## Los Alamos Readies Fourier Transform Spectrometer

The most powerful and precise instrument of its type in the world for studying light is nearing completion at Los Alamos National Laboratory. The Los Alamos Fourier Transform Spectrometer (FTS) Facility, a $2 million scientific workshop, will assist in uncovering the properties of atoms and molecules by looking at light radiated or absorbed by different materials.

"The Los Alamos Fourier Transform Spectrometer is a world class facility that allows scientists to do some experiments in a week that otherwise would take six months, and it does them more accurately," said Byron Palmer, chief scientist for the FTS.

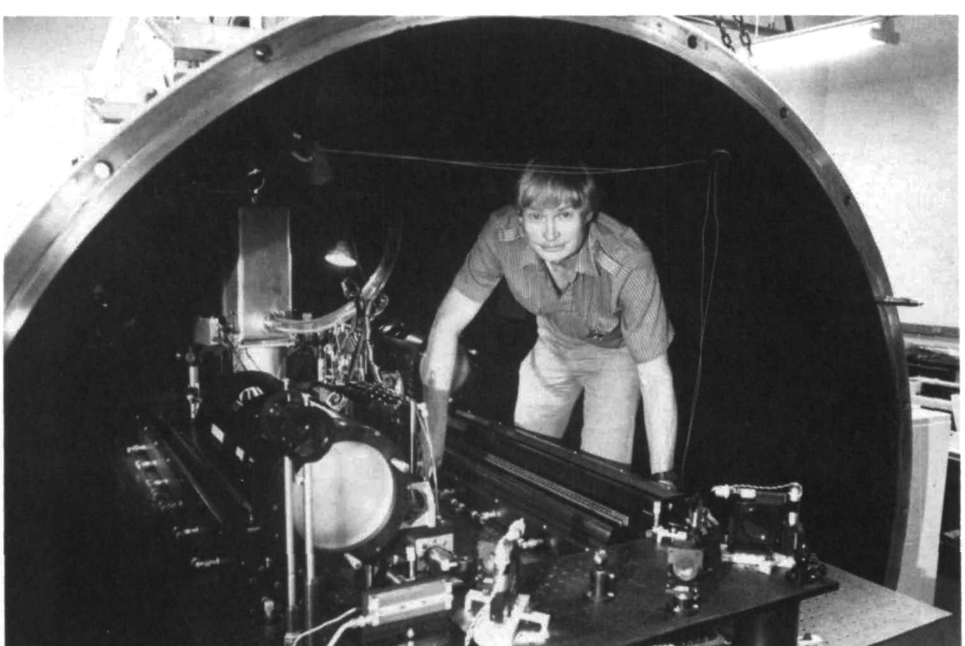
Only a few FTSs in the world are the caliber of the instrument at Los Alamos, and most of them are in France. The only other such instrument in the United States is at the National Solar Observatory at Kitt Peak, near Tucson, AZ.

"Not a week goes by that I don't get a call from someone asking about the availability of our FTS for an experiment," said Palmer. "We consider it an international resource and are pleased to make it available."

The FTS uses a beam splitter to divide the light into two beams which are then reflected by two movable mirrors. Once reflected, the light is recombined and its intensity measured. "The power of this FTS is that we can measure the intensity and the color, or wavelength, to a precision that is hard to approach with any other instrument," Palmer said. "It is capable of measuring the wavelength down to one part in a billion. This helps scientists solve very complicated problems."

Among the FTS's advantages is that it uses more of the available light than other similar types of instruments, he said. The FTS can handle more than a hundred times the light a monochromater uses, for example. The FTS also continuously uses all the light, while a monochromater uses only a small amount of it at any given time.

"We are pushing technology in most of the construction of this instrument," Palmer said. The two main mirrors, which cost $15,000 each, are precisely controlled by a computer to positions that are less than 10-billionths of an inch, or three times the diameter of the smallest atom. "Development of this powerful FTS was made possible by the advent of digital computers and advancements in optics and mechanics," said Palmer.



**B. Palmer demonstrates the Fourier Transform Spectrometer.**

## First Identification of a Polymer in Space

A polymer has been identified in the dust cloud surrounding Halley's comet. Walter Huebner, a scientist on leave from Los Alamos National Laboratory and now at the Southwest Research Institute in San Antonio (Texas), identified the molecule from data obtained during the 1986 encounter with the comet.

The polymer, called polyoxymethylene or POM, consists of hydrogen, carbon, and oxygen, three of the most abundant elements in space. It was one of the first polymers identified on Earth and was produced synthetically about the turn of the century.

Huebner identified POM by analyzing the masses of ions detected by a positive ion cluster composition analyzer (PICCA) aboard the Giotto spacecraft. PICCA detected an ion mass spectrum that Huebner says is a characteristic signature of POM and its decay products.

The presence of a significant amount of POM in the comet's inner coma indicates that the polymer remains an important component of the nucleus, even though the comet's outer layer eroded away during successive revolutions around the sun. "So it must have been present in the solar nebula when the sun and planets were formed 4–5 billion years ago," Huebner said. "Therefore, POM is an important tracer for the early history of the solar system."

The presence of POM in and around Halley's comet also helps explain unexpected data (such as the comet's extreme darkness and the distribution of its dust particles by composition and size) that were obtained by other instruments. Huebner said POM attaches itself to grains of carbon and silica, creating "clumps" of materials with tiny protrusions, or "whiskers." Some of these grains fall back to the comet's surface, he said, creating a porous mantle that absorbs and traps light. The POM attached to the grains breaks up when the temperature rises, releasing smaller particles. Huebner said this could be one reason why other instruments found larger dust particles close to the nucleus and smaller ones farther away.

The apparent presence of POM in the nebula from which the solar system was created means the polymer should also exist in interstellar clouds that astrophysicists are now studying, Huebner said. In fact, he said, the results of spectral absorption analyses of starlight passing through the interstellar medium can be explained in part by the presence of the polymer in or near them. The polymer can be produced in the clouds by bombarding water, carbon dioxide, and carbon monoxide molecules with cosmic rays or ultraviolet radiation, he said.

## NASA Lewis Research Center Announces Plans, Achievements

Recent news from the NASA Lewis Research Center (Cleveland, OH) includes several announcements of interest. A team of NASA Lewis scientists and engineers will be investigating the use of high temperature superconducting ceramic materials for lightweight, more efficient electrical power and propulsion systems for aircraft and spacecraft, and for microwave communications electronics.

*continued*

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The Center has added glass and ceramics research capabilities to existing metal, alloy, and electronic crystal facilities at its Microgravity Materials Science Laboratory. The Laboratory was created in 1985 to stimulate the development of experiments for microgravity. It offers scientists and engineers a low-cost, low-risk way to test new ideas for reduced-gravity materials science research. (*See the MRS BULLETIN, Vol. XII No. 2, p. 85.*)

Also announced was the development of the world's most efficient indium phosphide (InP) solar. Developed through a Lewis-managed program, the cell operated at 17.9% efficiency under simulated conditions. The highest efficiency attained previously was 16%. Most spacecraft are powered by silicon solar cells, and gallium arsenide cells are also coming into space use. InP cells, however, have been found to be much more resistant to the degrading radiation found in space. Tests indicate that InP cells will produce significantly more electrical power over the life of a satellite than is currently being produced.

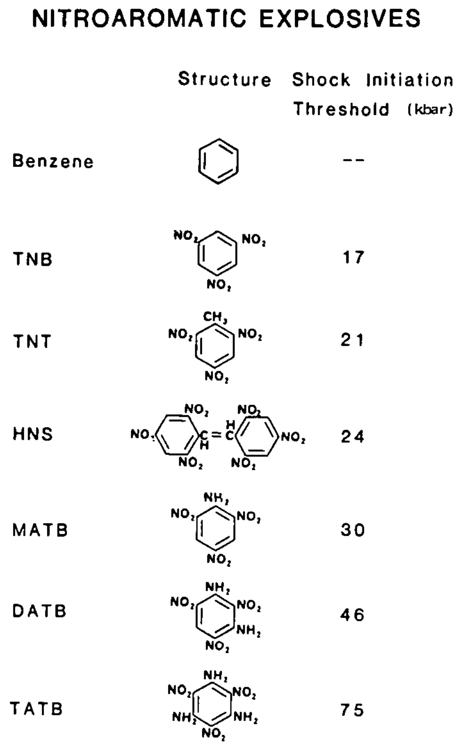
## XAES Used to Study Electronic Structure of Explosives

Sandia National Laboratories scientists have used advanced surface science instrumentation to help understand, at a molecular level, why a series of common explosives whose molecular structures differ from each other only slightly exhibit pronounced differences in their sensitivity to shock wave initiation. The local sensitivity of x-ray excited Auger electron spectroscopy (XAES) was used to study the electronic structure of nitroaromatic explosives, such as TNT, whose basic molecular structure is an aromatic ring of six carbon atoms (a benzene ring) to which nitro ($NO_2$) and sometimes other chemical groups are attached.

XAES is a local chemical probe that, unlike other techniques, allows scientists to look specifically at the energy levels involving carbon-carbon bonds. The Sandia scientists say that to their knowledge no other analysis technique can be used to directly probe the ring properties in these particular explosives.

"The studies represent the first case in which these properties of the explosives have been examined in such detail," says J.W. Rogers Jr., who led the team. The studies were carried out on benzene (a nonexplosive) and five explosives built on the benzene ring (see figure).

The analysis for TNB and TNT confirms theoretical predictions that the addition of nitro groups to the benzene ring weakens the ring's carbon bonds, making the molecule more sensitive to shock. The Auger studies also show that adding amino groups, such as in TATB, decreases an explosive's shock sensitivity. This, says Rogers, appears to be due to two effects: (1) as net electron donors, amino groups add electron density to the carbon bond, compensating for the weakening effect of the nitro groups; and (2) strong hydrogen bonding, which absorbs energy from a shock front and reduces the amount of it directed onto the ring itself. Thus shock sensitivity decreases in going from MATB to DATB to TATB as amino groups are added and overall lattice stability increases.




**Structure and shock initiation thresholds of nitroaromatic explosives studied at Sandia.**

The studies, says Rogers, have validated that the stability of the carbon ring is at least partly responsible for shock sensitivity on a molecular level. They reveal that other important effects, such as strong hydrogen bonding, are at work as well. Rogers is quick to point out, however, that in addition to the microscopic phenomena explored in the present work, macroscopic effects such as density and particle morphology also play an important role in initiation. Ultimately it will be necessary to understand the interplay and competition between the micro- and macroscopic effects in order to fully understand the initiation process.

## Keyworth to Head New Superconductivity Council

Dr. George A. Keyworth II, former White House Science Adviser, will head the Council on Superconductivity for American Competitiveness. The newly created association will serve as a technology clearinghouse for the emerging U.S. superconductor industry.

According to Keyworth, the Council will help American businesses apply new breakthroughs in superconductivity to improve U.S. industrial competitiveness. The United States currently holds a sizeable lead in superconductivity research, observes Keyworth, "but the true challenge is applying what we've learned in the lab to the commercial marketplace."

Sponsored by American corporations, as well as "associate" members from the academic and government communities, the Council's mission is to advance superconductivity research by stimulating the rapid exchange of information through conferences, technical seminars, briefings, and newsletters. The Council will also serve as a forum for industry, government, and academia on national issues related to superconductivity.

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## Los Alamos and Japanese Researchers Conduct Fusion Experiments

A team of Los Alamos National Laboratory and Japanese researchers has proved that sophisticated equipment could safely process and recycle tritium for long periods and in amounts comparable to those anticipated in future fusion reactors. The experiments were conducted at the Los Alamos Tritium Systems Test Assembly, which contains virtually all of the tritium fuel-processing equipment that may be used in the commercial production of fusion energy, except for the reactor itself.

Four Japanese scientists on the research team are working under the auspices of a five-year, $20 million agreement between the U.S. Department of Energy and the Japan Atomic Energy Research Institute. "Our current collaboration is the result of earlier research together," said Hiroshi Yoshida, the chemical and nuclear engineer heading the Japanese team.

During the first experiments, which lasted four days, the amount of tritium in the fuel-handling system was increased from about 45 grams to 91 grams, more

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than fusion projects had ever used before and close to the 100 grams that would be processed at any given time in presently conceived fusion reactors. The 100-gram operating level was achieved in the second experiment, lasting seven days. During the second experiment, the team also studied how the fuel cleanup system worked at removing impurities such as helium, methane, and nitrogen.

Design studies and engineering systems development that will tie into and use the Tritium Systems Test Assembly technology are also being done at the Tokamak Fusion Test Reactor at Princeton University, at Argonne National Laboratory, and at Oak Ridge National Laboratory.

## North Carolina Researchers Identify Superconductor Crystal Structure, Use Lasers to Deposit Superconductor Thin Films

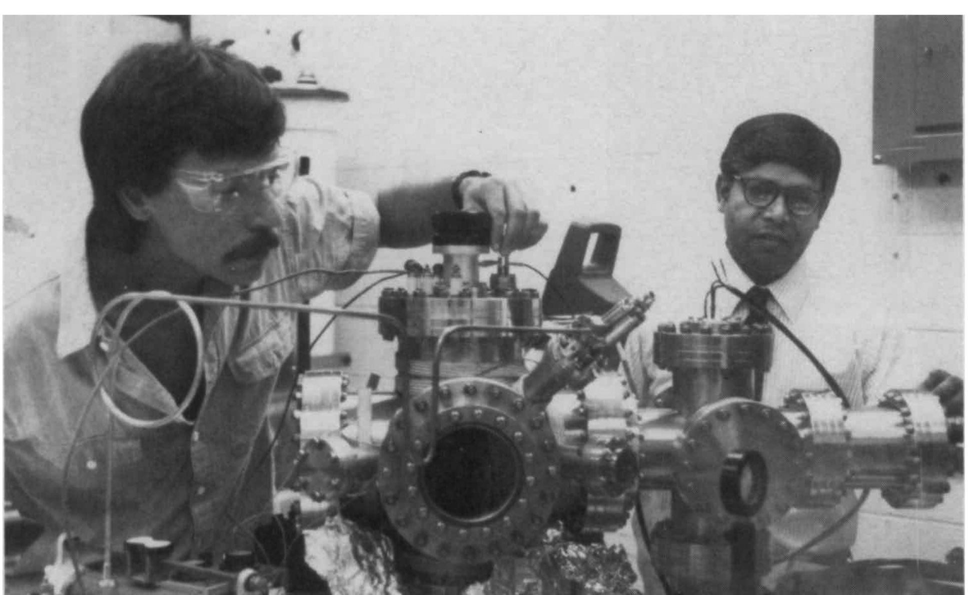
On August 14, 1987, North Carolina State University announced two breakthroughs in the search for economical high temperature superconductors. A research team headed by Dr. Jagdish Narayan, professor of materials science and engineering, said they have discovered the crystal structure of a phase of yttrium barium copper oxide that superconducts at 290 K (63°F). Narayan and his colleagues also developed a laser evaporation system that produces high quality thin superconductor films on various substrates, including silicon dioxide. If the two findings can be combined and extended, the result could be ultrahigh-speed electronic circuits that do not require expensive cooling.

During their work to characterize the atomic structures of yttrium barium copper oxide, the team used advanced analytical equipment at North Carolina State University and did further analysis at Oak Ridge National Laboratory in collaboration with scientists at the Solid State Division. Involved with Narayan in these studies were Dr. Anton F. Schreiner, professor of chemistry, and Nicholas Biunno and Rajiv Singh, doctoral candidates in materials science and engineering.

Findings from the project have been accepted for publication in an upcoming issue of *Applied Physics Letters*. A patent application is also pending on the identification and characterization of the new material's unit cell.

In addition to Biunno and Rajiv, Dr. Orlando H. Auciello, associate professor of nuclear engineering, participated in the laser processing project. The team used an excimer laser to bombard a bulk sample of the superconductor compound, causing evaporation of its atoms to produce a high quality, uniform thin film on silicon dioxide. Films were also grown on substrates of sapphire, magnesium oxide, and strontium titanate. Other scientists have produced similar thin films on other substrates, but the North Carolina State University group believe they are the first to deposit high temperature superconducting films on silicon.

The North Carolina group found that they can seal in the film's superconducting properties by using a heat treatment process. They also explored other applications of the laser process. "The method can be easily adapted to coating of wires, for power transmissions applications and for patterning of substrates that could be used in advanced integrated circuits," says Narayan.



**N. Biunno (left) and J. Narayan work with the laser deposition system.**

## High $T_c$ Superconductor Research in the UK

The Department of Trade and Industry (DTI) in the United Kingdom has established an industry-based steering committee to coordinate superconductivity research strategy. Ten firms — GEC, Plessey, BT, BAe, Lucas, Oxford Instruments, Phillips, STC, Thorn EMI, and ICI — will sit on the steering committee whose role is to galvanize British reaction toward a coordinated research program within industry and universities. Industry and the DTI are talking of providing an estimated £5 million for the first year of the committee's three-year research program.

Academics working in the field believe that Britain has kept up with the race to develop devices with the new superconductors despite the lack of necessary investment. Using ceramic superconducting material, a research team at Birmingham University has made Britain's first electronic device — a radio-frequency superconductor quantum interference device (SQUID). The problems Dr. Muirhead and his team are having at Birmingham are the same as scientists around the world — superconductivity at room temperature. Just the day after the Birmingham announcement, a team at Strathclyde University revealed that they had produced a similar device effective at liquid nitrogen temperatures. Both groups, at the early stages of their research, believe that they will continue to improve on their discoveries but are concerned about manpower and financial shortages.

In the industrial sector, a small research-based company, Basic Volume Limited, has developed the world's first ceramic high temperature superconductivity solenoid. This British breakthrough is an international first toward practical fabrication and utilization of the new lanthanide-transition metal oxide superconductors. (*See separate article in this section.*)

## Clarkson University Inaugurates High $T_c$ Superconductor Research

Clarkson University plans to continue research in high temperature superconductivity recently inaugurated when physicists there produced a high temperature superconducting ceramic material based on the yttrium barium copper oxide system.

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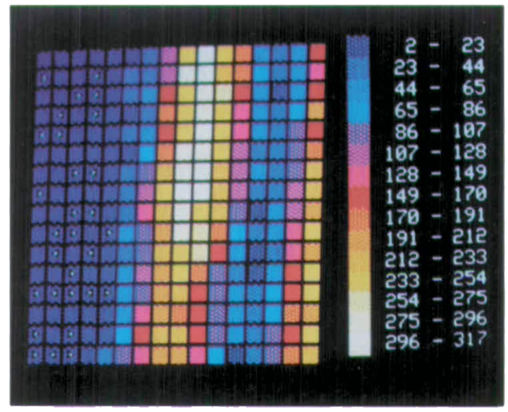


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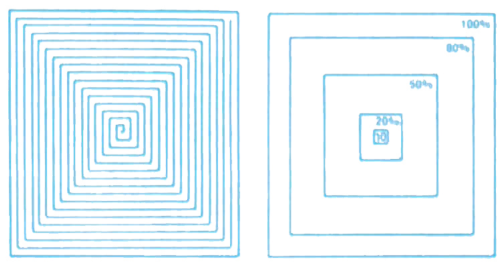


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Physics professor Sigurds Arajs, visiting professor J.A.J. Lourens, and graduate student James J. Cummings produced the superconductor.

Says Arajis, "We at Clarkson have a special advantage because of our Center for Advanced Materials Processing. CAMP provides the support and interaction necessary for researchers to find uses and applications for the results of our research." In the Spring of 1987 the state of New York awarded Clarkson $23.5 million to construct a major new laboratory for CAMP. In June 1987 CAMP was designated as one of eight Centers for Advanced Technology for New York. The designation brings with it $1 million per year in funding for research in advanced materials processing. In addition, a major component of CAMP is Clarkson's NASA Center for Commercial Crystal Growth in Space.

Commenting on the research opportunities available at Clarkson, Mark Ablowitz, Dean of Science, said "Students greatly benefit from this kind of research. What undergraduates at some other schools will learn from textbooks five years from now, our students will learn firsthand today."

## Superconductivity Coordinating Group Created at Los Alamos

A nine-member high temperature superconductivity coordinating group has been formed at Los Alamos National Laboratory. The group will be the Laboratory's focal point for a major scientific and technology transfer thrust to evaluate the commercial and strategic potential of the new high temperature superconducting materials. The group will coordinate the interaction of the Laboratory's work force with a broad basic and applied research program and with an active application effort.

The research program will involve theoretical physicists in the development of models to explain how and why the new superconductors work, while setting a basis for their practical application. Experimental and materials experts will investigate fundamental properties and develop processing technology to convert the superconductors into forms needed for application, such as thin films, coatings, wires, and tapes. Critical physical measurements will be collected on the performance of the materials, and systems analysts will focus on the economic impact of the new compounds.

The applied research program will explore near-term application possibilities in magnetic shielding, accelerators, power transmission lines, magnets, and motors.

Members of the group are: Mike Berger, Mechanical and Electronic Engineering Division; Al Clogston and Don M. Parkin, Center for Materials Science; Fred Morse, associate director for research; Thomas P. Starke, Defense Research and Applications Directorate; Lawrence R. Newkirk and Terry Wallace, Materials Science and Technology Division; Paul D. Gaetjens, senior counsel for intellectual property; and James M. Williams, Industrial Applications Office. Clogston will be the group's senior scientist and Wallace the program representative.

## Colorado State Scientists Claim Isolation of Superconducting Material at 70°F

Colorado State University researchers claim they have repeatedly demonstrated superconductivity up to room temperature and have isolated the materials that become superconducting at these high temperatures. "No one else has achieved constancy and been able to duplicate their results. We have been able to isolate small particles of the superconducting materials, identify and analyze their composition and hopefully now synthesize those compounds," say mechanical engineering professor Walajabad Sampath and co-researcher Sean Riley.

A patent is pending on the Colorado State process for isolating the superconducting material. The process was a result of research initiated by Sampath and mechanical engineering graduate student Nitant Mate. "We went down a totally different road from other labs. Our strategy has been to isolate a small region of superconducting material to provide a clue about how to synthesize superconductors," Sampath said. The superconducting material is a blend of the copper, yttrium, barium, and other oxides most widely accepted as yielding the best superconductors.

## Basic Volume Ltd. Produces Ceramic High $T_c$ Solenoid

Basic Volume Limited, a small research-based company in Britain, has produced a ceramic high temperature superconducting solenoid. This British breakthrough is an international first toward the practical fabrication and utilization of the new lanthanide-transition metal oxide superconductors.

The first tube, made on April 24, 1987, was of YBCO123 and 90 mm long with a 14 mm outside diameter and 11 mm inner diameter. The device was stable in water, contrary to previous reports. Since then larger tubes up to 31 mm in diameter have been made, with improvements in uniformity and density, in addition to dishes, rings, bars, sputtering targets, and other forms. One of the first tubes was sold in May to a major company in the field of superconductivity, and Basic Volume has since sold samples to universities and companies worldwide.

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Norwood Industrial Estate
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Telephone 01-761-1125/3556

## Electrical Probe Enables Measurements at Microscopic Distances

Sandia National Laboratories scientists have designed and used an instrument for measuring changes in electrical resistance over microscopic distances within integrated circuits or in grains of conducting material. The micropositional electrical probe is thought to be the first instrument for making contact resistance measurements on a microscopic scale.

A tiny movable arm, manipulated inside a scanning electron microscope under control of a minicomputer, moves a finely sharpened tungsten needle probe attached to a three-axis piezo-mechanical driver. The voltage can be measured at any point the needle is made to touch. The precisely controlled displacements are accomplished by applying precise voltages to the piezo drives, which are made from stacks of ferroelectric ceramics. The displacements are produced by the inverse of the peizoelectric effect.

The precision of the position-driving mechanism is such that voltage can be measured along a material at intervals as small as 250 Å. "The microprobe lets you do measurements that are dimensionally inaccessible without this apparatus," says Sandia physicist Carl Seager, co-designer of the device.

One of the microprobe's first applications at Sandia was to investigate electrical resistors and then to characterize the current flow in diodes and to learn more about the nonlinear behavior of varistors on the granular scale.

The microprobe was also used to examine the superconductor $Y_{1.2}Ba_{0.8}CuO_4$ after magnetic and optical measurements indicated that not all the material was superconducting. The micropositional electrical probe was used to study the electrical variations at the microscopic, granular scale. When the needle was contacting the interior of the grains, no current could be drawn. Only when the needle contacted the boundary, or shell, of the grain, did current flow. Apparently only a thin shell 1–2 microns around each grain is in fact

continued

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superconductive. This shell represents 5–10% of the entire material. Full details of this research will be reported by chemist David Ginley and colleagues with Sandia's superconducting materials research group.

## Varian Develops Titanium-Compound Targets

Varian Associates, Inc. (Palo Alto, CA) has developed what the company believes is the first high-purity, high-density titanium nitride compound target material suitable for producing films of the quality required for VLSI devices. Dr. Teodoro Brat, senior engineer at Varian's Specialty Metals Division (Grove City, Ohio), announced Varian's discovery at the Fifth Annual Workshop on Silicides and Metals for VLSI Applications in San Juan Bautista, CA.

According to Brat, the new target material makes it possible to produce TiN films of VLSI quality on industry-standard deposition equipment without resorting to reactive sputtering techniques. "We believe this is the purest (99.99%) and the densest (95%) titanium nitride material yet available in sputtering target form," he said. The films have sheet resistivity of $<40\ \mu\Omega$-cm before annealing, a significant advancement over reactively sputtered film resistivity. "We have achieved very high sputter rates of 2,000 Å/s," said Brat.

## Scale-Model Containment Structure Pressurized to Failure

A 1/6-scale model of a nuclear power plant containment building was pressurized to failure in a successful test at Sandia National Laboratories. Carried out for the U.S. Nuclear Regulatory Commission as part of its containment integrity research program, the test will help ensure that computer models of containment behavior are technically sound and accurate. The test results will be compared with pretest predictive computer models prepared by scientists from 10 organizations in the United States, France, Italy, West Germany, and the United Kingdom. Sandia researchers presented the test results at the Ninth Structural Mechanics in Reactor Technology Conference, Lausanne, Switzerland, August 17-21, 1987.

The test structure, designed to withstand a differential pressure of up to 46 psig was ultimately pressurized to 145 psig. After about an hour at that pressure, the gas supply could not maintain pressure and the test was terminated. Examination showed that the main mode of failure was a 20-inch tear in the structure's interior steel liner. The containment structure remained intact.

A detailed study is being made of the exact damage to the model, which was heavily instrumented. Monitors included 980 strain gauges (250 attached to the reinforcing steel during construction), 150 displacement transducers, 70 thermocouples, an acoustic-sensing system, still cameras at 18 locations (10 focused on closeup areas), and 12 video cameras (one internal to the structure). Data was transmitted to a computer in the command center 1,500 feet away.

## V. Narayanamurti Named Member of Swedish Academy

Venkatesh Narayanamurti, vice president for research at Sandia National Laboratories, has been elected a member of the Royal Swedish Academy of Engineering Sciences. Narayanamurti is one of three Americans elected to the academy this year. Among eminent American members previously elected to the academy are Glenn Seaborg, former chairman of the Atomic Energy Commission, and Erich Bloch, director of the National Science Foundation.

Narayanamurti was nominated by the Academy's division for basic and interdisciplinary engineering sciences "for his eminent achievements in solid state physics and electronics, with special regard to his pioneering effort in developing the field of phonon optics." Phonon optics involves the use of extremely high frequency acoustics — trillions of cycles per second — to detect and study atomic-scale defects and imperfections in various materials. The method also serves as a spectroscopic probe of solid state materials in a previously inaccessible frequency range.

## Army Materials Technology Lab Designated Center of Excellence for Corrosion Prevention and Control

The U.S. Army Materials Technology Laboratory (MTL) in Watertown, MA has been designated a Center of Excellence for Corrosion Prevention and Control, acknowledging MTL's long-standing leadership within the Army in materials technology, R&D, failure analysis, and solutions of problems in the field. MTL has been involved in corrosion prevention and control for more than a decade and has developed a detailed information base on materials exposure.

In metals, MTL's expertise encompasses aqueous corrosion, electrochemical testing, stress corrosion cracking, corrosion fatigue, high temperature oxidation/sulfidation, chemical defense, erosion/corrosion, wear and abrasion, nondestructive testing, reliability mechanics, and specifications and standards. In nonmetals, MTL specializes in composites, elastomers, and polymers.

The Center of Excellence will also serve as an active communications hub for corrosion prevention and control, failure analysis, and lessons learned throughout the Army Materiel Command and the Army community. "We feel strongly," says program manager Dr. Joseph Wells, "that active, open communications about corrosion failure analysis is as important as communicating the findings of sophisticated prevention-based research. It is certainly as cost beneficial as the research itself." MTL is establishing an integrated computer network throughout the Army Materiel Command to facilitate communication. A key element in the integration of corrosion prevention and control data will be technology transfer to industry, academia, and to such professional organizations as the National Association of Corrosion Engineers.

## T.E. Mitchell Joins Los Alamos

Terence E. Mitchell has joined the Center for Materials Science at Los Alamos National Laboratory. He will coordinate a major expansion of the electron microscopy facility and will interact with the various ceramics activities in the Laboratory. Mitchell received his BA in 1958 and PhD in 1962, both in physics from the University of Cambridge. He was at Case Western Reserve University for 24 years, becoming professor of materials science and serving as chairman of the Department of Materials Science and Engineering from 1983 to 1986. A member of the Materials Research Society, he is the author or coauthor of almost 200 publications in various professional journals and conference proceedings.

## Glasstech Solar to Develop $\alpha$-Si Solar Cell

Glasstech Solar, Inc. (Wheatridge, Colorado) has been awarded a cost-sharing contract from the Solar Energy Research Institute. The two-year contract valued at $610,000 is for the development of a 9% efficient, amorphous-silicon solar cell at a high deposition rate (20 Å/s$^{-1}$). Glasstech Solar is an affiliate of Glasstech, Inc., Perrysburg, Ohio.

MRS

# Dielectric Thermal Analyser

Insulating materials possess a dielectric constant (ε') characterising the extent of electrical polarization which can be induced in the material by an electric field. If an alternating electric field is applied, the polarization lags behind the field by a phase angle, δ, this results in partial dissipation of the stored energy. The dissipated energy is proportional to the dielectric loss (ε") and the stored energy to the dielectric constant (ε').

The DETA tecnique normally obtains data from thermal scans at constant impressed frequency. The transition temperatures at which molecular motions become faster than the impressed time scale being recorded as peaks in ε" (and tan δ).

It is a simple matter to multiplex frequencies over the whole frequency range 20Hz – 100kHz and under such condtions the peaks in ε" are shifted to higher temperatures as frequency is increased. A further option allows data to be obtained in the frequency plane under isothermal conditions.

The DETA cell, analyser and temperature programmer are shown above. The system is controlled by a computer (typically HP 9816 or 310, which is not shown). An automated cooling system and a sputter coater for sample preparation are available as optional extras.

The sample is clamped between a pair of stainless steel disc electrodes 33mm in diameter. The upper electrode is spring-loaded, but the clamping force can be adjusted (down to zero) by repositioning the lower, fixed electrode.

An optional 3 terminal electrode assembly is available.

Vacuum can be achieved via pumping on an outlet port in the base, or environmental control can be achieved by passing gases or non-corrosive vapours in through the vacuum ports.

Fig 1. Data from a polyurethane rubber over a wide temperature and frequency range is shown. The relaxation process located near to 0°C is due to the glass transition of the material. The shift in position of the maxima can be used to derive the Activation Energy.

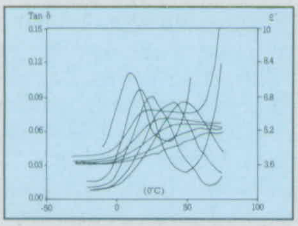
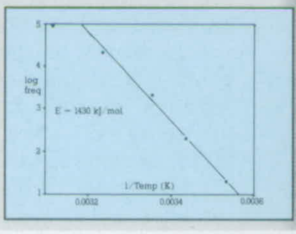



Fig 2. An Arrhenius plot from data obtained in the broad frequency sweep experiment of Fig 1.

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# DETA

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