

CHEMICAL AND BIOCHEMICAL ENGINEERING

Missouri S&T | Fall 2018

LAYERING ON HIGH PERFORMANCE

Liang uses atomic layer
deposition to design
materials for applications

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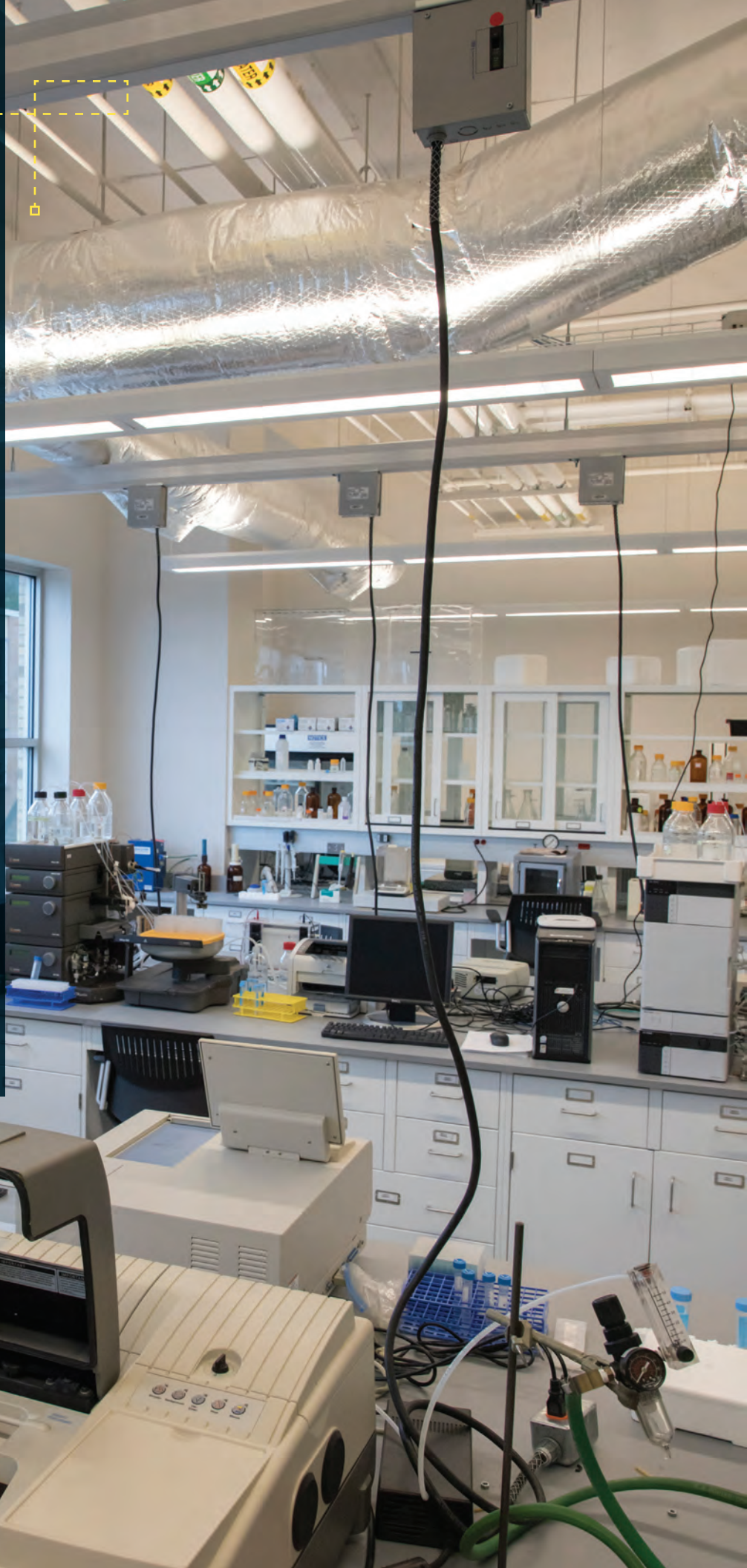


Undergraduate Bioseparations Lab, run by **Daniel Forciniti**, is a required course for a bachelor's degree in chemical engineering with an emphasis in biochemical engineering.

This lab is integrated with a research lab focused on protein purification and protein and peptide aggregation. Research projects are incorporated into the teaching lab, and equipment purchased with past research grants is shared with the undergraduates.

Other departmental labs

- Multiphase flows and reactors engineering and applications and imaging and visualization laboratory
- Synthesis biology computation and experimentation laboratory
- Biomaterials and tissue engineering laboratory
- Molecular dynamic modeling and simulation laboratory
- Synthesis, purification and characterization of tailored peptides and proteins laboratory
- Atomic, molecular and nanoparticles layer deposition laboratory
- CO₂ capture and 3-D print catalyst and adsorbent laboratory
- Hybrid energy and modeling and simulation laboratory
- Particulate flow modeling laboratory
- Enhanced oil recovery and interfacial phenomenon laboratory





DEAR ALUMNI, FRIENDS AND COLLEAGUES

Our department has achieved many notable accomplishments that I will summarize here. You can find more details inside. We have been informed officially about our ABET accreditation without any concerns. We have initiated industry outreach efforts to establish collaborative interactions and let industry benefit from our faculty expertise as well as the experimental and computing capabilities we have established in the recent years. Chevron, Cargill and Pfizer, Shell and Phillips 66 will be our focus at this time. We seek any support and help in such effort.

In Fall 2018, we will introduce the new classes for our new curriculum that we have recently changed to benefit our undergraduate students in their strong education that we have seen. We have made significant progress on developing a new undergraduate experiment that integrates Delta V of Emerson and Mimic of Mynah as offline simulator.

Peer-reviewed publications and Ph.D.s granted have increased during the past year. Our faculty members continue to be recognized on campus and nationally and internationally.

Six Ph.D. students won Distinguished Dissertation Awards in Fall 2017 and Spring 2018. These students published in peer-reviewed journal three papers before their graduation, and so far one Outstanding Dissertation Award in Spring 2018 for the students who have published three papers in peer-reviewed journal within one year after their graduation.

Our undergraduate students continue to achieve in extracurricular activities and receive awards. Our AIChE student chapter won the Best Student Chapter Award in the 2017 AIChE Annual Meeting.

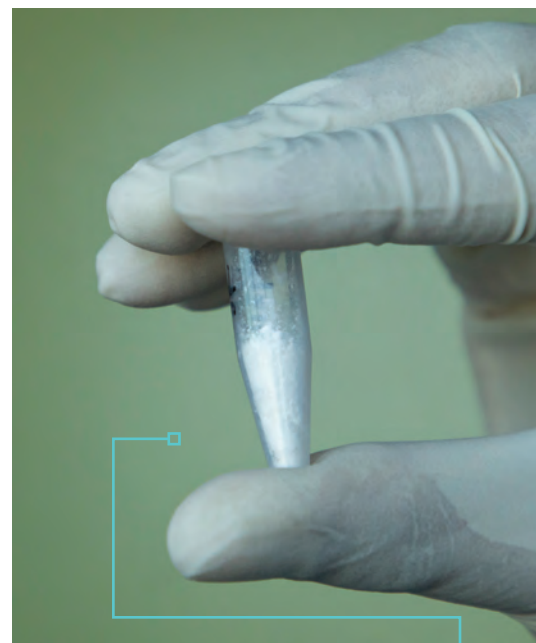
Our alumni continue their accomplishments and have won various campus awards.

In May 2018, our graduate program and research activities were reviewed by a distinguished team consisting of three members of the National Academy of Engineering and a distinguished professor. Their suggestions should help improve our scholarships, external research expenditure and graduate program while we maintain and enhance the strength of our undergraduate program, as the team noted.

We all appreciate the help and support of our alumni, friends and colleagues. We look forward to working with you for the best of our department and students.

Warm Regards,

Muthanna Al-Dahhan, D.Sc.
Chair of Chemical and Biochemical
Engineering and Curators' Distinguished
Professor of Chemical and Biochemical
Engineering and of Nuclear Engineering



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The pair are developing an adsorbent compound that could remove aromatic volatile organic compounds from gaseous streams.



LAYERING ON

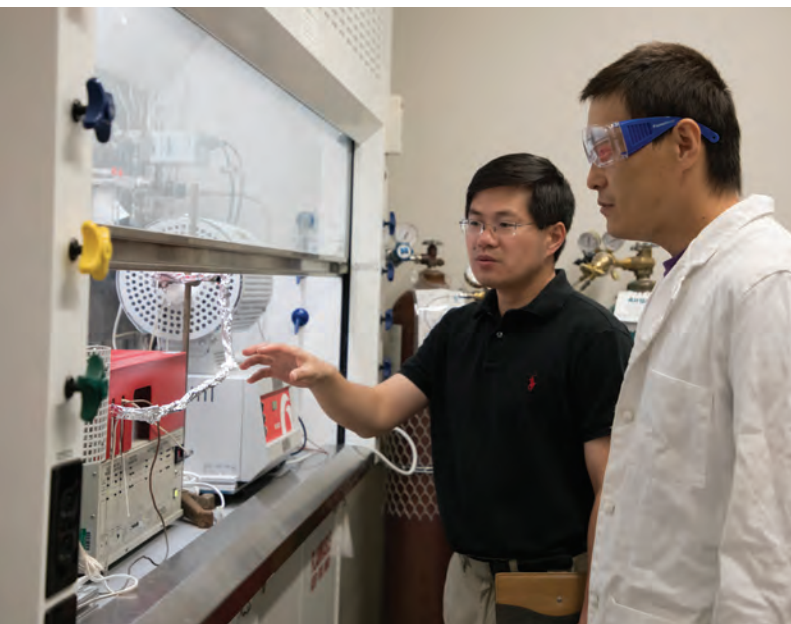
HIGH PERFORMANCE

Xinhua Liang focuses on performance, both in the laboratory and in his teaching. Liang brings prestige and funding to the chemical and biochemical engineering department through his work in the lab, receiving more than \$2 million in research funding in the last six years.

Since July 2016, Liang has earned six grants from Pacific Northwest National Laboratory, the Department of Energy, Brewer Science and the Gas Technology Institute.

"My current research mainly focuses on the preparation of nanostructured materials for various applications including catalysts, lithium ion batteries, solid oxide fuel cells and adsorbents," says Liang. "I am collaborating with several researchers on campus, including **Fateme Rezaei**, assistant professor of chemical and biochemical engineering, and **Jonghyun Park**, assistant professor of mechanical and aerospace engineering."

Liang's nanotechnology research group works at the intersection of physics, chemistry and materials science using atomic layer deposition to design and synthesize materials for applications like energy storage and environmental remediation. Atomic layer deposition is a thin film growth technique based on sequential, self-limiting surface chemical reactions. It allows for precise deposition of highly conformal coatings over complex 3-D structures. The value in applying this thin film coating technology is being able to harness the unexpected phenomena that result from the changes in structure and chemistry that occur at the atomic scale.



UNDERGRADUATE LAB OFFERS UNIQUE EXPERIENCE

We are developing a new undergraduate experiment using various devices for flow, pressure, temperature, levels and motor speed using recent technology instrumentation.

A Delta V distributed control system (DCS), industrial state-of-the-art process control software and related hardware donated by Emerson, and Mimic, an offline simulator software donated by Mynah, have been integrated on these instruments to allow an experiment to be operated via the internet and to simulate the experiment measurements control.

Students can control the process using operator consoles that communicate with the DCS. They can monitor the process, change set-points and acknowledge alarms if the process becomes unstable.

“Upon completion and introducing to the students in Fall 2018, the facility and the experiment will be a unique one in the nation and the world that will provide a unique hands-on experience to our students,” says **Muthanna Al-Dahhan**, chair and Curators’ Distinguished Professor of chemical and biochemical engineering.

AICHE STUDENT CHAPTER EARNS NATIONAL HONORS

The student chapter of the American Institute of Chemical Engineers was named the national organization’s best at its October 2017 national conference in Minneapolis.

Several others from our department also received recognition.

Lauren Ernat, ChE’18, won a third-place prize in the organization’s Chemical Engineering for Good Challenge (AICHE 4G) with an entry titled “Purification of Water using Micro-Scale Technologies.” The AIChE 4G award includes a \$1,000 prize for our student chapter.

Tarique Ahmad, ChE’18, received the Donald F. and Mildred Topp Othmer National Scholarship Award for outstanding academic achievement and student involvement. Ahmad also received the AIChE Virtus Dynamica Chemical Engineering Student Award in April.

Senior **Brent Johnston** received the Donald. F. Othmer Sophomore Academic Excellence Award for having the highest GPA among chapter members in their freshman or sophomore years.

Doctoral student **Sidharth Razdan** won the AIChE Separations Division Graduate Student Research Award in the area of bioseparations for his work on endotoxin removal from biological fluids (see p. 4 to read more about this work). The award will be presented at an October awards banquet in Pittsburgh.

Liang’s research group divides its research into several categories:

- Surface science and surface functionalization research focuses on applying atomic and molecular layer deposition to surfaces.
- Nanostructured materials for catalysis work focuses on preparing nanostructured catalysts with high catalytic activity, reaction selectivity and thermal stability for wide chemical use.
- Nanostructured materials for energy storage focuses on the area of energy storage, including lithium-ion batteries, solid-oxide fuel cells and supercapacitors.
- Nanostructured materials for environmental remediation looks at tuning titania, a photocatalyst, that can decrease ecological contaminants in water systems.

Liang was named to the inaugural class of Dean’s Scholars in 2016, an award that recognizes prodigious research, teaching excellence and campus service in the College of Engineering and Computing at Missouri S&T. The award honors assistant and associate professors who were nominated by their department chairs and selected by a five-person committee made up of senior faculty from the college’s nine departments. He also won a Faculty Research Award in 2015.

Liang’s hard work and dedication to teaching led to tenure and a promotion to associate professor in the department in 2017. □



BARUA RECEIVES PATENT

FOR USE OF POLYMERIC NANOPARTICLES TO REMOVE BACTERIAL TOXINS FROM FLUIDS

Sutapa Barua, assistant professor of chemical and biochemical engineering, was awarded a federal patent in March for developing a method that uses polymeric nanoparticles to effectively remove endotoxins from water and pharmaceutical formulations — research she hopes will improve drug safety and increase access to clean drinking water in the developing world.

Barua, who joined the university in 2014, also recently received a \$25,000 start-up grant from the university's office of technology transfer and economic development and \$10,000 from Missouri S&T's Innovation Fund. She will use the Technology Acceleration Grant to develop a low-cost, portable bio-filtration kit to synthesize nanoparticles that can adsorb water-borne toxins. With funds from the other grant, Barua will hire undergraduate and graduate student researchers.

The technique, as outlined in a July 2016 article in the journal *Nanotechnology*, involves using a one-step phase separation method, using a syringe pump, to synthesize the nanoparticles. Those polymer nanoparticles have a high endotoxin removal efficiency of nearly 1 million endotoxin units per milliliter of water, using only a few micrograms of the material.

After synthesis, the particles were characterized using a transmission electron microscope and dynamic light scattering. A custom-made fluorescence assay was used to determine the degree of binding between the endotoxin and the nanoparticles. The fluorescent compound BODIPY was used to tag the endotoxin for identification purposes.

The ramifications of this method — referred to in the 2016 journal article as “endotoxin hitchhiking” — are sizable. As the journal noted in an online “Lab Talk” feature, more than 200,000 people die

each year in this country from sepsis, and an estimated 18 million worldwide. Endotoxins, which are fragments of bacterial outer membranes, trigger the septic reaction.

The study “has large implications for the healthcare system, especially for those patients suffering from sepsis,” the journal editors wrote. “This novel removal technique has the potential to be explored for the removal of other deadly toxins that can be found in the bloodstream from a number of different diseases.”

The study further results in an “efficacious system that is applicable to minimize the endotoxin level for a variety of applications, including drinking water purification, drug formulation or pharmaceutical preparation.”

“Further research in the area will focus on developing nanoparticles for the removal of entire bacterial strains,” wrote the editors. “In addition to this, different sizes and shapes of nanoparticles will be tested for their effectiveness in binding endotoxin.”

“This novel removal technique has the potential to be explored for the removal of other deadly toxins that can be found in the bloodstream from a number of different diseases.”

Photo courtesy of Budweiser



SUPER BOWL SPOTLIGHT

A chemical engineering graduate shared the spotlight with NFL great Tom Brady of the New England Patriots and the underdog Philadelphia Eagles as part of an Anheuser-Busch InBev (A-B) Super Bowl LII commercial.

Kevin Fahrenkrog, ChE'88, was featured in the Budweiser ad buy "Stand by You" in a once-a-year time slot known for its high-profile marketing campaigns.

Fahrenkrog, general manager of A-B's Cartersville, Ga., brewery, is one of the employees who operate the plant's emergency water program. During natural disasters such as floods and hurricanes, A-B stops beer production at the Georgia brewery and cans water for disaster relief.

Over the past three decades, the company has partnered with the American Red Cross to provide more than 79 million cans of drinking water in response to natural disasters, including in Houston, Puerto Rico, California and Florida last year.



CHEMICAL ENGINEER JOINS CEC AS ASSOCIATE DEAN OF RESEARCH

Angela Lueking, a professor of energy and mineral engineering and chemical engineering at Pennsylvania State University and a recent program director at the National Science Foundation, has joined Missouri S&T as associate dean of research in the College of Engineering and Computing.

At the NSF, Lueking oversaw the molecular separations program during a two-year appointment. She earned a bachelor's degree in chemical engineering from the University of Nebraska, and master of science degrees in chemical engineering and environmental engineering and a Ph.D. in chemical engineering from the University of Michigan.

She will also hold a faculty appointment in chemical and biochemical engineering at S&T.

COLLEGE OF ENGINEERING AND COMPUTING HONORS PH.D. STUDENTS FOR TEACHING, RESEARCH

Four doctoral students in chemical and biochemical engineering were among 18 recognized by the College of Engineering and Computing (CEC) this past spring for their teaching excellence and scholarly productivity.

Three of those students were among the 10 inaugural CEC Dean's Graduate Educators, and a fourth was designated a Dean's Ph.D. Scholar. That combined total represents the highest concentration of winners from among the college's nine academic departments.

The Dean's Graduate Educator winners, their hometowns and names of their faculty advisors are as follows:

Vineet Alexander of Adoor, Kerala, India; **Muthanna Al-Dahhan**, advisor

Matthew Senter, of Defiance, Mo.; **Jee-Ching Wang**, advisor

Humayun Shariff, Chennai, Tamil Nadu, India; **Muthanna Al-Dahhan**, advisor

On the research side, **Xiaofeng Wang** of Liawu City, Shandong Province in China, was named a Dean's Ph.D. Scholar. His advisor is **Xinhua Liang**.

The CEC implemented the Dean's Ph.D. Scholar award in the 2016-17 academic year to honor its most productive doctoral students in scholarship. The graduate educator award was new in 2017-18.

SMITH'S BIOFUELS
RESEARCH AIMS TO

THINK GLOBALLY, ACT LOCALLY



The idea of recycling waste cooking oil into biodiesel fuel is nothing new. But the continued high cost of that process has made widespread adoption difficult.

Joseph Smith believes he has the solution to cut those costs — and increase the use of recycled biofuel.

“Fifty percent of the cost of recycling waste cooking oil is tied up in collection and shipping logistics,” says the Laufer Endowed Chair in Energy and professor of chemical and biochemical engineering. “So let’s cut out the shipping costs and make biofuels locally.”

Smith, whose work is funded by the National Science Foundation, believes that a small, modular skid-mounted facility would result in numerous smaller plants that would benefit the entire biodiesel industry by making it “greener” all around. Regional plants would simplify collecting and processing and would boost local economies in smaller cities by creating jobs, he says.

As the biodiesel industry expands, the excess of crude food-grade glycerol (a byproduct of the manufacturing process) mixed with salt and water is relatively unused. Smith says he has a solution for that, too.

“Most companies get rid of waste crude glycerol by either burning it or using it for dust suppression instead of repurposing it,” says Smith. “Our process operates at super-critical pressures, which eliminates salt production. We then concentrate and ferment the glycerol-and-water mixture and recycle methanol to make more biodiesel. This significantly reduces the amount of waste glycerol, which makes our process more sustainable.”

The research could lead to biodiesel-propelled vehicles that are flex-fuel-powered with drop-in fueling compatibilities, says Smith.

ABET ACCREDITATION

Missouri S&T and the chemical and biochemical engineering department received the official certification of ABET accreditation for six years with no concerns.

The Accreditation Board for Engineering Technology (ABET) is recognized as the worldwide leader in assuring quality and stimulating innovation in applied science, computing, engineering and engineering technology education.

ABET accredits educational programs, promotes quality and innovation in education, and consults and assists in the development and advancement of education worldwide.



FORCINITI NAMED ASSOCIATE PROVOST OF FACULTY AFFAIRS

Daniel Forciniti, professor of chemical and biochemical engineering and associate chair, has been named S&T's associate provost of faculty affairs.

In his new role, which took effect in June, Forciniti assists the office of Provost Robert Marley with faculty and workload assignment, promotion and tenure policy, and other matters in faculty affairs.

He also will represent Marley on various committees and at events, including working directly with academic affairs officials at the University of Missouri System and on other UM System campuses.

A member of the Missouri S&T faculty since 1991, Forciniti has served as a faculty fellow in the provost's office since January 2017. In his new assignment, he will spend 80 percent of his time as associate provost and 20 percent of his time in our department, where he will continue to teach, supervise students and conduct research in chemical engineering.



LUKS HONORED WITH SERVICE AWARD

Christi Patton Luks, associate teaching professor of chemical and biochemical engineering, received a university service award for her efforts to enhance faculty development.

The award from the Center for Educational Research and Teaching Innovation (CERTI) and Center for Advancing Faculty Excellence (CAFÉ) recognizes Luks' work leading programs on behalf of non-tenure-track faculty.

Luks is advisor for the Chem-E-Car team, AIChE and the Engineers Without Borders Honduras team.

FRENCH COMPANY HONORS AL-DAHMAN

Muthanna Al-Dahhan, chair and Curators' Distinguished Professor of chemical and biochemical engineering and of nuclear engineering, was honored by TOTAL, a French multinational integrated oil and gas company, and was invited to give the plenary lecture on multiscale modeling of packed bed two-phase flow hydrotreater during the TOTAL Annual Research Meeting of MATHIAS 2017 held Oct. 25–27 in Paris.



FROM STUDENT BODY PRESIDENT TO PHILLIPS 66

Scottie Thomas, ChE'18, came to Missouri S&T with a penchant for leadership honed during high school in Cape Girardeau, Mo., where he was a football captain and National Honor Society member.

At S&T, he grew into a campus leader immersed in university life, from working in an aerospace engineering research lab to his senior-year role of student body president.

"With my time in student council, I was able to help on the project to renovate and expand our current student fitness center, and work on new mental health programs for students across campus," Thomas says.

As a sophomore, Thomas directed the Student Union Board's comedy programming, managing a budget of more than \$65,000 while booking appearances by nationally known entertainers such as stand-up comedian Demetri Martin. The position also allowed him to connect with peers from other schools across the country.

As a first-year student, Thomas seized on the value of making connections outside the classroom. He worked as a research assistant for **Philip Whitefield** in the Center for Aerospace Particulate Emissions Reduction Research, learning about emissions technologies and how to fabricate parts from sheet metal.

That led to summer internships with Phillips 66 at its Wood River, Ill., plant after his sophomore and junior years. That's the same location where Thomas went to work after graduation.

"The people that you meet is the best part of college," he says. "Not too many days go by where you will not meet someone new who teaches you something different, whether it be about culture, classroom learning or life lessons."



REZAEI, LIANG TO LEAD \$330,000 NSF PROJECT

Fateme Rezaei (above left), assistant professor of chemical and biochemical engineering, recently received a three-year, \$333,680 grant from the National Science Foundation's Chemical, Bioengineering, Environmental and Transport Systems (CBET) to lead research on volatile organic compounds (VOCs).

Her co-principal investigator is **Xinhua Liang**, associate professor of chemical and biochemical engineering.

Their project is titled "Combined Capture and Reaction in Temperature Swing Adsorption: An Integrated Approach toward VOC Emissions Control." The two professors are working to develop novel adsorbent materials and processes for abatement of aromatic VOCs from gaseous streams.

Rezaei also received the 2018 Energy & Fuels Joint Award for Excellence in Publication at the American Chemical Society (ACS) national meeting in Boston in August.

The journal publishes research in the intersection of chemistry and chemical engineering and the application of non-nuclear energy and fuels.

Rezaei received a cash prize and will present an award lecture at the fall ACS national meeting.

GRADUATE STUDENTS HONORED

Six Ph.D. students in the department received Distinguished Dissertation Awards, an honor reserved for those who publish three or more papers as first author before graduating.

The fall 2017 recipients are **Harshul Thakkar**, **Zeyu Shang** and **Ibrahim Said**. The spring 2018 recipients are **Abbas Jawad Sultan**, **Xin Li** and **Xiaofeng Wang**.

The Outstanding Dissertation Award in May went to **Haidar Taofeeq**, MS ChE'15, PhD ChE'17, for publishing at least three papers as first author within one year of graduation.

Also, doctoral student **Vineet Alexander** won second place in the campus Three-Minute Thesis competition. His entry was titled "Performance Evaluation of a Hydrotreater Reactor."

And Ph.D. student **Paul Nakka** received a summer Graduate Research Fellowship from the university to support his doctoral work.

THREE ALUMNI JOIN ACADEMY OF CHEMICAL ENGINEERS

The Academy of Chemical Engineers inducted three new members at its annual ceremony in April.



David Denner, ChE'76, of Eureka, Mo., is president of Coronet Industries Inc. His wife, **Denise Lovasco Denner**, Chem'76, and his daughter, **Darcy R. Denner**, BSci'04, are both alumni.



Michael Hoerle, ChE'84, is vice president of engineering for Crown Iron Works in Minnesota. He previously spent 32 years with Cargill and holds six patents. He is married to **Ellen (Westerman)**, ChE'85.



Thomas Schmitt, ChE'67, is president of Hunt Refining and lives in Dallas. The former petroleum engineer holds an MBA from Harvard Business School and later worked on Wall Street.

ALUMNI UPDATE



1. **Nicole French**, ChE'13, a cell manager in L'Oréal's North Little Rock plant, was featured in the sixth episode of the L'Oréal Talent podcast in an interview that discussed what it takes to produce 500,000 units of mascara a day. French oversees the safety and operation of machinery and equipment. *Photo by Julie Levin*
2. **Robert Edward "Bob" Stevens**, ChE'81 (third from left), of Houston, Texas, a retired Bechtel Corp. executive, received the university's Award of Professional Distinction during winter commencement in December 2017. Stevens is vice president of the Academy of Chemical Engineers and a member of the Order of the Golden Shillelagh.
3. **Marvin Borgmeyer**, ChE'74, MS ChE'75, won the annual Baton Rouge, La., Golden Deeds Award. The retired ExxonMobil chemical engineer has lived in Louisiana since graduating. *Photo by Jason Griffith Photography*
4. **Kyle Lampe**, ChE'04, was named one of "20 under 40" by the American Society of Engineering Education (ASEE), an annual list of young up-and-coming researchers. He is an assistant professor who runs the Lampe Biomaterials Group at the University of Virginia. *Photo courtesy of Tom Cogill on behalf of UVA Engineering*
5. **Peggy Cahill Montana**, ChE'76, and her husband, **Duane**, CE'75, donated \$500,000 to the campus chapter of the Engineers Without Borders student group through their charitable foundation, the Montana Cahill Foundation. *Photo by George Bridges*
6. Two alumni were recognized by the Miner Alumni Association during Homecoming. **Jim Bertelsmeyer**, ChE'66 (second from right), received the Robert V. Wolf Alumni Service Award and **Bob Pahl**, ChE'68, MS ChE'70, PhD ChE'74 (second from left), received a 2017 Alumni Merit Award.



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UNDERGRADUATE LABS: BUILDING FULL-SCALE FUTURES

For many students in our department, undergraduate labs are the ultimate passage into the real world of fluid flow, heat exchange and other chemical processes. They're the places where theory and practice converge in the real world of unit operations, and aspiring chemical and biochemical engineers determine the mass, velocity and volume of their hopes and dreams.

Your annual support of the chemical and biochemical engineering department makes a difference in many ways. And sustaining undergraduate labs is one.

So when you get a phone call from a student eager to share what's happening on campus and in our department, we hope you'll take time to connect and catch up. We also hope you'll help us build full-scale futures by giving back.

give.mst.edu

