UNIVERSITY OF MARYLAND 1856

SPRING 2014

COLUMNS

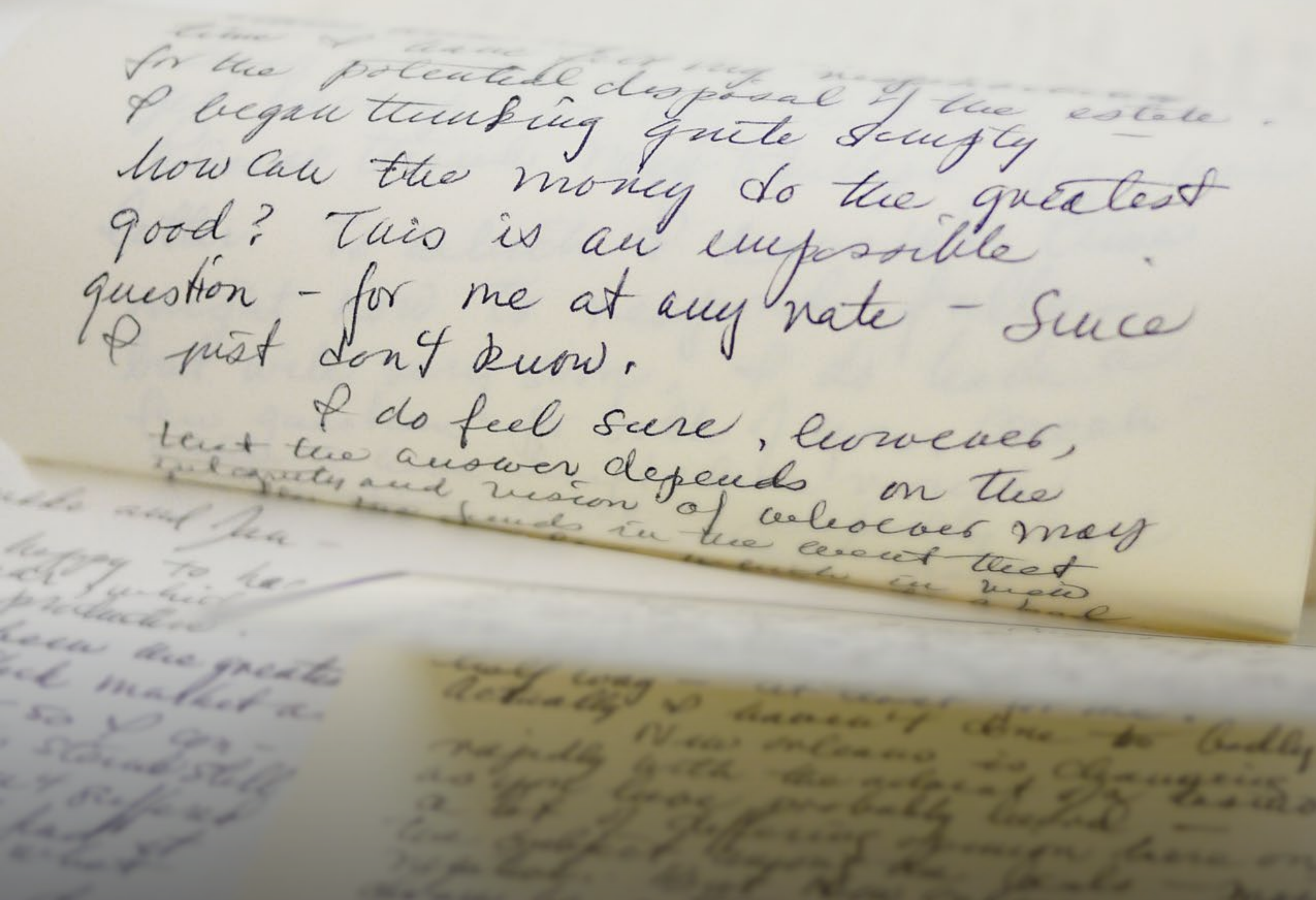
CHEMICAL AND BIOMOLECULAR ENGINEERING

A. JAMES CLARK SCHOOL *of* ENGINEERING

www.chbe.umd.edu

“The Greatest Good”

Alumna’s bequest creates new endowed Chair.



LIU: NSF CAREER AWARD | PUTTING A SQUEEZE ON BLOOD | ENGINEERING IN THE MAGIC KINGDOM

chair's MESSAGE

EDUCATION + IDEAS = TERP DREAMS REALIZED!

During my first year as Chair, a freshman walked into my office for advising. I asked him what his dream job was and he told me he wanted to work for the Walt Disney Company. Not the usual dream job for a chemical engineering major, but nonetheless, his personal dream. Within a few years, the same student landed a year-long, engineering co-op experience at Disney. He's back now to complete his final three semesters, and you can read more about him on page 11.

It seems every week, I hear a similar story, and I think this is one of the best parts of my job! In 1974, **Frances Balfour** came to UMD to fulfill her dream of completing her Ph.D. under Professor **Jan Sengers**' supervision. You can read her story on page 3.

Our students have gone on to graduate school at MIT, Berkeley, Princeton, the University of Minnesota and other top Ph.D. programs. As we were going to press, we learned that senior **Sudabeh (Sudi) Jawahery** received an NSF Graduate Research Fellowship! This fall, she'll be attending the graduate program in chemical engineering at the University of California, Berkeley.

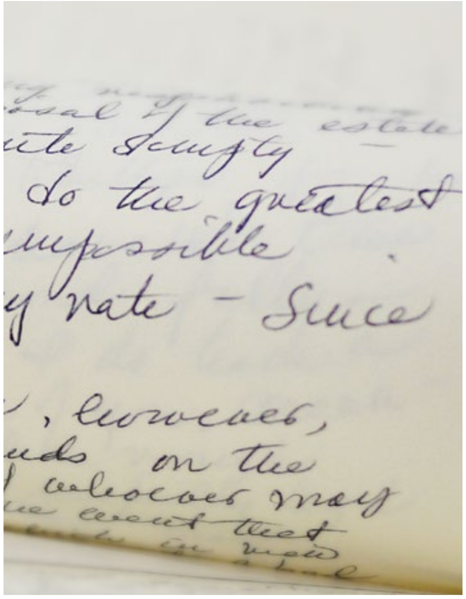
Before they graduate, our students dream about obtaining international experience and in recent years, they have studied abroad or interned in Korea (see **ter.ps/wiestborenkr**), Turkey, China (see **ter.ps/solaratpku**), Spain, Australia and many other places. They have also participated in development projects through Engineers Without Borders in Burkina Faso (see **ter.ps/ewbchbebf11**) and Peru.

Students, faculty and alumni are fulfilling dreams of career advancement and making the world a better place via discoveries, technology development and commercialization of everything from better beer (see page 6) to more cost effective batteries, stickier football gloves, and safer oil drilling. Alumni–if you have a story to tell about a dream realized, please let us know!

Go Terps!

Sheryl H. Ehrman
Keystone Professor and Chair

IN THIS ISSUE:



ON THE COVER:

In a 1997 letter to Professor Emeritus **Jan Sengers**, his former advisee and longtime friend, Dr. **Frances Balfour** (Ph.D. '82, chemistry), wondered what sort of legacy could be established by her estate. **"I began thinking quite simply–how can the money do the greatest good?"** she wrote, adding that the admiration and respect she felt for her mentor had led her to broach this very important and personal topic with him. In 2013, the University of Maryland's Department of Chemical and Biomolecular Engineering was honored to announce that, thanks to the generosity of this unusual alumna, it would soon begin the search for its first Robert Franklin and Frances Riggs Wright Distinguished Chair in Chemical Engineering. For the story behind the letter and bequest, see p. 3.

Scholarship, Friendship and Gratitude

BEQUEST OF ALUMNA FRANCES BALFOUR (PH.D. '82) CREATES NEW ENDOWED CHAIR

In 1974, a 49 year-old woman arrived, unexpected and without invitation, at the University of Maryland with a very specific request: She wanted to pursue a Ph.D. in chemistry—*if* she could study under Professor **Jan Sengers**. The woman's name was **Frances Balfour**, and her visit marked the start of a unique relationship that lasted over 35 years and ended with a bequest that established the **Robert Franklin and Frances Riggs Wright Distinguished Chair in Chemical Engineering**.

Balfour was born in 1925. Her father was an electrical engineer and the general manager of Westinghouse's New Orleans facility. Her mother, whom she described as a "beauty," was a homemaker. Her maternal grandfather, a surgeon, encouraged her interests in science and math, a rare pursuit for a young woman at the time. She received a bachelor's degree in chemistry from Duke University in 1947.

Widowed at a young age, Balfour had no children and never remarried. She never lost her love of science, and financial independence enabled her to return to college. She studied at Tulane University from 1958–1964, where she became familiar with work published by a physicist named **Jan V. Sengers**. But the school was not a good fit for her, and she left without receiving a degree.

Ten years later, Sengers, six years her junior, was a professor at the University of Maryland's Institute for Molecular Physics, and she had suddenly appeared, asking him to be her advisor.

"Now of course I could not refuse that!" says the now-Distinguished University Professor Emeritus, who holds joint appointments in the Department of Chemical and Biomolecular Engineering (ChBE) and the Institute for Physical Science and Technology (IPST).

Not everyone was so welcoming. "She was a bit rusty in her knowledge, so some people looked down on her a little," Sengers explains, "but I wanted to give her an opportunity to pursue a Ph.D."

Sengers, who was scheduled to take a sabbatical, arranged to have Balfour spend her first year at the National Institute of Standards and Technology, where she worked with his wife, Dr. **Anneke Levelt Sengers**, possibly her first female scientific role model.

After earning her doctorate in 1982, Balfour worked as a physical chemist in a shipyard in Mississippi. She eventually returned to her family's home in Metairie, Louisiana to care for her mother, and lived there for the rest of her own life. She stayed in touch with Jan and Anneke Sengers, with who she had become good friends.

Years later, Sengers visited Balfour while in New Orleans for a conference. "She started talking to me about what she should do with her legacy," he says, "and I [was] totally naïve. I had no idea she was thinking about the University of Maryland." Instead of suggesting a donation to the school, he replied that finding a recipient who shared her values should influence her decision. "Then she said, 'I knew I had the right Ph.D. advisor!' Later on I realized she was testing whether her money would be in safe hands at the University of Maryland."

When Balfour decided to leave an endowment to the university, Sengers had become the chair of the then-Department of Chemical Engineering. Although her Ph.D. was in chemistry, she agreed to use her legacy to help him strengthen the department. With the assistance of the Clark School's development staff, they established an endowed chair named in honor of her parents.

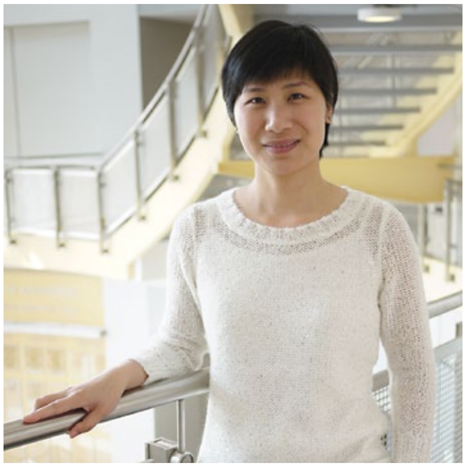
Dr. Frances Balfour passed away in 2011. Her generosity has enabled ChBE to begin the search for its first Robert Franklin and Frances Riggs Wright Distinguished Chair in Chemical Engineering.

"This was done in gratitude," Sengers says of his remarkable friend. She has entrusted her financial and spiritual legacy to us, because she knew that we would be worthy of her trust."

See page 10 to learn how another generous donation is advancing the department.

Liu Wins NSF CAREER Award

NEW CERAMIC REACTIVE-SEPARATIVE MEMBRANE COULD REDUCE WASTED METHANE



ASSISTANT PROFESSOR DONGXIA LIU.

A proposal to use a new ceramic membrane to improve the conversion of methane into alternative fuels has earned ChBE assistant professor **Dongxia Liu** a 5-year, $400,000 National Science Foundation Faculty Early Career Development Award.

Methane, the main component of natural gas, can be converted into C_2 (diatomic carbon)-based gases such as ethylene and ethane, which are used to produce commodity chemicals, polymers, and alternative fuels. It has the potential to play a significant role as a raw material for fuel and chemical production, reducing our need for petroleum. As a resource, Liu says, methane is abundant and much cheaper than petroleum. This should be a winning combination, but converting methane into usable products is a problem.

"The price of petroleum-like chemicals derived from methane is high because we do not have a cheap, efficient process for converting methane into these products," she explains, "so we cannot use it directly as an energy source in the near future."

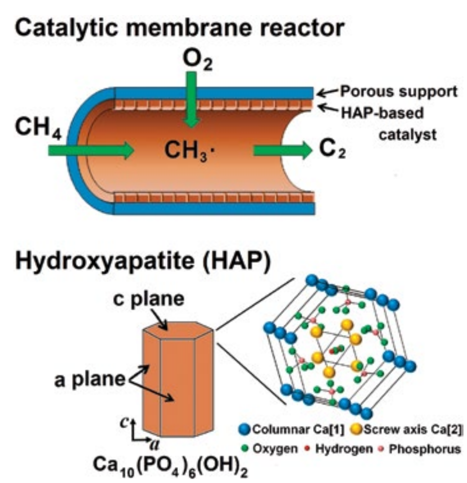
As a result, she adds, a lot of methane goes to waste. "When we drill for oil, we also get methane, but most of the methane produced by oil rigs, especially in remote locations, is burned off instead of used. That pollutes our environment by releasing carbon dioxide into the atmosphere."

When the methane that does get used undergoes the oxidative conversion process that converts it into C_2 products, two reactions take place. The first transforms the methane into the desired gases, such as ethylene and ethane. These products, however, are unstable under reaction conditions, so they react a second time, becoming carbon monoxide (CO) and carbon dioxide (CO_2) gas, which are undesired byproducts. Even under the best conditions, over 50 percent of the potential C_2 products derived from methane will be lost during this second reaction.

Liu explains that the challenge to efficient methane conversion lies with the critical control of oxygen (O_2) concentration and catalyst activity in the reaction chamber's membrane, which stimulates the process.

"What we need is a proper amount of O_2 in the reactor," says Liu. "If there is too much, the second, unwanted reaction happens; and if too little, the methane conversion is low so the process is not efficient."

The reactor's membrane is responsible for both permeation, the process by which oxygen from the atmosphere is added to the reactor, and methane activation, the reaction that produces C_2 gases. In an ideal situation, it would be capable of performing comparable levels of permeation and activation to ensure the speed and output required for industrial production of C_2 products. Currently, no available membrane material can create the C_2 gases as fast as it permeates O_2. This leaves the catalyzed ethylene and ethane exposed to excess oxygen and vulnerable to the second reaction that converts them to CO and CO_2.



Liu's research group is developing a new type of catalytic membrane based on a material called hydroxyapatite (HAP), a biomineral found in teeth and bones. The new material is reactive-separative, meaning it is both a catalyst for the reactions and capable of permeating C_2 in controlled concentrations into the reactor. Liu believes a perfected HAP-based membrane could perform each task at a comparable rate, wasting less methane, preventing the production of greenhouse gases, increasing product yield, and reducing the energy required to obtain the desired results. The technique used to create the membranes allows Liu's team to control their structure at the nanoscale, so they can also be tuned (adjusted or customized) for different reaction conditions and products.

"The mastery of methane conversion chemistry and technology is essential to provide value-added alternatives to petroleum-based chemicals and fuels," says Liu. "This research will stimulate new material discovery and develop techniques that can impact the future of the world's energy and chemical supplies."

Dimitrakopoulos Puts a Virtual Squeeze on Blood

The National Science Foundation (NSF) has awarded ChBE associate professor **Panos Dimitrakopoulos** a grant that will fund the development of advanced computations that could improve "lab-on-a-chip" devices, drug delivery, and the treatment of blood-based diseases.

The three-year, $300,000 award is the most recent of a series of grants Dimitrakopoulos' BioFluid Dynamics Laboratory has received to support the development of computational models that predict the behavior, physical transformations, and motion of erythrocytes (red blood cells) and capsules in situations that would be difficult to record live in the human body. The new study, which focuses on the squeezing motion of erythrocytes and capsules though tight spaces, will expand the scope of the work by including simulations of their behavior in microfluidic, lab-on-a-chip devices.

"We study microfluidic channels because they are used widely for the study of single and multiple cells, both healthy and ill," explains Dimitrakopoulos. "They are very simple to construct and need only a very small volume of blood. Microfluidics have a great variety of applications."

Understanding the squeezing motion of capsules and erythrocytes in microfluidic channels and vascular capillaries has wide applications in biomedical and physiological processes, including targeted drug delivery, cell sorting and characterization, hemopathology, and oxygen delivery to the body's tissues via its capillary network.

Currently, the scientific and medical communities have only a limited understanding of the lubrication physics that define the interaction between the membrane of a capsule or erythrocyte and the confined, solid walls of the narrow channels or capillaries through which they pass. In order to create simulations that realistically depict their "squeezing motion," Dimitrakopoulos' group will investigate their activity in square and rectangular microchannels of various configurations, and in vascular capillaries 3-8 micrometers in diameter. The behaviors of both healthy cells and those affected by elliptocytosis (a condition in which red blood cells are elliptical instead of biconcave discs) will be studied. Dimitrakopoulos also expects to identify the mechanical membrane properties (such as stiffness or flexibility) that hinder cell flow of both cells and capsules in these conditions.

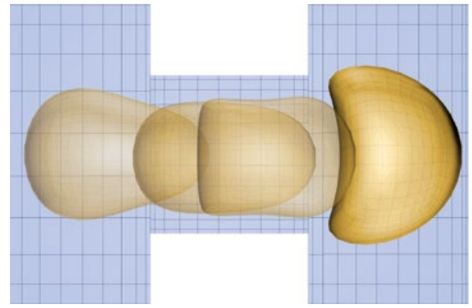
The computational study is made possible by Dimitrakopoulos' non-stiff membrane spectral boundary element algorithms, an advanced simulation system his research lab created for use in past studies.

"The proposed research has the potential to make a significant contribution to the physical understanding of the realistic motion of capsules," says Dimitrakopoulos. "It can help explain targeted drug delivery, the resistance of blood flow, and the cell deformation that affects the erythrocytes' aging and lifetime. Our findings can be used to improve lab-on-a-chip devices, the separation of healthy from diseased cells, and the control of common blood disorders."

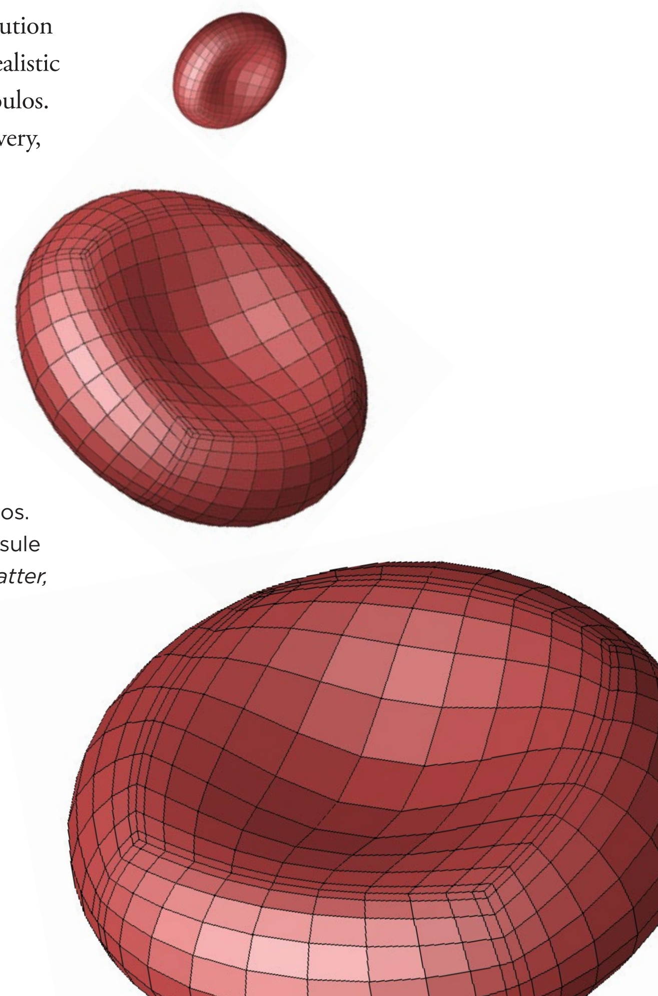
For more information:

Sun-Young Park and P. Dimitrakopoulos. "Transient dynamics of an elastic capsule in a microfluidic constriction." *Soft Matter*, 2013, 9, 8844-8855.

ter.ps/rbctanktread
ter.ps/rbcdisease



A COMPUTATIONAL MODEL SHOWING A CAPSULE'S CHANGES IN SHAPE AS IT MOVES THROUGH A CHANNEL IN A MICROFLUIDIC DEVICE. THE THREE-DIMENSIONAL CAPSULE VIEWS WERE DERIVED FROM THE ACTUAL SPECTRAL GRID USING ORTHOGRAPHIC PROJECTION IN PLOTTING. FROM "TRANSIENT DYNAMICS OF AN ELASTIC CAPSULE IN A MICROFLUIDIC CONSTRICTION."



Alumni Accomplishments, Honors and Awards

JURADO RECEIVES BREWERS ASSOCIATION AWARD

Jaimie Jurado (B.S. '83) received the Master Brewers Association of the Americas' (MBAA) Award of Honor at the group's annual conference. Jurado, a past president of the MBAA, was recognized for his "outstanding and dedicated service."

Jurado is currently the Director of Brewing Operations for the Abita Brewing Company, located in Abita Springs, La. Previously, he served in similar positions at the Susquehanna Brewing Company and the Gambrinus Company; and has also held positions at Patrizier-Bräu, Foster's, and the Stroh Brewery Company. He has studied brewing and managed breweries all over the world, including locations in Europe, Africa, Australia, and India.

KIM JOINS FACULTY OF INCHEON NATIONAL UNIVERSITY

Kyobum Kim (Ph.D. '10) has accepted a faculty position in the Department of Life Sciences and Bioengineering at Incheon National University, Korea.

In his new role, Kim will teach fundamental bioscience classes including cell biology and biochemistry, and develop new courses on tissue engineering, biomaterials, and stem cell science. He will also continue his research on the clinical application of stem cells and biomaterials in regenerative medicine.

During his graduate studies at the University of Maryland, Kim was advised by Fischell Department of Bioengineering professor **John Fisher**. As a member of Fisher's Tissue Engineering & Biomaterials Laboratory, he investigated stem cell response to engineered scaffolding (support structures) and hydrogels used in the regeneration of tissue and bone. In particular, he explored how adjusting the characteristics of the biomaterials that support implanted stem cells could be used to control the differentiation of those cells into the type of tissue cells required. These adjustments could also be used to influence the behavior of the patient's existing tissue cells.

Kim then joined Rice University professor **Antonios G. Mikos**' research group, one of the most prestigious in the fields of tissue engineering and biomaterials. There, he developed bilayer composite hydrogels to encourage the differentiation and growth of two distinct cell types in a single support structure. The goal was to engineer tissue that

Alumni Research

ALUMNA'S WORK COULD LOWER BIOFUEL PRODUCTION COSTS

Ezinne Achinivu (B.S. '10) is part of a research group that has devised a simple, effective and inexpensive way to perform a separation of materials that is an important step in the production of biofuel. The boost in efficiently saves energy and could lower the cost of alternative fuels derived from plants.

Achinivu, who is currently a Ph.D. student at North Carolina State University, first-authored a paper explaining the new process in a recent issue of *Green Chemistry.*

Biofuel production starts with biomass, material that often contains all of the non-edible parts of a food crop, waste wood, or even purpose-grown plants or trees. The high-energy cellulose found in the biomass is the key ingredient fuel producers need, so other material must be filtered out. Lignin, a polymer that strengthens plant cell walls, is difficult to break down and remove, and the extra effort required to do it increases the cost of the final product.

Achinivu and her colleagues mixed and heated their biomass with protic ionic liquids (PILs), an easy-to prepare and relatively inexpensive acid-amine combination. The lignin dissolves into the PIL, leaving solid pieces of cellulose behind. These are easily filtered out and move on to the next step in the biofuel production process. Meanwhile, the PIL-lignin mixture is distilled. The PIL is recovered and recycled, while the lignin left behind–now in the form of a powder–can be used to produce other products. Achinivu's team is currently developing PILs for use with different kinds of biomasses, and is also optimizing the PIL-lignin interactions in order to isolate the most lignin using the least amount of energy possible.

Ezinne C. Achinivu *et al.* "Lignin Extraction from Biomass with Protic Ionic Liquids." *Green Chem.,* 2014, 16, 1114-1119.
ter.ps/ezinnelignin

ALUMNUS' BACTERIA PROWL FOR PATHOGEN PREY

A bacterium that preys on pathogens, bioengineered by **Matthew Wook Chang** (Ph.D. '03), was featured in the September 11, 2013 issue of *Nature,* one of the world's most prominent international journals. Chang, now a professor in the School of Chemical and Biomedical Engineering at Nanyang Technological University, Singapore, created a strain of *E. coli* that seeks and destroys the antibiotic-resistant bacterium *P. aeruginosa,* a leading cause of hospital-acquired infections.

mimicked the layers of cartilage and bone found in osteochondral tissue.

After completing his studies at Rice, Kim became a postdoctoral research associate in the Department of Bioengineering at the University of Pittsburgh, where he investigated how to effectively deliver heparin-binding growth factors to cells.

QIN ELECTED FELLOW

S. Joe Qin (Ph.D. '92) has been named an elected fellow of the International Federation of Automatic Control (IFAC), a multinational partnership of independent professional societies that focus on the development and use of automatic control systems in scientific, biological, economic and social contexts.

Qin was recognized for "important contributions to data-driven statistical process monitoring and fault diagnosis and to the unification of different methods and applications of model predictive control." With his election, he becomes one of only 147 IFAC Fellows worldwide.

S. JOE QIN

Qin, the Fluor Professor of Process Engineering and Vice Dean of the Viterbi School of Engineering at the University of Southern California, is also an elected fellow of the Institute of Electrical and Electronics Engineers (IEEE) and the author of over 100 papers. He is the recipient of numerous honors for his achievements in research and education, including a National Science Foundation (NSF) CAREER Award, the Viterbi School's 2011 Northrop Grumman Best Teaching Award, the DuPont Young Professor Award, the Halliburton/Brown & Root Young Faculty Excellence Award, and the NSF-China Outstanding Young Investigator Award. He was also named the Chang Jiang Professor of Tsinghua University by China's Ministry of Education. His current research focuses on model predictive control, fault diagnosis, system identification, and monitoring of semiconductor, chemical, pulp and paper processes.

This is not the first time he has recruited *E. coli* to fight *P. aeruginosa*: In 2011, *Nature, Molecular Systems Biology,* and *The Scientist* featured his creation of *E. coli* that respond to the presence of *P. aeruginosa* first by finding it, then manufacturing a targeted antibiotic protein called pyocin. The *E. coli* swell with the antibiotic until they burst, releasing the pyocin onto *P. aeruginosa* and killing them both.

It's a noble sacrifice, but thanks to some modified tactics, it's no longer necessary. Chang's team is now genetically engineering *E. coli* to produce microcin S (MccS), a killer peptide, instead of pyocin. MccS is a much smaller molecule, so the *E. coli* can secrete it when necessary and live to fight another day. The improved bacteria also manufacture a nuclease (enzyme) called DNase I, which they use to penetrate and break up the biofilm that holds colonies of *P. aeruginosa* together. The advance in the work was published in September 2013 by *ACS Synthetic Biology.*

Both versions of Chang's *E. coli* have another important advantage: They exclusively hunt and kill *P. aeruginosa,* leaving good bacteria, like those that aid digestion, alone. This is because they only respond to a specific molecule *P. aeruginosa* bacteria excrete to communicate with each other as they form a colony and initiate an infection. Once the molecule is detected, the modified *E. coli* "activate" and track it back to its source, manufacturing their antibiotics along the way.

For more information:

In Young Hwang *et al.* "Reprogramming microbes to be a pathogen-seeking killer." *ACS Synthetic Biology*, 2013
ter.ps/changsynbio

MEDIA COVERAGE

ACHINIVU: BIOFUEL PRODUCTION

The Engineer: Technique aims to reduce the cost of biofuel production
ter.ps/ezinnetheeng

CHANG: HUNTER-KILLER BACTERIA

Nature: Engineered bacterium hunts down pathogens
ter.ps/changnat0913

Nature: Set a bug to kill a bug
ter.ps/setbugtokill

The Scientist: Bacteria Kamikazes
ter.ps/bactkamikaze

The Economist: Set a thief...
ter.ps/setathief

UMD: Fight Bacteria With Bacteria
ter.ps/killerecoli

Alumni Innovations

DO-IT-YOURSELF SOLUTIONS FOR LABS IN DEVELOPING NATIONS

Is your lab underfunded? Underequipped? In need of repairs? ChBE alumnus **Michael Sungwon Kang** (B.S. '12) is part of a growing organization that will help you help yourself in creative and affordable ways.

Kang, currently a graduate student in the University of California Berkeley/UC San Francisco Joint Graduate Program in Bioengineering, is the co-chair and COO of Tekla Labs, a graduate student-run nonprofit group that provides open source, do-it-yourself blueprints for building laboratory equipment.

Although the group's resources are available to everyone, it was founded with the goal of enabling scientists and schools in developing countries to build the equipment they need. A Tekla survey of 20 Latin American labs, for example, found that over 50 percent were in need of basic equipment such as chemical hoods, microscopes, magnetic stirrers, and centrifuges.

Tekla's online and downloadable Guide Library contains illustrated step-by-step instructions, photos, and lists of tools and parts required for each project, with a particular focus on using as many off-the-shelf, repurposed, and locally available components as possible. The website also hosts a growing community of international designers and scientists who contribute guides, share examples, and answer questions.

"In the past year we've enjoyed considerable success, and are working on growing bigger and becoming a foundational resource for research-grade designs," says Kang. "In just a year we've successfully hosted our first competition, Print My Lab, where we solicited 3D-printable designs for lab equipment."

In 2013, Tekla partnered with Instructables to present the Build My Lab competition, which awarded prizes for the best do-it-yourself solutions to real problems and needs submitted by researchers in Colombia, Nigeria, Peru, and Uganda.

Tekla has also earned its second win and a $10,000 prize in UC Berkeley's Big Ideas competition, and has delivered a number of conference talks and presentations at events such as the 2013 Clinton Global Initiative University conference and the Bay Area MakerFaire. Tekla staff also lead a session at the 2014 annual meeting of the American Association for the Advancement of Science.

Outside of Tekla Labs, Kang studies mechanosensitive behaviors and responses of neural progenitor cells under UC Berkeley professors **Sanjay Kumar** and **David Schaffer**.

Alumni Passings

CHARLES E. WAGGNER, 81

ChBE is sad to report that alumnus and A. James Clark School of Engineering Board of Visitors member **Charles E. "Chuck" Waggner** (B.S. '54) passed away in December 2013. He was 81.

"He was a valued and dedicated member of our Board of Visitors, and was also simply a great human being who genuinely cared about others," says Farvardin Professor and Dean **Darryll Pines**.

Waggner was born in Baltimore, Maryland and was a graduate of Baltimore Polytechnic Institute. He received a bachelor of science degree in chemical engineering from the University of Maryland, where he excelled in track and field and was the captain of the university's cross country team. He later obtained a juris doctor degree from Loyola University in Chicago.

Waggner enjoyed a distinguished career in the petrochemical industry, first working for Standard Oil in Baltimore, and then moving to Illinois to join the Cosden Oil Company, eventually transferring to Cosden's New York offices. The majority of his career was spent as a partner and Executive Vice President of Esselen Associates in Darien, Ct., where he worked until his passing.

At 46, Waggner became an avid runner, completing upwards of 70 marathons. In addition to competing in New York, Boston, and Houston, he ran internationally, achieving a personal best time of 2:55:36 at the London Marathon.

He is survived by his wife of 33 years, Joan; his six children, Robert, Sharon, Nancy, Mark, Ellen, and David; stepdaughters Christine and Torrey; and 11 grandchildren.

CLIFFORD E. LANHAM, 75

ChBE is sad to report the passing of one of its alumni, **Clifford E. Lanham** (M.S. '72), at the age of 75.

Lanham spent most of his career as a civilian research physicist and biomedical engineer for the U.S. Army. In 1989, he became the manager of the Army's domestic technology transfer program, which coordinates the Army's exchange of scientific and technical information with collaborators in academia, industry, and government offices. Later in his career Lanham worked as a consultant for Booz Allen Hamilton, the National Institute on Disability and Rehabilitation Research, the Office of Naval Research, the University of the District of Columbia, and Rockville Economic Development.

GREER HONORED BY AMERICAN CHEMICAL SOCIETY

ChBE professor emerita **Sandra Greer** knows firsthand how hard it is for women to forge careers in engineering and applied sciences. She has spent her own championing equality for women in academia and the lab, working to increase the number of women in fields in which they were and are underrepresented, and creating a more positive environment for all female students at colleges and universities.

The American Chemical Society (ACS) has recognized Greer's achievements by honoring her with its national Award for Encouraging Women Into Careers in the Chemical Sciences. The announcement was made in *Chemical and Engineering News.*

Early in her career, Greer was one of the founders of the National Institute of Standards and Technology's Standards Committee for Women, which among other achievements lobbied for and eventually saw the establishment of on-site daycare. When she joined the University of Maryland's Department of Chemistry and Biochemistry in 1978, she was its first tenure-track female professor and later its first female chair. When she accepted a joint appointment with ChBE in 1990, she became its first tenured female faculty member as well. In 1998 she helped found the National Committee for the Advancement of Women in the Chemical Sciences.

During her 30 years at Maryland, Greer was dedicated not only to her research, but also to improving the educational experience of all of its students. She has received the university's Distinguished Scholar-Teacher Award (1988-89) and Kirwan Undergraduate Education Award (2008), and the Clark School's Poole and Kent Teaching Award for Senior Faculty (2008) and Faculty & Staff Outstanding Commitment Award (2011). From 1987-1988, she chaired the President's Committee on Undergraduate Education–also known as the "Greer Committee"–an assignment that lead to the university becoming a national model of an environment conducive to the professional advancement of women.

"At the time I was hired in 1998, there weren't as many women on the faculty in engineering," says ChBE professor and chair **Sheryl Ehrman**. "It was great to have Sandra as a mentor and friend in the department as I came up through the tenure process. Outside of the department, she was a powerful advocate for fairness, and her service improved the campus climate for everyone."

After retiring from the University of Maryland, Greer served as the provost and dean of faculty at Mills College, an historically female institution, from 2008-2013. She is currently a professor of chemistry at Mills, as well as a member of its Hellman Summer Science & Math Fellows Program.

For the full story about Greer's award, see "ACS Award For Encouraging Women Into Careers In The Chemical Sciences," by Susan J. Ainsworth at **cen.acs.org**.

WANG WINS JUNIOR FACULTY RESEARCH AWARD

ChBE associate professor **Chunsheng Wang** was the 2013 recipient of the A. James Clark School of Engineering's Junior Faculty Outstanding Research Award.

Wang is a leader in the fields of electrochemistry and nanostructured materials, and his research focuses on energy conversion and energy storage systems. His innovations, such as a solvent-free composite PEO-ceramic fiber/mat electrolyte for lithium batteries, serve as models in the field.

"Dr. Wang's research in applied electrochemistry has greatly advanced the understanding of lithium-ion transport and synthesizing polymeric and inorganic nanostructured materials for electrolyte and electrode applications," says the Clark School's Dean **Darryll Pines**.

Wang, who received his Ph.D. in materials science and engineering from Zhejiang University, China, in 1995, joined the ChBE faculty and the University of Maryland Energy Research Center in 2007. He advises ChBE's undergraduate Chem-E Car team, which took first place at the American Institute of Chemical Engineers' mid-Atlantic regional competition in 2011, and has qualified for the national finals every year since.

Wang's research activities are in four areas: Li-ion batteries, Na-ion batteries, alkaline fuel cells, and electroanalytical techniques. His projects cover topics ranging from fundamental electrochemistry and materials synthesis to electrochemical devices. He was the recent recipient of an ARPA-E research grant for innovative energy storage systems for electric vehicles *(see back cover).*

To learn more about Chunsheng Wang's research, visit **cswang.umd.edu**.

ARPA-E, continued from back cover

University of Maryland and Army Research Lab will work together to develop a hybridized co-ion aqueous battery that could cut the Li-ion battery system cost in half and would enable an EV to travel twice as far per charge. The University of Maryland team is expected to make a critical breakthrough in improving the energy density of their battery by more than doubling the cell voltage up to 3.0V, and doubling cell capacity using intercalation chemistries.

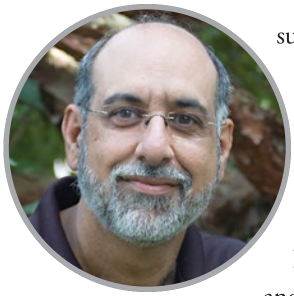
The intrinsically safe co-ion aqueous battery could significantly reduce the cost of battery management, improve reliability, and operate in temperatures ranging from -30°C to +70°C. If successful, it would make EVs cost- and safety-competitive, and able to travel 300 miles on a single charge, contributing to their widespread public acceptance. Increased use of EVs would decrease U.S. dependence on foreign oil and reduce CO_2 emissions from burning gasoline, which accounts for 28% of all greenhouse gas emissions.

Sung Professorships

RAGHAVAN'S APPOINTMENT RENEWED; ZACHARIAH NAMED 1ST SUNG DISTINGUISHED PROFESSOR

The Department of Chemical and Biomolecular Engineering and the A. James Clark School of Engineering extend their congratulations to professors **Michael Zachariah**, who has been named the first Patrick and Marguerite Sung Distinguished Professor in Chemical Engineering; and **Srinivasa Raghavan**, whose Patrick and Marguerite Sung Professorship in Chemical Engineering has been renewed.

Zachariah's appointment is second of two endowed professorships established by a $1.5 million gift from alumni **T.K. "Patrick" Sung** (M.S. '69 and Ph.D. '72, chemical engineering) and his wife, **Marguerite** (B.S. '70, mathematics), in 2007.


ZACHARIAH

"I am very grateful for the Sungs' generosity and support," says Zachariah. "The funds will enable my group to support graduate students in long range research on the measurement science of nanoparticles, which might have applications in the environment, medicine and energy."

"We're so pleased to be able to support exceptional faculty and research at the University of Maryland," says Mrs. Sung. "It gives us great satisfaction to know that we're helping Professor Raghavan and Professor Zachariah inspire and mentor students, so they will have the same enthusiasm and opportunities to succeed as we did. When we met Dr. Zachariah, we were very impressed by the quality and depth of his research. He's created a wonderful environment for research and training the next generation of scientists and engineers."


RAGHAVAN

"We felt creating the professorships was the best way to serve the students, the faculty, and the university," adds Dr. Sung. "We've enjoyed seeing how Dr. Raghavan's group has grown over the past several years. It's meant more research opportunities for students, more discoveries, and more published results, all of which improve the quality and reputation of the department, the Clark School, and the University of Maryland."

"I am honored and grateful to hold the Sung Professorship," says Raghavan. "It has provided a critical boost to my research efforts. I owe this honor to the hard work and creativity of the many excellent students who have worked with me."

honors&AWARDS

DEPARTMENT AWARDS

Congratulations to the following students, who were recognized at the Clark School's and department's 2013-2014 honors and awards ceremonies. They have all demonstrated outstanding scholarship, research skills, and service. Complete citations are available at: ter.ps/chbeawards14

- Outstanding Junior Award: **Matthew Renault**
- Outstanding Senior Award: **John Daristotle**
- David Arthur Berman Memorial Award: **Sudi Jawahery**
- Chairman's Award: **Christina Fontanos**
- Outstanding Student Service Award: **Marta Cherpak**

RESEARCHFEST

Winner, ChBE Division: **Wenbo Zhou**, advised by ChBE/Chemistry and Biochemistry professor **Michael Zachariah**, for "Morphological Changes to Surface Attached Bacterial Spores Subjected to Sub-second Thermal Stress."

AICHE COMPUTING & SYSTEMS TECHNOLOGY DIRECTORS' AWARD

Curtisha Travis, advised by ChBE professor **Ray Adomaitis**, was recognized for her presentation of "The Computational Challenges of Simulating Atomic Layer Deposition (ALD) Process Dynamics." The poster described a model that predicts the optimal conditions for atomic layer deposition of alumina when using water and trimethylaluminum as precursors. Her work is supported by the NASA Goddard Space Flight Center, the NSF, and the Gates Millennium Scholarship fund.

recent DISSERTATIONS

DECEMBER 2013

Vishal Javvaji: "New Concepts for Biopolymer Gelation."
Advisor: **Srinivasa Raghavan**

Yuting Zheng: "13C and 15N Metabolic Flux Analysis on the Marine Diatom Phaeodactylum Tricornutum to Investigate Efficient Unicellular Carbon and Nitrogen Assimilation Mechanisms."
Advisor: **Ganesh Sriram**

studentPROFILE

Engineering in the Magic Kingdom

Chemical and Biomolecular Engineering senior THOMAS PROCTOR knows exactly where he wants to be after he graduates: Disney World. This is how he's working to make it happen.

If you're thinking about a career in chemical and biomolecular engineering, you may imagine yourself working at some of the most successful companies and agencies in the world: 3M. Booz Allen Hamilton. DuPont. ExxonMobil. The Army Research Laboratory. The NIH. Proctor & Gamble.

What about Disney World?

Walt Disney World needs chemical and biomolecular engineers to keep some of its biggest attractions running. At The Seas with Nemo & Friends, they manage the water quality and filtration system of a multimillion-gallon marine environment. In the Animal Kingdom, they help biologists and veterinarians monitor soil and water quality, temperature, vegetation, and emissions from safari vehicles, and help ensure that biomaterial from one environment is not tracked into another. In the Materials division, they work with materials scientists and designers to create polymers and fabrics for costumes tailored for specific activities and conditions. Chemical engineers also help maintain the park's natural environment at its massive wastewater treatment facility, which also conditions water for pools, moats, and drinking. They may even work at the resort's laundry facility, where every linen, towel, uniform and costume must be cared for with specific detergents.

If you want a job at Disney, Proctor explains, one of the best ways to get your foot in the door is through its internship programs. Interning is often a two-step process that starts with the Disney College Program.

The College Program assigns interns to jobs in areas where the most help is needed. In Proctor's case, it was in food service and merchandising. Selling souvenirs and snacks may not seem like a meaningful internship for an aspiring engineer, but it does immerse prospective employees in Disney's unique culture, and what it offers students outside of their working hours is a "Disney education."

Disney World has an entire catalog of on-site courses and programs about the inner workings of the Magic Kingdom, and how to succeed in it. Proctor participated in several. Disney's Ultimate Engineering Exploration used lights-on track walks of popular rides to teach interns about ride physics, design for efficiency and longevity, animatronics, fabrication, and maintenance. Interns then attended a networking event at which they could meet Disney engineers from every department.

The final segment was a design competition that challenged the students to conceptualize a new feature for an existing attraction, which they presented to Disney's engineering executives. Teams were asked to consider a target audience, functional specifications, budget, materials, and installation. Proctor's group won Best Overall Presentation for its proposal to add a *TRON*-themed interactive game component to Tomorrowland.

> "**You really have to love the culture**. You have to be a people person. It's not for the shy."
>
> **–Thomas Proctor**

Proctor also attended a class called Creativity and Innovation, followed by the Engineering Professional Development Study, an eight week course that covered engineering's role in the park's vehicles and rides, attraction development, and on-site fabrication shops.

"The best thing I learned was everything that is involved in any one of Disney's engineering projects," says Proctor. "Every engineer stressed their formula for success: Leadership skills plus management skills times your technical skills, times your relationship skills. If you can be the best in each category you can be, then they say you're going to succeed at Disney."

Students don't wear the typical cap and gown when they complete Disney's Education Connection courses!

Successfully completing a College Program internship makes it easier to earn a place in the selective Disney Professional Internship Program, in which students are assigned to a department related to their major or career goals. Proctor hopes to join the program after earning his B.S. In the meantime, he has seasonal employee status.

"My plan is to go straight to Disney," he says. "It's exactly what I want to do."

For more information, visit:

profinterns.disneycareers.com
cp.disneycareers.com

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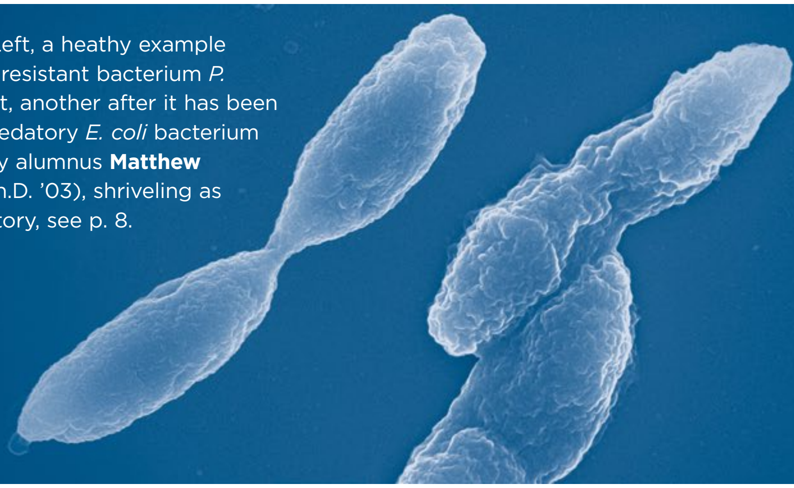

WHAT'S THIS? Left, a heathy example of the antibiotic-resistant bacterium *P. aeruginosa.* Right, another after it has been attacked by a predatory *E. coli* bacterium bioengineered by alumnus **Matthew Wook Chang** (Ph.D. '03), shriveling as it dies. For the story, see p. 8.

COLUMNS is published for alumni and friends of The Department of Chemical and Biomolecular Engineering at the A. James Clark School of Engineering. Your alumni news and comments are welcome. Please send them to:

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C. Wang: ARPA-E Grant for Electric Vehicle Energy Storage Systems

Department of Chemical and Biomolecular Engineering associate professor **Chunsheng Wang** is part of a University of Maryland Energy Research Center team that was awarded a grant from the Advanced Research Projects Agency-Energy (ARPA-E) to develop transformational electric vehicle (EV) energy storage systems using innovative chemistries, architectures and designs. The project is among only 22 selected nationwide that received a total of $36 million in research funding from ARPA-E's new program, Robust Affordable Next Generation Energy Storage Systems (RANGE).

The RANGE program's goal is to accelerate widespread EV adoption by dramatically improving driving range and reliability, and by providing low-cost, low-carbon alternatives to today's vehicles. RANGE seeks to reduce vehicle costs by re-envisioning the entire EV battery system, rather than working to increase the energy density of individual battery cells. RANGE projects will also focus on multifunctional energy storage designs that allow a single, robust system to simultaneously serve other functions in a vehicle, which reduces the EV's overall weight.

Wang's project, conducted in partnership with **Kan Xu** (Army Research Laboratory), is titled "Multiple-Electron Aqueous Battery," and was awarded $405,000.

Lithium-ion batteries have not been extensively adopted in electric vehicles due to short driving range, high cost, and low safety and reliability. In particular, the concerns over cell safety and reliability require more protection on pack- and system-level components, increasing the cost and reducing system energy density. Researchers at the

continues on page 9