brightly glowing silica nanoparticles known as “Cornell dots” or simply “C dots” have received approval from the U.S. Food and Drug Administration (FDA) for a first Investigational New Drug (IND) Application for targeted molecular imaging of cancer. The first-of-its-kind inorganic nanoparticle drug will be used in a first-in-human clinical trial in five melanoma patients at Memorial Sloan-Kettering Cancer Center (MSKCC) in New York City, the world’s oldest and largest private institution devoted to prevention, patient care, research, and education in cancer. Researchers will seek to verify that the nanoparticles are safe and effective in humans, and will provide quantitative data to guide future applications.

“The FDA approval finally puts a federal stamp of approval on all the assumptions we have been working under for years. This is really, really nice,” said Ulrich Wiesner, the Spencer T. Olin Professor of Materials Science and Engineering, who has devoted almost a decade of research to developing the nanoparticles. “Cancer is a terrible disease, and my family has a long history of it. I have a particular personal motivation to work in this area.”

C dots were initially developed as optical probes in Prof. Wiesner’s lab. The dots that will be used in the human trial are the result of about a decade of research at Cornell as well as half a decade of work at Hybrid Silica Technologies (HST, Inc.) a startup company spun out from the University on this materials technology. C dots can be tailored to any particle size. The latest generation of dots consist of tiny silica spheres less than eight nanometers in diameter that enclose several dye molecules. (A nanometer is one-billionth of a meter, about the length of three atoms in a row). The silica shell, essentially glass, is chemically inert, and the small size of the particles allows them to pass through the body and be excreted in the urine (see Figure 1 on page 6). For clinical applications, the dots are coated with polyethylene glycol, a process called PEGylation, which further protects them from being recognized by the body as foreign substances. They are further modified at MSKCC’s Nanotechnology Center for positron emission tomography (PET) imaging. The attachment of a radioactive label produces multimodal (PET-optical) particle probes that additionally enable... 

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From the Director

I am pleased to share the 2010-11 issue of the MS&E News. This edition is full of interesting news and notes covering the latest happenings and developments in the Department. We include research overviews for our most recent faculty hires, Rich Robinson and Delphine Gourdon. They, along with all of our junior faculty, are continuing to make great progress in building impressive research programs while also distinguishing themselves in the classroom and as advisors to our students. Of special note, Assistant Professor Richard Hennig recently won an NSF Career Award for his project, “Coupling Quantum Monte Carlo with Implicit Solvent Models for Materials in Energy and Information Technologies.” Congratulations Richard!

Senior faculty such as Uli Wiesner and Darrell Schlom continue to make headlines for groundbreaking discoveries. Uli’s work on Cornell dots, featured on page 1, has recently received approval from the U.S. Food and Drug Administration for the first Investigational New Drug Application for targeted molecular imaging of cancer. Darrell’s work with europium titanate, featured on page 3, has the potential to revolutionize the electronics industry.

Other stories celebrate the accomplishments of several of our undergraduate and graduate students, highlight important changes we are making to one of our signature undergraduate courses, and spotlight an important new competition with significant cash prizes that will provide our students with a tremendous opportunity to design an innovative technology while building a case for successful commercialization.

With spring on the horizon and commencement just around the corner, it is an exciting time of year. For anyone not already aware, Reunion 2011 is scheduled for June 9–12. If you plan to attend, please join us for our annual breakfast on Saturday morning, June 11, from 8:30–10:00 in 260 Bard Hall.

Enjoy this issue of the MS&E News. I hope to see you in Ithaca.

— Emmanuel P. Giannelis, Director, Department of Materials Science and Engineering
Continued on next page

**HO-HUM TO HIGH PERFORMANCE —**

**A boring material, when ‘stretched,’ could lead to electronics revolution**

By Anne Ju

The oxide compound europium titanate is pretty boring on its own. But sliced nanometers thin and physically stretched on a specially designed template, it takes on properties that could revolutionize the electronics industry, according to Cornell-led research.

The research team, publishing in the journal *Nature* Aug. 19, reports that thin films of europium titanate become both ferroelectric — electrically polarized — and ferromagnetic — exhibiting a permanent magnetic field — when laid and stretched across a substrate of dysprosium scandate, another type of oxide. The best simultaneously ferroelectric, ferromagnetic material to date pales in comparison by a factor of 1,000.

Simultaneous ferroelectricity and ferromagnetism is rare in nature and coveted by electronics visionaries. A material with this magical combination could form the basis for low-power, highly sensitive magnetic memory, magnetic sensors or highly tunable micro-wave devices.

The search for ferromagnetic ferroelectrics dates back to 1966, when the first such compound — a nickel boracite — was discovered. Since then, scientists have found a few additional ferromagnetic ferroelectrics, but none stronger than the nickel compound until now.

"Previous researchers were searching directly for a ferromagnetic ferroelectric — an extremely rare form of matter," said co-author Darrell Schlom, the Herbert F. Johnson Professor of Industrial Chemistry in MS&E.

"Our strategy is to use first-principles theory to look among materials that are neither ferromagnetic nor ferroelectric, of which there are many, and to identify candidates that, when squeezed or stretched, will take on these properties," added co-author Craig Fennie, Assistant Professor of Applied and Engineering Physics.

This fresh strategy, demonstrated using the europium titanate, opens the door to other ferromagnetic ferroelectrics that may work at even higher temperatures using this same materials-by-design strategy, the researchers said.

Other authors include David A. Muller, Professor of Applied and Engineering Physics; and first author June Hyuk Lee, a graduate student in Schlom’s lab.

The researchers took an ultra-thin layer of the oxide and “stretched” it by placing it on top of the disprosium compound. The crystal structure of the europium titanate became strained because of its tendency to align itself with the underlying arrangement of atoms in the substrate.

Fennie’s previous theoretical work had indicated that a different kind of material strain — more akin to “squishing” by compression — would also produce ferromagnetism and ferroelectricity. But the team discovered that the stretched europium compound displayed electrical properties 1,000 times better than the best-known ferroelectric/ferromagnetic material thus far, translating to thicker, higher-quality films.

This new approach to ferromagnetic ferroelectrics could prove a key step toward the development of...
next-generation memory storage, superb magnetic field sensors and many other applications long dreamed about. But commercial devices are a long way off; no devices have yet been made using this material. The Cornell experiment was conducted at an extremely cold temperature — about four degrees Kelvin (-452 Fahrenheit). The team is already working on materials that are predicted to show such properties at much higher temperatures.

The multidisciplinary team includes researchers from Penn State University, Ohio State University, Argonne National Laboratory, and others. The research was supported by the Cornell Center for Materials Research, a National Science Foundation-funded Materials Research and Engineering Center (MRSEC), and corresponding MRSECs at Penn State and Ohio State.

Mechanobiology, i.e., the effect of mechanical properties and/or external stimuli on the biological response of cells and tissues, is one of the main research interests of the Gourdon Group. In particular, they examine the extracellular matrix (ECM), a complex network of proteins including collagen, vitronectin, and fibronectin (FN) that couples cells with their microenvironment and therefore directly regulates the cells’ fate via physical and biochemical cues. Using a fluorescence resonance energy transfer (FRET)-based technique as an indirect indication of FN conformation and strain, they investigate both cell-made extracellular networks and manually-made single fibers used as model systems.

Although the ECM was often considered a static structure providing only mechanical integrity

Figure 1: Fret mapping of extracellular matrices generated in healthy and tumor conditions (a) Fibroblasts pretreated in breast cancer-conditioned media (Tumor) assemble fibronectin (FN) matrices with stiffer fibers than control cells (Control) as indicated by lower FRET (i.e., dark-blue fibers). Pre-conditioning with soluble factor TGF-β (Control+ TGF-β) mimicked tumor-mediated changes in FN assembly and stiffness, while administration of a TGF-β neutralizing antibody to tumor-conditioned media (Tumor- TGF-β) inhibited these effects. (b) Histograms of the FRET intensity derived from analysis of the complete 3D z-stacks of the fields of view shown in (a). Scale bars represent 50 μm.
to tissues, it is now known that all together (i) nano/microscale mechanical properties, (ii) nano-structural properties (protein conformations), and (iii) signaling capacity of the ECM can be affected by cell-generated or exogenously applied forces [1,2]. Because increased stiffness represents a hallmark of breast cancer that has been attributed to the altered physicochemical properties of the ECM, the group’s recent focus has been on the mechanical and structural characterization of tumor-associated ECM.

In collaboration with the Fischbach-Teschl Group in Biomedical Engineering, the Gourdon Group has recently demonstrated that fibronectin plays a fundamental role in modulating the composition and mechanical properties of the tumor-associated ECM [3]. Using a combination of FRET imaging and biochemical tools, they evaluated whether paracrine signaling between breast cancer cells and adipose progenitor cells regulates FN matrix assembly and stiffness enhancement in the tumor stroma. In particular, they utilized FRET to map the molecular conformation and stiffness of FN that has been assembled by preadipocytes (healthy fibroblasts) in response to tumor conditions, i.e., conditioned in media extracted from breast cancer cells. The results (summarized in Figure 1, left) reveal that tumor soluble factors not only promote FN matrix assembly, i.e. thicker matrices are deposited, but also stiffening and unfolding of FN matrix fibers. Among those tumor-secreted factors, they also identified growth factor-β (TGF-β) as being responsible for such altered matrix properties [3]. Insights gained by these studies advance our understanding of the role of FN in mammary tumorigenesis and may ultimately lead to improved anti-cancer therapies.

The Gourdon Group includes four graduate students (Roberto Andresen Eguiluz, Karin Wang, Rebecca Schur, and Kunjal Patel) and three undergraduate students (Shengling Hu, Keli Thurston, and Heather Schopper).


ABET Accreditation

During the fall 2010 semester, MS&E was evaluated by the Accreditation Board for Engineering and Technology (ABET), the national body that accredits engineering programs based on standards established by the professional societies of each discipline. Graduation from an ABET accredited program is one of the core requirements to obtain a professional engineer's license. ABET visits engineering programs periodically to assess both the technical aspects of the program and procedures that are in place to ensure continued improvement and development of the curriculum.

Largely through the efforts of Associate Professors Mike Thompson and Shef Baker, the Department passed with no weaknesses and has been re-accredited for another six-year term. The report from the evaluation noted many strengths of the program including the commitment to undergraduate teaching and the continued evolution of the curriculum to address developing areas such as biomaterials, computational materials, and energy. The only concern raised by the review was the need for expanded laboratory space as undergraduate enrollment continues to increase.

Alumni are a critical part of the ABET review process by providing invaluable feedback regarding their experiences in the program and their career perspectives regarding educational priorities. Ultimately, ABET accreditation is an important external validation of the high quality program that the faculty strive to provide to our students.
deeper detection, imaging, and monitoring of drug delivery using three-dimensional PET techniques.

Organic molecules that will bind to such desired targets as tumor surfaces or even specific locations within tumors can be attached to the outside of the PEG shell, so that the dots will attach to the tumor cells. When exposed to near-infrared light, the dots will fluoresce much brighter than unencapsulated dye, a beacon to identify the target cells. According to MSKCC researchers, the technology can show the extent of a tumor’s blood vessels, cell death, treatment response, and invasive or metastatic spread to lymph nodes and distant organs. The safety and capability to be cleared through the kidneys has been confirmed by studies in mice at MSKCC, reported in the January 2009 issue of the journal *Nano Letters* (Vol. 9 No. 1).

The new research represents the first trials ever approved by the FDA of an inorganic nanoparticle used in the same fashion as a drug in humans. “This is a very exciting and important first step for this new particle technology that we hope will ultimately lead to significant improvements in patient outcomes and prognoses for a number of different cancers,” said Michelle Bradbury M.D., Radiologist at MSKCC and Assistant Professor of Radiology at Weill Medical College who is the lead investigator of the study along with Snehal Patel M.D., a surgeon in MSKCC’s Head and Neck Cancer Service.

For human trials at MSKCC, the dots will be labeled with radioactive iodine which will make them visible in PET scans. The optical signal from the dots can only be seen for a few millimeters under the skin, Dr. Bradbury explained, and normal fluorescence in nearby cells can muddy the image. PET scans will provide information on how many dots are taken up by tumors, as well as showing where else in the body they go and how long they remain. “We do expect it to go to other organs,” she added. “We need to find out how fast it passes through. We get numbers and from that curve derive how much dose each organ gets. Are they cleared from the kidney at the same rate as in mice?”

The purpose of this clinical trial is to evaluate the distribution, tissue, uptake, and safety of the particles in humans by PET imaging. This study will provide data that will serve as a baseline to guide the design of future surgical and oncologic applications in the clinic. “The use of PET imaging is an ideal imaging technology for sensitively monitoring very small doses of this new particle probe in first in human trials,” added Dr. Steven Larson, Chief of MSKCC’s Nuclear Medicine Service. “This clinical trial is the culmination of a longstanding collaborative effort with our colleagues at Cornell and Hybrid Silica Technologies, as well as a testament to our own institutional colleagues here at MSKCC,” adds Dr. Bradbury. “With the support of many, in particular the Office of Clinical Research, we’ve pushed the envelope between a laboratory idea and the first FDA approved inorganic nanomedicine drug “product” that is now being tested in the clinic due to our focus on translational research,” Dr. Bradbury says.

One of the many advantages of C dots, Dr. Bradbury noted, is that they remain in the body long enough for surgery to be completed. “Surgeons love optical,” she said. “They don’t need the radioactivity, but [our study] confirms what the optical signal is. As you learn eventually you no longer need the radioactivity.” On the other hand, she added, the dots also may serve as a carrier to deliver radioactivity or drugs to tumors. “This is step one to jumpstart a process we think will do multiple things with one platform,” she said.

First generation Cornell dots were developed in 2005 by Hooisweng Ow (pronounced “Hoy-sweng-Oh”), then a graduate student working with Wiesner. Wiesner, Ow and Kenneth Wang ’77 co-founded the company Hybrid Silica Technologies to commercialize the invention. The dots, Wiesner said, also have possible applications in displays, optical computing, sensors, and such microarrays as DNA chips.

Wiesner’s original research was funded by the National Science Foundation, New York State, and Phillip Morris USA. — contributors: Bill Steele, Cornell Chronicle and press release from Memorial Sloan-Kettering Cancer Center.
The Robinson Group focuses on nanostructured materials for alternative energy applications. The group’s aim is to utilize the advanced properties of nanomaterials to build efficient thermoelectrics and batteries. These advanced properties arise in nanoparticles because basic properties are altered when a particle size shrinks down to lengthscales characteristic of elementary excitations or physical processes. The most celebrated nano-size effect is the change in optical properties: the band gap of a semiconductor will shift when its dimensions are comparable to the separation distance of an electron-hole bound pair (e.g., ~5nm for CdSe). The Robinson Group is making use of other, less studied nanoscale properties for their energy applications, such as the change in materials thermal properties called “acoustic confinement.” The thermoelectrics field has been rejuvenated by the use of nanomaterials which decrease thermal conductivity.

In the area of alternative energy, thermoelectrics are of intense interest because of their ability to convert waste heat into electrical power. For its part, the Robinson Group is creating nanolayered superlattice films of thermoelectric metal oxides. These films are designed to make use of acoustic confinement nano-size effects to produce more efficient thermoelectrics. They have recently succeeded in growing superlattice layers with thicknesses from 5 nm to 300 nm and lengths between 10 µm and 4 mm. Typical aspect ratios are 40 nm: 4 mm, or 1:100,000. Figure 1 shows recent results from their sodium cobaltate nanolayers. Thermoelectric measurements of these materials are currently being explored.

The Robinson Group is also synthesizing nanoparticles for energy applications through colloidal techniques. In a recent project, they synthesized uniform hyperbranched Co₂P nanocrystals by using tri-n-octylphosphine oxide (TOPO) as a phosphorus source. This is the first application of TOPO as a reactive reagent in nanocrystal synthesis. Co₂P is a material of interest due to its newly discovered catalytic properties. The morphology of Co₂P can be controlled from sheaf-like structures to hexagonal symmetric star structures by varying the concentration of the surfactant. This unique product differs significantly from other reported hyperbranched nanocrystals in that the highly anisotropic shapes can be stabilized as the majority shape (> 84%). Electron tomography studies show a high density region inside the sheaf-like structure and indicate the presence of a solid core, which suggests that the hyperbranched structure is not aggregates of many individual nanowires, but a single crystal growing from the original nanorod with nanowires splitting at its ends. The majority (97%) of star particles are planar, and the cyclic twinning mechanism is believed to be responsible for the hexagonal symmetry (Figure 2). This is a rare example of stabilized multiply twinned cores that act as nuclei for nanoparticles. The work was accepted in 2010 by the journal *Nano Letters*: “Controlled Synthesis of Uniform Cobalt Phosphide Hyperbranched Nanocrystals Using tri-n-octylphosphine Oxide as a Phosphorus Source.” H. Zhang, D.–H. Ha, R. Hovden, L. F. Kourkoutis, R. D. Robinson. *Nano Letters* 2010, accepted.

The Robinson Group includes four graduate students (Mahmut Aksit, Don-Hyung Ha, Obafemi Otelaja, and David Toledo), eight undergraduates (Jesseon Chang, Austin Cheng, Bo Hu, Ten Loh, Liane Moreau, Sarah Terry, Joseph Singh, and Naoki John Yoshida), and two postdocs (Jared Hertzberg and Haitao Zhang).
Professor Chris Ober Returns to Research

In November 2008, Chris Ober, the Francis N. Bard Professor of Materials Engineering, was named Interim Dean of the College of Engineering. Over the ensuing 19 months, Ober led the College during one of the most turbulent economic periods in Cornell’s storied history.

Ober’s term ended in June 2010 and he recently sat down to look back on some of the highlights of his time in Carpenter Hall. When asked what his greatest achievement was, Ober replied, “I think maintaining a positive spirit through the College during all of the uncertainty.” The College faced several difficult budgetary decisions during his tenure, and every department felt the impact one way or another. Ober was relieved that the College came out of this tough period with essentially no reductions in faculty. “At the time, we were contemplating a 20 percent reduction in faculty.”

Ober notes that a very enjoyable aspect of his role as interim dean was meeting new people. He says, “MS&E is a pretty small department. I know a lot of people in our community but meeting faculty outside of the group, new undergraduates, and alumni, that was really rewarding.” He adds, “I am also really impressed with the quality of the staff in the central college. They are really good and really smart people.”

Since turning over the leadership reins, Ober has spent a lot of time re-engaging with his group’s research activities. He will continue to pursue the question of nanoscale patterning and continue a close working relationship with the semiconductor industry. He said, “We are exploring self-assembly, molecular glass materials, physical vapor deposition, laser spike annealing, nanoparticle resists, and other approaches. One of the most enjoyable things is collaborating with the folks at MS&E on these topics.” Ober also hopes to spend more time with his start-up company which makes orthogonal photoresists. These are photoresists that work very well with organic semiconductors. In addition, he will continue examining problems related to the biology materials interface including the design of new polymer brushes and antifouling coding.

✦ Women in Materials Science and Engineering (WIMSE) won the 2010 Cornell Engineering Alumni Association’s Best Student Organization Award. Assistant Professor Lara Estroff is WIMSE’s creator and faculty advisor. In addition, Estroff was recently featured in a National Public Radio interview focusing on chiton — a tiny marine creature that may be a key to developing better bones and artificial teeth.

✦ Emmanuel Giannelis, the Walter R. Read Professor of Engineering and Director of MS&E, leads a research collaboration which recently won a $200,000 grant from the New York State Energy Research and Development Authority (NYSERDA) to develop new technologies for next-generation batteries.
Professor Emeritus Art Ruoff Turns 80 (September 17, 2010)

After receiving his Ph.D. in three years and working with the world famous physical Chemist Henry Eyring, Arthur L. Ruoff, The Class of 1912 Professor of Engineering Emeritus, joined Cornell as an assistant professor in 1955. He loved teaching and research. His first award in teaching was the Westinghouse Outstanding Teacher Award. His research involved the study of properties of materials at pressures and extreme pressures. He eventually reached pressures of 560 GPa. That’s 2.8 million times the normal pressure in an automobile tire. The pressure at the center of the earth is 360 GPa. His research group, which graduated 40 PhD’s and involved 12 postdoctoral associates, produced metallic oxygen at 100 GPa, metallic sulfur at 90GPa (a superconductor at 10K) and metallic Xenon at 150 GPa. They also showed that hydrogen was not yet metallic (at 420 GPa). He won the most prestigious award in high pressure research, the Bridgman Award.

Ruoff was on the committee which wrote the research proposal for the Materials Science Center (now CCMR) and CHESS both of which had major impacts on research at Cornell. He served as the Director of MS&E for 10 years during a time of tremendous growth in the undergraduate and graduate program. He and his wife, Enid Seaton Ruoff, have been married for 56 years, and have five sons: William, the Chief Risk Assessor at URS, the world’s largest pollution control company; Stephen (an MS&E undergraduate) who is founder and CEO of Ithaca Materials Research which has four laboratories around the U.S. plus one in Singapore for materials testing; Rodney who is the Distinguished Chair at the Cockrell University of Texas and a leader in buckyballs, carbon nanotubes, and graphene; Jeffrey who is a Professor of Cinema at Dartmouth; and Kenneth who is a Professor of Modern Japanese History at Portland State University and the first foreign winner of the Japanese Osaragi Prize for his book, “The People’s Emperor.” Mrs. Ruoff formerly served on the PTA and was elected to two terms on the Ithaca School Board. She was also a member of the Tompkins County Library Board.

Each of the Ruoff sons was most valuable player in their respective sports at Ithaca High School. Ruoff was a coach in the Ithaca Youth Soccer Programs and a coach, and then President, of Ithaca Youth Hockey. Ruoff is an avid student of history, government, and economics; he is the author of two books, an auditourial course in Materials Science used at 65 universities, and has a forthcoming book, “The Declaration of Energy Independence” scheduled for release in 2011, along with 322 publications and three submitted manuscripts. Invited papers on his research were given in 23 countries.

✦ Assistant Professor Richard Hennig recently won an NSF Career Award for his project, “Coupling Quantum Monte Carlo with Implicit Solvent Models for Materials in Energy and Information Technologies.”

✦ Associate Professor Chekesha Liddell Watson was one of eight Cornell faculty members to receive a Provost’s Award for Distinguished Scholarship in 2010. The Provost’s Awards recognize distinguished research by outstanding tenured faculty early in their careers. Liddell Watson was recognized for her studies in the synthesis and assembly of non-spherical colloidal particles. Her research program takes a calculated yet risky approach to address long-standing problems in the field, and her research group is now recognized as a leader in assembly of non-spherical particles. This recognition includes a research award of $15,000. In addition, Liddell Watson was named an Emerging Scholar by Diverse Issues in Higher Education in the fall.

✦ Darrell Schlom was appointed the Herbert F. Johnson Professor of Industrial Chemistry during the fall 2010 semester. In addition, Schom was named a 2010 MRS Fellow. For more on Schom, see page 3.

✦ Uli Wiesner, the Spencer T. Olin Professor of Materials Science and Engineering, leads a research collaboration which has developed a new method to create a patterned single-crystal thin film of semiconductor material that could lead to more efficient photovoltaic cells and batteries. Associate Professor Mike Thompson is also part of the research team. For more on Wiesner, see page 1.
Alumni
✦ Bill Edwards received his Ph.D. in 1996 as a member of the Ast Group. His research focused on conduction in Si-Ge alloys. While at Cornell, Edwards was a member of the Reserve Officers Training Corps (ROTC). After completing his program, Edwards accepted an R&D job at Hewlett Packard. He was called into duty in Iraq in 2005. Edwards is currently enrolled at the US Army War College in Carlisle, PA.

Graduate Program
✦ Byungki Jung, a Ph.D. student working with Associate Professor Mike Thompson and Professor Chris Ober, placed fourth in the 2010 Taiwan Semiconductor Manufacturing Company’s Outstanding Student Research Awards competition in the Electronic Device, Process and Patterning Technologies category. The competition is designed to recognize exceptional semiconductor related research carried out by graduate students at elite universities around the world. Experimental or first principle research oriented to both technological applications as well as fundamental understanding is judged for technical depth, innovation, technical and logical validity, accuracy, and simplicity. Jung was one of 12 finalists in his category and was the only student with a materials science background.
✦ Marie Krysak, (left) a Ph.D. student in the Ober Group, won the best-in-session award for her talk in the Patterning Materials and Systems session at the Semiconductor Research Corporation Techcon 2010 conference.

Undergraduate Program
✦ Florencia Paredes ’12, a member of the Thompson Group, took first place in the Technology and Engineering Division Poster Competition at the 2011 Emerging Researchers National (ERN) Conference in Science, Technology, Engineering, and Mathematics (STEM) in Washington, DC on February 26. The conference is a joint effort of the American Association for the Advancement of Science and the National Science Foundation (NSF) and brings together undergraduate and graduate students who participate in programs funded by the NSF Human Resource Development Unit. In addition to her win at the ERN Conference, Paredes won second place in the undergraduate poster competition at the 2010 Hispanic Engineer National Achievement Award Corporation Conference. That competition offered students the opportunity to display their research accomplishments and receive recognition for their scholarly investigation or scientific study. Each poster was individually judged by two STEM professionals from academia or industry and a total of 40 undergraduate and graduate students presented at the competition.
✦ Members of the Class of 2011 (right) were honored last spring during the Department’s annual Junior Awards ceremony. Andrea Bowring, second from the right, won the James L. Gregg Prize, and Lauren Mangano, Adrian Radocea, and Joshua Taillon won MS&E Fellowships. These awards recognize outstanding academic achievement within the junior class.
✦ Zhi Wei Seh (below) won the Class of 2010 Outstanding Senior Thesis Award. This award recognizes the best senior thesis on the basis of the research effort involved, the scientific significance of the results, and the ability of the student(s) to communicate their results. His work was entitled, “Single Crystal Composites: A Fundamental Study of Silica Gel Incorporation in Calcium Tartrate Crystals.”
Peter Bai, Jason Reed, and Shawn Darnall took first, second, and third place, respectively, for the Class of 2010 Senior Thesis Poster Awards. These awards recognize the best poster presentations by senior thesis students. Bai’s poster was entitled, “Mapping the Morphology Space of a Block Copolymer/Metal Nanoparticle Hybrid System.” He did his research work in the Wiesner Group. Reed’s poster was entitled, “Synthesis and Characterization of CdSe QD-NIMs.” Reed worked with the Giannelis and Robinson Groups in MS&E plus the Wise Group in Applied & Engineering Physics. Darnall’s poster was entitled, “Green Composites Based on Newsprint and Biodegradable Resins.” Darnall worked with the Netravali Group in Fiber Science.

Victor Poiesz ’11 and Adrian Radocea ’11 recently completed year-long Kessler Fellows programs. The Kessler Fellows Program provides select engineering undergraduate students interested in entrepreneurship with an opportunity to learn first-hand what it takes to make technological innovations marketable and scalable through specialized coursework during the spring semester, summer employment, and a fall seminar series. Poiesz worked at Cambrios in Sunnyvale, CA. Cambrios develops nanostructured electronic materials for the display industry. Radocea, a member of the Giannelis Group, worked at Zyvex Labs in Richardson, TX. Zyvex develops and commercializes atomically precise manufacturing technology.

Both Poiesz and Radocea have been active in the leadership of the Cornell Materials Society (CMS) — the local student chapter of the Materials Research Society. Poiesz was CMS Secretary in 2009 and Vice Chairman in 2010. Radocea was Vice Chairman in 2009 and Chairman in 2010.

Wangzhong Sheng ’12 was inducted into the Rawlings Cornell Presidential Research Scholars (RCPRS) program during the fall 2010 semester. The RCPRS program provides undergraduates demonstrating superior academic potential and intellectual curiosity significant research support for up to four years. Students chosen for the program are able to collaborate with faculty mentors of their choosing in designing and planning an individualized program of research — a degree of collaboration typically unheard of in the undergraduate experience.

Sheng joined Assistant Professor Lara Estroff’s group in the fall of his sophomore year. Working under the guidance of his...
graduate student mentor, Debra D.W. Lin, Sheng’s research has focused on biomineralization. He is currently examining parameters to control the synthesis of hydroxyapatite nanoparticles to obtain uniformly distributed particle sizes through hydrothermal aging.

✦ Samantha Stout ’10 won the ASM Twin-Tier Chapter 2009-10 Scholarship. Stout won the scholarship in recognition of her involvement and participation in ASM as well as her commitment to the field of materials science. A member of the Wiesner Group while at Cornell, Stout is now a Ph.D. student at UC-San Diego.

In addition, Stout was featured by Cornell as one of the 20 most dynamic members of the Class of 2010. Among her numerous extracurricular activities, she was very involved in Cornell Minds Matter — an organization which promotes mental health awareness and de-stigmatization. Stout was also the first MS&E major to study abroad and complete courses in the major while doing so. She spent her junior year at Imperial College in London. When asked why she chose Cornell, Stout replied, “For the strength of its engineering program and the opportunities for undergraduate research in materials science.”

Andrew Cypher ’10 helps the Baja Racing Team finish strong in South Carolina

The Cornell Baja Racing Team is a student engineering project team which designs, builds, and races an off-road, one-seat race vehicle every year in the Society of Automotive Engineers International’s Baja Series competitions. Up to 140 teams from top engineering universities around the world compete in these events. In 2010, Cornell’s 41 team members represented four colleges and five engineering majors.

For the last three years, Andrew Cypher ’10 represented MS&E on the team. Cypher participated jointly on the composites and drivetrain sub-teams due to his work implementing the first ever carbon fiber driveshaft during the 2009 Baja competition. In 2010, in addition to his duties as team co-leader, he designed and manufactured custom joints for the drive axles. Cypher noted, “Being an MS&E major on a mechanically orientated team puts me in a unique position to analyze and design mechanical systems from the perspective of optimizing through materials knowledge.”

Between April 8-11, 2010, the team competed at the International Baja Society for Automotive Engineers Carolina competition in Greenville, S.C. The car, GP06, placed second in a grueling four-hour, head-to-head endurance race, third for maneuverability, and fifth overall. They placed fifth for design, fifth in the suspension and traction time trial, and
also received an “Attention to Detail” award. Overall, they were the second highest placing U.S. team. **Chris Hendrix ’12** was a member of the 2010 team and is back again in 2011 as a member of the electrical sub-team working on coding. The 2011 team is working hard on getting a vehicle ready for upcoming competitions later this spring.

### New Student Competition

**Focused on Advanced Materials**

Aided by the support of Jung-Hyun Oh ’95, M.Eng. ’96, the Department has established a new, annual competition to help MS&E students, particularly undergraduates, spur technology and innovation through entrepreneurship. This team based competition, known as the Jung-Hyun Oh-Schramm-SSCP Competition, challenges students to design or prototype an innovative technology based on advanced materials, and to demonstrate that this technology can be successful in a commercial operation or as a small business innovation research (SBIR) proposal. First prize in the competition is $15,000, second prize is $8,000, and third prize is $4,000. There is a special prize of $3,000, the Director’s Design Prize, which will be awarded to the best project from an all-undergraduate student team. Teams must consist of two to five Cornell students (undergraduate and/or graduate) at least two of whom must be associated with MS&E.

The competition includes a proposal phase and a project phase. Proposals must summarize important aspects of the technology and present the business case for developing innovation. The proposals are evaluated by a group of entrepreneurs, business experts, and faculty who select a subset of up to eight finalists. Finalists move into the project phase where they are assigned a mentor to assist with project development. Finalists also receive a budget of $1,000 for prototyping, testing, or computer time. Finalists must summarize their prior work related to the project and provide a timeline for delivering technical results and a business plan for the final presentation.

Final oral presentations on technical results and business plans are made to the panel of competition judges. Judges use a number of evaluation criteria to allow projects with different technical and business approaches to be compared.

The current academic year is the first time the competition is being offered. Proposals were due in December 2010. From a total of 11 proposals, six finalists were selected. The finalists include a total of 24 students — 19 undergraduates and five graduates — from MS&E, Biomedical Engineering, and the Johnson School of Management. Written deliverables on the progress of each team and corresponding technical and financial plans were due in March. Final presentations and the announcement of the competition winners will be made in early May. Please visit the MS&E website (www.mse.cornell.edu) for more information.

### MAT SCI Expo 2010

Last April, MS&E hosted the third annual MAT SCI Expo. This recruiting event is geared to help first year and other prospective undergraduates learn answers to the regularly asked question: What is Materials Science? Two demonstrations which have become perennial favorites are cornstarch in water and liquid nitrogen ice cream. Students experience first-hand the mechanical properties of a mixture of cornstarch and water which, unlike your typical fluid, becomes rigid under high impact.

Other activities included demonstrations of shape memory alloys, light emitting diodes, and hydrogen fuel cells. This year’s expo was held on April 6 on North Campus.

**[Left]** Prof. Richard Hennig has perfected the liquid nitrogen ice cream recipe and regularly serves as “mix master” for this tasty treat. **[Right]** Stephanie Stoughton ’13 leaps into a tub of cornstarch and water.
A Fresh Approach to Materials Design

In the spring of 2010, with a nod towards enhancing our students’ competitiveness in the job market once they leave Cornell, the Department launched an initiative to update two cornerstones of the MS&E undergraduate curriculum: Materials Design Concepts I (offered in the junior year) and Materials Design Concepts II (offered in the senior year).

In recent years, Materials Design Concepts I and Materials Design Concepts II required juniors and seniors to meet together to review and report on invited industrial product development lectures. As a result, juniors would effectively receive two semesters of the same course while trying to assimilate the nuances of product design through their exposure to invited lectures. The intent of the curriculum update is to create two separate and distinct courses for juniors and seniors in order to provide hands-on experience in product development. The junior course emphasizes reverse engineering while the senior course emphasizes forward engineering (product synthesis).

The redesigned junior course requires students to be fully engaged in the analysis, research, and discussion of their team’s reverse engineering design projects and includes oral and written reports. Communication between teams is encouraged to promote a non-competitive team oriented approach for their design projects. Discussions include all aspects of their reverse engineering projects. Students engage various resources which include on and offline sources, companies, and individuals as needed. The course’s focus on reverse engineering requires students to strengthen material characterization skills, research techniques, and also provides exposure to engineering ethics.

The redesigned senior course emphasizes forward engineering through a materials enabled design approach. The students are exposed to the complexities of early stage product development which involves staging invention and innovation via the critical selection of materials for projected final product function, technical marketability, reliability, and cost. Each student is required to give an individual product research lecture, participate in team-based, hands-on design projects via a company startup approach, and participate in weekly steering committee design reviews of product concepts and design feasibility. Each startup team presentation is based on an intellectual property position requiring technological marketing, product concept, and process overview to leverage a business case for venture capital funding. All startup teams write final issue papers expanding on their startup product initiatives by outlining in more detail their inventive product concepts.

The launch of the curriculum update for the Materials Design Concepts courses during the fall 2010 semester successfully met all expectations by providing specific hands on experience with materials enabled design through reverse and forward materials engineering.

In Remembrance

Professor Boris (Bob) Batterman

Boris (Bob) Batterman, Cornell’s Walter S. Carpenter Jr. Professor of Applied and Engineering Physics Emeritus, died December 14 at his home in San Francisco. He was 80 years old.

Batterman joined the Cornell faculty in 1965 as a professor in both the MS&E and the School of Applied and Engineering Physics (A&EP). He served as chair of A&EP from 1974 to 1978 after which he became director of the newly established Cornell High Energy Synchrotron Source (CHESS), a national laboratory for synchrotron radiation research.

In 1983, Batterman received the Humboldt Award from the Federal Republic of Germany, and in 1985, he was named the Walter S. Carpenter Jr. Professor of Applied and Engineering Physics at Cornell.

In 2001, Batterman retired from Cornell and spent much of his time in San Francisco where he continued to be active in science with positions both at Stanford University and the University of California-Berkeley.

Born August 25, 1930, in Brooklyn, N.Y., Batterman attended Brooklyn Tech and Cooper Union in New York before earning his undergraduate degree in 1952 and his Ph.D. in physics in 1956, both at the Massachusetts Institute of Technology.

A tribute to Batterman’s life is scheduled for Wednesday, June 22, 2011, at 1:00 pm in the Robert Purcell Conference Center on the Cornell campus. The tribute will be part of the CHESS Annual Users’ meeting.
Kunjal Patel ’10, M.Eng.’11 (center), the outgoing president of Women in Materials Science and Engineering (WIMSE), photographed receiving the 2010 CEAA Award for Best Student Organization at CEAA’s spring 2010 meeting.

Several MS&E students attended the spring 2010 MRS meeting in San Francisco. Seen here with Chris Ober, Interim Dean and the Francis N. Bard Professor of Materials Engineering, are (l-r) Victor Poiesz ’11, Rebecca Schur ’10, Adrian Radocea ’11, and Ken Hackenberg ’11.

Students and Faculty enjoy a night of bowling at Helen Newman Lanes, November 2010. From left to right: Patrick Demarle, Dan Dryden, Jaser Faruq, Prof. Schlom, Dr. Dos Santos, Prof. Baker, Kevin Golovin (in background), and Prof. Hennig.

MS&E Class of 2010, Commencement, May 2010