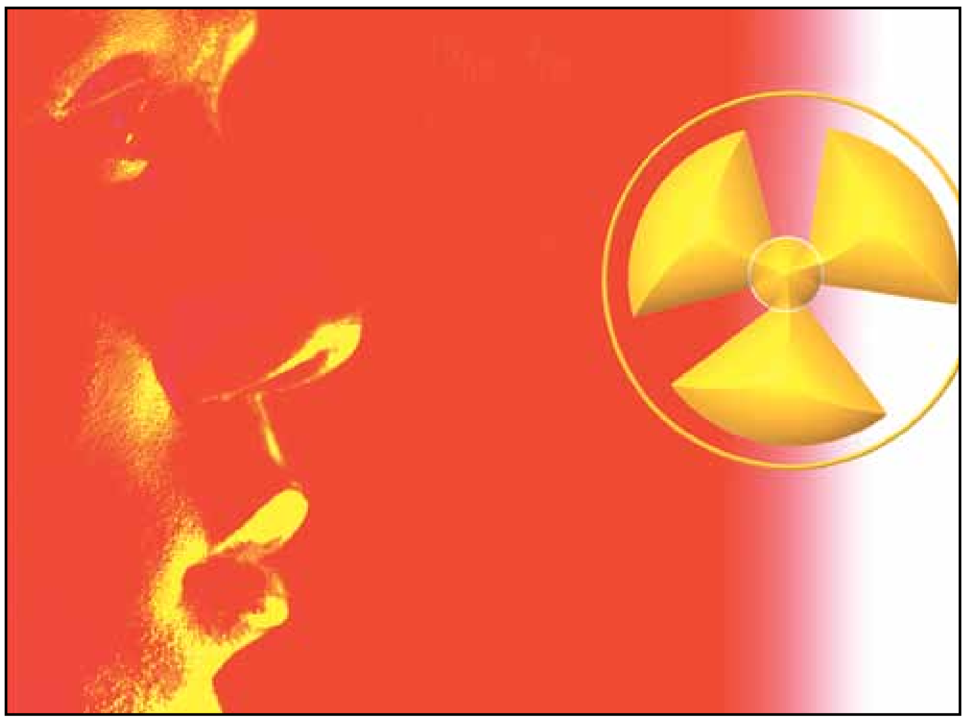
Pitt Chronicle

Newspaper of the University of Pittsburgh

Volume XI • Number 28 • October 11, 2010

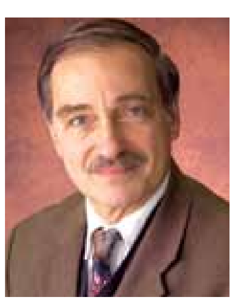
INSIDE

Pitt Team Gets $13.9 Million Grant Renewal For Radiation-Exposure Countermeasures



By Courtney McCrimmon

Researchers at the University of Pittsburgh Cancer Institute (UPCI) and the University of Pittsburgh School of Medicine have been awarded $13.9 million over five years by the National Institute of Allergy and Infectious Diseases (NIAID) to continue developing small molecule radiation protectors and mitigators that can be easily accessed and administered in the event of a large-scale radiological or nuclear emergency.



Joel Greenberger

In 2005, NIAID's Center for Countermeasures Against Radiation program granted $10 million over five years to Joel Greenberger, chair of the Department of Radiation Oncology at Pitt, and his team of researchers with the University's Center for Medical Countermeasures Against Radiation.

"With our previous funding, we dedicated our time to exploring the mitochondria—the energy generator of all cells—and developing drugs that could counteract damage caused by radiation exposure," Greenberger said. "We proved that targeting small molecules to the mitochondria was a successful approach. With our current funding, we hope to accomplish a variety of goals, including gene identification for targeted therapies and finding a new approach to the development of radiation mitigators. We also hope to develop strategies to deliver the drugs quickly and intelligently to block mitochondria 'wrong-doings' that could lead to massive cell death after a nuclear event."

"Our work is truly a multidisciplinary effort in which the combined expertise and knowledge of biochemists, clinical researchers, chemists, pharmacologists, and pharmacists led to the successful development of novel protectors and mitigators against irradiation damage."
—*Joel Greenberger*

Previous funding supported research examining several potent mitigators of radiation damage, including new classes of chemicals and known natural compounds. Greenberger's team, in conjunction with a team of chemists led by Peter Wipf, Pitt Distinguished Professor of Chemistry, aided in the development of JP4-039, a drug that assists the mitochondria in combating irradiation-induced cell death.

In addition, according to research from Greenberger's laboratory, resveratrol, the natural antioxidant commonly found in red wine and many plants, proved to protect cells in mouse models from radiation when altered by a process called acetylation.

"Our work is truly a multidisciplinary effort in which the combined expertise and knowledge of biochemists, clinical researchers, chemists, pharmacologists, and pharmacists led to the successful development of novel protectors and mitigators against irradiation damage," Greenberger said.

Pitt's Regional Biocontainment Laboratory Gets $1.9 Million to Study Rift Valley Fever

By Clare Collins

The University of Pittsburgh Regional Biocontainment Laboratory (RBL) has received a $1.9 million contract from the U.S. Department of Defense (DOD) to explore long-sought treatments for Rift Valley Fever (RVF), which poses significant risks to U.S. military and civilian populations as a potential agent of biowarfare.

The contract from the DOD's Defense Threat Reduction Agency will enable researchers to explore the biological processes that underlie disease caused by the RVF virus, a fever-causing viral disease that affects humans and domestic animals, such as cattle, buffalo, sheep, goats, and camels.

"RVF is a serious threat because it can spread very quickly through both animal and human populations," said Amy L. Hartman, principal investigator of the project, RBL research manager and research instructor in the Pitt Graduate School of Public Health's Department of Infectious Disease and Microbiology. "Epidemics have already occurred in Africa and Saudi Arabia, and the virus can potentially spread to the United States."

Throughout the three-year project, Hartman and her team, including Doug Reed, RBL aerobiology manager and coinvestigator on the contract, will develop animal models of RVF that will mimic the disease seen in humans. "This research should help us understand more about how the virus causes disease in animals after respiratory infection, with the eventual goal of developing drugs or vaccines that can offer wide-reaching protection to populations at risk," she said.

The Center for Vaccine Research (CVR) at the University houses both the RBL, which is celebrating its second anniversary this month, and the Vaccine Research Laboratory. Researchers at the CVR develop new methods and strategies to prevent and treat infectious diseases, potentially improving and protecting global health.

Pitt Is 11th Among U.S. Publics in "High Impact Universities" Rankings

By John Harvith

The University of Pittsburgh places 11th among U.S. public institutions of higher education, 25th among all U.S. universities, and 31st in the world in a new "High Impact Universities 2010" ranking conducted in affiliation with the University of Western Australia that benchmarks "the research output or performance of the world's top universities."

The other top U.S. public institutions in the ranking are UCLA, Berkeley, Michigan, University of Washington, UC-San Diego, Minnesota, Wisconsin, Penn State, UC-San Francisco, and North Carolina. The top private U.S. universities in the ranking are Harvard, Stanford, MIT, Penn, Johns Hopkins, Columbia, Chicago, Cornell, Yale, Duke, NYU, Northwestern, Rochester, and USC. Among the top foreign universities in the ranking are Cambridge, Oxford, the Imperial College of London, and the University of Paris. Pitt outranks, among many others, Caltech, Dartmouth, Illinois, Indiana, Maryland, Ohio State, Princeton, Purdue, Rice, Rutgers, Texas, Virginia, and Washington University in St. Louis.

The authors of the ranking, published online at www.highimpactuniversities.com/index.html, say that their project "is all about promoting a move toward *simplicity, transparency, and fairness* in the process of performance or impact assessment of university research" [italics theirs]. The ranking uses what it terms a research performance index or RPI for each university, employing indices of quantitative measures "of the quality and consistency of publication [by faculty members] as measured by citations or references." The authors say that these measures are "objective, verifiable, and difficult to manipulate."

The online publication considers each institution as possessing "five broad faculties" that it ranks separately and designates as follows: medicine, dentistry, pharmacology, and health sciences; pure, natural, and mathematical sciences; engineering, computing, and technology; life, biological, and agricultural sciences; and arts, humanities, business, and social sciences. The highest ranking of the Pitt faculty categories is the first—in medicine, dentistry, pharmacology, and health sciences—which is No. 6 among U.S. public institutions, No. 12 among all U.S. institutions, and No. 16 in the world, followed by the life, biological, and agricultural sciences category, in which Pitt is No. 8 among U.S. publics, No. 20 among all U.S. institutions, and No. 31 in the world; and the arts, humanities, business, and social sciences category, in which Pitt is ranked 16th among U.S. publics and 28th in both the U.S. and the world.

The RPI for each institution "is a percentage, indicating its overall quality and consistency of research output, with equal contributions from all faculties, as measured relative to a world 'dream team' comprising all the best faculties in the world."

According to the ranking's publication policy, the faculty publications used for the ranking were those appearing between 2000 and 2009 inclusive and were "restricted to journal and conference articles and authored and edited books," while no restrictions were placed on the sources of citations.

Three Pitt UCIS Centers Receive U.S. Dept. of Education Funding

By Amanda Leff Ritchie

Three University Center of International Studies (UCIS)-affiliated centers at the University of Pittsburgh recently received funding from the U.S. Department of Education. The centers are the Center for Russian and East European Studies (REES), the Center for Latin American Studies (CLAS), and the International Business Center (IBC).

The funding awards follow the Pitt Global Studies Program's recent first-time designation as a National Resource Center (NRC) by the Department of Education.

REES received a first-time designation as a Title VI Comprehensive NRC—it was formerly designated an Undergraduate NRC, with funding primarily focused on undergraduate education initiatives. The center's NRC grant of approximately $1.08 million acknowledges the excellence of REES' graduate and professional school programs, in addition to its traditionally strong undergraduate programs. REES also received about $1.45 million in Title VI funding for Foreign Language and Area Studies Fellowships.

The funding awards follow the Pitt Global Studies Program's recent first-time designation as a National Resource Center (NRC) by the Department of Education.

CLAS received its largest NRC grant to date—$288,796. The Department of Education also gave CLAS an additional $283,500 in funding for Foreign Language and Area Studies Fellowships. CLAS has held the NRC designation since 1979.

The IBC, a joint venture of Pitt's Joseph M. Katz Graduate School of Business and UCIS, received a four-year grant totaling approximately $1.53 million. The grant will allow the center to expand programming that focuses on emerging markets, the understanding of engineering and technology, and global corporate social responsibility.

PITT ARTS, Pittsburgh Symphony Set New Cheap Seats Pricing

The University of Pittsburgh's PITT ARTS program is offering Pitt faculty, staff, and students lower ticket prices and additional seating for Pittsburgh Symphony Orchestra (PSO) performances in Heinz Hall.

The PSO has added some new sections of Heinz Hall that are now available through the PITT ARTS program. In addition, there is no longer a separate—and higher—PSO ticket cost structure for Pitt faculty and staff. All Mellon Grand Classics and Pops concerts are available to the Pitt community with a valid Pittsburgh campus ID for the following prices: $25 for Orchestra seating, $17 for the Family Circle section, and $12 for Gallery seating.

The new prices and expanded selection of Cheap Seats are available online to the Pitt Community through the PITT ARTS Web site, www.pittarts.pitt.edu/tickets, or from the organization's temporary location, Room 316, William Pitt Union.

PITT ARTS said 358 faculty, staff, and students attended its Sept. 25 ninth annual Pitt Night with the PSO. The Pitt community met virtuoso pianist Yuja Wang and Maestro Manfred Honeck, PSO director, during a postconcert reception.

PITT ARTS has been connecting students on the Pittsburgh campus in Oakland to the cultural life of Pittsburgh since the arts organization was founded in 1997. Funded by the Office of the Provost, the program sponsors more than 110 free student outings for Pitt undergraduates each year. PITT ARTS also provides on-campus art experiences as well as discounted cultural opportunities for faculty, staff, and undergraduate and graduate students.

2010 University Flu Shot Schedule

The University of Pittsburgh is offering flu shots through November for Pitt faculty, staff, and students. The shots are free for those with a UPMC Health Plan member ID card (not Pitt ID cards), $25 for those without the health plan card. Shots will be administered between 10 a.m. and 2 p.m. on the following dates and at the following locations on the University's Pittsburgh campus in Oakland.

Oct. 11	William Pitt Union, Dining Rm. A
Oct. 25	Benedum Hall, Rm. 102
Nov. 1	Posvar Hall Galleria
Nov. 16	Bellefield Hall, 2nd-floor lobby
Nov. 23	Cathedral of Learning, Rm. 1228

Falk Pharmacy will offer the shots between 9 a.m. and 3 p.m. on Tuesdays and Thursdays through December.

PittChronicle

Newspaper of the University of Pittsburgh

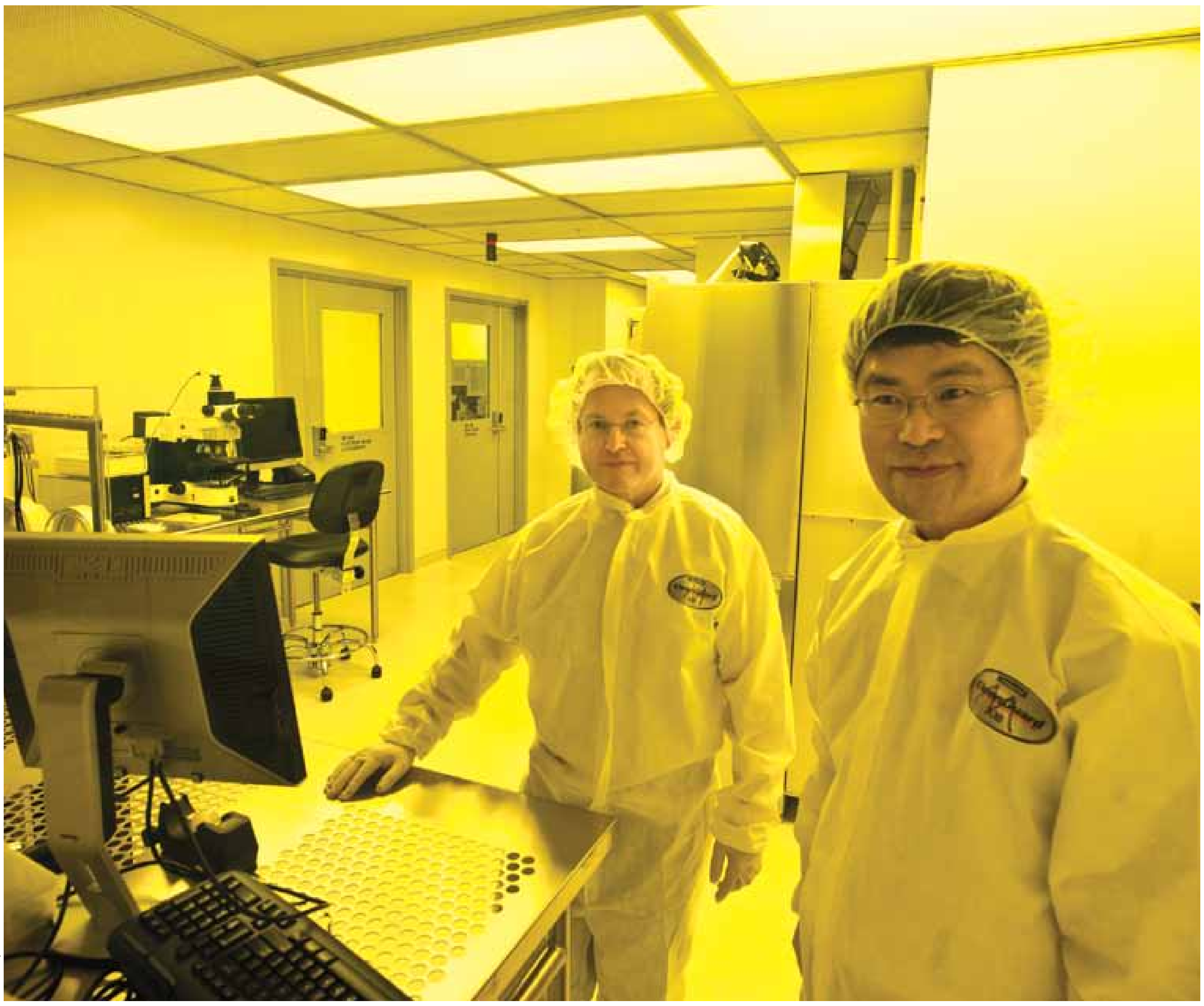
PUBLISHER	Robert Hill
ASSOCIATE PUBLISHER	John Harvith
EXECUTIVE EDITOR	Linda K. Schmitmeyer
EDITOR	Jane-Ellen Robinet
ART DIRECTOR	Gary A. Cravener
STAFF WRITERS	Sharon S. Blake John Fedele Morgan Kelly Amanda Leff Anthony M. Moore Patricia Lomando White
CONTRIBUTING WRITERS	Clare Collins Jeffery Fraser Courtney McCrimmon
HAPPENINGS EDITOR	Baindu Saidu

The *Pitt Chronicle* is published throughout the year by University News and Magazines, University of Pittsburgh, 400 Craig Hall, Pittsburgh, PA 15260,
Phone: 412-624-1033, Fax: 412-624-4895,
E-mail: chron@pitt.edu Web: www.chronicle.pitt.edu

The University of Pittsburgh is an affirmative action, equal opportunity institution that does not discriminate upon any basis prohibited by law.

Spotlight on **Research**

Building Blocks of Creation: The Age Of NanoScience and Technology



JIM BURKE/CIDDE

Hrvoje Petek (left) and Hong Koo Kim, codirectors of Pitt's Petersen Institute for NanoScience and Engineering, are standing in the nanofabrication area of the lab's "clean room." The area houses such advanced nanoscale patterning equipment as electron-beam or ion-beam lithography. The process requires an ultraclean environment with a controlled level of air contamination.

These researchers' exploration of nanoscience has led to homemade devices with remarkable capabilities, including a microscope capable of capturing on film light trapped within metal particles. They've set out to discover never-before-seen nanoparticles with properties that could nudge science closer to realizing true quantum computing with the potential for speeds and computational power that would make today's computers seem snail-like. And Pitt scientists are among the most proactive in assessing the impact these emerging nanotechnologies may have on human health and the environment, as well as in investigating ways to make these technologies safer.

By Jeffery Fraser

Each year, scientists are making discoveries that advance our understanding of nanoscience, lending substance to the speculation that nanotechnology is a revolutionary force that will profoundly change everything, from the electronics we use to the way doctors practice medicine.

For the most part, the scientists doing the heavy lifting are university-based researchers in physics, chemistry, engineering, biology, and other fields who—given the tools and freedom to explore—are laying the foundation for technologies few thought possible. Prominent among them are the more than 50 University of Pittsburgh researchers who are making significant contributions to the development of nanotechnologies, an endeavor that became a national initiative more than a decade ago.

Today, Pitt researchers are:

- developing special coatings with nanoparticles that prevent surfaces from icing;
- investigating materials containing nanosize bits of semiconductor material to solve one of the chief problems standing in the way of making paint convert sunlight into electricity; and
- integrating biology and nanotechnologies to develop highly sensitive, easy-to-use biosensors that push the boundaries of diagnostic medicine.

These researchers' exploration of nanoscience has led to homemade devices with remarkable capabilities, including a microscope capable of capturing on film light trapped within metal particles. They've set out to discover never-before-seen nanoparticles with properties that could nudge science closer to realizing true quantum computing with the potential for speeds and computational power that would make today's computers seem snail-like. And Pitt scientists are among the most proactive in assessing the impact these emerging nanotechnologies may have on human health and the environment, as well as in investigating ways to make these technologies safer.

A Matter of Scale

The prefix nano means 10^{-9}, or a billionth. A nanosecond is one billionth of a second; a nanometer, one billionth of a meter. At that scale, the head of a pin seems large, measuring about 2 million nanometers. Nanoscience, therefore, is the study of the world around us at the tiniest of levels. In this field, atoms and molecules are the building blocks for creating new materials and machines. The federal government defines nanoscience as the understanding and control of matter at dimensions between 1 and 100 nanometers; Pitt directs its research towards the smaller, more challenging end of that range, at 1-20 nanometers.

But size is only part of the intrigue, because materials at nanoscale possess remarkably different properties than their larger counterparts. "Very interesting things happen in that range," says George Klinzing, vice provost for research at Pitt. "If you are looking at friction, it's different at the level of 1-20 nanometers than it is in large particles of hundreds or thousands of nanometers. The basic laws are different. Understanding that is very important—and challenging. How are you going to manipulate these things? How are you going to make things if you're not sure how they'll behave? We put a lot of effort into understanding that."

The potential impact of nanotechnology on human health, the economy, and national security led President Bill Clinton to establish in 2000 the National Nanotechnology Initiative (NNI) as a multiagency framework to ensure U.S. leadership in the field by investing in basic research to understand nanoscale phenomena and facilitate technology transfer. Since then, NNI funding has risen approximately fourfold, from $462 million to nearly $1.8 billion in fiscal year 2010.

Pitt's traditional strength in materials research meant that, even before NNI, University researchers in fields ranging from chemistry to physics were investigating nanoscience with the support of a growing number of federal agencies eager to develop the new technology. In December 2002, under the leadership of then-Provost James V. Maher, Pitt created the Institute for NanoScience and Engineering to support and integrate the work of the increasing number of faculty from diverse disciplines embarking on nanoscience research.

Within four years, the institute was renamed the Petersen Institute for NanoScience and Engineering (PINSE). The institute's Benedum Hall home was renovated to accommodate a state-of-the-art nanoscale fabrication and characterization facility, the range of sophisticated instruments available to researches expanded significantly, and, with a $5 million gift from the Petersens, an endowment was created to support the work of Pitt's scientists.

An Uncommon Resource

Today PINSE stands as one of the most up-to-date, comprehensive institutes for nanoscale research on a university campus, offering scientists an uncommon asset for doing science at nanoscale and for securing external support for their work.

Few universities provide facilities and instruments to both characterize and fabricate nanomaterials in one place. "From

Continued on page 4

The Age of NanoScience and Technology

Continued from page 3

the beginning, our philosophy has been understanding nanomaterials through characterization and doing manipulation, fabrication, and synthesis into a designed structure in a synergistic environment," says Pitt's Hong Koo Kim, the Bell of Pennsylvania/Bell Atlantic Professor of Electrical and Computer Engineering and codirector of PINSE. "Many other research facilities focus on either characterization or fabrication, but when you emphasize only one, you may miss important aspects of the other and cannot develop a holistic picture."

The sophistication of the instruments available to scientists has done much to advance their understanding of nanomaterials and structures. PINSE has invested nearly $12 million to stock its characterization and fabrication facility with more than two dozen of the most advanced instruments required for high-level nanoscience research demands. All are housed in a clean-room environment. An example of an instrument available for characterization is the transmission electron microscope, which has a resolution of less than one nanometer. It allows scientists to visualize the atomic arrangement of nanomaterial and reconstruct the way atoms are arranged. On the fabrication side, Pitt scientists have access to instruments such as electron beam and focused ion beam nanolithography systems, which enable the researchers to build almost anything at nanoscale to their precise design specifications.

PINSE employs three technical staff members, a manager, and two research associates and provides resources and support to more than 50 affiliated faculty researchers across several disciplines.

In 2009, PINSE opened its doors to researchers beyond the Pitt campus, including individuals in industry and at other academic institutions. About a half-dozen PINSE-affiliated faculty also are engaged in collaborative research projects with various companies, and the list is expected to grow as the University steps up efforts to form industry partnerships around nanotechnology.

PINSE-affiliated faculty also are developing undergraduate and graduate-level coursework in nanoscience and nanotechnology, including entry-level courses in electrical engineering and a laboratory course that allows undergraduates to experience working with the leading-edge instruments and other amenities in the characterization and fabrication facility. "The philosophy is not only to educate our students in theory, but also to give them hands-on experience as well, because we see more and more job openings in the emerging nanotechnology industry," says Kim.

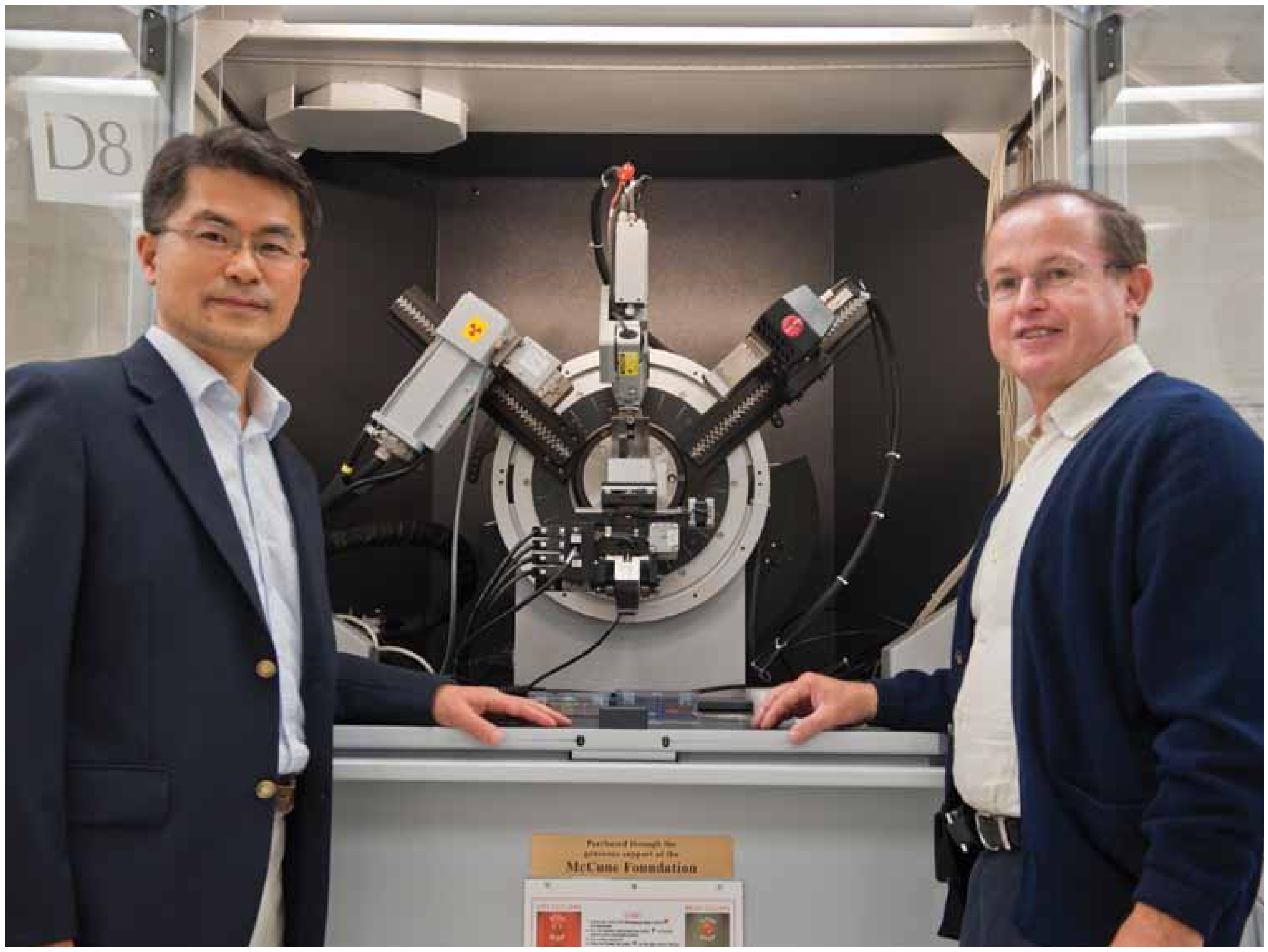
In 2009, PINSE opened its doors to researchers beyond the Pitt campus, including individuals in industry and at other academic institutions. About a half-dozen PINSE-affiliated faculty also are engaged in collaborative research projects with various companies, and the list is expected to grow as the University steps up efforts to form industry partnerships around nanotechnology.

Recognition at the Highest Levels

Nanotechnology research at Pitt is showing significant potential for helping to develop the kind of longer-term industry relationships the University seeks. That is the result of several factors, including the expertise of faculty members, the breadth of that expertise and their experience, and the expanding list of their accomplishments.

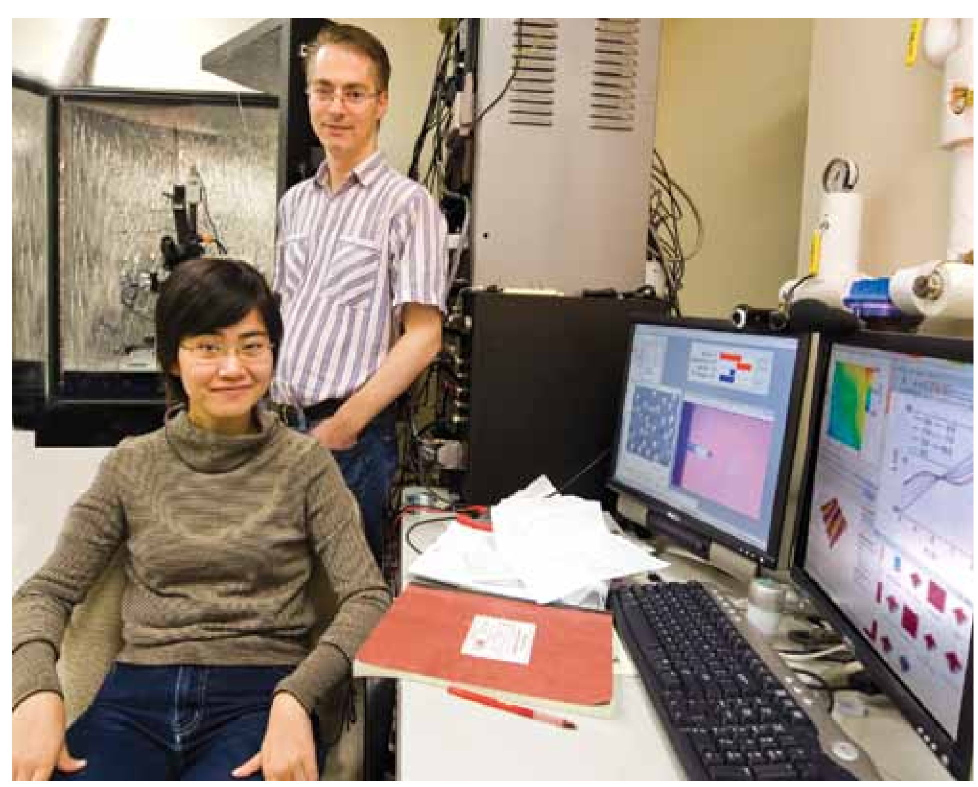
PINSE-affiliated faculty are involved in more than 100 nanoscience-related research projects during any given year. Their work is supported by an estimated $12 million in grants from federal government agencies, ranging from the National Science Foundation (NSF) and the Department of Energy to the Department of Defense and the National Institute of Standards and Technology. Many faculty have received prestigious awards, including at least 10 PINSE-affiliated scientists who have earned an NSF Career Award.

In fact, Pitt is regularly ranked among the top seven universities in both nanotechnology research and nanotechnology commercialization by *Small Times*, the leading nanotechnology trade publication. "Its breadth of expertise, resources, and publishing activities," the magazine recently wrote, "puts Pitt near the top for micro and nanotech research."



JIM BURKE/CIDDE

One of the key instruments in Pitt's nano lab is the X-ray diffraction system (above), which analyzes the structural properties of nanomaterials at the atomic or molecular level. The University's Petersen Institute for NanoScience and Engineering (PINSE) has invested almost $12 million to stock its facility with more than two dozen of the most advanced instruments required for high-level nanoscience research. Pictured are Hong Koo Kim (left) and Hrvoje Petek.



JIM BURKE/CIDDE

Jeremy Levy, (standing) a professor of physics and astronomy in Pitt's School of Arts and Sciences, researches nanosize structures and hopes to advance the basic science that underlies quantum computing. He and Cheng Cen, who recently earned her PhD in Levy's lab, are in front of an atomic-force microscope that is used to create the nanosize structures.

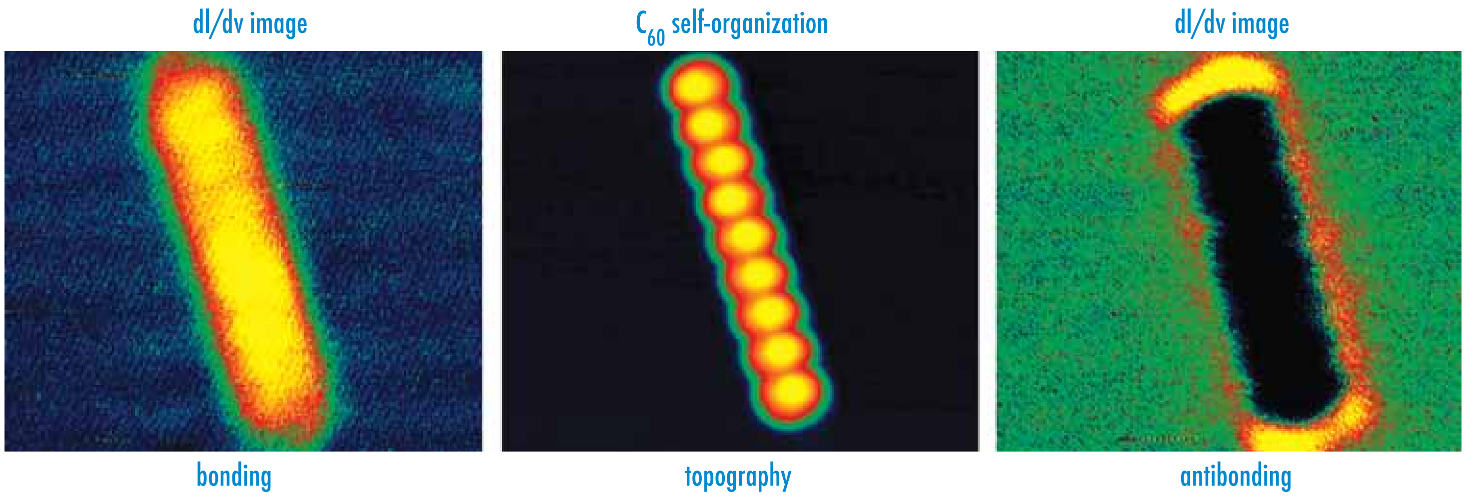
A Quantum Challenge

For decades, quantum computing has been a grand challenge for physicists seeking to realize nanoscience's potential for surpassing the speeds and computational abilities of today's best computers. Jeremy Levy's ambitious experimental research program is directly addressing the many challenges that must be overcome to reach that elusive goal.

Levy, a professor of physics and astronomy in Pitt's School of Arts and Sciences and director of the Center for Oxide-Semiconductor Materials for Quantum Computation, works to understand and create nanosize structures, investigate their properties, and discover new physics in the process. His laboratory specializes in a class of materials known as complex oxides, which act somewhat like semiconductors but have a more robust behavior.

Working with a system consisting of two oxides—a layer of lanthanum aluminate about 1 nanometer thick grown onto strontium titanate—Levy found that the

Spotlight on **Research**



As part of his exploration of single-molecule machines, Hrvoje Petek, Pitt professor of physics and chemistry and PINSE codirector, is investigating the fullerene C60, a molecule composed entirely of carbon that resembles a soccer ball-like hollow cage. Single-molecule machines show promise in advancing the miniaturization of electronics. Here, experimental and theoretical images of the superatom states of C60 molecules are shown along with images showing a line of nine C60 molecules on a copper surface where the superatom states transmit electrons as if they were metal atoms.

interface between the two materials can be switched between a conducting phase and an insulating phase. His lab also invented a method to control the process, which, he says, is reminiscent of an Etch A Sketch® toy. From those oxide nanostructures, his lab was able to make a transistor roughly 1,000 times smaller than those used in today's computers.

His work with oxide nanostructures has implications for advancing the basic science that underlies quantum computing. Recently, he was awarded a $7.5 million Multidisciplinary University Research Initiative grant from the U.S. Air Force Office of Scientific Research to support his work on quantum preservation, simulation, and transfer in oxide nanostructures. "What we are trying to do is to develop new types of quantum technology that utilize the properties of superconductors," says Levy. In one of those projects, researchers in Levy's lab are trying to discover new particles that have been predicted but never observed before in the universe. These particles possess topological properties that allow them to be "braided" in ways that offer advantages for developing a quantum computer, such as making it more tolerant of errors. "We are dealing with some of the most challenging parts of quantum computing," Levy says.

Jeremy Levy, Pitt professor of physics and astronomy, invented a way to control the way in which electricity flows at the interface between two types of oxides. Using this process, which he likens to an Etch A Sketch® toy, Levy made a transistor about 1,000 times smaller than those in today's computers.

Back to the Future

When it comes to nanomachines, none have been around longer than a prolific and diverse population of viruses known as bacteriophages. Recent evidence suggests these microorganisms evolved in nature at least 3.5 billion years ago, perhaps near the beginning of life itself—the "original nanomachines," Roger Hendrix calls them.

One notable attribute of bacteriophages is their ability to infect bacteria. They can penetrate bacterial cells, become one with them, and either kill or alter them. But they are not well understood, despite their advanced age and the fact that some 10 million trillion trillion individual bacteriophages are estimated to be roaming the planet at any one time.

A Distinguished Professor of Biological Sciences in Pitt's School of Arts and Sciences, Hendrix studies how bacteriophages—which have been refined by natural selection over billions of years of existence—are assembled from their component parts. Each bacteriophage has a protein shell for a head and a tail that is part of the machinery for injecting DNA into the cell that it infects.

Of particular interest to Hendrix is the introduction of DNA during the head assembly process and the elaborate rearrangement the protein shell then undergoes to make it more stable, sturdy, and resistant. The tail assembly also has its mysteries to solve. One is understanding how the tail is assembled to the same length for all bacteriophages in a population.

"It's a general question about how you assemble biological structures or nanostructures," says Hendrix. "How are the dimensions determined? If you're making a structure out of identical bricks, how do you know when to stop piling up the bricks?"

Answering such questions about bacteriophage assembly could have implications for the development of a range of nanotechnologies. "These nanomachines are more sophisticated than anything anyone can build in the lab these days," says Hendrix. "So understanding how they work is informative for understanding how we can make nanomachines."

JOE KAPLEWSKI/CIDDE

Roger Hendrix, Distinguished Professor of Biological Sciences in Pitt's School of Arts and Sciences, studies bacteriophages, which are viruses that evolved at least 3.5 billion years ago. Left, Hendrix works with Bonnie La, a second-year doctoral student, as they perform an electrophoretic analysis of the proteins of one of the phages studied in Hendrix's lab.

Faculty are involved in more than 100 nanoscience-related research projects during any given year. Their work is supported by an estimated $12 million in grants from federal government agencies, ranging from the NSF and the Department of Energy to the Department of Defense and the National Institute of Standards and Technology.

Breaking Speed Limits

A modern computer processor with a clock rate of a few gigahertzes can operate its transistors at a rate of about once every nanosecond. Most people would likely see that as fast; Hrvoje Petek sees it as an opportunity.

"In principle," says Petek, a physics and a chemistry professor in Pitt's School of Arts and Sciences and PINSE's codirector, "we should be able to make electronic devices that are much faster and that would consume much less energy if we could combine light with conventional electronics."

The focus of Petek's research is ultrafast phenomena in solid-state materials. And by ultrafast, he means phenomena that occur on time scales that are less than 10^{-12} second. An area of particular interest is ultrafast electron microscopy. One result of this work is the time-resolved photoemission electron microscope his laboratory developed that can image electric fields in a solid-state material or nanostructures with a remarkable 10^{-14} second time resolution.

"We have speeded up microscopy by many orders of magnitude," says Petek. "What this allows us to do is to image light on a nanometer scale."

Using the microscope, Petek is able to make movies of light being trapped inside metal particles and metal films. "The light pulses we can trap in nanofilms on nanometer scale may be combined with conventional electronic devices to speed them up and to reduce their energy consumption. To achieve that, the first thing that is necessary is to take movies of these trapped light pulses inside a metal film on both a femtosecond (one quadrillionth of a second) temporal scale and a nanometer spatial scale."

Petek is also exploring single-molecule machines. Using a scanning tunneling microscope, for example, he can shoot single electrons into a molecule and learn how its internal structure can be manipulated. It's a step into the next frontier in electronics. "There is going to be a limit on how far conventional electronic devices can be shrunk," Petek says. "At some point, rather than using silicon, there may be advantages to using molecular materials. Such single-molecule devices represent the smallest miniaturization of a device one can imagine."

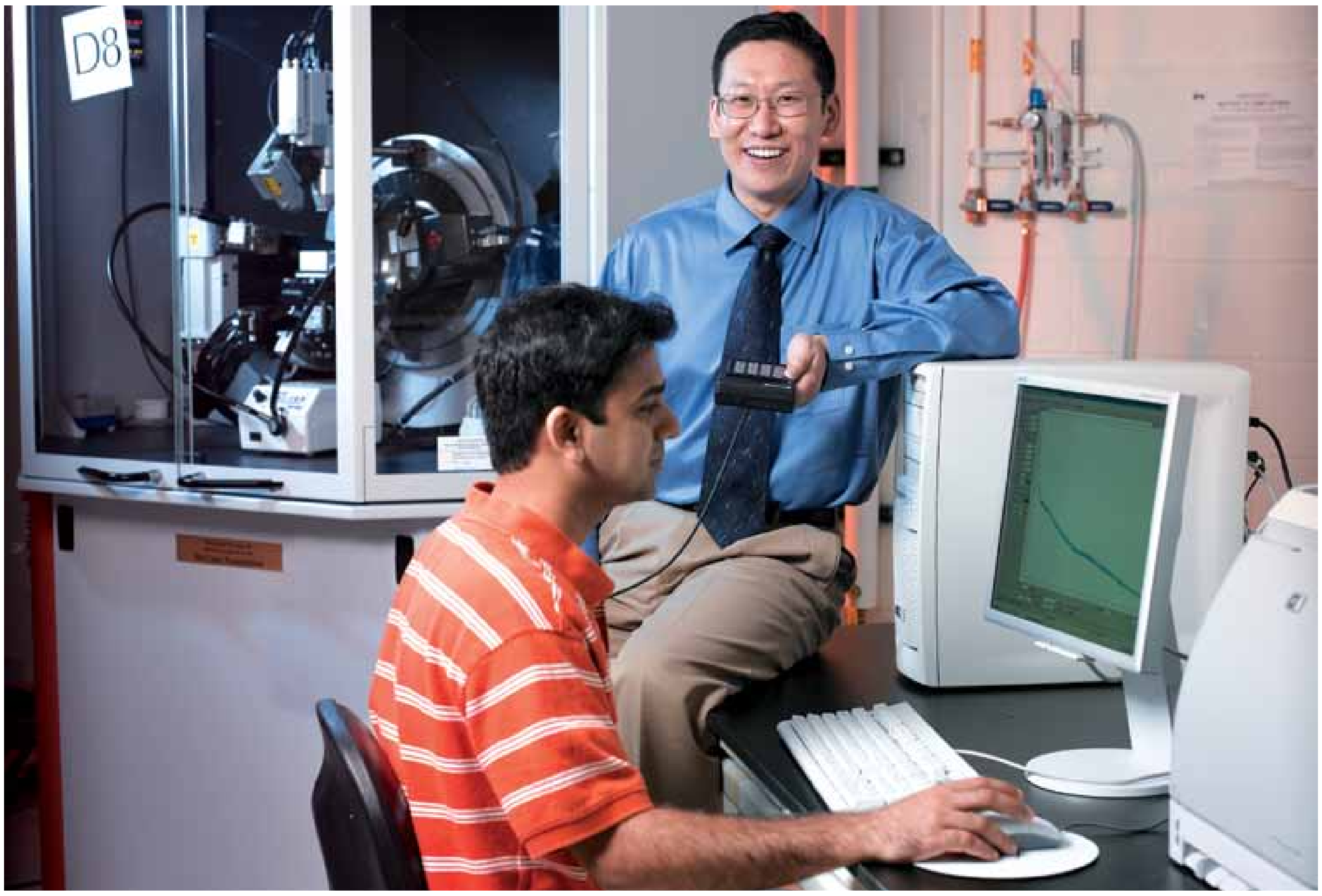
Ice and Sun

In his laboratory, Di Gao is investigating ways of modifying surfaces with nanoparticles that some day might lead to ice-proof roads, while also exploring the use of nanowire arrays to solve a stubborn problem confounding the development of a promising new technology for harnessing the power of the sun.

Continued on page 6

The Age of NanoScience and Technology

Continued from page 5



RIC EVANS

Part of the nanoscience research being done by Di Gao, a Pitt assistant professor of chemical and petroleum engineering and a W. K. Whiteford Faculty Fellow, is discovering how nanoparticles can be used to prevent ice buildup on road surfaces as well as on airplane wings and power lines. Above, Gao works with Ashish Yeri, a fourth-year PhD student. The large machine in the background is an X-ray diffractometer, which is used to examine the crystallinity of materials.

Gao is applying his study of superhydrophobic surfaces to develop coatings that prevent the conditions necessary for icing to begin. Particle size, in particular, is critical. And if making an anti-icing material is the goal, smaller is better. Gao's laboratory exploits that scientific fact by developing coatings that are a blend of polymers and nanoparticles small enough to deny supercooled water the nucleation center necessary for ice to form.

"Water basically gets bounced away," says Gao, an assistant professor of chemical and petroleum engineering and a William Kepler Whiteford Faculty Fellow at Pitt. "Eventually this can be applied to power lines and the wings of airplanes to prevent icing."

Road surfaces present another challenge. The coating when applied to a road surface won't endure the abuse of traffic and other factors. So, Gao is collaborating with other Pitt scientists to make an anti-icing concrete containing nanoparticles.

In his laboratory, Di Gao is investigating ways of modifying surfaces with nanoparticles that some day might lead to ice-proof roads, while also exploring the use of nanowire arrays to solve a stubborn problem confounding the development of a promising new technology for harnessing the power of the sun.

Gao's laboratory is also focusing its expertise on improving the efficiency of dye-sensitized solar cells, an emerging technology with the potential to harvest energy at a significantly lower cost than silicon-based cells; this research is attracting considerable attention throughout the world.

The emerging technology's potential won't be realized, however, until these new solar cells can be made to do a better job converting infrared light into electricity. One problem with current dye-sensitive solar cells is their disordered nanoparticle network, which requires electrons to hop between particles. Gao is trying to solve that problem by using ordered, or vertically aligned, titanium oxide nanowire arrays, which, he says, "give the electrons a freeway to get out of the cell and improve the electron transport efficiency of the anode."

Unconventional Optics

A basic premise of conventional optics is that light bends in a certain way when it enters a different medium. PINSE codirector Kim is interested in manipulating light in novel ways that cannot be achieved with conventional optics.

One of his interests in particular is making light bend the opposite way from its natural way of bending— and developing new nanomaterials that will allow that to be exploited as a platform for new applications ranging from extremely high resolution imaging to advanced photovoltaic devices.

While the potential for so-called negative-index metamaterials has been recognized and pursued for several years, moving the technology from the laboratory to real-world applications has been problematic. In most approaches, for example, light is lost as it travels through the metamaterials. And these materials work only for a narrow spectral range. Both drawbacks limit the materials' practical usefulness.

Kim, however, is taking a different approach, developing a nano-optic structure that can bend light in a negative direction in a way that is amenable to a wide range of wavelengths, is relatively easy to fabricate, and is almost lossless, meaning that light passes through it with minimal loss of energy. Such properties open the door to a host of possible advanced uses.

For instance, the new nano-optic structure, when used for imaging, could make it possible to produce smaller transistor patterns. The structure also has promise as an advanced lens capable of observing extremely small objects, achieving higher-resolution imaging than is currently available.

It could also lead to enhancing efficiencies of photovoltaic devices. "By bending light, this approach, this structure, allows the light to interact with thin-film solar cell material at longer distances," says Kim. "That means better absorption and better utilization of that solar energy, which produces higher efficiencies in electricity generation."

Photovoltaic Paint

Among the potential benefits of nanoparticles is the possibility of finally solving one of the major problems standing in the way of realizing a commercially viable photovoltaic paint able to convert sunlight into electricity. Although the world is moving closer to such a solar-power paint, available technologies fall short of reaching the needed conversion efficiencies because too few of the solar photons they absorb are converted into electrons. One scientist working on that problem is David Waldeck, a professor of chemistry and chair in Pitt's Department of Chemistry in the School of Arts and Sciences, whose research interests include understanding and controlling electron motion on nanometer scales.

Waldeck's laboratory is making composite materials of nanoscale bits of semiconductor that are mixed with a conducting polymer material. These semiconductor nanoparticles have several advantages. "We are able to tune the color of light they absorb and where their energy levels lie by changing their size," says Waldeck. "By changing the surface coating on the nanoparticles, we can place them at the interface of two different polymers and absorb most of the light at the boundary of the polymers. Because we can make one of the polymers be a cathode and the other polymer an anode— like the poles of a battery— absorbing the light at that boundary allows us to very efficiently drive the electron from one phase to another."

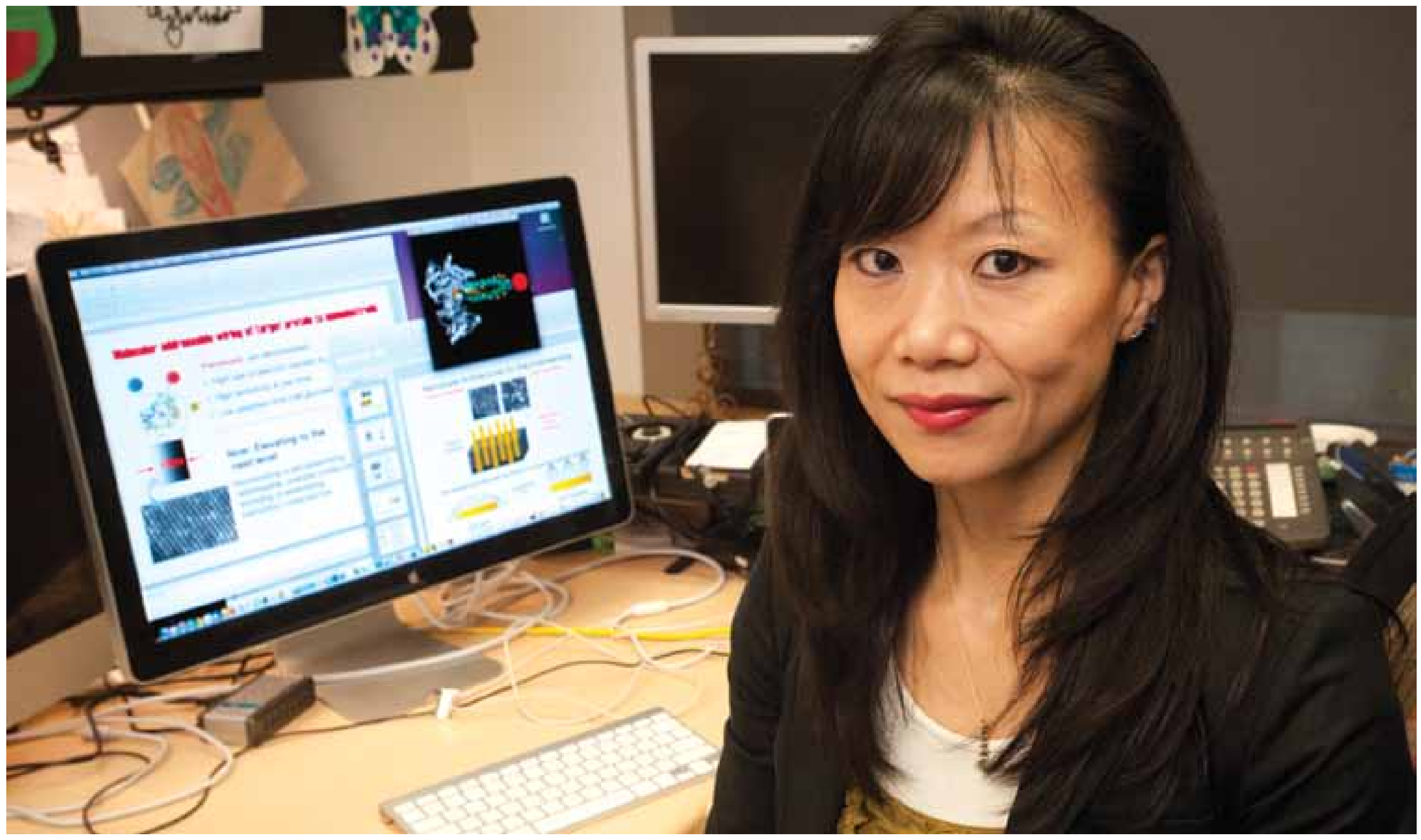
Such a development would offer a more efficient and less expensive process for converting light into electricity. "If it all works, you will be able to 'paint' your roof one day, plug it in, and save on your electricity bill. That's the basic idea."

Another research interest of Waldeck's is understanding how to manipulate light on nanometer-length scales. This work has led to a collaborative project with Joanne Yeh, a professor in the Pitt School of Medicine's Department of Structural Biology,

CIDDE

Pitt's David Waldeck (seated) works with Hong Koo Kim (standing left), and David Geller, the Richard L. Simmons Professor of Surgery in Pitt's School of Medicine and codirector of the UPMC Liver Cancer Center. Waldeck's research is focused on finding a way to use nanoparticles to make a commercially viable photovoltaic paint that can convert sunlight into electricity. Waldeck is a professor of chemistry and chair of the Department of Chemistry in the School of Arts and Sciences.

Among the potential benefits of nanoparticles are the possibilities of solving such problems as developing a viable photovoltaic paint able to convert sunlight into electricity ... or highly sensitive biodegradable sensors for early detection of diseases.



JOE KAPLELEWSKI/CIDDE

In the laboratory of Joanne Yeh (above), a professor in the School of Medicine's Department of Structural Biology, researchers are working on applying nanotechnology to medical problems. Yeh's lab has, for example, developed a biosensor capable of detecting prostate-specific antigen (PSA) levels in blood and urine. Currently, a blood test is the most common means of measuring elevated PSA levels, which can indicate cancer or other prostate problems. Yeh's computer screen shows images of what her lab's nanobiosensors look like at the atomic or nanoscale.

to develop enhanced biosensors that have drawn support from the National Institutes of Health and the National Aeronautics and Space Administration.

Waldeck's laboratory is creating thin metal films approximately 200 nanometers thick that are structured with holes, rings, or slits that enable them to direct the path along which light travels. Yeh's laboratory integrates biological materials onto these nanoplasmonic devices. The idea is to create new nanoplatforms for performing chemical and biological analysis using the same concepts of miniaturization and integration that have been so successfully applied to electronics.

A Role in Human Health

Applying nanotechnology to clinically relevant medical problems is an area attracting a great deal of interest and one that Pitt researchers have actively explored for several years.

Yeh, for example, has developed in her laboratory a novel approach called "coordinated biosensing" to make highly sensitive, biodegradable sensors for early detection of diseases. This process involves integrating another area of study in Yeh's laboratory, elucidation of the three-dimensional atomic resolution structures of proteins and nucleic acids by the single crystal X-ray diffraction method to form active "nanobioassemblies." Her approach enables the precise spatial incorporation of each sensor component to maximize the functionality and sensitivity of the biosensor. In addition to being highly sensitive, these biosensors are platform-independent and easily miniaturized.

Using this approach, Yeh's lab developed a biosensor capable of detecting prostate-specific antigen (PSA) with unprecedented sensitivities. Elevated PSA levels in men are an indication of prostate cancer and other prostate disorders. A blood test administered in a doctor's office or clinic is currently the most common method of measuring PSA levels. Yeh's biosensor has the potential to change that. One clear advantage Yeh's biosensor holds over conventional tests is that it accurately detects PSA in urine as well as in serum.

"We've tested our biosensors, and they are very accurate and robust," says Yeh. Moreover, they are small, inexpensive, and easy to use. The idea is that this technology will someday become a self-administered sensor that can be purchased at a pharmacy, much like today's home pregnancy tests. The sensors also have the potential to improve early detection of prostate cancer in places where health care resources are limited, like rural regions and Third World nations.

Yeh says the PSA biosensor is a preview of what is likely to develop from the marriage of nanotechnology and biomedicine. "Our goal is to develop these nanobiosensors not only for PSA [tests] but also for other diseases or other clinical markers that are relevant for determining abnormal disease states."

Supersensitive Detectors

Turning carbon nanotubes into chemical and biological sensors is one of Alexander Star's research interests. His research group recently used tubes with diameters 100,000 times smaller than a human hair to develop a sensor that can warn asthma sufferers of an impending attack.

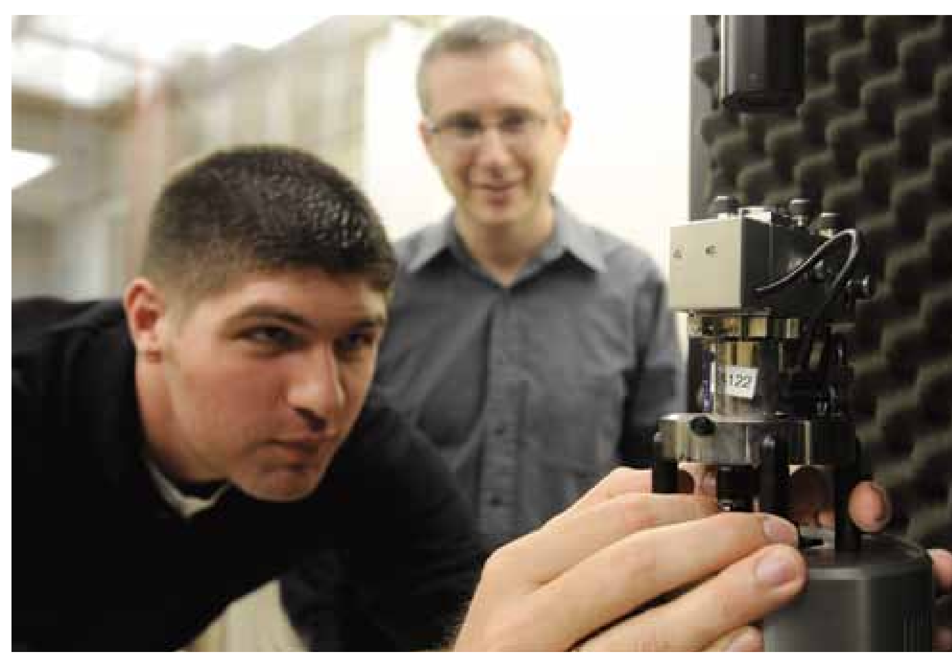
The sensor detects concentrations of nitric oxide in human breath. Nitric oxide is a marker of inflammation. Rising levels of the gas suggest a buildup of inflammation in the airways, which can predict an asthma attack.

A nanotube's advantage in detection is its extremely small size. When gas molecules like nitric oxide bind to the surface, they significantly impede the flow of electrical current— an event that can be detected. "Ideally, such sensors could be sold in pharmacies, like glucose sensors that test glucose levels in blood," says Star, an assistant professor of chemistry at Pitt. "People would be able to detect the nitric oxide levels in their breath and take their asthma medication as a preventive treatment."

Star's lab also found that cup-like nanomaterials can be built with nitrogen by stopping their growth at small segments. The lab is investigating how these nanocups can be joined to form hollow capsules, which might someday be used for targeted drug delivery. "We can figure out how to fill them with drugs and hopefully use them as next-generation therapeutic systems," Star adds.

For that to happen, nanomaterials must be made to safely degrade in the human body. Star's research includes investigating the impact such materials have on the environment and on human cells. His lab, for example, was the first to discover that enzymes derived from horseradish could be used as a catalyst for degrading nanotubes.

Recently, the first human enzyme capable of biodegrading carbon nanotubes was identified by an international team of researchers led by Valerian Kagan, a professor and vice chair in the Department of Environmental and Occupational Health in Pitt's Graduate School of Public Health. Tests on mice have suggested that inhaling carbon nanotubes can result in severe inflammation in the lungs and early onset of fibrosis. The researchers found that nanotubes degraded



JIM BURKE/CIDDE

Alexander Star (background), an assistant professor of chemistry in Pitt's School of Arts & Sciences, is working with other researchers in his lab to turn nanotubes into chemical and biological sensors. His research group recently used tubes with diameters 100,000 times smaller than a human hair to develop a sensor that can warn asthma sufferers of an impending attack. Above, Brett Allen, who recently completed his doctoral degree in chemistry under Star's supervision, uses an atomic force microscope to visualize carbon nanotubes.

with the human enzyme myeloperoxidase did not cause lung inflammation.

The findings suggest that carbon nanotubes might someday be developed as a safe method of delivering drugs and that a natural treatment for people exposed to carbon nanotubes is possible.

Pitt researchers, in fact, have been among the most proactive in investigating the potential adverse effects of nanotechnology. "Carbon nanotubes are being used in products, and companies want to produce them in large quantities," says Star, who was among the researchers involved in the Kagan study. "It's only appropriate to look at how they affect the body and the environment."

Far-Reaching Contributions

In microelectronics, basic research in solid-state physics and semiconductor materials led to new circuitry, small-scale chips, and other advances from which powerful personal computers, cell phones, and other technologies widely used today have evolved. The NNI, more than a decade ago, envisioned nanotechnology taking a similar trajectory, starting with understanding the underlying science and creating simple materials before evolving to more advanced materials and structures.

"Good research has specific goals," says Vice Provost Klinzing. "Often the goal is to answer an important question, improve an existing technology, or create a transformational technology. The importance of these goals is in proportion to their capacity to help improve the quality of our lives, reduce suffering, and lift the human spirit."

Pitt nanoscience investigators, accepting those challenges, are well positioned to make more than incremental advances. "We anticipate making more fundamental contributions in the future that will be even more far-reaching," says Kim.

University of Pittsburgh
PittChronicle
University News and Magazines
University of Pittsburgh
400 Craig Hall
200 South Craig Street
Pittsburgh, PA 15260

Happenings

Eduardo Trassierra Trio, William Pitt Union, October 13

Concerts

Eduardo Trassierra Trio, contemporary flamenco, noon **Oct. 13**, free, Nordy's Place, Lower Level, William Pitt Union, PITT ARTS' Artful Wednesdays, 412-624-4498, www.pittarts.pitt.edu.

Yo-Yo Ma and Kathryn Stott in Recital, renowned cellist and British pianist, respectively, 8 p.m. **Oct. 16**, Heinz Hall, 600 Penn Ave., Downtown, Heinz Hall Special Presentation, Pittsburgh Symphony Orchestra, 412-392-4900, ww.pittsburghsymphony.org, PITT ARTS Cheap Seats, 412-624-4498, www.pittarts.pitt.edu.

Exhibitions

Conney M. Kimbo Art Gallery, *Haiti Rising,* **Oct. 14-17**, Main Floor, William Pitt Union, Haitian Art Society of Pittsburgh, 412-624-0909.

Carnegie Museum of Art, *The Art of Structure,* **through Jan. 17**; *Past Meets Present: Decorative Arts and Design at Carnegie Museum of Art*, **ongoing**, 4400 Forbes Ave., Oakland, 412-622-3131, www.cmoa.org.

August Wilson Center for African American Culture, *In My Father's House*, mixed-media exhibition about how African Americans collect and preserve their culture, **ongoing,** 980 Liberty Ave., Downtown, Pittsburgh Cultural Trust, 412-456-6666, www.pgharts.org.

Lectures/Seminars/Readings

"Developing Competitive Grant Applications Under the New NIH Guidelines," Bruce Freeman, professor and chair, Department of Pharmacology, Pitt School of Medicine, 8:30 a.m. **Oct. 12,** S120 Thomas E. Starzl Biomedical Science Tower, Pitt Office of Academic Career Development, www.oacd.health.pitt.edu.

"Aspirin, Vioxx, and Stroke: Cyclooxygenase Mechanism of Stroke, Neuroprotection, and Recovery," Steven H. Graham, Connolly Family Chair, Stroke Institute, Pitt School of Medicine, 4 p.m. **Oct 12**, 2500 Posvar Hall, Provost Inaugural Lecture, 412-624-5750.

"Visualizing Britain Through Time: Building and Using an Indefinitely Scalable Library of Individual Statistical Data Values," Humphrey Southall, University of Portsmouth, U.K., 3:30 p.m. **Oct. 13**, 501 Information Sciences Building, Pitt World History Center, www.worldhistory.pitt.edu.

"Minority Health and the Media," Brian Primack, assistant professor, Pitt School of Medicine, noon **Oct.14,** Edward J. Forrest Continuing Education Center, Second Floor, Salk Hall, Pitt Office of Health Sciences Diversity, 412-648-2066, www.healthdiversity.pitt.edu.

"Teaching Clinical Reason," Jerome P. Kassirer, special assistant to the dean, Tufts University's School of Medicine, noon **Oct. 14**, Lecture Room 3, Scaife Hall, Pitt Medical Education Grand Rounds, 412-648-9000, www.megr.pitt.edu.

Roundtable Discussion with artists participating in Mattress Factory exhibition *Queloides: Race and Racism in Cuban Contemporary Art—A Conversation With Cuban Artists,* noon **Oct. 14**, 4130 Posvar Hall, Pitt Center for Latin American Studies, www.ucis.pitt.edu/clas. Exhibition runs Oct. 15 through Feb. 27.

"The Inside Track to a Top-Notch Internship," panel discussion with news, publishing, and public relations professionals, 7:30 p.m. **Oct. 14**, Ballroom, William Pitt Union, Pitt Department of English, 412-624-1737, www.english.pitt.edu.

Miel para Oshun, Frick Fine Arts Auditorium, October 14

"Economic Hit Man Details His Experience Exploiting Latin America and the Middle East," John Perkins, *New York Times* best-selling author, 8 p.m. **Oct. 14**, Auditorium, Soldiers and Sailors Memorial Hall & Museum, 4141 Fifth Ave., Oakland, Pitt Women's Studies Program, wstudies@pitt.edu.

"Teaching Faulkner," Julia Stern, professor of English and American Studies, Northwestern University, 12:30 p.m. **Oct. 15,** 526 Cathedral of Learning, Pitt's Humanities Center, humctr@pitt.edu, www.humcenter.pitt.edu.

Poetry Reading, Jennifer Kwon Dobbs, assistant professor of English, St. Olaf College, 4 p.m. Oct. 15, 208B Cathedral of Learning, Pittsburgh Consortium for Adoption Studies, mnovy@pitt.edu.

"August Wilson's Pittsburgh," Pitt history professor Laurence Glasco, 2 p.m., Synod Hall, 125 N. Craig St., Oakland, St. Paul Cathdral's Race & Reconciliation Dialogue Group, 412-681-8528.

Miscellaneous

Miel para Oshun (2001), directed by Humberto Solás, part of Cuban Eyes/Cubanize: Fifty Years of Cuban Cinema Since the Cuban Revolution film series, 6:30 p.m., **Oct. 14**, Frick Fine Arts Auditorium, www.amigosdelcinelatinoamericano.wordpress.com.

First Person Plural (2000), directed by Deann Borshay Liem, 7:30 p.m. **Oct. 14**, 4130 Posvar Hall, Pittsburgh Consortium for Adoption Studies, mnovy@pitt.edu.

Pittsburgh Code Camp 2010.2, event to help promote software development in the community, 8 a.m.-5 p.m. **Oct. 16,** 5th and 6th floors, Sennott Square, Pittsburgh.Net Users Group, 412-716-2594.

"Oral Presentations," workshop, 10 a.m. **Oct. 16,** Lecture Room 2, Scaife Hall, Pitt Survival Skills and Ethics Program, 412-578-3716, survival@pitt.edu.

Opera/Theater/Dance

The Barber of Seville by Gioacchino Rossini, libretto by Cesare Sterbini, **Oct. 12, 15, and 17**, Benedum Center, 803 Liberty Ave., Downtown, Pittsburgh Opera, 412-456-6666, www.benedumcenter.org, PITT ARTS' Pitt Night is **Oct. 15**, PITT ARTS Cheap Seats, 412-624-4498, www.pittarts.pitt.edu.

Pitt PhD Dissertation Defenses

Terri C. Thayer, School of Medicine's Immunology Graduate Program, 3:30 p.m. **Oct. 13,** "Critical Role of Superoxide Production in the Pathogenesis of Autoimmune Diabetes," S120 Starzl Biomedical Science Tower.

Gail Yamnitzky, School of Education's Administrative and Policy Studies, "Elementary Teachers' Perspectives on the Impact That Lesson Study Participation Had on Their Mathematical Content and Pedagogical-Content Knowledge," 8 a.m. **Oct. 14,** 4321 Posvar Hall.

Kai Heidemann, School of Arts and Sciences' Department of Sociology, 10 a.m. **Oct. 14,** "Giving Voice to Language: Basque Ethnolinguistic Mobilization and the Politics of Education Reform in France," 2432 Posvar Hall.

Divyasheel Sharma, School of Information Sciences' Graduate Program in Information and Technology, 10 a.m. **Oct. 14,** "Efficient Information Access in Data Intensive Sensor Networks," 1A04 Information Sciences Building.

Michael J. Welinkonich, School of Education's Department of Health and Physical Activity, "Effect of Carbohydrate-Protein Supplementation on Resistance Exercise Performance, Perceived Exertion, and Salivary Cortisol," 1 p.m. **Oct. 14**, Petersen Events Center Conference Room.

PUBLICATION NOTICE The next edition of *Pitt Chronicle* will be published Oct. 18. Items for publication in the newspaper's *Happenings* calendar (see page 7) should be received six working days prior to the desired publication date. *Happenings* items should include the following information: title of the event, name and title of speaker(s), date, time, location, sponsor(s), and a phone number and Web site for additional information. Items may be e-mailed to chron@pitt.edu, faxed to 412-624-4895, or sent by campus mail to 422 Craig Hall. For more information, call 412-624-1033 or e-mail robinet@pitt.edu.