honor Graduates**

Justin Biega and Kendell Pawelec were among 23 MSU students honored April 16 by the MSU Board of Trustees for their academic achievements. Board of Trustees awards are granted at each commencement to graduating seniors having the highest cumulative grade point averages at the close of the semester prior to graduation.

**Biega** from Plymouth, Mich., is a chemical engineering major and is the son of Diane and Robert Biega. A member of the Honors College, he has a 4.0 GPA. Biega is a graduate of Plymouth-Canton High School.

**Pawelec** of Howell, Mich., is a materials science and engineering major. She is the daughter of Melinda and John Pawelec. A member of the Honors College, she has a 4.0 GPA. Pawelec was home schooled.

**Outstanding Senior Award**

CHEMS graduating senior Ben Kremkow was awarded an Outstanding Senior Award by the Senior Class Council for his combined academic excellence and extracurricular involvement at MSU. Kremkow has been a member of the Spartan Marching Band, the Honors College, the International Society for Pharmaceutical Engineering, a representative on the University Undergraduate Research Advisory Board, and a member of Omega Chi Epsilon, the chemical engineering honor society.

Each year the MSU Senior Class Council recognizes up to 25 outstanding seniors in the year’s graduating class. The awardees are students who, in their time at Michigan State University, have succeeded academically, served enthusiastically, and impacted the university positively.

Kremkow will attend graduate school for a PhD in chemical engineering in the fall. He plans to work on a biotech, biomedical, or pharmaceutical project. This summer, he has an internship at Perrigo Company in Allegan, Mich., in engineering research and development.

**SWE Awards**

Linsey Seitz, Chelsea House, and Gabriela Fratta received Outstanding Member Awards at the Society of Women Engineers (SWE) awards banquet in February.

Linsey Seitz, a graduating senior and the current president of the Society of Women Engineers (SWE), received an award sponsored by Shell Oil Company.

Seitz also received a National Science Foundation Graduate Fellowship, which provides tuition and living expenses for three of the next five years. She is going to Stanford University in the fall to pursue a PhD in chemical engineering.

Seitz has worked with professor Christina Chan in her lab since her freshman year as a professorial assistant. She studied abroad twice (once with the Freshman Seminar Program in Ireland and with a six-week summer program in France). She also has done research full-time during two summers (once at MSU and once at Berkeley with the CPIMA SURE program). She has been an active member of SWE since her freshman year and is also a member of Tau Beta Pi and AIChE. Seitz grew up in Naperville, Ill., and is the daughter of Joe and Holly Seitz.

Chelsea House, a materials science and engineering junior who will graduate in December 2011, received an award sponsored by Alcoa. House, who is from Manistee, Mich., is the daughter of Bill and Terry House. She is a member of SWE and is currently the Great Lakes State Conference co-chair. She also is a member of the advisory editorial board for the Red Cedar Undergraduate Research journal and the Honors College, and is a peer mentor for Women in Engineering. House has worked in Melissa Baumann’s research lab, investigating the effects of microcracking in hydroxyapatite and its implications for synthetic bone replacement.

She has had two internships with Abbott Laboratories. This summer House has another internship with Abbott in its Vascular Device Division working on guidewire quality control for vascular stent systems.

Gabriela Fratta, a chemical engineering sophomore, received an award sponsored by BP.

Ben Kremkow
Linsey Seitz
Chelsea House (right)
Gabriela Fratta
Kayla Kalmbach, a CHEMS senior who had a goal to attend MSU for as long as she can remember, was featured at the engineering commencement where she sang the Star-Spangled Banner.

She is from East Grand Rapids, Mich., where she attended East Grand Rapids High School. Kalmbach is a four-year letter winner on the MSU varsity swimming and diving team and qualified for NCAA Regionals the past two years. Upon graduation, she moved to Clarksville, Tenn., to work for Hemlock Semiconductor in a start-up engineering capacity.

ChE senior Merek Roman gave the student commencement address at the College of Engineering graduation ceremony at the Breslin Center on May 9. Coming from a family of engineers, Roman has always had a mindset for engineering, though he is the first chemical engineer in his family. Roman was attracted to chemical engineering by his interest in chemistry during high school.

He is from Glen Arbor, Mich., and attended Glen Lake Community High School. While at Michigan State University, Roman was a traveling member of the Fencing Club and the 2009-2010 Student Engineering Council president.