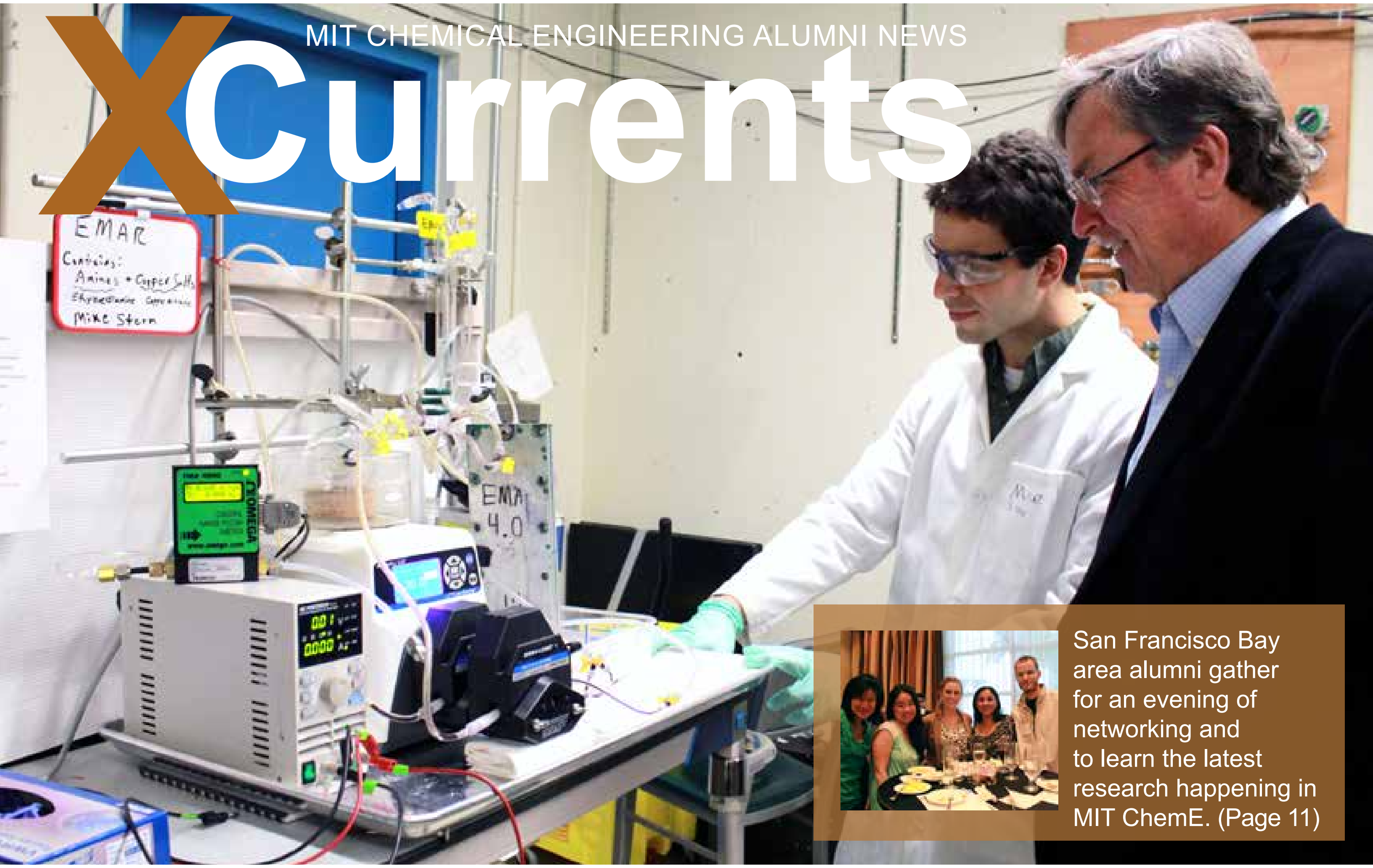
MIT CHEMICAL ENGINEERING ALUMNI NEWS

XCurrents



San Francisco Bay area alumni gather for an evening of networking and to learn the latest research happening in MIT ChemE. (Page 11)

Letter from *Department Head Klavs F. Jensen*

Welcome to the Fall 2013 edition of the Alumni Newsletter. We have had such sunny, warm weather it hardly seems like fall. Everyone is back on campus and engaged in teaching returning and new students. We continue to attract outstanding graduate students and new faculty. This September we welcomed a large group of excellent new graduate students along with three new faculty members, Kwanghun Chung, Heather Kulik, and James Swan.

After completing his PhD with Hang Lu PhD ’03, Kwanghun was a postdoc in the Diesseroth lab at Stanford, where he invented a novel technology, CLARITY, that enables a system-wide structural and molecular analysis of large-scale intact biological samples, notably the brain. He is among the first new faculty to join the new the Institute for Medical Engineering and Science (IMES) led by Arup Chakraborty and fitting for his interest in brain research, he is also a member of principal the Picower Institute of Learning and Memory at MIT.

After earning her PhD in materials science at MIT, Heather went to Stanford as a post-doc, where she studied catalysis using GPU-accelerated quantum chemistry techniques. Her research as an assistant professor focuses on quantum mechanical methods to understand and design heterogeneous, molecular, and biological catalysts. Jim Swan also uses computational tools and aims to combine theory and

Highlights

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MITChemEng MITChemE

Massachusetts Institute of Technology

Letter from the Department Head continued

simulation to model the fluid mechanics and out-of-equilibrium statistical physics that are fundamental to complex fluids and other soft matter. These newest ChemE professors have already done some outstanding research and we excited to have them as colleagues. More on our new faculty can be found on page X.

The main priority of the Department remains the renewal of Building 66. Course X's flagship is at the heart of MIT, geographically as well as in the Institute's long heritage of research and education initiatives. We are working toward creating modern laboratories equal to current research interests, to provide modern office and lab space for our students, and to ensure Department emains the top-ranked program. This fall, we start this process, as some students, staff and faculty begin the temporary move out of their offices and labs in 66 and into designated “swing” space. We are excited for the future of our space and research facilities; we could not do this with the support and help of our alumni and friends. An update on the work, as well as ways you can help us modernize our space to educate the next generation of chemical engineers, can be found on page 14.

Our faculty have been working hard this year, as evidenced by our faculty news on page 12. Bob Armstrong, my predecessor as department head, is now the director of MIT's Energy Initiative (MITEI). Bob has been an integral part of the Initiative from the beginning – ten years ago he began MIT's drive toward meeting the world's energy challenges by creating MIT's Energy Research Council with Ernie Moniz, the new secretary of the Department of Energy, and hosting small brainstorming sessions with each member of the MIT faculty. Today the Initiative helps transform the global energy system to meet the needs of the future and to help build a bridge to that future by improving today's energy systems. You can find more on MITEI and Bob's appointment on page 5.

In the past few months, I've had an opportunity to travel across the country and meet face-to-face with several of you as the Department has hosted events in the Palo Alto and Philadelphia areas. These have hopefully been useful experiences for the many alumni who attended. The faculty members who spoke at the events and I very much enjoyed our alumni conversations.

On June 24th, Professors Paula Hammond, Greg Stephanopoulos and I visited Palo Alto, and spoke and met with about 150 alumni in the San Francisco Bay area. Greg and Paula spoke on their work “Addressing Today's Health & Energy Challenges through Chemical Engineering.” We had a great time listening to ideas and work that our alumni are doing today and being able to discuss together our thoughts on the future of the field. MIT alumnus Doug Spreng was integral in our organization and execution of this event - we are very thankful for his guidance.

MIT Chemical Engineering professor Greg Stephanopoulos talks with alumni during the department's June 24th reception in Palo Alto. For more on the department's “Road Show” around the country, go to page 11.

[In Palo Alto] we had a great time listening to ideas and work that our alumni are doing today and being able to discuss together our thoughts on the future of the field.

September tenth brought us to our second alumni event, a night in Philadelphia with Delaware Valley and New Jersey area alumni. We were hosted by the Chemical Heritage Foundation (CHF), a beautiful space just a block from the Liberty Bell. Alumni networked and perused the CHF's extensive museum, and then heard from Professors Kristala Prather and Michael Strano, who discussed their work addressing the world's health and energy needs. It was a great evening. I'd like to especially thank Lucie and John Wilkens, Michael Thien and John Aunins for helping us organize that event.

We will keep you updated on future trips are to other areas of the country. Our next planned trip is for a very special alumni reception at the annual meeting for the American Institute of Chemical Engineers, planned for Monday, November 4, at the San Francisco Hilton Union Square. All of our alumni in the Bay area are invited to this special reception, as we recognize and celebrate 125 years of Course X. The theme of the reception will be a reminiscence of previous Course X generations: we plan to include photos and images of alumni during their younger years in Course X as well as an “old-school” feel. I hope you can join us.

On December 4th, we will host the 27th annual Hoyt C. Hottel Lecture. This year's lecturer will be Professor Emily A. Carter, the Gerhard R. Andlinger Professor in Energy and the Environment and Professor of Mechanical and Aerospace Engineering & Applied and Computational Mathematics at Princeton University. Professor Carter is the founding director of Princeton's Andlinger Center for Energy and the Environment, which supports its expanding program of research and teaching in the areas of sustainable energy development, energy conservation, and environmental protection and remediation related to energy. As always, the most current information on the Hottel Lecture is at *http://web.mit.edu/cheme/news/hottel.html*.

Mike's work on carbon capture is just one example of the innovative and pioneering work that our graduate students are doing.

On the cover of this fall's newsletter is an image of Professor Alan Hatton and Mike Stern, a graduate student in Alan's lab. Mike has been working on a way to "scrub" carbon dioxide from fossil-fuel emissions, without using the current complex and impractical technology. More on Stern's work can be found on page 18. Mike's work on carbon capture is just one example of the innovative and pioneering work that our graduate students are doing.

As I mentioned in at the start of the letter, we just welcomed a terrific new class of highly talented graduate students. The generous external support to our doctoral program by you, our alumni, is an essential asset in our effort to attract the very best students. We are truly indebted to you for your ongoing commitment and support. Beyond its value as a recruiting tool, funding for graduate fellowships is an essential element of our graduate educational philosophy. By providing fellowship support for first year doctoral students, we allow them to focus on the core subjects of chemical engineering and explore the breadth of research opportunities before choosing a thesis topic.

We hope you enjoy this issue of the newsletter. Please do write to us to let us know how you are doing and how we can continue to improve. Thank you for your support and best wishes for the coming fall.

Klavs F. Jensen
Department Head
MIT Chemical Engineering Department

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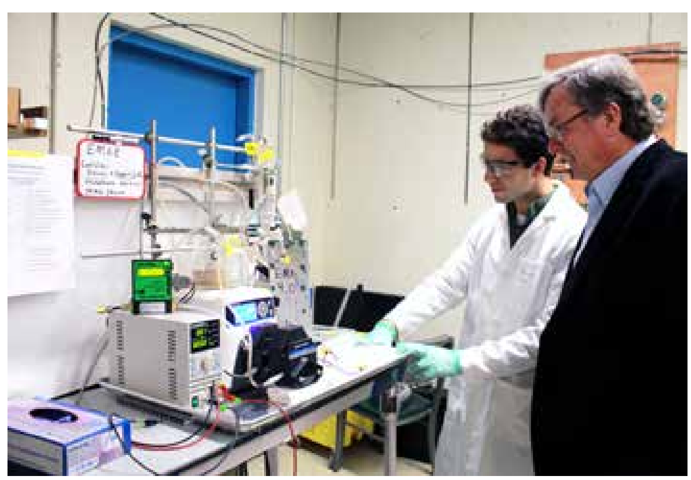


On the cover: Course X graduate student Mike Stern and his advisor Professor T. Alan Hatton explain Mike's ground-breaking work in carbon capture. For more information, go to page 18.

Practice School News

Greetings from the MIT Practice School!

I am pleased once again to be able to tell you the latest developments in the Practice School program and the stations we are running. During the Spring of 2013, the David H. Koch School of Chemical Engineering Practice continued its legacy of promoting Course X students' engineering problem solving and project management skills.

We're still in the planning stages of the centennial of the Practice School, which will be in 2016. One of our major projects is to create an online community for our Practice School alumni. We're working with MIT's newly hired social media specialist to find the most efficient way to do this, but I'd like to take a moment to extend a request to you, our esteemed alumni. Do you have ideas for how you'd like to stay in touch or communicate with your fellow practice school students? We'd love to hear your ideas. Melanie Miller, the alumni news editor, is also managing this project; contact her at *chemealum@mit.edu*.

Currently, our planning team is going through the Practice School archives, highlighting valuable items in the programs history. We're also finding some great photos. Here is a teaser. I'll share more as we get closer, and I hope to learn what some of those bright chemical engineering students are doing today.

Archive photo of students at a 1976 Oak Ridge station.

Spring 2013 Station

Novartis Pharmaceutical Corp., Basel, Switzerland
Directed by Claude Lupis

The return to Basel is always a welcomed opportunity. Walter Bisson, our seasoned Novartis coordinator, always ensures that all details of our stay are properly taken care of, and the Basel area, is of course, a great tourist destination. Eight students attended the station and worked at different Novartis sites, including Huningue, across the border in France.

Two of the projects were located at Schweizerhalle, in the outskirts of Basel. One of the production plants there is a multipurpose facility. The changeover from one production campaign to another involves a different equipment configuration and presents serious logistic challenges. The students, in their analysis of the situation, made several very fruitful recommendations. Another team, in the second session of the station, worked to optimize an existing process by examining its bottlenecks and finding solutions to increase productivity at minimum cost.

Two other projects were held at the Novartis Schoren site, south of the Basel city center. Their focus was on the use of near infrared (NIR) spectroscopy for analysis and control. That use has been greatly expanded in the pharmaceutical industry, spurred by the PAT (Process Analytical Technology) initiative of the US FDA, for better control of production and for an approach of "Quality by Design" rather than "Quality by Inspection."

The Novartis plant located in Schweizerhalle, where two Spring 2013 Practice School stations were located.

A fifth project, held on the Novartis campus, examined a reverse-phase chromatography step in order to increase the yield of the process, while the last two projects were held in Huningue, and dealt with the optimization of a UF/DF (ultrafiltration/diafiltration) operation. The membrane used for the UF/DF step had been discontinued by its manufacturer, and the company was under pressure to demonstrate that a new alternate membrane complied with all regulatory specifications. The work of the students proved very successful and, on the last day of the station, the students were invited to present their results not only to their sponsors, but also to the operators of the plant.

"Fasnacht", the ancient three-day carnival, is always a high point in the students' life in Basel, and this year was no exception. Other enjoyable and enriching experiences were visits of Colmar and Strasbourg, in Alsace, France.

I look forward to sharing more Practice School work and adventures with you in the next newsletter!

Best regards,

T. Alan Hatton
Director

Bob Armstrong Named Director of MITEI

On May 16, 2013, Robert C. Armstrong became the new director of the MIT Energy Initiative (MITEI), as outgoing director Ernest Moniz left the Institute to head the U.S. Department of Energy.

Armstrong has served as the deputy director of MITEI since its founding six years ago. He was co-chair (with Moniz) of the Energy Research Council that laid the groundwork for MITEI and set its guiding principles. Armstrong has since played a leading role in the Initiative's development, alongside Moniz. He is the Chevron Professor of Chemical Engineering, and has been a member of the MIT faculty since 1973. Armstrong was head of Chemical Engineering from 1996 to 2007.

"Professor Armstrong has been a guiding force in the development and success of the MIT Energy Initiative," MIT President L. Rafael Reif said. "He helped shape its transformation from a promising idea into a pioneering source of energy research, policy analysis and education."

Reif continued, "Under Professor Armstrong's leadership, MITEI will continue its bold interdisciplinary approach to developing global energy solutions, and it will remain a vital force in MIT's innovation ecosystem. Given Professor Armstrong's superb technical grounding and his strong relationships with research partners in industry, government and philanthropy, we look forward to this new era at MITEI with the greatest confidence and optimism."

Maria Zuber, MIT's vice president for research, said, "Professor Armstrong's broad and deep knowledge of energy, combined with his strong commitment to energy research and education, make him the ideal choice to take the reins at MITEI. I'm looking forward to continuing to work closely with him to further strengthen and spread energy research across the Institute."

In 2008, Armstrong was elected to the National Academy of Engineering for conducting outstanding research on non-Newtonian fluid mechanics, co-authoring landmark textbooks, and providing leadership in chemical engineering education. Armstrong has received the Warren K. Lewis Award and Professional Progress Award, both from the American Institute of Chemical Engineers, for his outstanding and continuing contributions to chemical engineering education and the rheology and fluid mechanics of complex fluids. He also received the 2006 Bingham Medal from the Society of Rheology, which is devoted to the study of the science of deformation and flow of matter.

Armstrong (far right) attends a recent "Women in Clean Energy" symposium hosted by MITEI.

Armstrong played a vital role in shaping the design of MITEI to focus on linking science, innovation and policy to help transform global energy systems. During his service as deputy director, the Initiative has supported almost 800 research projects at the Institute and continues to engage a quarter of the MIT faculty in its projects and programs.

Armstrong maintains strong relationships with MITEI's coalition of industry, foundation, government and private partners. More than two-thirds of the projects supported through this coalition have been in no- or low-carbon research, including renewable energy, energy efficiency, carbon management, and enabling tools such as biotechnology, nanotechnology and advanced modeling. The largest single area of funded research is in solar energy, with more than 100 research projects in this area alone.

Armstrong has been influential in stressing a major focus on education at MITEI. The Initiative has awarded 252 graduate fellowships in energy and 104 undergraduate research opportunities. The Initiative established an energy minor in 2009. This experiment in interdisciplinary undergraduate education represents the first official academic program that brings together all five schools across MIT. ◊

On May 13, 2013, The department hosted its annual Award Ceremony and traditional dessert reception. Presided by Department Head Klavs F. Jensen, the ceremony recognized undergraduates, graduate students, staff and faculty for their achievements and contributions to the department during the school year.

A variety of organizations, as well as individuals, outside the department and MIT donated prizes and scholarships to students in chemical engineering. The awards are below.

Course X Awards Day 2013

Robert T. Haslam Cup

Awarded to a student who shows outstanding professional promise in Chemical Engineering

Linh T. Bui '13

Roger de Friez Hunneman Prize

Recognizes outstanding scholarship in class and research

John Yazbek '13

Phi Beta Kappa

Nikita Consul '13
Tiffany Peng '13
Roberta Poceviciute '13
Eric Trac '13
Camille Wasden '13

Amgen Scholar

Julia B. Sun '15

Wing S. Fong Memorial Prize

Awarded to a chemical engineering senior of Chinese descent with the highest cumulative GPA, in honor of the memory of Wing S. Fong, his hard work, and dedication to his adopted home, university, and country.

Tiffany Peng '13

C. Michael Mohr Outstanding Faculty Award

Recognizes excellence in teaching in undergraduate subjects

Patrick Doyle, Professor of Chemical Engineering

Edward W. Merrill Outstanding Teaching Assistant Award

Shengchang Tang (G)

Outstanding Graduate Teaching Assistant Award

Chih-Jen Shih (G)

Graduate Student Council Outstanding Faculty Award

William Deen, Professor Emeritus

Fall 2012 Best Student Seminar

Nigel Reuel (G)

Spring 2013 Best Student Seminar

Sagar Chakraborty (G)

Chemical Engineering Outstanding Employee Award

Joel Dashnaw, Graduate Student Coordinator

Chemical Engineering Individual Accomplishment Award

Alison Martin, Assistant to the Executive Officer

Rock Award

Given to a deserving student for showing leadership on the athletic field

Ben Woolston (G)

School of Engineering Infinite Mile Award for Sustained Excellence

Gwen Wilcox, Administrative Assistant

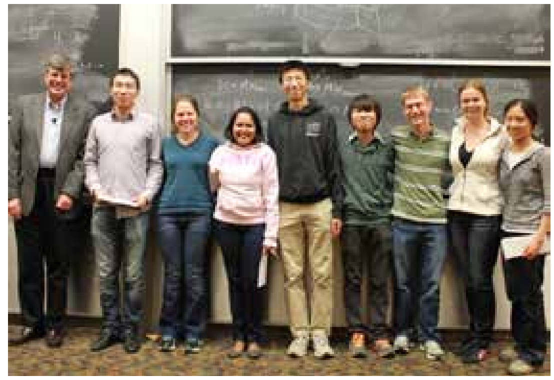
Departmental Special Service Awards

Course X Undergraduate Chapter of AIChE

Mark Kalinich
Ksenia Timachova
Jean Fang
Alan Miranda
Kimberly Aziz
David Hou
Samantha Hagerman
Michelle Teplensky
Paige Finkelstein
Tejas Navaratna
Brian Alejandro
Charlotte Kirk








Departmental Special Service Awards

Graduate Student Council for Course X (GSCX)
Steven Edgar
Sean Faltermeier
Rachel Hoffman
Kevin Kaczorowski
Lionel Lam
Rosanna Lim
Katie Maass
Sakul Ratanalert
Ray Smith
Ben Woolston

Departmental Special Service Awards

Graduate Student Advisory Board (GSAB)
Emily Chang
Mo Jiang
Katie Maass
Sayalee Mahajan
Brandon Reizman
Tatyana Shatova
Ray Smith
Shengchang Tang
Muzhou Wang

Congratulations Class of 2013!

Course X's most recent alumni class was feted at this year's Commencement Reception, Friday, June 6th, 2013. Graduates, families, faculty, friends and alumni survived the deluge of rain to mingle at the Chemical Engineering Tent on the McDermott Circle.

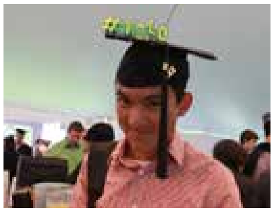














Meet Course X Student Entrepreneurs

The SunHub team, co-led by graduate student David Borrelli, wins the MIT Clean Energy Prize's Audience Choice Award.

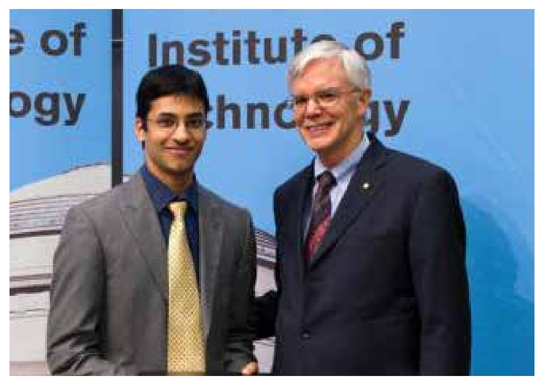
The sixth annual MIT Clean Energy Prize (CEP) competition, held May 6, 2013, awarded a total of $320,000 to five teams that have developed clean-energy startups and innovations.

The contest, co-sponsored by Massachusetts utility NSTAR and the U.S. Department of Energy (DOE) and open to teams from any American university, is the nation's leading student-run energy business-plan competition. Past participants have gone on to raise a total of $130 million in funding.

More than 50 teams entered this year's contest; 15 semifinalists made it to the grand finale. SunHub, winner of the Audience Choice Award, offers solar education to homeowners, helping them make better choices when buying solar-energy systems. SunHub team members are David Borrelli, a PhD student in chemical engineering at MIT, and Kevin Yates, an MBA student at MIT Sloan.

Borelli is a member of Karen Gleason's research group, and a Saudi Aramco-MIT Energy Fellow. His energy interests lie in technology related to energy production, such as photovoltaics and thermoelectric materials. He is also interested in some technologies related to energy use and transfer, including biodiesel, batteries, and fuel cells.

Course X senior Akshar Wunnava, along with a handful of chosen MIT entrepreneurs, met with UK Prime Minister David Cameron during his visit to MIT. While visiting the Media Lab in May 2013, Cameron met informally with a small group of students and recent alumni who have started businesses, or are in the process of doing so. Wunnava was one of seven young entrepreneurs who gave a brief introduction to their concepts for a startup; Cameron then asked questions about their projects.



Wunnava receives the 2012 Patrick J. McGovern '59 Entrepreneurship Award.

Wunnava said, "It was a pretty cool experience, especially to be an undergraduate and to share how my experience here at MIT has shaped what I've learned about business."

Wunnava said he is working on a startup to develop bacterial batteries for use in off-grid villages. Wunnava, a 2013-2015 fellow of the Legatum Center for Development and Entrepreneurship, is looking at the more than 1.6 billion people in the world without access to grid electricity. The majority of these people use kerosene lanterns or solar lanterns, which are much too expensive and face several disadvantages. To alleviate these concerns, he has cofounded BioBatts, a development venture that aims to develop and distribute microbial power generators for lighting/phone charging applications in off-grid villages.

BioBatts' technology consists of genetically modified bacteria producing current through a novel and portable electrode set-up that can be recharged by adding the company's proprietary broth (a mixture of sugar and nutrients). Its products will be significantly cheaper, cleaner, and more effective than kerosene lamps and solar lanterns/chargers. Currently, it is in the process of developing field-ready prototypes and exploring various business models. Market research is being conducted in Kanpur, Uttar Pradesh, India. The hope is to conduct a pilot there as well.

Along with his research experience in chemical engineering, Wunnava has business experience as an intern at Goldman Sachs' Natural Resources Investment Banking Division. Born in India, he is fluent in both Hindi and Telugu, the languages spoken in the areas of interest for BioBatts. He hopes to pursue a Master's degree in chemical engineering from MIT and then move to India to work on BioBatts full-time. ◊

Assoc. Prof Kristala Prather Earns Tenure

Kristala Jones Prather, the Theodore T. Miller Associate Professor of Chemical Engineering at MIT, has been awarded permanent tenure.

"Kristala is an innovative researcher and dedicated teacher. She continually strives to bring out the best in those around her, be they students, researchers, or fellow faculty members," said Klavs F. Jensen, Warren K. Lewis Professor of Chemical Engineering and head of the MIT Chemical Engineering Department, "Kristala is an important part of our Department's future."

Prather is an investigator in the multi-institutional Synthetic Biology Engineering Research Center (SynBERC) funded by the National Science Foundation (USA).

She received an SB degree from MIT in 1994 and PhD from the University of California, Berkeley (1999), and worked four years in BioProcess Research and Development at the Merck Research Labs (Rahway, N.J.).She is the recipient of a Camille and Henry Dreyfus Foundation New Faculty Award (2004), an Office of Naval Research Young Investigator Award (2005), a Technology Review "TR35" Young Innovator Award (2007), a National Science Foundation CAREER Award (2010), and the Biochemical Engineering Journal Young Investigator Award (2011). Additional honors include selection as the Van Ness Lecturer at Rensselaer Polytechnic Institute (2012) and a Young Scientist of the World Economic Forum Annual Meeting of the New Champions (2012). Prather has been recognized for excellence in teaching with the C. Michael Mohr Outstanding Faculty Award for Undergraduate Teaching in the Dept. of Chemical Engineering (2006) and the MIT School of Engineering Junior Bose Award for Excellence in Teaching (2010).

Prather is an important asset to organizations across the campus. For example, she has been a long-time collaborator of the MIT Portugal Program (MPP) – an international collaboration between MIT, the Portuguese government and industry. Prather is a faculty member of the MPP's Bioengineering focus area, and under this program, she participates in research projects in collaboration with Portuguese Faculty at Instituto Superior Técnico (Lisboa, Portugal) in the development and test of E. coli strains specifically adapted to meet the upstream and downstream processing challenges associated with large scale production of plasmid vectors. She is also a supervisor of several PhD Bioengineering MPP PhD candidates that have been developing part of their research project at her MIT laboratory.

Prather has also served as a member of the MIT Office of Engineering Outreach Programs' advisory board since November 2009. Through a SynBERC grant, she secured the funding to establish the SEED Academy Synthetic Biology course, for which she serves as the faculty advisor. About 120 high school students from Boston, Cambridge and Lawrence have been exposed to synthetic biology because of this course.

Prather's research interests are centered on the design and assembly of recombinant microorganisms for the production of small molecules, with additional efforts in novel bioprocess design approaches. Research combines the traditions of metabolic engineering with the practices of biocatalysis to expand and optimize the biosynthetic capacity of microbial systems. More simply, the Prather Lab is harnessing the synthetic power of biology to build microbial chemical factories. A particular focus is the elucidation of design principles for the production of unnatural organic compounds with engineered control of metabolic flux within the framework of the burgeoning field of synthetic biology. ◊

Congratulations to the MIT Cycling Club, including Course X graduate student and men's team captain, Zach Ulissi, on winning its second national title. The club team returned home as national champions after competing in the 2013 Division II Collegiate Road National Championships in Utah from May 3-5, 2013. The women were victorious in the team time trial, came third and fourth individually in the criterium and earned second, fifth and eighth place individually in the road race. The men won the road race, were fourth in the team time trial and picked up a few points in criterium. MIT won the team omnium competition, a combination of the women's and men's point total, with 428 points, a full 100 points ahead of second place Colorado Mesa University. ◊

Alumni and Faculty Mix at Local Receptions in California and Pennsylvania

Discuss how chemical engineers are "Addressing Today's Health and Energy Challenges"

June 24, 2013
Sofitel San Francisco Bay
Palo Alto, California

The Department kicked off its roadshow with a visit to the largest concentration of US-based MIT alumni outside Boston area: the San Francisco Bay area. Around 170 alumni and guests registered to network and see professors Paula Hammond and Greg Stephanopoulos discuss their research, as well as an update on the Department from head Klavs Jensen.

Hammond's discussion of "Electrostatic Nanolayer Delivery Platforms: from Macro- to Nano-pharmacies" explained her method of creating ultrathin polymer and organic–inorganic composite thin films to aid tissue engineering, biomedical devices, and wound healing applications. Stephanopoulos's "Metabolic Engineering: Enabling Technology of a Biobased Economy," looked at his lab's work in metabolic engineering and how it can produce cost effective biosynthetic routes to fuels, chemicals and pharmaceuticals in an envisioned future bio-based economy.

September 10, 2013
The Chemical Heritage Foundation
Philadelphia, Pennsylvania

Alumni from the Delaware Valley area, Philadelphia and Princeton came out to see Jensen and Kristala Prather and Michael Strano, who spoke on "Design and assembly of novel routes for bio-based fuels and chemicals" and "Chemical engineering nanotechnology: new materials and concepts for global challenges," respectively.

After spending some time exploring the CHF's remarkable museum space, the alumni and faculty discussed implications of the professors' work to deal with current and future energy needs. Prather's use of synthetic biology to create a better biofuel and Strano's use of graphene and carbon nanotubes to build smaller, mroe efficient batteries were highlights and prompted animated debate with many of the local attendees.

The Department wishes to thank the CHF and its president, Carsten Reinhardt, for hosting our event. If you're in Philadelphia, a trip to the free CHF museum on Chestnut Street is worth the trip. ◊

Faculty News

Paula Hammond Elected to AAAS, wins DoD Ovarian Cancer Teal Innovator Award and AIChE's 2013 Charles M. A. Stine Award

"Election to the [AAAS] is both an honor for extraordinary accomplishment and a call to serve," Academy President Leslie C. Berlowitz said in a statement. "We look forward to drawing on the knowledge and expertise of these distinguished men and women to advance solutions to the pressing policy challenges of the day." The current membership of AAAS includes more than 250 Nobel laureates and more than 60 Pulitzer Prize winners.

Hammond also received the Teal Innovator Award from Department of Defense's Ovarian Cancer Research Program. This award "supports a visionary individual from any field principally outside of, but not exclusive of, ovarian cancer to focus his/her creativity, innovation, and leadership on ovarian cancer research. The Teal Innovator Award will provide the Principal Investigator (PI) with the funding and freedom to pursue his/her most novel, visionary, high-risk ideas that could significantly impact the field of ovarian cancer research or patient care."

The Charles M.A. Stine Award is bestowed annually to a leading researcher in recognition of outstanding contributions to the field of materials science and engineering. The award is sponsored by E.I. duPont de Nemours & Co. It recognizes an individual's outstanding contribution to the scientific, technological, educational or service areas of materials engineering and science.

Richard Braatz to receive Excellence in Technical Innovation Award

On Monday, November 4th, the International Society of Automation will honor Richard Braatz with its Excellence in Technical Innovation Award for his "contributions to the development of process automation and control systems used for industrial pharmaceutical crystallization."

Founded in 1945, the International Society of Automation (www.isa.org) is a leading, global, nonprofit organization that is setting the standard for automation by helping over 30,000 worldwide members and other professionals solve difficult technical problems, while enhancing their leadership and personal career capabilities. Based in Research Triangle Park, North Carolina, ISA develops standards, certifies industry professionals, provides education and training, publishes books and technical articles, and hosts exhibitions for automation professionals.

Karen Gleason Elected a Fellow of AIChE

Professor Karen Gleason was elected a Fellow of AIChE. To gain this honor, a senior member of AIChE must have been practicing chemical engineering for more than 25 years and has demonstrated significant accomplishments in, and contributions to the profession.

Last year, Gleason earned the Excellence in Process Development Research Award. This award recognizes individuals who have made significant technical contributions to the advancement of process development within research, teaching, or regulatory activities. Emphasis is placed on accomplishments and advances made within the last ten years although the award can also be given to someone for an outstanding career.

Will Tisdale earns DOE Early Career Award

Assitant Professor William A. Tisdale has been named a recipient of the 2013 Early Career Award of the Office of Science of the Department of Energy (DOE).

Now in its fourth year, the Early Career Awards support the development of individual research programs by outstanding scientists who are in the early stages of their careers, and stimulates research careers in the disciplines supported by the DOE's Office of Science. Across the Office of Basic Energy Sciences divisions, 61 awards were made from about 770 proposals that went out for peer review.

Tisdale, the Charles and Hilda Roddey Career Development Assistant Professor of Chemical Engineering, will use his award to support work over five years to develop a novel ultrafast microscopy technique for visualizing electronic processes at interfaces in next-generation solar cells.

Brad Olsen named Paul M. Cook Career Development Professor

Assistant Professor Brad Olsen is the next holder of the Paul M. Cook Career Development Professorship. This chair was established with a generous contribution from Cook, who earned a degree in chemical engineering in 1947, to support an MIT junior faculty member with a strong interest in materials and chemical sciences.

The Olsen Lab focuses on engineering new biofunctional and bioinspired materials and understanding the novel polymer physics required to control the nanoscale structure and properties of these complex systems. To do this, they apply cutting-edge polymer chemistry and protein engineering to synthesize new materials at the interface of biology and the physical sciences. To intelligently design such systems, the lab investigates the relationships between molecular structure and self-assembly, applying concepts from block copolymer assembly and polymer gels to understand complex biohybrid materials. These efforts are aimed at applying biological components or biological design principles to dramatically extend the capability of soft materials such as solar energy converters, catalysts, and biomedical hydrogels. Through the study of protein-based systems, the researchers also hope to produce a new sustainable source of functional polymers.

Greg Stephanopoulos elected fellow in the American Academy of Microbiology

Professor Greg Stephanopoulos has been elected to be a 2013 fellow in the American Academy of Microbiology. Fellows of the Academy are elected annually through a highly selective, peer-review process, based on their records of scientific achievement and original contributions that have advanced microbiology. There are over 2,000 Fellows representing all subspecialties of microbiology, including basic and applied research, teaching, public health, industry, and government service.

Foundation Fighting Blindness honors Langer

On April 9, 2013, the Foundation Fighting Blindness, the leading private nonprofit organization funding research into treatments and cures for blinding retinal diseases, presented its Visionary Award to Institute Professor Robert Langer.

The Langer Lab has made countless discoveries and translated them into a range of drugs and drug delivery mechanisms, helping people with a variety of conditions including cancer, heart disease and diseases of the eye, most recently as co-founder of Kala Pharmaceuticals.

Langer keynoted a Symposium on Retinal Innovation on April 10. The event featured global leaders in translational research in drug development, regenerative therapies, gene replacement and other treatments for retinal degenerative diseases, together with CEOs of companies from start-ups to global enterprises and the world's most prominent life sciences venture capital investors in the vision space. ◊

2013 Hottel Lecture in Chemical Engineering Wednesday, Dec. 4, 2013

Emily A. Carter

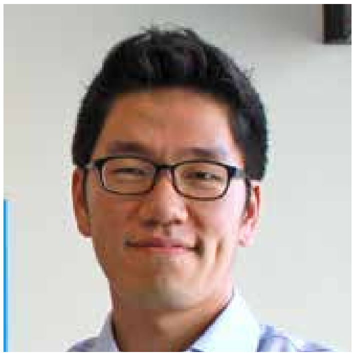
Gerhard R. Andlinger Professor in Energy and the Environment

Professor of Mechanical and Aerospace Engineering & Applied and Computational Mathematics

Professor Carter is the Founding Director of the Andlinger Center for Energy and the Environment at Princeton University. Her current research is focused entirely on enabling discovery and design of molecules and materials for sustainable energy, including converting sunlight to electricity and fuels, providing clean electricity from solid oxide fuel cells, clean and efficient combustion of biofuels, optimizing lightweight metal alloys for fuel-efficient vehicles, and characterizing hydrogen isotope incorporation into plasma facing components of fusion reactors.

For more information on the Hottel lecture, go to *http://web.mit.edu/cheme/news/hottel.html*

ChemE Welcomes Three New Professors



Kwanghun Chung joined the faculty in September 2013 as an assistant professor. His research group is devoted to developing and applying novel technologies for integrative and comprehensive understanding of large-scale complex biological systems. They develop a host of methods that enable rapid extraction of system-wide structural, molecular, and genomic information from intact tissues. Chung combines these technologies with physiological and behavioral approaches to study function and dysfunction of mammalian brain as well as other organs. Chung's mission is to empower the scientific community by openly sharing the research outcome and offering training courses to broadly and rapidly disseminate the technologies. He is also a member of IMES and a principal investigator of the Picower Institute of Learning and Memory.

Chung received his BS in chemical and biological engineering at Seoul National University in 2005. He then earned his PhD in 2009 from the Georgia Institute of Technology. After completing collaborations stemming from his PhD work, he then joined Karl Deisseroth Lab at Stanford University for post-doctoral training in 2010. In his time in Karl Deisseroth Lab, he invented a novel technology termed CLARITY, which enables system-wide structural and molecular analysis of large-scale intact biological samples including rodent brains and human clinical samples.

Heather Kulik will join the faculty in November 2013 as an assistant professor. In 2009, she received a PhD in materials science from MIT, under Professor. Nicola Marzari. She earned a BE in chemical engineering from Cooper Union in 2004. Her research group focuses on developing and applying accurate and efficient quantum mechanical methods to understand and design heterogeneous, molecular, and biological catalysts. A firm understanding of the fundamentals of catalysis is critical for tackling human health challenges and managing disease as well as addressing modern challenges in energy and efficient use of raw feedstocks. Through studying a wide range of catalysts - from enzymes to surface science, she aims to elucidate unifying principles that govern catalysis and provide a blueprint for catalyst design.

Kulik's postdoctoral work at Stanford focused on GPU-accelerated quantum chemistry techniques to study catalysis. Recent recognitions include the Burroughs Wellcome Fund Career Award at the Scientific Interface, 2012-2017 and the 2004 William C. and Esther Hoffman Beller Prize for Excellence in Chemical Engineering.

James Swan has joined the faculty as an assistant professor in September 2013. He received a PhD in 2010 and an MS degree in 2007 from the California Institute of Technology, both in chemical engineering. In 2004, he earned a B.S. degree from the University of Arizona, also in chemical engineering. Swan's research interests lie in computational fluid mechanics and colloid science, flow properties, biophysical media, and directed self-assembly of nanomaterials. His research group investigates the structure and dynamics of soft matter and the distinctive roles of non-conservative (hydrodynamic) and conservative (thermodynamic) forces in determining the mechanical properties of functional materials. They use of theory and simulation to make predictions of novel physical phenomena in soft matter with the goal of directing engineering applications and elucidating physical experiments. This requires a combination simple physical reasoning and sophisticated mathematical and computational analysis. They have studied intricate and relevant problems ranging from the flow of complex fluids to the precise measurement of biophysical forces.

His research earned the Postdoctoral Scholar Poster Prize at the 82nd Annual Meeting of the Society of Rheology and he was the recipient of the 2010 CalTech Graduate Student Council Teaching and Mentorship Award, as selected by his peers. ◊

Daniel C. Pregibon PhD'08

Alumnus Highlight

Current methods of detecting microRNA (miRNA) — gene-regulating molecules implicated in the onset of various diseases — can be time-consuming and costly: The custom equipment used in such tests costs more than $100,000, and the limited throughput of these systems further hinders progress.

Former Doyle Lab member Daniel Pregibon PhD '08 and fellow MIT alumnus Davide Marini PhD '03 are helping to rectify these issues through their fast-growing, Cambridge-headquartered startup, Firefly BioWorks Inc., which provides technology that allows for rapid miRNA detection in a large number of samples using standard lab equipment. This technology has helped the company thrive — and also has the potential to increase the body of research on miRNA, which could help lead to better disease diagnosis and screening.

The company's core technology, called Optical Liquid Stamping (OLS) — which was invented at MIT by Firefly co-founder and Chief Technical Officer Pregibon — works by imprinting (or stamping) microparticle structures onto photosensitive fluids. The resulting three-dimensional hydrogel particles, encoded with unique "barcodes," can be used for the detection of miRNAs across large numbers of samples. These particles are custom-designed for readout in virtually any flow cytometer, a cost-effective device that's accessible to most scientists.

"Our manufacturing process allows us to make very sophisticated particles that can be read on the most basic instruments," says co-founder and CEO Marini.

The company's first commercial product, FirePlex miRSelect, an miRNA-detection kit that uses an assay based on OLS-manufactured particles and custom software, began selling about a year ago. Since then, the company has drawn a steady influx of customers (primarily academic and clinical scientists) while seeing rapid revenue growth.

To date, most of the company's revenue has come from backers who see value in Firefly's novel technology. In addition to a cumulative $2.5 million awarded through Small Business Innovation Research grants — primarily from the National Cancer Institute — the company has attracted $3 million from roughly 20 independent investors. Its most recent funding came from a $500,000 grant from the Massachusetts Life Sciences Center.

Pregibon developed the technology in the lab of MIT chemical engineering professor Patrick Doyle, a Firefly co-founder who serves on the company's scientific advisory board. Firefly's intellectual property is partially licensed through the Technology Licensing Office at MIT, along with several other Firefly patents. Firefly's technology, from OLS to miRNA detection, has been described in papers published in several leading journals, including Science, Nature Materials, Nature Protocols and Analytical Chemistry.

"Imagine sticking a microscopic barcode on a microscopic product," Marini says. "How do you scan it? At the beginning we thought we would have to build our own scanner. This would have been an expensive proposition. Instead, by using a few clever tricks, we redesigned the barcode to make it readable by existing instruments. You can write these 'barcodes,' and all you need is one scanner to read different codes. To quote an investor: 'It shifts the complexity from the equipment to the particle.'

Firefly's aim is to strengthen preventive medicine in the United States. "In the long term, we see these products helping in the shift from reactive to preventative medicine," Marini says. "We believe we will see a proliferation of tools for detection of diseases. We want to move away from the system we have now, which is curing before it's too late."

Pregibon says Firefly's technology can be used across several molecule classes that are important in development and disease research: proteins, messenger RNA and DNA, among many others. "Essentially, the possibilities are endless," Pregibon says.

For more information and the full article on Firefly Bioworks, go to *http://web.mit.edu/newsoffice/2013/microrna-detection-on-the-cheap.html* ◊

Research Highlights

For more information, go to *web.mit.edu/cheme/news/*

Practicing medicine at the nanoscale

New approaches to drug delivery offer hope for new, more targeted treatments.

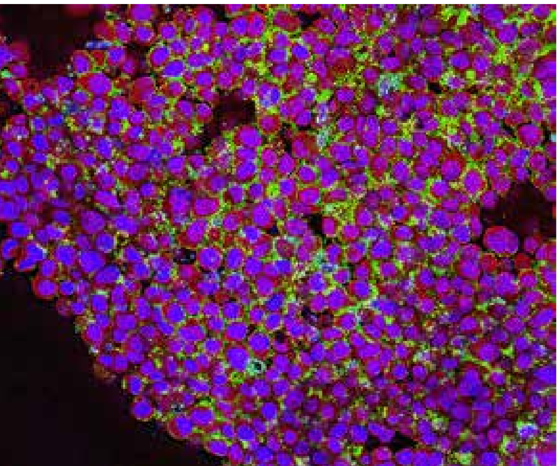
Article by Anne Trafton, courtesy of the MIT News Office.

Modern medicine is largely based on treating patients with "small-molecule" drugs, which include pain relievers like aspirin and antibiotics such as penicillin.

Those drugs have prolonged the human lifespan and made many life-threatening ailments easily treatable, but scientists believe the new approach of nanoscale drug delivery can offer even more progress. Delivering RNA or DNA to specific cells offers the promise of selectively turning genes on or off, while nanoscale devices that can be injected or implanted in the body could allow doctors to target drugs to specific tissues over a defined period of time.

"There's a growing understanding of the biological basis of disease, and a growing understanding of the roles certain genes play in disease," says Daniel Anderson, the Samuel A. Goldblith Associate Professor of Chemical Engineering and a member of MIT's Institute for Medical Engineering and Science and David H. Koch Institute for Integrative Cancer Research. "The question is, 'How can we take advantage of this?'"

Researchers in Anderson's lab, as well as many others at MIT, are working on new ways to deliver RNA and DNA to treat a variety of diseases. Cancer is a primary target, but deliveries of genetic material could also help with many diseases caused by defective genes, including Huntington's disease and hemophilia. "There are many genes that we think if we could just turn them off or turn them on, it could be therapeutic," Anderson says.



(at left) Human bread cancer cells (purple) are targeted by nanoparticles (green) developed by Paula Hammond. The particles bind to receptors overexpressed by cancer cells. Image: Paula T. Hammond and Erik C. Dreaden

One promising avenue is RNA interference (RNAi), a naturally occurring process that allows cells to fine-tune their gene expression. Short strands of RNA called siRNA intercept and destroy messenger RNA before it can carry protein-building instructions from DNA to the rest of the cell. Scientists hope that by creating their own siRNA to target specific genes, they will be able to turn off genes that cause disease.

However, this potential has not yet been realized because of challenges in safely delivering siRNA to the right tissues and avoiding other tissues. Using viruses is one possibility, but is an option that carries some safety risks, so many researchers are now investigating synthetic delivery vehicles for genetic material.

Anderson's lab is developing materials called lipidoids, fatty molecules that can envelop and deliver strands of siRNA. Studies have shown that these materials can effectively deliver RNA and shrink tumors in animals; MIT researchers are now working on developing them for human tests. These particles can deliver many RNA sequences at once, allowing researchers to target multiple genes. "A lot of these diseases, in particular cancer, are complicated and may require turning off multiple genes, or turning some genes off and some genes on," Anderson says.

Anderson is also using a technique called nucleic-acid origami to fold DNA and RNA into structures suitable for targeting cancer cells. Nucleic-acid origami, developed within the past few years, allows for extremely precise control over the location of every atom within a structure — something that is difficult to achieve with other types of nanoparticles, Anderson says.

Multipronged approach

Paula Hammond, the David H. Koch Professor of Engineering and a member of the Koch Institute, is also developing new materials for delivering both RNA and traditional drugs. Using her layer-by-layer assembly technique, she is creating nanoparticles that incorporate layers of multiple types of RNA, or combine RNA with a chemotherapy drug.

This multipronged attack could allow researchers to design treatments that cut off many of tumor cells' possible escape routes. "We're very interested in looking at combinations that would involve RNAi that knocks down the ability of cells to counteract chemotherapy attack," Hammond says. Hammond's research in this area is now focused on cancer, but the approach could also lend itself to treating the inflammation produced by infectious diseases, she says. "With RNAi, the approach is fairly modular, and once you understand which genes you need to impact, you can work on targeting them," Hammond says.

Hammond's lab is also working on medical-device coatings that could secrete useful drugs, hormones or growth factors. One such project involves coating hip implants with layers that secrete bone growth factors. In studies with animals, she has shown that these coatings can promote the growth of natural bone, and stronger adhesion between hip implants and the body's own bone. If the work translates to human clinical use, it could allow hip implants to last longer and reduce the need for additional surgeries to replace the implants.

Hammond is also working on materials that promote wound healing by preprogrammed release of growth factors from bandages and dressings, and on ultrathin, transparent coatings for cataract-replacement lenses that release anti-inflammatory drugs.◊

Patterning graphene with DNA

Folded DNA templates allow researchers to precisely cut out graphene shapes, which could be used in electronic circuits.

Article by Anne Trafton, courtesy of the MIT News Office.

DNA's unique structure is ideal for carrying genetic information, but scientists have recently found ways to exploit this versatile molecule for other purposes: By controlling DNA sequences, they can manipulate the molecule to form many different nanoscale shapes.

Chemical and molecular engineers at MIT and Harvard University have now expanded this approach by using folded DNA to control the nanostructure of inorganic materials. After building DNA nanostructures of various shapes, they used the molecules as templates to create nanoscale patterns on sheets of graphene. This could be an important step toward large-scale production of electronic chips made of graphene, a one-atom-thick sheet of carbon with unique electronic properties.

"This gives us a chemical tool to program shapes and patterns at the nanometer scale, forming electronic circuits, for example," says Michael Strano, a professor of chemical engineering at MIT and a senior author of a paper describing the technique in the April 9 issue of Nature Communications.

Peng Yin, an assistant professor of systems biology at Harvard Medical School and a member of Harvard's Wyss Institute for Biologically Inspired Engineering, is also a senior author of the paper, and MIT postdoc Zhong Jin is the lead author. Other authors are Harvard postdocs Wei Sun and Yonggang Ke, MIT graduate students Chih-Jen Shih and Geraldine Paulus, and MIT postdocs Qing Hua Wang and Bin Mu.

Most of these DNA nanostructures are made using a novel approach developed in Yin's lab. Complex DNA nanostructures with precisely prescribed shapes are constructed using short synthetic DNA strands called single-stranded tiles. Each of these tiles acts like an interlocking toy brick and binds with four designated neighbors.

Using these single-stranded tiles, Yin's lab has created more than 100 distinct nanoscale shapes, including the full alphabet of capital English letters and many emoticons. These structures are designed using computer software and can be assembled in a simple reaction. Alternatively, such structures can be constructed using an approach called DNA origami, in which many short strands of DNA fold a long strand into a desired shape.

However, DNA tends to degrade when exposed to sunlight or oxygen, and can react with other molecules, so it is not ideal as a long-term building material. "We'd like to exploit the properties of more stable nanomaterials for structural applications or electronics," Strano says.

Instead, he and his colleagues transferred the precise structural information encoded in DNA to sturdier graphene. The chemical process involved is fairly straightforward, Strano says: First, the DNA is anchored onto a graphene surface using a molecule called aminopyrine, which is similar in structure to graphene. The DNA is then coated with small clusters of silver along the surface, which allows a subsequent layer of gold to be deposited on top of the silver.

Once the molecule is coated in gold, the stable metallized DNA can be used as a mask for a process called plasma lithography. Oxygen plasma, a very reactive "gas flow" of ionized molecules, is used to wear away any unprotected graphene, leaving behind a graphene structure identical to the original DNA shape. The metallized DNA is then washed away with sodium cyanide.

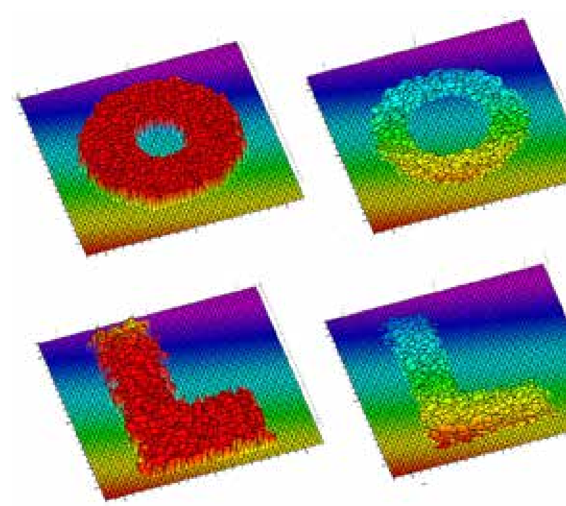
Shaping graphene circuits

The research team used this technique to create several types of shapes, including X and Y junctions, as well as rings and ribbons. They found that although most of the structural information is preserved, some information is lost when the DNA is coated in metal, so the technique is not yet as precise as another technique called e-beam lithography.

However, e-beam lithography, which uses beams of electrons to carve shapes into graphene, is expensive and takes a long time, so it would be very difficult to scale it up to mass-produce electrical or other components made of graphene.

One shape of particular interest to scientists is a graphene ribbon, which is a very narrow strip of graphene that confines the material's electrons, giving it new properties. Graphene doesn't normally have a bandgap — a property necessary for any material to act as a typical transistor. However, graphene ribbons do have a bandgap, so they could be used as components of electronic circuits.

"There is still interest in using graphene for digital electronics. Graphene itself isn't ideal for this, but if you pattern it into ribbons, it may be possible," Strano says. ◊



At left, metallized DNA (red) forms letters on a graphene surface. Treatment with oxygen plasma etches the shape of the letters into the graphene, right. Image: Zhong Jin

Getting the carbon out of emissions

Proposed method could be more efficient than previous systems and easier to retrofit in existing power plants.

Article by David L. Chandler, courtesy of the MIT News Office.

Many researchers around the world are seeking ways to "scrub" carbon dioxide (CO2) from the emissions of fossil-fuel power plants as a way of curbing the gas that is considered most responsible for global climate change. But most such systems rely on complex plumbing to divert the steam used to drive the turbines that generate power in these plants, and such systems are not practical as retrofits to existing plants.

Now, researchers at MIT have come up with a scrubbing system that requires no steam connection, can operate at lower temperatures, and would essentially be a "plug-and-play" solution that could be added relatively easily to any existing power plant.

The new electrochemical system is described in a paper just published online in the journal Energy and Environmental Science, and written by doctoral student Michael Stern, chemical engineering professor T. Alan Hatton and two others.

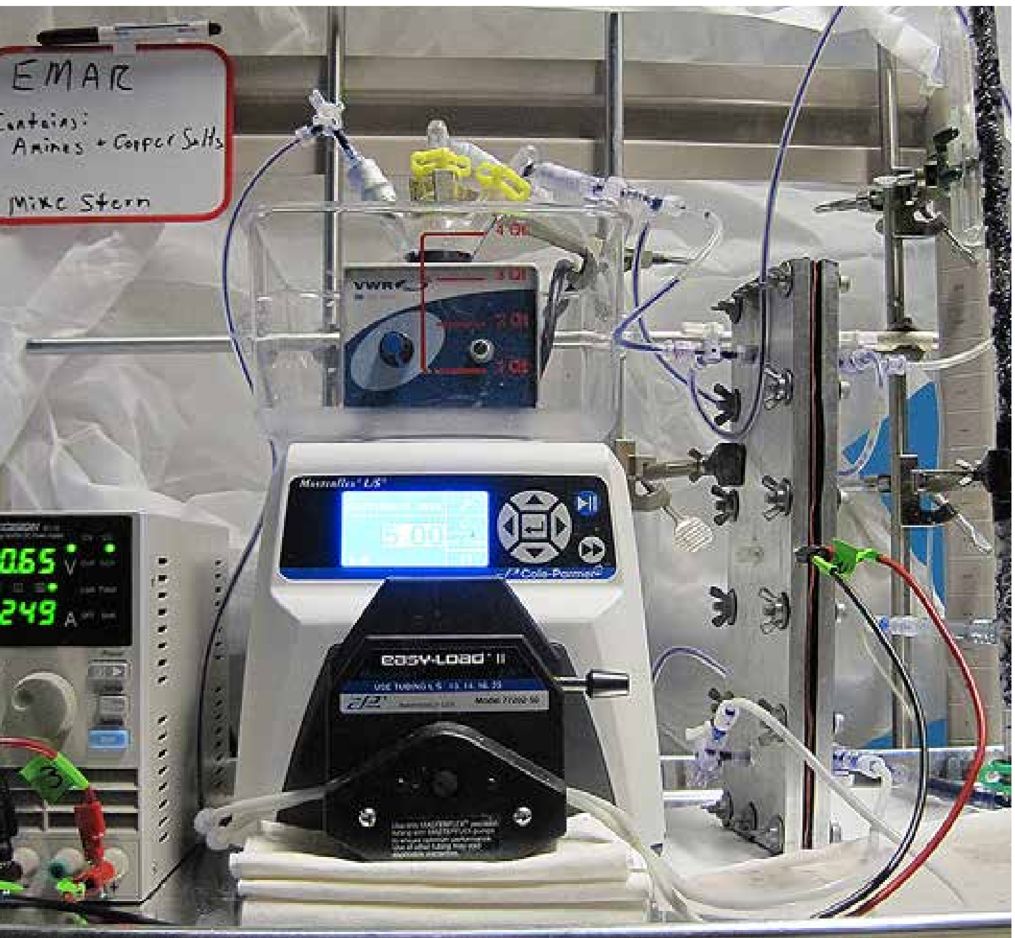
The system is a variation on a well-studied technology that uses chemical compounds called amines, which bind with CO2 in the plant's emission stream and can then release the gas when heated in a separate chamber. But the conventional process requires that almost half of the power plant's low-pressure steam be diverted to provide the heat needed to force the amines to release the gas. That massive diversion would require such extensive changes to existing power plants that it is not considered economically feasible as a retrofit.

In the new system, an electrochemical process replaces the steam-based separation of amines and CO2. This system only requires electricity, so it can easily be added to an existing plant.

The system uses a solution of amines, injected at the top of an absorption column in which the effluent gases are rising from below. The amines bind with CO2 in the emissions stream and are collected in liquid form at the bottom of the column. Then, they are processed electrochemically, using a metal electrode to force the release of the CO2; the original amine molecules are then regenerated and reused.

As with the conventional thermal-amine scrubber systems, this technology should be capable of removing 90 percent of CO2 from a plant's emissions, the researchers say. But while the conventional CO2-capture process uses about 40 percent of a plant's power output, the new system would consume only about 25 percent of the power, making it more attractive.

In addition, while steam-based sys-



Graduate student Michael Stern and his co-workers built this laboratory-scale device to prove the principles behind the electrochemical carbon-capture system. Image: Michael Stern

"Our system is something you just plug in, so you can quickly turn it down when you have a high cost or high need for electricity."
- Mike Stern, Course X graduate student

tems must operate continuously, the all-electric system can be dialed back during peak demand, providing greater operational flexibility, Stern says. "Our system is something you just plug in, so you can quickly turn it down when you have a high cost or high need for electricity," he says.

Another advantage is that this process produces CO2 under pressure, which is required to inject the gas into underground reservoirs for long-term disposal. Other systems require a separate compressor to pressurize the gas, creating further complexity and inefficiency.

The chemicals themselves — mostly small polyamines — are widely used and easily available industrial materials, says Hatton, the Ralph Landau Professor of Chemical Engineering Practice. Further research will examine which of several such compounds works best in the proposed system.

So far, the research team, which also includes former MIT research scientist Fritz Simeon and Howard Herzog, a senior research engineer at the MIT Energy Initiative, has done mathematical modeling and a small-scale laboratory test of the system. Next, they hope to move on to larger-scale tests to prove the system's performance. They say it could take five to 10 years for the system to be developed to the point of widespread commercialization.

David Heldebrant, a senior research scientist in materials chemistry at the Pacific Northwest National Laboratory, who was not involved in this work, says, "The electrochemical approach to CO2 capture has been previously proposed by other groups, but with varying degrees of success. What separates Hatton and his team from the field is that they have demonstrated the first comprehensive study of the thermodynamic and engineering principles that are needed to project the performance of electrochemical systems."

Heldebrant adds: "As with any process, the main questions and uncertainty pertain to the costs and lifetime of the system." But he says this research "is of the highest quality," and the team has "done a great job identifying the critical science and engineering for such a system."

Because it does not rely on steam from a boiler, this system could also be used for other applications that do not involve steam — such as cement factories, which are among the leading producers of CO2 emissions, Stern says. It could also be used to curb emissions from steel or aluminum plants.

It could also be useful in other CO2 removal, Hatton says, such as in submarines or spacecraft, where carbon dioxide can accumulate to levels that could endanger human health, and must be continually removed.

The work was supported by Siemens AG and by the U.S. Department of Energy through the Advanced Research Projects Agency for Energy. ◊

Other Fall 2013 Course X Research News

- Karen Gleason finds a new way to produce a less expensive solar cell
- Greg Stephanopoulos engineers cells for more efficient biofuel production
- Bob Cohen and colleagues develop a glass coating that could prevent frost buildup
- Kristala Prather and colleagues use biology to improve chemical synthesis
- Prof. Jesse Kroll studies how anthropogenic emissions interact with organic compounds emitted by trees
- Paula Hammond's new research enables high-speed customization of novel nanoparticles for drug delivery and other uses

For more information on these stories and other Departmental news, go to *web.mit.edu/cheme/news/*

Todd Zion PhD ’04

Alumnus Highlight

The Half-Billion-Dollar Idea

While at MIT, Zion developed an insulin product that ultimately drew the attention of a pharmaceutical giant.

Article by Rob Matheson, courtesy of the MIT News Office.

It seems improbable that a PhD thesis would lead to a multimillion-dollar payday. But that’s what happened for Todd Zion PhD ’04, who worked tirelessly on a new type of diabetes drug as an MIT doctoral candidate — and for several years thereafter — and eventually sold that compound’s blueprints to a pharmaceutical giant.

The progression from bench researcher to entrepreneurial success story, Zion says, took diligence, frugality and, in his company’s early stages, MIT’s resources for entrepreneurs.

During the early 2000s, in MIT’s Nanostructured Materials Research Laboratory — then run by former professor of chemical engineering Jackie Ying — Zion began chemically modifying insulin for diabetics. The modified insulin would automatically adjust to fluctuating levels of blood glucose, requiring just a single injection per day.

In 2003, he licensed this drug as SmartInsulin through MIT’s Technology Licensing Office and co-founded the company SmartCells to further develop the drug and turn it into a viable commercial product.

It worked: Seven years later, Merck & Co. acquired SmartCells and the license for SmartInsulin for a substantial upfront sum and milestone payments (to be made if the drug succeeds at certain defined stages in its development) that could exceed $500 million — an unprecedented amount for what was then a preclinical drug.

After nearly a decade of work on the drug, Zion met the acquisition with mixed feelings: On the one hand, it was a relief that Merck could take the drug through robust clinical trials, but on the other hand, his work was done. “When you realize you’re not needed anymore, there’s a gap. But once I got past that, I realized our drug was in good hands,” he says.

On the heels of the acquisition, Zion purchased the private Devereux School in Marblehead, Mass., which his three children attended, to save it from closing. It was a welcome change, Zion says. “In any biotech startup, everyday it’s some degree of failure until you finally succeed,” he says. “But with owning a school, just seeing young children’s smiles and hearing their laughter is rewarding every day.”

Lean and mean

What may be most impressive about the SmartCells acquisition is how much of the total buyout will actually go to its shareholders: Because the company was built in what Zion calls “a very capital-efficient manner,” he, his 17 employees and various shareholders were handsomely rewarded.

At the time of the company’s acquisition, SmartCells had raised only $10 million in funding, primarily from angel investors and grants from the National Institutes of Health — remarkably little for a company working on a potentially revolutionary diabetes treatment, Zion says. Generally, startups raise far more capital, and the ultimate payout, if it comes at all, rarely leaves much profit. “We had some help, but at the end of the day, we were pretty lean and mean,” Zion says.

Zion and his co-founders aimed to develop SmartCells’ core technology in the most cost-effective way possible. Raising millions to build infrastructure and conduct advanced clinical trials — as many biotech startups do — wasn’t worth the money, he says. Thus, SmartCells lived a spartan existence — the “road less traveled,” Zion says — but it paid off.

“Part of our strategy was not only to be innovative in the technology developed, but also in how we were going to

"Being associated with MIT certainly opened up doors to potential funding sources and a number of advisors. Plus, there's a tremendous amount of resources already within the MIT community to help a would-be entrepreneur get off the ground. And I think it's the combination of those two things that were really important in the early days."
- Todd Zion PhD '04

build this enterprise and how we looked at it as a venture," he says. "You live like a pauper for seven years building up this risky asset [SmartInsulin] and so I think there's a sense that we were vindicated — this is a path you can take and you can succeed."

It helped that the company's eventual acquisition by big pharma was by design, Zion says. SmartCells had aimed to take SmartInsulin only to a point where it had taken "the risk out of the asset," Zion says: It would have to be seen as a viable commercial product, but not so far along that a larger company couldn't take over and run its own clinical trial.

It was at exactly that point when the company sold, Zion says. "We knew our job was to get the insulin to the point where enough risk had been taken off the table, so that someone else could take it the rest of the way. And we really stuck to that from day one," he says. "It was the perfect time to sell."

Off the ground

Zion says MIT's resources for entrepreneurs and inventors — such as the Venture Mentoring Service (VMS) and the Institute's entrepreneurship competitions — played a role in helping him turn his ideas into reality.

"Being associated with MIT certainly opened up doors to potential funding sources and a number of advisors," Zion says. "Plus, there's a tremendous amount of resources already within the MIT community to help a would-be entrepreneur get off the ground. And I think it's the combination of those two things that were really important in the early days."

The roots of SmartCells actually trace back to Zion winning MIT's annual $50K (now $100K) Entrepreneurship Competition in 2003: From that experience, he earned startup funds for the company, learned the risks and rewards of building a business, and met a number of angel investors and entrepreneurs, among other things. "It really clicked that building a business could be the right way to bridge the gap between interesting technology and commercially viable products," Zion says.

From there, Zion recruited his SmartCells co-founders: his former MIT lab partner, Tom Lancaster PhD '04, along with experienced entrepreneur James Herriman, who he met through VMS.

But it wasn't just tangible resources — people and funds — that Zion gained from MIT: He says his PhD experience also taught him the value of diligence and self-reliance in the face of challenges. It also instilled the ability to "face failure head-on" in the lab — a virtue that transferred to his business, Zion says.

"My time at MIT prepared me for anything I could face as an entrepreneur," Zion says. "When you're starting a venture in a very technologically challenging area, you have to be prepared for repeated failures and learn from them. Our philosophy at SmartCells was always to find the riskiest things and make a beeline for those, because you'll learn so much more than just turning to easier problems."

Zion has since returned to MIT as a VMS mentor. His time with young entrepreneurs has helped him reflect on what it takes to successfully see technology through from MIT labs to the market: primarily, he says, hard work, humility, and a willingness to gather advice from experts.

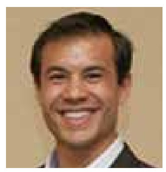
"That was certainly the key to my success: I knew how little I knew," he says. "So I was able to assemble the right team, at the right time, and build that team in the right way. My advice: Recognize what you don't know and surround yourself with people who can help." ◊

Alumni News

We want to hear from alumni like you! Please send us your news and photos.
Please direct news to: ***Melanie Miller, Editor***
Email: ***chemealum@mit.edu***, Phone: ***617-253-6500***, Fax: ***617-258-8992***

Sanjay Amin ScD ’75 has retired after 35 years in the pharmaceutical Industry. His last corporate position was co-leader of Global Active Ingredients with Pfizer in New York City. He now spends his time between India and the US (Michigan) , traveling, golfing and playing with his grandchildren.

David K. Lam SM ’70 ScD ’73 was profiled in April 2013 by *Technology Review*. Called a “Mentor Capitalist,” Lam’s role as technologist, entrepreneur, and mentor has been recognized widely; two U.S. presidents have called on his services, one for a minority business development commission and the other for a trade mission to China. He has authored more than 20 technical papers, and this year he was inducted into the Silicon Valley Engineering Hall of Fame. Lam and his wife, Lynn Barringer, live in Saratoga, California; they have four children and four grandchildren. He likes to read, listen to music, and watch 49ers football, and he is working on a book about entrepreneurial management.



Tanguy Chau SM/PhD ’10, MBA ’11 has been elected to MIT’s board of trustees and will serve on the Chemical Engineering subcommittee. Chau is currently an associate at McKinsey & Company, and is founder of Sample6 Technologies. Chau received his BS degree in chemical engineering from the University of California at Berkeley. He earned his SM and PhD in chemical engineering practice from MIT in 2010, and received an MBA from the MIT Sloan School of Management in 2011. While at MIT, he founded and led technology development for Sample6 Technologies (previously Novophage), a startup that leverages synthetic biology to prevent and treat bacterial contaminations in medical and industrial settings. In 2012, he joined McKinsey & Company, where he primarily serves technology and health care private equity clients. He was a student member of the Corporation Joint Advisory Committee from 2008 to 2011.

The Boston Globe recently profiled **Jasmina Aganovic ’09,** head of a skin-care company Bona Clara, and her plan to be a “21st-century Mary Kay.” Aganovic’s anti-aging skin-care line is sold online through the websites of her “brand ambassadors.” She plans to expand into makeup. ◊

In Memoriam

O. Charles Roddey SM ’51

Otha (Charles) Roddey, age 89, of Carlsbad, California, passed away on Sunday, May 12, 2013. He was born January 7, 1924 in Arkansas to his parents, Otha and Anna Roddey.

He married his first wife Hilda Blaine Roddey on October 7, 1951 in Darling, Mississippi. They had three children. He held two degrees in Chemical Engineering, a Bachelor of Science from Louisiana State University and a Master\'s Degree from Massachusetts Institute of Technology. During World War II he was a Captain in the U.S. Army and served 3-1/2 years in several assignments ending in the Philippines.

Charles began his business career as a process development engineer with ESSO Standard Oil Company before starting a long and successful career at The Ralph M. Parsons Company in 1961. He was elected to the Board of Directors of The Ralph M. Parsons Company in 1977, President of the company in January 1979, and President of the Parsons Corporation in 1983. He was also a Director of The Parsons Corporation. He retired from the Corporation in 1988.

His civic activities included service with United Way, the Parson\'s Tournament for Life golf event to benefit the American Cancer Society, and the San Gabriel Valley Council of the Boy Scouts of America.

The MIT Chemical Engineering Department is grateful for the support Mr. Roddey has shown our students and faculty throughout the years. He will be missed.

Blast from the Past

In the Spring 2013 edition, fellow alumni and former staff found friends in the posted photos:

In the photo to the left, Efstathios Avgoustiniatos SM ’90 PhD ’02 says, “At left is Angelos Kyrlidis SM ’89 PhD ’93 (with the beard) and next to him is Dimitris Maroudas PhD ’92. They both started their graduate studies in the fall of 1987 and did their PhD in Bob Brown’s group.”

Former graduate administrator Janet Fischer also identified Jeff Feerer as the jacketed fellow second from the right.

Janet Fischer also identified all three of these students. Left to right, they are Guillermo Ameer ScD ’99, (now a professor of biomedical engineering at Northwestern), Anand Asthagiri PhD ’00 (now a chemical engineering professor at CalTech) and Rebecca Carrier PhD ’00 (today a professor at Northeastern).

Where is Janet Fischer is now? She is now the graduate administrator for Course VI, and keeps up regularly with ChemE staff, faculty and alumni.

In the photo to the right, Isabella Goldmints PhD ’99 wrote in, “I am in the top left picture in the center of this picture (with hairband and glasses) and Fred von Gottberg, PhD ‘98 (or ‘97) is the person on the right (standing).” And of course that is Professor Bob Cohen partially hidden in the center of the photo.

Today Isabella is a Senior Technologist at Infineum USA, a petroleum additive company in New Jersey and a joint venture of ExxonMobil and Shell.

Do you have photos or images you’d like to share? Email *chemealum@mit.edu*.

Thank You for Your Support!

This honor roll is a special salute to those who have given over $100 to the MIT Chemical Engineering Department for the period of July 1, 2012, through June 30, 2013.

Thank you to everyone who has supported us throughout the year!

Every effort has been made to ensure the accuracy of this list.
Please direct corrections to: ***Melanie Miller, Editor,*** at melmils@mit.edu

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Fall 2013Chemical Engineering Dept. Seminar Schedule

All Seminars are Fridays at 3pm in 66-110, unless otherwise noted.

Friday, October 4
Life's Little Mysteries: Multiscale Modeling of Living Systems
Andy Spakowitz Chemical Engineering, Stanford University

Friday, October 11
Reimagining Silicon via Nanowire Engineering
Michael Filler, Chemical & Biomolecular Engineering, Georgia Institute of Technology

Friday, October 18
Title TBA
Cliff Wang, Chemical Engineering, Stanford University

Friday, November 22
Antibodies by Design
Pete Tessier, Chemical & Biological Engineering, Rensselaer Polytechnic Institute

Wednesday, December 4
HOYT C. HOTTEL LECTURE
Emily Carter, Gerhard R. Andlinger Professor in Energy and the Environment Mechanical and Aerospace Engineering & Applied and Computational Mathematics, Princeton University

The MIT Chemical Engineering Department
cordially invites you to attend the

MIT CHEMICAL ENGINEERING RECEPTION
2013 Annual AIChE Meeting

Monday, November 4th, 2013
from 7:00 – 9:00 p.m.

Continental Ballroom 6
Hilton San Francisco Union Square
333 O'Farrell Street
San Francisco, California

CELEBRATING 125 YEARS OF COURSE X

This event will also recognize

PROFESSOR KAREN K. GLEASON '82, SM '82
Elected Fellow of AIChE

PROFESSOR PAULA T. HAMMOND '84, PHD '93
Recipient of the Charles M.A. Stine Award

and

GRADUATE STUDENT MICHAEL STERN
Winner of the AIChE Separations Division Award