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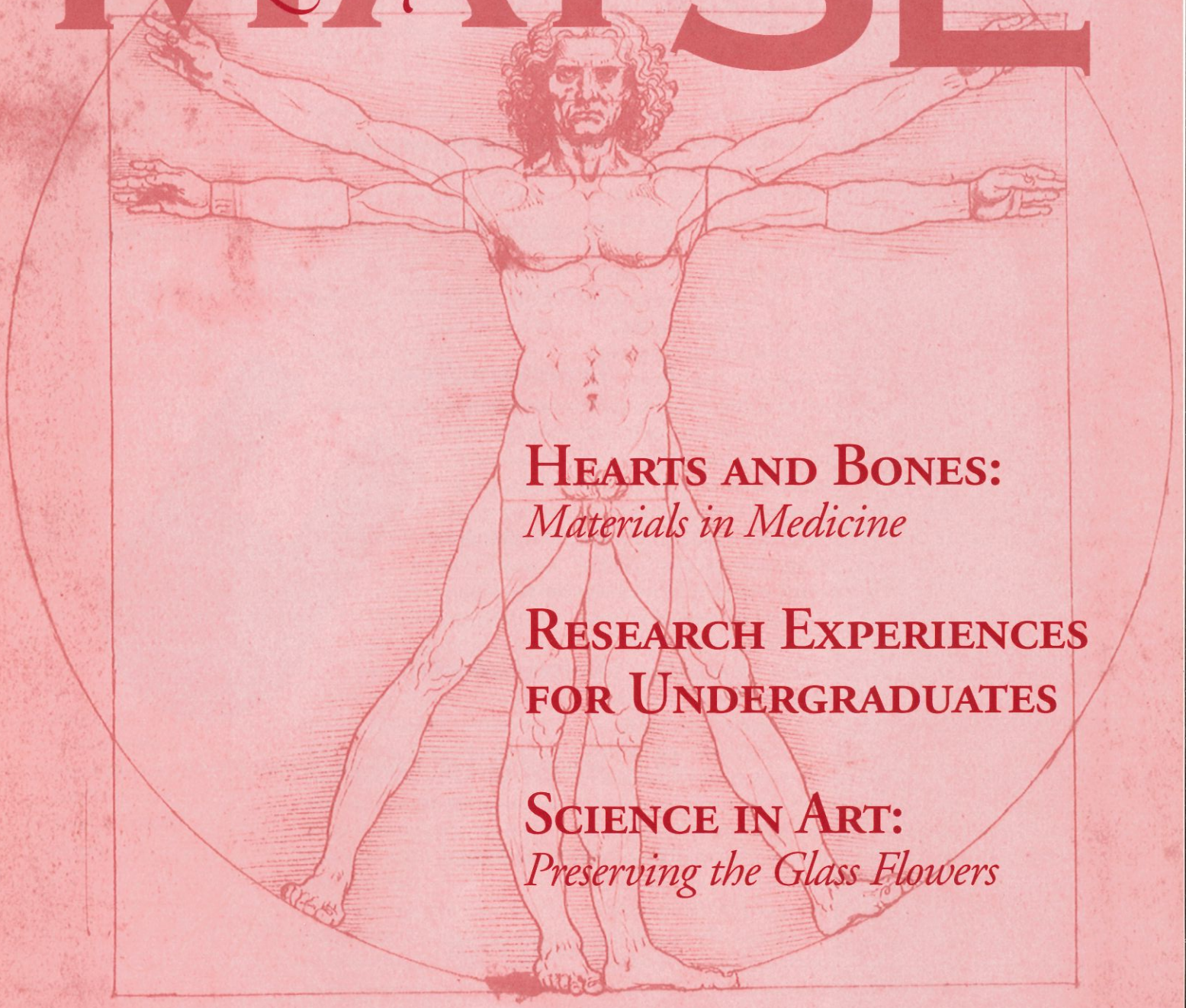

Hearts and Bones:
Materials in Medicine

Research Experiences for Undergraduates

Science in Art:
Preserving the Glass Flowers

PENNSTATE

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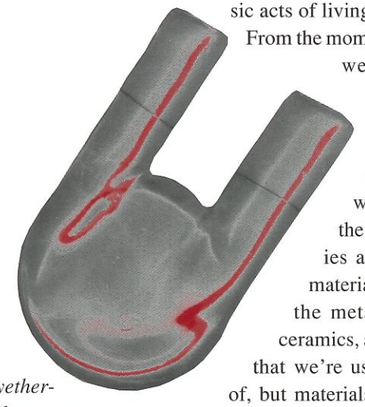
contents:

HEARTS AND BONES
MATERIALS IN MEDICINE

The heart. Some revere it as the source of human love. Biologically speaking we can't live without it because it moves the life-giving blood through our bodies. And think about the time you broke a bone in your arm or leg. How much more difficult was it to carry out the basic acts of living?

From the moment we're born, we begin aging. Along the way there is disease or accidents that can wreak havoc in the body. Our bodies are all made of materials. Perhaps not the metals, polymers, ceramics, and composites that we're used to thinking of, but materials—or biomaterials, if you will—nonetheless. And just like other materials used in extreme environments or for moving parts, the body's materials can crack, break, or just wear out.



A polyether-urethaneurea blood sac used in the Penn State Total Artificial Heart.

Today people live much longer than they used to—many of them outlasting their "parts." In the harsh and unforgiving biological environment of the body, it's not always easy to replace something that is broken or worn out—the body won't let you put just anything in it. Besides, spare parts for humans aren't readily available. But in this world where materials can take us into space, perhaps they could be used to mend bone, replace organs, save lives? Why not see if we can make the parts? It seems the perfect challenge for a materials scientist.

Materials science and engineering department head Richard Tressler says, "we have an unusual opportunity in the biomaterials area because of our size and diversity, coupled with the Hershey Medical School, our Life Sciences Consortium, and the veterinary medicine facilities." Two faculty in the Department of Materials Science and Engineering are already using Penn State's capabilities as they venture into the world of biomaterials. Jim Runt, professor of polymer science, is involved in the Penn State Artificial Heart project. Paul Brown, professor of ceramic science and engineering, studies hydroxyapatite for its potential use as a synthetic bone and tooth material. A search for a third person who can draw on Penn State's strengths to form a biomaterials group is planned.

Runt and Brown study vastly different body parts, but in both cases their work must deal with the body's biological constraints in addition to the usual problems of making new materials or applying them in real-world situations.

Since the late 1960s Penn State has been involved with the development of an artificial heart at Hershey Medical Center. Why an artificial heart? Annually 20,000 people would benefit from heart replacement surgery. Unfortunately only 2,000 donated hearts are available each year for transplantation. An artificial heart that is available "off the shelf" could save innumerable lives considering the fact that many potential patients die before they are even put onto a waiting list for heart replacement.

The Penn State Heart is one of only two air-driven artificial hearts to receive FDA approval for use as a bridge to transplant. It was developed in the mid 1980s by a team at Hershey Medical Center led by physician William Pierce (now retired). The programs are now headed by Drs. Gus Rosenburg and Alan Snyder of Hershey Medical Center. The goal of the current program is to develop an electric, wireless, completely implantable, and permanent device that will allow recipients to return to a relatively normal life.

Besides the large number of people who could be helped by a total artificial heart (TAH),

Editors Note:
This article on biomaterials research is the first in a series that will focus on the research activity of our current faculty.

Annually, 20,000 people would benefit from heart replacement surgery—only 2,000 hearts are available each year for transplant.

there are a great many more who can be helped with something called a left ventricular assist device (LVAD). The LVAD is designed to assist the heart's left ventricle with the strenuous task of moving blood into the aorta. This assistance allows the heart to rest and recover from surgery, as well as keeps patients alive while they wait for a donor organ. In the current plan, the LVAD has replaced the TAH as a bridge to surgery or heart replacement, and the TAH will become a permanent heart replacement device.

Both the TAH and the LVAD incorporate fist-sized blood pumps to move the blood through their systems. The blood pumps are made of titanium housings that enclose "blood sacs" fabricated using segmented poly(etherurethaneureas) or PEUU. The use of segmented polyurethane was proposed by Pierce and his colleague, James Donachy, at the inception of the artificial heart project, and it has been used in each iteration since then. Runt's involvement with the artificial heart is concentrated on developing an understanding of the long term performance of PEUUs in biological environments and on developing experimental PEUU materials for the blood sacs used in both the Penn State heart, and for Arrow International which has plans to commercialize a ventricular assist device.

Runt explains that in the biomaterials arena of the TAH project there is an interesting situation. "The large companies that used to make blood sac materials aren't in the game anymore because they can't afford the liability. Smaller companies are involved and different materials are available now, and we need them to have good performance over time in the aggressive body environment." Runt and his group are working to improve some of the less desirable properties of the polymeric materials currently used for the blood sacs. They are also characterizing materials that have been tested *in vivo* to determine which materials are most biostable. "The holy grail is to get a blood sac that is stable for two to five years," Runt says.

The blood sacs are made by fabricating a form and dipping it repeatedly in a polymer solution. In most of the tests and comparisons that Runt's group carries out, there are several distinct, but similar, materials being evaluated for further development as blood sac materials. These include commercially available segmented PEUUs with the trade name BioSpan®, a reference material called Biomer®, and an experimental diffusion barrier material.

David Weisberg, a graduate student in Runt's group, has the responsibility of developing the new polymers for the TAH and LVAD systems. There have been some problems with the commercially available polymers in that gas and water vapor are able to transport across them, so their project is focused on creating a polymer with enhanced barrier properties. Previous attempts at synthesizing a better material for the blood sacs elicited a polymer that combined the biocompatibility of the PEUUs with another polymer—poly(isobutylene) [PIB]. The PEUUs were laminated with the PIB materials and blood sac permeability was reduced, but interface adhesion was extremely poor. Another attempt by Dr. Bronco Gordon, then Penn State professor of polymer science, and his former graduate student, Dr. James Yeh, combined the materials by creating a PEUU-PIB copolymer that was suitable for trilaminate casting and reduced permeability by an order of magnitude. However, the material's mechanical properties were compromised.

Finally, in collaboration with Gordon (now at PCI, Inc. in Arizona), Weisberg and Runt have been investigating a new synthesis process based on improving the molecular weight of the copolymer. The process places the hydroxyl groups on the initiating end of the PIB molecule which results in a backbone nearly identical to that of the commercial PEUUs, but with the requisite enhanced barrier properties. The new process allows molecular weight tailoring of the PIB macromonomer which, in previous efforts, seemed to be the key to maintaining the material's mechanical properties. Synthesis of this family of copolymers is continuing. The next task is to test its barrier and mechanical properties, and characterize what happens to it in the body.

This aspect of biocompatibility and understanding how the harsh environment of the body affects a material's properties over time is an important, even determining factor as to which material is ultimately used. Is there any degradation caused by continuous operation or biological environment exposure? What happens to the material's surface? Are the mechanical properties affected? Is it important? "These are all questions to be answered," says Runt.

Limin Wu, a visiting professor working with Runt, has just completed analysis of blood sacs, explanted from calves, that were *in vivo* for times ranging between five and 130 days. The materials were put through a battery of tests including dynamic mechanical analysis, SEM studies, gel permeation chromatography, FTIR spectroscopy, and X-ray photoelectron spectroscopy.

Developing an artificial heart is an impressive goal, and one that requires a great deal of teamwork from physicians, engineers, and scientists. The development of the Penn State heart has required nearly three decades, and it's not finished yet. It may be one of those works continually in progress—constantly being tweaked and made better. Both the artificial heart and the LVAD have been used successfully in patients. It is the kind of work that, in Runt's words, "has the potential to affect the real world." For him it has been gratifying to know that the work has a direct relationship to health issues and providing a higher quality of life for many people.

Professor Paul Brown began his career at NIST studying conventional cements for use in highway applications. It sounds like a roundabout way to become involved in biomaterials, but Brown's background in mixing components to achieve different properties in concrete systems is similar to his work on creating synthetic bone via low-temperature chemical formation of hydroxyapatite.

Hydroxyapatite has long been studied and used as a replacement for natural bone. It is recognized by the body as the natural ceramic constituent in bones and teeth. However, previous research has concentrated on producing hydroxyapatite via traditional sintering processes. One problem with sintering to form hydroxyapatite is that it requires foreknowledge of the exact part to be replaced which involves measurements, time, and a means of forming the part correctly.

Imagine a situation in which a doctor in an operating room (at around $50 per minute) opens a patient to fix a bone crushed in an automobile accident. The doctor doesn't know what she'll find. Think what it would mean if she could combine two reactants, mix them with water to create a putty-like product that can be laid down in a bone cavity, and within two hours of mixing a complete reaction would occur that produces hydroxyapatite. Brown thinks it's possible.

In fact, over the past several years, Brown and several students who have since graduated, have been able to accomplish something like the above scenario. But it wasn't always as easy as it sounds. Hydroxyapatite can have a range of compositions depending on the ratio of initial particulate reactants used. One of the first problems Brown encountered was a rate-limiting mechanism for hydroxyapatite formation. The time to formation could be anywhere from hours to weeks.

The constraints for *in vivo* hydroxyapatite formation are considerable. Not only must the chemical reaction be non-aggressive to the surrounding tissues, and occur at body temperature (38°C) and atmospheric pressure, it must occur fairly quickly. A doctor cannot leave a patient "open" for two weeks waiting for a chemical reaction to occur—just as they would not want to close a patient while a reaction is incomplete. Additionally, risk of infection begins to increase exponentially at about four hours. If chemically formed hydroxyapatite was to be a viable medical treatment, the rate limiting mechanism was a problem that had to be solved.

Brown and his students found that what caused the hydroxyapatite formation to slow was the reaction itself. When the two reactants—basically calcium and phosphate—began forming hydroxyapatite, it first formed around the particulate reactants, cutting them off from the solution and slowing the reaction time. Through solubility and phase diagram construction, Brown and his students determined that increasing the phosphate to calcium ratio, as well as reducing the reactants particulate size allowed the reaction to occur more quickly. "Get it right, and it takes two hours," says Brown. "Get it wrong and it takes two weeks." Animal studies with collaborators at Hershey Medical Center have shown that this method of formation will work *in vivo*. In fact, Brown's work has shown that eventually the body's own bone-forming and bone-destroying organisms (osteoclasts and osteoblasts, respectively), will begin resorbing the synthetic hydroxyapatite and replacing it with new "natural" bone.

But it turns out that bone is a funny thing. Generally, making a ceramic dense will make it stronger. The ceramic in bone, however, is highly porous. Sintered hydroxyapatite does not bond well with bone leaving a distinct interface between the synthetic hydroxyapatite and natural bone. This happens because natural bone ingrowth cannot occur without the presence of pores at least 75 µm wide.

In teeth, hydroxyapatite alone can be useful. Teeth are basically devoid of living materials. They are hard and dense with low mechanical loading requirements. Bone however is flexible, living, and porous. Natural bone, to get around the problems associated with the highly porous ceramic, is actually a composite. The porous ceramic component of bone is infiltrated with collagen fibrils—a biopolymer—which actually biologically enable the creation of natural bone. The collagen–bone composite exhibits high fracture toughness and good mechanical loading properties. Brown and a former student, Kevor TenHuisen, were successful in creating a hydroxyapatite–collagen composite with mechanical properties in the lower range of bone. The problem with a hydroxyapatite–collagen composite is that collagen from one person can't be put into another person without an immune system response.

Brown and his current students are working on making polymer–hydroxyapatite composites that will mimic natural bone. If they are successful, it will be years before any practical application will result from their work. Research of this type must go through a battery of experiments including *in vitro* studies, clinical trial in animals, and limited studies in humans just as the artificial heart has. But Brown is optimistic and thinks that this application has the potential to help many people. "We have an aging population," he says. "There are millions of people who could benefit from bone replacement."

Biomaterials have been around for decades. And they will continue to grow and develop into a major industry as the world population continues to age. Both Brown and Runt agree that the biomaterials area has the potential to positively affect millions of people. "The interface between the medical people and the biomaterials industry isn't optimized yet," says Brown. "But it will be." As more materials students become interested in biological applications for materials, Penn State will be there as it has in the past drawing on its collaborative strengths to train our best students and help them mend the hearts and bones of the world.

Remember your first year of college? Think back to that time, whether it be ten or fifty years ago. Your life was just beginning and you had so many options before you. So many options and no way of knowing which was the right one to choose. Confused? Maybe you were interested in science or engineering. But what kind . . . mechanical, electrical, physics or chemistry, aerospace, chemical? So many choices. Just what does an engineer do anyway?

Research Experiences for Undergraduates

This summer eighteen students came to Penn State to find out what life in the science and engineering disciplines is all about. They were participants in a National Science Foundation sponsored program called Research Experiences for Undergraduates (REU).

NSF's goal for the REU program is to attract and retain talented undergraduates in the engineering, science, and math disciplines, and encourage them toward graduate school. NSF's experience has shown that the most effective means of accomplishing that is to provide active research experiences. So for ten weeks this summer, undergraduate students came here to spend forty hours a week in a lab environment carrying out research, side-by-side with graduate students and professors. And for many of them it was their first chance to be away from home and get some real-life experience to go along with the educational one.

Most of the students who come to spend the summer at Penn State are planning to major in an engineering field, although several have been chemistry majors. They've chosen civil, mechanical, aerospace, electrical, computer, or chemical engineering. But before they received the brochure describing Penn State's REU program in materials science and engineering, not one of the eighteen students who participated in the REU program this summer had ever heard of the materials discipline.

The Department of Materials Science and Engineering's REU Site is run by Suzanne Mohney and Merrilea Mayo, respectively assistant and associate professors of materials science and engineering. In addition to NSF's goals for the program, they have several of their own. "We wanted to use the program to expose students to the materials discipline," says Mohney. For that reason, their program is unique in several ways. "We only accept students who've just completed their freshman or sophomore years," Mayo explains. "And we don't allow students to come back a second year." This allows them to filter more students through the program, spreading the word about the materials discipline farther and faster than if students were invited back for successive years.

Of the forty or fifty students who have participated in the REU program at Penn State over the past three summers, four have changed their major to materials science and engineering. Some have told their friends about their experience, and the friends have called for information on the discipline. Others are considering obtaining master's or doctoral degrees in materials. In fact, of the nineteen REU students from the initial two years of the program, 73 percent indicate that they will apply to graduate school. Another eleven percent are on a medical school track, and four percent plan to obtain an MBA. It seems that both NSF's and the REU site goals are being accomplished.

Mohney and Mayo have also focused on retaining traditionally underrepresented groups (such as women and minorities) in the engineering field through their program. "If a student works in one of our research labs," Mohney says, "that person almost always ends up pursuing an engineering degree." By giving these students research training early in their educational career, they gain insight and perspective into what an engineer or scientist really does, and they gain experience which gives them the confidence to become that person.

Mayo's follow-up research on students who have participated in the program shows that of the 87 percent contacted from the initial two years of the program, 96 percent are still in science, math, or engineering. (Compare that to the average national retention rate of 36 to 39 percent that Mayo uncovered in several reports to government and private agencies.)

The success of Mayo and Mohney's REU site has been systematically built into the program in several ways. First, the REU experience mirrors that of new graduate students. Each REU student is matched up with a professor whose interests or research parallels the student's interests or major. For instance a mechanical engineering student might work with a professor whose research involves studying the mechanical properties of materials. Secondly, Mayo and Mohney have carefully designing the types of research experiences that the students are offered. In general, all the projects fall into the broad category *materials processing for optimized properties*.

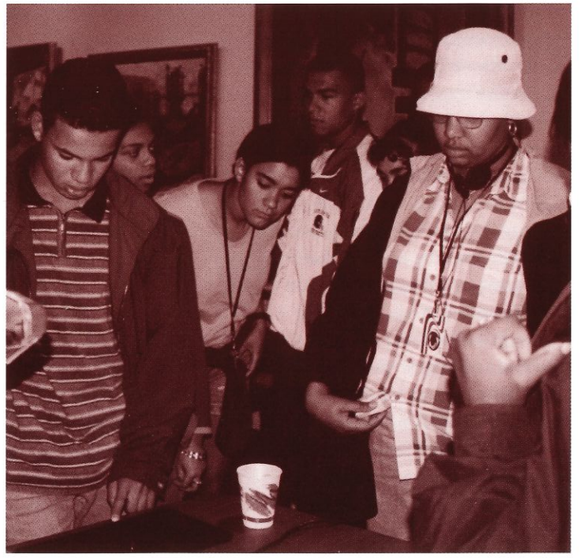
In their original proposal to NSF, Mohney and Mayo stated "because processing projects are invariably hands-on and produce quick, visible connections between cause and effect, such projects are ideal for stimulating undergraduate interest." Additionally, students of varying abilities can be integrated easily into a research program. Projects can begin with a straightforward "recipe" approach to processing, advance through more complicated aspects such as characterizing the resulting material, and eventually focus on optimizing the material's properties, which involves an understanding of the relationship between processing variables and the end product. Students can progress through this sequence at their own pace, building on their successes.

Besides spending their days in the lab, the REU students take tours of other Penn State research facilities and attend lectures so that they receive a well-rounded view of the materials discipline. They tour the Applied Research Lab's laser welding facility, the Materials Research Institute Building with its state-of-the-art Class 10 clean rooms, the spray metal forming facilities, and IMRL's diamond labs. As a group, this year's REU students concluded that it was really amazing how materials science and engineering fits into every other area of engineering—and they were thrilled to get a jump start on the things they'll need to learn for the materials classes required in their own majors. For most of them it's a summer program that, in their own words, is "much better than flipping burgers at Burger King." For others it has become much more.

Mayo and Mohney have just submitted a proposal to the National Science Foundation for a renewal of their REU site program.

Recruiting the Next Generation of Materials Students

This summer, while the undergraduate students were away from campus, we spent our time trying to recruit the next generation of materials scientists and engineers. Two programs—*Spend a Summer Day* and *Kodak BEST*—were held at the University Park campus, giving high school students from across the state and into New York the opportunity to visit the campus and find out more about the opportunities we offer. The Spend a Summer Day program didn't work out too well for us. During the four days that the program was held, less than five students came to find out more about materials. This was partly because students visited programs based on their future career interests. If students don't know about you, they don't join your major. We'll be working with the sponsors of the Spend a Summer Day program during the next year in order to correct the problem.



Another program, Kodak BEST, was a great success for our department. Twenty-five students learned about the materials discipline. In the photo (left), the Kodak BEST students are gathered around a *Miracle Thaw*®. They had all seen it on TV, but didn't believe that it worked. Graduate student Tabbetha Dobbins (not seen) demonstrated the ice melting properties of the device and explained how the structure of the materials in the *Miracle Thaw*® give it the conductive properties that cause it to melt the ice (or perform) the way it does. The students also got to see shape-memory alloys in action, examined stuff like space shuttle tiles and fiber optics, and asked a million questions.

The hands-on activity really involved the students, and it was a good way to teach them what materials science and engineering is all about. The might never become a materials scientist or engineer, but next time they see a *Miracle Thaw*® on TV, they might just tell a friend how they know how it works.

Upcoming Events

December 8–9, 1997
International Workshop on Oxide Electronics
University of Maryland
For info: Dr. Darrell Schlom at schlom@ems.psu.edu

December 21, 1997
Fall Commencement Ceremonies
University Park

March 9–13, 1998
Spring Break
University Park

April 4, 1998
Engineering Open House
Penn State University Park Campus
For info: Dr. John Hellmann at matse@ems.psu.edu

April 6–10, 1998
Fifth International Symposium on Ferroic Domains and Mesoscopic Structures
The Penn Stater Conference Center Hotel
For info: Dr. Wenwu Cao at (814) 865-4101

April 24, 1998
Golden Anniversary Symposium on Metals Into the 21st Century
in conjunction with the McFarland Award
For info: Todd Palmer at tap103@psu.edu

May 3-6, 1998
ACerS Centennial Celebration
Drop by the Penn State booth commemorating 75 Years of Penn State Ceramics. And don't forget the Alumni Reception planned for May 4, at the Omni Netherland Hotel.

May 15-17, 1998
Spring Commencement Ceremonies
University Park

department news

Materials Faculty Benefit from Air Products–Penn State Alliance

A cooperative partnership agreement signed last April between Air Products and Chemicals, Inc. and Penn State is paying off for two materials science and engineering faculty members. The agreement calls for Penn State to further expand Air Product's access to its research facilities, and in return Air Products made a multimillion-dollar commitment to fund research at Penn State in fields of mutual interest, including materials science, for the next several years.

Professor Long-Qing Chen, whose expertise is in mathematical modeling of materials, with Professor Jie Shen of the math department, will work in collaboration with chemists at Air Products to numerically model the bubble growth and development of polyurethane foam cell structures. Polyurethane foams are used in applications including thermal insulation in appliances and as cushioning for automobile seats and in furniture. The physical properties of the foams depend on many variables including the ratio of solid material to empty space, the cell structure, and the void distribution in the foams. Chen will develop a 3D computer program for modeling cell structure development based on different initial bubble distributions. He will also analyze modeled cell structures in order to compare them with experimental observations.

Professor Richard Tressler will conduct high temperature testing and analysis of multicomponent metallic oxide materials to identify those with appropriate mechanical properties for Air Products' gas separation applications. The materials used in these applications must be optimized to withstand the high temperatures and pressures that exist within the working range of the gas separation process. Tressler will use Penn State's specialized high-temperature testing facilities to develop a detailed knowledge of the candidate materials mechanical behavior in order to develop a theoretical basis for material improvements.

On a related project, Tressler will work with Air Products on an $84 million DOE-funded project designed to tap vast natural gas resources in remote areas by converting natural gas into liquid fuels that can easily be transported, for example, via the Trans-Alaskan Pipeline. The key to this project is a ceramic membrane material that can separate oxygen from air and use it to break apart natural gas to form carbon monoxide and hydrogen. Tressler has worked with Air Products in the past to provide data on ceramic materials mechanical behavior in complex thermal environments. Further work will focus on improving specific materials mechanical performance.

News Notes

Equipment Donations: Three mass spectrometers were recently donated to the Center for Environmental Chemistry and Geochemistry. A mass spectrometer valued at $200,000 was donated by Exxon Research and Engineering Company. Two other mass spectrometers were donated by Dr. Johnie Brown. The spectrometers will be used by researchers at the center. Another mass spectrometer donation is in the works from Northrup–Grummon Co. It looks like no one will have to share for a while!

Partings: Joan Corman retired from the department in May—about the same time that she married Fred Pecht. I wonder if it's a coincidence!

Three members of our accounting unit have recently departed. Kelly Rhoades accepted an administrative assistant position with the EMS Energy Institute, Naomi McNulty defected to the College of Liberal Arts, and Shannon Fitzgerald has moved to Warren, PA and will be married in December. Congratulations to all!

New Arrivals: Jenny Houser has joined us to replace Joan Corman. Jenny will work with the recruiting committee on planning and carrying out recruiting events.

Gloria Henry has joined the accounting staff, as has Carol Fee. Gloria will work on budget items with Cindy Mihalik who was recently promoted. Carol will replace Shannon in preparing budgets for research proposals.

Happy Anniversaries to Us . . .

In 1998, the Department of Materials Science and Engineering will celebrate two anniversaries. First, it's the Golden Anniversary of the McFarland Award. The Penn State Chapter of ASM is planning a *Golden Anniversary Symposium on Metals into the 21st Century*, to commemorate the event. It's being planned around the Blue and White Weekend which begins on April 24 next year. Watch for more information on the celebratory events arriving in January.

We're also celebrating the 75th Anniversary of Ceramics at Penn State. In conjunction with the annual Pennsylvania Ceramics Association (PCA) meeting, we're planning some special events for alumni. The PCA Meeting and Alumni Extravaganza will run from October 15–17, 1998. That's Homecoming Weekend, and we're playing Purdue, so it should be a good game.

Also, plan to stop by the Penn State booth at the Centennial Celebration of the American Ceramic Society, May 3–6. The booth will commemorate 75 Years of Penn State Ceramics. Come by and visit with former classmates and professors, and see your history . . . the present . . . and the future of Penn State ceramics. And don't forget the Alumni Reception planned for May 4 at the Omni Netherland Hotel. Look for more information on these events coming soon!

Obituaries

Darrell Dochstader ('55 Ceramics) passed away at the age of 55 on August 4. Dochstader learned he had leukemia in June 1996, and underwent a successful bone marrow transplant in April, but due to his weakened immune system was unable to fight off a recent secondary illness.

Dochstader was a co-founder of Gar Doc Inc., and served as its managing director until his death. He also co-founded two other business ventures: Technical Graphics (serving as its president since 1988), and Technical Graphics Security Products. He was an active member of his community serving on the Board of Directors for both the Nashua Center for the Arts and the Science Center of New Hampshire, as well as participating in other community organizations. He was named a Centennial Fellow by the College of Earth and Mineral Sciences in 1996.

Dochstader is survived by his wife, Candy, his six daughters, his parents and two brothers, two sons-in-law, and two nephews.

James Sarver ('57, '58, '61 Ceramics) died July 16, at University Hospitals of Cleveland from complications of a heart attack he suffered July 7. Sarver, who was 62, was considered one of the best known lighting technicians. He held eight patents.

Sarver began his career with General Electric and managed the fluorescent engineering division. He began the metal halide design team, mentored several lighting executives and directed the development of barium peroxide getters and scandium chips. In his role as president of Venture Lighting International he made significant contributions to the growth and success of Advanced Lighting Technologies.

Sarver was a devoted Nittany Lion fan. He met his wife, Mary, at Penn State while studying ceramic engineering. In addition to his wife, Sarver is survived by three daughters, a son, three grandchildren, and a sister.

Amos Johnson Shaler, head of the Penn State metallurgy department from 1953 to 1960, died in his State College home on August 12. He was 80. Shaler had a distinguished career as a researcher, teacher, consultant and writer. In his research efforts he helped develop a method for removing heavy metals from wastewater and technology for preventing oil spills in the ocean. He held fifteen patents. In 1957 he received the ASM Teaching Award and was the founding vice-chairman of *Acta Metallurgica*. In addition he wrote *Metallurgy for Engineers*, which was published in 1952. In 1937 he was a member of the Macmillan Expedition to Baffin Bay near Greenland. He was a member of the International Oceanographic foundation, National Academy of Forensic Engineers, American Powder Metallurgy Institute, AIME, and the American Society for Metals.

He is survived by his wife, Patricia, two daughters, a son, and a sister.

Photo: Hillel Burger. Courtesy of The Botanical Museum of Harvard University, Cambridge, MA.

Science in Art: Preserving the Glass Flowers

Imagine holding in your hand a sprig of apple blossoms. Each tiny white petal and daintily veined leaf a miniature miracle of science and engineering. You lift the blossoms toward your face and inhale deeply to catch their delicate scent . . . but you smell nothing, because the blossoms are, quite literally, a work of art.

The Ware Collection of Blaschka Glass Models of Plants, popularly called the Glass Flowers, are a collection of more than 3,000 scientifically precise and utterly realistic models of flowering and fruiting plants—all made from glass. The models represent nearly 840 distinct plant species, and include actual size specimens, enlarged cross-sections, fruits, berries, flowers, fungi, etc. The models were commissioned in 1886 by George Goodale, then director of Harvard University's Botanical Museum for use in botanical study, and were financed by Elizabeth Ware and her daughter Mary Ware, who was a former student of Goodale.

Today, the glass flowers are permanently displayed at Harvard's Botanical Museum. A new exhibit, *Modeling Nature: Slices of Glass History from the Collections*, is the result of an effort to provide more historical background on the artists, insight into how the models were made, and the nature of glass itself. In addition, the Glass Flowers administrator, Susan Rossi-Wilcox, needed to know what could be done to preserve the glass flowers—some have broken while others have developed a "mold." She also wanted to know more about how the models were made. Carlo Pantano, professor of materials science and engineering, and our reigning glass expert, met Rossi-Wilcox when he presented the 1994 Glass Art Society's Dominick Labino Lecture. He was just the person for the job.

The Glass Flowers were created by Leopold Blaschka (1822–1895) and his son Rudolph Blaschka (1857–1939). Glass-working in the Blaschka family dated back to 15th century Czechoslovakia. To create the flowers, the Blaschka's used techniques that they adapted from their jewelry-making experience. Each model part was initially formed by working glass pieces in an open flame to rough out the form of flower petals, leaves, and other plant structures. Early models were then painted, but the Blaschkas realized that the paint would not be permanent. The challenge for them became developing permanent and scratch resistant colors for their glass flowers.

A letter from Mary Ware to Oakes Ames (Goodale's successor), written in 1928 while she visited the Blaschkas in Dresden, describes the change in the coloring process. "One change in the character of his work . . . since I was last here is very noteworthy. At that time, he bought most of his glass and was just beginning to make some, and his finish was in paint. Now he *himself* makes a large part of the glass and *all* the enamels, which he powders to use as paint. This he considers to be practically indestructible, except by force."

Many boxes of colored powders and glass pieces that Pantano calls "cullets" were recovered from the Blaschka studio. Pantano, in collaboration with David Lange at Harvard, has analyzed these powders, cullets, and fragments from the models, with the objectives of comparing the Blaschka's glasses to commercial glass compositions available then, discovering any unique elements of the glass compositions or enameling processes employed by the Blaschkas, and providing a scientific basis for preserving the models. Characterization techniques included optical, electron, and hot-stage microscopy, electron microprobe analysis and X-ray diffraction.

The analysis confirms earlier theory on how the glass models were made. Pantano's findings, which will appear in the *Journal of the American Ceramic Society* state, "Each glass constituent of the plant model is comprised of a base glass shape (stems, petals, flowers, fruit, etc.) that is coated (enameled) with one or more layers of glass to provide the desired color or texture." Pantano says that the process the Blaschkas used consisted of painting the surface of the base glass form with a slurry of ground powders that could have included ground glass and some of the crystalline oxide pigments. The entire piece would have then been fired at a temperature that would allow the enamel to soften and adhere to the base form without causing the base to soften or distort. Through electron microprobe analysis, Pantano found that many of the glass cullets contain lead. "This was basically used as a solder glass," he says. The lead allowed the Blaschkas to anneal the colored enamels to the base below its 805°C flow-point which one of Pantano's students measured using hot-stage microscopy. Flow-points of the cullets were mostly below 800°C.

Further analysis of the glass flowers will be necessary in order to discover more about the Blaschka's materials and techniques, but the current analysis has provided initial insight for developing a preservation plan. As Pantano puts it, "The inherent conservation issues associated with soft glasses used with mixed media materials such as adhesives, varnishes, and so forth, are as individual as each paper-thin petal and as complex as the multi-colored enameled fruits." With his assistance, the Blaschka dedication to the Glass Flowers will continue to inspire both artists and scientists for years to come.

The exhibit Modeling Nature: Slices of Glass History from the Collections, will be on display through April 1998.

alumni news

Sixties

Richard A. Beaumont ('69 Metals) is employed by ALCOA. He has 24 years of experience in ferrous alloys, titanium, and nickel-based superalloys. He received ALCOA's Arthur Vining Davis Award in 1994 for developing thermomechanical processing for Inconel Alloy 706.

Glenn W. Bush ('55, '58, '60 Metals) is self employed as a consultant. His was previously employed with National Steel Corp. for 28 years.

David W. Collins ('68 Solid State Science) obtained his J.D. from Seton Hall Law School in 1974 and became a corporate patent attorney. He is a member of the New Jersey and California Bars specializing in intellectual property law.

T. Chalmers Creese ('61 Ceramics) works in the steel industry at Le Tourneau Inc.

Robert P. Dunkle ('68 Metals) is retired. He held positions in sales, marketing, technical service, process and product development and quality assurance during his career.

Robert Faas ('62 Fuels) is self-employed as a consultant. Previously he worked for 27 years at Westinghouse Electric in the nuclear power industry.

Samuel P. Faile ('69 Solid State Science) is developing new fireworks for entertainment. This involves electrical discharges to set off an atomic process that transmutes the elements: metal–air–salt→silver.

David L. Fancher ('68 Solid State Science) writes that although he taught physics at Kansas Wesleyan University for many years, he is now in the business of helping people "make money." He has been the captain of the USTA Seniors Tennis Team that has gone to the National Championships for the last three years in a row—"somewhat akin to the Chicago Bulls 3-peat in the NBA."

Wayne G. Fedio ('65 Metals) has retired after 32 years of service with USX, North Star Steel Corp., and New Jersey Steel Corp.

John H. Fetchen ('69 Metals) is a department and senior project manager at SE Technologies, Inc.

Joseph C. Grabinski ('66 Fuels) spent thirty years at Great Lakes Steel in various positions in the utility and energy departments. He is a past president of his local Association of Energy Engineers.

Leonard A. Greco ('68 metals) is the plant manger at Allegheny Ludlum's precision rolled strip facilities in Connecticut. He oversees the manufacture of thin gage stainless, high temperature, magnetic, and controlled expansion strip products.

Raymond T. Greer ('68 Solid State Science) is a professor of aerospace engineering and engineering mechanics at Iowa State University.

Chuck Greskovich ('64, '66, '68 Ceramics) is a staff member at the General Electric Corporate R&D Center ceramics lab. He works in the areas of processing, microstructural development and optical properties of sintered ceramics. Greskovich was an EMS Centennial Fellow.

Richard B. Griffin ('64 Metals) has been a member of the faculty at Texas A&M since 1977. He received a NACE Technical Achievement

Myers Receives Alumni Fellow Award

Dr. Mark B. Myers, senior vice president for corporate research and development at Xerox Corporation visited Penn State in September to receive the Alumni Fellow Award at the College of Earth and Mineral Sciences' annual Obelisk Dinner.

Myers received his Ph.D. in solid state science from Penn State in 1964. In his position at Xerox, Myers is responsible for all of the company's corporate research centers and its advanced development. He is a director of Xerox Canada, Inc. and SDL, Inc., as well as a member of a six-person corporate committee that sets the company's strategic direction.

While at Penn State Myers presented two lectures. One on "Frontiers of Research in the Information Technology World of Xerox," and the other titled "The Changing Innovations Systems in the Global Enterprise (with an emphasis on the role of science and national R&D policies)."

Myers plays an active role in scientific policy making and has a great interest in education issues. He is a member of the National Research Council's Board on Engineering Education, its Board on Science, Technology, and Economic Policy, and serves on its Task Force on Engineering Education in the United States and Japan. He is a trustee of his alma mater Earlham College in Illinois and serves on engineering or telecommunications advisory boards at several universities.

The Alumni Fellow Award is sponsored by the Penn State Alumni Association and is the most prestigious of the association's awards. The Board of Trustees has designated the title of Alumni Fellow as permanent and lifelong.

Alumni Receive Awards at 1997 ACerS Meeting

Darryl P. Butt ('84, '91 Ceramics) received the 1997 Robert L. Coble Award for Young Scholars. He was cited for his "leadership and contributions in diverse ceramic research topics and his role as a mentor to students." Butt is the leader of the Corrosion and Interfaces Team at Los Alamos National Lab in New Mexico.

Warren W. Wolf, Jr. ('63 Ceramics) presented the Arthur L. Freidberg Memorial Lecture at the 1997 ACerS Meeting. His talk focused on "New Insights into Glass Fiber Safety: The Role of Fiber Durability." Wolf is R&D director at Owens Corning in Ohio. In addition to his bachelor's from Penn State he received M.B.A. and Ph.D. degrees from Xavier University and Ohio State University, respectively.

Award in 1992 and the 1993 Association of Former Students University Level Award.

Eugene L. Grumer ('61 Fuels) is working as a planning analyst at the North Atlantic Refinery, a subsidiary of Vitol, in Come By Chance, Newfoundland. He writes that "it averages only 15°F cooler than Happy Valley due to a Gulf Stream influence."

John A. Halchak ('62 Metals) is a fellow of ASM International and received the San Fernando Valley Engineers Council Engineering Merit Award and the "Silver Snoopy" Astronauts Achievement Award both in 1992. He works at Boeing–North America, Rocketdyne Division.

Loren W. Hill ('65 Fuels) is a senior fellow research chemist at Monsanto in the area of industrial coatings. He was the 1991 Mattiello Lecturer of the Federation of Societies for Coatings Technology.

Charles R. Hutchison ('62, '64 Ceramics) is employed at Bettis Atomic Power Laboratory supporting the Naval Reactors program. He studies fuel manufacturing, process development of fuels, and steam generation components.

William L. Jenkins ('66 Ceramics) is president of Eye Lighting International which produces high intensity discharge lamps for world markets. He was an EMS Centennial Fellow.

David W. Johnson, Jr. ('64, '68 Ceramics) is head of the metallurgy and ceramics research department at Bell Labs. He was the president of the American Ceramic Society from 1994 to 1995, and received the Ross Coffin Purdy and Fulrath Awards from ACerS.

Don Jones ('64 Fuels) is employed as a senior project engineer with BP Oil in the technical service department as the technical support person for the lubricants business.

Kay Allen Keller ('62 Fuels) is the owner of a railroad car repair business. He previously spent thirty years in the railroad industry.

Dave King ('69 Metals) has spent 27 years at IBM doing materials analysis, process development, and manufacturing process support in electronic packaging.

Wulf Knausenberger ('69 Solid State Science) retired from AT&T Bell Labs in 1995. He is now practicing as a consultant and teacher in interconnection and packaging technology. In 1995 he was elected a Fellow of IEEE.

Eric R. Kreidler ('61, '63, '67 Ceramics) is a professor in the the Department of Materials Science and Engineering at Ohio State. He is also a Fellow of the American Ceramics Society.

Matthew P. Kristof ('65 Ceramics) is in data planning and administration at Northrop Grumman's electronic sensors and systems division.

Richard S. Krouse ('63 Ceramics) has been working in the environmental consulting business and is currently vice president of the north region and senior client services manager at RMT, Inc.

Konrad J. Kundig ('62 Metals) is the director of communications and technical information services with International Copper Association, Ltd.

Norman R. Laine ('62 Fuels) is employed in the Davison Chemical Division of W. R. Grace working in the areas of petroleum refining catalysts, and activated alumina powders and particles for catalytic applications.

Ronald M. Latanision ('64 Metals) is chairman of the Council on Primary and Secondary Education, and professor of materials science and engineering and nuclear engineering at MIT.

James H. Lindsay ('69 Metals) is a staff research scientist in metal finishing research, primarily electrodeposition, for General Motors. He was named the 1996 recipient of the American Electroplater and Surface Finisher Society's Scientific Achievement Award.

Robert O. Lussow ('66 Solid State Science) retired from IBM after thirty years in management and technical positions in the microelectronics industry. He is currently a consultant with PTC services.

William C. Mack ('65 Metals) is employed by American Spring Wire. He became a fellow of ASTM in 1995.

Edward L. McKinley ('68 Ceramics) is the manager of regulatory affairs for Owens-Brockway Plastics where he has worked for the past 25 years mainly in the glass container division. He was elected chair of the Drug Packaging Subcommittee of the Society of the Plastics Industry in 1996.

David L. Miller ('69 Solid State Science) is self employed as a consultant specializing in electronics and communications.

Robert O. Miller ('65 Solid State Science) is a consultant for various national and international firms regarding technology transfer and building fabrication plants. He has received various quality awards.

Don Moyer ('66 Metals) has thirty years of experience in the foundry industry and held all levels of supervisory and managerial positions. He is currently working in the restaurant business and as a consultant in the metals industry.

Lawrence E. Newhart ('64 Fuels) left the energy and construction industry in 1996 after 32 years to become an entrepreneur. He acquired Storeroom Solutions, Inc.—a company that assists large industrial plant customers in managing their in-plant storerooms.

Larry A. Niemond ('61 Metals) is the technical vice president at Standard Steel and is a professional engineer in Pennsylvania.

Thomas R. O'Connell ('60 Metals) has worked for Westinghouse for 34 years in the nuclear power area.

John O. Parke ('66 Metals) is the vice president of operations at Freedom Forge. From 1984 to 1991 he was the general manager of Titanium Metals Corp. He was an EMS Centennial Fellow.

John F. Rakszawski ('60 Fuels) retired from BOC Group Technical Center at Murray Hill, NJ on January 1, 1996.

Gordon Rosenblatt ('66 Metals) is the founder of a medical imaging company called Morphometrix Technologies.

Robert J. Roy ('60 Metals) is self-employed as a consultant to the steel industry.

Walter D. Sadowski ('62 Metals) is a superintendent of metallurgy and quality control at the Marlins Ferry Plant of Wheeling–Pittsburgh Steel Corp.

Peter T. Sarjeant ('67 Solid State Science) worked on product development of wood-based raw materials converting them to detergents, surfactants, ink resins, cement additives, etc. He is now into bridge, bagpipes, beekeeping, and bookkeeping.

W. Joseph Schlitt ('68 Metals) is a registered professional engineer in Texas, and is an author, editor, and patentee in the field of hydrometallurgy. He specializes in leaching and recovery of nonferrous metals, and has been elected to Sigma Xi, Tau Beta Pi, and Phi Kappa Phi.

Walter A. Schulze ('68, '73 Solid State Science) is a professor of ceramic engineering and electrical engineering at the New York State College of Ceramics, Alfred University. He is a fellow of the American Ceramic Society and was an EMS Centennial Fellow.

B. Thomas Shirk ('68 Solid State Science) is the owner and president of Hoosier Magnetics—"one of the largest manufacturers of ferrite raw materials in the world." He received the Entrepreneur of the Year Award for Northwest Ohio in 1996.

David A. Shores ('62, '64, '67 Metals) is a professor in the Department of Chemical Engineering and Materials Science at the University of Minnesota. He is active in the Electrochemical Society and was an EMS Centennial Fellow.

Roman S. Slysh ('60 Fuels) worked in R&D as a polymer chemist until his retirement in 1991.

Ronald G. Sorice ('69 Ceramics) is a vice president of ceramics for the Americas at Cerdec Corp. He was an EMS Centennial Fellow.

George Sotter ('61 Fuels) is self-employed as a consultant.

Ed Sproles ('68 Metals) is employed at Lucent Technologies in the areas of design, manufacturing, and electrical connectors testing, reliability, and materials. He is a Fellow of ASTM.

Robert Strimple ('66 Ceramics) is a senior research engineer at Homer Research Labs with Bethlehem Steel Corp. He received the Charles W. Briggs Award for the best paper of the Iron and Steel Society of AIME in 1973, and holds three U.S. patents.

James J. Tietjen ('58, '63 Fuels) is dean of the School of Technology Marketing and Management at the Stevens Institute of Technology in New Jersey. Before joining Steven's in his first position as department head for the management and engineering management department, he was president of SRI Ineternational, president of David Sarnoff Research Center, and vice president at RCA Laboratories. Tietjen is a Penn State distinguished alumnus and received the David Sarnoff award for Outstanding Technical Achievement in 1967 and 1970.

James G. Tyson ('64 Metals) is the district manager of customer technical services at U.S. Steel.

Gary C. Vezzoli ('69 Solid State Science) is employed by the U.S. Army Research Laboratory and the Dante Alighieri Society of Massachusetts. He conducts research on the effects of high-pressure and high-temperature in solids and low melting liquids, and in high-temperature superconductivity and threshold switching in chalcogen glasses and transition metal oxides.

Dennis J. Viechnicki ('66 Ceramics) is chief of the materials division of the Weapons and Materials Research Directorate of the U.S. Army Research Laboratory. He is also a fellow of the American Ceramic Society and has received three Army R&D Achievement Awards.

Richard M. Wardrop, Jr. ('68 Metals) was named chairman of AK Steel Corp. effective February 1, 1997. He received the 1995 McFarland Award from the Penn State Chapter of ASM.

Melvin G. Wees ('68 Ceramics) is the director of procurement and logistics at Harbison-Walker Refractories, Inc.

Edward O. Woolridge ('63 Metals) is a materials engineer with the U.S. Nuclear Regulatory Commission. He received the 1996 ASME Codes and Standards Dedicated Service Award.

William E. Zimmerman ('64 Metals) founded Tranzact, Inc. in 1984 which recycles nonferrous refractory metals for sale to foundry, specialty steel, and high alloy industries.

Seventies

Carol L. (Boberage) Anderson ('78 Metals) worked in coal preparation research until 1985. Since then she has been a computer systems engineer at Consol, Inc. managing the central systems, networks, and applications development.

John L. Avau ('71 Metals) is currently a manager of metallurgical services and regional sales manager with Blair Strip Steel Co.

Ricky L. Balthaser ('72 Metals) is a quality systems manager at Alumax Extrusions, Inc. in Cressona, Pennsylvania.

Dean Beckley ('76 Ceramics) is a senior member of the technical staff and quality control manager for raw materials with AVX Corp. Under "Significant Awards" he writes "B.S. of Cer Sci (Dr. Tressler will attest that, for me, this was not only significant but "almost" unexpected)." He was also the 1976 Heisman Trophy runner-up.

Glenn G. Biever ('72, '75 Ceramics) is a director of product technology with BMI France.

Bruce Boris ('77 Metals) has been the NDT inspection laboratory manager at Titanium Metals Corp. since 1989.

Cliff Bourne ('78 Ceramics) is the manager of process engineering at Murata Electronics, Inc. manufacturing ceramic chip capacitors. He also writes that he (and his wife) enjoy home schooling their nine children.

Thomas B. Buerkle ('70 Metals) received his MBA from the University of Pittsburgh in 1976 and is the department manager of glidcop operations at OMG-America.

Douglas D. Burleigh ('72 Solid State Science) is currently working for Rohr Inc. in Chula Vista, California on the thermal protection system for the X-33 experimental space launch vehicle.

Tong Yul Cho ('72 Solid State Science) is a professor in the Department of Materials Science and Engineering at the University of Ulsan in Korea. He was previously a professor at the Republic of Korea Naval Academy, dean of Academic Affairs, and chief of the faculty. He retired from the Navy in September 1985 at the Rank of Captain.

Theodore P. Christini ('65, '67, '70 Metals) is a senior research associate at Sterling Diagnostic Imaging, Inc., and conducts process and product research for X-ray intensifying screens used in medical imaging. He is the author or co-author of six patents.

Roy A. Christini ('74, '77 Metals) has been with Alcoa for nineteen years. He received the 1988 TMS Extractive Metallurgy Technology Award and the 1990 Arthur Vining Davis Award from Alcoa. He holds eight patents.

E. Daniel Christoff ('79 Ceramics) is self employed as the CEO of ExceleTel Inc.—a computer telephony and messaging company.

Thomas E. Colter ('71 Metals) is employed with Westinghouse Electric Corp. in the plant apparatus division. He is using ultrasonic NDT to test piping systems, pressure vessels, and valves.

Paul H. Conley ('77 Ceramics) is a senior application specialist in pneumatic and electric furnace steel production for Harbison-Walker Refractories.

John A. Coppola ('69, '71 Ceramics) is vice president of corporate R&D at Schuller International in Littleton, Colorado.

Robert C. Creese ('72 Metals) is a professor at West Virginia University.

Michael I. D'Andries ('70 Metals) is a consultant with Booz, Allen, and Hamilton, Inc. in the area of material survivability to nuclear, biological, and chemical agent exposure. Until 1993 he served in the U.S. Army. He was Lieutenant Colonel when he retired.

William J. Dangel ('79 Metals) is an applications engineer at L&N Metallurgical Products Co.

Radhanath P. Das ('74 Metals) is studying hydrometallurgical processes to recover metals from complex, lean, off grade, and waste resources at the Regional Research Laboratory in Bhubaneswar, India. He leads a team of twenty scientists. In 1993 he received the "Best Metallurgist" award given jointly by the Indian Institute of Metals and the Government of India.

Allen D. Davis, Jr. ('70, '77 Ceramics) after many career changes due to company reorganization, is working in applications engineering at Corhart Refractories. He holds one patent.

Brian Ferg ('72 Ceramics) has twenty years of experience in the investment costing industry, specifically with aerospace and industrial gas turbine engines. He is employed by Concorde Castings.

James L. Fleischer ('72 Metals) is a manger of technical services at Carpenter Technology.

Eugene G. Gagnon ('70 Fuels) works at General Motors's R&D center and represents GM on the United States Advanced Battery Consortium. He also developed a recycling program to be implemented at all GM plants to improve manufacturing operations and reduce manufacturing costs.

Andrew G. Gargus ('76 Fuels) is self employed with Prochem Scientific working in the area of application engineering marketing and sales of new measurement technologies and their use in the chemical industry. He received an R&D 100 Award for an environmental analysis instrument, and coached his son, Nathan, now a cadet at West Point, through the long selection process of entering a military academy.

Mary Lou Grachen ('79 Ceramics) has held various positions during her fifteen years at Corning, Inc. She was previously employed with Viking Glass Company.

Robert A. Heckman ('74 Metals) has been at Superior Tube Co. in Collegeville, Pennsylvania, for four years as director of technical engineering. Heckman was recently re-elected as president of the Oley Valley School Board. His son Rob-

ert has been accepted to Penn State–Altoona for Fall 1997.

Edwin J. Hippo ('74, '77 Fuels) is a professor in the Department of Mechanical Engineering and Energy Processes at Southern Illinois University at Carbondale, Illinois. He holds several patents.

Donald G. Hnath ('72 Metals) is employed by Los Alamos Technical Associates. He has ten years of welding process development experience in the aerospace and defense industries, and fifteen years of project and program management experience in defense and DOE technology development.

Asaji Hosoi ('73 Metals) is employed by Mitsubishi Motors America, Inc. in Bloomington, IL.

Joseph F. Huth, III ('72 Ceramics) is the director of research and technology for Spang & Co. which is a manufacturer of soft magnetic alloys and Mn-Zn ferrites. He is the author or co-author of four patents.

Samuel T. Jack ('71 Fuels) has written two books and is the holder of several patents.

Tim Jenkins ('71 Ceramics) is an engineering manager with Osram Sylvania.

Mary Lynn Johnson ('70 Fuels) was a governmental air pollution chemist and taught chemistry, flame chemistry, and air pollution courses from the high school to graduate level before she retired. She is a Fellow of the American Institute of Chemistry.

David G. Johnston ('78 Ceramics) is the manager of photolithography process engineering at Seagate Technology's recording head operations in Bloomington, Minnesota. He joined Seagate after fourteen years with Texas Instruments.

Fred L. Jones ('71 Fuels) is the president of Cogen Designs, Inc. He was an EMS Centennial Fellow.

Ricky L. Keller ('79 Polymers) directs engineering and marketing for extrusion equipment for blown and cast film at David Standard, Corp.

Christopher Kennedy ('71, '74 Ceramics) is vice president of technology at Lanxide Corp. He was an EMS Centennial Fellow.

Veryl D. Kifer ('70 Metals) is a metallurgical lab superintendent with CSC, Ltd.

Karl P. Kimmerling ('79 Metals) is vice president of manufacturing at The Timken Co. He received his J.D. in Corporate Law from the University of Akron School of Law in 1987. He received the 1997 McFarland Award from the Penn State Chapter of ASM.

David A. Klimas ('72 Ceramics) coordinates the international technical service and development of glass enamels for the automotive container and flat glass industries at Cerdec Corp. He holds U.S. patents for lead free glass and lead free frit.

Gary A. Kos ('74 Ceramics) is a product manager with Ferro Corp.

David M. Kotchick ('73, '75, '78 Ceramics) was recently promoted to director of advanced environmental control systems with Allied Signal Aerospace.

Gary L. Kriner ('74 Ceramics) is a production manager with Guardian Industries in Richburg, South Carolina.

Binod Kumar ('73, '76 Ceramics) has been at the University of Dayton for eighteen years. He writes that he is doing "some exciting work on solid electrolytes for rechargeable lithium batteries and high-temperature superconductors." He is the electronic and advanced ceramics group leader in the metals and ceramics division.

Stephen S. Lyle ('72 Ceramics) is in sales, marketing, and management of technical ceramics at Carborundum–BN.

Duane D. Maietta ('72 Metals) is plant manager with Allegheny–Teledyne, Inc.—Kopper Plant. He works in the area of steam generator tubing manufacture for the commercial and naval nuclear steam generation industries.

Edward J. Majzlik, Jr. ('71, 74 Metals) is an advisory engineer at the Savannah River Technology Center of Westinghouse Corp. He is studying hydrogen's effect on stainless steel, materials testing, metallography, and failure analysis.

James L. Mansfield ('74 Ceramics) works at HYDE Manufacturing Co. He switched specialties in 1988 from glass to quality assurance.

Gregory J. Manzo ('79 Metals) after holding various positions is now the vice president of technology at Ellwood Quality Steels Co. in New Castle, Pennsylvania. He was an EMS Centennial Fellow.

Thomas O. Mason ('74 Ceramics) was named the 1996–1999 James N. and Margie M. Krebs Professor by the McCormick School of Engineering and Applied Science at Northwestern University. The award recognizes outstanding teaching and promotes course development. He has also received two awards (1990 Schwartzwalder-Pace Award and the 1995 Fulrath Award of the Northern California Section) from and is a Fellow of the American Ceramic Society.

Tomiyoshi Masuda ('79 Fuels) is the general manager of the steel making division of Oita Works at Nippon Steel Corp. in Japan.

Mark S. Mazanek ('79 Metals) is a founder of a project development company that utilizes proprietary, high temperature technology to recover iron, zinc, and lead from steel industry wastes and byproducts. He is a co-inventor on two U.S. Patents.

David J. Michael ('72, '74 Ceramics) is the group manager of research at Harbison Walker Refractories.

Joseph R. Monkowski ('78 Ceramics) is a group president with Pacific Scientific, Inc. He has held several other management and engineering positions throughout his career and received the 1993 Outstanding Engineering Alumnus of Penn State and was an EMS Centennial Fellow.

Douglas E. Musser ('75 Materials Technology) is an associate metallurgist with Copperweld, Shelby Division.

Richard L. Nester ('74 Metals) is general manager of quality assurance and customer service at Wheeling–Nissan, Inc. He received his MBA in 1991.

John A. Olenick ('78 Ceramics) is a supervisor of microelectronics operations at Eastman Kodak.

Dennis Peters ('72, '74 Ceramics) is vice president of R&D at Resco Products, Inc.

Craig C. Peterson ('74 Metals) is a metallurgical engineer with Central Steel and Wire Co. in Chicago.

Jim Reuther ('79 Fuels) is a principal research scientist at Battelle in Columbus, Ohio. He has been awarded two U.S. patents for clean-burning gas-appliance burners; both have been commercialized into consumer products. He received a 1996 R&D 100 Award for porous insert and a 1996 Award of Excellence from the International Appliance Technical Conference. Reuther is a soccer referee for several national (collegiate and professional) leagues.

Ray F. Schumacher ('70 Ceramics) is working in glass technology dealing with vitrification of radioactive wastes at the Westinghouse Savannah River Co., and "hoping to survive the next downsizing."

Bernard Schwartz ('72 Ceramics) is vice president of process and product development at Florida Tile Industries.

Rosalia N. Scripa ('72 Ceramics) was appointed associate dean of Academic and Student Affairs of the School of Engineering at the University of Alabama—Birmingham, in October 1996. She was also selected as a University of Alabama-Birmingham Outstanding Woman Faculty Member in 1996 and a University of Florida Alumnae of Outstanding Achievement in 1997.

Jyotindra Shah ('76, Metals) has more than fifteen years of experience in the field of fluidized bed combustion, and firetube and watertube boiler steam generation. He is employed by Johnston Boiler Company.

Lane G. Shaw ('76 Polymers) is the vice president for business management at AlphaGery Corp.

Bonnie J. Spencer ('70 Solid State Science) is an electronics engineer with the Underwriters Laboratories and works as a quality system auditor (ISO/QS 9000).

Bill Spengler ('79 Ceramics) has been an engineer in the materials science department at Dana Corp. for more than eight years. He received an MBA in 1989 from Bowling Green State University in Ohio.

Wayne H. Stair ('78 Polymers) was employed with Goodyear Tire and Rubber Co. from 1978 to January

Continued on page 20

faculty facts

James Adair, has been hired as an associate professor. He will be jointly appointed between the Ceramic Science and Engineering Program and the Intercollege Materials Research Lab (IMRL). Adair will also serve as the new director of the Particulate Materials Center replacing Gary Messing who is now serving as director of IMRL.

Altaf Carim, associate professor of materials science and engineering, was named the associate editor of the *Journal of the American Ceramic Society*.

Mike Chung, professor of polymer science, was issued four new U.S. patents and the technologies he has developed for borane catalyst polyolefins have been licensed by Exxon, Amoco, Revlon, and Uniroyal.

Tarasankar DebRoy, professor of materials science and engineering, is the editor of a new journal *Science and Technology of Welding and Joining*, that will be published by the Institute of Materials, London, England.

Semih Eser, assistant professor of fuel science, has been promoted to senior research associate.

David J. Green, professor of ceramic science and engineering, submitted a patent disclosure in March titled *Crack Arrest in Brittle Materials Using Residual Stresses*.

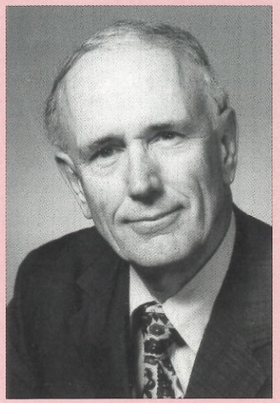
Patrick Hatcher, professor of fuel science and geosciences, was appointed director of the Center for Environmental Chemistry in the EMS Energy Institute. He was also invited to the editorial board of two new journals *Acta Hydrochimica et Hydrobiologica*, and *Ancient Biomacromolecules*.

Paul R. Howell, professor of metallurgy, received his third nomination for the TMS Educator Award.

Sanat Kumar, was promoted to the rank of professor of materials science and engineering. He is a faculty member of the Polymer Science and Engineering Program.

Merrilea Mayo, associate professor of materials science and engineering, was on a committee to plan the new Materials Research Society's Headquarters. The new building was complete in September, and is located in the same Pittsburgh industrial park as the TMS Headquarters. It will replace the old MRS headquarters which Mayo says

Emeritus Faculty Member Receives 1997 Hosler Alumni Scholar Medal



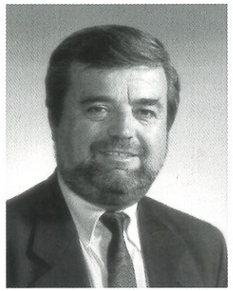
Philip L. Walker, Jr., Evan Pugh research professor emeritus of materials science, was awarded the 1997 Charles L. Hosler Alumni Scholar Medal. The Hosler Medal is the highest honor given by the College of Earth and Mineral Sciences. It was established in 1992 to honor the career achievements of Dr. Charles Hosler, the College's eleventh dean, and to recognize "an alumnus who has made outstanding contributions to the development of science."

Walker received his B.S. and M.S. degrees from Johns Hopkins University, and his Ph.D. in fuel technology from Penn State in 1952—the same year he joined the faculty as an assistant professor. Two years later he was promoted to associate professor and named head of the Department of Fuel Technology. In 1959 when the College was reorganized he became chairman of the Fuel Technology Division, and when the ceramics, metals, and fuels programs were merged into the single Department of Materials Science and Engineering, Walker was chosen to administer the new department and served as its head from 1967 to 1978.

During this time, Walker was establishing an international reputation in carbon research. He became such a dominant figure in the field of carbon—publishing 340 scholarly papers, providing dedicated service to the American Carbon Society, and fulfilling editorial roles for *Carbon* and *Chemistry and Physics of Carbon*—that he became widely known as "Mr. Carbon."

Walker was honored by Penn State in 1974 when he was name Evan Pugh research professor in materials science, and again by his peers who presented him with the Henry Storch Award of the American Chemical Society for his distinguished contributions to the science and utilization of coal. He has also received the George Skakel Memorial Award of the American Carbon Society for his overall contributions and achievements that significantly influenced the science and technology of carbon materials. He continues to be a tremendous support to the Department of Materials Science and Engineering through the establishment of a professorship and a student scholarship fund.

1997 Wilson Research Award

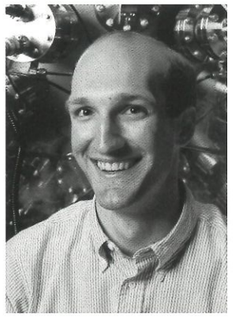


Digby D. Macdonald, professor of materials science and engineering, was presented the 1997 Wilson Award for Outstanding Research for his achievement in the field of electrochemistry and corrosion. His recent work on the mechanisms of growth and the breakdown of passive films on reactive metal surfaces in contact with aqueous environments, and the extension of this work to the prediction of corrosion damage, is being recognized as novel and very important. Macdonald is known for both his scientific knowledge and his practical engineering ability. In his nomination letter, materials science and engineering department head, Richard Tressler noted that it is the duality of Macdonald's "accomplishments as an electrochemist and a corrosion engineer which his referees site as world class."

Macdonald has been with the Department of Materials Science and Engineering since 1991, and is also the director of the Center for Advanced Materials. He is a member of several professional electrochemistry and corrosion societies, and has received numerous awards including the Carl Wagner Award from the Electrochemical Society, the Willis Rodney Whitney Award from NACE, the W. B. Lewis Award from Atomic Energy of Canada Ltd., and is a Foreign Fellow of the Royal Society of Canada (to name just a few). He has published more than 386 papers in scientific journals, books, and conference proceedings, and is the author of *Transient Techniques in Electrochemistry*. He holds three patents.

The Wilson Research Awards were established in 1989 to honor significant research achievement by faculty in the College of Earth and Mineral Sciences. The award is made possible by the bequests of Matthew J. Wilson, Jr. ('18 mining engineering) and Anne Coghlan Wilson.

1997 Wilson Teaching Award



Darrell G. Schlom, assistant professor of materials science and engineering, received the 1997 Wilson Award for Outstanding Teaching from the College of Earth and Mineral Sciences. Undergraduate students who took Solid State Science (MatSE 413) nominated Schlom for the award because, as they say, he has "revolutionized the way modern materials physics is taught." MatSE 413 requires studying various physical phenomena associated with solid state materials to prepare students for future study of electronic and photonic material properties. Schlom's approach to teaching the course includes using *Mathematica*—a computer program that allows students to create three-dimensional representations of mathematical expressions as they would appear in the physical world. His students praise him not only for his ability to bring physical meaning to the complex mathematics of the quantum mechanics involved in the course, but also for his dedication to their education. They say " . . . his open-door policy (his door is usually open until after midnight) of helping students whenever he is in his office is a testamnent to his determination to offer students every possible opportunity to learn."

Schlom is spreading the word about this new method of teaching materials physics. At the fall 1996 Materials Research Society meeting held in Boston, Schlom demonstrated the use of *Mathematica* for teaching materials physics and has published an article in the *Journal of Materials Education* that describes the technique.

The Wilson Teaching Award was first given in 1969 to recognize outstanding teaching activity in the college. The Wilson Awards are made possible by the bequests of Matthew J. Wilson, Jr. ('18 mining engineering) and Anne Coghlan Wilson.

were quite literally a "corrugated tin shack that backed up with sewer water every time it rained." Mayo worked with two other individuals to plan the building and see it through construction. The whole project took just over eighteen months, and Mayo says the best part was "getting to spend $2 million of someone else's money!"

Robert E. Newnham, Alcoa Professor of Solid State Science, was made a Distinguished Life Member of the American Ceramic Society at the annual meeting held this year in Cincinnati. The award is "in recognition of his pioneering research on ceramic composites and their application as 'smart' materials and devices, for his exceptional guidance of students, and for his devotion to international scientific exchange and cooperation." Newnham has received numerous awards throughout his career for his research contributions to the field of crystallography, electronic ceramics, and his efforts in education.

Paul Painter, professor of polymer science and engineering, was nominated for an Excellence in Undergraduate Advising Award by the Undergraduate Student Government Academic Assembly.

Clive A. Randall, assistant professor of materials science and engineering, was recently appointed director of the Center for Dielectric Studies at Penn State's Intercollege Materials Research Laboratory. The center was founded in 1983 to study ceramic dielectric materials that serve as the technological basis for components used in electronic circuits. The center's initial focus was on materials and technology used to manufacture multilayer capacitors, but was expanded to address the problems of integrated ceramics packaging. Randall is internationally recognized for his contributions in this field.

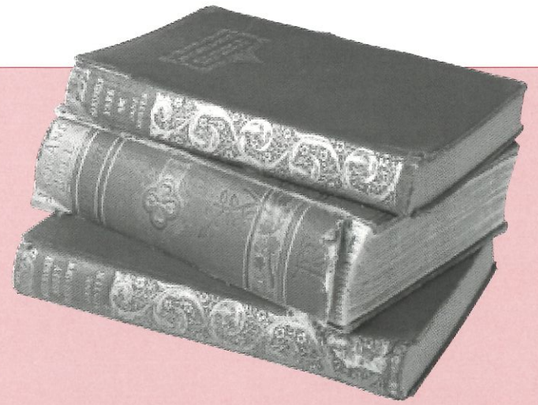
Sarma V. Pisupati, assistant professor of fuel science, received the Outstanding Technical Paper Award at the 13th Annual Pittsburgh Coal Conference for his paper titled *Simultaneous SOx/NOx Control Using BioLime™ in PCC and CFBC*. He was also named director of the Combustion Lab in the EMS Energy Institute.

Harold Schobert, professor of fuel science, was named chair elect of the American Chemical Society's Division of Fuel Chemistry, and selected at Penn State as an outstanding faculty member by the Golden Key Honor Society.

Chunshan Song, has been hired as an associate professor of fuel science to fill a tenure track position in the area of natural gas utilization. Song previously held an appointment at the EMS Energy Institute as a senior research associate. He was also asked to be a guest editor during 1997–1998 for the international journal *Catalysis Today*.

Richard E. Tressler, professor and head of materials science and engineering, was co-chair of the International Symposium on Ceramic Matrix Composites held October 28–30, in Tokyo, Japan. The symposium was intended to provide a forum for basic scientists and industrial engineers to learn from each other about the limiting factors of carbon matrix composite (CMC) use in structural applications and discuss theories that might explain boundary instability problems in CMCs.

The Book Shelf



Professors **Michael Coleman** and **Paul Painter** have completely revised the second edition of *Fundamentals of Polymer Science*. It is being used as a textbook for polymer students and is available through Technomics Publishing Company.

Introduction to Mechanical Properties of Ceramics, a textbook by **David J. Green**, has been accepted for publication by Cambridge University Press.

The second edition of *Energy and Fuels in Society: Analysis of Bills and Media Reports,* by **Ljubisa J. Radovic**, associate professor of fuel science, has been published by McGraw Hill, Inc., College Custom Series. The book was written specifically for the Materials Science and Engineering 101 course of the same name that Radovic teaches in an effort to bring daily-life relevance to the general science education of non-science majors. Radovic's objectives for the book (and the course) are to provide a general understanding of the energy-related media reports that shape public opinion, and to evaluate energy bills—both environmental and monetary ones.

Professor **Peter Thrower's** text book *Materials in Today's World,* used for many years in Penn State's introductory course Materials Science and Engineering 81, is being adopted for use by other universities.

The Era of Materials, edited by S. K. Majumdar, R. E. Tressler, and E. W. Miller, is a comprehensive look at the materials that play a role in our everyday lives. The general introduction by **Richard Tressler**, professor and head of the materials science and engineering department, describes the evolution of materials throughout history, groups particular materials according to their uses (for example "materials for communication" or "materials for transportation"), and examines their future role in our society as the limits of today's technology continue expanding. The introduction lays the foundation for the in-depth chapters written by Penn State materials experts. The chapters examine both the basic foundation of materials science and engineering as well as its applications. *The Era of Materials* is being published by the Pennsylvania Academy of Science and will be available in February 1998.

student scoop

Students Receive Awards at 1997 Wilson Banquet

Andrea C. Lang received the 1997 **George W. Brindley Award for Excellence in Crystal Chemistry**. It is given to recognize outstanding undergraduate scholarship in crystal chemistry and to honor Professor Brindley—teacher, researcher, and internationally recognized scientist. His studies in clay minerals and ceramics formed the basis of modern understanding in these fields.

Robert Goettler received the third place **William Grundy Haven Memorial Award** for his demonstrated promise in the College of Earth and Mineral Sciences. Eligibility for the award includes the ability to express thoughts clearly and accurately in written form. The award honors William Grundy Haven who was a freshman geology student at Penn State when he joined the armed forces during World War II. He was a combat infantryman in the 28th Division whose life ended serving in the Battle of the Bulge.

The **Robert W. Lindsay Award in Metallurgy** is given to recognize undergraduate scholarship in physical metallurgy and to honor Professor Lindsay for his twenty-seven years of teaching and research in metallurgy at Penn State. The 1997 award was presented to both Victor Jablokov and Keith Whitmire for their excellent performance in the metallurgy 405 and 406 courses, and their future promise as metallurgical engineers.

The **Frank and Lucy Rusinko Award in Fuel Science** was presented to graduate student Christopher Frye who demonstrated academic excellence in his course work this year.

Each year the College recognizes one advanced standing student for outstanding scholarship with the **Dean Edward Steidle Memorial Scholar** award. This year Marissa L. Mock received the award. Marissa is a senior in the polymer science and engineering specialization of the department. The award is given to the most truly outstanding student in the College of Earth and Mineral Sciences who intends to continue their studies in graduate school. The selection process usually emphasizes excellence in course work performance, but can also include other factors such as research accomplishment or unusual creativity of a scholarly nature.

Reza Sharifi received the **C.C. Wright Award in Fuel Science** for his outstanding scholarly achievement as a graduate student in fuel science. Given on an annual basis, the award is named in honor of Dr. Calvert C. Wright who came to Penn State as a National Research Council fellow to continue his research on coal hydrogenation—the first step toward coal liquefaction—that he had begun at the University of Washington. Wright's lab at Penn State was described as the first coal hydrogenation laboratory at any institution in the United States.

1997 Xerox Awards

The 21st Annual Xerox Awards in Materials Research were presented at the Xerox Awards Day on May 13, 1997. The awards are given each year for the best published work or research by a Ph.D. candidate and an M.S. candidate, and for the best research by a baccalaureate candidate—up to two in each category. The awards are given for creative research accomplishment only—grades, references, etc. are not considered in the competition. Students receiving awards this year include:

Ph.D.
David Cann (Clive Randall, advisor), Intercollege Graduate Program in Materials, for his thesis titled, *Thermochemical Interactions at Electrode Interfaces in Electroceramic Applications*. David graduated in August and has accepted a faculty position in the Department of Materials Science and Engineering at Iowa State.

John Seidensticker (Merrilea Mayo, advisor), Department of Materials Science and Engineering, for his thesis on *Impurity Effects on Superplasticity in Tetragonal Zirconia Polycrystals*. John also received a National Research Council Fellowship for postgraduate work at NIST. His proposal received an A+ ranking which his advisor Merrilea Mayo says was probably the best out of 2,000 proposals submitted.

B.S.
Robert Goettler (Darrell Schlom, advisor), Department of Materials Science and Engineering, for his thesis *Origin of the (100) Orientation of Y_2O_3 and CeO_2 Epitaxial Films Grown on Si (100)*. Robert graduated with his bachelor's in May, earlier this year.

Mark D. Waugh, (Clive Randall, advisor), Department of Materials Science and Engineering, for his thesis, *Structure–Property Investigations of a Modified $PbHfO_3$ Compound for High Energy Storage*. Mark graduated with his bachelor's in May, earlier this year.

Two-Year Luce Award Goes to Materials Student

Monica Woodward will receive one of four two-year awards sponsored by the Women in Science and Engineering (WISE) Institute. Monica is a junior in the polymer science specialization of the materials science and engineering department. She is also minoring in chemistry, Spanish, and geography, and plans to attend graduate school in either materials science or biomedical engineering.

Monica competed for the award last spring with more than 140 other women in science and engineering disciplines at Penn State. The award is part of the national Clare Boothe Luce Program that encourages women to "enter, study, graduate in, and teach" science and engineering. The award covers tuition, fees, and a living stipend.

1997–1998 Scholarships

Many students in the department received scholarship awards for the 1997–1998 academic year. The awards are based on academic merit and in some cases financial need. Many of the scholarships are a direct result of the generosity of our alumni.

AVX/Kyocera Foundation Scholarship in Materials Science and Engineering
John Bobiak
David Crouch
Daniel Fuller
Stephen McCashin
Dennis O'Leary
David Witcomb
Kyle Zarambo

Frances Hamilton Byers Scholarship
Jonathan Nichols
Chris Leitz
Troy Taylor
Geena Joys
Amit Daga
David Pikas
Deborah Waltmeyer

C. Philip Cook, Jr. Memorial Scholarship in Ceramic Science and Engineering
Dana Lemesh
Richard Wolf
Matthew Opitz

Glass Container Industry Research Corporation Scholarship
David Scrymgeour

George Gleason Memorial Scholarship
Leroy Morrison

Harman Award in Metallurgy
Robert A. Zilionis, Jr.

Hommel Scholarship in Ceramic Science and Engineering
Peakhong Tan

Floyd A. Hummel, Jr. Scholarship in Ceramic Science and Engineering
Brian Flannigan

Harvey P. Kocher Memorial Scholarship
Carl Brubaker

Thomas M. and Eleanor W. Krebs Scholarship in Metallurgy
Melissa Marshall

Helen R. and Van H. Leichliter Metallurgy Scholarship
Robert Zilionis, Jr.

Mr. and Mrs. Frank D. Lovett, Sr. Memorial Award
Andrea Lang

Penn State Metallurgy Alumni Scholarship
Stephen Chatfield
Brianna Cooper
Christian Dela Cruz
Shawn Holmberg
Theodore Inniss
Nicholas Marchetti
Kevin McHenry
Christina Reynolds

Arnulf I. Muan Graduate Fellowship in EMS
Matthew A. Seabaugh

Pennsylvania Ceramics Association Scholarship
Benjamin Markel

Anthony J. and Alberta L. Perrotta Scholarship in Materials Science and Engineering
Diane Day
Craig Stringer

James and Mary Ellen Tietjen Scholarship in the College of Earth and Mineral Sciences
Katrina Krulla
Craig Stringer
Jonathan Wickstrom

George H. and Madeleine Hager Todd Scholarship
Tonya Faust
Stephen Heffelfinger
Keith Williams
Keith Whitmire

Virginia S. and Philip L. Walker Jr. Scholarship in Materials Science and Engineering
Patrick Donahue
Jonathan Wickstrom

Sam Zerfoss Memorial Scholarship
Andrea Lang
Kristy Lang
Joseph Rahalla
Benjamin Markell
Matthew Motyka

Unnamed Departmental Scholarships
David McMahon

Materials science and engineering students not only work hard, they play hard. Several are pictured here enjoying a volleyball game at the 1997 Ox Roast hosted by undergraduate ceramics students during the Blue and White Game this spring.

Continued from page 14

1997. He now owns a polymer sales company—America International, Inc.

Michael J. Stempo ('77 Metals) is the marketing manager–primary metals for Air Products and Chemicals in Allentown, Pennsylvania.

Theodore D. Taylor ('66, '71 Ceramics) is a professor in ceramic and materials engineering at Clemson University. He teaches undergraduate and graduate classes in glass. His research involves glass melting problems.

Jim Van Ackeren ('75, '77 Ceramics) has been the materials technology leader for the aerospace equipment system with Allied Signal Aerospace since March 1995.

Joseph C. Veshinfsky ('79 Ceramics) is working for Lucent Technologies in Allentown, Pennsylvania, studying electromigration in MOS interconnects.

Richard D. Walsh, Jr. ('78 Metals) is the general manager of engineered products operations at Stockham Valves. He holds two U.S. patents and was the 1991 National Management Association's National Chairman of the Board.

William P. Whitney, II ('70 Ceramics) now has 35 years with Corning after receiving his Ph.D. from Penn State on an educational leave-of-absence. He is now executive scientist and director of the corporate systems department and a Paul Harris Fellow of Rotary International.

Tom Yager ('77 Ceramics) is manager of process control for ink jet components with Hewlett-Packard.

MRS Chapter Activities

The local Materials Research Society chapter is planning some activities and providing special services for the Penn State materials community:

♦ In November, they are planning a luncheon meeting with an invited speaker.

♦ The MRS Fall Meeting is December 1-5 in Boston, Massachusetts, and the local chapter hopes to get a group of students together to attend the conference, providing transportation and perhaps lodging. Contact John DeLucca (jmd14@psu.edu) for more information.

♦ Next spring, MRS will be co-sponsoring a poster competition with the American Ceramic Society. They will offer $250, $150 and $100 cash prizes. More details later.

♦ The MRS National Headquarters has moved into a new building, and is looking for volunteers to help decorate it in a general materials motif. Interested volunteers should contact Professor Merrilea Mayo (mayo@ems.psu.edu).

♦ Student members' résumés are being collected to put online for prospective employers to browse. Contact David Pratt (dwp4@psu.edu) for further details or to make suggestions.

♦ Check out the local MRS chapter's web page at: **http://www.clubs.psu.edu/mrs/**

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