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Van Dover joins MS&E faculty after long research career at Bell Laboratories

After a 22-year career at Bell Laboratories, R. Bruce van Dover is completing his first year as a full professor of Materials Science and Engineering at Cornell.

Van Dover is recognized as a world-class researcher in the fields of superconducting, magnetic, and electronic materials. His work has already yielded more than 200 publications, some 50 patents, and more than 9,000 citations (he was the 29th most cited researcher in the physical

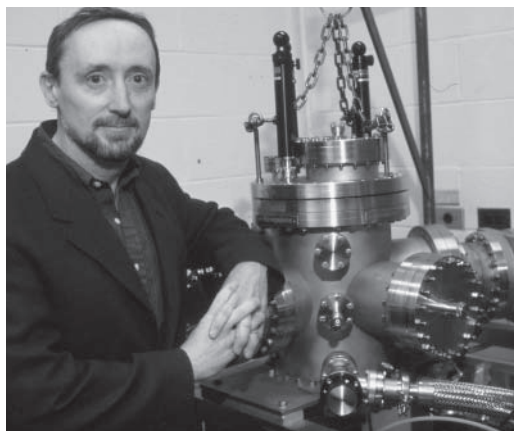
sciences) as reported by Science Citation Index. His current goals, he said, include not only the continuation of collaborative research, but "active involvement in graduate and undergraduate education, and in mentoring junior faculty."

Van Dover earned the B.S. degree in electrical engineering and engineering physics at Princeton University, and did his graduate work at Stanford University, where he received a Ph.D. in applied physics in 1980.

He joined the technical staff at Bell Laboratories in Murray Hill, NJ, in 1980, and in 1999 he became a distinguished member of the technical staff. Since 2001 he has held the position of adjunct professor of applied physics and applied mathematics at Columbia University.

His current research includes studies of magnetic thin films and novel optical materials, and characterization of nanometer-scale superconductors, dielectrics, and magnetic materials.

Van Dover is a fellow of the American Physical Society, a senior member of the Institute of Electrical and Electronic Engineers, and a member of the Materials Research Society and the American Association for the Advancement of Science.



R. Bruce van Dover

Alumni:

Are you coming for Alumni Weekend?

MS&E will hold its annual breakfast for alumni and their families and friends on Saturday, June 7 from 8:30 to 9:30 in the Bard Hall Lounge (room 260). Please RSVP to Carol Armstrong:

ca20@cornell.edu
or 607/255-9617

Please send your email address, with your degree and year of graduation, to matsci-web@cornell.edu.

To view alumni addresses on mse.cornell.edu, click on People and then Alumni; the user word is "alums" and the password is "bardthurston".

ABET 2000 curriculum review needs your input

Believe it or not, even university departments have to undergo periodic performance reviews and evaluations. For the undergraduate program, we are accredited by a body known as ABET that reviews us every six years. MS&E will undergo a practice review this fall with a full review in 2004.

In the past, these reviews simply ensured that a standard level of materials science and engineering was covered by every accredited department (the core curriculum). In 2000, ABET changed the criteria to one based on continual curriculum evaluation and improvement. We have the freedom now to design a curriculum that truly meets the needs of our students in their ultimate careers.

As part of this evolution, we need your input - your perspective from industrial and professional careers. We have designed a Web-based survey to help us prioritize our objectives and expected outcomes in the curriculum. Please take five minutes to help define the MS&E experience for the next generation of students by going to www.mse.cornell.edu/abet and filling out the survey. You are also welcome to directly write the chairs of either the ABET or Curriculum committees with your recommendations. (PS Dropping thermo is probably not in the cards however!) Thank you in advance for your help!

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FROM THE DIRECTOR



Welcome to our Spring 2003 MS&E News. As you can see, many things have been happening in Bard Hall since our last communication. I am extremely pleased to announce that R. Bruce van Dover joined the MS&E faculty. He brings to us a wealth of industrial experience and a world-class scientific reputation. In addition, Kit Umbach—a long time member of the MS&E community, has been appointed to a faculty position. He will be spearheading development of a surface characterization facility in conjunction with the Cornell Center for Materials Research (CCMR). I'm sorry to have to report that Prof. Yuri Suzuki left MS&E to join another academic institution closer to her family. We wish her well in her new position; she will be missed. I am also deeply saddened by the passing of Professor Peter Krusius, MS&E graduate field member and colleague in Electrical and Computer Engineering.

Our undergraduate and graduate programs are entering a period of growth and development. Our junior class will include more than 30 students in the Fall. These students will take advantage of changes that incorporate a focus on hands-on learning earlier in the curriculum along with new equipment acquired with the generous support of our alumni and friends. We expect the sophomore class to be even bigger, an indication of the vigor of materials science at Cornell University. Our M.S./Ph.D. applications have increased 68% over last year and an outstanding group will arrive in Fall 2003. U.S. News and World Report recently ranked our graduate program 8th in the country and our undergraduate program was ranked 4th.

As part of our efforts to continue improvement to our academic programs, we hope that each of our alumni will assist us with feedback on their experiences at Cornell. This will be invaluable in our preparations for our undergraduate program accreditation review under the new ABET (Accreditation Board in Engineering Teaching) criteria. Please visit www.mse.cornell.edu/abet to learn more and complete our brief survey. Your feedback is critical to this process.

Duffield Hall should be approved for partial occupancy within 3 months. MS&E will be an integral participant in the new state-of-the-art building and we expect that its new environment will provide more opportunities for exciting interdisciplinary materials research.

Enjoy the Summer. Please stop in to see us if you are in Ithaca.

—Christopher Ober, Director, Department of Materials Science and Engineering

MS&E community mourns death of J. Peter Krusius



*J. Peter Krusius
1944–2003*

J. Peter Krusius, Cornell professor of Electrical and Computer Engineering with extensive ties to MS&E, died on January 30 at the age of 58. He was a member of the Graduate Field of Materials Science and Engineering, and served as director of the Electronic Packaging Program and of the Joint Services Electronics Program.

Krusius came to Cornell in 1979 as a Fulbright fellow, and then joined the faculty as an associate professor in 1981. He became a full professor in 1987.

Born in Helsinki, Finland, in 1944, he attended both Finnish and German schools, and then studied at Helsinki Technical University, where he earned the Ph.D. in electron physics in 1975. Before coming to Cornell, he did postdoctoral work at the University of Dortmund in West Germany, at Helsinki Technical University, and in the Semiconductor Laboratory at the Technical Research Center of Finland. He spent sabbatical leaves at IBM's T. J. Watson Research Center and at the Royal Institute of Technology in Stockholm, Sweden, as a visiting professor.

Krusius' most recent research was in three areas related to solid-state semiconductor devices: nanoelectronics, electronic packaging, and optoelectronics. He was a founder of Rainbow Displays, Inc. (RDI), formed in 1996 by Cornell professors and former IBM executives to develop and manufacture large tiled LCD flat panel displays; Krusius designed and helped develop much of the technology. Last year the magazine *Information Display* awarded RDI its Display of the Year Gold Award for its display technology.

Among Krusius' contributions to the instructional program at Cornell was the introduction of a graduate course in microfabrication, and he worked with MS&E Professor Dieter Ast in developing a 300-level version of the course. This course is being taught for the first time this term by Ast.

Krusius was diagnosed with pancreatic cancer in October, but continued working and making plans almost to the time he died. He is survived by his wife of 33 years, Eeva, and their three sons, Paul, Otto, and Leo.

MS&E professors receive honors and awards

Several members of the MS&E faculty received international, national, or university honors in recent months.

■ Professor Arthur Ruoff, the Class of 1912 Professor of Engineering, was presented in March with a Merit of Honor Award from The University of Utah Emeritus Alumni Association. He received his PhD from the University of Utah in 1955 as a student of the late Dr. Henry Eyring. This award is presented to alumni who have given distinguished service to the nation, the University, the community and/or their profession. Ruoff received this award in recognition of his status as an international expert in high pressure and ultra pressure studies, as well as his distinguished teaching career at Cornell University. With his research group, he has achieved the highest static pressure, using diamond tips squeezed together, of 5.6 million atmospheres, compared with the pressure at the center of the earth of 3.6 million atmospheres. Such high pressures enabled him to create materials that are not found under normal pressure, such as metallic oxygen, metallic sulfur and metallic xenon. In 1993, Ruoff was awarded the Bridgman Award of the International Association for the Advancement of High Pressure Science and Technology, the highest award given in this field of research.



Arthur Ruoff

Vohra wins prize for scholarly distinction

Yogesh K. Vohra, who was a postdoctoral fellow and subsequently a professor in MS&E at Cornell, is this year's recipient of a prize awarded annually to a faculty member by the University of Alabama at Birmingham. The Caroline P. and Charles W. Ireland Prize for Scholarly Distinction recognizes professional and academic achievements and contributions to the university and local community.

Vohra earned his bachelor's and master's degrees at Delhi University in India, and his doctorate from Bombay University in 1979. At Cornell he was a postdoctoral fellow working with Professor Arthur Ruoff and was on the faculty from 1988 to 1992. He is a specialist in the field of synthetic diamonds and high-pressure science.

■ Emmanuel Giannelis was elected a corresponding member of the European Academy of Sciences, one of the most prestigious European scientific institutions, for profound contributions to materials science and fundamental developments in the field of polymer nanocomposites. In addition, Giannelis was appointed the Walter R. Read Professor of Engineering in recognition of excellence in research and teaching at both the undergraduate and graduate levels.



Emmanuel Giannelis

■ Christopher Ober was honored in Chemical and Engineering News in their article on Chemistry Highlights 2002. A two-photon dye that may permit device microfabrication to be carried out in three dimensions and with greater efficiency, reliability, and speed than previously possible was designed, synthesized, and demonstrated by Ober, Seth R. Marder and Joseph W. Perry of the University of Arizona, and co-workers [Science, 296, 1106 (2002); C&EN, May 13, page 9]. Absorption of two photons by the dye leads to the production of acid, which can be used to activate microfabrication reactions.

■ Shefford Baker was recently awarded the Sonny Yau '72 Excellence in Teaching Award, the highest award for teaching excellence at the College of Engineering.

Among Baker's course offerings is the undergraduate engineering distribution course MSE 261, Introduction to the Mechanical Properties of Materials: from Nanodevices to Superstructures, which draws students from across the college and the university as well as those planning to major in MS&E.

The Excellence in Teaching Awards have been established by alumni and represent the highest award for teaching in the college. Baker was nominated by his colleagues in MS&E, based on feedback from student course evaluations and comments, and by a committee of former teaching prize winners from within the Engineering College as well as colleagues from several other colleges at Cornell.



Shefford Baker

Umbach begins new phase of career at MS&E

When Christopher "Kit" Umbach became an assistant professor of MS&E at the beginning of this academic year, he was already well acquainted with Cornell. He received his Ph.D. in applied and engineering physics at Cornell in 1991, stayed on for postdoctoral research for two years, was a lecturer in MS&E for a year, and then served as a research associate in MS&E until his appointment to the faculty.

Umbach's research interest is in surface characterization of thin films and glasses using x-ray scattering and scanned probe microscopy, and nanopatterning of surfaces using charged beams and reactive etching. In his current position, he is working to develop a facility for surface characterization.

Umbach received his B.A. in physics and philosophy from Yale University in 1981, and subsequently spent a year on a DAAD fellowship at the Max Planck Institute in Stuttgart, Germany.



Christopher Umbach

The bright lights of Bard Hall: Malliaras' research focuses on OLEDs

Organic light emitting devices (OLEDs) are being developed for applications in flat panel displays and lighting. Practically every consumer electronics company and many start-up companies have active research and development programs in OLEDs. In the last few years, OLED-based displays have begun to enter the market in products such as car stereos, cell phones and other small appliances. Just a few months ago, IBM announced a 20" flat panel display from OLEDs, driven by amorphous silicon transistors. The flat panel display market revenues were \$33 billion in 2002, and are expected to nearly double by 2005. Combining advantages such as bright, saturated colors, a small form factor and a high efficiency, OLEDs are forecasted to capture a large share of that market.

In the simplest configuration, an OLED consists of a single layer of an organic semiconductor sandwiched between two metal electrodes, one with a high work function (anode) and one with a low work function (cathode). Under the application of a forward bias, holes are injected from the anode into the highest occupied molecular orbital (HOMO) of the organic layer and migrate towards the cathode. In a similar fashion, electrons injected from the cathode into the lowest unoccupied molecular orbital (LUMO) of the organic migrate towards the anode. When a hole and an electron meet in the bulk of the organic layer, they may combine to form an exciton. A fraction of these excitons recombine radiatively, giving rise to light emission.

The Achilles heel of OLEDs is the low work function cathode which is required for efficient electron injection. Typical devices utilize cathodes from Ca or Mg, and suffer from "dark spot" degradation, which is the formation and growth of non-emissive spots that grow and eventually kill the device. These dark spots are associated with oxidation of the cathode and necessitate that OLEDs are protected from oxygen and moisture. This is done by encapsulation, which increases the manufacturing cost and prohibits the use of plastic substrates, since the latter are highly permeable to oxygen and moisture. Consequently, there is a strong interest to find ways to improve electron injection from high work function metals.

Understanding and improving charge injection is a major thrust in Prof. Malliaras' group in the Department of Materials Science and Engineering at Cornell University. The MS&E group has recently demonstrated highly efficient OLEDs using air-stable cathodes (Fig. 1). This was achieved by using transition metal complexes as the semiconductor layer.

Below the MS&E OLED research group. From left: Yu Jye Foo (sophomore), Alon Gorodetsky (senior), Jason Slinker (first year graduate), Prof. George Malliaras, Dan Bernards (first year graduate) and Sara Parker (junior).



Fig. 1: OLED with air stable electrodes

Transition metal complexes, such as ruthenium tris-bipyridine ($[\text{Ru}(\text{bpy})_3]^{2+}$) shown in Fig. 2, have been subject of extensive electrochemical and spectroscopic studies. These materials satisfy the basic requirements for OLEDs: Their excellent stability in multiple redox states indicates that electronic carriers can be readily injected and transported in these materials. Their luminescence efficiency can be very high, evident by the fact that these materials have been used as tracer dyes in sensor applications.

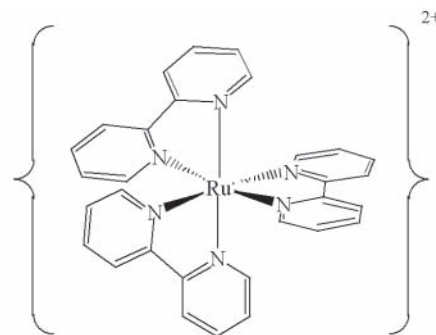


Fig. 2: Chemical structure of $[\text{Ru}(\text{bpy})_3]^{2+}$.

In addition to being molecular semiconductors, transition metal complexes feature ionic conductivity. For example, $[\text{Ru}(\text{bpy})_3]^{2+}$ carries a net 2+ charge, which is compensated by two counter ions such as PF_6^- or ClO_4^- . Upon the application of a bias, the counter ions redistribute and pile redistribution causes the applied bias to drop almost exclusively at the two contacts, enhancing charge injection. The Cornell MS&E group has shown that this enhancement is large enough to make both the cathode and the anode ohmic, regardless of the metals used. As a result, air-stable cathodes such as Au have been used to fabricate efficient devices that do not suffer from dark spot formation.

In collaboration with the chemistry groups of Profs. Abruña and Houston (Cornell) and Prof. Bernhard (Princeton), the MS&E group has been

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investigating the properties of ruthenium, osmium and iridium complexes in order to establish a relationship between the chemical structure and the device performance in these class of electroluminescent materials. The fruit of these efforts are devices with brightness exceeding 300 cd/m² at just 3 V bias (a computer screen operates at 100 cd/m²). Moreover, an iridium complex that yields devices with efficiency of 10 Lm/W has been identified—the highest reported efficiency for an electroluminescence device processed from solution. This efficiency approaches that of fluorescent tubes and state-of-the-art multilayer OLEDs (about 70 Lm/W), which is remarkable for such a simple device. With further optimization of the complexes as well as the devices, higher efficiencies will soon be achieved.

A great deal of issues remain to be addressed before the ultimate limits of performance of transition metal complex-based devices are reached. For example, the temporal response of these devices, which is dominated by the mobility of the counter ions, is still too slow for most applications. Tuning the color of these complexes to yield devices that emit in the blue part of the spectrum is only now being attempted. The MS&E group and its collaborators are embarking on a journey that might make the lights of Bard Hall a bit brighter.

The following published and forthcoming papers describe the work of the OLED group:

•Stefan Bernhard, Xicun Gao, George G. Malliaras and Héctor D. Abruña, “Efficient electroluminescent devices based on a chelated osmium(II) complex”, *Adv. Mater.* **14**, 433 (2002).

•Stefan Bernhard, Jason A. Barron, Paul L. Houston, Héctor D. Abruña, Jennifer Ruglovsky, Xicun Gao and George G. Malliaras “Electroluminescence in ruthenium(II) complexes”, *J. Am. Chem. Soc.* **124**, 13624 (2002).

•Jason A. Barron, Stefan Bernhard, Paul L. Houston, Héctor D. Abruña, Jennifer Ruglovsky and George G. Malliaras “Electroluminescence in ruthenium(II) dendrimers”, to appear in *J. Phys. Chem.* (2003).

•Keon W. Lee, Jason Slinker, Alon A. Gorodetsky, Samuel Flores-Torres, Héctor D. Abruña, Paul L. Houston and George G. Malliaras, “Photophysical properties of tris(bipyridyl)ruthenium(II) thin films and devices”, to appear in *Physical Chemistry and Chemical Physics* (2003).

•Jason Slinker, Alon A. Gorodetsky, Stefan Bernhard and George G. Malliaras, “Efficient yellow electroluminescence from a single layer of a cyclo-metalated iridium complex”, to appear in *J. Am. Chem. Soc.* (2003).

•Jason Slinker, Dan Bernards, Paul L. Houston, Héctor D. Abruña, Stefan Bernhard and George G. Malliaras, “Solid-State Electroluminescent devices based on transition metal complexes”, to appear in *ChemComm. as a Focus Article* (2003).

•Alon Gorodetsky, Sara Parker, Jason Slinker, Dan Bernards, Samuel Flores-Torres, Héctor D. Abruña and George G. Malliaras, “Contact issues in electroluminescent devices from ruthenium(II) complexes”, to appear in *Synth. Metals* (2003).

Former graduate student elected fellow of ANS



K. Linga Murty

A former graduate student, K. Linga Murty, was recently elected a fellow of the American Nuclear Society (ANS). A professor of materials science and nuclear engineering at North Carolina State University since 1981, he currently serves as program director for metals research in the Division of Materials Research of the National Science Foundation.

Murty received bachelor's and master's degrees from Andhra University in India. At Cornell he did graduate work in MS&E, working with Professor Arthur Ruoff, and received the Ph.D. in applied physics in 1970. Subsequently, he held research positions and fellowships at the University of California at Berkeley and at the University of Newcastle in Australia. He has also worked in industrial engineering research and has served as a consultant to research centers in Korea and India.

Honors he has received include the ANS Mishima Award for “outstanding contributions in nuclear materials and fuels research and development.”

Announcing the Sixth International Symposium on Functional π -Electron Systems June 14-19, 2004 Cornell University

This symposium series began in 1989 in Osaka, Japan, as the "International Symposium on Functional Dyes". The name of the symposium was changed a few years ago to reflect its broadened scope and align it with recent developments in academic, industrial and government research institutions.

The $f\pi$ series is a unique forum for the discussion of structure-properties relationships in π -conjugated materials. Over 600 scientists from 29 nations attended the 2002 symposium in Ulm, Germany. The sixth symposium, organized at Cornell University by Prof. George Malliaras, will continue the tradition and bring together chemists, physicists, biologists and engineers to discuss recent developments in the field of π -conjugated materials. The technical program will include 45 plenary lectures, over 60 contributed lectures and 3 extensive poster sessions. Papers are solicited on the following topics:

- Synthesis of functional π -electron materials
- Supramolecular organization and patterning
- Structure vs. properties relationships
- Applications in electronic & photonic devices and biosensors
- Industrial aspects of π -electron materials

For additional information on this 2004 symposium, please see www.fpi6.cornell.edu.

MS&E students awarded prizes and fellowships

Parker wins national award

Sara Parker, a Gregg Prize winner, also received a prestigious national award this spring: a Barry M. Goldwater Scholarship

Goldwater Scholarships are awarded each year to undergraduates in the fields of science, mathematics, or engineering. This year four Cornell students were among the 300 selected from a field of 1,093 undergraduates nominated by colleges and universities nationwide.

Each recipient receives an award of up to \$7,500 per year to help cover the costs of tuition, fees, books, and room and board.

The MS&E department recognized outstanding students with the award last fall of James L. Gregg Memorial Prizes and Nanotechnology Fellowships.

The Gregg Prize goes to the outstanding junior in MS&E. The 2001-2002 recipient was Eric Verploegen; the 2002-2003 recipient was Sara Parker. Each winner was presented with a certificate and a check for \$1,500. The award is named in honor of James L. Gregg, who was a professor of metallurgical engineering.

The merit-based Nanotechnology Fellowships were awarded to six students from the class of 2003 and six from the class of 2004. The seniors are Alon Gorodetsky, Heather Chapman, Jarrett Silver, Jeffrey Biser, Sarah Rosenstein, and Marshall Cox. The juniors are Man Hoi Wong, Aaron Kueck, Conrad Lovell, Amit Patel, Emily Walton, and Michael Miller.

Verploegen was presented with his Gregg Prize not long before he graduated last December; he will begin graduate school at MIT next fall. While an undergraduate, he worked with Professor Ulrich Wiesner in the study of polymeric materials, and wrote his senior thesis based on that research.

He also worked in the research group headed by Professor Stephen Sass, and he held a summer Engineering Co-op Program job at Osram Sylvania in Massachusetts.

Verploegen's honors included election to the Cornell chapter of the honor society Alpha Sigma Mu and the National Society of Collegiate Scholars, and he received several grants and awards, including a Cornell Tradition Fellowship Award. His community activities included participation in service projects in the Ithaca area, tutoring at Ithaca High School, and summer work with Habitat for Humanity.

Parker, the 2002-2003 Gregg Prize winner, also plans to attend graduate school. Her MS&E concentrations are electronics and polymers; she has worked with Professor Steven Sass in research on periodic structures on silicon and is currently in Professor George Malliaras's research group studying light-emitting diodes.

She is an officer of the Materials Research Society chapter and is also active in Tau Beta Pi and the Society of Women Engineers. She does peer advising and is a cooperative workshop facilitator for core mathematics courses.



The Nanotechnology junior prize winners (left to right) are Man Hoi Wong, Aaron Kueck, Emily Walton, Sara Parker, Amit Patel, Michael Miller and Conrad Lovell

Right: Posing for their picture on a spring morning outside Bard Hall are senior prize-winners (left to right) Sarah Rosenstein, Eric Verploegen, Jeffrey Biser, and Alon Gorodetsky. Not pictured: Heather Chapman, Jarrett Silver and Marshall Cox



MS&E graduate students receive Silver Awards at MRS Spring meeting

Graduate students Prita Pant and Yulong Shen received Silver Awards from the Materials Research Society at the Spring 2003 meeting held in San Francisco. MRS Graduate Student Awards honor graduate students whose academic achievements and materials research display a high order of excellence and distinction; students who show promise for future achievement in materials research. Winners received a cash prize and a certificate.

Pant's research topic was strain relaxation by misfit dislocation array. Working with Prof. Shefford Baker, Pant developed an analytical model for strain relaxation of thin films by dislocation arrays. The model can be used to calculate the critical strains at which elastic strains can be relaxed by the formation of dislocations. This is of interest in making semiconductor films with low dislocation densities. Pant also recently won an Engineering Graduate Student Association award for her poster presented as part of the recent Cornell Society of Engineers (CSE) meeting.

Shen's research focuses on understanding the fundamentals of charge injection in organic semiconductors. As a graduate student in Prof. Malliaras's group, she demonstrated that the current injected in an amorphous semiconductor depends on the carrier mobility, which is the first experimental observation of this effect. She has also developed schemes to improve charge injection and enhance the performance of organic electronic devices such as light emitting diodes. She is the author of seven articles in refereed journals, among which are the Physical Review Letters, Chemical Physics Letters, Applied Physics Letters and Advanced Materials. Shen also won the SPIE (International Society for Optical Engineering) Educational Scholarship in Optical Science and Engineering and the Raymond Davis Scholarship of the Society for Imaging Science and Technology.

MS&E-sponsored Microscopy Image Competition draws entries from undergraduates in U.S. and Canada

A grain of pentacene and a platinum film in the shape of a palm tree were the images that won first prizes in the initial 2002 Microscopy Image Competition sponsored by the MS&E department at Cornell and the Delta Chapter of Alpha Sigma Mu and open to undergraduates studying materials science in the U.S. or Canada. Any imaging technique could be used.

The first-place winners in the "Images in the Material World" competition were a Cornell chemical engineering student, Christopher Johnson (now graduated and employed at Rohm Haas), who

won in the category "Most Scientifically Significant Image," and Megan Cordill of Washington State University, who won for the "Most Artistic Image." Second- and third-place prizes were also awarded.

This initial competition was judged by MS&E Professors Stephen Sass and Christopher Ober. Prizes of digital cameras were provided by the Eastman Kodak Company.

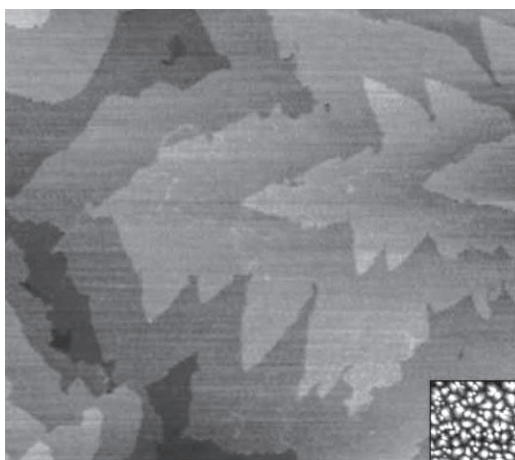
The second annual competition, co-sponsored by MS&E and the Cornell chapter of the Materials Research Society is now underway.

First place for "Most Scientifically Significant Image" was awarded to the atomic force microscopy image (at far left) of "Pentacene Growth at Elevated Temperature" by Christopher Johnson of Cornell.

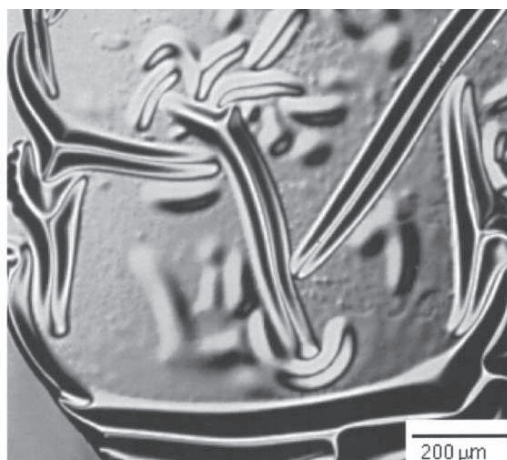
Johnson worked on his project with a graduate student, Michelle Swiggers, in Professor George Malliaras's group. The image shows a segment, 12 μm wide, of a large grain of pentacene grown on silicon at elevated temperature; the inset shows growth at room temperature.

Megan Cordill's image "Platinum Palm Tree" (at left), taken with an optical microscope, won first place as the "Most Artistic Image." It was described as "straight buckles spontaneously formed in a palm tree shape after sputter deposition of a platinum film on SiO_2 ."

To view all 2002 and 2003 winning entries, go to www.mse.cornell.edu.



Pentacene Growth at Elevated Temperature



Platinum Palm Tree

Fundraising goal surpassed for project to improve undergraduate labs

The half million dollar fundraising goal for a project to improve MS&E undergraduate laboratory facilities has been substantially exceeded according to the project coordinator, Alison Shull.

The initiative, begun in late 2001, has provided extensive instrumentation and computing hardware and software for course-related experiments in the senior and the junior laboratories as well as faculty guided undergraduate research projects.

An early fundraising incentive was a matching-grant pledge of up to \$250,000 from an anonymous donor. Subsequently, donations from alumni were received and several corporations donated equipment (see the listing on page 8). Then in late April of this year, the National Science Foundation granted a \$100,000 Nanotechnology Undergraduate Education

Award to MS&E and Cornell's Applied and Engineering Physics Department for a collaboration on the integration of nanotechnology into the undergraduate engineering curriculum.

"The enthusiasm generated by this project has been great" Shull said, "as generous donors enabled us to get some high end, state of the art equipment into the facility, freshmen through graduate students have contributed substantially to the development of new lab modules that use the equipment." New experiments are already integrated into the senior laboratory course and development is underway for a new junior laboratory course, to be introduced next fall, that will have "hands-on" laboratory modules based on and reinforcing concepts from concurrent junior-year MS&E core lecture courses.

Examples of the wide range of topics covered in lab development work by MS&E students, supervised by Shull and Professor David Grubb, are:

- synthesis, structural and optical characterization of 3-D photonic crystals
- mechanical testing and microstructural analyses of metals, ceramics, polymers, and composite materials including engineered biomaterials
- thermal analysis of Pb-Tn alloys and polystyrene sheets and foams
- lithography, deposition and electrical testing and measurement of thin metal films,

(continued on page 8)

Alex Zunger gives Johnson Memorial Lectures

Alex Zunger, director of the Solid State Theory Group of the National Renewable Energy Laboratory in Colorado and professor of physics at Colorado University, gave the annual Herbert H. Johnson Memorial Lectures at the MS&E department on November 20 and 21. The lecture series honors the late Professor Herbert H. Johnson, who was director of the department in the early 1970s.

Zunger, a specialist in condensed matter theory of materials, has published more than 400 journal articles and has received a number of honors, including the 2001 John Bardeen Award of the Minerals, Metals & Materials Society (TMS) and the 2001 Rahman Award of the American Physical Society.

His lectures were titled “Understanding Semiconductor Quantum Dots” and “Quantum Architecture of Novel Solids.”



Zunger, at center, was feted at a dinner held in connection with the Johnson Lectures. Charlie Tracey, Ph.D. '68, a contributor to the lecture fund, is at left and Christopher Ober, MS&E director, is at right. Mrs. Johnson and other family members attended the dinner.

New courses enrich undergraduate curricula

Two courses that help keep instruction in step with advances in technology have been added to the MS&E curriculum. Professor Emmanuel Giannelis offers each year a popular introductory course in nanotechnology for freshman and this year he added an upper-level course in technology management.

Engineering/MS&E 111: Nanotechnology was filled to capacity with 170 students in the fall term, which represents nearly a quarter of all engineering freshman. The agenda included discussions by guest lecturers who

spoke about the development of their specialized fields in nanotechnology, and the students worked in groups on presentations on such topics as nanophotonics, nanostructures and devices, nanomedicine, and nanoelectronics.

MS&E 481/587: Technology Management was offered for the first time in the spring term. The course was designed to provide students in engineering and sciences with knowledge and analytical skills to manage research and development for a strategic competitive advantage. Topics included technology evaluation, R&D portfolio, intellectual property portfolio and management, technology transfer, and technology, policy and society. Visiting industry lecturers presented case studies on their experience and led informative discussion. In particular Charles Tracey, Visiting Scientist, made substantial contributions to the course drawing on his experience in technology management in industry.

Fundraising (continued from page 7)

semiconductors, and conducting polymers

- optical analyses of natural and synthetic absorption based paint pigments and thin film interference based paint pigments
- thermomechanical properties of NiTi shape memory alloy
- optical test and measurement of silica fibers and other photonic waveguiding materials and structures
- optoelectronic measurements of solar cell materials

Corporate Donations for Undergraduate Laboratory Improvement

- Agilent Technologies:** optical microscope; optical test and measurement equipment
- Intel Corporation:** computers and wireless networking equipment
- Instron Corporation:** mechanical tester
- TA Instruments:** differential scanning calorimeter
- Ocean Optics, Inc.:** spectrometers
- National Instruments Corporation:** hardware and software for data acquisition and instrument control