

# News Briefs

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## General Developments

*Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Administration Building, A635, Gaithersburg, MD 20899; telephone: 301/975-3572.*

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### **GAS EXPANSION PROCESS PROBES “THE GLUE OF LIFE”**

A new method for measuring one of the fundamental forces of life—the weak hydrogen bonds that hold molecules together—may soon help scientists design drugs, model the chemistry of the Earth’s ozone layer, and better understand the functions of the body’s proteins. The process, a slit-jet supersonic expansion, expands gaseous mixtures of molecules in an area of high pressure through a narrow slit into a vacuum. This cools the gases to near absolute zero and allows the formation of weak hydrogen bonds. Infrared laser light is then used to warm and vibrate the molecules, breaking the bonds. Spectroscopic analysis of the breaking bonds provides a precise measurement of the force they possessed. Such measurements are particularly important to biochemists because hydrogen bonds hold together the two strands of the DNA molecule, the genetic material that regulates protein formation and determines an organism’s characteristics.

### **FIRST LICENSE GRANTED FOR REMINERALIZING PROCESS**

A simplified method for rapidly putting minerals into teeth moved closer to the marketplace as the result of the first patent license granted to a U.S. dental materials manufacturer to produce and market dentifrice products and chewing gum for remineralizing teeth. This means that for the first time, a toothpaste, gel, powder or chewing gum soon

may be available to help prevent and repair beginning cavities, restore decalcified areas and make teeth less sensitive to hot and cold temperatures. An exclusive license with the patented remineralization process has been granted to a private company by the American Dental Association Health Foundation (ADAHF). The new products will be based on a method developed by a scientist at the ADAHF Paffenbarger Research Center at NIST. The method involves the use of amorphous calcium compounds or a carbonate solution that crystallize to form hydroxyapatite, the primary mineral in teeth and bone. A dentist at the private company, and the chief executive officer of the company, say, “This is the first major scientific and technological breakthrough in the toothpaste industry since the introduction of fluoride in the 1960s.”

### **REPORT DESCRIBES CIRCUIT EVALUATION TECHNIQUE**

NIST has created a computer procedure that ties together three software programs, creating a powerful tool for predicting the behavior of integrated circuits. The NIST method, called KEYS (for linKing softwarE to analYze waferS), links the programs SUXES (Stanford University eXtractor of model parameterS), SPICE (Simulation Program with Integrated Circuit Emphasis) and STAT2. SPICE predicts currents and voltages at chosen circuit nodes but requires accurate models files and input parameters. SUXES obtains model parameters and adapts to any model. And STAT2 determines correlation coefficients and generates wafer maps of selected parameters. KEYS combines the strengths of all three, allowing users to characterize individual chips, wafers or lots. KEYS is described in NIST Special Publication 400-90, available for \$26 (print) or \$12.50 (microfiche) prepaid from the National Technical Information Service, Springfield, VA 22161, (800) 553-6847. Order by PB 92-191220.

**LOW LEAD LEVELS ASSESSED IN STUDY OF CONSUMER PAINTS**

In tests of 31 different consumer paints, researchers at NIST found lead concentrations to be well below the required level (600 parts per million) as mandated by the Consumer Product Safety Commission in 1978. NIST found that in all cases, lead concentrations were less than 100 ppm. In fact, many samples had levels so low they could not be detected. This study was conducted for the U.S. Department of Housing and Urban Development as part of HUD's lead-paint abatement program. The NIST researchers tested nine oil-based paints—five exterior and four interior—and 22 water-based paints—11 exterior and 11 interior. The paints selected were a variety of quality grades and colors, and were purchased from local retail stores. Lead Concentration in Consumer Paints: A Pilot Study (NISTIR 4851) is available from the National Technical Information Service, Springfield, VA 22161, (800) 553-6847, for \$17 (print) and \$9 (microfiche) prepaid. Order by PB 92-213370.

**CONSORTIUM PROPOSED TO IMPROVE POLYMER PROCESSING**

Chemical and mechanical engineers from companies that produce engineering resins are invited to join a cooperative research and development program to improve the processing of polymer blends and alloys. The goal of the proposed research program is to use NIST measurement tools to develop the data and processing models industry needs to produce new and more economical resins. New information will enable producers to make critical in-process measurements that are not possible now. The initial project will be an in-depth study on a non-proprietary blend system. Generic technology on interfacial structure formation and characterization can be developed and applied to company-specific blends and alloy development. The NIST research tools include the small-angle neutron-scattering shear mixing apparatus at the NIST research reactor, the small-angle x-ray scattering facility, the light-scattering shear mixing apparatus, and the temperature-jump light scattering instrument for time resolved and kinetic studies. For information on the proposed 3-year program, contact Charles C. Han, B210 Polymer Building, NIST, Gaithersburg, MD 20899, (301) 975-6771.

**SMALL BUSINESSES CAN HELP DEVELOP LAB AUTOMATION**

NIST's Consortium on Automated Analytical Laboratory Systems, known as CAALS, recently created a new program tailored for small businesses. The consortium, a partnership of private-sector firms and government agencies, is working to advance automation in analytical chemistry by defining specifications and establishing standards that enable laboratory instruments to communicate and work together. "We wanted to get small businesses involved because of their highly innovative nature and their unique roles in the laboratory automation marketplace," explains NIST chemist and CAALS manager. The new program, known as CAALS Associates, allows small businesses to help devise specifications and standards for laboratory automation. For a \$5,000 annual fee, CAALS Associates participate in quarterly workshops and receive relevant reports and newsletters. The program is also open to individuals, not-for-profit organizations, universities and trade associations. For more information, contact CAALS, A343 Chemistry Building, NIST, Gaithersburg, MD 20899, (301) 975-4142.

**FEBRUARY MEETING TO FEATURE 1992 BALDRIGE WINNERS**

"Quest for Excellence V," Feb. 15–17, 1993, at the Washington Hilton and Towers in Washington, DC, will be the first conference to feature presentations by all of the 1992 winners of the Malcolm Baldrige National Quality Award. Chief executive officers and other team members from the winning companies will describe in detail their quality improvement strategies and results. The conference provides a unique networking opportunity for people from across the country to exchange plans and ideas for quality and productivity improvements. It is being co-sponsored by NIST, the American Society for Quality Control and the Association for Quality and Participation. For more information about "Quest for Excellence V," call (301) 975-2036.

**NIST/SBA LINK PROGRAMS FOR SMALL MANUFACTURERS**

NIST and the Small Business Administration have announced a joint agreement to link SBA's business management and financial assistance

programs with NIST's national network of Manufacturing Technology Centers (MTCs). The agreement will streamline delivery of SBA-backed financing for replacing old, outdated manufacturing and design processes with new, advanced methods. The NIST MTCs assist small and mid-sized manufacturers in selecting appropriate modern technologies and processes, integrating the new technologies into the manufacturer's operation, and arranging workforce training and similar tasks. The network includes five operational centers headquartered in Cleveland, OH; Albany, NY; Columbia, SC; Ann Arbor, MI; and Overland Park, KS. Two new centers recently were announced for Los Angeles, CA, and Minneapolis, MN.

#### **INDUSTRY, NIST TO TEST FURNITURE FIRE BLOCKERS**

NIST and a private company have signed a cooperative research and development agreement to test the effectiveness of a fire-blocking barrier on the flammability of upholstered furniture. The idea is to keep a fire small by placing a fire-resistant layer between the furniture's outside fabric covering and its foam cushion. While the outside fabric may burn or char, the barrier would help prevent the sofa or chair from becoming engulfed in flames and spreading the fire. A similar technique has been used effectively in airplane seats. Researchers from the private company and NIST will run over 100 tests of samples using an industry-developed barrier, a polyurethane foam material and 15 different types of fabric. Based on the results of these tests, NIST will conduct full-scale tests on 10 items of upholstered furniture made with the barrier material. The private company will provide the materials and furniture for the tests. The project is expected to take 6 months.

#### **UNITED STATES, CANADA AGREE ON "EQUAL TIME"**

By mutual agreement, the United States and Canada have recognized each other's time scales as being equivalent at a level of 10  $\mu$ s. This means that North American users of precise time information may get their time "hacks" from shortwave radio stations at either NIST or the National Research Council of Canada with equal certainty. Depending on the level of accuracy desired, users still will have to compensate for propagation delays in broadcast time signals. For very low accuracy requirements — one-tenth of a second to one second — there is little

or no need for propagation correction. NIST broadcasts time information from shortwave radio station WWV in Fort Collins, CO, and the NRC broadcasts from station CHU in Ottawa. Listeners in the eastern part of the United States may find reception of CHU's signals stronger and propagation delays shorter; likewise, time users in western Canada may find WWV to be better for their purposes. In either case, all legal requirements will be met by obtaining time information from either country.

#### **UNITED STATES AND RUSSIA DESIGNATE STANDARDS FOCAL POINTS**

The NIST National Center for Standards Code and Information (the inquiry point for the United States under the GATT Standards Code) and the Scientific Research Institute for Technical Information, Classification and Coding at GOSSTANDART, Moscow, have been designated focal points for the exchange of standards-related information between the two countries. The contact points were established by the U.S. Department of Commerce and the Russian Ministry of Foreign Economic Relations. The agreement was reached Sept. 9, 1992, at the first meeting in St. Petersburg, Russia, of the Standards Working Group of the Intergovernmental U.S./Russia Business Development Committee. At the meeting, the group recognized that harmonized standards and conformity assessment procedures, as well as technical regulations, are important for the development of commercial, economic, scientific and technical cooperation between the United States and Russia.

#### **NEW REPORT DETAILS FEDERAL AGENCIES' ROLE IN AMPP**

Announced in January 1992, the federal Advanced Materials and Processing Program represents the efforts of 10 federal agencies, the Office of Management and Budget, and the Office of Science and Technology Policy to extend U.S. leadership in materials science and engineering. The AMPP proposes a 10 percent increase for materials research and development in fiscal year 1993. A comprehensive report, *Advanced Materials and Processing: The Fiscal Year 1993 Program*, describes activities that will strengthen the federal materials R&D development effort and foster increased cooperation between government, industry and academia. The new report will help industry and academic

researchers locate government resources in specific areas of interest. Also listed are national user facilities operated by NIST, the Department of Energy and the National Science Foundation that are available to researchers requiring photon, neutron and magnetic sources. Copies of the report are available from Samuel J. Schneider, B309 Materials Building, NIST, Gaithersburg, MD 20899, (301) 975-5655.

#### **1992 BALDRIGE AWARD WINNERS SET NUMEROUS FIRSTS**

For the first time in its history, the Malcolm Baldrige National Quality Award has been presented to five companies in a single year. The 1992 award recipients, announced by President Bush on Oct. 14, 1992, are AT&T Network Systems Group/Transmission Systems Business Unit (Morristown, NJ) and Texas Instruments Inc. Defense Systems & Electronics Group (Dallas, TX) in the manufacturing category; AT&T Universal Card Services (Jacksonville, FL) and The Ritz-Carlton Hotel Co. (Atlanta, GA) in the service category; and Granite Rock Co. (Watsonville, CA) in the small business category. Other 1992 milestones include the first time two divisions of the same corporation (AT&T) have won; the first time for two winners in the service category; and the first winners from the hospitality (Ritz-Carlton), construction (Granite Rock) and financial (AT&T Universal Card Services) industries. The award, managed by NIST with the active involvement of the private sector, was established by legislation in August 1987 to raise awareness about quality management and to recognize U.S. companies that have a world-class system of management, employee involvement and customer satisfaction. The five winners will be honored at a ceremony in Washington, DC, later this year.

#### **FUTURE THERAPIES MAY "BUILD" ON ENZYME STRUCTURE**

The determination of a new high-resolution structure for a liver detoxification enzyme will help scientists understand how the liver filters cancer-causing substances from the body, and may eventually lead to new cancer therapies. Scientists at the Center for Advanced Research in Biotechnology and the University of Maryland College Park describe the three-dimensional structure of glutathione S-transferase, or GST, in the Oct. 27, 1992, issue of *Biochemistry*. GST is a liver enzyme that protects people and animals from carcinogens encountered in the environment. Knowing the

structure of this complex molecule could enable pharmaceutical companies to design more effective chemotherapy drugs, as well as enzyme-inhibitors that would make cancer cells more susceptible to chemotherapy. Researchers cloned (produced multiple identical copies) GST from genetically engineered *E. coli* bacteria in order to map more than 4000 atoms and 434 amino acids that make up the protein's structure. CARB was established by NIST and the University of Maryland in 1984. Both institutes supply staff and funding to CARB's Rockville, MD laboratories.

#### **REPORT SHOWS FEDERAL AGENCIES COMMITTED TO METRIC**

The federal government's metric transition program is proceeding in a practical, orderly and evolutionary way toward the use of metric units in its business-related activities, states a summary report on the metric transition plans of 34 federal agencies. The metric system long has been the international standard of measurement. In 1988, the Congress recognized the importance of metric specifications for products in global markets by including "metric usage" provisions in the Omnibus Trade and Competitiveness Act. The amendments strengthened the Metric Conversion Act of 1975 and made each federal agency responsible for implementing metric usage in grants, contracts and other business-related activities, to the extent economically feasible, by the end of fiscal year 1992 (which ended Sept. 30, 1992). Copies of the report, *Metric Transition Plans and Activities of Federal Government Agencies* (NISTIR 4911), are available for \$27 prepaid from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650. Order by number PB 92-222249.

#### **WORKING WITH INDUSTRY TO MEASURE PERFORMANCE**

NIST has signed a cooperative research and development agreement with private industry to assess the performance of commercial automatic network analyzers used to calibrate microwave system components. ANAs have replaced many manual systems for microwave calibrations throughout government and industry. NIST pioneered the development of six-port ANAs, which enhanced ANA technology. While the six-port device is still available for NIST calibrations, it is costly for the user. NIST wants to determine whether it can achieve calibration integrity by using commercial instruments at a lower cost to customers. During the

3-year agreement, NIST will explore the feasibility of using commercial ANAs for NIST calibration services and develop procedures for validating their use in routine calibrations. For more information, contact Bob Judish, Div. 813.01, NIST, Boulder, CO 80303, (303) 497-3380.

#### **FOURTEEN INVENTIONS NOW AVAILABLE FOR LICENSING**

NIST recently announced that the following 14 government-owned inventions are now available for licensing:

- A Diffraction Device Which Detects the Bragg Condition (Docket No. 87-025);
- Apparatus for Identifying and Comparing Lattice Structures and Determining Lattice Structure Symmetries (Docket No. 88-023);
- Coprecipitation Synthesis of Precursors to Bismuth-Containing Superconductors (Docket No. 88-043);
- Microtip-Controlled Nanostructure Fabrication (Docket No. 92-024) and Multitipped Field-Emission Tool for Parallel-Process Nanostructure Fabrication (Docket No. 89-001);
- Optical Sensor for the Measurement of Molecular Orientation and Viscosity of Polymeric Materials Based on Fluorescence Radiation (Docket No. 89-015);
- Colloidal Processing Method for Coating Ceramic Reinforcing Agents (Docket No. 89-016);
- Process for Separating Azeotropic or Close-Boiling Mixtures by Use of a Composite Membrane, the Membrane and Its Process of Manufacture (Docket No. 89-028);
- Bi-Flow Expansion Device (Docket No. 89-033);
- Synthetic Dental Compositions and Bonding Methods (Docket No. 89-039);
- Aqueous Two-Phase Protein Extraction (Docket No. 90-006);
- Line-Width Micro-Bridge Test Structure (Docket No. 91-015);
- MMIC Package and Interconnect Test Fixture (Docket No. 91-016);
- Sensors for Sampling the Sizes, Geometrical Distribution and Small Particles Accumulating on a Solid Surface (Docket No. 91-017); and
- Method and Structure for Eliminating the Effects Caused by Imperfections in Electrical

Test Structures Utilized in Submicrometer Feature Metrology (Docket No. 91-020).

For technical and licensing information on these inventions, contact Bruce E. Mattson, B256 Physics Building, NIST, Gaithersburg, MD 20899, (301) 975-3084.

#### **CRADA KICKS OFF HIGH-NITROGEN STEELS PROGRAM**

A private company and NIST have established a cooperative research and development program to develop a new approach to producing stainless steels with high-nitrogen content. The NIST-patented process produces metal powders with ultrahigh nitrogen content using a gas atomization technique. This approach offers a better way of incorporating a controllable, uniform concentration of nitrogen in materials. Nitrogenated stainless steels are known to have superior strength, toughness and resistance to oxidation and corrosion. Under the program, researchers from the company will work with NIST metallurgists at the institute's powder processing laboratory. They will use the NIST metal atomizer to produce rapidly solidified stainless steel powders. The use of nitrogen gas in the process imparts the high nitrogen content in the material. The powders will be fabricated into usable parts to near-net shape by various consolidation methods. For information on the 3-year CRADA program, contact Frank Biancanello, Metallurgy Division, B156 Industrial Building, NIST, Gaithersburg, MD 20899, (301) 975-6177.

#### **BULLETIN SURVEYS PAPERS IN ELECTRONICS METROLOGY**

Measurement programs in semiconductor microelectronics, signals and systems, electrical systems and electromagnetic interference are among those described in the Technical Progress Bulletin, now available from NIST. The quarterly bulletin covers programs that provide national reference standards, measurement methods, supporting theory and data, and traceability to national standards. It features abstracts of papers and other published works arranged by topic (with phone numbers of contacts listed). Semiconductor topics covered include silicon materials, integrated circuit test structures, photodetectors and radiation effects. Also presented are sections on waveform, cryoelectronic, antenna, noise, laser and optical fiber metrology. To receive the most recent issue or to be placed on the mailing list, write (stating profes-

sional affiliation or technical interest) to Technical Progress Bulletin, EEEL, B358 Metrology Building, NIST, Gaithersburg, MD 20899, or call (301) 975-2220.

#### **LICENSING EXPANDED FOR SIMPLIFIED BONDING SYSTEM**

Two U.S. dental materials manufacturers have been added to the list of firms authorized to use the American Dental Association Health Foundation patented bonding system for restoring teeth. The two companies now are among a group of five U.S. firms licensed to produce and market a simplified, two-step system for bonding dental resins to hard tooth tissues, both dentin and enamel. The "ultrasimplified" bonding system was developed in the ADAHF Paffenbarger Research Center at NIST. "The bonding system permits dentists to do a better job in conserving tooth structures, rebuilding badly damaged teeth, and making cosmetic improvements to front teeth," says Rafael L. Bowen, PRC director. He points out that in addition to conserving tooth structures, adhesive bonding methods increase patient comfort during and after dental procedures.

#### **NEW EXPORT OFFICE OPENS AT NIST GAITHERSBURG**

Under a unique agreement, the Commerce Department's main export promotion agency, the International Trade Administration, has established a branch office of its United States and Foreign Commercial Service at NIST's Gaithersburg, MD site. The new office provides area companies with resources on overseas marketing and facilitates collaborations with Commerce Department officers at U.S. embassies worldwide. For more information, write Stephen Hall at Room A102, Building 411, NIST, Gaithersburg, MD 20899, or call (301) 975-3904. Firms not in the Washington, DC, area can call (800) 872-8723 for the location of the nearest ITA district office.

#### **NIST/INDUSTRY SET STANDARDS IN TELECOMMUNICATIONS**

NIST has been working with the telecommunications industry to develop phase noise and synchronization standards for new optical fiber communication systems. The industry turned to NIST because of its experience in characterizing these specifications for clocks and oscillators. Since 1991,

the institute has participated in industry-wide meetings to develop standards for the proposed optical fiber network. The most recent of these, an August workshop at NIST's Boulder Laboratory, familiarized 43 industry representatives with new, NIST-developed measures for system performance that have been adopted by the U.S. and international telecommunications communities. NIST will continue to work with the industry on synchronizing and timing questions, which promise to get more severe as communication data rates increase. For details, contact Marc A. Weiss, Div. 847, NIST, Boulder, CO 80303, (303) 497-3261.

#### **UNITED STATES LEADS WORLD IN PDE STANDARD DEVELOPMENT**

A recent report by the National Initiative for Product Data Exchange states that the United States is setting the pace in an international drive to create a key information and manufacturing technology standard. The product data exchange standard will enable manufacturers to describe and exchange all useful information about a given product in computerized format. To produce a "snapshot" of the U.S. effort, NIPDE surveyed over 100 U.S. corporations, industrial consortia, standards organizations and government agencies currently participating in more than 300 product data exchange projects and activities. The survey shows that U.S. activities in PDE have an annual expenditure between \$30 million and \$50 million, involve personnel assignments equivalent to 200 full-time engineers and other technicians, and make up 50 to 75 percent of the worldwide activity in PDE standard development. The NIPDE Product Data Exchange Baseline Activities Report is available by writing NIPDE, B102 Radiation Physics Building, NIST, Gaithersburg, MD 20899.

#### **NIST IGBT MODEL USED BY INDUSTRY SUBJECT OF CRADA**

The generic analytical model for insulated-gate bipolar transistors (IGBTs) developed by a NIST scientist has been selected for use by a major U.S. semiconductor manufacturer and supplier of IGBTs. The model also has been adopted by an auto manufacturer in the design of electronic systems for its products. The scientist's model already has been incorporated in several widely used circuit simulation programs, and he has developed an automated parameter extraction sequence to model a variety of commercially available IGBTs. NIST and

a private company have entered into a Cooperative Research and Development Agreement to further develop the model and the automated parameter extraction sequence and to make the results available in a commercial parameter-extraction package for developers of circuit simulators. The cooperative work will facilitate the development of libraries of IGBT component models for circuit simulators.

#### **MAGNETIZATION MEASUREMENTS APPLIED TO SUPERCONDUCTIVITY IN FIRST-TIME MEASUREMENT OF OFFSET SUSCEPTIBILITY**

NIST researchers have measured the offset susceptibility of a sintered high-temperature superconductor,  $\text{YBa}_2\text{Cu}_3\text{O}_7$ . Such a sintered superconductor can be regarded as an assembly of weakly connected superconducting grains. The magnetic response is useful for characterization and provides information on both intrinsic (intragranular) and coupling (intergranular) components. The offset susceptibility is a new aspect of superconductor magnetization which had been predicted from Fourier analysis but never before measured, largely because it is not detectable with usual pick-up coil techniques. The researchers used a cryogenic Hall-probe magnetometer, developed at NIST, to measure magnetization directly rather than by induction. The measurements are useful in gauging the appropriateness of certain critical-state models of magnetization, and the technique can be applied to magnetic materials. Often the ac and dc susceptibilities of superconductors are treated independently, with the dc susceptibility defined as the ratio of the magnetization per unit volume to the external dc magnetic field. The authors extend the definition of the dc susceptibility for excitation fields having both a dc and a time-varying component, which results in the novel offset susceptibility. The work will appear in a forthcoming issue of *Physical Review B*.

#### **CERTIFICATION PLAN DEVELOPED FOR ANTENNA NEAR-FIELD SCANNING RANGES**

NIST scientists have developed and documented a certification plan that when followed provides the information needed to determine if an antenna near-field planar scanning range is qualified for characterizing the performance of phased-array antennas to a given accuracy. The NIST invention and development of near-field scanning methods has

led to their widespread use, especially for complex antennas having many elements in an array and to the consequent establishment of a large number of near-field ranges in the United States and abroad. NIST has assisted many U.S. organizations in developing and qualifying their ranges for the measurement of high-performance phased arrays; in addition, NIST provides calibration services for characterizing the probes used in the near-field measurements. Previously there has been no collected guidance for an organization desiring to certify a new range or to re-certify a range after modifications.

NIST scientists now have distilled their expertise in this respect and in the plan discuss important certification aspects specifically as they relate to the characterization of phased arrays and identify the many factors that must be considered and evaluated.

#### **NIST MEASUREMENTS SHOW HIGH $T_c$ SUPERCONDUCTOR MECHANICAL PROPERTIES ENTERING PRACTICAL RANGE FOR MAGNETS**

A NIST scientist has found an order-of-magnitude increase in the strain tolerance of certain high-critical-temperature superconductors, with the implication that for the first time the mechanical properties of high  $T_c$  superconductors are entering the practical design range for magnet applications. The measurements were made using a NIST-designed apparatus that operates in the hybrid magnet facility of the MIT National Magnet Laboratory at fields up to 25 T. Using new Ag-sheathed Bi-based superconductor samples produced by non-sintering processes (such as melt processing) and supplied by private companies, the scientist found the point of irreversible strain damage in these materials could be extended up to a value of 0.6 percent from the previous value of 0.05 percent found in virtually all earlier bulk-sintered high  $T_c$  superconductors. The NIST scientist believes that in the specimens he has measured irreversible strain damage may equate to actual fracture of the superconducting material. Future development of these conductors will center on the use of ductile matrix materials and subdividing the superconductor into small filaments to achieve greater strain tolerance. The results were recently published in *Applied Physics Letters*.

### INDUSTRY WORKSHOP ATTENDEES STRESS NEED FOR NIST CALIBRATIONS FOR NEW TRACEABILITY

A recent workshop was held at NIST on "Metrological Issues in Precision-Tolerance Manufacturing." During the workshop representatives of key U.S. discrete-part manufacturing sectors—including commercial aircraft, heavy-equipment, automobiles, engines, computers, instrumentation and microelectronics—urgently requested that NIST provide a new and higher-accuracy standard for dimensional measurements, including those for coordinate measuring machines, involute gears, small-bore microwave devices, x-ray optical surfaces, and nanometer-scale microelectronics. Among the attendees were representatives of industry, the machine tool and gear manufacturers associations, and an array of instrument and gage manufacturers. The recurring bases of needs as stated by these companies are the "new traceability" required to meet ISO-9000-type quality requirements for products to be sold both in the European Economic Community and Pacific-rim nations, and to provide fixed reference points to support development of innovative products, such as STMs with well-characterized probes and next-generation nanoelectronic fabrication machines, processes, and devices. A summary report of the workshop and NIST follow-up action plan will soon be available.

### TWO NEW NIST PRECISION MEASUREMENT GRANTS AWARDED FOR FY 93

Two new \$30,000 NIST Precision Measurement Grants have been awarded for fiscal year 1993. The recipients, Alex de Lozanne and Qian Niu of the University of Texas at Austin, and Thad G. Walker of the University of Wisconsin-Madison, were selected from an initial group of 34 candidates. NIST sponsors these grants to promote fundamental research in measurement science in U.S. colleges and universities, and to foster contacts between NIST scientists and researchers in the academic community actively engaged in such work.

The aim of de Lozanne and Niu's project, "Quantum Charge Pump for a Current Standard," is to conduct experimental and theoretical studies on the realization of a quantum charge pump (QCP). Novel lithographic techniques made possible by the scanning tunneling microscope will be used to pattern the two-dimensional electron gas at a GaAs-AlGaAs interface. For a 750 MHz applied

bias voltage and at a temperature of 2 K, the 50 nm features of the QCP should result in a dc current of 120 pA having a precision of 1 part in  $10^8$ .

Walker's project, "Beta-Asymmetry Experiments Using Trapped Atoms," involves optically cooling and confining via radiation pressure short-lived radioactive atoms produced by an accelerator and spin polarizing the atoms by optical pumping. This will enable a variety of beta-decay experiments to be carried out with unprecedented precision. Walker's initial experiment will be to determine the beta-asymmetry parameter for the mirror nuclear decay of potassium 37 to argon 37. This measurement will provide a precision test of the so-called standard model of particle physics.

### ATOMIC ENERGY SHIFTS IN STRONG LASER FIELDS

When an atom is subject to an intense time-varying electric field (such as the electromagnetic field produced by intense laser radiation), the atomic energy levels are shifted by the external field, an effect called the light shift or ac Stark shift. A thorough understanding of these shifts is necessary to interpret results from experiments that use intense lasers to probe atomic structure or for laser-based ultrasensitive detection of isotopes. For a highly monochromatic laser not tuned to any atomic transition and for a Rydberg level with binding energy much less than the laser photon energy, theory predicts that the energy shift in the level will approach the value given by the so-called ponderomotive potential. In a Rydberg level, a single electron is in a large orbit loosely bound to the nucleus (which is embedded in the core of the remaining electrons), and this electron exhibits near-classical behavior in certain circumstances. The ponderomotive potential is simply the classical average kinetic energy a free electron gains when driven into oscillation by an external electromagnetic field.

Previous measurements of Rydberg level ac Stark shifts disagree with each other and with predictions, with recently reported values less than half the ponderomotive potential. In addition, some measurements of the energy of electrons produced in certain laser ionization experiments, which should also approach ponderomotive values, deviate significantly from the theory. No acceptable theoretical justification has been proposed to explain these apparent discrepancies.

Recently, scientists at NIST conducted experiments to determine whether these serious dis-



crepancies result from incomplete understanding of the physical principles or from experimental difficulties. Careful, systematic measurements of ac Stark shifts in high-lying levels of calcium and xenon were made using laser ionization techniques. The results are in excellent agreement with detailed theories of laser-atom interactions which predict near-ponderomotive energy shifts and suggest possible reasons for the apparently contradictory results reported by other researchers. These experiments should restore confidence in the simple picture of a Rydberg electron behaving essentially as a free electron when subject to an intense electromagnetic field with photon energy much larger than the Rydberg binding energy.

#### **NIST ORGANIZES INTERCOMPARISON OF U.S. AND RUSSIAN ACCELERATORS USING PROTON BEAMS FOR CANCER THERAPY**

Cancer therapy studies using high-energy proton beams are under way in several major medical centers in the United States, including the Harvard Cyclotron and a new dedicated medical accelerator at Loma Linda University in California. Russian medical centers, including one at the Institute for Theoretical and Experimental Physics (ITEP) in Moscow, have been investigating proton therapy for two decades. The National Cancer Institute (NCI) is studying how the Russian experience may apply to new clinical trials for the United States. NIST is collaborating with the Radiation Research Program at NCI in developing new dosimetry systems to facilitate intercomparisons between these laboratories. Preliminary work has focused on investigations of alanine-electron spin resonance (ESR) and radiochromic films for use in measuring detailed proton dose and depth-dose curves in high-energy proton beams. The initial irradiations were carried out in Moscow. Dose measurements and depth-dose profiles obtained from alanine samples read at the NIST ESR facility agreed with the ITEP values to within  $\pm 5$  percent of the ITEP values for samples irradiated to 100 Gy with protons having an energy of 200 MeV. More recently measurements have been made with the Harvard Cyclotron. Accelerators at Loma Linda and in St. Petersburg will be included in the next round of measurements.

#### **LMR SENSITIVITY ENHANCEMENT LEADS TO OBSERVATIONS OF NEW SPECTRA**

A NIST scientist and a guest researcher recently have observed a number of "new" spectra of atomic and molecular species using a substantially improved laser magnetic resonance (LMR) spectro-

meter. LMR spectroscopy was invented in the late 1960s at the NIST Boulder laboratories, and there are now a number of LMR spectrometers in operation throughout the world. These systems have produced a steady stream of results, but the NIST enhancements of LMR sensitivity have resulted in a rapid succession of new observations of spectra from S, Si, Fe, Al,  $^{17}\text{O}$  in natural abundance, and  $^{16}\text{O}$  sub Doppler. Other measurements include the fine structure transitions in  $\text{N}^+$  and new ground state and metastable states in  $\text{OH}^+$ .

The three instrumental improvements providing for these new results were: an increase of the magnetic field modulation frequency from 13 to 40 kHz, an improvement in the laser pump efficiency at short wavelengths, and the addition of a new intra-laser-cavity microwave discharge to the sample region. The higher modulation frequency increases the instrumental sensitivity threefold; higher pump efficiency permits three to four times more laser lines to oscillate in the 40 to 100  $\mu\text{m}$  region, and the new microwave discharge cavity permits the formation of ions within the NIST far infrared LMR spectrometer for the first time.

The results represent a major advance in spectroscopy with potential applications in studies of important species in space and in the upper atmosphere.

#### **FERROELECTRIC OXIDE THIN FILMS FOR PHOTONICS**

Photonics, the interaction of light with matter, is the basis for the next generation of devices that use optical signals rather than electrical signals to transfer information. Such devices will be used in future telecommunications, optical computing, and image processing systems. Devices for switching and modulating optical signals require the development of new photonic materials. Work at NIST has focused on ferroelectric oxides, a class of materials which exhibit the strongest electro-optical responses of any material. A metallorganic chemical vapor deposition facility has been constructed for the fabrication of ferroelectric oxide thin films. Studies have focused on establishing the processing conditions for the ferroelectric oxide compound barium titanate ( $\text{BaTiO}_3$ ), and polycrystalline thin films of this material have now been produced. Structural, electrical, and electro-optical measurements on these films will establish the effect of defects on the properties that are critical to the performance of  $\text{BaTiO}_3$  thin films in future photonic devices.

### **NITROGENATED METAL ALLOYS VIA GAS ATOMIZATION**

Researchers at NIST recently have received a patent on use of gas atomization to produce nitrogenated metal alloys with improved properties. Discussions are under way with industry to exploit this result. The enhanced properties that nitrogen can bestow on steel by substituting for carbon have long been known. However, scientists at NIST have found that substantial additional benefits are realized when nitrogenated alloy powders are produced by atomization in nitrogen gas and bulk alloys then are formed by hot isostatic pressing. These benefits include repeatable-predictable nitrogen content, elimination of hollow spheres found in other gas atomized powders, microstructural refinement, and increased homogeneity. Also, the nitrogenated alloys produced at NIST have nearly twice the ultimate strength of comparable conventionally prepared alloys. Investigations performed for process prediction and control show that the nitrogen is absorbed mainly during alloy melting instead of by gas entrapment during atomization.

### **NIST RESEARCHERS DOCUMENT THERMAL AGING OF FOAM INSULATION**

NIST researchers have completed a 1 year study of rigid polyisocyanurate foam thermal insulation, documenting the decrease in insulating capability and change in other important properties due to exposure to elevated temperature and humidity. Foam blown insulation is used extensively throughout the building industry. It is widely acknowledged that the material ages in place and decreases in effectiveness with time. However, the extent of decrease is subject to debate and determining the "long-term thermal conductivity" to use for building design is somewhat arbitrary at present. The researchers exposed samples to five different combinations of elevated temperature and/or humidity and measured changes in thermal conductivity, mass, volume, and density at approximately 50 day intervals over the year. They determined three regimes of aging by correlating the changes in thermal conductivity with changes in density. This technique could be used in an accelerated aging test to characterize a production lot of foam over its lifetime. Additionally, by using Fourier transform infrared spectroscopy and measurements under a scanning electron microscope, they determined the mechanisms of change occurring within the foam.

### **NIST RECOMMENDS MOISTURE CONTROL MEASURES TO THE HOTEL-MOTEL INDUSTRY**

NIST researchers have used their simulation program MOIST to determine moisture control measures for buildings located in hot humid climates. Mold and mildew is a serious problem in buildings located in southern coastal areas. The American Hotel and Motel Association estimates that mold and mildew problems cost their industry \$68 million each year. During the summer, outdoor moisture enters the wall construction by diffusion and air infiltration. If the wallpaper offers a high water-vapor resistance, moisture accumulates behind it, resulting in pink and chartreuse splotches with mildew colonies emitting fungal spores which often cause unacceptable indoor air quality. Through yearly simulations in the southern coastal region, NIST found the mold and mildew problems could be avoided by specifying wallpaper with a minimum permeance, installing an exterior vapor barrier, installing an exterior air barrier, and not excessively cooling the interior space.

### **TEST SPECIFICATIONS FOR COBOL PUBLISHED**

NIST Special Publication 500-203, Conformance Test Specifications for COBOL Intrinsic Function Module, contains test specifications for the COBOL Intrinsic Functions Module of Federal Information Processing Standard (FIPS) 21-3, Programming Language COBOL (which adopts ANSI X3.23-1985 and Addendum ANSI X3.23A-1989). The document serves as a reference model and as a user's guide for the COBOL Intrinsic Function Module Tests in the 1985 COBOL Compiler Validation System. NIST tests COBOL implementations for conformance to FIPS 21-3 to provide language processor validations in support of federal procurement requirements. Validation services also are provided for the FIPS for Ada, C, FORTRAN, MUMPS, Pascal, and Structured Query Language.

### **PARALLEL PROCESSING RESEARCH ADVANCES**

NIST researchers used the novel technique of time-perturbation tuning (TPT) to evaluate and improve the performance of programs on multiple-instruction, multiple-data (MIMD) computer systems. TPT combines synthetic delays with statistically designed experiments (DEX) to yield an attractive new technique for MIMD program

improvement. TPT works on programs for both shared and distributed memory, and it scales well with increasing system size. Research results are contained in NISTIR 4859, Time Perturbation Tuning of MIMD Programs. The paper was presented at the Sixth International Conference on Modeling Techniques and Tools for Computer Performance Evaluation in Edinburgh, Scotland.

#### **NIST HOSTS COMPUTER SYSTEM SECURITY AND PRIVACY ADVISORY BOARD**

On Sept. 15–17, NIST hosted a 3 day meeting of the Computer System Security and Privacy Advisory Board (CSSPAB) to assist in conducting a National Cryptographic Review. In March 1992, the board recommended to the Secretary of Commerce that a review be held to examine the positive and negative implications of widespread use of public and private key cryptography. Under Secretary for Technology Robert White has asked NIST to conduct the review.

At the meeting, the CSSPAB focused on identifying the topics to be addressed in the review, including the mechanics for conducting the study; identification of potential participants and organizations; methods for NIST to gather economic impact data; issues that the review should seek to resolve; and methods to avoid disclosures harmful to national security interests.

#### **FEDERAL INFORMATION PROCESSING STANDARDS (FIPS) ACTIVITIES**

NIST has proposed the reaffirmation of FIPS 46-1, Data Encryption Standard (DES), for use by federal agencies for the next 5 years. Issued in 1977 and reaffirmed in 1983 and 1987, the DES provides an algorithm to be implemented in electronic hardware devices and used for the cryptographic protection of computer data. The purpose of the current review is to assess the continued adequacy of the standard to protect federal information resources.

Also proposed is a revision to FIPS 127-1, Database Language SQL, which would adopt the draft proposed American National Standard: Database Language SQL (dpANS X3.135–199X), expected to be approved as an American National Standard later in 1992. The proposed revision provides a substantial, upward-compatible enhancement of Database Language SQL at three levels of conformance.

Finally, NIST has proposed a new FIPS for Automated Password Generator. The proposed standard specifies an algorithm to automate the

generation of passwords for use in systems that require computer-generated pronounceable passwords. This proposed standard is for use in conjunction with FIPS 112, Password Usage Standard, which specifies basic security criteria for the design, implementation, and use of passwords.

#### **NIST ELECTROMIGRATION WORK SAVES INDUSTRY \$26.6 MILLION**

A consulting economist has completed an impact study of the work on electromigration conducted by NIST scientists. The economist has concluded that the NIST research produced past and future savings to the electronics industry of more than \$26.6 million. The cost of the research, spread over an 11 year period, was just over \$1.6 million. Electromigration is a significant failure mechanism threatening the implementation of advanced fine-geometry semiconductor integrated-circuit designs. It occurs as a result of high-current densities in the thin-film metallization lines on an integrated-circuit chip. Two major types of failure are possible: breaks in a conducting line that produce an open circuit and short circuits between closely spaced lines.

The impact study surveyed 10 companies, including six of the seven largest U.S. semiconductor manufacturers. Eight of the 10 companies responded to a written questionnaire, and follow-up telephone interviews were conducted with all 10 companies. The identified savings result from an increased confidence in characterizing metallizations, reduction in time necessary to resolve measurement discrepancies between vendors and users, more efficient research and development related to the metallization process, and improved control and yield in the production of integrated circuits.

#### **COMPANY PROMOTES SOFTWARE BASED ON NIST TESTING STRATEGIES APPROACH**

A private company is promoting a new software package that incorporates the testing strategies approach developed by NIST scientists for complex, multi-state components such as high-resolution data converters. Three major U.S. semiconductor manufacturers are already working with the private company to demonstrate the benefits of the NIST approach as applied to testing of their products through the use of the software. Complex semiconductor devices require extensive testing to confirm that all functions are working as designed. Modern high-speed automated test equipment is expensive, and a few seconds more test time per part may make it impractical for a manufacturer to market the part.

The use of the NIST approach significantly reduces the number of test points required for testing an individual part beyond the reductions from all-codes testing now achieved in industry. The result is less expensive testing with the same level of reliability. For example, for a 16 bit analog-to-digital converter, heuristic methods now applied by one semiconductor manufacturer reduce the number of codes so that the time required for testing is about 30 s, still too costly given the anticipated selling price of the part. Using the NIST-based software permits testing this part in 2 s, a fully acceptable figure. Depending on the device, the number of test codes required by the NIST approach can be reduced by factors of 64 and more over the reductions achieved by the current state of the art in testing.

#### **KERR-EFFECT DISPLAY SIMULATOR DEVELOPED**

NIST scientists have developed a model that can simulate how a video flat-panel display based on an electro-optical Kerr-effect pixel would present an image and implemented the model in a computer program for the Princeton Engine videocomputer. The input of the display simulator is any video image (for example, as obtained from commercial television); the output is image-processed to reflect the performance characteristics of the flat-panel display. Through the use of the Princeton Engine, the effects of a change entered by keyboard to the value of a variable parameter of the model are displayed on a television screen instantaneously, i.e., in real time. These parameters represent critical characteristics such as contrast, brightness, gray scale, and horizontal and vertical viewing angle. This real-time display permits comparison of the original video with the processed video side-by-side on the same monitor. In addition, the program can display a plot of the intensity transfer function associated with the electro-optical media, so that the effects of parameter changes on the intensity distribution can be monitored; this curve can be displayed separately or overlaid on the image. The Kerr-effect display simulator is serving as a developmental tool for future simulators of display technologies having more complex underlying physics or for which transfer functions may be obtainable only empirically. Under development is a model for a twisted nematic liquid-crystal display, used in displays for some lap-top computers and portable television sets.

#### **FINDING THE ELUSIVE EDGE OF AN X-RAY MASK LINE**

NIST scientists are developing methods for objectively and accurately measuring the width of sub-micrometer-wide lines on the masks used in x-ray lithography. The goal of the project is to obtain a high level of agreement between theoretical and experimental image profiles of actual lines on x-ray masks. Good agreement would confirm that the theoretically determined position of the edge in the image is, in fact, its actual position. The desired width of a line would then be the distance between its theoretically determined left and right edges. Agreement achieved so far between theoretical and experimental image profiles of lines is good enough to conclude that using the theoretically determined edge position will be an improvement over using a subjectively determined edge position. Further refinements of theory and experiment are expected to bring the results to agree within experimental error.

The widths of x-ray mask lines are typically measured by using a scanning electron microscope (SEM), but electron scattering causes the edges of features smaller than several tenths of a micrometer to appear indistinct in the SEM image, with the result that the accuracy of the measurement is compromised. One of the scientists is developing a theoretical model of image formation in the SEM using as a basis proven image-modeling methodology developed earlier at NIST with respect to an analogous optical diffraction problem in the optical microscope. He is combining this approach with a Monte Carlo model of electron scattering previously developed at NIST for x-ray microanalysis applications. The scientists have designed and constructed a unique laser-interferometer controlled stage and modified a conventional SEM so that it will operate in a more easily modeled transmission mode which can be used on x-ray masks.

#### **NOISE CANCELLATION IN UV/VISIBLE FOURIER TRANSFORM SPECTROSCOPY**

NIST scientists have demonstrated a tenfold improvement of the signal-to-noise ratio (SNR) in high-resolution UV/visible Fourier Transform (FT) spectra of an analytical Inductively-Coupled Plasma (ICP), normally used for spectrochemical analysis. This is the largest known experimental SNR enhancement in broadband UV/visible FT spectroscopy, a technique that is especially susceptible to additive or multiplicative noise in the

source. The noise cancellation technique utilizes a unique optical design to remove a substantial fraction of the multiplicative noise in the ICP, even if the noise is dependent upon the emitting frequency. The resulting increased dynamic range of the ICP/FTS combination is essential for an ongoing collaborative effort with another Laboratory. The goal of this effort is to issue a new ICP spectral atlas and to provide spectroscopic data for diagnostic studies of the ICP. The noise reduction technique should also be applicable to ground-based UV/visible FTS of stars and of practical combustion systems.

#### **ATOMIZATION CFD**

A NIST scientist recently has worked with the Supersonic Inert Gas Metal Atomization (SiGMA) Consortium to implement successfully an important example of technology transfer. The objective of the SiGMA project is to characterize and demonstrate control of this industrially attractive atomization process and to disseminate both the results and the technology involved to member companies. The consortium is run by NIST Office of Intelligent Processing of Materials.

The NIST scientist has developed and disseminated to interested consortium members a sequence of computational models to analyze the gas flow field critical to atomization productivity. The latest model uses computational fluid dynamics (CFD) to describe the flow field near the atomization die.

One member of the consortium reports that a 40 percent increase in their product yields is attributable to the gas flow improvements they have made through a combination of the CFD results and associated techniques obtained via their participation in this NIST project. Several years ago, the consortium member reported that a 40-percent improvement in product yield was considered to be the maximum possible that could be obtained using atomization.

#### **HOT-ELECTRON CASCADES IN COLD-SURFACE PHOTOCHEMISTRY**

An exciting new area of photochemistry, which could have potential applications within a broad spectrum of delicate surface fabrication processes, is being led by both experimental and theoretical studies at NIST. The new hot-electron (or excited-electron) surface photochemistry is based on a mechanism in which ultraviolet laser light is directed onto a surface or interface upon which a chemical bond-making or bond-breaking reaction is to occur.

According to recent theoretical modeling by a NIST scientist photon absorption by valence electron excitation of the substrate is followed by a cascade process in which a distribution of hot electrons is produced. These electrons in turn undergo ultrafast reactive charge-transfer scattering at the surface. The highly non-equilibrium distribution of products forms rapidly compared to the time scales required for thermal chemistry. This distinguishing characteristic of hot-electron photochemistry not only opens new possibilities for the formation of metastable products but also limits heating and the consequent thermal degradation of the material.

The present theory is adapted from a model of hot-hole-induced cascades first developed at NIST for tunneling spectroscopy and from a theory of inelastic resonance scattering used to explain a broad range of surface-related phenomena (including electron-molecule scattering, quantum well tunneling, and resonant desorption of atoms and ions from surfaces). The latest results were presented in an invited talk at the workshop, "Photo-Induced Processes at the Gas-Solid Interface," sponsored by the European Science Foundation.

#### **CITATIONS FOR ELECTRON MEAN FREE PATH PAPERS TOP 1000**

A knowledge of the distance a hot electron travels in a solid before making a collision and losing energy is of utmost importance in interpreting experimental data. The surface sensitivities of most spectroscopic techniques are strongly dependent upon the electron mean free path, and knowledge of the mean free path is critical for quantitative determination of elemental compositions of materials by Auger- and photoelectron spectroscopy.

Ideally, the mean free path as a function of electron energy for a given material should be determined by experiments. Unfortunately, such experiments are subject to large errors and relatively few have been carried out. There have been no systematic experimental studies that cover a wide range of electron energies and materials.

For more than a decade a NIST scientist has developed theoretical methods to calculate electron mean free paths with increasing accuracy. Calculations of electron mean free paths have been published for a wide variety of solids and compounds at many electron energies. This work constitutes the only comprehensive study of the electron mean free path in solids and is cited widely in the scientific literature: the number of citations recently exceeded 1000.

**THEORY OF “OPEN” QUANTUM COLLISIONS STIMULATES NEW EXPERIMENTS**

The quantitative description of the novel physics of ultracold collisions requires completely new collision theories to describe the dissipation introduced by excited state decay during the very long time scale of the collision. Ultracold collisions are prototypes of the general phenomena of “open” quantum collisions in which energy is exchanged with the environment of the colliding system. In this case, the environment is the vacuum of the radiation field, to which the excited state decays by spontaneous emission. A new optical Bloch equation methodology, developed by a NIST scientist and a foreign collaborator has been applied to associative ionization of Na atoms in magneto-optical traps and atomic beams at low temperature. The theory predicts the change of the associative ionization rate as the collision temperature and the laser detuning and intensity are varied. Good agreement is found with the results of recent experiments at the University of Maryland, which measured the associative ionization rate as a function of laser intensity both in a magneto-optical trap at 0.3 mK and in an atomic beam at 12 mK. This demonstrates that the new methods describing “open” collisions show promise for predicting the new collision dynamics.

**NIST TO CALIBRATE USDA NETWORK FOR MONITORING SOLAR ULTRAVIOLET**

The U.S. Department of Agriculture (USDA) is currently establishing a national solar ultraviolet (UV) measurement network. This network is primarily charged with radiometric measurements of the solar UV-B (280-320 nm) irradiance. Current stratospheric ozone models predict that, with a loss of ozone, the UV-B irradiance will increase substantially. Since UV-B radiation can cause skin cancer and cataracts in humans and is deleterious for plants, animals, and materials, this ozone loss scenario could have severe ecological, health, and economic costs. The accurate measurement of solar UV-B irradiance requires state-of-the-art radiometry. NIST will characterize each USDA network instrument and publish the results with a detailed uncertainty analysis. NIST will also carry out a detailed UV-B instrument intercomparison at the first network site. We also are hoping to include in this intercomparison UV-B reference instruments for the NSF Antarctica program, the EPA ozone monitoring program, and other international UV-B networks.

**MAGNETIC FLUX MAPPING IN HIGH-TEMPERATURE SUPERCONDUCTORS**

Magnetic flux distribution is critical to performance in all applications of superconducting components. Most existing techniques for measuring magnetization yield average properties of a specimen. The few flux mapping methods currently available have limited temperature ranges, poor resolution, or no capability to operate in an applied magnetic field. A new magneto-optical measurement technique for quantitative flux mapping has been set up at NIST which overcomes these limits. This was achieved through a collaborative effort with the inventors from the Institute for Solid State Physics (Russian Academy of Sciences). The specimen is contained in a miniature cryostat wherein temperature may be controlled dynamically from 5 K to room temperature during application of a variable magnetic field. The flux distribution at the surface of the superconductor is detected using a Bi-doped garnet film overlaid on the specimen. Field strength and direction are measured at a spatial resolution approaching 1  $\mu\text{m}$ . Direct, real-time observation of the flux distribution is achieved with a polarizing light optical microscope and a video recording system.

**NIST HANDBOOK 146 TRANSLATED INTO JAPANESE**

NIST's HAZARD I Fire Hazard Assessment Method software manuals (NIST Handbook 146) have been translated into Japanese by the Japanese Association of Fire Safety Science and Technology. The translation of this two-volume set was undertaken to allow easier utilization of HAZARD I in Japan for establishing the equivalency of unique building designs to the Building Standard Law of Japan (their national building code). Copies of the Japanese version of Handbook 146 will be made available within Japan by the association. A limited number of copies will be available from NIST for use by Japanese guest researchers and others who might be more comfortable with the Japanese text.

**NIST HOLDS WORKSHOP ON ELEVATOR USE DURING FIRES**

Throughout most of the world, warning signs next to elevators indicate they should not be used in fire situations. Today, elevators are not intended as means of fire egress and should not be used for fire evacuation. However, the idea of using elevators to

speed up fire evacuation and to evacuate persons with disabilities has gained considerable attention in the last few years.

A workshop on elevator use during fires was held at NIST Sept. 29. Participants included representatives of the elevator industry, building owners, fire protection engineers, and the fire service. The workshop consisted of presentations and an open discussion. A NIST scientist presented the results of a study about the feasibility and design considerations concerning elevator evacuation. Speakers presented the results of a human behavior study on elevator evacuation, and emphasized the associated training requirements and the organizational challenges. Industry concerns were also presented, indicating that the elevator code (ASME A17.1) currently allows elevators to be used for emergency evacuation of the disabled by the fire service or building employees.

During the open discussion, it was agreed that elevator evacuation is technically feasible. While many details must be worked out, it was agreed that the fire protection community should have the ability to use elevator fire evacuation as one of many tools (sprinklers, compartmentation, etc.) to protect life in new and remodeled buildings. Because elevator evacuation only for the disabled is much simpler than for the general population, it seems that the next logical step is an application of elevator evacuation for the disabled. Based on what is learned in this step, an application for the general population could follow.

#### **NIST AND THE U.S. NUCLEAR REGULATORY COMMISSION (NRC) COLLABORATE ON SOFTWARE QUALITY ASSURANCE FOR NUCLEAR APPLICATIONS**

Under an interagency agreement with the NRC, NIST examined the contents of a software quality assurance standard, ASMENQA2, written by the American Society of Mechanical Engineers specifically for the nuclear industry. NISTIR 4909, Software Quality Assurance: Documentation and Reviews, analyzes the applicability, content, and omissions of the standard and compares it with a general software quality assurance standard produced by the Institute of Electrical and Electronics Engineers. The report includes recommendations for the documentation of software systems and gives information for use in safety evaluation reviews. Many report recommendations are applicable for software quality assurance in general.

A related publication, NIST Special Publication 500-204, High Integrity Software Standards and

Guidelines, presents the results of a study of standards, draft standards, and guidelines that provide requirements for the assurance of software in safety systems in nuclear power plants. The study focused on identifying the attributes necessary in a standard to provide reasonable assurance for software in nuclear systems. The report concludes with recommendations for guidance for the assurance of high-integrity systems.

#### **NEW PUBLICATION ADDRESSES DATA MANAGEMENT REQUIREMENTS OF THE DEPARTMENT OF DEFENSE COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS) PROGRAM**

As part of their continuing support for the CALS initiative, NIST researchers have published NISTIR 4902, Database Language SQL: Integrator of CALS Data Repositories. Previous reports to CALS identified the importance of Database Language Structured Query Language (SQL) and its distributed processing counterpart, Remote Database Access, for their ability to address a significant portion of CALS data management requirements. The new report presents the new "Object SQL" facilities proposed for inclusion in SQL3, introduces SQL abstract data types (ADTs), and discusses the benefits of "generic ADT packages" for management of application-specific objects. The document also proposes a new external repository interface that would allow integration of heterogeneous, non-SQL data repositories.

#### **NIST DEVELOPS SCORING PACKAGE FOR OPTICAL CHARACTER RECOGNITION TECHNOLOGY**

NISTIR 4950, NIST Scoring Package User's Guide, Release 1.0, assists users of optical character recognition technology in evaluating and selecting the commercially available product best suited to their requirements. Application requirements germane to a specific automated character recognition problem are embodied in a representative set of referenced images. Along with image data, a referenced image has associated with it the ASCII textual information to be recognized in the image. This reference information serves as ground truth for measuring recognition performance. Images are presented to a recognition system, results are returned, and the scoring package reconciles hypothesized text with the referenced text. Accumulated statistics measure computer performance.

## PROGRAMS FOR NEURAL NETWORK CALCULATIONS

Software developed by NIST will enhance the efficiency, and thus the feasibility, of industrially important systems based on neural network computations. Neural networks are an active area of research and development for numerous applications, particularly for automatic character recognition systems. For example, at least a dozen U.S. companies, several companies in Europe, and other research groups are developing optical character recognition systems for deciphering handwritten characters. The time-consuming task of "training" the neural networks has for some years been done by a method known as backpropagation. Mathematically, "training" corresponds to minimizing an error function. Backpropagation is known to be a slow method, and better methods (such as conjugate gradient methods) have been known for years, but backpropagation continues to be used.

A NIST scientist has written an easy-to-use training program using conjugate gradients, which runs from 10 to 100 times faster than backpropagation. He has made the program available to users via electronic mail. To date, over 50 copies have been distributed to users in universities, government, and industry in the United States and 11 foreign countries.

Members of the image recognition group, have used his training program as part of a state-of-the-art recognition system that correctly recognizes over 96 percent of handwritten digits.

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## Standard Reference Materials

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### NEW STANDARD SHINES FOR PRECIOUS METALS INDUSTRY

A recently created NIST standard for the precious metal rhodium will help mineral processors avoid million-dollar measurement errors and, at the same time, help the auto industry meet stringent Clean Air Act requirements. Working in collaboration with private industry, NIST scientists have prepared a rhodium solution standard. Rhodium, a silvery white metal, is used along with platinum and palladium in automobile catalytic converters. Rhodium catalyzes the conversion of nitrogen-oxide emissions to harmless nitrogen gas. Metal reclaimers had requested that NIST create a Standard Reference Material for rhodium to help

eliminate collective measurement errors amounting to \$50 million on the world market. An accurate rhodium standard also will ensure that catalytic converters contain the proper amount of the metal. The NIST rhodium Standard Reference Material (SRM 3144) will be available in early 1993 from NIST's Standard Reference Materials Program, Room 204, Building 202, Gaithersburg, MD 20899, (301) 975-6776, fax: (301) 948-3730.

**STANDARD REFERENCE MATERIAL 2724—SULFUR IN DISTILLATE (DIESEL) FUEL OIL** EPA proposal (54 FR 35276, Aug. 24, 1989) requires refiners to reduce the sulfur content of on-highway diesel fuel from current average levels of approximately 0.25 weight percent to levels not exceeding 0.05 weight percent, effective Oct. 1, 1993. Standard Reference Material (SRM) 2724 was developed to help industry and the U.S. government implement this new national program of diesel fuel quality control. It is intended primarily for use in the determination of total sulfur in diesel fuels or material of similar matrix. SRM 2724 will allow industrial laboratories to evaluate their test methods and calibrate their equipment that will be used to verify the compliance requirements of their products almost a year in advance of the effective date of the ruling.

SRM 2724 is a commercial "No. 2-D" distillate fuel oil as defined by the American Society for Testing and Materials. It consists of 100 mL of diesel fuel oil; the certified sulfur content is  $(0.0425 \pm 0.0004)$  weight percent. This value is based on NIST's most accurate method for the determination of sulfur, isotope dilution thermal ionization mass spectrometry. In addition to the certified sulfur content, supplemental physical property data are provided to enable the analyst to better match the matrix of the SRM to that of the sample being analyzed.

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## Standard Reference Data

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### NIST STRUCTURAL CERAMICS DATABASE UPDATED

Standard Reference Database 30 contains state-of-the-art materials property data for both research and commercial grades of silicon carbides and silicon nitrides. This new version updates the documentation of data sources through 1991 and adds new mechanical and corrosion properties. Silicon



carbides and silicon nitrides are primary candidates for the manufacture of heat exchangers, ceramic engine components, sensors, and cutting tools because of their high strength, dimensional stability, chemical inertness, and wear resistance.

#### **NIST THERMOPHYSICAL PROPERTIES OF PURE FLUIDS UPDATED**

Standard Reference Database 12 is a major update of Interactive FORTRAN Programs to Calculate Thermo-physical Properties of Fluids—MIPROPS. This new update computes thermophysical properties according to the extremely accurate and wide-ranging NIST standard reference equation of state correlations to cover the range from the triple point to the critical point. Properties at the desired state points or tabular information, in the form of isochores, isobars, isotherms, and isentropes, may be displayed and saved in a file for further use. The five new fluids included in this upgrade are carbon dioxide, carbon monoxide, deuterium, normal hydrogen, and xenon. The number of thermophysical properties now has been increased to 34. This database has generated great interest in the cryogenic, aerospace, and bulk chemicals industries.