Poate Appointed Dean at NJIT

John M. Poate has been appointed as Dean of the College of Science and Liberal Arts and Distinguished Professor of Physics at the New Jersey Institute of Technology (NJIT). NJIT is a state institution located in University Heights, Newark, New Jersey. It has been emerging as a strong institution in New Jersey, and one of Poate's jobs will be to accelerate that progress. His technical focus at NJIT will be on developing programs in photonic and electronic materials. In the broader scope of the institute, Poate plans to develop programs in environmental and urban infrastructure, areas already strong at NJIT. He will maintain ties with his former department at Bell Laboratories, Lucent Technologies, at Murray Hill where he headed the Silicon Processing Research Department. His research at Bell Labs has been concentrated on the defect properties of silicon resulting from ion implantation and on the development of improved processing technologies.

Poate had joined Bell Labs in 1971 as a member of the technical staff, following employment as a Harwell Fellow at the Atomic Energy Research Establishment in England. He has pioneered the development of ion beam techniques for both the analysis and modification of the near-surface properties of matter. This work has led to the fabrication and better understanding of several classes of electronic materials. His publications include over 250 scientific papers, co-authorship of three monographs on thin film reactions, laser annealing of semiconductors and ion implantation, and co-editorship of six conference proceedings.

He has co-chaired several international scientific meetings including the first international meeting in 1978 dedicated to the laser-processing of semiconductors. He was co-director of a NATO Advanced Research Institute on Surface Modification and Alloying in 1981 and Advanced Study Institute on Semiconductors and Processing, 1991. He served on the 1986 Academy of Sciences committee which investigated the position of U.S. materials research with regard to the surface modification and fabrication of electronic materials and structures. He was the 1987 Dorn Lecturer at Northwestern University. In 1993 he was co-chair of an NSF Panel studying the future of Atomic Resolution Electron Microscopy. He has served on the NSF Materials Research Advisory Council and is now a member of the Department of Energy Council of Materials. He is on advisory committees for the University of Illinois and Lawrence Livermore National Laboratory.

Poate received his BSc and MSc degrees at Melbourne University and his PhD degree in nuclear physics in 1967 from the Australian National University. As an undergraduate he was awarded the Dixson Scholarship and William Sutherland Prize for physics. Currently, Poate is a Fellow of the American Physical Society. He is former president and councillor of the Materials Research Society and past chair of the Division of Materials Physics of the American Physical Society. He is editor of the *Journal of Applied Physics Reviews*.

Radiation Detectors Achieve Accurate Readings at Room Temperature

Paul Luke, a staff scientist in the Engineering Division at Ernest Orlando Lawrence Berkeley National Laboratory, has developed a method that allows radiation detectors operating at room temperature to achieve levels of performance approaching that of liquid-nitrogen-cooled detectors. By eliminating the need for cooling, these detectors are expected to have widespread application in areas that require high performance detectors but where the technology needed for refrigeration is undesirable.

The detector uses an arrangement of parallel strip electrodes and the technique of "charge subtraction" to provide an accurate reading of the energy of radiation. The parallel strips are interconnected to form two sets of interdigital electrodes. Charge signals induced on these two electrodes are subtracted to yield a net signal that is insensitive to charge trapping. As a result, energy resolution is greatly improved from earlier techniques. According to Luke, "A number of materials can be used as the detecting medium but, except for a very few, namely germanium and silicon, the charge collection process is far from perfect. Often, the positive charges are not as efficiently collected as the negative ones. This results in an inaccurate reading of the ionization and it means that you can't rely on the signal's strength to tell you the energy of the radiation. In other words, the energy resolution is poor."

This technique can be applied to wide bandgap compound semiconductors such as cadmium telluride, cadmium zinc telluride, and mercuric iodide. These materials offer advantages over silicon and germanium, which are used in existing high performance radiation detectors.

"The problem with germanium and silicon is that you need to cool them down to liquid nitrogen temperatures to use them as high-resolution radiation detectors," said Luke, "whereas the compound semicon-

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ductors, because of the wider bandgaps, can be operated at room temperature."

"This opens up a set of new applications where good energy resolution is desired but providing liquid-nitrogen cooling to the detectors is not practical—for example, hand-held instruments used in the field," said Luke.

Another advantage of the technique is its use of induced charge signals to determine the depth of radiation interaction in the detector. By measuring the difference between the total charge induced by a particle of radiation and the charge induced at one of the two grid electrodes, it is possible to determine where the ionization originates along the direction perpendicular to the electrode planes. This can be used, in conjunction with shadow masks or x-ray optics, to determine the direction of incoming radiation, thus providing imaging capability.

Surgical Semiconductor Laser Produces Sharply Focused Beam

By making modifications to semiconductor lasers, researchers at the University of Rochester have devised a way to make them perform with the power and precision that laser surgeons routinely demand. Most laser surgery is done using powerful and expensive gas lasers since their semiconductor counterparts usually lack the power necessary for most surgery. The work at Rochester—recently presented at the annual meeting of the Optical Society of American and published in the July 29, 1996 issue of *Applied Physics Letters*—cleans up the beam produced by a semiconductor laser, creating a sharply focused beam with more power and precision than the beams produced by most such lasers.

The useful power output of semiconductor lasers is limited by the tendency of their beams to fragment into a number of parallel but weaker beams. While this does not pose a problem for applications that do not require much power, such as laser printers, it limits their use in surgery where higher power and precision are critical. The new laser produces a unified beam no wider than a grain of sand, with the power efficiently packaged in the center. The researchers believe the design makes possible semiconductor lasers with 6 to 12 watts of power, two to four times as powerful as current devices. Currently the only way for semiconductor lasers to produce such power is for several to be used in tandem, but this results in poor beam quality.

"Traditionally, with higher power you lose the ability to focus a semiconductor laser on its target," said graduate student John Marciante. "Rather than a single strong beam, you get three to five weaker beams, greatly diminishing the laser's power and performance."

To compensate for this breakdown of semiconductor laser beams, Marciante and Professor of Optics Govind Agrawal propose inserting two extra layers of slightly modified semiconducting material on either side of the active layer of gallium arsenide where the beam is formed.

"It's long been known that in filamentation, you get a 'positive' bending in the beams of high-powered semiconductor lasers, but nobody has been able to successfully counteract that with a 'negative' bending," Marciante said. "The layers we're inserting induce negative bending,

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resulting in a net bend of zero for the laser beam and keeping it sharply focused."

While a prototype has yet to be built, Agrawal said that the laser performed well in computer simulations. He said that since the inserted layers are made of the same semiconducting materials used in the other layers of the laser—with a small amount of aluminum added to give them slightly different properties—the new laser should not be significantly costlier or more difficult to produce than current semiconductor lasers.

Natishan Receives the William Blum Award

Paul M. Natishan, a research materials scientist at the Naval Research Laboratory (NRL), has received the eighteenth William Blum Award of the National Capital Section of The Electrochemical Society (ECS). This award was presented to Natishan in recognition of his outstanding contributions to the field of corrosion science and protection, especially in the area of passivity and its breakdown.

Natishan works in the Environmental Effects Branch of NRL's Materials Science and Technology Division. He has done extensive work on the use of ion beam surface modification to study and improve the pitting behavior of aluminum. His experimental work has been important in shaping the theory that the pH of zero charge of an oxide surface determines the susceptibility to localized breakdown of the oxide film.

Natishan has also conducted studies on the formation and rupture of oxide blisters on aluminum and has shown that pit propagation on ion-implanted aluminum is related to the mechanical failure of the oxide film caused by the production of hydrogen gas at the oxide/metal interface. Other areas where Natishan has made important contributions include the production and use of diamond materials and the use of inhibitors and coatings to prevent microbiologically influenced corrosion.

After obtaining his PhD degree in materials science from the University Virginia in 1983, Natishan was awarded a National Research Council Postdoctoral Fellowship at NRL in the areas of passivity and localized corrosion and joined NRL on a permanent basis in 1985.

XAFS of Technetium Helps Sort Out Radioactive Waste Problems

Using x-ray absorption spectroscopy, scientists at Ernest Orlando Lawrence Berkeley National Laboratory (Berkeley Lab.) have developed methods to examine the *in situ* chemical properties of technetium, a component of radioactive waste. This method holds promise for detecting a variety of other chemical species in radioactive wastes, and for evaluating the safest way to isolate these radioactive elements from the environment.

One possibility of isolating waste containing technetium is to put it into a cement waste form. The problem is that technetium in cement takes on a form that is water-soluble. "Technetium's most common oxidation state is the pertechnetate ion, which is a very soluble material. So if the method of mixing cement with radioactive waste containing pertechnetate is to be successful, it is necessary to reduce the technetium to a less soluble material, such as TcO_2," said Deputy Division Director Norman Edelstein of Berkeley Lab.'s Chemical Sciences Division.

X-ray absorption fine structure (XAFS) spectroscopy was the method of choice for studying technetium in cement. "It is the only technique that we know of that can determine the oxidation state of metal ions in a cement, and it also provides information on the identity of other atoms near the Tc," said Edelstein.

According to Jerome Bucher, a member of the Chemical Sciences Division team, when using XAFS, the researchers were able to look at many of their formulations and determine that the technetium was not completely reduced from the pertechnetate form by the blast furnace slag materials.

To obtain data using XAFS, researchers irradiate a sample contained in a cell just millimeters thick, and about 2 cm long, with x-rays. This ejects an inner shell electron of the ion, and other electrons fall back to the inner shell emitting radiation that is characteristic of the particular element that the ion is based upon. The characteristic radiation emitted from the ion is measured as a function of x-ray energy to determine the oxidation state of and chemical species containing the ion. Because inner shell electrons are bound so tightly to their nuclei, extremely high-energy radiation is necessary to push them into a higher shell—thus the need for x-rays.

"One of the real benefits of XAFS is that you can get the oxidation state of the technetium in the cement without chemically separating it from the cement, along with structural information about the nearby atoms," said team member David Shuh. XAFS works on materials like cement that have an amorphous structure instead of a crystalline one.

The team prepared a series of cement mixtures, each containing simulated technetium waste and a different component of blast furnace slag, and then measured the oxidation state of the Tc in each sample. They found that iron sulfide (FeS) and sodium sulfide (Na_2S) were equally effective chemical additives for reducing the pertechnetate ion into more stable forms. Their research also demonstrates that XAFS spectroscopy is a useful tool for studying the chemistry of technetium in radioactive waste forms.

This work suggests that XAFS will be applicable to the study of a wider variety of radioactive contaminants isolated in cement, as well as help to evaluate the effectiveness of other methods for isolating radioactive wastes.

Bacteria's Sweet-Tooth for Molasses Provides Clean-Up Solution to TNT-Contaminated Soil

A pilot clean-up program using molasses-fed bacteria has been conducted at the former Joliet Army Ammunition Plant about 50 miles southwest of Chicago. The plant produced a toxic, explosive chemical used in a wide variety of weapons from the 1940s through the 1960s. According to Argonne National Laboratory researcher John Manning, TNT (2,4,6-trinitrotoluene) is usually found in the top few meters of contaminated soil. The first step in the pilot clean-up process was to excavate the soil by hand, using garden-type screens. The screening removes rocks and other large particles, leaving only small particles of TNT in the soil. Next, the soil was added to water, creating a slurry, which was sent to bioreactors. Molasses was added to the bioreactors twice a week and served as food for several species of bacteria that occur naturally in the soil. As the bacteria feed on the molasses and grow, they also consume the TNT—even though they cannot use TNT as their only food source.

"Molasses has all sorts of things that micro-organisms like—sugars, proteins, amino acids," said Manning. "TNT-eating bacteria grow 10 times faster with molasses than without it."

Argonne researchers operated four bioreactors, each with a working volume of 300 gallons. The slurry in the reactors was 85% water and 15% soil by weight. Each week 10–20% of the volume of the slurry in the reactors was replaced with fresh slurry. The slurry that was removed was separated into water and soil. The water was treated and the cleaned soil stored in drums.

Digitally Encoded "Phantom" Developed to Test Vision of Ultrasound Scanners

Two University of Rochester researchers have invented a "phantom" for quick, accurate testing and standardization of ultrasound scanners. The new phantom, a term for the test device used to assess the accuracy of ultrasound machines, is a digitally encoded plastic transparency that the researchers believe is more accurate, works more quickly, and is less expensive to manufacture than current phantoms, which are cumbersome hand-built blocks made of various tissue-mimicking materials with tumorlike lumps imbedded in them. The digitally produced phantom was created by graduate student Dan Phillips and Kevin Parker, professor of electrical engineering and radiology and director of the Rochester Center for Biomedical Ultrasound.

Realizing that they could take accurate ultrasound scans of precisely positioned, digitally created patterns of dots and lines, Parker and Phillips used a computer and a common laser printer to create a digital halftone pattern on a piece of copier paper, which they then transferred to an ordinary transparency. They experiment with digitally created patterns of the letter "E," like those on eye charts, to check the accuracy of ultrasound scanners.

The new phantom addresses a major problem in the emerging field of telemedicine where doctors transmit images to distant colleagues for consultation. In telemedicine, the image produced by an ultrasound system must be electronically encoded, transmitted, and decoded, and then displayed on a different computer—a chain of events that presents many opportunities for distortion of the original scan. But by comparing test scans of a phantom sent just before and after a telemedical consultation, doctors can determine if the images have been transmitted with minimal distortion. Without such a system, a doctor accustomed to reading ultrasound scans taken on-site is hard-pressed to accurately interpret an image taken remotely.

The research team said that the new phantom can also be used in the rapidly growing field of color Doppler imaging, which is frequently used to observe movement within the body, such as the flow of blood. By vibrating the phantom, graduate student Stephen McAleavey has found ways to more accurately evaluate color Doppler images.

Process Turns Corn into Chemicals

Researchers from Argonne National Laboratory (ANL), Oak Ridge National Laboratory, the National Renewable Energy Laboratory, and Pacific Northwest National Laboratory have developed a process to convert corn into a cost-efficient source of commercial chemicals. The chemicals produced will be incorporated into polymers and solvents for use in clothing, fibers, paints, inks, food additives, and an array of other industrial and consumer products. The process first makes succinic acid by fermenting glucose sugar from corn, then separates and purifies the acid, and converts it chemically into 1,2-butanediol, tetrahydrofuran, N-methyl pyrrolidone and other chemicals used to make a wide assortment of products.

Mark Donnelly and his colleagues at ANL have applied genetic techniques to create a mutant of a bacterium that normally produces only small amounts of succinic acid. The mutant produces greater amounts of the acid, and scientist Shih-Perng Tsai and his group at ANL have established an efficient process for purifying the acid from the mixture of materials found in fermentation broths.

Quirk Awarded Kumho Endowed Professorship

In keeping with its commitment to technological advancement, The Kumho Group of Korea has funded the Kumho Endowed Professorship in Polymer Science at The University of Akron. Roderick Quirk has been named the inaugural holder of the endowed professorship. The Kumho Group is an international manufacturer involved in synthetic rubber, chemicals, tires, and other areas.

Quirk, who also is recognized as a Distinguished Professor of Polymer Science, has taught at The University of Akron since 1983; however, he has been familiar with the UA program for more than 20 years. Some of his research involves developing new elastomers for environmentally friendly tires.

Heating Device Developed for Ultralow Emissions

An environmentally friendly device to operate heaters for home and industrial uses has been developed at Sandia National Laboratories. This device creates only 5 ppm of NO_x, a pollutant that contributes to smog. Air-quality limits are about 20 ppm, said Jay Keller, a researcher at Sandia's Combustion Research Facility. Keller is a co-inventor of the device with researchers Taz Bramlette and Pamela Barr. Besides low NO_x, this clean combustion approach also emits very low amounts of carbon monoxide.

Working with an experimental, see-through burner, the research team minimized emissions by mixing fuel and air prior to burning, and by keeping the fuel-air ratio lean. The one-way valve design prevents the burning fuel from igniting this premixed fuel in a flame "flashback," Keller said.

Barr said, "The invention operates safely because it keeps the fuel and air separate until the valve opens. Both gases mix after they pass through the valve. Allowing the fuel and air to mix during the journey to the combustion chamber minimizes the local regions of fuel-rich combustion, which is a major source of pollutants."

Researchers Obtain Femtosecond X-Ray Beams

Scientists at the Ernest Orlando Lawrence Berkeley National Laboratory have produced directed beams of femtosecond x-rays. Lasting only a few femtoseconds, the strobelike pulses of x-ray light will be used to study the motion of atoms during ultrafast physical and chemical processes. In a paper published in the October 11 issue of *Science*, the researchers reported that sending a short, powerful pulse of infrared laser light across the path of a narrowly focused electron beam generated pulses of x-rays that were 300 femtoseconds in duration.

The production of directed beams of x-

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rays on a femtosecond time-scale has been highly prized by the scientific community because, at room temperature, atomic motion takes place, in most cases, on a time-scale of approximately 100 femtoseconds. With femtosecond x-ray pulses, it would be possible, for example, to track the movement of atoms in a sample of material during a phase transition (solid to liquid to gas), a chemical reaction, or any other process of physical change.

The directed beams of femtosecond x-rays were produced at a branch line off the 50 MeV linear accelerator that feeds electrons into the synchrotron booster. Atop this branch line is a femtosecond terawatt near-infrared laser. The laser provides a tightly focused electron beam that is about 90 μm in width; the laser produces photons in 100 femtosecond pulses.

"By crossing the photon and electron beams at a right angle, we obtain scattered x-ray pulses lasting about 300 femtoseconds that travel along the direction of the electron beam," said Robert Schoenlein of the Materials Sciences Division. "The duration of the x-ray burst is determined by the transit time of the laser pulse across the waist of the focused electron beam."

Once femtosecond pulses of x-rays are generated, a magnet is used to remove the electron beam. What is left are pure femtosecond pulses of x-rays. The research team detected these pulses using an x-ray sensitive phosphor screen. Visible photons from the phosphor were then imaged onto a charged-coupling device camera.

The images showed that the x-ray photons arrived as an elliptically shaped beam, similar to the shape of the electron beam from which they were generated. Additional measurements indicated that the beam was delivered at an energy of 30 keV and flux of about 10^5 photons per pulse. These results were in accordance with theoretical predictions. □

CONFERENCE REPORT

Major Topics of Small-Angle Scattering Discussed in Brazil at SAS-96

The X International Conference on Small-Angle Scattering (SAS-96), chaired by Aldo Craievich, took place on July 21–25, 1996 at Campinas, São Paulo State, Brazil. The choice was mainly motivated by the excellent development of this technique in Brazil and by the conclusion of the synchrotron radiation facility of the Brazilian National S. R. Laboratory at Campinas (LNLS), the first equipment of this kind in the southern hemisphere.

The conference was held at the Telebras R&D Center. The exciting and pleasant conference was full of new scientific results and conducted in a friendly atmosphere. The number of participants and scientific contributions were the highest so far: 220 scientists, from 25 countries, presented 215 scientific papers and submitted 90 manuscripts for the proceedings of the Conference, to be published by the *Journal of Applied Crystallography*.

The different sessions, microsymposia and poster sessions received a high level of attendance. The field of small-angle scattering continues to develop rapidly, both in the extension of the scientific fields covered and in the depth of the analysis and of the theory. Several people organized, in parallel sessions, eight short microsymposia in particularly "hot," but necessarily less general, fields. The microsymposia were centered on a number of subjects, including the following.

Impressive results were presented on simultaneous use of wide- and small-angle techniques, for example, time-resolved experiments of x-ray scattering during crystallization. This progress is mainly due to the high flux available at the synchrotron sources.

Important achievements obtained recently in the understanding of the structure of complex liquids, such as microemulsions and bicontinuous and lamellar phases, were reported. The progress in this field is mainly due to improvements in the theory of data analysis.

The use of perfect-crystal cameras allows measurements with very high resolution, at least at facilities where a large flux is available. The microsymposium dedicated to this subject provided an opportunity to discuss recent devices.

Ill-ordered materials and anisotropic studies is another topic where many original studies continue to appear, namely, in the field of liquid crystals. Here, too, the technique plays an important role through the generalized use of high-definition, two-dimensional detectors.

Associating polymers, block copolymers, and gels, the fields where small-angle scattering is probably the dominant technique, correspond to many new materials. Their structural properties are the object of new experiments where isotropic substitution plays a major role.

In the growing field of biology, structures and conformations and their modifications under the action of external parameters have been the object of detailed studies and many possibilities remain open for specific studies by x-rays of tiny samples, using the focusing possibilities and the high fluxes of synchrotron sources.

The general sessions of the conference and the poster session were divided into four classical large domains where small-angle scattering is important: General Interest, Inorganic Materials, Polymers and Complex Fluids, and Biology.

SAS applications to solid-state physics and biology are rapidly developing fields and interesting original results have been reported, for instance, in the case of time-resolved experiments on superalloys, nanocrystalline material characterization, and the use of x-ray standing waves for investigations of thin films.

A satellite workshop was held just after the end of SAS-96, focusing on Instrumentation and Industrial Applications of SAS. Papers on these subjects were presented and discussed in two short microsymposia which took place at LNLS on July 26. Reports on new developments of neutron SAS sources, status reports of a number of new synchrotron SAS beamlines, and x-ray detectors were presented. The talks on industrial applications dealt with the industrial use of large academic facilities and on SAS applications such as on-line characterization of fiber processing. The participants recommended inclusion of these subjects in forthcoming SAS conferences.

The number of students present at the scientific sessions, coming from many universities in Brazil, is encouraging for the future development of the technique in South America. The visit to the new synchrotron radiation facility at LNLS showed that the necessary heavy technology around such a large instrument already exists in Brazil, that new and original technical ideas are under development, and that the forthcoming years can be seen with optimism.

José Teixeira
Laboratoire Léon Brillouin, Saclay, France