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MIT CHEMICAL ENGINEERING ALUMNI NEWS

XCurrents

Institute Professor Bob Langer receives National Medal of Technology and Innovation (Page 9)

Letter from *Department Head Klavs F. Jensen*

As I write this letter to you, Boston has had its third snowstorm in as many weeks, and it is difficult to envision spring coming any time soon. Nonetheless, I bid you a warm welcome to the spring edition of the Course X alumni news and am glad to share with you our latest events and advances.

As you can see throughout the newsletter, this is an exciting time for MIT Chemical Engineering. Our faculty members continue to be recognized for their research and educational contributions, while our laboratories are producing some of the most cutting-edge research seen today. MIT Chemical Engineering is a leader in the field, and one way we've been able to keep this level is to remain flexible in order to address the needs of our students, our researchers, and the world around us.

A critical element of this flexibility is our physical space, which in the past few years has expanded beyond Building 66 to include space in the new David H. Koch Center for Integrative Cancer Research building for five faculty members, Professors Anderson, Hammond, Langer, Love and Wittrup. Moreover, the shared facilities enable research between

Highlights

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Letter from the Department Head continued

Chemical Engineering faculty and Koch Institute researchers. Chemical Engineering has also benefitted from the move of the old Cancer Center to the Koch Institute as we received the space left behind on the 5th floor of E17/E18. This space has now been renovated for four senior faculty, with use of substantial funds from you, our alumni. Seven members of the faculty, Professors Chakraborty, Doyle, Green, Prather, Rutledge, Sikes, and Trout, now occupy "ChemE East" on the fifth floor of buildings E17/18/19.

This additional space is a first step towards creating the up-to-date facilities the Department needs to remain the leader of the discipline. As you know, we have long been faced with a deteriorating infrastructure in our flagship Landau Building. Designed by I.M. Pei and an historical precursor to his work on the East Wing of the National Gallery of Art, Building 66 is a unique and intriguing structure. But just as the field of chemical engineering has evolved to confront the needs of today's world, our facilities must catch up to the needs of the modern researcher. The poor state of the building and its importance to Chemical Engineering was recognized by the Institute survey of its infrastructure: MIT 2030. We are fortunate to be among one of the first buildings to be renovated in this new renewal program. The much needed renovation of the building is projected to cost $45 million, with MIT providing $25 million in renewal funds toward new infrastructure.

"Just as the field of chemical engineering has evolved to confront the needs of today's world, our facilities must catch up to the needs of the modern researcher."

The Department has to raise the remaining $20 million to create modern laboratories and offices. Ninety percent of its five floors will be upgraded in some way: outdated labs will be outfitted with the latest research equipment, student offices will be modernized and moved out of the labs to meet modern safety standards, and the heating and cooling infrastructure will be upgraded. Such facilities and flexible spaces are essential to remain competitive and attract new faculty members and top-notch students, each with unique needs to conduct cutting-edge research.

The renovation will commence when we have raised the $20 million. We hope we can rely on your help and generosity as in the past. When the renovation is done, Chemical Engineering will have gone from approximately 100,000 square feet of outdated space five years ago to 140,000 square feet of newly renovated space. This space change, along will our terrific group of young faculty, will ensure our continued leadership position. More information about the new space is on page 12. We will keep you updated on the progress of this exciting effort and provide ways in which you can help us.

This January, the Department welcomed our newest faculty member: Fikile Brushett. Fikile received his BS from the University of Pennsylvania and his PhD from the University of Illinois – Champaign-Urbana, both degrees in chemical engineering. His thesis research focused on electrochemical energy conversion, specifically microfluidic fuel cells. He then went on to do a two-year postdoctoral study at Argonne National Laboratory on battery and solid oxide fuel cell technologies. Fikile plans to study electrochemical processes for energy storage and conversion applications; specifically, fundamental questions related to the performance and durability of the catalysts, electrodes and internal interfaces within these systems. (more on page 11).

Many of you may recognize Professor (and department alumnus) Clark Colton on this edition's cover. Clark, along with energy related faculty, has worked hard to bring to fruition our latest undergraduate project lab course, which focuses on real-world energy problems. Students work directly with MIT researchers and industry sponsors to address specific energy projects while learning teamwork and presentation skills. I encourage you to learn more about this unique undergraduate experience in its profile on page 22.

Energy and sustainability are import issues for all of us, so it is timely that our 2013 Lewis Lecturer is Dr.Yoshimitsu Kobayashi, president and CEO of Mitsubishi Chemical Holdings Corporation and a leader in promoting corporate sustainability. Dr. Kobayashi's management style is guided by the concept of "Good Chemistry for Sustainability, Health, and Comfort." His lecture will be here on campus on Friday, April 5th – I hope you can join us. More information on the Lewis Lecture can be found at *web.mit.edu/cheme/news/lewis/*.

In May we will host Professor George Georgiou of UT Austin, who will be giving the 2013 Alan S. Michaels Lecture. George's lecture, "What's in your blood? Molecular Deconvolution of the Human Serum Antibody Repertoire in Health and Disease," will delve into his work in developing a suite of proteomic, microfluidic, protein engineering and informatics technologies to address the relationships between antibody production and the body's immunological mechanisms. The lecture will be May 3rd (*http://web.mit.edu/cheme/news/michaels/*).

The individuals and teams that make up MIT Chemical Engineering continue to make tremendous progress in education and research across a broad front of chemical engineering, including energy, manufacturing, and bioengineering. It is wonderful to be a part of the ChemE family and to share its advances in educating and helping the world around us. Watch our website, *web.mit.edu/cheme/* for the latest; you can find us on Facebook (*MIT Chemical Engineering*) and Twitter (*MITChemE*) for live updates on the goings on around the department and the Institute.

In an effort to connect more with you, our alumni, we are also planning a number of alumni events across the country, including Boston, New Jersey, Florida, Houston, and the Bay Area.

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 continued support and best regards.

Klavs F. Jensen
Department Head
MIT Chemical Engineering Department

Update on XCurrents Fall 2012 Cover Story

In November of 2012, *Technology Review* profiled the MIT-Novartis collaboration to create continuous pharmaceutical manufacturing. The magazine explains that the work at MIT is "being further studied at the Novartis headquarters in Basel, Switzerland.... One benefit could be a significantly reduced time between issuing a manufacturing order for a product and having the finished drug in hand. This would be especially helpful during clinical trials, in which companies have to balance the need for sufficient drugs for upcoming trial stages with the risk that most of those drugs will end up failing. The faster production times promised by the continuous method—at least 10 times speedier in the MIT experimental facility—and the smaller scale of production would be much better suited to the uncertain nature of drug development."

Also, in October 2012, The MIT-Novartis project was a runner-up for the Wall Street Journal's Technology Innovation Award in Manufacturing Technology. For this award, the judges chose a total of 37 winners and runners-up from over 500 applications from more than two dozen countries. The winners and runners-up best answered the questions: Does the innovation break with conventional processes in its field? Does it go beyond marginal improvement? Will it have a wide impact? ◊

XCurrents is a semi-annual newsletter for alumni and friends of the MIT Chemical Engineering Department.

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Other ways to connect

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On the cover: In the newest undergraduate lab course, 10.27 Energy Engineering Projects, students work on real-world energy problems. Here, Professor Clark Colton gets an update on students' work. For more, go to page 22.

Practice School News

Greetings from the MIT Practice School!

Once again, I am happy to be able to bring you the latest happenings of the Practice School and its stations. The David H. Koch School of Chemical Engineering Practice continues to be a dynamic and unique educational opportunity within the Department, attracting top students from around the country and the world. All of our host companies were welcoming and provided projects with outstanding practical opportunities for our students. Thank you to all those to have helped provide the kind of education that only these hands-on real-world challenges can offer. And a hearty thank you to you – our alumni; your gracious and consistent support of the Practice School is vital to its success.

This past summer and fall, our students attend stations across the globe. Although the products and industries varied, the core challenges were similar and ones where the students were able to connect their classroom lessons to very real industrial issues. Let me share with you details from the station directors:

Summer 2012 Stations

Novartis Pharmaceutical Corp., San Carlos CA
Directed by Claude Lupis

This was our second station in San Carlos, and like the first one, it was organized by our Novartis coordinator in the US, Tom Blacklock. That, in addition to the hospitality and cooperation of our San Carlos hosts, ensured that all proceeded very smoothly.

Nine students attended the station and worked on a variety of issues in teams of three. Novartis in San Carlos specializes in inhaled products and has become a recognized authority on the spray drying process. Numerous factors, both chemical and physical, affect the final product and several of the students' projects dealt with the optimization of the process for specific drugs. However, other types of issues were also tackled, such as the elimination or reduction of electrostatic charges which impeded the smooth running of an operation. In our second session, all our three projects were jointly sponsored by the Bill and Melinda Gates Foundation and addressed needs of developing nations. One of the projects dealt with the non-invasive delivery of drugs for the treatment of infant respiratory distress syndrome, while the second examined strategies to prevent postpartum hemorrhage after childbirth through the inhalation of drugs, and the third investigated methods of fortifying table salt with iron and other compounds to combat anemia and other mineral or vitamin deficiencies.

Students attending the Summer '12 Novartis station enjoy their time in sunny California.

All these projects were most interesting and challenging and kept the students highly motivated. Perhaps not surprisingly, the results were very satisfactory. While the students worked hard and long hours, they also found the time to take advantage of the beauty of the San Francisco area and a trip through the Napa Valley may have been the highlight of their touristic activities.

Cabot Corporation, Billerica MA
Directed by William Dalzell and Robert Fisher

Cabot Corporation has hosted the MIT Practice School for the past seven summers. Cabot is the world's leading supplier of carbon black (CB), most of which is used for car and truck tires. The CB is also used as a component of other rubber products and elastomers. Cabot also makes inkjet toners (some use CB), fumed metal oxides, and specialty metals and fluids.

Our collaboration with Cabot over the past few years has been very successful with many challenging educational projects for the students and some interesting and valuable findings by the student teams. This session focused on developing a more thorough understanding of various facets associated with two existing product lines and a proof of concept investigation. All three projects required major experimental and modeling efforts, each being highly visible platforms within the corporation. One project focused on the process changes that could impact the rheology of the final product. Another involved incorporation of coagulation aides into a spin-off product using interesting new materials that could introduce unique features to a commercial product. The third was a continuation of a project that Cabot supported in our undergraduate laboratory (10.27) this spring semester. The object was to understand mixing characteristics in a co-flow diffuser system; currently in a production plant. The role of concepts associated with Kelvin-Helmholtz stability, turbulence, and cavitation as impacting on jet break-up was the focus of the analysis used to interpret the experimental metrics obtained. These were primarily high speed digital video images captured in a full scale mock-up of the plant system, fabricated to permit tracer studies with simulant fluids in realistic plant operational parameter space. Each project provided results well received by their sponsors and the general R&D audience that attend our presentations. The corporate wide interest is obvious from the lively discussions that ensue, both with us and among themselves. These helped greatly in our pursuit to provide the thorough technology transfer requirement of the Practice School program.

Fall 2012 Stations

General Mills (GMI), Minneapolis MN

Directed by Shreerang Chhatre

General Mills, Inc. is a leading global manufacturer and marketer of branded consumer foods sold through retail stores. The General Mills Practice School station has always presented technically challenging problems and the fall 2012 session was no exception. Eight students attended the station hosted by the James Ford Bell (JFB) Technical Center at Golden Valley, MN. The three projects involved (1) process control improvements for a forming process, (2) a study of sugar crystallization on cereal, and (3) formulation studies of snack bars.

Students at the GMI station spend a well-earned break at Itasca State Park near Minneapolis.

In the first week, students received safety training and a thorough orientation to food manufacturing practices. Proposal presentations and reports allowed the students to prioritize their time and to carve out a problem that they could solve within a month. Then, the students worked with their sponsors and dedicated technicians at JFB pilot plants to perform a set of experiments to validate their hypotheses. A combined theoretical, simulation and experimental approach was taken to better understand the problems at hand. Concepts from thermodynamics, transport phenomena, reaction engineering, rheology, and interfacial phenomena were applied to develop a scientific understanding of the problems.

The environment at General Mills was friendly and the students had the freedom to implement their own ideas. Mark Arlinghaus, the General Mills coordinator, did a fantastic job in planning the logistics over the two months. Apartments in downtown Minneapolis and great fall weather provided ample opportunity for social activities. The students visited the Minnesota State Fair and a couple of state parks during their stay at Minneapolis. The students also enjoyed the countless restaurants offering a wide variety of cuisine. Visits to the Mall of America, couple of baseball games at Target Field and the Walker Art Center provided some respite from otherwise hectic work days.

BP, Naperville and Hull UK

Directed by Shreerang Chhatre and Bob Hanlon

BP Plc. is one of the leading global oil and gas super majors. The BP Practice School Station has always provided the students with opportunities to apply their core Chemical Engineering knowledge. This fall, a team of 8 students attended the BP station in Naperville, IL and Hull, UK.

The students spent the first month in the downstream R&D center at Naperville working on three projects involving (1) quantification of fuel contamination, (2) data analytics for refining systems, and (3) modeling of an industrial crystallizer. The first week at Naperville started with safety training followed by a short course on Aspen Plus and Aspen Dynamics by Randy Field from the MIT Energy Initiative. In the second half of the week, the students defined the scope of the three projects in consultation with their sponsors. The second month at BP's Research and Technology center in Hull exposed the students to a great selection of projects covering a wide-range of modeling work involving (1) fundamental reaction kinetics of a heterogeneous catalysis process, (2) distillation strategy optimization, and (3) total cost analyses of different manufacturing routes for the production of certain specialty chemicals. BP/Hull did an excellent job of ensuring that each effort was aligned to an important business objective, as best evidenced by their strong and active attendance during presentations, thereby ensuring that the students kept their eyes on the higher goal while working in the depths of their respective models.

The work culture at BP was very supportive and the students had good access to subject matter experts and other resources. Continuous communication with resident experts at BP ensured internal validation for the student's approaches and models. One of the teams even managed to get experimental data to validate their model. Concepts from thermodynamics, transport phenomena, and reaction engineering were routinely used in the projects. George Huff, the BP station coordinator, did an excellent job with the logistics of the projects both in Naperville and Hull, where he was also aided by Mark Sankey. Overall, the sponsors were happy with both the scientific rigor and the amount of work during their stint at BP.

Naperville has many highly rated restaurants offering a variety of cuisines which offered a respite from work. The group visited downtown Chicago to take advantage of food, sports, and sightseeing opportunities. The students also visited the Argonne National Laboratory and toured the linear accelerator and high energy X-ray exhibits. In Hull, the students got a good dose of English history during our group tour of York and then again during our individual tours of the larger region spanning from London to Edinburgh.

Sponsors pose with the MIT students attending the Fall '12 BP station in Hull, UK.

Merck Sharp & Dohme, Singapore
Directed by Claude Lupis

Merck & Co operates as Merck Sharp & Dohme (MSD) outside the United States and Canada. In Singapore, it has several sites. Eight students attended the station and worked in the Active Pharmaceutical Ingredients and Pharma sites of the company, in the "Tuas" area of the island, about 30 kilometers from the main center of Singapore and the famed Orchard Road. In the API area, the projects dealt primarily with crystallization issues and solvent recycling and recovery, while in the Pharma area, the projects dealt with bilayer adhesion in tablets and the characterization of capsule defects. All these required a broad variety of technical skills and initiatives and the students worked hard and diligently, motivated by the realization that solutions were of very practical value to our host company. They would have worked even harder, were it not for the fact that safety regulations kept them mostly out of the plants on weekends and after regular business hours. Fairly long commutes at not very flexible times also presented somewhat of a handicap that the students nonetheless overcame without complaint.

Singapore offers a wide range of touristic opportunities that were happily seized by all. One of the highlights was the visit to the zoo and another was the variety of food available on the island. Of particular note were the delicious dumplings at the Din Tai Fung restaurant in the Paragon Mall and the lavish Thanksgiving dinner at the Fullerton Hotel, one of a very few places allowing us the opportunity to celebrate Thanksgiving while in Singapore.

The Practice School also hosted its second station at Corning Glass, again directed by Bob Hanlon. His expanded account of his and the students' experiences is on page 10.

Best regards,

T. Alan Hatton
Director
David H. Koch School for
Chemical Engineering Practice









2012 Practice School Dinner

In October 2012 at the Hotel Marlowe in Cambridge, the department held its annual Awards Banquet for the Practice School, attended by industrial sponsors, MIT administration officials, and students, faculty and staff of the department. At the pre-dinner Poster Session, students showed off their research to the industry visitors. Our speaker was Bernhard van Lengerich, chief science officer and VP technology and strategy of General Mills, who discussed GM's twelve-year relationship with the Practice School in his talk, "Connected Innovation: The Power of Many."

2012 Practice School Award Winners

William C. Rousseau Award for the continual demonstration of outstanding leadership skills in project teamwork, while adhering to highest standards of integrity and ethics

Vishnu Sresht

Rosemary Wojtowicz Award for the kindness and concern for the well-being of others

Shengchang (Shawn) Tang

J. Edward Vivian Prize for outstanding leadership and management of project work

Kendele Snodgrass

Justin Kleingartner

Jefferson W. Tester Prize for showing the most enthusiasm and leadership

Lea Poquerusse

2012-2013 Graduate Fellowships

Graduate financial support continues to be an essential ingredient for maintaining the quality of our graduate programs. This funding helps MIT Chemical Engineering recruit the very best students by providing support for the first academic year so they can concentrate on core graduate level coursework, free of the demands of teaching and research. The result is a firm base in engineering science on which to build future graduate studies.

Fellowships come from many different arenas: industrial and research organizations, as well as alumni individuals and groups. We are very grateful for this support!

First year graduate students Harry Watson, Christine Ensley and Kathryn Maxwell meet alumni at the 2012 Practice School Dinner.

Adel F Sarofim Fellow
Jennifer Lewis, NC State

Alfred E. Wechsler Fellow
Qinyi Chew, Cornell

Alkermes Fellow
Kathryn Maxwell, Vanderbilt

Arch Chilton Scurlock ('43) Fellow
Andong Liu, Nanyang

Chemical Engineering Practice School Fellow
Nahan Li, NUS

Stern Practice School Fellow
Chad Hunter, U of Rochester

Charles and Hilda Roddey Fellow
Paul Bisso, Columbia

Landau ChE Practice School Fellows
David Emerson, Penn State
Karthick Murugappan, UC Berkeley
Daniel Piephoff, NC State

Dow Fellow
Abel Cortinas, Texas Tech

Edwin R Gilliland '33 Fellow
Jae Jung Kim, Seoul National

Eni MIT Energy Fellows
Andong Liu, Nanyang
Harry Watson, Vanderbilt

David H. Koch ('62) Fellows
Christine Ensley, Stanford
Isaac Roes, U of Waterloo
Manish Shetty, IIT Mumbai
Mikhil Ranka, U of Illinois
Wenda Tian, UC Berkeley
Zhe Zhang, Tsinghua
Harry Watson, Vanderbilt
Sahag Voskian, WPI

Frederic A L Holloway '39 Fellow
Elisabeth McLaughlin, Arizona State

George M. Keller ('48) Fellow
Kevin Kauffman, Ohio State
Rohit Kannan, IIT Madras

Wm. & Margaret Rousseau Fellow
Monique Kauke, UWisc Madison

John C. Sluder ('41) Fellow
Kehang Han, Tsinghua

R. C. Reid ('54) & G. Williams Fellow
Moon Young Lee, Johns Hopkins

Haas Family Fellow
Aaron Huang, Washington U
Hok Hei Tam, Ohio State
Justin Nelson, UMinnesota Twin Cities

H. ('53) & L. Stern Prac. School Fellow
Chad Hunter, U of Rochester

Jerry ('40) & Geraldine Mcafee Fellows
Jane Hung, U of Washington
Siah Hong Tan, Johns Hopkins

MITSCEP 1936 Course Xa Fellow
Ankur Gupta, IIT Delhi

Total S.A. MIT Energy Fellows
Jennifer Lewis, NC State
Moon Young Lee, Johns Hopkins

Saudi Aramco MIT Energy Fellow
Siah Hong Tan, Johns Hopkins

Walsh ('37) Memorial Pres. Fellows
Monique Kauke, UWisc Madison
Sahag Voskian, WPI

Samsong Fellows
Jae Jung Kim, Seoul National
Myung Sun Kang, KAIST
Won Jun Jo, Pohang Institute of Science and Technology

Robert T. Haslam ('11) ChemE Fellows
Dongying Shen, CalTech
Sue Zanne Tan, UWisc Madison
Xiaoxue Wang, Tsinghua

Rosemary Wojtowicz Fellow
Zhilong Zhu, UIUC

Robert T. Haslam ('11) Pres. Fellows
Jane Hung, U of Washington
Jose Gomez, Instituto Tecnologico de Monterrey
Daniel Piephoff, NC State

Tae-Sup Lee Fellows
Myung Sun Kang, KAIST
Won Jun Jo, Pohang Institute of Science and Technology

Singapore Ministry of Defense Fellow
Qinyi Chew, Cornell

Frank Hall Thorp Fellow
Jose Gomez, Instituto Tecnologico de Monterrey

Keith & Helen Rumbel Fellow
Nicholas Mozdzierz, RPI

NSF Fellows
Daniel Piephoff, NC State
Jennifer Lewis, NC State
Moon Young Lee, Johns Hopkins

GEM Fellow
Chibueze Amanchukwu, Texas A&M

LGO Fellow
Matthew Dumouchel, Cornell

Lemelson Minority Engineering Fellow
Jose Gomez, Instituto Tecnologico de Monterrey

Institute Professor Bob Langer receives 2013 National Medal of Technology and Innovation

On February 4, 2013, President Barack Obama presented David H. Koch Institute Professor Robert Langer with the nation's highest honor for scientific discovery and invention. He was among 22 eminent scientists nationwide honored during a White House ceremony. Langer received the National Medal of Technology and Innovation for inventing new and different ways to administer drugs to patients.

Langer won the National Medal of Science in 2006.

"We are so grateful to all of you," Obama said to the 12 science medal recipients and 10 technology medal recipients during the ceremony. "The incredible contributions that you've made have enhanced our lives in immeasurable ways, in ways that are practical but also inspirational. And so we know that you are going to continue to inspire and in many cases teach the next generation of inventors and scientists who will discover things that we can't even dream of at this point."

Langer, a biomedical engineer who focuses on biomaterials, has developed a variety of novel drug-delivery systems based on polymers, including materials that can release drugs continuously over a prolonged period of time. He is developing nanoparticles that precisely target disease sites, including tumors. Langer is also a pioneer in the field of tissue engineering, where his discoveries led to the creation of new tissues such as artificial skin for burn victims.

The National Medal of Technology and Innovation was established in 1980 and is administered for the White House by the U.S. Department of Commerce's Patent and Trademark Office. The award recognizes those who have made lasting contributions to America's competitiveness and quality of life and helped strengthen the nation's technological workforce. ◊

Alumnus Highlight

Pedro Valencia PhD '12

Pedro Valencia, who earned his PhD in chemical engineering at MIT in November 2012, was named in Forbes magazine's 2012 list of the top 30 rising stars in science and health.

Valencia was cited for figuring out "how to more quickly synthesize nanoparticles that can be used to make drugs more effective and less toxic and to put multiple drugs inside the same nanotech medicine. This has resulted in many top-notch scientific publications and the formation of a start-up, Blend Therapeutics."

Valencia, a former student of Robert Langer, the David H. Koch Institute Professor, earned his BS in chemical engineering from the University of Wisconsin-Madison in 2007, and was at the top of his class. He completed his MS in chemical engineering practice at MIT in 2009. While at MIT, he worked on the development of targeted nanoparticles for cancer therapy and was co-advised by Professor Langer and Dr. Omid Farokhzad of the Brigham Women's Hospital - Harvard Medical School. Valencia also won a Teaching Assistant achievment award and led one of the twelve top teams in the MIT $100K competition.

The youngest of a family of 16, Valencia is originally from Colombia; he immigrated to the US at the age of 17. He plans to join the Boston Consulting Group in 2013 and is married to his high-school sweetheart from Colombia; they have two beautiful children: a daughter (2 and half years old) and a son (2 months old).

Your project pulled my team together.

MIT Practice School at Corning, Inc., Fall 2012

Bob Hanlon
Station Director

As we entered out second session here, one of the questions Corning wanted to address was this: How can we maximize the value of having eight Chemical Engineering graduate students conduct six projects over two months? And this, in turn, raised the question, how is value even quantified for our program?

The Corning group spends some bonding time at Niagara Falls.

While the impact we have is always immediate due to the nature of our one-month projects, the translation of our impact into value may require some time. Yes, when the stars align, it is indeed possible for a one-month project to realize an immediate financial reward for the host company, one that is relatively easy and always fun to capture. More often than not though, the impact a team creates may not provide tangible value to the company until long after the students are gone. An example of this scenario is when our projects 'jolt' the host company's thinking, resulting in a powerful re-commitment to or re-direction of their work. Because of this time-delay, the connection between our impact and the associated value generated for the company becomes difficult to quantify. For these projects, we work with the host company to capture the verbatim feedback from their personnel, thereby enabling a more comprehensive assessment of our longer-term value. One such project fell into this category when the students brought together a range of personnel, both within the group and between different business units, to support their efforts. The act of doing this helped one of the champions of the project re-energize her team. As she shared with me at the end of the program, "Your project pulled my team together." Difficult to quantify, important to capture.

To help answer the question posed at the beginning of this article while keeping the above concepts around value in mind, Corning did an interesting experiment that ended up benefitting all involved. As is the case for other companies, Corning has a technology pipeline that starts at the front end with a large diameter of ideas and ends at the back end with a small diameter of commercialized products. The narrowing of the pipeline is driven by a highly structured process designed to maximize ROI for R&D's efforts, a critical need in light of the rapid rise in costs as a project moves from one end to the other. Such a rapid increase in costs necessitates a corresponding shift in skill requirements for the engineer, from being comfortable in the ambiguity and failure characteristic of the front end to being driven by the need for certainty and success characteristic of the back end.

During our inaugural Fall '11 session, Corning created projects for us in the middle of this pipeline. For our Fall '12 session, in true Design-of-Experiment thinking, Corning created a new mix of projects by targeting the two ends of the pipeline. Our first set of projects focused on commercial or near-commercial products (Gorilla Glass, Optical Fibers, Ceramic Dies) and so provided the students opportunities to experience quick-hit, tangible-value results. One project team identified the root-cause of a certain manufacturing problem and was thus in the enviable position of seeing their recommended solution successfully implemented while we were still there.

Corning Inc.'s headquarters building in Corning, NY.

The second set of projects focused on longer-range opportunities involving Corning's efforts to apply their technology and expertise to develop new markets (Biosensing, Gas Separations, Polymer Processing). These projects provided the students with all the ambiguity they needed to truly experience via practice what it takes to confront an open field, determine for themselves which direction to head in, and then make positive progress in that direction. They checked things out, tried things out, found failures, found successes. They brought results home for Corning, making a positive difference in the long-term trajectory of each project. This was a great experience for each team on how to tackle the open-ended problem statement characteristic of a research envi-

"How can we maximize the value of having eight Chemical Engineering graduate students conduct six projects over two months? And this, in turn, raised the question, how is value even quantified for our program?"

ronment, an experience that they would only rarely (if at all) see in a university setting.

Corning is currently assessing the results of these experiments, and the conclusions they draw will be used to identify how best to align our program with their technology pipeline for the upcoming Fall '13 session.

An additional experience of note from this session occurred with the first set of projects in which the students were provided with an opportunity to practice the art of problem solving, a trademark of the global engineering community. Corning has developed their own approach to problem solving, building on the industry tools of, for example, Six Sigma and Kepner-Tregoe, while incorporating their own in-house tool based on the Strong Inference model popularized by John R. Platt (*Science* 16 October 1964: Vol. 146 no. 3642 pp. 347-353). In a nutshell, this model embraces the creation of a range of hypotheses as possible causes of a given problem, and then further embraces a logically structured approach towards knocking each one of these hypotheses down. The one that's left standing is most likely the sought-after cause. This was an invaluable opportunity, one not available in the classroom, for the students to practice the use of real world approaches to solving real world problems. In future sessions, we look forward to strengthening the alignment of our program with Corning's approach to problem solving. ◊

The Department welcomes its newest faculty member

Professor Fikile Brushett brings expertise in electrochemical energy conversion

On December 3, 2012, MIT Chemical Engineering welcomed its latest faculty member: Assistant Professor Fikile R. Brushett. As of January 1, 2013, Prof. Brushett holds the Raymond A. & Helen E. St. Laurent Career Development Chair. He received his bachelor's degree in Chemical & Biomolecular Engineering from the University of Pennsylvania in 2006. In 2010, he completed his Ph.D. in Chemical Engineering at the University of Illinois at Urbana-Champaign under the supervision of Professor Paul J.A. Kenis. His research at UIUC focused on microfluidic fuel cells. At Illinois, Brushett was the recipient of a GEM Fellowship, a SURGE Fellowship, and a Harry G. Drickamer Research Fellowship. From 2010 to 2012, Brushett was a Director's Postdoctoral Fellow at Argonne National Laboratory (ANL) working with Dr. Jack Vaughey. At ANL, his research focused on non-aqueous redox flow batteries and developing in-situ imaging techniques for lithium-ion batteries.

A key societal challenge in 21st century will be the distribution of energy in an efficient, cost-effective, and sustainable fashion. Professor Brushett's research group focuses on the design, synthesis, and characterization of electrochemically-active materials and the development of electrochemical processes with an overarching goal of enabling clean energy technologies. To this end, his laboratory employs novel microfluidic and visualization approaches, in concert with more traditional electroanalytical and surface characterization techniques, to probe the fundamental processes that underlie the performance and durability of electrochemical systems. Building on this knowledge, he seeks to rationally design robust and cost-effective next-generation materials and systems for technologies that include fuel cells, electrolyzers, advanced batteries, flow batteries, and photovoltaics.

Department News

Modern Facilities for Modern Researchers

The forty-year-old Ralph Landau Building embarks on much needed infrastructure renovations

Article by Melanie Miller, Chemical Engineering

When the Ralph Laundau building, MIT's Building 66, was built in 1976, it was a symbol of cutting-edge modernism. Designed by I.M. Pei, the 30-60-90 concrete triangle housed open and contemporary public spaces and brand-new laboratories ready to accommodate all sorts of discoveries.

But as the field of chemical engineering has evolved through the decades to keep up with the needs of today's environment, Building 66 has not been able to keep up. As one of Pei's first triangular buildings and a precursor to his work on the West Wing of the National Gallery, it is an architectural work of art, but that designation gives added constraints in the maintenance of laboratories and infrastructure and renovations for needs that have changed since 1976.

Halloween Wake-up Call

Clear evidence of this is a catastrophic steam explosion that happened in the sub-basement of the building on the evening of October 31, 2008. On that night, a steam pipe violently ruptured due an effect known as a "water-hammer." It ripped a hole through an office wall and filled the building with 400-degree steam at 200 psi, continuing for hours. Fortunately no one was hurt, but *The Tech* reported that "graduate students said they felt the building tremble as if there had been an earthquake. 'All of a sudden we heard this really loud explosion … you could hear this whooshing sound, and the whole building shook.'"

Ceiling tiles on all six floors turned to mush, sprinkler systems accelerated damage on some floors and plastic signage in the sub-basement melted like objects in a Dali painting. The classrooms and laboratories were eventually back in working order, but this was a wakeup-call that the building's issues needed to be addressed immediately.

Some Upgrades but the Need Remains

As the Chemical Engineering Department has grown, we have expanded past the walls of Building 66, into the Koch Institute for Integrative Cancer Research; the "ChemE East" area of Buildings E17, E18, and E19; and the biological engineering areas of Building 56. These areas, as well as several individual laboratories in Building 66, have been recently upgraded to meet the needs of the professors and researchers. Despite this, the desperate need to modernize Building 66's infrastructure, and the rest of its areas, remains. The building has been "red-listed" on the Institute's list of spaces that need renovation, and the estimated for this vital renovation is $45 million. MIT has designated $25 million in capital renewal funds toward new infrastructure for our building. The Department needs to raise the remaining $20 million to create modern laboratories and offices. Such facilities and flexible spaces are essential to remain competitive and attract new faculty members and top-notch students, each with unique needs to conduct cutting-edge research. A Building 66 Renovation Fund has been set up, and the Department is in the early stages of fund raising.

Soaked and fallen ceiling tiles riddle a hallway on the fifth floor, six levels away from the initial steam explosion on Friday, October 31, 2008.

As the renovation begins, updates will be posted on the Department's website, *web.mit.edu/cheme/*. ◊

Named Lecture Series

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

This spring, the Department will host two leaders in chemical engineering industry and academia. We hope to see you there. Webcasts of these and other past lectures can be found at ***web.mit.edu/cheme/news/webcast.html.***

Friday, April 5, 2013
3pm in 34-101

35th Warren K. Lewis Lecture in Chemical Engineering

Management's Co-dependence on Mother Earth: Sustainability in the Chemical Industry and the Four-Dimensional Analysis

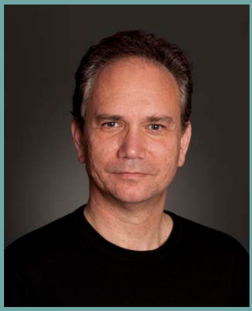
Dr. Yoshimitsu Kobayashi
President and Chief Executive Officer
Mitsubishi Chemical Holdings Corporation

Central to Dr. Kobayashi's management thinking has been the concept of "Good Chemistry for Kaiteki", which in Japanese implies, "Good Chemistry for Sustainability, Health, and Comfort". His management plan for the group of companies has been guided by this concept. He established a new research institute to support his effort in a global scope. He wrote an influential book, titled "Good Chemistry for Kaiteki". He has established himself as, in the words of David N. Weidman, chairman and CEO of Celanese Corporation, "a thought leader of responsible business". To further amplify this theme, he recently published two more books. The first, titled "Management Codependent on Mother Earth: The MOS Manifesto" is available in both Japanese and English, while the second, titled "Resolution to Stand Against the Crisis" is available only in Japanese at this point in time. Hopefully, an English version will be available soon.

Friday, May 3 2013
3pm in 66-110

19th Alan S. Michaels Lectureship in Medical and Biological Engineering

What's in your blood? Molecular Deconvolution of the Human Serum Antibody Repertoire in Health and Disease



George Georgiou
Depts of Chemical Engineering, Biomedical Engineering, and Molecular Genetics and Biology
University of Texas, Austin

George Georgiou holds the Cockrell Chair in Engineering at the University of Texas at Austin where he serves on the faculties of Chemical Engineering, Biomedical Engineering, the Section of Molecular Genetics and Microbiology and the Institute for Cell and Molecular Biology. He received his B.Sc. degree from the University of Manchester, U.K. and his M.S. and Ph.D. degrees from Cornell. His group is working in molecular biotechnology with special emphasis on the engineering and preclinical development of therapeutic enzymes, the system analysis of human B cell responses and on certain aspects of bacterial genetics. Professor Georgiou was elected to the National Academy of Engineering (NAE) in 2005 and to the U.S. Institute of Medicine (IOM) of the National Academy of Sciences in 2011. He received the Professional Progress award from American Institute of Chemical Engineers in 2003 and in 2008 he was named as one of the top "100 Chemical Engineers of the Modern Era" by the same organization

Faculty News

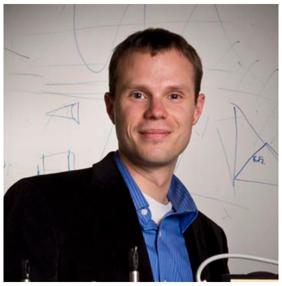
Robert Langer Earns Domestic and International Awards

Robert Langer, the David H. Koch Institute Professor at MIT, was among eight recipients worldwide of the 2013 Wolf Prize. The prestigious international prizes are awarded annually in five categories, each worth $100,000; Langer was cited for his contributions in chemistry. More than 30 Wolf Prize recipients have gone on to win the Nobel Prize.

"Robert Langer is primarily responsible for innovations in polymer chemistry that have had profound impact on medicine, particularly in the areas of drug delivery and tissue engineering," the Wolf Foundation said in its announcement.

Langer also received the Wilhelm Exner Medal of the Austrian "Gewerbeverein" in Vienna on November 19, 2012. The award was presented to him during a celebration at the Palais Eschenbach in Vienna. The Austrian "Gewerbeverein" was founded in 1839 as an independent representative of trade, craft, industry, and liberal professions. Since 1921 this medal, named after the well known Austrian supporter of economic development and technology, Wilhelm Exner (1840 bis 1931), is given annually to scientists and researchers "who have promoted economy in an outstanding way, directly or indirectly, through their excellent scientific contributions."

Langer was also named R&D Magazine's 2012 Scientist of the Year and elected to the National Academy of Inventors (NAI). The National Academy of Inventors was founded in 2010, in order to recognize investigators at universities and non-profit research institutes who translate their research findings into inventions that may benefit society.



Bradley Olsen Awarded NSF CAREER Grant

Professor Bradley Olsen has received a grant from the Faculty Early Career Development (CAREER) Program, which offers the National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations. The NSF hopes that "Such activities should build a firm foundation for a lifetime of leadership in integrating education and research."

Chris Love Receives Two NIH Awards

(*As reported by the journal* BioTechniques, *10/19/2013*) Over the next five years, the National Institutes of Health (NIH) plans to allocate more than $90 million for the development and application of single-cell analysis tools in areas such as immunology, neuroscience, and cancer. Supported by the NIH Common Fund, the federal agency will award 26 grants over this time period as part of its Single Cell Analysis Program (SCAP).

It's become increasingly clear over the past few years that no two cells are alike, and that their individualities collectively may reveal new clues about human biology and disease.

With the goal of understanding what makes each human cells unique, 15 high-risk SCAP projects will aim to develop new techniques that probe the proteomes, protein activity, genes, chromatin and other aspects of individual cells. Eight more projects will further develop and validate single-cell analysis prototype techniques for use at the bench and bedside.

"These types of technologies are clearly needed right now," said J. Christopher Love, associate professor of chemical engineering at MIT, who has received two SCAP awards.

The breadth of awarded projects for single cell technologies—from imaging to physical tools for isolating cells—is striking, he said. In addition, the crosstalk between SCAP's investigators will allow ideas to merge together in new ways.

One of Love's SCAP projects will focus on the development of a chip that uses arrays of sub-nanoliter-sized compartments to separate individual cells for analysis. This project may help in the analysis of small tissue samples from patients. For example, mucosal tissue samples taken to monitor HIV infection, through pinch biopsies or cytobrush samples, yield only 10,000–100,000 cells. "That is too limiting to run many conventional analytical methods on with single cell resolution," he added.

In a higher-stakes project, Love's group also plans to improve single cell transcriptional analysis techniques. The idea is to use DNA barcoding to trace transcripts back to individual cells, which would increasing the number of cells and endpoints that can be monitored.

Greg Stephanopoulos Garners Two Medals

Professor Greg Stephanopoulos has won the 2012 Siegfried Medal for outstanding research in the field of chemical process development. This renowned prize is awarded every other year by Siegfried Ltd. of Zofingen, Switzerland, in cooperation with the Organic Chemistry Institute of the University of Zurich. The international jury comprises industry and academia representatives from Europe, the USA and Asia, among them Nobel Prize Laureate Professor Ryoji Noyori from Japan. Stephanopoulos was awarded the medal at the 2012 Siegfried Symposium in Zurich, where he gave the lecture, "Metabolic engineering: Synthetic process chemistry of the 21st century."

Stephanopoulos was also honored with the American Association of Engineering Societies's 2013 John Fritz Medal, referred to as the highest award in the engineering profession. It is presented each year for scientific or industrial achievement in any field of pure or applied science.

Paula Hammond Named One of Boston Globe's "Bostonians Changing the World"

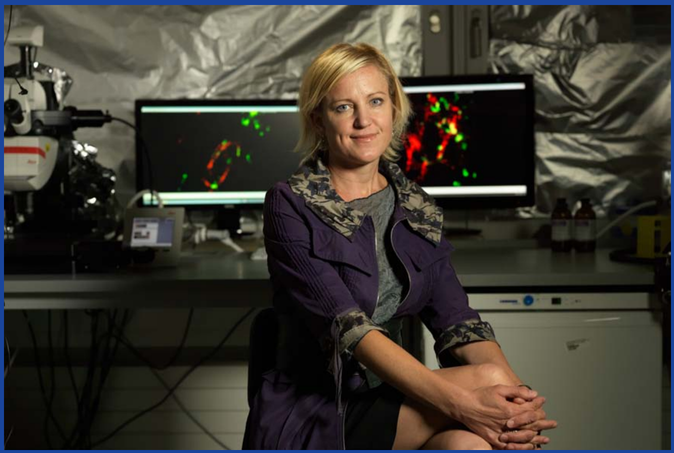
A native of Newton, MA, just outside Boston, Professor Paula Hammond was listed as one of twelve Bostonians who are changing the world in 2012. Naming her work on an anticoagulant sponge, super-thin batteries, and RNA, the newspaper called her "a sort of architect of molecules, stacking impossibly thin sheets of polymers to invent new, flexible materials for multiple applications."

Hammond mentioned that her scientific work benefits from its location in the Boston area, which hosts "local drug companies she has been able to recruit as partners."

For the most updated ChemE faculty news, go to web.mit.edu/cheme/. ◊

Alumna Highlight

Melody Swartz PhD '98



Bioengineer Melody Swartz was among the 23 recipients of the prestigious John D. & Catherine T. MacArthur Foundation "genius grants," which were announced earlier October 2, 2012.

Winners for 2012 ranged from scientists and writers to a mandolinist and a stringed-instrument bow maker. Each received $500,000, which will be given out in quarterly installments over five years. They are free to use it however they choose.

Swartz, who earned her PhD degree in chemical engineering from Course X in 1998, won for "enhancing understanding of the dynamic processes of tissue vascularization and immune responses to tumor invasion using a large toolbox of concepts and methods from biophysics, cell culture, molecular genetics, engineering, and immunology," according to the foundation website. "Her body of research has important implications not only for normal tissue development and maintenance but also for cancer biology."

Swartz, 43, is a professor in the Institute for Bioengineering at the École Polytechnique Fédérale de Lausanne in Switzerland. *Photo courtesy of the MacArthur Foundation.*

A new way to create rare sugars

Professor Yuriy Román and his team discover an inorganic catalyst that could pave the way to a more robust synthesis of valuable rare sugars.

Article by Melanie Miller, Chemical Engineering

Despite their low natural abundance, rare sugars have enormous potential in several important applications, including their use as components for antiviral drugs, low-calorie sweeteners with low glycemic indexes, anti-inflammatory agents with immunosuppressive properties and chiral building blocks in natural products synthesis. In order to meet today's high demand for the sugars, scientists currently use costly and complex biochemical processes to transform easily found abundant sugars into these rare ones.

These biochemical processes use three main classes of enzymes, two of which — isomerases and oxidoreductases — are popular because they are active on a wide range of simple substrates; however such general activity is not always an advantage because it can result in the formation of side products (for example xylose isomerase converts glucose into fructose and simultaneously converts fructose into mannose). These processes have generated some commercially available rare sugars, but the complex nature of that biochemical process makes it very costly. The third class of enzymes, epimerases, are potentially the most useful biocatalysts for the widespread production of rare sugars because they offer high specificity for products and are capable of selectively modifying sugars at multiple carbon positions. But like all biological catalysts, epimerases can be fragile because they require very specific reaction conditions and can only act on previously functionalized sugars.

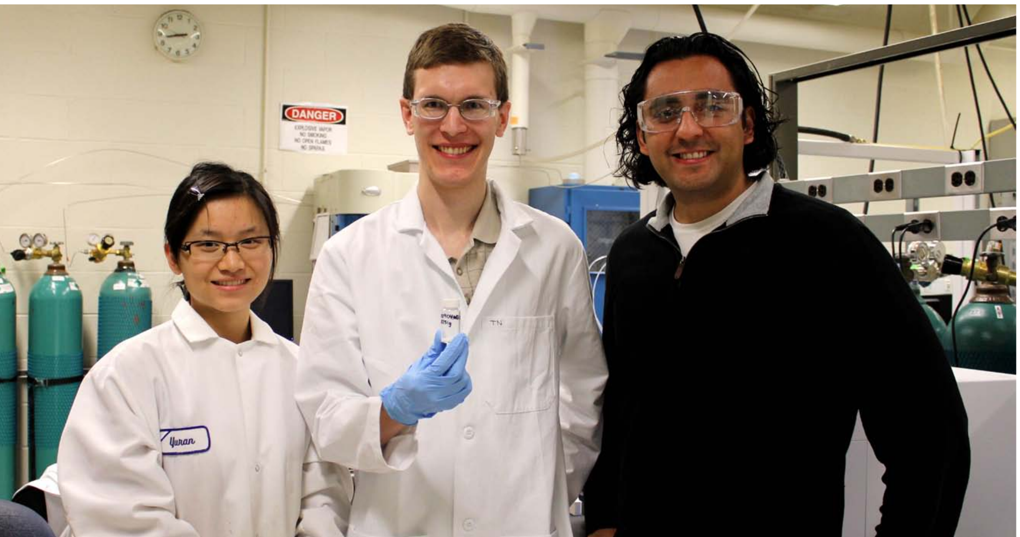
In a paper published in October 2012 in *Nature Communications*, an MIT team has found a way to use inorganic catalysts in place of the enzymes to generate sugar epimers in a simple and robust manner. The catalytic system involves using a tin-substituted microporous silicate (Sn-Beta zeolite) combined with a borate salt. "This work is exciting because the zeolite/borate combination generates sugar epimers with yields similar to those typically observed with biological catalysts," explains Professor Yuriy Román, Texaco-Mangelsdorf Assistant Professor of Chemical Engineering, "Inorganic materials can rarely perform as well as their biological counterparts in the selective conversion of sugars."

MIT graduate student and lead author William R. Gunther said, "Our system opens up exciting opportunities for the production of rare sugars using inorganic catalysts, such as L-ribose, which can be used in anti-viral and anti-cancer agents."

Román and his team found that Sn-Beta zeolite in the presence of sodium tetraborate is shown to catalyze the selective epimerization of aldoses in aqueous media. The reaction proceeds by way of a rather unusual 1,2 carbon-shift mechanism, wherein C-C bonds move within the molecule's backbone.

Looking toward the future, Roman's group is excited to investigate in more detail the unusual carbon-shift mechanism, which may be applied to other classes of biomass-derived oxygenated molecules and to more general reactions, such as those currently associated with C–C bond-forming events in prebiotic chemistry that could have led to the origins of life.

Authors on this paper include Yuran Wang, Yuewei Ji, Vladimir K. Michaelis, Sean T. Hunt and Robert G. Griffin. The research was supported by the National Science Foundation.◊



(at left) Paper authors (l-r) Yuran Wang, William Gunther and Yuriy Román show a sample of the inorganic catalyst Sn-Beta zeolites with borate salts. Photo: Melanie Miller

Other Spring 2013 Course X Research News

- Paula Hammond helps make polymer patch that could offer a better alternative to traditional vaccines

- Jensen and Langer find a way to deliver RNA, proteins and nanoparticles by “squeezing” cells

- Strano and Blankschtein find that adding a coating of graphene has little effect on how a surface interacts with liquids — except in extreme cases

- Using ultrasound waves, Professors Blankschtein and Langer have found a way to enhance the permeability of skin to drugs, making transdermal drug delivery more efficient

- Bob Langer’s new tissue scaffold could be used for drug development and implantable therapeutic devices

- Michael Strano determines that graphene’s behavior depends on where it sits

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

Alumna Highlight

Rachel Peterson ’09

One might not think that an MIT education could help someone prepare for a career as an NFL cheerleader. But don’t tell that to Rachel Peterson. Thanks in part to the indomitable attitude she nourished at MIT, Peterson is entering her second season as a member of the San Francisco 49ers Gold Rush—and that’s not even her day job.

“Succeeding at MIT gave me a confidence that I can accomplish anything,” she says. “MIT gave me the mind-set of not being afraid. You can really find creative solutions to any problem.”

A chemical-engineering major at MIT, Peterson was a member of three campus dance groups: MIT Ridonkulous, Mocha Moves, and the MIT Dance Troupe. She’d had plenty of dance experience growing up in South Florida, where she was part of a local dance company called Hip Hop Kidz, co-captained her high-school cheerleading team, and founded her own dance troupe, Party People.

“Dancing is so much fun,” she says. “Cheering is such a unique experience and something I knew I would never regret.”

Cheerleading aside, Peterson is putting her MIT degree to good use as a chemical engineer at Tesla Motors, the Silicon Valley–based electric-vehicle company. At Tesla, she runs initial characterization tests on lithium-ion cells and evaluates their potential for use in electric vehicles. She’s confident that electric cars will one day be a viable part of the transportation landscape.

“It’s not going to happen overnight, and it’s not going to be easy, but it can happen,” she says. “The key is to create an electric vehicle that really impresses the consumer. That’s what our company is trying to accomplish.”

She admits she often gets a double take when she mentions her two careers. “Usually someone knows one thing about me but not the other,” she says. “People are usually surprised, but if anything, I’m happy to break the stereotype.”

(from the October 24, 2012 edition of *MIT Technology Review*, reported by Jan London.)

Research Highlights

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

New injectable gels toughen up after entering the body

These more durable gels could help drug delivery and tissue engineering.

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

Gels that can be injected into the body, carrying drugs or cells that regenerate damaged tissue, hold promise for treating many types of disease, including cancer. However, these injectable gels don't always maintain their solid structure once inside the body.

MIT chemical engineers have now designed an injectable gel that responds to the body's high temperature by forming a reinforcing network that makes the gel much more durable, allowing it to function over a longer period of time.

The research team, led by Bradley Olsen, an assistant professor of chemical engineering, described the new gels in a recent issue of the journal Advanced Functional Materials. Lead author of the paper is Matthew Glassman, a graduate student in Olsen's lab. Jacqueline Chan, a former visiting student at MIT, is also an author.

Olsen and his students worked with a family of gels known as shear thinning hydrogels, which have a unique ability to switch between solid-like and liquid-like states. When exposed to mechanical stress — such as being pushed through an injection needle — these gels flow like fluid. But once inside the body, the gels return to their normal solid-like state.

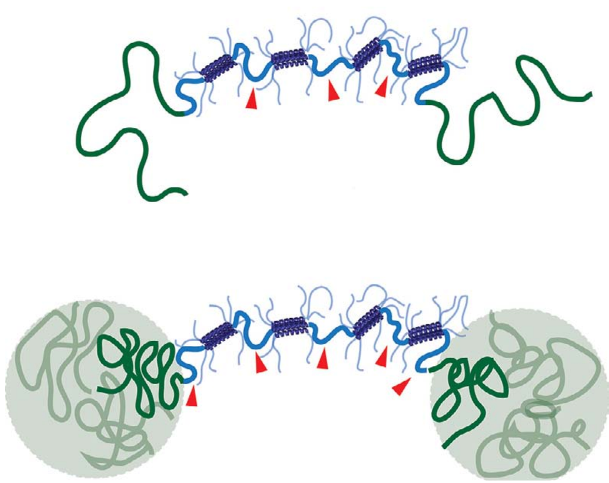
However, a drawback of these materials is that after they are injected into the body, they are still vulnerable to mechanical stresses. If such stresses make them undergo the transition to a liquid-like state again, they can fall apart.

"Shear thinning is inherently not durable," Olsen says. "How do you undergo a transition from not durable, which is required to be injected, to very durable, which is required for a long, useful implant life?"

The MIT team answered that question by creating a reinforcing network within their gels that is activated only when the gel is heated to body temperature (37 degrees Celsius).

Shear thinning gels can be made with many different materials (including polymers such as polyethylene glycol, or PEG), but Olsen's lab is focusing on protein hydrogels, which are appealing because they can be designed relatively easily to promote biological functions such as cellular adhesion and cell migration.

The protein hydrogels in this study consist of loosely packed proteins held together by links between protein segments known as coiled coils, which form when two or three helical proteins coil into a ropelike structure.



(at left) When the new shear thinning hydrogel (top) is heated to body temperature, polymer chains join together to form a reinforcing network that improves the gel's stability (bottom).

Image: Matt Glassman

The MIT researchers designed their hydrogel to include a second reinforcing network, which takes shape when polymers attached to the ends of each protein bind together. At lower temperatures, these polymers are soluble in water, so they float freely in the gel. However, when heated to body temperature, they become insoluble and separate out of the watery solution. This allows them to join together and form a sturdy grid within the gel, making it much more durable.

The researchers found that gels with this reinforcing network were much slower to degrade when exposed to mechanical stress and were significantly stiffer. This offers a promising way to thwart the tendency of shear thinning materials to erode once in the body, says Jason Burdick, an associate professor of bioengineering at the University of Pennsylvania.

"Building in this secondary network based on a different type of mechanism is a very elegant way to overcome that obstacle through material design," says Burdick, who was not part of the research team.

Another advantage of these gels is that they can be tuned to degrade over time, which would be useful for long-term drug release. The researchers are now working on ways to control this feature, as well as incorporating different types of biological functions into the gels.

The research was funded by the U.S. Army Research Office through MIT's Institute for Soldier Nanotechnologies (ISN). Potential applications of these nanostructured gels to soldier medicine include preventing blood loss, accelerating wound healing and protecting against infections and disease. ◊

New material harvests energy from water vapor

Polymer film could be used in artificial muscle and to power micro- and nanoelectronic devices.

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

MIT engineers have created a new polymer film that can generate electricity by drawing on a ubiquitous source: water vapor.

The new material changes its shape after absorbing tiny amounts of evaporated water, allowing it to repeatedly curl up and down. Harnessing this continuous motion could drive robotic limbs or generate enough electricity to power micro- and nanoelectronic devices, such as environmental sensors.

"With a sensor powered by a battery, you have to replace it periodically. If you have this device, you can harvest energy from the environment so you don't have to replace it very often," says Mingming Ma, a postdoc at MIT's David H. Koch Institute for Integrative Cancer Research and lead author of a paper describing the new material in the Jan. 11 issue of Science.

"We are very excited about this new material, and we expect as we achieve higher efficiency in converting mechanical energy into electricity, this material will find even broader applications," says Robert Langer, the David H. Koch Institute Professor at MIT and senior author of the paper. Those potential applications include large-scale, water-vapor-powered generators, or smaller generators to power wearable electronics.

Other authors of the Science paper are Koch Institute postdoc Liang Guo and Daniel Anderson, the Samuel A. Goldblith Associate Professor of Chemical Engineering and a member of the Koch Institute and MIT's Institute for Medical Engineering and Science.

The new film is made from an interlocking network of two different polymers. One of the polymers, polypyrrole, forms a hard but flexible matrix that provides structural support. The other polymer, polyol-borate, is a soft gel that swells when it absorbs water.

Previous efforts to make water-responsive films have used only polypyrrole, which shows a much weaker response on its own. "By incorporating the two different kinds of polymers, you can generate a much bigger displacement, as well as a stronger force," Guo says.

The film harvests energy found in the water gradient between dry and water-rich environments. When the 20-micrometer-thick film lies on a surface that contains even a small amount of moisture, the bottom layer absorbs evaporated water, forcing the film to curl away from the surface. Once the bottom of the film is exposed to air, it quickly releases the moisture, somersaults forward, and starts to curl up again. As this cycle is repeated, the continuous motion converts the chemical energy of the water gradient into mechanical energy.

Such films could act as either actuators (a type of motor) or generators. As an actuator, the material can be surprisingly powerful: The researchers demonstrated that a 25-milligram film can lift a load of glass slides 380 times its own weight, or transport a load of silver wires 10 times its own weight, by working as a potent water-powered "mini tractor." Using only water as an energy source, this film could replace the electricity-powered actuators now used to control small robotic limbs.

"It doesn't need a lot of water," Ma says. "A very small amount of moisture would be enough."

The mechanical energy generated by the material can also be converted into electricity by coupling the polymer film with a piezoelectric material, which converts mechanical stress to an electric charge. This system can generate an average power of 5.6 nanowatts, which can be stored in capacitors to power ultra-low-power microelectronic devices, such as temperature and humidity sensors.

If used to generate electricity on a larger scale, the film could harvest energy from the environment — for example, while placed above a lake or river. Or, it could be attached to clothing, where the mere evaporation of sweat could fuel devices such as physiological monitoring sensors. "You could be running or exercising and generating power," Guo says.

On a smaller scale, the film could power microelectricalmechanical systems (MEMS), including environmental sensors, or even smaller devices, such as nanoelectronics. The researchers are now working to improve the efficiency of the conversion of mechanical energy to electrical energy, which could allow smaller films to power larger devices.

The research was funded by the National Heart, Lung, and Blood Institute Program of Excellence in Nanotechnology, the National Cancer Institute, and the Armed Forces Institute of Regenerative Medicine. ◊

Research Highlights

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

Wrinkled surfaces could have widespread applications

MIT team discovers way of making perfectly ordered and repeatable surfaces with patterns of microscale wrinkles.

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

The wrinkles on a raisin result from a simple effect: As the pulp inside dries, the skin grows stiff and buckles to accommodate its shrinking size. Now, a team of researchers at MIT has discovered a way to harness that same principle in a controlled and orderly way, creating wrinkled surfaces with precise sizes and patterns.

This basic method, they say, could be harnessed for a wide variety of useful structures: microfluidic systems for biological research, sensing and diagnostics; new photonic devices that can control light waves; controllable adhesive surfaces; antireflective coatings; and antifouling surfaces that prevent microbial buildup.

A paper describing this new process, coauthored by MIT postdocs Jie Yin and Jose Luis Yagüe, former student Damien Eggenspieler SM ’10, and professors Mary Boyce and Karen Gleason, was published in the journal *Advanced Materials*.

The process uses two layers of material. The bottom layer, or substrate, is a silicon-based polymer that can be stretched, like canvas mounted on a stretcher frame. Then, a second layer of polymeric material is deposited through an initiated chemical vapor deposition (iCVD) process in which the material is heated in a vacuum so that it vaporizes, and then lands on the stretched surface and bonds tightly to it. Then — and this is the key to the new process — the stretching is released first in one direction, and then in the other, rather than all at once.

When the tension is released all at once, the result is a jumbled, chaotic pattern of wrinkles, like the surface of a raisin. But the controlled, stepwise release system developed by the MIT team creates a perfectly orderly herringbone pattern.

The size and spacing of the herringbone ribs, it turns out, is determined by exactly how much the underlying material was originally stretched in each direction, the coating’s thickness, and in which order the two directions are released. The MIT team has shown the ability to control the exact size, periodic spacing and angles in both directions for the first time.

The system is unusual in its ability to produce precisely controlled patterns without the need for masks or complex printing, molding or scanning processes, Gleason says.

Controlling the patterns

Fundamentally, “it’s the same process that gives you your fingerprints,” says Gleason, the Alexander and I. Michael Kasser Professor of Chemical Engineering. But in this case, precise control over the resulting patterns requires the iCVD process, which Gleason and her colleagues have been developing for years. This gives a high degree of control over the thickness of layers deposited, and also enables control of the surface chemistry of the coatings.

Additionally, the iCVD method provides the high degree of adhesion that is needed to form buckled patterns. Without sufficient adhesion, the surface layer would simply separate from the substrate.

“One distinguishing feature of what we’re showing is the ability to create deterministic two-dimensional patterns of wrinkles,” such as a zigzag herringbone pattern, says Boyce, the Ford Professor of Engineering and head of MIT’s Department of Mechanical Engineering. “The deterministic nature of these patterns is very powerful and yields principles for designing desired surface topologies.”

“One important application is the measurement of ultra-thin-film material properties without knowing the thin-film thickness,” Yagüe says. The film’s material stiffness and thickness could be measured by analyzing the pattern, he says.

Many potential uses

Another possible application, the researchers say, is microfluidic devices such as those used to test for molecules in a biological sample, where tiny channels of precise dimensions need to be produced on a surface. These could potentially be used as sensors for contaminants, or as medical diagnostic devices. Another possible use is in the control of reflections or the wettability of a surface — making it attract or repel water, properties that depend both on the surface shape and the chemical composition of the material.

"Fundamentally, it's the same process that gives you your fingerprints,"
- Karen Gleason, Alexander and I. Michael Kasser Professor of Chemical Engineering and author of the study

Such patterns can also be used to make surfaces adhere to each other — and in this case, the degree of adhesion can also be controlled. "You can dynamically tune the patterning — direct stretching or other actuation can be used to tune the pattern and corresponding properties actively during use," Boyce says, even letting surfaces return to perfectly flat. This could, for example, be used to provide secure bonding with quick-release capability or to actively alter reflectivity or wettability.

Many techniques have been used to create surfaces with such tiny patterns, whose dimensions can range from nanometers (billionths of a meter) to tens of micrometers (millionths of a meter). But most such methods require complex fabrication processes, or can only be used for very tiny areas.

The new method is both very simple (consisting of just two or three steps) and can be used to make patterned surfaces of larger sizes, the team says. "You don't need an external template" to create the pattern, says Yin, the paper's lead author.

The predictability of the resulting patterns was a big surprise, members of the team say. "One of the amazing things is to note how beautifully the experiments and the simulation match," Gleason says.

John Hutchinson, a professor of engineering and of applied mechanics at Harvard University who was not involved in this research, says, "Wrinkling phenomena are highly nonlinear and answers to questions concerning pattern formation have been slow to emerge." He says the MIT team's work "is an important step forward in this active area of research that bridges the chemical and mechanical engineering communities. The advance rests on theoretical insights combined with experimental demonstration and numerical simulation — it covers all the bases."

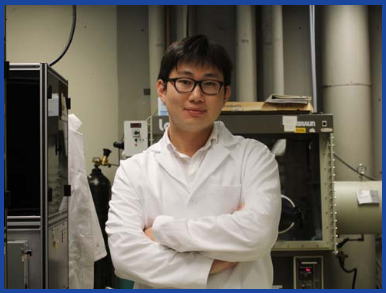
The work was funded by the King Fahd University of Petroleum and Minerals in Saudi Arabia. ◊

Images taken with a 3-D microscope show wrinkled surfaces produced using a method developed by the MIT team. The size, spacing and angles of the wrinkles vary depending on how much the original underlying surface was stretched, and how the stretching was released.

Images by Jose Luis Yague and Felice Frankel

Student Highlight

Graduate Student Hyomin Lee



In October 2012, The Department of Materials Science and the Materials Processing Center of MIT hosted their 2012 "Materials Day" with the theme of "Materials for Energy Harvesting." Hyomin Lee, a member of Professor Bob Cohen's laboratory, won the event's "Best Poster Presentation Award" for his presentation "Zwitter-Wettability and Antifogging Coatings with Frost Resisting Capabilities."

Lee's research involves understanding the role of chemical composition, porosity and roughness on hydrophilic surfaces and applying this in diverse applications. Based on the key considerations for designing stable hydrophilic surfaces, fabrication techniques such as Layer-by-Layer assembly, which provides a versatile and inexpensive approach to design hydrophilic surfaces, is used in common applications such as anti-fogging to create mechanically robust coatings. Also surface modifications and systematic design and synthesis of responsive polymers in order to create solvent-responsive surfaces are some of the key issues on which he focuses. This work is in collaboration with Prof. Rubner in the Materials Science and Engineering Department.

Student News

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

Discovering solutions: Undergrads take the lead in 10.27

Article by Leda Zimmerman, courtesy of the MIT Energy Initiative.

Undergraduates taking 10.27, the Energy Engineering Projects Laboratory, may find themselves far outside their comfort zones, says Clark Colton, a professor in the Department of Chemical Engineering. But Colton would not have it any other way. Students accustomed to homework sets and solutions must instead formulate their own problems and "figure out the best paths to take," says Colton, who shaped this Energy Studies Minor elective. "One of the culture shocks students experience in this class is that there's not always an answer."

10.27 is the latest entry in a grand 75-year-old MIT tradition, according to Colton. The semester-long project class for undergrads is designed not just to stimulate "creative and critical thinking," he says, but to equip students with a host of skills essential for navigating the ambiguities and hurdles of actual engineering ventures. Assigned real problems suggested by industry partners and by MIT's own research faculty, students learn to discover solutions, work in teams, and write reports. In the case of 10.27, which joins project classes on chemical and biological engineering, the focus is energy, "the number one technical topic in our country, which relates to the economy, national security, and the environment," says Colton. "Amongst students, it's a biggie, a very important problem."

Two years since it joined the curriculum, student demand for 10.27 runs greater than available slots for the subject—perhaps because the class offers students a unique opportunity to actually contribute to the field of energy. "It was really exciting to get results and learn about something that no one else had seen," says Marie Burkland '13 of chemical engineering. She was part of a three-person team investigating a new phenomenon called thermopower waves—a way of converting chemical energy to electrical energy through the use of carbon nanotubes.

Michael Strano, the Charles and Hilda Roddey Professor of Chemical Engineering, was behind the discovery of this phenomenon and served as an instructor for 10.27. He assigned Burkland's group the research goal of trying to improve the energy efficiency of the process—an initial step in deploying thermopower waves in a battery or power source device. There is no "canned solution" to this kind of problem, says Strano. He can "seed students with ideas" and teach them how to make a device to measure electrical power, but "there is still a discovery aspect, because things they are observing are new even to me."

Burkland says her group "bounced ideas off of Professor Strano and his grad student for a couple weeks" to figure out what areas might prove most fruitful to investigate. "They gave us ideas for where there could be improvements," she says. Burkland found the process highly motivating: "It's exciting; you can make your own rules, take the project in the direction you want." By the end of 13 weeks, Burkland's group had invented a new method for starting a reaction in the carbon nanotubes: "We did it with a resistance wire that gets really hot, is really precise, and all you have to do is touch it to the nanotube device to start a reaction." This innovation not only allows greater control over the amount of energy required to start the wave, notes Strano, but also is very practical because "it is easy to press a button to start this kind of ignition." Says Burkland, "It's a step toward an application in the real world."

"MIT undergraduates are really bright and are able within a short period of time to understand a problem and come up with their own ideas," says Strano. "This is what makes it very different from conventional lab courses. There's no TA telling them what to do." When unexpected obstacles emerged, says Strano, "they had to deviate from plans. They made new objectives and solved some experimental problems that nobody had solved before." In a course like 10.27, it's not just the students who learn. "It's a special space," says Strano.

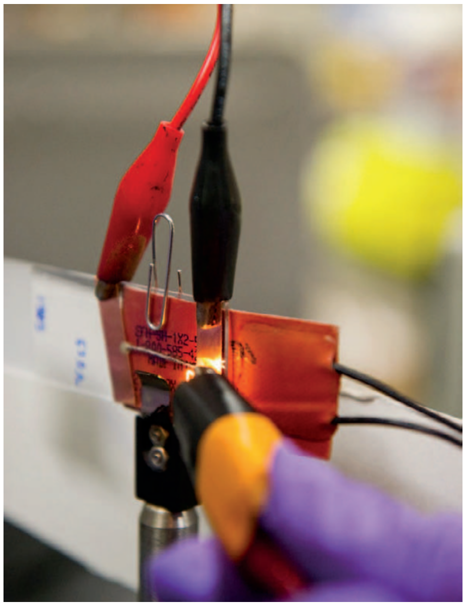
While 10.27 was "a ton of work," states Burkland, with students often putting in extra lab hours, mastering new technologies, negotiating roles within their teams, and delivering written and oral presentations to other groups, it also was an invalu-

In their class project, Tshiamo Lechina '13 of ChemE (right) and Melissa Showers '13 of MechE (left) worked with Professor Clark Colton to develop flow visualization techniques that will permit analysis of fluid dynamics in a process to create new materials for more energy-efficient tires. Here the group adjusts a transparent chamber in which a high-velocity liquid jet mixes with a second, co-flowing liquid. In collaboration with the Edgerton Center, the team made use of a high-speed video camera to capture details of the mixing process at 15,000 frames/second. Team member not pictured: David Campos '14 of ChemE. Photo: Justin Knight

""One of the culture shocks students experience in this class is that there's not always an answer."
- Clark Colton, Professor of Chemical Engineering and one of the founders of the new 10.27 course

able experience, she believes. She planned an experiment, collected and analyzed data, generated technical reports—all skills Burkland says she applied in a summer research job. "I say, wow, I know all this stuff. I don't have to seek help for how to manage a project, document it, and produce results in an effective way."

This is precisely the point of 10.27, suggests Colton: "Every student must learn the details of their application— everyone must learn at the beginning what it's all about, just like real life. When you go to a company you have to start with the basics of that industry, applying what you know. We do it here, in a microcosm." Colton has high expectations for the 60 or so students who have already taken 10.27 and for the next cohort: "I fully expect students in this course to be involved in innovations in industry, solving important problems, becoming entrepreneurs and leaders." ◊



(at left) Marie Burkland '13 of ChemE (right) and Jared Forman '13 of Chemistry (center) set up a camera to capture images of a thermopower wave being launched by an "electric match" (above), a device they designed and built. Professor Michael Strano watches from the sidelines. Team member not pictured: Ksenia Timachova '13 of ChemE. Photos: Justin Knight

Student Highlight

Graduate Student Katie Quinn

Katie Quinn (at right) and MIT mens cycling team captain Adam Bry enjoy the 2012 ECCC Championship Cup along with the yellow jerseys given to the series points winners. Photo: Kenny Cheung.

MIT's women's cycling team is known as a perennial powerhouse. Women's captain Katie Quinn, a third-year grad student in chemical engineering, continued the strong tradition as the Eastern Collegiate Cycling Conference (ECCC) series points winner, garnering the highest total points accumulated in all races over the 2012 season. At nationals, Laura Ralston, a fourth-year grad student in economics, defended her title in the criterium, while Quinn won the road race. The women also won the team time trial by a significant margin, completing the monopoly on the stars-and-stripes jerseys given to national champions.

Quinn is a member of the Maheshri laboratory; her research includes the origin and consequences of transcriptional fluctuations and stochastic models of transcription.

Student News

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

Finding his voice

First-generation college student Eric Trac makes the most of MIT — whether through medical research or community service.

Article by Jessica Fujimori, courtesy of the MIT News Office.

Eric Trac's senior year at MIT has been a busy one. He's finishing his coursework in chemical engineering, applying to medical school, and researching a gel that can help heal scarred vocal cords. He's also mentoring youth debaters in Boston, planning a community service trip to his hometown of San Francisco, and setting up a mentoring program for premedical students. And when he gets the chance, he calls home to talk to his mother.

A rough start

Ten years ago, Trac didn't speak much in school. He didn't understand much, either: The son of Vietnamese refugees, Trac didn't speak English at home and struggled through elementary school, bringing home standardized test marks that were far below average.

Neither of Trac's parents had attended college; his mother had abandoned her dreams of becoming a pharmacist to flee Vietnam's Communist regime in 1979. "My mother was forced to work countless hours at a series of minimum-wage jobs in order to support my family," Trac recounted in an essay, "Teardrops Don't Always Drip Down," that was awarded an Isabelle de Courtivron Prize last year by MIT's School of Humanities, Arts, and Social Sciences.

One night when Trac was 10, his mother called him into the kitchen, where she sat holding his poor test results. That night changed his life, Trac says: "At 10 years old, I realized that if I wanted to avoid my mother's fate — the fate of working multiple jobs to feed her family and having almost no control over her own life or the lives of those she loved — I would have to work hard. I took the only path in front of me, which was to open my books and start reading."

For the next two years, Trac and his mother routinely stayed up until 2 or 3 a.m. as she helped him through his homework and read books to him in English, translating into Vietnamese intermittently. By high school, the hard work had paid off. "The material surpassed my mother's knowledge, but I retained my work ethic and my attitude toward academics," Trac says.

Trac hadn't thought much about college — until joining his high school debate club. "I think that was the first time that I sat down and started writing my own arguments, articulating my own thoughts, in front of others," Trac reflects. "I got to see that I have potential of my own."

"I resolved to work hard in high school to make college financially viable through scholarships and financial aid," Trac says. "Ultimately, I secured a nearly free, world-class education at MIT."

MIT and medicine

Trac's enjoyment of his high-school chemistry and math classes led him to major in chemical engineering at the Institute. He became interested in medicine during his sophomore year, and decided to follow a premedical track.

"Medicine gives me a unique opportunity to see the impact of my work, and the work of science, on nearly a daily basis," Trac says.

He joined a research project dually affiliated with the laboratory of Robert Langer, the David H. Koch Institute Professor at MIT, and the Center for Laryngeal Surgery and Voice Rehabilitation at Massachusetts General Hospital. The team is working on drug delivery for an injectable hydrogel developed to restore the flexibility of scarred vocal cords.

"People who use their voices very often, such as singers or lecturers, may scar and stiffen their vocal folds over time," Trac explains. "This hydrogel could restore the flexibility of the vocal folds, thereby restoring these individuals' voices."

Trac is now working to incorporate an anti-inflammatory drug called dexamethasone into the hydrogel. "Ideally, once the hydrogel is injected into the vocal cords, dexamethasone would slowly release over an extended period of time," he says.

Giving back

Over the last year, Trac has worked with MIT's Prehealth Advising office and the local chapter of the American Medical Student Association to implement a mentoring program connecting premedical students with alumni who have gone on to

"I think about this rare opportunity I have, to come to MIT to study, and I think I should cherish it and make the most of it."

- Eric Trac, Course X senior and first generation college student

medical school all over the country. By its second semester, last fall, the program had attracted some 70 alumni mentors and more than 100 MIT undergraduates. "The solution just required talking to people, meeting people, getting people together to build a program," Trac says.

During his time at MIT, Trac has volunteered at a local high school and at a school in St. Louis for students with severe learning and behavioral problems. A few times a month, he goes on an outing with his "Best Buddy," an individual with an intellectual disability. "I thought it was a good way to improve someone's life on a one-to-one basis," he says.

Trac is also a mentor in the Boston Debate League, which helps disadvantaged youths recognize their own potential through debate — a message that resonates with his own story.

Though Trac's early years were difficult, the obstacles he's overcome have given him perspective and motivation, he says. "Occasionally, I think about this rare opportunity I have, to come to MIT to study, and I think I should cherish it and make the most of it," Trac says.

Another of his inspirations is closer to his heart: "My mother sacrificed a lot for me to do the things I'm currently doing, to actually attend college," Trac says. "I think that I can repay her sacrifices by giving the things I do my very best." ◊

(Image by Allegra Boverman)

Alumnus Highlight

Wolf R. Vieth SB '56 ScD '61

Vieth and his wife enjoy a well-earned retirement at their home on the island of Maui, Hawaii.

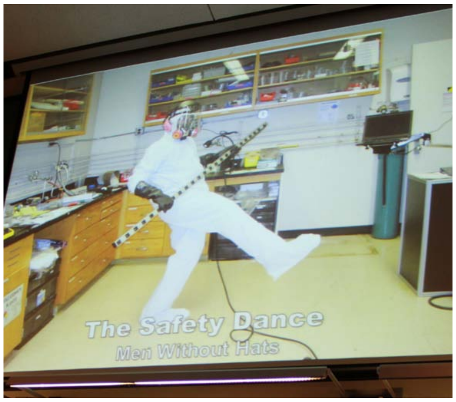
Wolf Vieth SB '56 ScD '61, is a professor emeritus of Rutgers Univeristy, where he was chairman of the Department of Chemical and Biochemical Engineering at a critical juncture in its formative years, 1968 - 1978. Before Rutgers, Vieth had been an active researcher and author since 1961, spending seven years on the MIT Chemical Engineering faculty, becoming associate professor and director of the Practice School from 1962 to 1964.

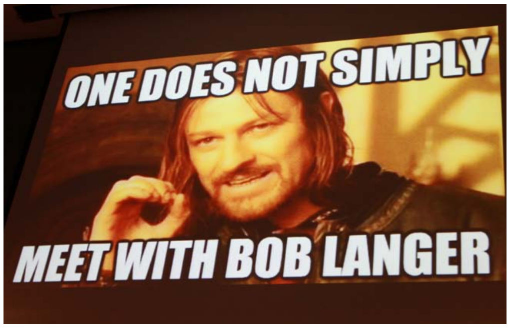
His work continues to have considerable impact, sixteen years after his retirement from Rutgers. Since 1996, his author citations have nearly doubled to a total of more than 3,000. The main reason for this is the filling of a crucial need by his premier reference book, *Diffusion in and Through Polymers*, Hanser Press, 1991, which, together with a key cluster of five related articles accounts for nearly one-half of all citations to date. The material for the book originated in his thesis work with Alan Michaels at MIT and continued through the years at Rutgers.

In addition, one of his patents, *Electrocodeposition of Collagen-Enzyme Complexes*, underwent a resurgence in 2010, being applied to the development of medical stents, tissue scaffolds and in controlled release applications.

2012 Holiday Party

On Friday, December 14th, 2012, the faculty, staff, students and their families celebrated the holidays with the traditional day of baking contest, skits, dinner and caroling.





2012 Course X Alumni Reception at AIChE

At the annual AIChE meeting in Pittsburgh in October 2012, Course X alumni and friends from around the world gathered to mingle and network, as well as honor the MIT faculty who were recipients of AIChE awards:

Professor William M. Deen
Winner of the Warren K. Lewis Award

Professor Karen K. Gleason
Winner of the Process Development Research Award

Professor George Stephanopoulos
Winner of the Founders Award

Professor Michael S. Strano
Winner of the NSEF Forum Award

In Memoriam

James Katzer PhD ’70

Dr. James Robert Katzer died of a heart attack in his sleep November 2 in Marshalltown, Iowa. He was 71.

Katzer began his chemical engineering career as an Iowa State undergraduate in fall 1961. He spent a year prior at Marshalltown Junior College (now called Marshalltown Community College). While an Iowa State student he held Tau Beta Pi and Pi Mu Epsilon honors as well as interned at a DuPont plastics plant in Parkersburg, W. Va. In May 1964 he graduated with a perfect 4.0 GPA – the top cumulative mark for a 1964 Iowa State engineering graduate. He soon pursued a PhD in chemical engineering at MIT, which he earned in 1970.

In his professional life, Katzer accumulated a rich mix of academia and industry within his catalysis and reaction engineering repertoire. He began his academic life’s work as an assistant professor of chemical engineering in 1969 at the University of Delaware. By 1978 he progressed to full professor after a brief visiting professorship at Stanford University. During his promotion to professor he founded the university’s Center for Catalytic Science & Technology. There he attracted $800,000 in new research funding in its first year. By 1980 the Center had 23 industrial companies supporting it at $25,000 each and had a total research budget of $1.8 million. “In only nine years at (the University of) Delaware, Jim Katzer established himself as a strong teacher and scholar and realized the vision of the Center, which was one of the first of its kind,” said faculty colleague Bruce Gates in 2001. Gates is now a distinguished professor in the Department of Chemical Engineering and Materials Science at University of California, Davis.

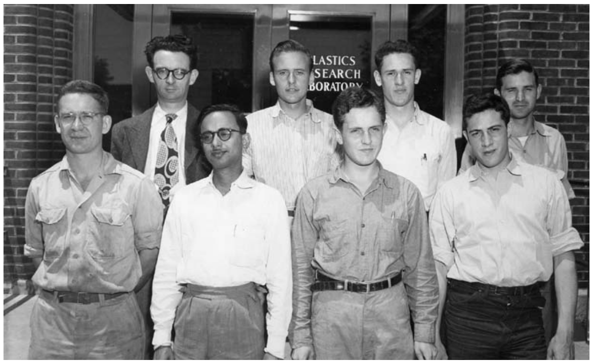
By 1981 Katzer established a career in industry, where he first became manager of the Catalyst Section at the Mobil Oil Corporation’s Central Research Laboratory in Princeton, N.J. Various research and administrative positions led him to become vice president of technology in 1997.

Katzer’s diverse experience in catalysis and reaction engineering research and commercialization piqued national interest in 1998. In that year he was elected to the National Academy of Engineering – considered the highest achievement for an American engineer. With the merger of Exxon and Mobil Oil Corporation in late 1999, Katzer became manager of planning and performance analysis. He thrived in that role managing downstream research, development and engineering. He retired from ExxonMobil Research and Engineering Company in 2003.

Although retirement may warrant rest for some, Katzer continued to stay heavily involved in the profession. At the time of his death he was a member of the Technical Advisory Council for Rive Technology, a member of the Technical Advisory Board for China National Institute for Clean and Low-Carbon Fuels, as well as affiliate professor and a member of the Industry Advisory Council for the Iowa State University Department of Chemical and Biological Engineering. In addition, from 2006 to 2009 he was a panel member of the National Research Council of The National Academies. He also was, from 2004 to 2007, a visiting scientist for the Laboratory for Energy and The Environment at MIT. He was a member of MIT Chemical Engineering’s Visiting Committee at the time of his death.

Department Head Klavs Jensen noted the Department’s loss, stating, “Jim had a broad background in the energy and petroleum industry with in depth knowledge of oil, gas, coal, alternate energy, hydrogen, and power generating technologies and associated economics. He was a wonderful person and we will miss his gentle, wise advice.” ◊

Blast from the Past



(to the left) Marshall E. Baker SB ’48 SM ’50 sent in a great image of his “Practice School class of 4A49. This was our third station and two of our original ten were back at the Institute taking classes.

I have been able to contact only two recently, Oliverio Phillips and Dean Thacker. So they know I’m sending this photo in.”

Back row left to right: Hugh Thomas, David S. Laity, Marshall E. Baker, Dean Thacker. Front row left to right: W. Phillip Bloecher, Tuhin K. Roy, Oliverio Phillips, Peter A. Guercio.

Do you recognize yourself or someone else in these photos or have your own you’d like to share? Email *chemealum@mit.edu*.

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***

Special note: The alumni donor honor roll for the period of July 1, 2012, through June 30, 2013, will be in the Fall 2013 edition of the alumni news. *We sincerely appreciate everyone who has supported us throughout the year!*

Mary Jane Hellyar SM '77 PhD '82 has been named Tredegar Corporation's president of Tredegar Film Products Corporation, effective September 24, 2012. The company has also named Hellyar a corporate vice president, effective September 24, 2012. Prior to joining Tredegar, Hellyar served as chief executive officer of Technocorp Energy OLED in Rochester, NY and previously held various positions with Eastman Kodak Company, including corporate executive vice president and president of the Film, Photofinishing and Entertainment Group and the display and components business unit. She has an extensive background in research and development, product commercialization, and operational excellence. Tredegar Corporation is primarily a manufacturer of plastic films and aluminum extrusions.

David Levy PhD '92 has joined Natcore Technology as Director of Research and Technology. He is inventor of the atmospheric Spatial Atomic Layer Deposition process (SALD). Levy brings 20 years of industrial R&D experience with vapor/vacuum coating, nanoparticle synthesis and dispersions, liquid coating, circuits and electronic devices to Natcore, a company that uses its liquid phase deposition (LPD) technology to grow antireflective coatings on silicon wafers for the purpose of creating solar cells.

While working with air-free synthesis of nanoparticles, Levy also gained familiarity with quantum dot systems. The ability to create a three dimensional matrix of quantum dots is a critical step toward the formation of a fully functioning tandem cell, a principal goal of Natcore scientists. These cells could achieve twice the power output of today's most efficient solar cells.

Levy's initial technical efforts at Natcore will be focused on two programs: The optimization of their "Absolute Black" technology for coating solar cells, and the completion of a fully automated version of their AR-Box that can utilize that technology. "Absolute Black" refers to Natcore's technology that enables a solar cell to absorb 99.7% of the light that reaches it, thereby producing significantly more energy on a daily basis than will a panel made from cells using the industry standard antireflective coating. AR-Box is Natcore's tool that uses their exclusive LPD process to grow antireflective coatings on silicon wafers.

Alonzo (Lon) Cook PhD '96 joined the faculty of Brigham Young University in 2012 after 16 years working in the medical device industry. Cook graduated from BYU with BS and MS degrees in chemical engineering, and later received his PhD from MIT, with an emphasis on engineering applications in medicine. His industry experience was in business development and research and development of tissue engineering and medical devices, primarily in the fields of cardiovascular, ophthalmic and orthopedic products. His previous employers include Semprus BioSciences (Teleflex), Johnson & Johnson and W.L. Gore & Associates. He is also an author on numerous peer-reviewed publications and an inventor on 4 issued patents. His current research focuses on tissue engineering and regenerative medicine.

Brian Anderson SM '04 PhD '05 has been named the GE Plastics Material Engineering Professor at West Virginia University, effective January 2013.

An associate professor in the Department of Chemical Engineering, Anderson has conducted extensive research in the areas of natural gas hydrates; thermodynamic modeling;

and sustainable energy and development, most notably in the area of geothermal systems. He has been nominated for the 2013 Department of Energy's Presidential Early Career Award for Science and Engineers, was the recipient of the 2011 DOE Secretary's Honor Award for his work in response to the Deepwater Horizon oil spill and was selected to the National Academy of Engineering's 2010 Frontiers of Engineering Education Workshop. Anderson was named the Statler College's "Teacher of the Year" in 2010.

A native of Ripley, W.Va., he earned his bachelor's degree in chemical engineering from WVU in 2000, and his master's and doctoral degrees from Massachusetts Institute of Technology in 2004 and 2005, respectively.

Helen Chuang PhD '08 received an award at the 17th annual Women of Color in Technology (WoCT) STEM (Science, Technology, Engineering and Mathematics) Conference in Dallas in October 2012.

The conference recognizes outstanding women in the STEM fields and provides opportunities for professional development, networking and recruiting.

Chuang is a systems engineer in Northrop Grumman Electronic Systems sector, working on the analysis of radiometric data from the Space-Based Infrared Systems. Prior to joining Northrop Grumman, Chuang pursued a successful career in biomedicine where she published a host of technical papers, presented at numerous professional conferences, and participated in two patents and four grant proposals.

Chuang is a strong proponent for the incubation of STEM interest among students, serving as a mentor at both MIT and CalTech, and as a director for MIT's nationwide engineering outreach program. Chuang earned a bachelor's degree in chemical engineering from Caltech and a doctorate in chemical engineering from MIT with a minor in finance and management.

Carmen Jiawen '12 won the AIChE National Student Paper Contest at the annual AIChE Meeting in Pittsburgh in October, 2012. Her paper, "Soft hydrogel microparticles of controlled size and stiffness using an emulsion-based method," had won at the AIChE regional level months before. Her work "demonstrated an emulsion-based photopolymerization method to create soft hydrogel microparticles of controlled size and stiffness. [She] then demonstrated in vivo and in vitro biocompatibility, and explored potential applications in controlled release, and tried to functionalize the surface." ◊

The Department Welcomes New Development Officer

Bruce Siegal joins MIT supporting the Department of Chemical Engineering and the Department of Materials Science.

Before coming to MIT, Siegal was a successful development officer working with the chair and faculty of the mechanical & industrial engineering department at Northeastern University. He has over 20 years of successful business development experience in the private sector including technology consulting, management and research sales.

Siegal was raised in Newton, MA, and continues to reside there. He is an avid runner, and active in the Boy Scouts (two sons are Eagle Scouts).

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Spring Chemical Engineering Dept. Seminar Schedule

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

Friday, March 22
Folding under pressure: Mechanical forces in development of native and engineered tissues
Celeste Nelson, Princeton University

Friday, April 5, 34-101
Lewis Lecture: Management's Co-dependence on Mother Earth: Sustainability in the Chemical Industry and Four-Dimensional Analysis
Dr. Yoshimitsu Kobayashi, President and CEO, Mitsubishi Chemical Holdings Corporation

Friday, April 19
Polymer Nanostructures that Direct Biological Function
Ashutosh Chilkoti, Duke University

Friday, April 26
Insight into the Kinetics of Oligomer Formation During Amyloidosis
Georges Belfort, Rensselaer Polytechnic Institute

Friday, May 3
Michaels Lecture: 'What's in your blood? Molecular Deconvolution of the Human Serum Antibody Repertoire in Health and Disease'
George Georgiou, University of Texas, Austin

Friday, May 10
Molecular simulations of polymers
Doros Theodorou, National Technical Institute of Athens, Greece

Come visit us on campus June 7th!

You are invited to attend the

Annual MIT ChemE Alumni Reception

Friday, June 7, 2013

1pm
(immediately following Commencement)

Tent in McDermott Court