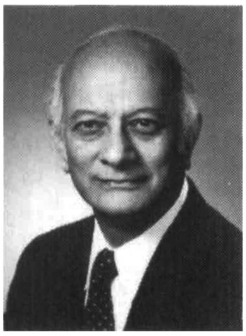
Japanese Honor R. Roy



President Ikuzo Tanaka of the Tokyo Institute of Technology announced that the institution has awarded an honorary doctorate to Dr. Rustum Roy, Director of the Science, Technology and Society Program and Evan Pugh Professor of the Solid State at Pennsylvania State University. The honorary degree was conferred at a ceremony on May 11, 1987 in Tokyo. Roy delivered a technical address on the occasion and then lectured at the Japanese Ceramic Society and several government laboratories and industries.

The Japanese award recognizes Roy's research accomplishments in materials chemistry and materials synthesis over his 40-year career. It also recognizes his role in encouraging a long succession of eminent Japanese scientists to spend a year or two at Penn State, thereby building bridges between the two countries.

The author of some 500 papers and five books, Roy founded and directed Penn State's Materials Research Laboratory for 23 years. He is a member of the National Academy of Engineering (U.S.), Royal Swedish Academy of Engineering Sciences, and Indian National Science Academy. He recently became the first director of the University's Science, Technology, and Society Program. A founding member and Councillor of the Materials Research Society, Roy is also a principal editor for *Journal of Materials Research*, a member of the Editorial Board of the MRS BULLETIN, and organizer of the MRS symposium series, Frontiers of Materials Research.

Varian and Hewlett-Packard to Develop Gas-Source MBE

Varian Associates, Inc. and Hewlett-Packard Company have entered into a joint program to develop a gas-source molecular beam epitaxy (MBE) system that will be introduced in late 1987. Gas-source MBE equipment differs from solid-source systems in that some or all of the furnaces are replaced with gas injectors which spray materials in gas form or as a molecular beam onto the wafers.

The companies said the system will make it simpler and more cost-effective to make gallium arsenide and other compound semiconductor devices in production quantities. Such devices, which offer considerable speed advantages over silicon and are more resistant to heat and radiation, have long been considered too expensive and too difficult to manufacture for a broad range of applications.

Thomas Cooper, MBE operations manager at Varian, says the joint effort will speed the company's gas-source MBE development project by nearly a year, as well as enhancing Hewlett-Packard's efforts in the growth of high electron mobility transistor (HEMT) material.

Hewlett-Packard will design gas handling and manifold equipment for the new gas-source system, while Varian will develop the gas injectors and pumping packages. A prototype gas-source MBE has already been installed at Hewlett-Packard, and evaluation and testing began in June.

Hewlett-Packard currently operates four Varian solid-source MBE systems in plants in Santa Rosa and Palo Alto, CA.

DOE Announces New Computer Data Base on Superconductivity

U.S. Secretary of Energy John S. Herrington said the Department of Energy (DOE) will establish a computerized data base to help U.S. scientists keep abreast of rapidly developing superconductor research results and to help the United States maintain a competitive advantage in superconductivity.

"Scientists and industry normally rely on articles published in scientific journals to learn of new research developments," Herrington said. "Superconductor research is producing new results so fast that these communications channels are being overwhelmed."

"If American scientists are going to stay in the forefront of this research, and American industry in the forefront of its application, we must provide a better way to facilitate the free flow of information and scientific data. The Department of Energy can use its existing computerized scientific and technical information systems, and expand upon them, to expedite the flow of this information. We intend to do so."

DOE has already begun a network to coordinate information exchange among researchers. Now available only to DOE contractors on a trial basis, this network will be broadened to make it available to the commercial and scientific communities and federal agencies. "There still are many technical problems to be worked out, however, and there is a need to make all of the developments in the field more readily accessible to all scientists," Secretary Herrington said. Plans are to include articles and preprints, names and contacts for researchers, wire service news, trade news, and meeting announcements.

DOE's data base on superconductors will be expanded and made accessible through the Department's existing Office of Scientific and Technical Information (OSTI) integrated technical information system. OSTI will offer on-line access to data, bibliographic data bases, and research in progress. The information will also be available through electronic mail and other information dissemination capabilities.

Researchers seeking more information about the data base can contact A. Corona at (615) 576-1222.

T.G. Stoebe Named MSE Chairman at University of Washington

Thomas G. Stoebe has been named chairman of the Materials Science and Engineering Department at the University of Washington. He had served as a faculty member at the University of Washington since 1966, and as associate dean of the College of Engineering for the past five years. His current research interests include optical materials, luminescent devices, and lattice defect properties of solids. Stoebe is a graduate of Stanford University, where he earned his BS degree in 1961, MS degree in 1963, and PhD in 1965. Stoebe is a member of the Materials Research Society.

Argonne to Develop Practical Superconducting Wire

Argonne National Laboratory has been named by the U.S. Department of Energy to develop a practical conducting wire from the new superconducting ceramics. The goal is to produce within five years a practical wire that loses all resistance to electrical current at −321°F (77K). Working closely with Argonne on the project will be Brookhaven National Laboratory (New York) and Ames Laboratory (Iowa).

Argonne researchers have already shaped a superconductor wire about six mils (0.01 inch) in diameter and on April 28 announced an improved current density of 191 A/cm^2 measured in a 0.007-inch-thick wire cooled to 65K.

Ni/H_2 Battery Being Tested for Remote Terrestrial Applications

Donald M. Bush of the Storage Batteries Division, Sandia National Laboratories, is leading a joint Sandia/industry project to see if multicell nickel/hydrogen batteries can be built to operate for 20 to 30 years at

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costs economically feasible for terrestrial applications. A technical report estimates that the life-cycle cost for a 15 kWh Ni/H_2 battery for use in a full-scale photovoltaic system with a 30-year life could be as low as 3.9 cents per kWh.

The experimental batteries and cells now being tested at Sandia were designed and developed by COMSAT Laboratories (Clarksburg, MD) and Johnson Controls (Milwaukee, WI) under a contract with Sandia. Characterization and life-cycle tests on a 100-Ah battery began in July 1984. It had accumulated more than 1,100 cycles when it was connected in parallel with a laboratory-scale photovoltaic array and constant current load in January 1987. Long-term tests are continuing.

Recently designed thicker positive electrodes have made possible capacities of more than 150 Ah. Johnson Controls is scheduled to deliver a 300-Ah, 24-V, 7-kWh battery to Sandia in September. It will be incorporated into an experimental field-scale photovoltaic system.

Clarkson University Named New York State Center for Advanced Technology

Clarkson University's Center for Advanced Materials Processing (CAMP) has been designated a Center for Advanced Technology (CAT) by the New York State Science and Technology Foundation. Under the CAT program Clarkson will receive $1 million per year for the next four years, beginning July 1, 1987, to fund leading-edge research in the development and processing of materials. In addition to providing operating funds for CAMP, the New York state legislature voted over $25 million to construct a building to house CAMP on the Clarkson University campus in Potsdam, NY. CAMP also expects to receive about $2 million from industry this coming fiscal year.

Interdisciplinary research teams have been formed to:

- Develop economical techniques to produce monodispersed fine particles of technological interest.
- Develop the technology for rapid optimization of methods for processing fine particle slurries into useful forms.
- Develop coherent models for properties and optimal processing techniques for polymers loaded with fine particles and fibers.
- Improve the quality of cadmium telluride and gallium arsenide crystals grown by directional solidification.
- Develop silicon carbide semiconductor devices.
- Develop improved techniques for removing contaminants from silicon wafers.

Clarkson is one of eight universities in New York to be designated a Center for Advanced Technology. The other seven New York Centers for Advanced Technology are located at Columbia University, Cornell University, Polytechnic University, State University of New York at Buffalo, State University of New York at Stony Brook, Syracuse University, and University of Rochester.

Allied-Signal Funds MSE Fellowship at Northwestern

The Department of Materials Science and Engineering in the Technological Institute at Northwestern University has received $14,000 from Allied-Signal Foundation, Inc. to establish a research fellowship in materials science. The fellowship will be used to assist a graduate student in the department. Upon receipt of the award, Prof. D. Lynn Johnson, department chairman, said, "We have identified several areas of mutual interest, including high temperature superconductors and structural ceramics. We also have offered to assist in recruiting activity and in collaborative research."

Army Materials Lab Finds SBIR Program Productive, Cost-Effective

Working with small business through the Small Business Innovation Research (SBIR) Program, the U.S. Army Materials Technology Laboratory (MTL) is helping to stimulate scientific and technological innovation in the private sector through high quality research and development on Department of Defense (DOD) interests.

"We are wholly in support of the SBIR Program because both the Army and other DOD components as well as small business benefit," says Dr. Edward Wright, MTL's director. "We have found that this program is a productive and very cost-effective avenue toward getting novel ideas evaluated, prioritized and pursued."

U.S. Composites (Troy, NY) the first small business to be awarded a contract by MTL under the SBIR Program, is approaching the end of Phase II. The company focused on developing a resin applicator ring to continuously impregnate moving fibers with resin in a controlled environment for effective braiding of composites. This concept was conceived by U.S. Composites president August Hugo Kruesi, who has U.S. and international patents on his process. E.I. DuPont de Nemours & Company has committed itself to provide some Phase III funding to U.S. Composites to pursue commercial applications of the achievement.

Potential structural applications for braided composites are vast within the Army and include helicopter and propeller blades, launch tubes and lightweight bridging components. The potential advantages of effective manufacture of composite parts via braiding include high production rates, precise fiber orientation, net shape fabrication, superior damage tolerance, and cost savings of up to 40% along with quality improvements. The first Army components fabricated to demonstrate the resin applicator were subscale trails for the lightweight howitzer. These were manufactured during October 1986 on a composite braider located at Watervliet Arsenal's Benet Weapons Laboratory (Watervliet, NY).

"We are very pleased with the results of this SBIR Program," says Thomas O'Brien, Advanced Technical Section, Benet Weapons Laboratory. "It has provided us with an innovative solution to a major limitation in the manufacture of braided composite components, that of applying the precise amount of resin to the part. We feel that the resin applicator system will be a great step forward in the manufacture of composite components. The success of this project, resulting from the cooperative efforts of MTL, Benet Weapons Laboratory and U.S. Composites, effectively demonstrates the viability of the SBIR Program."

Los Alamos Tests Materials for Use in Space

A Los Alamos National Laboratory team is determining which materials will better withstand the corrosive atmosphere of a low orbit, 60–180 miles from Earth, where a space station will be placed in the next decade. The low-earth orbit is much more corrosive than the geosynchronous orbit, about 22,000 miles above Earth, where communications satellites are located. The research is focusing on duplicating the orbit's atmosphere and then testing how various materials resist the adverse conditions.

"We are studying the atomic oxygen found in the low-earth orbit and how it interacts with the carbon-based materials which the U.S. space station will be made from," says Jon Cross, a chemical physicist and leader of the space materials testing project.

"It is very difficult to reach the same high velocity that spacecraft have in the low orbit," says Cross. "To accurately study the interactions between oxygen atomic particles and the spacecraft's surface, we heat oxygen to temperatures equivalent to 36,000°F." These temperatures are attained by shooting a laser beam into the gas, turning it into a low-density atomic beam

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which is then fired at the materials being tested. By measuring how much of a material's surface is lost and what type of burning is produced, the team evaluates the effectiveness of various substances.

Thin laminations of silicon carbide and carbon fibers glued together with a special epoxy will be used for the construction material in space, but a strong covering must be used to protect those materials in orbit. Current experiments are focusing on Kapton insulation. Considerable data is available on the material and its durability in orbit because earlier U.S. space missions used Kapton as a protective thermal blanket. That information is being used in analyzing the results of the Los Alamos experiments.

Teflon and various dry lubricants will also be tested for use in space. The Los Alamos work is being done in conjunction with the NASA's Johnson Space Center in Houston, TX.

Academies Name Committee to Assist DOE in SSC Site Selection

At the request of the U.S. Department of Energy (DOE), the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE) have appointed a committee of experts to evaluate the suitability of proposed locations for the Superconducting Super Collider (SSC) recently approved by President Reagan for completion in 1996. The 20-member committee includes experts in high energy physics, engineering geology, accelerator design, economics, procurement, the environment, construction, and large-facility management. Edward A. Frieman, director of the Scripps Institution of Oceanography (La Jolla, CA), will serve as committee chairman.

Proposals were due to DOE by August 3 from states and others seeking to host the SSC. DOE will send proposals that meet minimum eligibility criteria to the Academies' committee in September. The committee plans to respond in December with a short list of best-qualified sites. The selection of a preferred site for the SSC will be made by DOE, not by the NAS/NAE study group, in July 1988. DOE will select a final site in January 1989, after completing an environmental impact statement.

Despite a large number of site requirements, including DOE's stipulation that the land be provided free to the federal government, competition for the location of the SSC is already intense. One reason is that the SSC will be among the most massive scientific construction projects ever attempted, requiring an onsite work force of up to 4,500 persons during its seven-year construction phase. The super collider will support a full-time staff of some 3,000—including 500 visitors taking part in research projects—and is likely to become a mecca for high energy physics researchers from all over the world.

NAS Panel Endorses Science and Technology Centers, Cautions NSF on Implementation

Science and technology centers, as proposed in President Reagan's State of the Union message last January, could make "significant contributions to science and to the nation's economic competitiveness," according to a new report by a National Academy of Sciences (NAS) panel. But realizing these contributions, the panel told the National Science Foundation (NSF), will require proper management, adequate resources, and "the selection of programs for which centers are the most effective form of organization."

The panel, chaired by Stanford University chemistry professor Richard Zare, concluded that such centers would be an appropriate way to organize research that requires diverse experience and expertise or such extensive resources that advantages of scale, duration, or facilities are important. It also recommended that centers be located on college or university campuses, led by regular faculty, and integrated into academic programs to provide education and research experience for students, researchers, industrial fellows, and others. The report does not recommend how many centers there should be, nor does it suggest specific research areas that might benefit, since "describing a finite number of candidates might steer researchers away from areas of even greater promise or prejudice the review process against their selection."

NSF plans to support science and technology centers beginning with fiscal year 1988. These centers, combined with other currently operating centers, would comprise 10% of the NSF's budget. NSF asked the NAS panel for guidance in implementing its part of the government-wide program. Other federal agencies are expected to participate, but the panel envisioned that NSF's primary role would be the support of basic science.

The panel cautioned that center support should not divert federal funds away from other modes of scientific research, such as individual research. This issue was recently debated by the National Science Board (NSB), which also expressed concern about phasing out unproductive or unsuccessful centers. Erich Bloch, NSF director, assured the NSB that a balance would be found between centers and individual investigators. The panel reinforced this by saying that "the single investigator with one or few graduate students is the appropriate unit for many fields of scientific inquiry."

The report also says that less formal group projects should not suffer because of increased emphasis on center research. These informal group projects usually lack the formal administrative structure characterizing a center and comprise about 16% of NSF's current research funding.

The panel identified other possible problem areas, warning against a "self-defeating drift" in the work of the centers toward a "short-term focus on commercial applications." It also stressed that the new centers should not be perceived as a cure for understaffing or lack of facilities and equipment in academic research.

According to the panel, the cost for each center could range between \$500,000 and \$10 million but typically might run \$1 million to \$5 million annually. It recommended a funding cycle of not more than nine years with a review every three years.

The panel suggested a two-stage review for each proposal submitted to the NSF. Initial screening, it said, should be based purely on the quality of the proposed research. If the proposal passes this stage, a second review would determine whether the research requires a center-based approach. Reviewers would then decide on how to balance awards among different fields to best meet the goals of the science and technology centers program. The panel stressed that centers should have a unifying intellectual theme that could reflect work in one or many disciplines.

NSF now funds a number of other kinds of centers at a cost of \$115 million in fiscal year 1987. Among them are 12 Materials Research Laboratories, 45 Industry University Cooperative Centers, 21 Engineering Research Centers, and several specialized centers not part of larger programs.

Dyed Photoresist Improves Metal Line Patterning

Sandia National Laboratories has developed a photoresist for fabricating complex high-reliability radiation-hardened integrated circuits (ICs). The photoresist provides a key to making ICs with precisely defined current-carrying metal lines that have smooth straight edges. A dye increases the ability of the photoresist to absorb light, reducing light reflection and scattering during the photolithographic patterning of chip features made of reflective materials like aluminum. A photoresist using this dye is now available from Shipley, Inc. (Newton, MA), which independently developed the product concurrently with Sandia. The nontoxic dye appears to

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offer significant advantages over other photoresist dyes and alternate methods of absorbing light used to expose photoresist.

Sandia's studies have shown that addition of this dye in concentrations of up to almost 10 g/l of photoresist does not significantly change photoresist viscosity, refractive index, thermal properties, or solubility in developer. Most importantly, the dye is strongly absorbing in the desired light wavelength range of 390–450 nm. It also has a low metal content, and addition of the dye to the formula increases the cost effectiveness of photoresist materials.

The dye now being used at Sandia is extracted from natural sources. "We are carefully monitoring the best way to add this dye to the photoresist formula so that the dye's few naturally occurring impurities can be efficiently filtered out prior to use," says Clifford Renschler of Sandia's Chemistry of Organic Materials Division. "Shipley has supplied a synthesized version which we are now evaluating."

Renschler developed the dyed photoresist at the request of process engineers at the Center for Radiation-hardened Microelectronics (CRM) located at Sandia. CRM engineers needed a photoresist that would let them successfully pattern the metal lines on a variety of devices, including a developmental 256K nonvolatile memory chip. The new photoresist produced clean metal lines, where other products were unsuccessful. The CRM now routinely uses the new material for the metal patterning steps during fabrication of all parts with 2-micron metal lines.

Sandia Schedules High-Pressure Test for Scale-Model Containment Building

Engineers at Sandia National Laboratories will pressurize a 1/6-scale model of a nuclear power plant containment building until it fails. The 37-foot-tall reinforced concrete structure, built by United Engineers and Contractors (Philadelphia, PA), is the largest and most complex concrete containment scale model ever constructed. The test is part of a Nuclear Regulatory Commission program to provide data to improve techniques for predicting light water reactor containment building behavior if a severe accident produces extremely high pressures inside the containment building. Analysis of the test will help ensure that appropriate physics has been used in designing complex computer models of containment behavior.

During the past several years, Sandia has tested 1/32-scale and 1/8-scale model steel structures to failure. "Careful analysis of results from all scale-model tests should provide regulators and the nuclear industry with a clearer picture of the most likely timing, mode, and location of containment damage that could occur in the event of high internal pressures, says Dan Horschel, lead engineer and a member of Sandia's Containment Integrity Division.

More than 1,200 data channels will provide information during testing. During construction, about 250 strain gauges were attached to the reinforcing steel in addition to hundreds of thermocouples, pressure transducers, displacement gauges, and concrete crack gauges on strategic locations inside and outside the model and embedded in the concrete.

During the first structural integrity test, the model will be pressurized in five steps to 115% of its 46 psig design pressure. Pressure will then be reduced to the design level for crack mapping. Next, an integrated leak rate test will verify that the model conforms with established criteria for nuclear power plant containment buildings. The final high-pressure test, during which the model will be pressurized until it fails, is scheduled for July 28, 1987. Researchers expect the final test to take about four days, as internal pressure is gradually increased in discrete pressure steps. During the experiment, researchers will monitor the instrumentation and compare the readings with pretest predictions.

Ten organizations from five countries—the United States, France, Italy, West Germany, and the United Kingdom—have conducted detailed pretest analyses of Sandia's 1/6-scale model tests. Comparisons of these analyses and test results will be presented at the Ninth International Structural Mechanics in Reactor Technology Conference, August 17-21 1987, Lausanne, Switzerland.

New NBS SAXS Facility Available for Cooperative, Proprietary Research

A National Bureau of Standards research facility for studying the microstructures of polymers, metals, ceramics, and biological materials is now available to scientists in industry, government, and universities for cooperative and proprietary research. The small-angle x-ray scattering (SAXS) facility is located in Gaithersburg, MD.

Research opportunities with the SAXS method are very broad. For polymers research, SAXS can be used to study the phase separation of molecules, crystallite morphology, melting and crystal growth, molecular dimensions, and polymer networks. Metallurgists can use SAXS to study crystal structure, void formation and growth, and phase separation in metals and alloys. SAXS can also be used to study pore characteristics in ceramics and to measure molecular arrangements in biological materials.

NBS polymer scientists plan to use the new SAXS instrument to obtain information on the microstructures of polymer blends to develop polymer alloy phase diagrams. It is estimated that polymer blends currently account for 20% of the 2.5 billion-pound worldwide consumption of new engineering polymer materials.

The SAXS instrument, which measures 10 m long, uses a 12-kW rotating anode generator to produce a highly collimated pinhole beam of x-rays. This extremely narrow beam is used as a probe to characterize the internal structures of materials in the 1–100 nm range. The SAXS facility will be equipped with a sample chamber to take measurements on materials from room temperature up to 400°C. Measurements also can be taken on materials being deformed under stress.

The NBS facility was designed by polymer physicist John D. Barnes with assistance from research chemist Frederick I. Mopsik, and mechanical engineer Manfred Osti.

For information on the SAXS facility or to schedule research time, contact: John D. Barnes, B210 Polymers Building, National Bureau of Standards, Gaithersburg, MD 20899; (301) 975-6786.

Sandia Explores Improved Safety in the Aluminum Industry

Improving safety for workers in the aluminum industry is the long-term goal of a research program begun last fall by Sandia National Laboratories for the Aluminum Association. "Our contract work centers on steam explosion suppression," says principal investigator Lloyd Nelson. "If explosions are to become a thing of the past for the aluminum industry, we need to know why they happen—and under what conditions they are most likely to occur." A typical operation where that knowledge might be applied is direct chill casting used in many metals industries, he continued.

A Sandia research team supervised by Marshall Berman has done extensive research on steam explosions since the mid-1970s, when the Nuclear Regulatory Commission asked Sandia to study the phenomenon and its possible threat to nuclear reactors in the event of a core meltdown. "As a result of that NRC research, we've done a lot of experimental, theoretical, and numerical work on steam explosions," says Marshall. "Now, under the new contract, we're in a position to transfer some of that technology."

To zero in on conditions that cause steam explosions, Maureen Eatough and

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Ken Guay conducted a series of small-scale lab experiments to determine how wet surfaces of different materials affect the explosive reaction. The experiments involved dropping molten aluminum into saucers (with different kinds of inside surfaces) submerged in water-filled tubs. After testing everything from rusted steel to graphite, "it's apparent that the surface material affects the initiation and force of the explosion," says Lloyd.

Lloyd theorizes that another factor may be a key to solving the steam explosion problem. He and Guay experimented with increasing the viscosity of the water contacted by molten metal. By dropping molten tin into a beaker of water, they learned that adding a thickening agent such as glycerol or cellulose gum to the water (giving it the consistency of thin motor oil) would suppress an explosion if enough of the agent were added. "We found that a 15-fold increase in viscosity over that of water alone is needed to suppress the molten-tin explosions," reports Lloyd.

If the solution is viscous enough it prevents rapid collapse of steam bubbles near the tin drop, thus averting an explosion. A field-scale experiment coordinated by Bill Marshall, Jr., using a molten mixture of iron-aluminum oxide, confirmed the viscosity finding. The large-scale test resulted in only a gentle, partial breakup of the melt when it was dropped into a water/cellulose gum solution. Control experiments with water alone produced violent spontaneous explosions.

Electrode Gap Controller Improves VAR Process

An improved electrode gap controller designed for vacuum arc remelting (VAR) may result in improved high-strength metals for use in airplanes, spacecraft, and other severe environments where extreme speed, temperature, and stress are common. VAR has been used since the 1950s to produce ingots with high degrees of purity and physical and chemical uniformity. Such ingots also have reduced levels of oxygen, nitrogen, and hydrogen. VAR is used to produce high-strength steels, titanium alloys, nickel-based alloys, and other specialty metals.

The basic VAR process works by suspending a large consumable metal electrode in a vacuum furnace. The electrode is slowly melted by a metal vapor arc and the metal falls into a molten pool inside a water-cooled copper crucible, where it gradually resolidifies. The arc occupies the gap between the electrode and the molten pool. Holding a constant electrode gap is important because defects form in the ingot if the gap varies and causes unsteady melting and resolidification.

Controllers now in use drive the electrode at a velocity based on parameters with a time constant of 10–20 minutes—somewhat like trying to adjust highway speed within a few miles per hour based on a look at the speedometer 15 minutes earlier.

Frank J. Zanner, a metallurgist in Sandia National Laboratories' Process Metallurgy Division, says the new microprocessor-based electrode gap controller is immune to electrical "noise" in the VAR furnace and is responsive to current furnace conditions. It eliminates the 10–20 minute delayed response to changing arc conditions, allowing ingots to be produced at consistent quality and uniformity levels.

The controller system provides instant control of electrode gap by using a computer, an adaptive algorithm, electrical short detection electronics, and a known relationship. The controller has been tested in large industrial VAR furnaces that can melt 18-inch-diameter, 8,000-pound electrodes. Testing involved Teledyne Allvac (Monroe, NC), Retech Inc. (Ukiah, CA), and the Cameron Iron Works (Houston, TX). Retech has licensed the patent on a nonexclusive basis and is making and marketing the improved controller.

Geophysicists to Probe Greenland Ice Cap to Measure Gravitational Constant, Test Fifth Force Theory

A team of scientists will travel to Greenland to make some of the most sensitive geophysical measurements ever made of the Newtonian gravitational constant, G, and to test a new theory that a fifth, yet undiscovered, force may exist in the universe. The experiment is designed to detect and measure possible variations in the gravitational constant over distances in excess of 300 feet, far beyond laboratory measurements of gravity that are generally limited to length of a few inches. The researchers believe they will be able to measure the gravitational constant to better than 1 part in 1,000 over distances of 300 to 5,000 feet.

Geophysicists Mark A. Zumberge (Institute of Geophysics and Planetary Physics at the Scripps Institution of Oceanography) and Mark E. Ander (Los Alamos National Laboratory) will lower a gravity meter down a hole bored into the Greenland ice cap to measure accurately the gravitational constant first determined by Sir Isaac Newton more than 300 years ago.

"If the effective gravitational constant can be proved to be dependent upon distance, it will mean that a fifth force exists in nature," comments Ander. Such a finding could assist physicists in the pursuit of a unified field theory that could tie together the known forces of gravity and electromagnetism and the concepts of strong and weak forces, two factors of nuclear particle physics. It would also profoundly affect other branches of physics such as general relativity, astrophysics, and cosmology.

The research team will measure the changes in the force of gravity at different depths within the ice sheet through a 6,700-foot-deep borehole. The gravity meter will be lowered to about 5,000 feet and then raised in 300-foot intervals where measurements will be taken. About a dozen readings will be taken as the instrument moves up the hole. Calculations from these measurements will determine the value of the force of gravity inside the hole as a function of the position of the instrument in the ice sheet. The gravitational effects of the earth beneath the ice will be factored out of the final calculations.

The investigation is supported by the National Science Foundation Divisions of Polar Programs and Physics, Los Alamos National Laboratory, and additional funding from Amoco Production Company, Mobil Research and Development Company, and the Air Force Geophysics Laboratory (Bedford, MA).

NRC Sponsors Joint Project to Encourage Interdisciplinary Collaboration

Though interdisciplinary research between physical-engineering sciences and biological-clinical sciences has produced important new knowledge and medical advances, there are major impediments to interdisciplinary collaborations—differences in conceptual approach, lack of career incentives and rewards, and differences in formal training and education. Because of these differences, scientists may be unaware of how and when to capitalize on the benefits of collaborative research.

These and other problems will be examined by a joint undertaking of the Institute of Medicine and the National Research Council's Commission on Physical Sciences, Mathematics, and Resources. The 18-month project will explore ways to encourage interdisciplinary collaboration, such as identifying appropriate educational preparation, creating career incentives, and overcoming institutional and funding barriers. Project officers are Barbara Filner and Donald Shapiro.

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