## New High $T_c$ Superconductor Families Synthesized

Scientists, headed by Hideo Ihara at the Superconducting Materials Section of the Materials Science Division of the Electrotechnical Laboratory (under MITI) in Tsukuba, Japan, announced the synthesis of two nontoxic families of superconductors: $Ag_{1-x}Cu_xBa_2Ca_{n-1}O_{2n+3-\delta}$ and $Cu_{1-x}Ba_2Ca_{n-1}Cu_nO_{2n+4}$. The compounds superconduct at temperatures higher than previously achieved: $T_c > 117$ K and >116 K, respectively, relatively higher than the 110 K at which other nontoxic bismuth-based oxides have achieved superconductivity.

The small CuO-block spacing of this family also suggests a lower anistropy and higher $J_c$ than other Hg-, Tl-, and Bi-based superconductor families. Currently, the substance which acts as a superconductor at the highest temperature, 157 K, poses problems because it contains mercury, which is highly toxic.

The phase of the first material has a tetragonal structure with lattice constants of $a = 7.7270$ Å and $c = 36.222$ Å. The $T_c$ value of the $Ag_{1-x}Ba_2Ca_3Cu_{4+x}O_{10-\delta}$ phase was 117.1 K. The relationship between the lattice constant $c$ and the number of $CuO_2$ layers $N$ is $c/2 = 5.3 + 3.2N$ (Å). The small $CuO_2$ block spacing (8.5 Å) of this family suggests a lower anistropy and higher $J_c$ than Hg and Tl-based superconductor families.

The substances are produced using a newly developed technique. The source material for the high-pressure synthesis is a mixture of precursor materials of $Ba_2Ca_2Cu_3O_7$, $Ba_2Ca_3Cu_4O_9$, $Ba_2Ca_3Cu_5O_{10}$, or $Ba_2Ca_4Cu_6O_{12}$ and silver oxides of $Ag_2O$ or AgO. The precursor materials were prepared by calcining a well-ground mixture of $BaCO_3$, $CaCO_3$, and CuO powders with normal composition at 930°C for 20 hours in $O_2$. After regrinding and mixing with powdered AgO or $Ag_2O$, the pressed pellets were sealed in a gold capsule. The capsule was then heated in an internal graphite tube heater at 1100°C for 1–3 hours under a pressure of 5 GPa. The sample was subsequently quenched to room temperature before the pressure was released. It was then annealed at 300°C for 5–10 hours in flowing oxygen, as for Hg-based superconductors.

This research was presented in two articles in the March and April 1994 issues of the *Japanese Journal of Applied Physics*.

F.S. Myers

## Ceramic-Metal Composite Could Find Use in Cutting Tools

A new ceramic-metal composite made from tungsten carbide chemically bonded with a modified nickel aluminide alloy could find uses in rock and coal drilling equipment or dies. Tests have shown that the composite is harder and may last longer than tungsten carbide bonded with composite. Tungsten carbide-cobalt composite is used worldwide for dies and in drilling equipment and other cutting tools.

The new composite is less expensive than currently used commercial materials, and nickel and aluminum are readily available metals. Also, the excellent high-temperature properties of nickel aluminide will allow tools made from the material to be operated at higher temperatures.

The composite is made by mixing ceramic powder with a modified nickel aluminide powder, which holds the ceramic powder together. Hot pressing and sintering consolidate the material into a dense form.

The composite was developed by researchers at Oak Ridge National Laboratory, and it has been patented by Martin Marietta Energy Systems and Dow Chemical Company.

## National Educators' Workshop Issues Annual Call for Experiments

The National Educators' Workshop, to be held November 7–9, 1994 at NIST facilities in Gaithersburg, Maryland has issued its seventh annual call for experiments.

This year's focus is on new and evolving topics in engineering materials, science, and technology with an emphasis on experiments and demonstrations for use in materials laboratory courses.

Complete write-ups of the experiments will be reproduced and distributed at the NEW: Update 94 meeting in November. The long-range objective is to gather a solid collection of demonstrations and experiments in a Manual of Experiments to be made available to educators through the Materials Education Council and participating societies.

Those interested in providing experiments should submit a brief abstract no later than **June 1, 1994** to: Dr. James A. Jacobs, National Educators' Workshop: Update 94, School of Technology, Norfolk State University, 2401 Corprew Avenue, Norfolk, VA 23504. Phone (804) 683-8109 or 8712; fax (804) 683-8215.





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## MIT's Gatos Prize Goes to P. Chaudhari

The Massachusetts Institute of Technology has awarded its 1994 Harry C. Gatos Distinguished Lecture and Prize in electronic materials research to Praveen Chaudhari of IBM.

The two-day visiting lectureship and $5,000 prize were established with a gift from Sumitomo Electric Industries of Osaka, Japan in 1991. The award is given every two years to someone who has contributed significantly to the advancement of the processing of electronic materials and to the understanding of their behavior and role in electronics applications.

Chaudhari delivered his lecture, "The Synthesis, Structure and Properties of Grain Boundaries in the Cuprate Superconductors: Application to Wires, SQUIDs, and Symmetry of the Wave Function," on February 23, 1994.

A researcher at IBM's Thomas J. Watson Research Center, Chaudhari received his PhD from MIT in 1966 and joined IBM that year. He has been the company's director of science and served on President Reagan's Advisory Council on Superconductivity. Along with Merton Flemings of MIT, he co-chaired the National Research Council's comprehensive materials science and engineering study that resulted in the publication of *Materials Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials*. He holds more than a dozen patents, including the one on erasable materials used in optical storage devices.

## Cheaper, More Efficient Material Developed for Magnetic Refrigeration

An aluminum, dysprosium, erbium material developed by Ames Laboratory researchers could reduce the overall cost of magnetic refrigerators by an estimated 40% and also increase their efficiency.

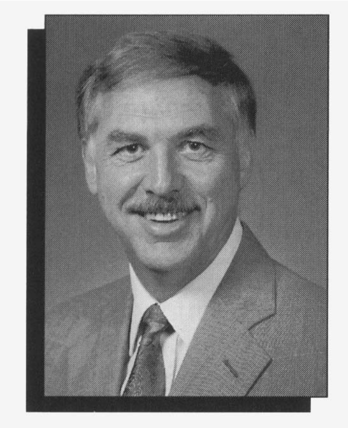
For the cooling power they deliver, magnetic refrigerators are about 20 times more compact than gas-based refrigerators, and they do not use chlorofluorocarbons. Many researchers are working to apply magnetic refrigerators in space exploration, medical imaging devices, food processing, and the production of liquefied gases like hydrogen, which could replace fossil fuels.

In a magnetic refrigerator, the new material will undergo rapid magnetization and demagnetization to manipulate heat. According to Karl Gschneidner, director of the Rare-Earth Information Center at Iowa State University, the material responds to this process 30% better than the currently used material composed of gadolinium and palladium. In the new material, inexpensive aluminum replaces the rare and expensive palladium.

A superconducting solenoid, the biggest capital cost in the refrigerator, is needed to make it work. With the new material, said Gschneidner, a smaller superconducting solenoid can deliver the same cooling power.

## Appleton Named Associate Lab Director for Advanced Neutron Source

Bill R. Appleton has been named associate laboratory director for the Advanced Neutron Source to be built at Oak Ridge National Laboratory. He assumes responsibility for supporting the implementation and construction of the ANS and is charged with marshaling the necessary resources to bring ANS to a successful completion.



The new research facility will address a broad range of scientific disciplines such as structural biology, materials research and testing, isotope production for medical and industrial applications, and environmental pollutant analysis. Scheduled for completion in 2003, the ANS will be five to ten times more powerful than existing facilities in the United States, which are nearly 30 years old and approaching the end of their useful lifetimes. As a national user facility, the ANS is expected to serve more than 1,000 guest researchers from industry, universities, and government each year.

The ANS is in the Administration's FY 1995 budget request as an enhanced infrastructure initiative at $40 million, an increase of $23 million, or 135%, over the FY 1994 appropriation. The FY 1995 request is distributed as $26.7 million for construction, $12.3 million for operating monies, and $1 million for capital equipment. Congress is now holding hearings on the budget but has not authorized or appropriated any funds. "The Department of Energy has testified before several committees and is supporting the ANS, but final deposition awaits congressional actions," said Appleton.

Appleton, who joined Oak Ridge in 1968, was previously associate laboratory director for Physical Sciences and Advanced Materials. His research has concentrated on the use of ion beam and laser processing techniques for the surface modification of materials, and on fundamental studies of ion-solid interactions. He has received numerous Department of Energy awards for his research and is a fellow of the American Physical Society and the American Association for the Advancement of Science. He is also active in the Materials Research Council. Currently a councillor of the Materials Research Society, he has served MRS as an officer, meeting chair, and symposium organizer.

Appleton holds a bachelor's degree in physics from the University of Missouri and master's and doctoral degrees in solid-state physics from Rutgers University. He is the editor of three books and has published more than 170 journal articles, reviews, and book chapters.

## V.P. Dravid is NSF Young Investigator

Vinayak P. Dravid, assistant professor with the Department of Materials Science and Engineering at Northwestern University, was recently selected to receive a National Science Foundation Young Investigator Award for 1993–1998. Dravid joined Northwestern in 1990 after earning a PhD in materials science and engineering from Lehigh University. His research and teaching interests revolve around nanoscale phenomena in materials, including analytical and high-resolution transmission electron microscopy, crystallography and crystal defects, and surface and interface phenomena in solids. Dravid's work has earned him awards from the Microscopy Society of America and the American Ceramic Society. He is the faculty advisor for the MRS University Chapter of Northwestern University.

## Prototype Optically Based MBE Control System Demonstrates Real-Time Accuracy

Sandia National Laboratories researchers Scott A. Chalmers and Kevi P. Killeen report* that they have developed a molecular beam epitaxy control system that monitors the growth rates of aluminum and gallium in real time with the accuracy and reproducibility needed to produce high-precision devices. "Our results show that optical-based flux monitoring can be used as a practical and very flexible MBE control system, one that is based on determining layer thicknesses rather than controlling growth





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times," Chalmers and Killeen say.

In a demonstration experiment they grew a series of nanometer-scale mirrors (distributed Bragg reflectors) with layer thicknesses accurate to within 0.3%. The mirrors consisted of 12 periods of AlAs and GaAs, 69.6 nm and 83.1 nm thick, respectively. The mirrors were grown at about 1 atomic layer per second (3 Å or 0.3 nm/s). After initial calibrations, no adjustments were necessary during the growth process . "With our technique we can keep the growth rates constant or vary them as we wish during the process," says Killeen.

The system is designed to be a simple, compatible add-on to present MBE machines, which cost about $1 million.

The system splits the light from a hollow cathode lamp into a signal beam and a reference beam. Only the signal beam goes through a port in the MBE vacuum chamber, passes through the atomic elements being deposited during crystal growth, and is measured on the other side by a photodiode. The computer-controlled system takes the ratio of the signal and reference beams continuously during growth, providing instantaneous readings of the atomic-beam flux and therefore a measure of the rate of surface deposition.

Chalmers and Killeen reduced the cathode lamp variations to less than 0.1% by using the output of the photodiode that measures the reference beam intensity as feedback. This reduction combined with the two-beam referencing achieved measurement stability and accuracy.

The prototype system is being moved to an MBE machine at Sandia, where Chalmers and Killeen will add an ability to control temperature and the MBE shutters, extend the system to indium, improve the software control, and make the whole system more robust.

This integration into a more manufacturing-like environment is part of an ARPA-sponsored partnership devoted to MBE sensors and controls for improved synthesis of III/V quantum-well devices. Partners includes Hughes, Texas Instruments. J.A. Woollam Co., Superior Vacuum Technology, EPI Division of Chorus Corporation, and the universities of Colorado, Virginia, New Mexico, and Southern California.

**Applied Physics Letters*, December 6, 1993, p. 3131.

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# CALL FOR PAPERS

# ENVIRONMENTALLY BENIGN MATERIALS AND PROCESSES

*Journal of Materials Research* (JMR) will feature a special section of original research papers on environmentally benign materials and processes in the upcoming March 1995 issue.

Much has been written about the magnitude of our environmental problems both from the view of their impact on quality of life and the difficulties and costs of clean up. It is frequently not realized that the root cause of many problems is often our uninformed choices concerning the materials embedded in our industrial and consumer products and the production processes used to make them. On the policy side, much is being done to think through the regulatory, management, and other changes that will be required to encourage an *ab initio* greener economy. However, materials science and engineering often tend to be downplayed.

MRS has sponsored several symposia on environmental issues, but while JMR has accepted papers it has not until now focused in that area.

The March 1995 issue of JMR will focus on green materials and processes. Papers reporting materials substitution, materials modification and new processes (and modifications to old processes) that decrease the environmental impact of materials are solicited. Eliminating or reducing poisonous materials, decreasing or eliminating stack and waste water effluents by new processes, energy conservation through net shape processing, turning wastes into by-products, etc., are all suitable topics. Papers that are primarily policy, epidemiological, review or tutorial are not suitable. It is our hope to see success stories documented and important new technical directions spotlighted. Prof. Julian Szekely of Massachusetts Institute of Technology has agreed to serve as editor for these papers.

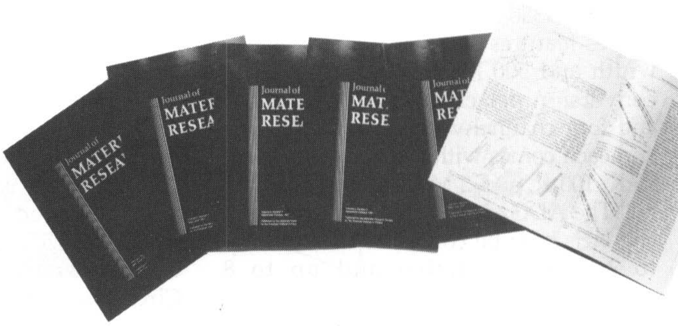
To be considered for this issue, manuscripts must be received at the USA Editorial Office by **July 15, 1994.** Manuscripts received after this deadline will have too little time for adequate review in order for them to be included in this issue, and no extensions of the deadline will be granted.

All manuscripts submitted for this special section of the March 1995 issue will be reviewed in a normal but expedited fashion.The top 15-20 manuscripts of all those accepted will be scheduled for publication in the March 1995 issue of JMR, appearing in the standard JMR format in a separate section of the issue. Any manuscripts that are accepted for publication but cannot be included in the group scheduled for publication in the March 1995 issue will be scheduled to appear in the next available issue of JMR. The March 1995 issue will be mailed to all JMR subscribers prior to the MRS 1995 Spring Meeting in San Francisco (April 17- 21, 1995) and will be on display at that meeting.

Send your manuscripts (one original plus three copies) for consideration to:

Dr. Robert A. Laudise, Editor-in-Chief
Journal of Materials Research
Materials Research Society
9800 McKnight Road, Pittsburgh, PA 15237
telephone (412) 367-9111; fax (412) 367-4373

Indicate that the manuscripts are intended for the JMR March 1995 special section on environmentally benign materials and processes.



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