Argonne Announces Joint Projects in High Temperature Superconductivity

The Superconductivity Pilot Center at Argonne National Laboratory near Chicago recently announced several joint agreements to develop practical uses for high temperature superconductor materials.

Electrical Cables

A joint research project with HiT$_c$ Superconco aims to develop thin, flexible filaments—about four ten-thousandths of an inch in diameter—that can be woven into thicker, more flexible cables with more current carrying capacity than already existing wire made from superconducting materials. The project also involves developing electrical contacts to connect the cables to normal electrical conductors.

HiT$_c$ Superconco, a subsidiary of Lambertville Ceramic Manufacturing, will make filaments and cables. Argonne will work on electrical contacts, develop heat treatments to produce the most useful properties in filaments, measure electrical and magnetic properties of filaments, and determine their crystalline and atomic structure.

Practical Tapes and Wires

Microelectronics and Computer Technology Corp. (MCC) will join with Argonne to investigate an improved method of sputter deposition for making wires and tapes with enough flexibility and current density for practical application.

MCC has developed a proprietary sputtering apparatus for high temperature superconductors, which promises more efficient use of target materials and a 1,000-fold increase in deposition rates. With further development, the process could make possible mass production of practical superconducting wires and tapes. The Argonne-MCC project is aimed at speeding development of this technique.

Argonne will build a vacuum chamber for the MCC sputtering apparatus and will use the combination to study various materials with the goal of developing practical superconducting wires and tapes using targets capable of lengthy production runs. In addition, Argonne will investigate novel processing methods and will study the microstructures and superconducting properties of sample wires and tapes made by sputtering.

MCC, a research consortium of 21 shareholders and 21 associate members, will examine various substrate materials and processing methods in hopes of reducing materials and production costs. MCC is also involved in a joint consortium on high temperature superconductivity with the Texas Center for Superdondictivity at the University of Houston.

Superconducting Magnetic Energy Storage

The joint research project with Conbustion Engineering, Inc. will assess the technical and commercial feasibility of small superconducting magnetic energy storage (SMES) systems using high temperature superconductors. If shown to be feasible, SMES systems could store electricity during periods of low demand and release it during periods of high demand, minimizing peak-demand electricity costs. Small SMES systems might also be used as power backup to protect sensitive equipment.

The one-year project will asses the use of high temperature superconductors in SMES devices up to approximately room-size. Such devices would use superconducting magnets to store 20 to 300 kilowatt-hours of electricity. Three humdred kilowatt-hours would power an average home for one to two weeks.

Argonne will provide information on the properties and performance of existing high temperature superconductors and those likely to be developed in the near future. The laboratory will also assess the required size of the high temperature superconducting magnet and its containment structure, examine combinations of high and low temperature superconductors in system components, and analyze the system's heat-transfer requirements.

Combustion Engineering (Windsor, Connecticut), a unit of Asea Brown Boveri, Inc., will examine market needs to identify performance requirements for small SMES systems and will study systems data for the SMES magnetic storage coil, coil restraint structures, and power conditioning equipment to deliver power to and from the SMES coil. The firm will also estimate manufacturing costs for several coil and system designs, and compare costs to those of other energy-storage technologies.

SBIR Contract Targets Nonlinear Optical Materials

Maxdem Incorporated, Pasadena, California, recently began work on a Phase II SBIR contract for the development of nonlinear optical materials derived from organic polymers. The contract was awarded by NASA through the Jet Propulsion Laboratory.

Headed by Mark S. Trimmer, the project is directed toward the development of new soluble, thermally stable rigid-rod poly-

https://doi.org/10.1557/S0883769400059650 Published online by Cambridge University Press

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mers which were shown to exhibit significant nonlinear optical characteristics during the Phase I period. The materials are considered promising because stable films and coatings of high optical quality can be prepared. The films and coatings will be evaluated as wave guides for use in all-optical signal processing devices.

Maxdem will also receive a Phase I SBIR award from the Strategic Defense Initiative Organization to focus on the development of thermally stable, low dielectric polymers for advanced electronic systems. This research, directed by Neil H. Hendricks, will take new soluble polyquinolines recently prepared under support from the NASA Langley Research Center's Polymer Branch to a more advanced stage of development. Project goals include demonstration of the efficacy of the polymers in high density microelectronics packaging, and development of prototype devices.

Zeolite Sensors Cut Monitoring Costs

New sensor technology using zeolites will make it easier and less expensive to monitor levels of toxic substances and pollutants in the environment. The research, conducted jointly by the University of New Mexico and Sandia National Laboratories, could also have significant implications for monitoring medical and chemical processes.

According to Thomas Bein, assistant professor of chemistry at the University of New Mexico and head of the research team, sophisticated devices already exist to detect virtually every substance in the atmosphere, but the detection process is costly and cumbersome. Through the study of zeolites the research team, funded primarily by the National Science Foundation, has developed an alternative, lower cost technology.

The technology is based on combining thin film microcomposite coatings that have molecular recognition properties with acoustic wave devices. The films are derived from suspensions of small crystals of zeolites with pore sizes between 0.4 and 0.8 nm (e.g., zeolite Y, chabazite and ZSM-5) in hydrolyzed tetraethylorthosilicate. The films can be designed as single layers of zeolites protruding out of an amorphous SiO_2 matrix.

Bein estimates that about 70 different zeolite types have been identified, each with a different pore structure. Many of the zeolites match potentially harmful molecules found in the environment, such as benzene, ethanol, and carbon monoxide. Since the pores in one zeolite structure are all exactly the same, they can be used as a molecular sieve, admitting whichever substance matches their pore size and excluding all others that are larger.

The new detection devices which Bein and colleagues Kelly Brown, Kenneth A. Dean, C. Jeffrey Brinker and Gregory C. Frye are investigating will be about the size of a pocket radio and will cost substantially less than laboratory instrumentation, according to Bein. They could be planted onsite to provide constant monitoring. Tiny microchips would transmit a signal as soon

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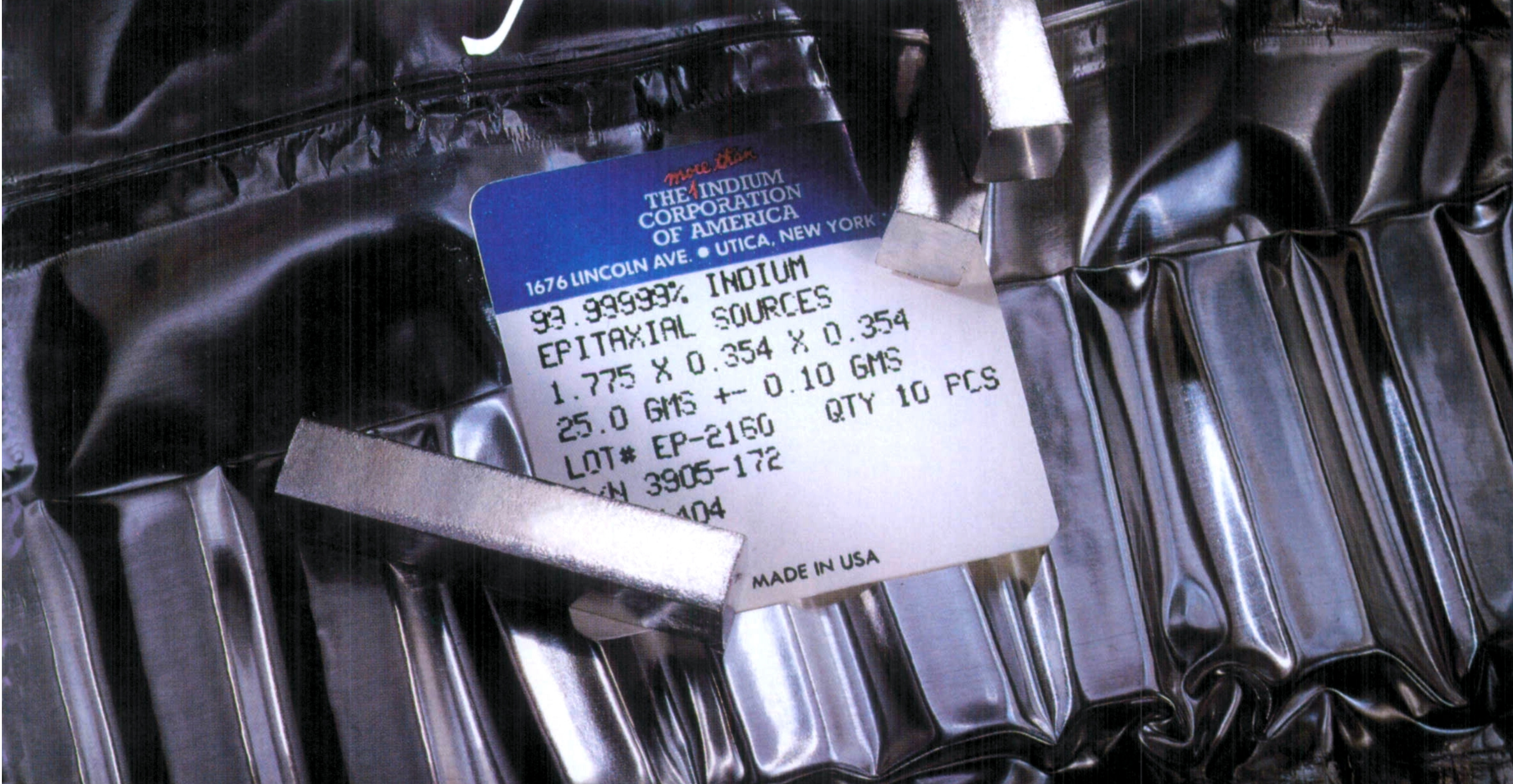

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The U.S. Department of Energy recently approved a grant that will help the scientists take their research from the laboratory to the field. The team hopes to have the zeolite sensor devices actually monitoring the environment at selected sites within two or three years, according to Bein, who presented his research in April during the symposium on Materials for Sensors and Separations at 1990 MRS Spring Meeting in San Francisco.

Ultrasound-Induced Collisions Enhance Reactivity of Metals

University of Illinois researchers have reported that ultrasound-induced collisions can make microscopic metal particles highly reactive. The ability to enhance the reactivity of metals used for catalysis makes ultrasound a potential moneysaver in industrial processes, the researchers say. Ultrasound can also strip metals of their unreactive coatings, freeing the pure, elemental metal inside to promote chemical reactions.

"Using ultrasound, we can enhance the reactivity of metal powders in some reactions almost a million-fold," said chemist Kenneth S. Suslick. "We should be able to replace expensive metal catalysts with metals that are normally less reactive, but also less expensive," he added.

Along with former graduate student Stephen J. Doktycz, Suslick collided particles in solution at speeds they say reached 1,000 miles per hour. Suslick and Doktycz calculated that the temperatures achieved at the point of collision were between 2600 and 3400°C, enough to melt and fuse zinc, chromium, nickel, tin, iron, and (to a lesser extent) molybdenum particles.

The researchers used a scanning electron microscope to photograph particles of different metals after collisions. Their photographs show sperical particles fused together by a thin neck, in a dumbbell shape. The shape results when the particles recoil from one another as they cool and solidify, said Suslick. After cooling, the stripped and fused particles remain reactive, he added.

Suslick's and Doktycz's investigations of sonochemistry were supported by the National Science Foundation.

Prototype Superconducting Motor Developed

Using a higher-temperature superconducting coil produced by Argonne National Laboratory, the Reliance Electric Company has designed and manufactured a prototype 10-watt direct-current electric motor. Although too small to be of commercial value, the prototype is providing scientific and technical data for engineers to use in developing larger, more practical motors. The Electric Power Research Institute (EPRI), which provided the funding for the joint project, hopes to transfer the success of the dc motor to alternating current designs used by the electric utility industry.

The superconducting coil uses over 300 inches of wire and has a current density of 100 A/cm^2 in a magnetic field of 150 gauss. Conventional motors with copper wire operate at a current density of 300 A/cm^2. Although the magnetic field is not strong enough to make a practical motor, "this is 10 times what we were able to do a year ago," said Roger Poeppel, senior engineer with Argonne.

Argonne scientists initially created a superconducting material in powder form, then mixed it with acrylic to form a wire. The wire was covered with electrical insulation and wound on a form to produce a coil. The coil was then heated to remove the acrylic, leaving a rigid, insulated ceramic helix. The motor's armature has conventional copper coils and sits above a small body of liquid nitrogen containing the coil.

Mehrabian to be Carnegie Mellon President

Robert Mehrabian, credited with leading the University of California at Santa Barbara's engineering college to national prominence, will soon be the next president of Carnegie Mellon University, Pittsburgh, Pennsylvania. He succeeds Richard M. Cyert, Carnegie Mellon president since 1972. Cyert, who will leave the post on June 30. Cyert is credited with Carnegie Mellon's rise both in international reputation and research expenditures.

During his tenure at UCSB Mehrabian initiated a doctoral program in materials science, recruited more than 65 new faculty, and established seven research centers in areas such as robotics, high performance composites, compound semiconductors, and risk studies and safety in chemical and nuclear plants. Obtaining substantial funding from industry and government, UCSB's engineering college increased its budget sevenfold in six years. In 1986, UCSB completed construction of a new engineering building.

Mehrabian joined UCSB after four years in the federal government, first as chief of the Metallurgy Division, later as director of the Center for Materials Science at the National Bureau of Standards.

Mehrabian holds eight patents as coinventor of new metalworking and composite fabrication processes. For the past six years he has been a member of Alcoa's Science and Technology Advisory Council and has been a consultant to numerous companies in the field of materials. He was one of the founders of Superconductor

https://doi.org/10.1557/S0883769400059650 Published online by Cambridge University Press

Technologies Incorporated and has published extensively in metallurgy and materials science.

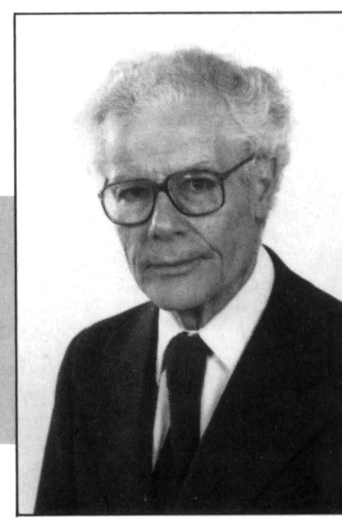
Mehrabian earned a bachelor's degree in 1964 and a PhD in 1968 from the Massachusetts Institute of Technology. He is a member of the Materials Research Society and the National Academy of Engineering, and a Fellow of the American Society for Metals International.

1990 Franklin Medal Goes to David Turnbull

The Board of Trustees of the Franklin Institute awarded the Franklin Medal to Prof. David Turnbull of Harvard University, Cambridge, Massachusetts. In granting the award, the Franklin Institute cited Turnbull for "... his pioneering theoretical and experimental research in phase transitions in condensed matter, particularly in the formation of the amorphous state by normally crystalline materials."

The Franklin Medal, established in 1913, is one of the most distinguished U.S. awards to be given for important achievements in science and technology. Notable among previous recipients of the Franklin Medal are Guglielmo Marconi, Niels Bohr, Albert Einstein, Enrico Fermi, and Stephen Hawking.

During his career as a scientist at the General Electric Research Laboratory and, later, as a Gordon McKay Professor of Applied Physics at Harvard, David Turnbull, through theory and experiment, laid much of the groundwork for our modern understanding of transformations in metals and alloys. His elaboration of the mechanism of crystal nucleation established the principles to control the grain size of castings, and anyone who deals with diffusion or any kind of transformation in crystalline or amorphous solids, ultimately falls back on the understanding which stems from Turnbull's work.



David Turnbull received his BS degree from Monmouth College in 1936 and his PhD in physical chemistry from the University of Illinois in 1939. He left a faculty position at Case Institute of Technology to go to the GE Research Laboratory in 1946. From there he came to his present position at Harvard in 1962 as a Gordon McKay Professor of Applied Physics. He is a member of the National Academy of Science and is a Fellow of the American Chemical Society, the American Physical Society, and the American Academy of Arts and Sciences. He was awarded the Acta Metallurgica Gold Medal and the Von Hippel Award of the Materials Research Society in 1979. In 1986 he was awarded the Japan Prize (See the *MRS BULLETIN*, Vol. XI, No. 3, 1986). □

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