Message from the Department Head

I am very pleased to introduce a new format to the CEMS newsletter. We are transforming how we keep our family of alumni and friends informed of the myriad of activities and developments that enable us to deliver the best education and most impactful research to our students, postdocs and collaborators. While retaining our tradition of providing you with a rich complement of informative and substantive information about the department, we have enhanced the newsletter with color and even more compelling content, without adding to the cost of production.

Amundson Hall is buzzing with activity. Over the summer the entire south face of the building was removed and a magnificent new window façade was installed, including a striking array of vertical glass panels that contain a multilayer polymer film that produces optical effects inside and outside the building (photo on page 20). There is no way to convey with words the aesthetic appeal of this beautiful architectural innovation. You simply must see this for yourself!

In addition, all of the windows in the “mines and metallurgy” portion of the building have been replaced, and we estimate that together these improvements will save about $100,000 annually in heating and air conditioning costs. On the back side of Amundson Hall, the Gore Annex is rising. We expect the six floor, 42,000 square foot addition to be completed in July 2014.

This edition of the newsletter features a groundbreaking initiative in research led by two young members of the CEMS faculty, Assistant Professors Andre Mkhoyan and David Flannigan. For old guys like me, “seeing is believing,” and these two pioneers in electron microscopy have brought the most advanced tools in the world to the University of Minnesota for resolving sub-Ångstrom scale structural features and femtosecond (10^{-14} s) dynamics, feats I find simply unimaginable. Their work will transform how scientists and engineers understand technology at the most fundamental levels. You’re among the first to hear about this.

World’s first FEI ultrafast electron microscope at UMN

The University of Minnesota-Twin Cities will be the first in the world to install a new FEI Tecnai™ Femto ultrafast electron microscope (UEM) that will be used to examine the dynamics of materials at the atomic and molecular scale over time spans measured in femtoseconds (one millionth of a billionth of a second). Researchers expect that the technology will enable them to conduct fundamental research on the structure and dynamics of matter that could lead to new solutions in energy, medicine, and digital technologies.

The new Tecnai™ Femto UEM, produced by FEI Company, is the first system to commercialize the patented ultrafast electron microscopy technology pioneered by Nobel laureate Professor Ahmed Zewail at the California Institute of Technology. The equipment will be installed later this month in the University of Minnesota Shepherd Laboratories and then moved to the Gore Annex of Amundson Hall when construction is completed next year.

Unlike an optical microscope that uses light to form images, an electron microscope uses a high-energy beam of electrons to create an image of the specimen. It is capable of much higher magnifications and has a greater resolving power than a light microscope, allowing it to see much smaller objects in finer detail. The newly developed UEM combines

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GUEST MESSAGE FROM EXECUTIVE OFFICER

Uniquely Minnesotan: CEMS unveils new technology and equipment to lead electron microscopy field

With two new, multi-million dollar electron microscopes, one a high-resolution (S)TEM and the other an ultrafast TEM, Assistant Professors K. Andre Mkhoyan and David J. Flannigan are conducting innovative research that is gaining worldwide attention.

Understanding how atomic arrangements and motions affect the properties of materials is one of the central quests in science. The way atoms bond together in materials determines their structure, which, in turn, determines their electrical, optical, magnetic, and mechanical properties. For this reason, the ability to "see" and "watch" atoms with ever increasing spatial and temporal resolution is a huge advantage if you are in the business of discovering new materials and explaining how they work. Most importantly, the insight you gain by "seeing" and "watching" atoms gives you a competitive advantage on the rest of the world when you are designing new materials.

Two young, energetic, enthusiastic and creative CEMS faculty members, K. Andre Mkhoyan and David J. Flannigan, brought two state-of-the-art electron microscopes to the University of Minnesota making it both easier to "see" and to "watch" atoms. The rest of us are also very excited as we contemplate the advances these technologies will generate in each of our respective research fields: polymers, photovoltaics, semiconductors, organic electronics, magnetic materials, catalysis, coatings, etc. Some of this hardware is not something you can buy off the shelf if you have a few million dollars. In order to make true advances in electron microscopy, it takes more than just writing a check. Flannigan and Mkhoyan are at the forefront of the electron microscopy field; developing new hardware and new methods to analyze the data and pushing the limits of resolution in all four dimensions. They are asking what may have been unthinkable to ask. Can you “see” atomic orbitals? Can you “watch” atoms vibrate? In fact, they are leading the companies that make the state-of-the-art electron microscopes. State-of-the-art is starting with them and their graduate students. Their excitement and ideas are infectious; we are witnessing a lot of discussions at the CEMS lunch table, the coffee room and the faculty offices on how to use these advanced electron microscopes to push revolutionary science in materials and chemical engineering. Ultimately, the combination of new technologies and the collaborative environment created in CEMS over many decades will catapult us into a “world leader” position not only in electron microscopy, but also in materials science.

Sincerely,

Eray Aydil
Executive Officer and Professor, Department of Chemical Engineering and Materials Science

Feature article on pages 10-11
Hermann Gies named 29th George T. Piercy Professor

Gies is a Professor of Crystallography in the Department of Mineralogy in the Institute of Geology, Mineralogy, and Geophysics at Ruhr-Universität Bochum, FRG in Germany.

When I received the invitation by Michael Tsapatsis to spend two months as a visiting professor in CEMS during the summer of 2013, I accepted with great pleasure after consulting my group and my family. I was really delighted after I was informed that the invitation included the George T. Piercy Visiting Professor award.

Michael Tsapatsis and I share a common interest in micro- and mesoporous materials. We are fascinated by their structure-property relationship, but from quite different perspectives. Michael’s activities are well known in the department, and my focus is structure determination and refinement of nanocrystalline microporous materials using a combination of diffraction and spectroscopic techniques. X-ray diffraction experiments, as an example, make the structure of the bulk material accessible, while SS-NMR experiments analyze the local order. The insight is extremely important to understand the properties, but also the synthesis of these materials. The emphasis is explained by me working in an earth science department at the Ruhr-University in Bochum, Germany, which I joined after graduating with a Ph.D. in chemistry. In the Institut of Geology, Mineralog and Geophysics, I am leading the crystallography group with crystal chemistry as our field of research.

The Piercy Professorship has offered me the opportunity to gain insight into more applied research activities in the field of porous materials and to interact with the faculty and the students on problems of mutual interest. For many days and many hours per day, we spent time discussing findings and exchanging ideas. I hope that some of the conclusions we arrived at also led to advances in those respective projects. In a more general perspective, I was very impressed by the range of research disciplines and activities in CEMS and by the high level of quality research being conducted. As a newcomer to the United States, I also underwent a crash course by the members of the CEMS faculty in U.S. politics, science administration, university affairs, etc. during the get together over lunch in the Campus Club, which I was allowed to join as test member. I was not sure about the test, but I liked the daily soup.

Notable Alumni Achievements

Aaron W. Bartel (MatSci ’05), a structural thermoplastic composites engineer, was honored for aerospace innovation by his employer, Boeing. Boeing awarded Bartel with the company’s annual Special Invention Award, which highlights the best of the company’s innovation. Bartel was part of a team that invented a soluble tooling for complex parts fabrication.

Greg Frankenfield (ChemE ’81, MBA ’84), CEO and co-founder of Magenic, won the University of Minnesota Entrepreneur of the Year Award as part of the recent Minnesota Cup competition.

Doraiswami Ramkrishna (Ph.D. ChemE ’65) wrote an article titled “The Neal Amundson era. Rapid evolution of chemical engineering science” for the September 2013 issue of the AIChE Journal. Neal Amundson was chosen to be the first distinguished individual to be honored with a Founders Tribute for that journal.

Triantafyllos Stylianopoulos (Ph.D. ChemE ’08), lecturer at the University of Cyprus, was awarded a $1.9 million grant by the European Research Council (ERC) to establish the Cancer Biophysics Laboratory at the University of Cyprus. ERC grants are the most competitive and prestigious research grants within the European Union.

Srinivas Tummala (Ph.D. ChemE ’00), senior principal scientist at Bristol-Myers Squibb Company, was recently awarded the 2013 AIChE Industrial Progress Award. Tummala won the award for contributions to Quality by Design process development of small-molecule active pharmaceutical compounds in the areas of reaction science and model-based design space development.

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CEMS welcomes new faculty members

Xiang Cheng and Mike Manno join the Department of Chemical Engineering and Materials Science faculty.

Xiang Cheng, Assistant Professor

Cheng’s research group studies soft materials physics in experiments, with a special focus on the emergent flow behaviors of soft materials and their mesoscopic structural origins. Research in soft materials has had a profound impact on our society. The invention of liquid crystal displays (LCD), the development of e-ink used in consumer products like Kindle™ reading tablets via charged colloidal particles, and the potential use of shear-thickening suspensions to “top kill” disastrous blowouts in oil wells are just a few examples that highlight the fascinating applications of soft materials. In each case, the underlying mechanism is governed by the unique structures of soft materials on mesoscopic length scales between the molecular and the macroscopic. These mesoscopic structures can readily respond to stimuli such as weak electromagnetic fields, shear, acoustic vibrations or even thermal fluctuations. Thus, understanding the interplay between mesoscopic structures of a soft material and its bulk material properties, as well as controlling structural transitions through external forces, becomes the key for advancing Cheng’s soft material research.

Cheng’s research group also studies the special flow behaviors of suspensions such as shear thinning and shear thickening and try to reveal their microscopic origins. As an extension, they also investigate the shear-induced dynamics of biological fluids such as suspensions of swimming bacteria. (2) Granular flows with applications to geological problems. Using the state-of-the-art high-speed imaging techniques for discrete granular particles and fluid flows, they investigate water splashes on granular surfaces, much like the phenomenon that happens on a rainy day at a sandy beach (Fig. 2).

Understanding the mechanism of splash dynamics is crucial for preventing the splash-induced soil erosion that costs multi-billion dollars in U.S. agriculture and can also improve many industrial coating processes using rough surfaces. Cheng’s research group applies their lab-scale experiments to the understanding of emergent patterns in the geo-scale of natural granular flows. (3) Glass/jamming transition of soft materials. Large classes of materials ranging from simple glass-forming liquids, polymer melts, to even shaving foams, show a similar transition between a flowing fluid-like state and a disordered solid state. These transitions in different systems can be unified with the generic jamming phase diagram. By developing a novel setup, “confocal rheoscope,” which couples a confocal microscope to a mechanically deformable cell, they investigate the effect of mechanical perturbations on the jamming transition. The goal of Cheng’s research is to control and furthermore to design soft materials with desirable material properties, based on the understanding of their mesoscopic or microscopic structures.

Xiang Cheng

Xiang Cheng earned his doctorate in physics from The University of Chicago and bachelor’s degree in physics from Peking University in China. Prior to joining the faculty, Cheng was a postdoctoral associate at the Cornell Center for Materials Research at Cornell University.

Mike Manno

Mike Manno earned his doctorate in chemical engineering from the University of Minnesota and bachelor’s degree in chemical and biomedical engineering from the University of Illinois at Urbana-Champaign. Manno previously held a dual appointment as a postdoctoral research associate in the Characterization Facility and Department of Chemical Engineering and Materials Science at the University of Minnesota.

New Faculty

Fig. 1: Micrometer-size fluorescent particles in a liquid phase (left) and in a crystalline phase.

Fig. 2: Splash of a dyed water drop on a sand surface. The photo was taken at 9,000 frames per second.
Mike Manno, Teaching Assistant Professor

Mike Manno

Manno’s primary responsibility as a Teaching Assistant Professor will be educating materials science undergraduates in the structural, electronic, and magnetic characterization of materials. During the Fall 2013 semester he will be co-instructing, with Prof. Chris Leighton, the Structural Characterization Lab, MatS 3801. With a rising demand for novel and specialized materials to solve society’s challenges, it is vital to ensure that scientists and engineers are knowledgeable in the synthesis and the characterization of these materials. The ever increasing role that material interfaces play in engineering new material systems require scientists and engineers to be educated in both classical characterization techniques (e.g. x-ray diffraction, infrared spectroscopy, optical microscopy) that are tailored for these new material systems, as well as characterization techniques specifically designed to characterize thin films, surfaces, and interfaces (e.g. grazing incidence x-ray reflectivity, x-ray photoelectron spectroscopy, and scanning electron microscopy). In MatS 3801, students learn the theory and operation of research-grade characterization instruments, such as x-ray diffractometers, scanning electron microscopes, and scanning probe microscopes (examples displayed in Figure 1), for the characterization of bulk and thin film materials. This experience provides students a solid background in materials characterization that will be utilized in subsequent classes offered by the department.

Along with his teaching responsibilities, Manno will continue his research interests in synthesizing and characterizing transition metal-based sulfide materials through collaborations with the Aydil and Leighton research groups. For instance, sulfide-based photovoltaic materials such as FeS₂ and Cu₂ZnSnS₄ are projected as viable, low-cost [1], and earth-abundant [2] alternatives to the conventional photovoltaic materials (i.e. c-Si, CdTe, CuIn(Ga)ₓSₓ₋ₓ). Highly efficient solar cells often require phase-pure films with low levels of impurity disorder and high carrier mobility. Utilizing thin film synthesis routes such as ex situ sulfidation and reactive sputtering, as well as single crystal synthesis via chemical vapor transport, relationships between processing conditions and the structure, electronic, and absorption properties of these materials can be studied. Recent findings such as electron transport changes in ex situ sulfidized FeS₂ films from intergranular hopping transport to activated band transport n-type dopants [3] and enhanced grain growth in Cu₂ZnSnS₄ films via controlled incorporation of Na and K impurities during ex situ sulfidation (as shown in Figure 2) [4], are achieved through this approach. Current studies are exploring how these synthesis procedures affect carrier mobility, electrical transport behavior, and compatibility with solar cell device fabrication.

References:
The “green” movement is no longer a novel idea. Consumers have been driving electric cars, using solar panels to heat their homes, and fueling up with ethanol for decades. Still, there is more research to be done to refine environmentally-friendly lifestyle alternatives, and students and faculty in the Department of Chemical Engineering and Materials Science are advancing sustainable technologies in a variety of ways.

**Sustainability in Biomass**
Regents Professor Lanny Schmidt holds a unique perspective on the evolution of green science and engineering as an emerging, and now standard, field of interest for students and faculty alike. Schmidt’s research for the past 15 years has been devoted to processing biomass into renewable chemicals and fuels under the title, “Catalytic Reforming of Biomass in Millisecond Reactors.” For the past 10 years, he has taught an upper division elective course on renewable energy technologies. The course examines various ways to convert biomass into fuels and chemicals and considers direct conversion of sunlight into electricity. Schmidt recognizes that green chemistry and engineering topics are resonating with students in their educational and professional pursuits. “Students have a greater interest in learning about new technologies that will conserve energy, make a better life, and provide employment,” said Schmidt.

Sam Blass, a materials science Ph.D. student working in Schmidt’s lab, agrees. “Millisecond reactors are an exciting area of research because of their uniqueness. The reactors carry out high-speed chemical reactions at temperatures around 1600 degrees Fahrenheit. The energy needed to drive these chemical reactions is supplied from the reactant itself so the unit can operate without any heat input.” Blass further explained the environmental benefits of this work by describing each stage of the conversion process. “Millisecond reactors are capable of processing a wide range of biomass feedstocks into a mixture of hydrogen and carbon monoxide, also known as syngas. Gases (methane), liquids (ethanol), or solids (cellulose and corn stover) can all be converted into syngas. Syngas can then be upgraded through more conventional processes to gasoline and diesel.” Blass envisions the research that he is conducting now will eventually lead to fundamental changes on broader industrial and societal levels. “Biorefineries are smaller than conventional oil refineries and require smaller-scale reactors. Research in small-scale biomass upgrading technology is necessary to improve the economic feasibility of biorefineries and help widespread biofuel production become a reality.”

**Bright Future for Solar Cells and OLEDs**
The goal of advancing scientific research to the point of widespread commercial use is no more apparent than in recent breakthroughs to engineer inexpensive, durable electronics and solar cells made with non-toxic chemicals. Ting Chen, a materials science Ph.D. student, is a member of a team comprised of researchers from the Department of Mechanical Engineering at the University of Minnesota and the National Renewable Energy Laboratory in Golden, Colo. that have discovered a novel technology to produce a specialized type of ink from non-toxic nanometer-sized crystals of silicon, often called “electronic ink.” This “electronic ink” could produce cheaper electronic devices with techniques that essentially print onto inexpensive sheets of plastic. “Imagine a world where every child in a developing country could learn reading and math from a touch pad that costs less than $10 or home solar cells that finally cost less than fossil fuels,” said Uwe Kortshagen, a University of Minnesota mechanical engineering professor and one of the lead researchers on the project.

Lowering manufacturing costs and increasing efficiency decreases the price (cents per kilowatt hour) of solar-derived electricity, which in turn, increases consumer accessibility. To this end, Professor Eray Aydil and his students are working on solar cells made from abundant, nontoxic semiconductor materials, using low-cost manufacturing approaches. Aydil’s team includes graduate student Boris Chernomordik and four undergraduate students: Amelie Beland, Donna Deng, Anne Hunter, and Priyanka Ketkar. Their work on a new solar cell material, copper zinc tin sulfide (CZTS), is enabling production of thin film solar cells from colloidal nanocrystal dispersions (or inks). The research team prepared Cu2ZnSnS4 (CZTS, an Earth-abundant, nontoxic material) as nanocrystals, printed them on substrates from inks and then converted these nanocrystals to large-grain films suitable for solar cells. This new method is safer and simpler, and Aydil is now working with Professor Lorraine Francis to use these inks in a spray to deposit CZTS films on larger areas,
much like painting. “CZTS is a promising new material that has generated a lot of interest in just the past few years,” said Aydil.

One energy efficient product that has already proven itself in the consumer marketplace is the LED light bulb. However, an area that has been less extensively researched is organic light-emitting devices (OLEDs). Associate Professor Russell Holmes and his research team are seeking to understand the structure-property-device relationships in OLED devices. These devices hold promise as highly efficient, low-toxicity, and cheap white lights which could replace incandescent and even fluorescent lights. This past summer, Holmes and his research group grew their first white OLED in the laboratory, which could then be used for lighting.

Nick Erickson, a graduate student in that group, explained that, “The research we do helps us understand fundamental material and device properties. We want to understand what drives device operation and performance from the ‘ground up.’ In doing so, we are able to design single-color, single-engineered layer devices which are on par with the most efficient devices in our field, but are much simpler to fabricate and use fewer materials. This novel device design has several unique characteristics which allow us to finely tune the nano-scale electronic and optical properties. It is important that we fully understand the device operation of each individual set of materials for a particular color device, since there are several ways to create a white device which rely on combining red, green, and blue-light emitting elements. To ultimately achieve high performance in a white device, we must be able to first achieve high performance in the sub-units (single color devices). In the future we would like to understand the physical mechanisms which impact efficiency (and particularly, the loss of efficiency). Better understanding these processes, together with our simple device design, might allow OLEDs to be fabricated more cheaply while still achieving high efficiency, two important factors in the adoption of OLED technology.” OLEDs are proving to be a promising lighting source, and consumers could eventually find OLED technology

Solar vehicle project provides practical experience on global scale

Amelie Beland, one of the undergraduate students working in Eray Aydil’s laboratory on a new solar cell material, has also gained real-world, hands-on experience through the University of Minnesota Solar Vehicle Project (UMNSVP) team.

Beland was a driver on the race crew that finished in fourth place in the Cruiser Class in the 2013 World Solar Challenge, a 3,000-kilometer cross-country race across the Australian Outback in October. She also led the Array Team in acquiring, testing, assembling, and attaching all of the solar cells on the Daedalus, the first-ever two-seater car that balances practicality with efficiency. The University of Minnesota was the only team in the race to completely design and build by students.

Beland explained that, “Solar cars have become somewhat standardized over the past few years. Everyone has come to the same conclusions on how to build an aerodynamic car and how everything should be functioning on the car. We saw the Cruiser Class as an opportunity to try something new. It’s also a step towards making solar powered cars more practical. We were excited to compete because we really want to bring the U back to the forefront of solar racing and establish ourselves as leaders in the development of alternative energy resources. We also enjoyed experiencing Australia’s culture and seeing how engineers from around the world approached this unique challenge.”

The University of Minnesota Solar Vehicle Project (UMNSVP) team crosses the finish line in the 2013 World Solar Challenge race through the Australian Outback in October.
Lodge named Regents Professor

The designation is the highest level of recognition given to faculty members at the University of Minnesota.

Lodge is one of the most productive, innovative, and influential polymer scientists in the world, focusing his research on the structure and dynamics of polymeric systems. He has published more than 300 papers on his innovative and groundbreaking research. His laboratory at the University of Minnesota contains a powerful and innovative array of experimental tools, which is truly second to none in scope, allowing him to be one of the most productive and influential polymer scientists in the world. Potential applications of his work include improved delivery of medicines within the body, solution viscosity modification, and nanostructure templating.

A sought-after teacher and adviser, Lodge is an outstanding classroom instructor who created the popular Polymer Physical Chemistry course. Lodge has advised and trained more than 100 students and post-doctoral associates who are heavily recruited by industry or who have attained faculty positions at prestigious institutions.

Recently Promoted Faculty

Aditya Bhan was promoted to the rank of Associate Professor with tenure. Bhan’s research has focused on hydrocarbon-based reaction pathways for (i) conversion of methanol to chemicals and transportation fuels, (ii) the use of light alkanes in deoxygenation reactions, (iii) isomerization, alkylation, dehydration, and esterification reactions of alkanols and ethers. Bhan foresees his research evolving to include kinetic modeling of large scale reaction systems as well as the selective deoxygenation of sugar and lignin monomers derived from biomass for the synthesis of renewable “building block” compounds that can be converted to chemicals. His group brings expertise in mechanistic catalysis to advance our ability to understand, design and control chemical transformations relevant for conversion of alternative carbon sources such as biomass and natural gas to fuels and chemicals.

Efie Kokkoli was promoted to the rank of Professor. Efie joined the faculty in the Department of Chemical Engineering and Materials Science in Fall 2003 as an assistant professor and has since established a research laboratory with an emphasis on the design of novel biomimetic peptide-amphiphile ligands for the development of functionalized biomaterials for the targeted delivery of therapeutics and tissue engineering. Her research group has recently started to focus on the design of aptamer-amphiphiles that can produce “super-folding” functional DNA self-assembled structures of biotechnological importance.
David Flannigan
Assistant Professor David Flannigan is a recipient of the 2013 Love of Learning Award from the Phi Kappa Phi Honor Society. The $500 cash award is given annually to 147 recipients to support career development activities. Flannigan also received the award in 2012. Founded in 1897, Phi Beta Kappa Phi is the nation’s oldest, largest, and most selective collegiate honor society for all academic disciplines. Flannigan received an American Chemical Society Petroleum Research Fund Doctoral New Investigator grant that will provide for $100,000 in research funds over two years. The Doctoral New Investigator grants program aims to promote the careers of young faculty by supporting research of high scientific caliber. Flannigan will use the research grant to investigate a long-standing problem arising in petroleum extraction, transport, and processing – the crystallization of waxy paraffins within containment vessels in cold-weather environments.

Yiannis Kaznessis
In a recent Proceedings of the National Academy of Sciences of the USA paper, entitled “A closure scheme for chemical master equations,” University of Minnesota researchers offer a solution to a mathematical problem that remained unsolved for more than seventy years. The Minnesota team of Professor Yiannis Kaznessis and Patrick Smadbeck, a Ph.D. chemical engineering student in the Kaznessis research group, developed a numerical closure scheme for the equation that governs random molecular events in biological systems. Randomness is a defining feature of biomolecular systems, determining all too frequently the fate of a living organism. The most complete model of randomly evolving molecular populations is one based on the master probability equation. The “master” in the name reflects the all-encompassing nature of an equation that purports to govern all possible outcomes for all time. Because of its ambitious character, the master equation remained unsolved for all but the simplest of molecular interaction networks. Now, with the first complete solution of chemical master equations, a wide range of experimental observations of biomolecular interactions may be mathematically conceptualized.

Christopher Leighton
In collaborative work with the group of Peter Schiffer at the University of Illinois, in addition to groups at Penn State and Los Alamos National Lab, post-doc Liam O’Brien and faculty member Chris Leighton have made an important breakthrough in a class of materials known as “artificial spin ice.” Such systems are simply arrays of nanoscale magnetic islands placed on lattices that geometrically frustrate the magnetic interactions between the islands. The arrays are easily tunable and provide a new platform for the study of frustration, a physical concept of broad importance in nature. In the new research, published in the journal Nature, the team demonstrated a means to anneal artificial spin ice into a “thermalized” state, where the true ground state behavior can be visualized. Such states cannot be accessed in as-made samples, a problem that has hindered progress in the field for some time. This breakthrough enabled the observation of small regions where the magnetic charges order into crystallites, a phenomenon that was predicted theoretically but not yet observed. The work paves the way for further fundamental breakthroughs into the physics of frustration, with potential application to data storage and processing.

Michael Tsapatsis
Professor Michael Tsapatsis was the recipient of the 2013 AIChE Alpha Chi Sigma Award for Chemical Engineering Research. The Institute Award recognizes outstanding accomplishments in fundamental or applied chemical engineering research. Tsapatsis was recognized for breakthrough contributions in the design, synthesis and applications of molecular sieve membranes, adsorbents and hierarchical catalysts. He was presented with the award at the Institute Honor’s Ceremony, held during the AIChE’s annual meeting in San Francisco, Calif. Prior winners from the department include Rutherford Aris (1969) and Lanny Schmidt (1993).

Tsapatsis and Junger Caro, professor of physical chemistry at Leibniz University, received the 2013 Breck Award from the International Zeolite Association (IZA) for their pioneering work on the processing of zeolite and MOF nanostructures enabling separation membranes. Caro and Tsapatsis were presented with the prize at the Moscow International Zeolite Conference in July, in front of approximately one thousand conference participants. Established in 1983, the Breck Award is named for Donald W. Breck of the Union Carbide Corporation who was a major figure in the early development of synthetic molecular sieves and one of the founders of the IZA. The $1000 award is given every three years to an individual or group for significant contributions to molecular sieve science and technology achieved since the last IZA conference.

Kechun Zhang
Assistant Professor Kechun Zhang was awarded a grant by the Samsung Global Research Outreach (GRO) program for his winning proposal, “Engineering a Metabolic Platform for Biosynthesis of Branched Biochemicals.” Zhang’s proposal is one of only two winning proposals in the field of metabolic engineering. The Samsung GRO program is an annual call from Samsung Electronics, Co., Ltd. & related Samsung companies for innovative research ideas, and the competition is open to leading universities around the world. For 2013, 74 award winning proposals in 57 subjects under 14 research themes were selected.
With powerful new microscopes, CEMS becomes a global leader in electron microscopy

Assistant Professors K. Andre Mkhoyan and David J. Flannigan are utilizing state-of-the-art electron microscopes to pioneer new research.

Mkhoyan research

The acquisition of a new generation, state-of-the-art, aberration-corrected, analytical high-resolution scanning and transmission electron microscope (HR-STEM) fills a critical need for a first-class electron microscopy facility at the University of Minnesota. This aberration-corrected HR-STEM is a cutting-edge instrument that will allow us to push the limits of our understanding of the fundamentals of nano-scale materials via atomic, and even sub-atomic level imaging and spectroscopy. Aberration correction has ushered in a new era in electron microscopy. Much new science has become possible with these aberration-corrected microscopes that was previously inaccessible using non-corrected microscopes. Without such an aberration-corrected electron microscope, no research university can claim to be at the forefront of nanotechnology and materials science.

Acquisition of an HR-STEM will significantly enhance the nano-scale characterization capabilities at UMN, and will benefit as many as 31 principal investigators, more than 200 graduate students and research associates from eight different departments across three colleges, in addition to many outside academic users and local companies. More than 130 research grants will benefit from such imaging capabilities increasing the number and quality of papers and monographs. This microscope represents the establishment of cutting-edge infrastructure for nano-scale characterization in a single microscope, where unprecedented sub-0.1nm resolution imaging is combined with electron energy loss and x-ray spectroscopy to simultaneously probe local structure, chemistry, bonding, etc. This microscope greatly enhances UMN’s role as a leader in nanotechnology research.

Microscope continued from page 1

these high magnifications with the added ability to watch matter change and evolve in real time on very fast time scales.

“Our new microscope will be used at incredibly small and fast scales, and it should have a big impact on our research,” said David Flannigan, an assistant professor of chemical engineering and materials science and a former member of Professor Zewail’s research team at Caltech. “Over the last decade microscope manufacturers like FEI have developed instruments that have made observations of objects as small as individual atoms seemingly routine. Ultrafast electron microscopy now gives us a powerful tool to look at the movements and changes that occur at this scale.”

Flannigan explained that because the size scale is so small, the time scale is also condensed. It doesn’t take very long for atoms to move less than one nanometer (one billionth of a meter). During the developmental stages of the new Tecnai™ Femto UEM, researchers were able to measure changes over time periods as short as tens of femtoseconds. Using this newly commercialized technology, scientists expect to be able to study a wide range of fundamental atomic-scale processes, including real-time energy propagation, structural transformations, and variations in electric and magnetic fields.

“Until now, the only commercialized instruments that one could look at processes in this time scale were limited to observations of bulk materials,” said Trisha Rice, FEI’s vice president and general manager of the Materials Science Business Unit. “The Tecnai™ Femto UEM is the first to combine femtosecond time resolution with nanometer spatial resolution, allowing researchers to see the structural changes that occur at the atomic scale in response to energetic stimuli.”

The arrival of the Tecnai™ Femto UEM comes on the heels of the installation of another electron microscope at the University of Minnesota. The FEI Titan™ G² 60-300 aberration-corrected analytical scanning and transmission electron microscope was installed in Shepherd Laboratories earlier this year. This ultra-high-resolution electron microscope can be used to see sub-0.1 nanometer objects.

“Together, these two pieces of equipment establish the University of Minnesota as a world-class electron microscopy center,” said Frank Bates, head of the University’s Department of Chemical Engineering and Materials Science. “Every computer chip and solar cell is based on materials research. Modern technology is developed one atom at a time. This is a big step forward.”

News release written by Rhonda Zurn, College of Science and Engineering and Brooke Dillon, University News Service.
With powerful new microscopes, CeMs becomes a global leader in electron microscopy.

FaCulty researCh

David Flannigan

Transmission electron microscopy is widely considered to be an all-in-one materials characterization technique; information about bonding, structure, electronic and magnetic properties, and chemical composition can be obtained with varying techniques in one table-top instrument. Further, the spatial resolutions achievable with current transmission electron microscopes (TEMs) equipped with aberration correctors are nearing the de Broglie wavelength of the accelerated electrons. In addition to increases in spatial resolution, there is much interest in observing atomic-scale dynamic processes with TEMs. Major advances have been made in the development and implementation of a wide variety of in situ specimen holders for initiating and observing dynamic processes. With such holders, one can now study specimens under elevated temperatures and pressures, in static or flowing liquids, and under electrical bias.

If one wishes to study dynamic processes with atomic-scale spatial resolution truly in real-time (i.e., as the intrinsic dynamics occur), then a solution to the temporal aliasing that arises due to the limited read-out rates of current CCD cameras must be found. Commercially-available CCD cameras that can be integrated into the TEM column can capture dynamics occurring on the millisecond time scale (with bright electron sources). However, this temporal resolution is too coarse for many processes occurring at the atomic scale. For example, a phonon propagating at the speed of sound in room-temperature crystalline silicon will travel approximately eight nanometers (15 unit cells) in one picosecond. Thus, an entirely new approach is required if one wishes to directly visualize such ultrafast phenomena.

To this end, the Flannigan group is developing and employing a technique called ultrafast transmission electron microscopy (UTEM). With UTEM, access can be gained to the temporal scales required to directly visualize rapid, non-equilibrium dynamic processes occurring in materials on spatial scales on the order of bond lengths. This is achieved by operating a modified TEM in a stroboscopic pump-probe fashion by photoelectrically generating coherent, well-timed electron packets in the microscope gun region. These probe photoelectrons are accelerated down the TEM column where they travel through the specimen before reaching a standard CCD detector. A second laser pulse is used to excite (pump) the specimen in situ. Structural, electronic, and magnetic changes are visualized by varying the arrival time of the pump laser pulse relative to the probe electron packet at the specimen. In this way, the dynamic response of the specimen to a femtosecond laser pulse can be elucidated with a temporal resolution essentially limited by the laser pulse durations (~100 femtoseconds).

Type of Microscope

The UTEM will consist of a 200 kV FEI Tecnai G² T20 TWIN transmission electron microscope that has been modified to provide optical access to both the electron gun and specimen regions. This microscope will be the first of its kind, and less than five institutions world-wide currently have UTEMs of some form.

Flannigan research

David Flannigan
2013-14 Undergraduate Scholarships

Congratulations to the 39 undergraduate students who received CEMS scholarships for the 2013-14 academic year. With the generosity of CEMS donors, $125,200 was awarded among these recipients.

American Institute of Chemical Engineers Scholarship Fund
David Fischer

Frank and Janis Bates Scholarship
Emma Abbott

Raul Caretta Scholarship
Shay Wallace

George and Joan Carlson Scholarship
Elizabeth Han

CEMS Scholarship Fund
Corey Rosenthal

Tu and Pi-Fang Chen Scholarship
Andrew Bonifas, Samuel Engsberg, Bart Hillberg, Daniel Mueller, Jenna Ronquillo

Bobbie Huston Cronquist Scholarship Fund
Melissa Cassel

Thomas W. Cummins Scholarship
Bishwesh Joshi

Rosalie Sperling Dinkey Scholarship Fund
Angela Bowitz

Harry Fischman Scholarship
Matthew Phelps

Fridley Scholarship Fund
Tyler Lillemo, Kevin Nguyenam, Tho Nguyen, Anthony Vodovnik, Ian Wise

Donald Leask Fuller Scholarship Fund
Andrew Swanson

Christie John Geankoplis Scholarship Gift
Quang Duy Tran

Archie B. Japs Scholarship
Joseph Amato

Kemp Scholarship Fund
John Hougard

Kenneth V. Krake Scholarship Fund
Jennifer Chang

Vincent K. Leung Scholarship
Kelsey Marchetti

Charles A. Mann Award/Chemical Engineering (1934)
Christina Dinh, Yanpu He, Christopher Lindsay

Wendell & Dottie Manske Scholarship
Nikola Trukov

Joan Mattern Scholarship in CSE
Alyssa Fish

Jim & Lorinda Mishek Scholarship
Michael Roberts

Athos J. Monti Scholarship
Rochelle Zordich

Procter and Gamble Company Scholarship
Brandon Pietz

Ed & Cora Remus Scholarship
Matthew Hormann

Jeffrey & Patricia Schott Scholarship
Jacob Pedersen

Donald & Patricia Sullivan Scholarship Fund
Charles Smith

Barbara J. and David J. Yarusso Scholarship Gift
Thuy Anh Tran

Kenneth J. & Kathryn Valentas Scholarship
Bradley Slowinski

Paula Zoromski Memorial Scholarship
Ioana Ciuta

New Undergraduate Student Scholarship

Mendesh Family Scholarship

John S. Mendesh recently established the Mendesh Family Scholarship for chemical engineering and materials science undergraduate students. John (ChemE ’79, MBA ’84) explained that, “My time and experience at the University of Minnesota, both as a chemical engineering undergraduate student and an Evans Scholar, has been instrumental in any success that I have had. Thanks to the University of Minnesota and these two programs in particular, I’ve had a successful 30+ year career at General Mills in a range of positions that include my current position as Vice President, R&D. And while it’s not possible for me to repay the many benefits I have received, I am hoping that the Mendesh Family Scholarship will help others pursue their dreams through the College of Science and Engineering.”

John is also a member of the Evans Scholarship Board of Governors and the University of Minnesota College of Science and Engineering Board of Advisors. He supports breakthrough cancer research at the University through his service on the Board of Children’s Cancer Research Fund and was instrumental in establishing Partners in Food Solutions linking technical experts in the food industry with small and medium sized food companies in Africa.
A well-earned break for Jennifer Pogatchnik

After 11 years of service, Jennifer Payne Pogatchnik has stepped down from her position. We thank Jennifer for her hard work and dedication to the department. Jennifer’s remarks from her going away party in the College of Science and Engineering on Sept. 24 are below.

Roosevelt said, “Far and away the best prize that life offers is the chance to work hard at work worth doing.” I would alter his words just a little and say, “Far and away the best prize that life offers is the chance to work hard at work worth doing with amazing people that you love.”

My story is a love story probably very similar to many of your stories. Eleven years ago, I came to the University of Minnesota. Those first few months were intimidating, but before long I fell in love with the place and the kind and generous people I was lucky enough to work with. I fell in love with my donors, my development colleagues, my Dean(s) and the CEMS faculty.

I fell in love with CEMS donors who shared my belief that an investment in education was an investment in ending poverty, curing illness and creating a better planet for the next generation. I fell in love with Dean H. Ted Davis who was one of the kindest individuals with whom I have ever met. I fell in love with Dean Crouch who works tirelessly to advance the college and who shows courage in the eye of confrontation and who always does the right thing even if it makes him unpopular.

I fell in love with all of the amazing people in Amundson Hall. I will always hold Frank Bates in the highest regard, despite when he hired me he told me we needed $6 million for Campaign FIRST, which quickly escalated to $10 million and ultimately $20 million! Frank is an articulate University soldier with boundless energy and a huge heart for affording others the same opportunities he had. The “U” is a better place because of CEMS and Frank.

I fell in love with smart, hardworking folk, generous faculty, the early morning walk across the Washington Avenue Bridge, campus squirrels, excited new students every Fall, scholarships that changed lives, Gopher sports and ALL of YOU!

Future CEMS scholar?

Greta Mishek, granddaughter of Jim ‘MetalEng ’74 and Lorinda Mishek, is delighted at the prospect of becoming a future engineer!

CEMS welcomes Courtney Billing as new development officer

The Department of Chemical Engineering and Materials Science welcomes Courtney Billing to her new role as senior development officer for the department. Prior to joining the College of Science and Engineering, Courtney was a member of the University of Minnesota Medical Foundation for more than five years where she contributed significantly to the U of M Amplatz Children’s Hospital and the Children’s Health Campaign. Prior to joining the University of Minnesota, Courtney served as associate director of development in The Henry Samueli School of Engineering at University of California, Irvine. Courtney began her work in the College of Science and Engineering on Nov. 4 and can be reached at cbilling@umn.edu or 612.626.9501.
Tu Chen chose to attend the University of Minnesota based on the strength of the metallurgical engineering program and its emphasis on the emerging field of Materials Science. Chen reflects on his support for future generations of materials science students.

Tu Chen (MetalEng M.S. ’64, ChemE Ph.D. and MetalEng Ph.D. ’67) feels very fortunate to have worked for his advisor, Professor John M. Sivertsen, as he was able to obtain valuable background in materials science, solid state physics, and science of magnetic materials. That knowledge served him well in starting his career at IBM, Northrop, and Xerox Palo Alto Research Center. Chen founded Komag Inc. to manufacture thin film magnetic media and achieved a great deal of success in business. He wanted to establish this scholarship in recognition of the support from Professor Sivertsen and the University of Minnesota, which allowed him and his family to pursue the “American Dream.”

What are some of your fondest memories in the department?
My fondest memory is the excellent research environment in the materials science program (previously the metallurgical engineering program) and the excellent cross-intellectual discipline academic environment at the University. Also, the beautiful campus and surrounding area are quite memorable.

How did your experiences in the department shape your professional career?
At the time I applied for graduate study in the United States (from Taiwan), I was offered three fellowships from the University of California at Berkeley, University of Missouri-Rolla, and the University of Minnesota. I chose UMN because it had the most advanced program in materials science at that time (1961), with courses like, “Magnetism & Semiconductors in Metallurgical Engineering.” I made the right choice to become a student of Professor John M. Sivertsen and learned a lot from him in magnetic material. Consequently, I rose to a high level of achievement in the magnetic material field. I was recognized for my research work by being named an IEEE Fellow and IEEE Magnetic Society R.B. Johnson Award in 2000. I co-founded two successful hard disk computer memory component companies, Komag Inc. and Headway Corp. that are based on the most advanced magnetic material technologies. All of these accomplishments are based on what I learned in my graduate work in CEMS at the University of Minnesota.

Why are you dedicated to supporting undergraduate education?
We need to ensure that there are good undergraduate candidates from the University to apply for advanced degrees in graduate schools. There are many excellent students who cannot afford undergraduate study, so if we can support some bright students who are eager to obtain a college education, but cannot afford to do so, the scholarship will not only help those students, but also help our graduate programs in materials science.

What would your advice be to current students in chemical engineering and materials science programs?
Be sure to take multi-disciplinary courses and do in-depth learning in theory and experimental work so you can become an independent researcher for advanced material in the future.
Alumni entries and photos from all decades are encouraged! A special thank you to alumni in this issue who provided updates. In the next issue, let’s hear from our graduates from the 1980’s. Tell us about your career, family, and memories of CEMS.

1945

Laurence “Larry” Stine [ChemE ’45]. I spent some time in the Navy after Minnesota and then went on to graduate school at Northwestern University. I joined Universal Oil Products (UOP) in 1947 and still work there after 65 years. All old timers should keep a hand in. I was recently honored at UOP for achieving 75 patents.

1962

Larry J. Johnson [MetalEng ’62]. After graduation I joined IBM in Rochester, Minn. as a metallurgical engineer in their materials laboratories. Work activity centered on specifications and applications of various metals used in high-speed card punches and card moving devices. In the late 60’s I was promoted into management and retired from IBM in 1992. After my retirement, I worked for four years at PEMSTAR, a contract manufacturing company in Rochester. I also did some consulting work for a high technology lock company in Lexington, Ky.

I married my wife, Janet Lawrence, in 1962 and we have three sons and five grandchildren. Over the years we have been active in the founding and operation of Hiawatha Homes, a facility for disabled persons. I remain active on the board of several other non-profit organizations and am the Treasurer of a local cemetery association.

My wife and I enjoy traveling and have been to Europe, Australia, Africa, and the Far East. We have made several family trips to Alaska, both site seeing and fishing. We also enjoy lake recreation with our family in a cabin we have near Aitkin. It has been a good 50 plus years.

James A. Kvistad [ChemE ’62]. My first job after graduation was with the Film Department of DuPont in Buffalo, N.Y. I spent seven years involved in product development, mainly new applications for polyvinyl fluoride films. While in Buffalo, I continued my education and obtained a masters degree in chemical engineering from the State University of New York at Buffalo. When one thinks of Buffalo, one word comes to mind. SNOW! So my wife and I decided to take advantage of it and begin a lifelong love of downhill skiing which we continue to this day.

In 1969 I left DuPont, moved to St. Paul and begin working for 3M, where I spent my time in product development and technical service, including 12 years in international technical service. Most of my 3M career was spent in the Occupational Health and Environmental Safety Division, dealing with respiratory and hearing protection products.

Being retired, I now have the time to spend five weeks in Colorado during the ski season. My other activities include sailing on my 23 foot Columbia sailboat, attending the Guthrie Theater and St. Paul Chamber Orchestra and spending time with my three grandsons. Our plans for the immediate future include a trip to Oxford, England to visit my daughter and see my 18 month old granddaughter.

1964

Bob Goldstein [Ph.D. ChemE ’64]. I completed my Ph.D. thesis under Professor Neal Amundson. My wife, Dee, and I recently celebrated our 50th wedding anniversary and my 75th birthday with a family reunion in July at Leech Lake in Walker, Minnesota. Our entire family attended (17 people in all), including our three children, their spouses and our six grandchildren. We all engaged in many activities, such as fishing, bowling, jet skiing, sailing, etc. All-in-all, we had a once-in-a-lifetime, fun-filled and memorable celebration.

Charlie Novak [ChemE ’64]. Updates are much easier right now than memories. I am retired and spend half the year in Arizona and the other half in Minnesota.

1965

Paul Nick Nelson [ChemE ’65]. After graduation, I worked for Goodyear Tire [4+] and 3M [32+] years before retiring and moving to Colorado where my wife Cindy and I have been for the last 11 years. Our address has remained the same: 637 Cameron Ct/Loveland, CO 80537. We have two grandchildren living in the Twin Cities metro area and return to Minnesota a few times each year.

1967

David Kudish [M.S. ChemE ’67]. After graduation, I worked at Shell Chemical for about one year in long-range planning, then joined the U.S. Air Force and served in Texas, Colorado and New York. After that, I went to work on Wall Street and enjoyed a successful career, first at Dean Witter and later, Oppenheimer & Co. I was recruited to join Hewitt Associates (now Aon-Hewitt) in Chicago in 1974 to start a consulting practice in advising on investments for institutional-size pension, endowment and foundation funds. I became a partner in 1979.

I formed my own consulting practice in 1984 that grew rapidly. I completed a three-year program in entrepreneurial management at Harvard Business School in 1996. Later that year, I sold my consulting practice and formed a specialized investment advisory practice in Chicago. I retired in 2010 and live in both Aspen, Colo. and Miami, Fla.

I have three successfully employed children who live in Miami. I have been single since my wife passed in Jan. 2010. I serve as a

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volunteer for several not-for-profits locally and nationally, and I became a public speaker in the counter-terrorism field and serve on the Boards of Directors/Trustees of several such organizations.

1970

William F. Harris [ChemE M.S. ’64, Ph.D. ’70]. I obtained my degrees in chemical engineering with Skip Scriven as an advisor. This picture shows me receiving an A-award for research from the South African National Research Foundation (NRF) at a ceremony in Cape Town in September 2012. I’m flanked on the left by the Director of the NRF and on the right by the Minister of Science and Technology. My current research interest concerns mathematical issues to do with the eye and ocular surgery, and I have a general interest in geometrical problems in biology.

Dale Schruben [M.S. ChemE ’70]. I received my M.S. degree in the early 70’s. Now I find mental activity in the review of proposals for the government. For physical activity I like to fish. Attached is a rainbow trout from this spring taken in our backyard. Our log cabin is three miles on a dirt road from a major road. The electrical inspector told me ours was the first totally off grid solar system for Fremont County, Idaho. I designed it myself. Since that picture was taken I have set a new personal record with a 20 1/2 inch trout.

1972

Arvind Varma [Ph.D. ChemE ’72] continues as the R. Games Slayter Distinguished Professor of Chemical Engineering at Purdue University. I have been School Head since 2004 and the position was endowed last year, with the title Jay and Cynthia Ihlenfeld Head of Chemical Engineering. I received the 2013 Warren K. Lewis Award at the recent 2013 AIChE meeting. Among other professional activities, I have continued to serve (since 1996) as the founding Series Editor for the Cambridge Series in Chemical Engineering, published by the Cambridge University Press. I met and married my wife, Karen (’72) at the “U” and we have two daughters, both lawyers, and three granddaughters, ages 6, 3 and 3 – the latter two from each daughter.

1973

Larry Erickson [ChemE ’73]. My two years in the department at that time were very inspiring for me. That was the era of Rutherford Aris, Neil Amundson, L.E. [Skip] Scriven, Lanny Schmidt, Arnie Frederickson, Ken Keller, Herb Isbin and John Dahler. They were an intellectually rigorous and inspiring faculty and I thrived in that program. I went on to complete a Ph.D. at the University of Washington in Seattle and enjoyed a long career in research at the Weyerhaeuser Company. I used my knowledge from the University of Minnesota countless times to resolve complex technical issues in a very satisfying career as a result of my experiences in CEMS.

Mike Hansel [ChemE ’73]. I’m a Senior Chemical Engineer and Vice President at Barr Engineering Company, where I specialize in environmental permitting and compliance. I’ve been at Barr 12 years, and prior to that worked with Koch Petroleum (now Flint Hills Resources) and Koch Industries for 15 years in a number of roles, including Director of Strategic Environmental Planning and Refinery Environmental Manager. Prior to that, I spent 12 years at the Minnesota Pollution Control Agency. I’m a registered Professional Engineer in Minnesota and Michigan. I’ve published a few articles and coauthored a couple of books, but that was years ago. For fun I’ve been involved in community and high school theatre since 1991, and enjoy singing, hiking and going to the lake. Most people would remember me as how I looked in 1973!

1975

David J Starz [ChemE ’75]. I went to work for Exxon Chemical in June 1975 and retired from ExxonMobil on January 1, 2013. My main work area was in Polypropylene manufacturing and technology, which was assisted by studying polymer processing during my time at the “U” with Dr. Chris Macasko. I worked in the design and start up of manufacturing plants in Texas, Louisiana, France and Singapore. My role included extrusion system design, project planning and execution, troubleshooting and overall process improvement. I married Rita J. McNallan (UMN School of Occupational Therapy, ’74) in 1977 and we have two children and two grandchildren. We currently live in Spring Branch near Canyon Lake in the Texas Hill Country.

1977

Bruce McClintick [ChemE ’77]. I retired from Dow Corning Corporation in 2009 after 32.5 years. I am currently serving as Treasurer for the Woods and Water Council BSA (volunteer for 13 years). I am traveling around the world with my wife including visits to our two children who live in Los Angeles and Portland. I’ve been married for 36 years to my high school sweetheart and fellow U of M grad who retired after teaching elementary school for 34 yrs.

Some of my favorite college memories were: Greek dancing and drinking Ouzo with Prof. George Stephanopoulos at his house during graduation week with my fellow AIChE Student Chapter buddies.

Sitting in one of the first “video” classrooms where Rutherford Aris would write his lectures for reaction engineering on some
notepad and project it to a screen for all to see. It was dark and I had never seen so many Greek symbols used in formulas. Needless to say it was very hard to stay awake and I paid the price on the final.

Playing touch football in the commons area with ChemE friends during the fall quarter in between class or skipping class if it was a perfect fall day.

Meeting with my former student advisor Prof. Chris Macosko to discuss potential graduates interested in Dow Corning during my 10 years of campus recruiting. He was and still is the original energizer bunny! He must be running on magical rubber bands that he created.

1983
Matt Callstrom [ChemE ’83, Chem Ph.D. ’87]. After I obtained a Ph.D. in organic chemistry with Paul Gassman, I completed a post doctoral fellowship at Harvard (with George Whitesides). I secured an academic position at The Ohio State University and advanced to Associate Professor. I earned an M.D. from Mayo Medical School and completed a residency and fellowship in Radiology there. I am now staff in Radiology at Mayo Rochester as Vice Chair. I am married (wife, Brenda) with two children (Joe, age 23 and Peter, age 20).

1997
David Bahr [Ph.D. MatSci ’97]. I was named Head and Professor of Materials Engineering at Purdue University in fall 2012. Since arriving at Purdue last year after 15 years as a faculty member in and then School Director of Mechanical and Materials Engineering Washington State University, I’ve been pleasantly surprised at how many other CEMS alumni are at Purdue. Not quite a Minnesota mafia, but getting there. Our family (Val, and the three and a half year old twins, Steve and Greg) has settled into living in West Lafayette, Ind. and we’re re-adjusting to life in the Midwest after 15 years living on the Washington-Idaho border.

Kangtaek Lee [Ph.D. ChemE ’97] of Yonsei University, organized one of the symposia at the World Congress of Chemical Engineering in Seoul in Aug. 2013. It was a great opportunity for him to update ties with fellow colloids researchers, including his Ph.D. advisor (Alon McCormick), his postdoc advisor [Themis Matsoukas, Penn State], and other colleagues.

2009
Neel Kulkarni [ChemE ’09]. I started my career at General Mills with the Progresso Soups brand as a chemical engineer, based out of Philadelphia. I recently changed jobs and am now a Sr. Process Engineer with Unilever. This role is greatly refreshing as it allows me to connect even greater with chemical engineering (focused on thermodynamics, fluid mechanics, etc.). The job will involve leading commercialization and scale ups from R&D to manufacturing in our plants. I enjoy following the fields of finance and economics and recently passed the CFA (Chartered Financial Analyst) Level 1 exam in December. Someday, I hope to enter the venture capital field. I also got married last July, and we live in New York.

In Memoriam
Frederick J. Edeskuty, Sr. [ChemE ’44] on May 10, 2013.
John Ingram Hughes [ChemE ’41] on June 20, 2013.
Ken Susie, Sr. [ChemE ’41] on June 29, 2013.
Notable Alumni Achievements  continued from page 3

Brian Chacka [ChemE ’99]. The Society of Petroleum Engineers (SPE) recently honored Chacka with the SPE Young Member Outstanding Service Award at SPE’s Annual Technical Conference and Exhibition held in New Orleans. Chacka is an Operations Engineer at Denbury Resources Inc. in Plano, Texas, focusing on enhanced oil recovery through CO₂ sequestration. The SPE Young Member Outstanding Service Award recognizes contributions to and leadership in public and community matters, the Society, the petroleum engineering profession, and/or the petroleum industry by SPE members under the age of 36. SPE serves more than 110,000 members worldwide, sharing technical knowledge for the benefit of our industry. Each year, SPE presents awards that recognize members whose efforts have advanced petroleum technology, as well as their professional achievements and contributions to the industry and the society. “It is an honor to recognize Brian for his commitment and dedication to the oil and gas industry with the SPE Young Member Outstanding Service Award. SPE international award winners were nominated by their colleagues and selected by their peers for their achievement and contributions and it’s my pleasure to congratulate them on receiving this prestigious international award from SPE,” said Egbert Imomoh, 2013 SPE President. Since graduating from the department, Chacka has worked in the upstream oil and gas industry. He resides in Dallas and enjoys traveling, including several visits to Minnesota each year. He can be reached at BrianChacka@yahoo.com.


Subramanian Viswanathan, [Ph.D. ChemE ’73] The Mining, Geological, and Metallurgical Institute of India awarded Viswanathan the Dr. Coggin Brown Memorial Gold Medal for outstanding contributions to geology. He was also awarded the M. K. Ray Silver Medal by The Geological, Mining, and Metallurgical Society of India for the best paper published in its Quarterly Journal: Geochemistry of strontium and related elements in rocks and minerals from an Early Precambrian Batholith. Since his retirement as the Director of the Atomic Minerals Division of the Department of Atomic Energy, Government of India, on March 31, 1993, Viswanathan has published 15 research papers in reputed journals. Although he has completed 80 years of age, he keeps himself busy publishing research papers. Viswanathan remarked, “The years that I spent at the University of Minnesota are the best part of my life. As the famous folk singer, Mary Hopkins, sang: ’Those were the days, my friend.’”

Green Science  continued from page 7

Within Associate Professor Aditya Bhan’s research group, the science of analyzing the conversion of biomass and natural gas as alternative carbon sources in the chemical transformation for fuels and chemicals is equally as important as the motivations behind that research. Jeremy Bedard, a materials science Ph.D. student in Bhan’s group is personally validated by the research he is conducting. “While a lot of the research is fundamental and very specific to a certain phenomenon, it is all part of a grand goal that has real-world applications. At the end of the day, you want to feel like your accomplishments are making a difference,” said Bedard.
First MN-IP license leads to promising advances in composites

Research collaboration led to innovation with Professors Chris Macosko and Andreas Stein

Frank Thibodeau of Artiman Ventures, a Palo Alto venture capital firm, is on a mission. For the past four years, Thibodeau has been tenaciously pursuing ways to improve the quality of a certain class of composite materials, the reinforced plastics used to make a broad variety of high performance products in the aerospace, automotive, marine and sports equipment industries.

Thibodeau, who is well versed in the science and economics of composite materials, wanted to explore new techniques for making stronger, more versatile composites that are less costly to produce than the current models. Armed with some promising initial data from research at the University of Hawaii, Thibodeau sought out the right expertise to test these theories. He found that talent in an interdisciplinary research team in the University of Minnesota’s College of Science and Engineering.

Through Adama Materials, a startup company launched to commercialize the technology, Thibodeau funded a two-year research project at the U of M led by Chris Macosko, a chemical engineering professor and polymer expert, and Andreas Stein, a chemistry professor with expertise in nanocomposites and materials chemistry.

Fiber-reinforced composites, the kind used in high-performance plastics, generally consist of a fabric or substrate (glass, carbon or other fibers) combined with a polymer matrix (glue, epoxy or resin of some kind). The problem is that the polymers used can be brittle and unable to adequately absorb impact. This can lead to cracking. Existing technologies for making polymers tougher have drawbacks though: as the polymer increases in durability, it becomes more flexible, bendable, and decreases in strength.

Recent advances in composite materials have explored the use of modified nanoparticles, such as graphene, to make the polymers stronger without losing other properties. (Graphene was the subject of the 2010 Nobel Prize for Physics and is now being touted as a “miracle material.”) Up until now, the quantities of graphene needed to strengthen the polymer have been relatively high. While the properties are there, the cost is increased significantly as more graphene (or filler) is used, making the option less appealing. In their research, Macosko and Stein are perfecting a method that requires a much smaller percentage of filler than previously thought.

“By modifying the surface with different functional groups, we identified a way to make the nanosheet compatible with the polymer so it mixes well,” said Stein. “This method requires less graphene, making it more attractive for commercial use.”

The new technology, which has a patent pending through the University of Minnesota, was recently licensed by Adama Materials through the U of M’s Office for Technology Commercialization. As Adama Materials takes this technology into the growing composites market, the discovery has the potential to have a major impact on the high performance plastics industry.

In addition to the exciting technological advances that resulted, there’s another reason to celebrate this successful collaboration. It’s the first MN-IP sponsored research agreement to have a license deal finalized.

MN-IP, or Minnesota Innovation Partnerships, is a U of M program launched in December 2011 to provide more security and flexibility to companies interested in sponsoring research at the University. As a venture capitalist, Thibodeau was attracted to the MN-IP model, which allowed him to secure an option to an exclusive license for the technology up front, eliminating the need for lengthy, and sometimes costly, negotiations once the research is complete.

Sponsored research, like the kind conducted by Macosko and Stein, provides critical resources for conducting research that has the potential to address important societal needs, such as developing medicines for life-threatening illnesses or developing new food processing techniques to ensure the food we eat is safe. On the flip side, it fulfills an industry need for specialized research that does not require substantial investments in infrastructure, equipment and staff.

Perhaps a less acknowledged benefit is that it gives graduate students, who play a large role in most research projects, the opportunity to get direct experience working with industry. Yong Tae Park, a postdoctoral researcher in chemical engineering and materials science, is also part of the research team. This experience is invaluable to Park and others as necessary training to become part of a well-prepared workforce.

Article written by Erin Dennis, Office of the Vice President for Research, UMN.
CONSTRUCTION UPDATE

Major renovations to Amundson Hall and construction of the new Gore Annex are revitalizing CEMS!

New windows on the south facade of Amundson Hall cast a variety of colors in the sunlight. (Photo taken on Aug. 30, 2013).

Concrete was poured for a new materials science laboratory in the Gore Annex. (Photo taken on Oct. 14, 2013).