

# 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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### FEDERAL LABS JOIN FORCES TO HELP U.S. INDUSTRY

NIST and Sandia National Laboratories in Albuquerque, NM, have signed an agreement that will combine their technological resources to help boost the competitiveness of U.S. companies in world markets. Covering microelectronics, advanced manufacturing, materials and standards, the agreement will be driven by industrial needs and build on the success of existing programs at the two laboratories. Initially, NIST and Sandia will concentrate on microelectronics research and target efforts at improving the quality of U.S. semiconductor products. The first joint projects under this agreement will be in semiconductor packaging and manufacturing process control. In packaging, NIST and Sandia have special facilities for resolving obstacles, such as the production of test chips, which allow producers to gauge chip and packaging performance.

### BRIDGE BUILDER GETS HELPING "HAND" FROM ROBOCRANE

Under terms of a new cooperative research and development agreement, a private company plans to use NIST's novel robot crane technology to install temporary bridges over beaches or wetlands. The CRADA partners initially will develop a prototype system for integrating NIST's RoboCrane and the company's Modular Bridging System (MBS). RoboCrane, a device that can lift more than five times its own weight and precisely maneuver loads

over a large working volume, will be able to install the MBS more rapidly than conventional manual techniques. The MBS also may permit traffic to flow over construction sites while road work proceeds underneath it. Long-range CRADA objectives call for expanding the integrated system for general bridge and road construction/repair jobs, military transport over obstacles, hazardous material handling, and lunar and other space construction. For more information, contact James S. Albus, Robot Systems Division, B124 Metrology Building, Gaithersburg, MD 20899-0001, (301) 975-3418.

### NIST/U.S.&FCS JOINT EFFORT TACKLES EXPORT CONCERNS

In recognition of mutual objectives in promoting export of goods and services from the United States, NIST and the U.S. and Foreign Commercial Service (FCS), a unit of the Commerce Department's International Trade Administration, have agreed to work together to achieve common goals concerning standards and exports. A recent memorandum covers formal and working relationships between the agencies for assignment of NIST employees as standards experts to selected U.S. embassies and missions. Under its Standards Assistance Program, NIST works to facilitate exports by encouraging harmonization of foreign and U.S. standards and conformity assessment practices at key locations. NIST currently is furnishing support for U.S. standards advisors to the Saudi Arabian Standards Organization and the U.S. Mission to the European Community. Through its Office of Standards Services, NIST assists industry and the federal agencies in efforts to improve the acceptance of U.S. technology and manufacturing practices, and to promote more effective U.S. contributions to international standardization, conformity assessment, quality assurance, and testing.

**INITIAL GRANTEES SAY ATP MAKES A DIFFERENCE**

An early study of the short-term effects generated by NIST's Advanced Technology Program suggests that, as intended, the ATP fosters promising lines of research that otherwise would have fallen to budgetary decisions, and improves industrial co-operation. According to the consulting firm that surveyed the 11 companies awarded grants in the ATP's first competition in 1991, the ATP also enhanced the credibility of the grantees in the marketplace. Difficulty in forming and operating a research consortium under the federal government's strict financial rules was among the few problems noted by survey respondents. The ATP makes awards to private companies and industry-led cooperative ventures to support research on promising but high-risk technologies. To obtain a single copy of the 30-page study, *The Advanced Technology Program, An Assessment of Short-Term Impacts: First Competition Participants*, contact ATP office.

**NEW GUIDE CAN HELP STATES BUILD A QUALITY AWARD**

Getting the commitment of state leaders, including the governor, should be one of the first steps in creating a successful state quality award program, recommends a new guide developed for NIST by the National Governors' Association. Several states and cities already have established quality awards, with many using the Malcolm Baldrige National Quality Award as a model. These awards are used not only as an economic development tool but also to encourage private industry, schools, and state and local governments to use quality management to improve the way they do business. Recognizing this fact, NIST commissioned the new guide to outline questions and issues raised in establishing an award program. Included are areas such as developing a core group of experts to help guide the effort, setting up criteria and the application and evaluation processes, establishing fees and securing funding. *Designing and Implementing a State Quality Award Program* (NIST GCR 92-620) is available from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650, for \$19.50. Order by PB 93-154458.

**NEW DIRECTORY ACCESSES OVER 900 TESTING LABS**

Laboratory accreditation is growing in importance as industry and government establish or enhance

their efforts to improve the quality of testing and calibration services. The National Voluntary Laboratory Accreditation Program 1993 Directory lists more than 900 domestic and foreign laboratories accredited by the NIST NVLAP program for specific test methods as of January 1993. The current fields of testing are acoustical, asbestos fiber analysis, carpet, commercial products (paint, paper, plastics, plumbing, and seals and sealants), computer applications, construction materials, electromagnetic compatibility and telecommunications, ionizing radiation dosimetry, solid fuel room heaters and thermal insulation. The labs are listed alphabetically, by field of testing and by state. For a copy of NIST SP 810, send a self-addressed mailing label to NVLAP, Rm. A162, Building 411, NIST, Gaithersburg, MD 20899-0001, (301) 975-4016, fax: (301) 926-2884.

**TWO AGENCIES JOIN FORCES, COORDINATE RESEARCH**

Both NIST and the National Science Foundation have long histories of supporting and conducting a variety of research programs. NIST's work is primarily directed toward industrial outreach, and NSF's activities are geared to academia. A new agreement between the two agencies links NSF and NIST in order to transfer basic technology discoveries from academic laboratories to the marketplace. The agreement will coordinate research common to the two agencies in four areas: advanced materials and processing; manufacturing technology; chemical science and engineering, including biotechnology; and high-performance computing and communications. The joint agreement is geared to help key industrial sectors of the U.S. economy. For example, chemists and chemical engineers account for 51 percent of the U.S. workforce in research and development. NIST and NSF programs in chemical sciences such as biotechnology, materials processing, health care, energy and petroleum refining can help enhance the competitive position of these industries in world markets.

**U.S., SAUDI ARABIA TO CONTINUE STANDARDS WORK**

A formal memorandum of understanding was signed March 19, 1993, between NIST and the Saudi Arabian Standards Organization to continue technical cooperation and standards development activities. The agreement, which recognizes the importance of the SASO in business relations between the United States and Saudi Arabia, also reflects the significance to the SASO of obtaining

continued U.S. technical assistance. The MOU formalizes cooperative linkages with U.S. private-sector and government technical experts. Saudi Arabia is the leading member of the Gulf Cooperation Council Standardization and Metrology Organization. Other members are Bahrain, Kuwait, Oman, Qatar and the United Arab Emirates. SASO technical standards are generally adopted by the other members of the GCC. These countries represent a market potential for U.S. manufacturers estimated to be more than \$7 billion annually. The MOU officially acknowledges NIST's successful pilot program, initiated in 1990, for providing technical assistance to countries that desire standards on domestic products compatible with those in the United States.

#### **PARTNERS WORK TO PROVIDE CORROSION INFORMATION**

Since 1982, researchers from the National Association of Corrosion Engineers and NIST have been working to minimize corrosion's negative impact on U.S. industry, as well as on the safety of structures and facilities. Together, the two organizations are developing a series of personal computer software modules that provide rapid access to reliable information on the performance of engineering materials in corrosive environments. These expert systems contain "critically evaluated" scientific data for the design of industrial plants, pipelines, petrochemical facilities, structures, equipment and other products susceptible to the effects of corrosion. With user-friendly software, the PC modules cover the spectrum from classic databases to true "expert systems" that mimic a consultant. For information on the corrosion program, contact Richard Ricker, B254 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6023. For a listing of NACE/NIST products, contact NACE, P.O. Box 218340, Houston, TX 77218, (713) 492-0535, fax: (713) 492-8254.

#### **KEEP COMPUTERS "ON-TIME" WITH NEW SERVICE**

NIST and the University of Colorado at Boulder, CO, have jointly announced a new service for computer users that allows them to obtain precise time from an international computer network. Any computer connected to the Internet network can utilize the Network Time Service without additional charges or fees. Time information is traceable directly to the NIST primary clock system. Users can access the host computer in Boulder using sev-

eral protocols, including the Network Time Protocol or the simpler "daytime" protocol (that provides complete timing information, including advance notice of leap seconds and Daylight Savings Time/Standard Time transitions). For information about the Network Time Service or instructions for its use, leave an electronic mail message at `TIME@TIME_A.TIMEFREQ.BLDRDOC.GOV` or write to NTS, Div. 847, NIST, Boulder, CO 80303-3328.

#### **1993 BALDRIGE AWARD APPLICATIONS TOTAL 76**

Seventy-six U.S. companies are in the running for a 1993 Malcolm Baldrige National Quality Award. They include 32 manufacturing firms, 13 service companies and 31 small businesses. Last year, 90 companies applied and five won. The award program was established in 1987 to recognize the quality achievements of U.S. companies and also to promote national awareness about the importance of improving quality management. The award program has helped stimulate a grassroots effort throughout the United States, and the world, to improve quality in many organizations. Many state, local, trade association and international quality award programs are modeled after the Baldrige Award. Firms applying for the 1993 award must provide details on their quality management system citing achievements and improvements in seven areas. Applications are evaluated by an independent NIST-appointed board. Announcement of the 1993 winners and an award ceremony will take place later in the fall. The award program is managed by NIST with the active involvement of the private sector.

#### **PREFERRED METRIC UNITS LISTED IN NEW STANDARD**

Government and industry officials concerned with metric usage in grants, contracts and other business-related activities of federal agencies will be interested in Federal Standard 376B, Preferred Metric Units for General Use by the Federal Government. The standard was approved by the 40 federal agencies that make up the Metrication Operating Committee. It was developed by the Standards and Metric Practices Subcommittee. Both groups operate under the Interagency Council on Metric Policy. The 376B standard is a revised and improved version of a 1983 standard, 376A. The new standard lists metric units recommended for use throughout the federal government and is

specified in the Federal Standardization Handbook issued by the General Services Administration. GSA has authorized the use of the standard by all federal agencies. Copies of 376B are available from GSA, Specifications Section (3FBP-W), Suite 8100, 470 L'Enfant Plaza SW, Washington, DC 20407, (202) 755-0325.

#### **MORE QUESTIONS, MORE ANSWERS:**

##### **ISO 9000**

Exporters, manufacturers, testing labs and others concerned about quality, quality systems and registration will find answers to previously unaddressed questions on the ISO 9000 standards and related issues in a new NIST report. *More Questions and Answers on the ISO 9000 Standard Series and Related Issues* (NISTIR 5122) is a sequel to a widely distributed report on quality standards (NISTIR 4721). Special attention is given to ISO-9000-related events within the European Community that might affect U.S. trade. Information is provided on the EC conformity assessment scheme, quality system registration/approval, and the distinction between quality system certification and quality system registration. Also described is the federal government's use of ISO 9000, how to select a quality system registrar, and the accreditation programs of the Registrar Accreditation Board (an American Society for Quality Control affiliate) and other foreign accreditation bodies. Copies of NISTIR 5122 are not available from NIST. It may be obtained for \$19.50 prepaid from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650. Order by PB 93-140689.

#### **NEW CLOCK IS "ONE IN A MILLION" FOR ACCURACY**

NIST-7, an atomic clock that will neither gain nor lose a second in 1 million years, recently debuted at NIST's Boulder, CO, laboratory. When fully evaluated in a year, it is expected to show an accuracy of one second in 3 million years—making NIST-7 the world's most accurate clock. Who needs such accuracy? Examples of atomic clock time users are NASA (for guiding deep space probes), the Department of Defense (for operating a satellite-based navigation network), the investment banking firm Salomon Brothers (for time stamping international financial transactions) and California's Los Angeles County (for timing traffic signals). NIST-7 is the seventh generation of atomic clocks built by

NIST (and its predecessor, the National Bureau of Standards) since 1949, and replaces NBS-6, which was accurate to one second in 300000 years. While both clocks measure time by counting the vibrations of a beam of cesium-133 atoms (one second elapses after 9192631770 vibrations), NIST-7 uses lasers rather than magnetic fields to better manipulate the beam and increase the clock's accuracy.

#### **TRAPPING ATOMS MAY "CAPTURE" TIME IN LESS SPACE**

A new cooperative research and development agreement between NIST and a private company seeks to develop advanced atomic clocks that use super-cold cesium atoms to measure time. The collaborators hope that the new timekeepers will provide private industry with a field standard comparable to current national laboratory standards. Traditional atomic clocks measure time by counting vibrations of cesium atoms streaming through a tube at speeds of around 200 m/s. For the advanced clocks, NIST physicists are slowing these atoms to about 1 cm/s by laser cooling them to very near absolute zero. NIST and the private company plan to design clocks that will be much smaller than those currently keeping the international time standard, yet potentially just as accurate.

#### **"CLIPPER CHIP" OFFERS ADDED COMMUNICATIONS PRIVACY**

The White House has announced a voluntary program for use of a new technology that improves the security and privacy of telephone communications while meeting law enforcement needs. Developed by the National Security Agency with NIST assistance, the state-of-the-art "Clipper Chip" can be used in new, relatively inexpensive encryption devices that can be attached to telephones. The microcircuit scrambles communications using a powerful encryption algorithm. Each device containing the chip will have two unique "keys" that must both be used to decode messages. "Key escrow" agents will retain the keys and provide access only to government officials with legal authorization to conduct a wiretap. Companies and individuals will gain protection for proprietary and private information, while law enforcement agencies still will be able to intercept lawfully the phone conversations of criminals. NIST is working on a standard to facilitate federal government procurement and use of the "Clipper Chip."

**GO WITH THE FLOW: IMPROVING GAS MEASUREMENTS**

Gas measurement facilities that calibrate devices for regulating gas flow during the manufacture of semiconductors and other products now can have their accuracy assessed by a new NIST service. Tests of facilities can be conducted using a new gas flow measurement artifact designed by NIST and SEMATECH. A tandem arrangement of two flow meters in a portable case, the artifact serves as a transfer standard to link the gas flow measurement capabilities of laboratories to national standards. NIST personnel will conduct on-site evaluations of gas measurement facilities on a cost-recovery basis. Data produced can be analyzed graphically to document both the imprecision uncertainties of the tested laboratory and an estimate of its systematic error for the tested conditions. For more information or to schedule a test session, contact George E. Mattingly, Fluid Mechanics Building, Room 105, NIST, Gaithersburg, MD 20899-0001, (301) 975-5939, E-mail: gem@micf.nist.gov, fax: (301) 258-9201.

**CATALOG HELPS USERS BUILD ISDN SOLUTIONS**

The ISDN, or Integrated Services Digital Network, is a telecommunications technology that makes it possible to send and receive voice, data and pictures simultaneously over telephone lines. However, many potential ISDN users are confused about how the technology can be applied and what type of equipment is needed. A new catalog describing over 30 ISDN applications should help clear up much of the confusion. Each application lists the type of equipment and services the user needs to build the application. More than 120 products from 60 suppliers are described. The catalog was developed by the North American ISDN Users' Forum. In 1988, NIST organized NIUF with industry to help users and manufacturers agree on ISDN applications, relevant standards, and options and conformance tests. The catalog focuses on applications identified as high priority by NIUF members. A Catalog of National ISDN Solutions for Selected NIUF Applications is available for \$44.50 prepaid from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650. Order by PB 93-162881.

**U.S./RUSSIAN STANDARDS GROUP REPORT AVAILABLE**

The Proceedings of the Second Meeting of the Intergovernmental U.S./Russian Business Development Committee's Standards Working Group, March 23-24, 1993 (NISTIR 5166) reports on the exchange of information regarding standards and conformity assessment practices of each country, and an understanding of new standards-related legislative initiatives within Russia. Of particular significance at the meeting was the signing of an MOU for cooperation on standards, certification, testing and metrology between the United States (NIST) and Russia (GOSSTANDART). The Department of Commerce used this opportunity to make the first public announcement of a new initiative to provide financial support to Russians desiring to learn more about U.S. standardization practices within industrial and commercial enterprises. Copies of NISTIR 5166 are available for \$36.50 prepaid from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650. Order by PB 93-179968.

**CRADA MILESTONE MARKED; FY92 COUNT EQUALED**

Last month, NIST entered into its 300th cooperative research and development agreement since the CRADA mechanism was established by Congress in 1988. The agreement, with the South Carolina Research Authority of North Charleston, SC, calls for the partners to establish and operate a testbed facility for the manufacture of electrical products designed in conformance to STEP (STandard for Exchange of Product model data). STEP is the U.S.-led drive to create a universal system for exchanging information on a product's design, manufacture, and support. A new monthly record for CRADA signings was set in April when NIST entered into 20 agreements. This brought the total number of CRADAs (through April 30, 1993) to 316, and for the first 7 months of fiscal year 1993 to 82. The latter figure equals the entire CRADA count for the previous fiscal year. For information on establishing a CRADA partnership with NIST, contact Bruce E. Mattson, B256 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3084.

**NEW REFERENCE "MEASURES UP" FOR ELECTRONICS**

Measurement capability for the electronics industry is critical to research and development, manufacturing, marketplace entry, and after-sales support functions. It affects the performance, quality, reliability, and cost of products. A new NIST publication, *Measurements for Competitiveness in Electronics* (NISTIR 4583), identifies those currently unmet measurement needs most critical for the U.S. electronics industry to compete successfully worldwide. Nine fields of electronics are covered: semiconductors, magnetics, superconductors, microwaves, lasers, optical-fiber communications, optical-fiber sensors, video, and electromagnetic compatibility. Each field's section contains a technology review, an overview of economic importance to the world market, a look at U.S. industry goals for competing internationally, and a discussion of measurements needed to meet those goals. Examinations of the importance of measurements in competitiveness, NIST's role in measurements and the U.S. electronics industry as a whole also are included. NISTIR 4583 is available for \$52 (print) and \$19.50 (microfiche) prepaid from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650. Order by PB 93-160588.

**BIBLIOGRAPHIES LIST WHAT'S NEW IN NIST EM STUDIES**

Persons interested in NIST electromagnetics research can now obtain two bibliographies that list publications by the institute's EM scientists in Boulder, CO, from 1970 to the present. A Bibliography of the NIST Electromagnetic Fields Division Publications (NISTIR 3993) covers antennas, dielectric measurements, electromagnetic interference, microwave metrology, noise, remote sensing, time domain and waveform metrology. The second reference, *Metrology for Electromagnetic Technology: A Bibliography of NIST Publications* (NISTIR 3994) covers optical electronic metrology, cryoelectronic metrology, and superconductor and magnetic measurement. Copies of these bibliographies may be ordered from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650. NISTIR 3993 is available for \$27 (print) and \$12.50 (microfiche) prepaid; order by PB 92-116367. NISTIR 3994 is available for \$19.50 (print) and \$9 (microfiche); order by PB 92-116375.

**NATIONAL CONFERENCE ON WEIGHTS AND MEASURES HOLDS "INTERIM MEETING"**

The National Conference on Weights and Measures held its "Interim Meeting" at the Bethesda Hyatt Jan. 10-14. Technical committees met concurrently throughout the week to develop legal metrology standards and manage other study programs, many of which will be recommended to the conference in July 1993, at its 78th Annual Meeting in Kansas City, MO. The Specifications and Tolerances Committee will recommend that the conference should permit custody transfer (controlling \$1.6 trillion revenue metric ton-km) of individual railroad cars by means of coupled-in-motion weighing technology, and that electronic audit trails, already permitted, should meet minimum standards of protection and provide increasing amounts of information, depending upon how much metrological control is accessible remotely.

The Laws and Regulations Committee met with representatives of the Food and Drug Administration, Federal Trade Commission, the U.S. Department of Agriculture, and more than 200 trade associations and packagers to implement new requirements and coordinate manufacturing and other interests for labeling all consumer and non-consumer packages in metric units of measure by 1994.

Both the Specifications and Tolerances and Laws and Regulations Committees resolved measurement and method of sale issues for the retail sale of compressed natural gas as a motor fuel. The Education, Administration, and Consumer Affairs Committee concluded review of a training module on general legal metrology administration. The Liaison Committee concluded management and development of a new consumer pamphlet that will be available in February from the Consumer Information Center in Pueblo, CO. Several representatives of the executive committee met with staff of Congressmen to discuss the importance of state and local weights and measures agencies as the infrastructure of the marketplace, to provide measurement traceability to local and international business concerns through their weights and measures laboratories, and to maintain a fair marketplace for honest business.

**COLLABORATION WITH INDUSTRIAL PARTNER EXTENDED FOR ANOTHER YEAR**

The cooperative research and development agreement between a major U.S. roller bearing manufacturer, and NIST recently was extended for another

year. The original agreement was signed last year to carry out research in spindle characterization for implementation of hard-turning applications. Hard turning is referred to single point turning of materials harder than 55 R<sub>c</sub> such as tool steels and bearing steels. Precision turning of hard materials is a critical and potentially cost-effective technology, especially for small-batch production, because it eliminates costly grinding setups or multiple heat treatment processes to obtain proper hardness after cutting. Under last year's agreement, the manufacturer has loaned a state-of-the-art roller bearing spindle to be characterized. Under this year's agreement, the company will upgrade this spindle and send a researcher for a period of 6 mo to work with NIST researchers to evaluate the new spindle for hard-turning applications.

#### **NIST HELPS KICK OFF THE NGIS PROGRAM**

On Nov. 5, NIST hosted the kickoff meeting marking the beginning of the Next Generation Inspection System (NGIS) program. NGIS is a development effort by a consortium of U.S. companies and NIST whose goal is to improve current manufacturing inspection methods and demonstrate practical results. NGIS is administered by the National Center for Manufacturing Sciences.

The next generation of inspection systems will contribute to higher quality products and reduced manufacturing costs through faster inspection, inspection of complex surfaces, better integration of computer-based inspection systems into the factory through use of part models for inspection programming and results analysis, data formats for inspection results, and provision of feedback of inspection results to manufacturing processes.

NIST's contribution to the program centers around a testbed that supports experiments in developing advanced systems and techniques for manufacturing inspection. A goal is to improve on current part inspection that uses touch-trigger probes. Testbed facilities include a coordinate measuring machine, sensor systems developed by industry, sensor systems developed at NIST, control systems, and computer hardware and software.

Projects that will use this testbed include: development of advanced sensor systems, such as vision and laser probes; integration of multiple sensor systems; development of advanced data analysis systems; and development of a NIST hierarchical control system for inspection tasks.

#### **CIM STANDARDS FOR APPAREL INDUSTRY**

The Apparel Product Data Exchange Standard (APDES) Project Team at NIST published two reports entitled, "Report on Scoping the Apparel Manufacturing Enterprise" and "A Prototype Application Protocol for Ready-to-Wear Pattern Making." The first report identifies a set of manufacturing data interfaces that could be standardized for the effective computer integration of the information required to operate an apparel manufacturing enterprise. The second report describes an information model for ready-to-wear pattern making, one of the manufacturing data interfaces defined in the first report, along with its testing procedures.

The Defense Logistics Agency (DLA) is sponsoring the NIST project to extend the emerging international Standard for the Exchange of Product Model Data (STEP) to include apparel product data. This work is part of a larger DLA program to improve apparel manufacturing technology. These extensions will lay the groundwork for computer integration of the apparel product life cycle, and it will enable clothing manufacturers to reap the benefits of standardized product data representation. NIST is working with the American Apparel Manufacturers Association, the Fashion Institute of Technology, and several other organizations and companies to develop official STEP standards for apparel. These reports will serve as input for developing such standards.

#### **LIQUID-HYDROGEN COLD NEUTRON SOURCE MODELED BY NIST RESEARCHERS**

A novel design has been developed for a new, second-generation cold neutron source to be installed in the NIST Research Reactor as part of the Cold Neutron Research Facility (CNRF). The new source is an essential element in the successful completion of the CNRF, which is a major national resource. The design, developed at NIST uses a spherical cavity with an annular blanket of liquid hydrogen to moderate the neutrons and deliver the cold neutron beam through an aperture. It is preferable to have no moving parts in the hydrogen system and to remove any heat generated using natural circulation. Of prime importance is the stability of the fluid cooling system and the ability to maintain a minimum overall hydrogen density.

To verify the design, a full-scale engineering simulation was constructed and tested at NIST. The

engineering simulation was realized by building a glass model of the moderator cavity whose mass could be determined by direct weighing, with liquid hydrogen circulating under design heat-loads. In addition, a NIST scientist developed a numerical model of the complete fluid circulation system to permit exploration of operating parameter space. These tests and the numerical model confirmed the basic soundness of the design, identified areas that could be improved, established the heat load that could be handled, and led to further insights regarding the fluid circulation and the relationship between vapor-void fraction and heat load. As a result, full-scale construction of the actual source is now under way, with full confidence that the system will meet all requirements.

#### **LASER-ENHANCED-IONIZATION SPECTROSCOPY USING DIODE LASERS**

NIST scientists have used diode lasers to detect trace impurities by laser-enhanced ionization in flames. In one experiment they demonstrated a detection sensitivity of 300 ppt (parts/trillion) of rubidium in water. Their first experiments were performed on rubidium and cesium since the spectral lines for these could be reached easily with readily available diode lasers.

The results demonstrate a promise for diode lasers in analytical chemistry. There are many other optical methods that would be applied in chemical analysis if the lasers required were not as cumbersome and expensive as conventional lasers (e.g., dye lasers). The simplicity, low cost, and small size of the diode lasers make them attractive for such analytical applications. However, in some cases it will be important to reduce the natural linewidth, and it is important to extend the frequency coverage, particularly to the blue/green region where many important chemical lines are found.

The very simple experimental system consists of an atmospheric-pressure, air-hydrogen (or acetylene) flame and water samples that contain the atoms of interest at low concentrations. The water samples are aspirated into the flame where the diode laser excites the atoms, which are then ionized by the flame. The ionization is detected by the increased flame conductivity using probe electrodes.

#### **TRANSFER OF ARC WELDING TECHNOLOGY**

A private company has signed a second cooperative research and development agreement (CRADA) with NIST. In the previous CRADA, NIST's weld sensing technology was evaluated for its ability to monitor the weld quality of the company's production lines. It was found that the NIST weld sensors could improve the detection of welding problems when evaluated with the electrodes/shielding gas combination used in production. As a result of the success of the first CRADA, the company plans to use the NIST technology in both production and research applications.

In the second CRADA, NIST will help the company implement this technology and the company will evaluate the NIST technology under high-volume production conditions. The private company has decided to replicate the entire NIST weld sensing capability (the sensing systems as well as special calibration equipment) in its welding research laboratory, with equipment selection advice from NIST. This in-house capability will permit new applications to be developed and improve the technology transfer between NIST and the company. NIST also will assist with the interpretation of the production data, using the sensing strategies and algorithms evaluated under the first CRADA.

#### **MOISTURE PROFILES NEAR A DIELECTRIC/SILICON INTERFACE**

Scientists at NIST made the first definitive measurements of the moisture profile in a dielectric film deposited on a silicon substrate. The sample, a polyimide resin (PI) used in electronic packaging, was supplied by a private company as part of a cooperative program begun under a recent CRADA. The observed high concentration of moisture in the polymer adjacent to a solid interface had long been postulated to explain various moisture-related problems encountered in composites, protective coatings, and electronic packagings. However, despite the importance of this effect, there was no direct evidence prior to these measurements.

The measurements were made using a neutron reflectivity (NR) technique developed at NIST. A significant difference in the NR results was



observed between a dry sample and one exposed to deuterated water vapor. This difference can be accounted for by the presence of a moisture rich layer about 25 Å thick near the PI/silicon interface in the wet sample. The water content within this thin layer reached 16 percent by volume as compared to the bulk saturation level in PI of 2.4 percent. The work here not only provides the first direct evidence but also permits quantification of the effect.

#### **EXPANDED RESEARCH WORK ON SUBSTITUTED DERIVATIVES OF THE 123 SUPERCONDUCTOR**

Much recent materials research worldwide on high-temperature superconductivity is focused on the effect of different parts of the structure of 123-type superconductors on the electric properties of these materials. Substitution compounds in which the Y, Ba, chain Cu, and plane Cu atoms are replaced selectively by impurity metal atoms of different species are being intensely studied. A critical component of these efforts is the determination of atomic arrangements with high precision in order to establish correlations between selected bond distances and values of the critical temperature  $T_c$ , and the superconducting properties. An expanded program of research in this field is under way at NIST in collaboration with private industry and the National Center for Scientific Research (Grenoble, France). A visiting scientist from France is supported jointly by private industry and NIST to accelerate this materials research effort. Compounds of general formula  $RL_2Cu_{3-x}M_xO_y$  ( $R$ =rare earth;  $L$ =Ba, Sr;  $M$ =Co, Fe, ...) are being investigated with neutron powder diffraction methods. The new high-resolution powder diffractometer now being tested at the NIST reactor will be a key to more rapid progress in this critical area.

#### **VISIBILITY THROUGH SMOKE CLOUDS**

NIST scientists and a university professor have obtained results critical to (a) assessing the visibility through plumes from burning oil spills and (b) the climatic effect of large fires such as in Kuwait. Jointly funded by the Mineral Management Service (Department of the Interior) and NIST, the team found that light transmission through a cloud of smoke is unchanged as the average agglomerate size grows by a factor of 24. The smoke, produced by the burning of crude oil in a 60 cm diameter pan, was drawn into a 1 m<sup>3</sup> cubical chamber. The team measured the transmittance of light through the

chamber at three wavelengths spanning the visible range over a 2 h period. They then demonstrated that this constancy of the transmittance is inconsistent with predictions of the commonly used Mie theory, but fully consistent with predictions based on fractal optics.

#### **NEW MECHANISM FOR SOOT FORMATION IN FLAMES**

NIST scientists have developed critical new insights into the formation of soot in turbulent flames. Soot formation is desirable in such applications as furnaces and the production of carbon black, but is not beneficial in fires, since its incandescence is the primary cause of heat transfer and flame spread. At present there is no model for predicting the soot yields from various fuels. The NIST team obtained time- and spatially resolved planar images of hydroxyl (OH·) radicals using laser-induced fluorescence, as well as simultaneous soot density profiles from elastic scattering of the particles themselves. [OH· is the species responsible for burnout of the soot formed in flames.]

The experiments were performed in time-varying, laminar CH<sub>4</sub>/air diffusion flames burning in a co-flowing, axisymmetric configuration at atmospheric pressure. Acoustic forcing was used to phase lock the periodic flame flicker to the pulsed laser system operating at 10 Hz. For conditions where the tip of the flame is clipped, the soot signals increased by more than a factor of seven compared to a steady-state, laminar flame with the same mean fuel flow velocity. Quantitative absorption measurements with a He-Ne laser also showed an order-of-magnitude increase in soot volume fraction for the flickering flames. The time-varying flames exhibited a larger range of combustion conditions than observed in corresponding steady-state flames, including different residence times, temperature histories, local stoichiometries, and strain and scalar dissipation rates. Future work will focus on elucidating the particular combination of these parameters responsible for the greatly increased soot production observed in the time-varying flames. A manuscript detailing these revolutionary findings has been submitted to Combustion and Flame.

#### **NIST SUPPORTS COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS) PROGRAM IN RASTER GRAPHICS**

In its continuing support of the CALS initiative of the Department of Defense, NIST contributed to the development of raster graphics file formats for

large documents. NISTIR 5108, Raster Graphics: A Tutorial and Implementation Guide, examines the technical issues facing an implementor of the raster data interchange format defined in the Open Document Architecture (ODA) Raster Document Application Profile. Intended for system architects and programmers, the tutorial provides an overview of relevant standards, discusses the benefits of ODA, and gives an overview of ODA.

#### **NIST SPONSORS SYMPOSIUM ON DIGITAL SIGNATURE APPLICATIONS**

Recently NIST's Federal Digital Signature Applications Symposium attracted about 200 participants from government and industry. The symposium provided a forum for discussion of common problems and issues in the application of digital signature technology to federal government systems.

The Digital Signature Standard (DSS) has been proposed to provide a digital signature that can be used to identify and authenticate the originator of electronic information and to verify that information has not been altered after it is signed, providing message integrity. Incorporating the proposed DSS into government applications would allow federal agencies to completely replace many paper-based systems with automated electronic systems, resulting in increased efficiency and reduced costs.

#### **NORTH AMERICAN INTEGRATED SERVICES DIGITAL NETWORK (ISDN) USERS' FORUM (NIUF) MEETS**

The NIUF drew over 200 users and implementors of ISDN technology to its recent meeting held at NIST. The NIUF now has 32 signatories to the cooperative research and development agreement with industry, which governs the management of the forum. Highlights included meetings hosted by a private company to discuss National ISDN-2 Customer Equipment Guidelines, the submission of three new ISDN user applications, and the approval of six working group charters. The plenary approved two documents for publication: A Catalog of National ISDN Solutions for Selected NIUF Applications and Unified Message Notification (Application Profile).

#### **NIST LEADS DEMONSTRATION OF ELECTRONIC COMMERCE REPLY CARD**

NIST has been selected by industry to lead the Electronic Business Reply Card demonstration targeted for the 1993 CALS Expo in Atlanta in

December, one of two high-visibility "scenario" demonstrations in the new Electronic Commerce of Component Information (ECCI) program. ECCI was formed in the context of the industry-government National Initiative for Product Data Exchange in response to urgent needs of the electronics sector. The demonstration is intended to highlight the electronic transfer of information associated with the release and distribution of new components and products and also establishes the networking and interface framework for the ECCI project.

Currently, the exchange of component information for electronic products is paper intensive and "data books" are out of date from the moment they are received by customers. The dissemination of new product announcements and response to requests for detailed component information are other drains on industry resources. One company, for example, spends approximately \$9 to respond to each request for information on a new product, not including the cost of the product announcement or the preparation of the information package to be distributed. Electronic notification of new products, requests for information, and receipt of requested information would represent a substantial cost savings to information providers and would increase the timeliness and quality of the data received by end users.

The second scenario project demonstrates the exchange of digital information associated with the selection and acquisition of components during the product design process, allowing the end user to incorporate the information received directly into computer-aided engineering/design systems. Taken together, the two scenarios will demonstrate the concept of a virtual enterprise of trading partners and information brokers using electronic commerce in the production, distribution, and application of electronic component information and products.

#### **LASER FOCUS WORLD ARTICLE REPORTS NIST CONCLUSIONS ON NEED FOR LASER BEAM ANALYSIS**

In the article "Laser Beam Analysis Pinpoints Critical Parameters," NIST scientists report and substantiate their conclusions that accurate analysis of laser beam parameters—beam width, divergence, shape, and a factor relating to propagation constant—is needed to match a laser with a given application. Total power alone is not a sufficient consideration to ensure that a laser is used efficiently and effectively.

This article was featured as a special "technology guide" on beam diagnostics in the January 1993 issue of *Laser Focus World*. Referring to specific applications, the authors state "Beam attributes affect quality for applications such as laser printers and laser machining . . . these attributes also affect barcode-scanning reliability, fiberoptic-coupling efficiency, optical-recording density, and surgical efficiency." Another major conclusion based on the authors' NIST experience is that diffraction effects on near-field beam profiles result in sufficiently rapid changes of profile with distance that beam analysis should be carried out in the far field.

NIST has received numerous requests over the past 10 years to provide more support to laser users in the area of beam-profile analysis. In this regard, NIST has been participating for the past 2 years in Subcommittee 9 on lasers of the International Organization for Standardization; a working group of the subcommittee is in the process of developing a standard procedure for beam analysis.

#### **NIST HAS NEW MASS COMPARISON CAPABILITY**

NIST has installed a new mass comparator. The comparator is an electronic balance capable of comparing nominally equal weights of any value from 100 g to 1 kg. The built-in weight handler of the balance is essentially a computer-controlled pick-and-place robot so that measurements are typically made without the environmentally altering presence of an operator. Readability of the device is 1  $\mu$ g. The device is to be used for state-of-the-art transfer of the national unit of mass to NIST clients and other NIST groups. When environmental factors such as barometric pressure, temperature, humidity, and CO<sub>2</sub> content of air are accounted for or controlled, the comparator will yield measurements with a precision approaching a part in 10<sup>9</sup>.

#### **INITIAL RELEASE OF STEP READY FOR COMMERCIAL USE**

By unanimous vote of 10 countries, the International Organization for Standardization Subcommittee TC184/SC4 registered all documents of the STEP Initial Release as Draft International Standards. The Standard for Exchange of Product Model Data (STEP) specifies how to represent all elements of product data in digital form and how to share them among business partners in the form of physical files. This is the same type of data typically generated and used by CAD, CAE, and CAM applications.

The decision is indicative of a broad consensus across Europe, the United States, and Japan that

the initial release of STEP is now technically complete and that widespread commercialization of this important technology can now proceed. This vote gives a "green light" to multiple implementation efforts worldwide at both vendor companies and at the five STEP centers in France, Germany, Japan, the United Kingdom, and the United States. The release caps a major technical collaboration of over 300 experts across 16 countries who worked together to produce the 2,300 pages of standards documentation.

The initial release addresses two priority application areas, drafting and product configuration management, and many more are under way. Work is progressing nicely on 17 additional application protocols that will be added to STEP in the near future.

#### **MAMMOGRAPHY, X RAYS, AND QUALITY CONTROL**

General improvement of image quality for mammography requires more accurate control and measurement of x-ray source voltage than is available through current non-invasive methods such as penetrameters and filter packs. Although the needed refinement is accessible through traditional (invasive) measurements using high-potential dividers, there are complications due to the wide range of frequencies and voltage waveforms which must be accommodated. In response to this situation, scientists at NIST have devised an alternative approach using moderate resolution, wavelength dispersive, diffraction spectroscopy. Using a prototype system, they have demonstrated that the needed precision and accuracy can be achieved. The approach, is readily generalized for measurements throughout the range of radiological and radiographical x-ray imaging.

The device uses Laue diffraction to obtain two images of the spectrum of the source symmetrically disposed with respect to the centerline or zero wavelength position. A wavelength contained in the source spectrum appears at two points in the "focal plane" separated by a readily calculated distance. At the high-frequency limit of the continuous spectrum, photons are emitted with the full energy,  $E = eV$ , of the electrons being accelerated by the x-ray source voltage,  $V$ . The spectrograph is thus an absolute instrument requiring only a measurement of a length ratio to establish the x-ray tube voltage without reference to any external standardization. In practice it is more convenient to note the locations of the characteristic emission lines of the target and use these to indirectly establish the camera scale.

### **NIST/INDUSTRY CONSORTIUM ON POLYMER BLENDS**

Representatives from seven companies met recently with staff from NIST to form an industrial consortium on polymer blends and alloys. The purpose of the consortium is to develop the science base to control the microstructure of polymer blends through interfacial modification and shear mixing. The focus of the consortium derived from input provided by industrial representatives at a workshop held at NIST in April 1992.

Polymer blends are mixtures of two or more polymers that produce a material with superior properties over those of the constituents. The enhancement of properties derives from the microstructure formed in the course of processing. The ability to control and manipulate the microstructure in predictable ways is key to the more efficient processing and enhancement of properties.

NIST and industrial scientists will collaborate on small-angle neutron and light-scattering studies of a particular polymer blend under shear fields and temperature variations. The active participation by industrial scientists is considered critical to transferring the knowledge to industry. Researchers from member companies of the consortium will then have access to sophisticated measurement facilities at NIST for conducting independent investigations on systems of particular interest to their companies.

### **NIST EVALUATES ALTERNATIVE REFRIGERANTS FOR INDUSTRY**

NIST researchers completed an evaluation of Refrigerant 22 (R-22) and Refrigerant 502 (R-502) alternatives and presented the results at a special January meeting of the Air-Conditioning and Refrigeration Institute, the trade association of 170 U.S. refrigeration and air-conditioning companies. Finding replacements for these refrigerants is critical to U.S. competitiveness because more than 5000 U.S. companies rely on HCFCs and CFCs to produce goods and services valued at over \$28 billion a year. Over 700000 jobs and \$200 billion worth of installed refrigeration equipment face certain servicing problems, reduced energy efficiency, and possible obsolescence.

Using a semi-theoretical model, CYCLE II, NIST staff screened a broad range of fluids and their mixtures at different compositions. Two pure fluids, one azeotrope, and nine zeotropes were

evaluated, both as potential "drop-ins" for existing equipment and assuming a system modified to take advantage of the fluid's properties. Although the final selection of replacement refrigerants will be based on laboratory tests, the simulation study limited the list of fluids that warrant expensive laboratory evaluations.

### **NIST CONDUCTS SUCCESSFUL MULTIVENDOR OPEN SYSTEMS INTERCONNECTION (OSI)/FRAME RELAY INTEROPERABILITY TRIAL**

In a cooperative project with industry, NIST recently carried out a multivendor trial and interoperability demonstration of the use of frame relay technology in OSI networks. Several private companies participated in the demonstration. The trial's primary objective was to illustrate the viability of frame relay technology to support OSI applications and the integration of frame relay into existing OSI networking environments. OSI applications demonstrated included X.400 electronic mail, file transfer access and management, and virtual terminal. The trial confirmed the technical feasibility of OSI end and intermediate systems operating OSI higher-layer protocols directly over user interfaces to frame relay networks. Also shown was the interworking of frame relay with other networks commonly used in OSI environments, such as IEEE 802.3-based local-area networks (LANs) and X.25 wide-area networks (WANs). In these scenarios, the frame relay networks acted as transit networks to concatenate geographically separated LANs and WANs. It is expected that the trial success will open the door for frame relay to be included in the emerging Industry/Government Open Systems Specification (IGOSS).

### **NEW PUBLICATION FOCUSES ON DATABASE MANAGEMENT IN ENGINEERING**

NIST researchers collaborated on a study of the applicability of database technology to engineering systems. NISTIR 4987, Database Management Systems in Engineering, describes the new generation of database systems that support the evolutionary nature of the engineering environment by focusing on the temporal dimensions of data management. In addition, the trend in manufacturing toward concurrent engineering raises new considerations for the cooperative use of data in a distributed engineering environment.

**OPTICAL CHARACTER RECOGNITION (OCR) RESEARCH ADVANCES**

NIST researchers are evaluating techniques to measure the performance of OCR systems that capture data from forms. Many large data entry systems are being designed to collect data from specified areas of forms, some of which may be multipart and completed with machine-printed or handprinted characters. As this technology advances, the number of OCR products available in the marketplace increases. Many of these products accomplish the data capture with a high degree of accuracy, but each product is based on a different, often proprietary, set of algorithms. NISTIR 5129, *Methods for Evaluating the Performance of Systems Intended to Recognize Characters from Image Data Scanned from Forms*, assists system developers and users of OCR technology in selecting the OCR system best suited to their requirements.

**ANALYSIS OF COMMENTS ON PROPOSAL FOR CONFORMITY ASSESSMENT SYSTEM EVALUATION (CASE) PROGRAM**

In response to a March 1992 Federal Register notice proposing the establishment of a voluntary Conformity Assessment System Evaluation (CASE) program, NIST received comments from 173 respondents. CASE would enable the Department of Commerce, acting through NIST, to provide required assurances to foreign governments that designated U.S.-based conformity assessment activities related to product sample testing, product certification, and quality systems registration satisfy international guidelines for their acceptance. The comments indicate a preference for NIST to provide recognition of privately operated accreditation programs, although considerable support was also received for NIST to provide both accreditation as well as recognition. The results of the analysis are reported in NISTIR 5138, *A Program for Conformity Assessment System Evaluation: Analysis of Comments on the NIST Proposal*.

**NIST DEMONSTRATES WORLD-RECORD FREQUENCY RESPONSE OF 8 TERAHERTZ IN HIGH-TEMPERATURE JOSEPHSON JUNCTION**

NIST recently demonstrated the highest frequency response ever achieved—8 THz—in a lithographed Josephson junction, thus showing the speed potential for a reproducible element of an integrated circuit (as opposed to a special one-of-a-kind point-

contact device). At the same time, researchers demonstrated the highest switching voltage of any microfabricated Josephson junction, showing that the fabrication process is robust with achievable allowances for manufacturing variation.

The demonstration of frequency response required developing a very high-frequency far-infrared laser to serve as the source and fabrication of the first antenna-coupled high-temperature superconductor-normal metal-superconductor junction, a development depending on the capability of the division to make both litho-graphed micro-antennas and step-edge junctions. These junctions are formed over a nearly vertical, 100 nm high step in a substrate. A yttrium-barium-copper oxide (YBCO) thin film is then deposited at an angle onto the substrate so that it is not continuous across the step. Next, a layer of normal metal is deposited on top of the YBCO to connect the two superconducting regions. The normal metal becomes weakly superconducting as electrons move back and forth between the superconducting and normal films. This phenomenon is called the "proximity effect" and causes the device to behave like a Josephson junction.

Application areas for the NIST (patent applied for) technology include electrical standards, specialized digital circuitry, sensitive radiation detectors, and biomagnetic instrumentation. U.S. manufacturers already have incorporated results from the NIST work in their advanced development programs.

**GUILDLINE OFFERS AC VOLTAGE REFERENCE BASED ON NIST-DEVELOPED DIGITALLY SYNTHESIZED SOURCE**

A calculable rms ac voltage source developed by NIST has become the basis for a new product developed by a private company. The company's instrument depends on NIST's digital waveform synthesis technology to generate 16 precision waveforms stored in non-volatile memory. The NIST design is patented and a licensing agreement between the company and NIST has been negotiated.

NIST scientists have been developing variants of the basic source design; the company's instrument is patterned on a version producing stepped sine-wave voltages at a nominal level of 7.07 V rms from 0.01 to 50 kHz, with an uncertainty of less than 10 parts per million (ppm) to 1 kHz and less than 50 ppm to 50 kHz. The design principle of applying digital methods to creating waveforms from data

stored in memory provides great flexibility, including the capability of generating sine waves with known amounts of distortion, as well as a variety of other useful test waveforms. The team currently is developing an enhanced version of the source incorporating features such as active attenuators for scaling the output to as low as 1 mV, frequency capability to 100 kHz with 128 steps per period, and an IEEE 488 bus interface.

#### **ISO PROJECT STARTED ON STEP APPLICATION PROTOCOL FOR DIMENSIONAL INSPECTION PLANS**

At its meeting, in early 1993 in Turin, Italy, ISO TC184/SC4 approved an application protocol (AP) project for ISO 10303, Product Data Representation and Exchange. (ISO 10303 is also known as STEP.) The AP will allow industries to use STEP integrated resources to represent and exchange data with dimensional inspection planning applications. The project is sponsored by NIST.

The Inspection Planning AP will specify information requirements for exchange, access, and use of STEP for inspecting manufactured parts using coordinate measuring machines and vision systems. The project is a collaboration between the NIST National PDES Testbed and the ESPRIT VIMP (vision-based, on-line inspection of manufactured part) project. This AP will enable specification of data structures consistent with the ANSI/CAM-1 DMIS standard (Dimensional Measurement Interface Specification). With this AP, companies will be able to create standard inspection plans based on product definitions in digital form.

#### **NIST TEAM DEVELOPS TAILORED STATIONARY PHASES FOR CAROTENOID ISOMER SEPARATIONS**

As part of an ongoing research effort to understand and utilize molecular interactions that provide for separations in liquid chromatography, researchers at NIST have developed new stationary phases optimized for the separation of carotenoid isomers. Carotenoids are a class of organic compounds that occur naturally in fruits and vegetables and are beginning to be of significant interest in a variety of industrial and health fields. Carotenoids, used widely as natural pigments and as nutrients in food, are being investigated for their effect in the reduction of various diseases, including cancer. Because of the economic and medicinal significance of these compounds, the ability to separate individual carotenoid compounds is of considerable importance. Subtle differences in the geometry of

carotenoid molecules give rise to numerous isomers and related compounds, making the separation and measurement of individual carotenoid species very difficult.

The ability to separate and measure carotenoids has been enhanced recently by the development of a new stationary phase for liquid chromatography tailored specifically to "recognize" the subtle structural variations among carotenoid compounds. To a large extent, the ability of a column to provide separation is controlled by the structure of the bonded phase at the molecular level. The selection of suitable substrate properties (particle size, pore size, and surface area) and surface modification procedures (ligand and phase type) permits wide variations to be created in the retention properties of the resulting bonded stationary phase. By optimizing each of these parameters for carotenoids, a column was developed that provides significantly improved separations of complex isomer mixtures. The development of a carotenoid column represents a practical application of years of basic research into the nature of fundamental chromatographic retention processes.

#### **MAGNETIC ENGINEERING OF THIN FILMS**

The recent discovery of the "giant magnetoresistance (GMR) effect" in magnetic multilayers has stimulated much interest in the antiferromagnetic coupling between magnetic layers, which is associated with the GMR effect. This effect could serve as the basis for producing new, improved non-volatile memory chips, critical to the personal computer industry.

Scientists at NIST recently studied selected samples from a private company because some thin films they produced, containing layers of cobalt and copper, exhibit the largest GMR effect found to date. These films were found to be nearly polycrystalline (made up of many crystallites). This surprising result raised the question of which crystallite was most important in determining the observed physical properties. Accordingly, several different single-crystal cobalt-copper multilayers were produced and studied. These studies indicated that the (100) crystallites are responsible for the antiferromagnetic coupling. These results suggest that controlling the (100) crystallite concentration in these multilayers will be a way to control the antiferromagnetic coupling and, thus, to engineer the desired values of the antiferromagnetic coupling strength for thin-film device applications.

### **NEW CARBON-DIOXIDE LASER LINES OBSERVED**

The laser spectroscopy group at NIST recently observed 40 new continuous-wave laser lines of carbon dioxide. These lines, the 9  $\mu\text{m}$  hot-band lines, some developing over 8 W of output power, will provide a new source of laser radiation for spectroscopy. Frequencies of 36 of the 40 lines have been directly measured relative to other well-known  $\text{CO}_2$  lines using a heterodyne technique.

The carbon-dioxide laser has been so thoroughly studied over many years that it is surprising to find new laser lines in the system. The new observations were made possible by the use of a special high-resolution grating (a grating-coupled laser cavity was used), a ribbed laser tube, and a higher than normal discharge current. The lines had been predicted by theory but never observed until this work.

### **PATENT DISCLOSURE ON LASER REFRIGERATOR**

The current best means for cooling solids to low temperatures are cryogenic liquids and Sterling cycle refrigerators. Cryogenic fluids are messy, expensive, and difficult to regulate and automate. Sterling cycle pumps are unreliable and vibrate. A NIST scientist has invented an all solid-state refrigerator, which consists of a laser beam directed onto a semitransparent crystalline solid and exploits internal quantum mechanisms to cool the solid. The laser beam frequency is set to be a little lower than the direct band gap of the solid, so that the solid absorbs the photon from the laser beam and then re-emits it at slightly higher energy. The result is a net loss of energy and a cooling of the solid. The invention would substitute for a Sterling refrigerator over temperatures ranging from 40 to 200 K. It is estimated that more than 95 percent of Sterling refrigerators are used in this temperature range. Currently, Sterling refrigerators are most often used in infrared viewing systems, but if high-temperature superconductors become practical, cryogenic cooling devices may be important for a wider range of applications.

### **IMPROVING AMORPHOUS SILICON FILMS FOR ELECTRONIC APPLICATIONS**

Because hydrogenated amorphous silicon (a-Si:H) films are inexpensive to produce in very large areas, they are leading contenders for solar electricity generation. They also are used for thin-film

transistors in display and reading devices. However, for reasons not well understood, the properties of these devices depend critically on the plasma deposition conditions, and their electrical properties do not attain what is believed possible. A major cause of this uncertainty is an inadequate understanding of the atomic structure of this amorphous material, knowledge that a novel application of a scanning tunneling microscope (STM) is beginning to provide. Using an STM a NIST scientist has directly measured the atomic-scale structure of the surface of these films as a function of time during growth. The films are found initially to grow very homogeneously and compactly, but with increasing thickness this degenerates into rough and relatively porous materials (on an atomic scale). These observations have forced a rethinking of deposition processes and plasma chemistry, as well as of the properties and defects of this semiconductor material. These results, as well as NMR and x-ray scattering observations from other laboratories, implicate small voids in the material as primary determinants of electrical imperfections. This is stimulating researchers and engineers to develop more optimal deposition methods.

### **INVESTIGATION OF POLYMER/METAL INTERFACES USING ULTRA SOFT X-RAY ABSORPTION SPECTROSCOPY**

Researchers from private industry are collaborating with a NIST scientist of a University of Michigan researcher to study polymer surfaces and metal polymer interfaces using ultra soft x-ray absorption spectroscopy at the National Synchrotron Light Source, Brookhaven National Laboratory. They have been able to study the buried interface between DVS bis-BCB (divinyl siloxane bis-benzocyclobutene) coated with 10 to 50 nm of aluminum. The functional groups at the surface of the polymer undergo a dramatic orientation change upon metal over coating during the formation of the polymer metal interface. DVS bis-BCB is used for dielectric layers in new generation multilayer interconnect devices. Their experiments provide new detailed chemical information critical for predicting and optimizing the adhesion at metal/polymer interfaces.

### **CRACK PROPAGATION IN AGING AIRCRAFT**

In one design approach for airplane fuselages, circumferential rings or frames are intended to steer dangerous longitudinal cracks—if they should

appear—in the less-threatening circumferential direction around the fuselage. However, since the highly publicized Aloha Airlines accident in 1988, in which the roof of a Boeing 737 ripped off and exposed passengers to the open sky, it has been hypothesized that in the case of aging aircraft, cracks that start running longitudinally may continue to do so because cracked rivet holes may provide a path of lesser resistance.

To gain an understanding of this crack propagation mechanism, the Federal Aviation Administration, through the National Aging Aircraft Research Program, contracted with NIST to investigate the process of fracture in aircraft structural aluminum-alloy sheet in the presence of multiple cracks. Under this contract, NIST scientists will use its specialized facilities and capabilities to carry out a series of 12 instrumented tension tests on 4 m (13 ft) precracked aluminum-alloy panels to characterize the manner in which cracks propagate and link up to produce failure.

#### **AISI PROJECT ON MICROSTRUCTURAL ENGINEERING**

The American Iron and Steel Institute (AISI) is sponsoring an industry/NIST/university R&D project entitled "Microstructural Engineering in Hot-Strip Mills." The collaborators are U.S. Steel, University of British Columbia, and NIST. The objective of the project is to develop a predictive tool (model) that quantitatively links the properties of hot-rolled products to the processing parameters of a hot-strip mill. The project will focus on the microalloyed steel grades. Successful completion of the project will be invaluable in determining the optimal processing conditions to achieve the desired product properties and in shortening the alloy development cycle.

#### **NIST/MIT NEUTRON DIFFRACTOMETER OPERATIONAL**

NIST scientists in cooperation with researchers at the Massachusetts Institute of Technology (MIT), have completed development of a new, state-of-the-art powder neutron diffractometer for materials research at the NIST Reactor. The instrument is a 32-detector ultra high resolution powder diffractometer installed at the BT-1 thermal neutron port. The new instrument features a unique array of focusing monochromators in which any one of three can be remotely selected according to the characteristics of the sample under study. This feature, along with the detector system, increases the

rate of data collection by about a factor of 10 (and with better resolution) when compared to the highly productive five-detector instrument which the new one replaces.

As is now well known, Rietveld analysis of neutron powder diffraction data provides details of atomic arrangements in technologically important materials, which is not possible with other diffraction methods. With this capability, this experimental station is expected to play a major role in research programs of mutual interest to NIST, MIT, and many other industrial and university collaborators. High-temperature superconductors, advanced magnetic materials, intercalation compounds, fast-ion conductors, advanced ceramics, and catalysts are examples of materials to be characterized with the new instrument.

#### **NIST CONDUCTS ROUND-ROBIN OF HEAT-FLOW-METER-APPARATUS FOR THERMAL INSULATION TESTING**

Under the auspices of ASTM Committee C-16 on thermal insulation, NIST has begun the first phase of a round-robin to investigate the precision of small heat-flow-meter apparatus. The heat-flow-meter apparatus is used widely by the insulation industry to determine the thermal conductivity of insulation and building products as both a research tool and for quality control. Presently, the precision of the small class of heat-flow-meter apparatus has not been determined. Using NIST's 1 m guarded hot plate, a NIST scientist has characterized the thermal conductivity of three specimens of fibrous-glass board for circulation to 14 participating laboratories in the United States and Canada. Results of the round-robin will be used to modify the precision and bias statement of the ASTM test method for heat-flow-meter apparatus (ASTM C518).

#### **THERMAL ENVELOPE DESIGN GUIDELINES**

NIST has published a thermal envelope design guide for federal office buildings for the General Services Administration, which addresses design issues related to the thermal integrity and airtightness of office building envelopes. This document was developed to present current guidance on thermal envelope design and performance from the building research, design, and construction communities in a form that will assist building design professionals in designing office buildings with improved performance. The resultant performance improvements include reduced energy consump-



tion, the ability to maintain thermal comfort within the building, and improved indoor air quality.

While office building envelopes are generally successful in meeting a range of structural, aesthetic, and thermal requirements, poor thermal envelope performance often occurs due to the existence of defects in the thermal insulation, air barrier, and vapor retarder systems. These defects result from designs that do not adequately account for heat, air, and moisture transmission, with many being associated with inappropriate or inadequate detailing of the connections of envelope components. Other defects result from designs that appear adequate but cannot be constructed in the field or will not maintain adequate performance over time. Despite the existence of these thermal-envelope performance problems, information is available to design and construct envelopes that do perform well. To bridge the gap between available knowledge and current practice, NIST developed these guidelines based on research performed, published research results, guidance from the design and construction industry, and input from selected technical experts in the field.

#### **NIST PUBLISHES MANUAL FOR DATA ADMINISTRATION**

NIST Special Publication 500-208, Manual for Data Administration, provides guidance to data administrators in developing and carry out a data administration (DA) function. It assists data administrators in establishing an organization's DA function, or with adding, reviewing, developing, or implementing related activities and responsibilities. The manual resulted from 2 years of research and development by the Data Administration Standards and Procedures Working Group, sponsored by the National Capital Region chapter of the Data Administration Management Association.

#### **NIST HOSTS SIGCAT '93**

NIST recently hosted the second National Conference and Educational Symposium on Compact Disc-Read Only Memory (CD-ROM) Applications and Technology (SIGCAT '93), which was sponsored by the U.S. Geological Survey in conjunction with the Federation of Government Information Processing Councils. Addressing the theme of "Mainstreaming CD-ROM," the conference featured government and industry speakers on key CD-ROM issues involving software, standards,

production, and media reliability. Topics included data compression, handicapped environments, education, licensing, encryption, and software. The applications track showcased over 20 separate CD-ROM success stories from the federal sector.

#### **INTEGRATED SERVICES DIGITAL NETWORK (ISDN) AGREEMENTS PUBLISHED**

NIST Special Publication 823-3, North American Integrated Services Digital Network Users' Forum (NIUF) Agreements on ISDN, compiles the existing NIUF agreements for an ISDN developed and approved in the forum as of October 1991. ISDN is an advanced telecommunications technology which allows the exchange of voice, data, and image information concurrently over telephone lines. The document also references the conformance tests that had been completed by the NIUF.

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### **Standard Reference Materials**

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#### **STANDARD REFERENCE MATERIAL 2520—OPTICAL FIBER DIAMETER STANDARD**

The use of fiber optics in communication has revolutionized the way in which information is transferred between locations. Maintaining the integrity of the information during transfer requires stringent quality control of fiber geometry on a micrometer scale.

The Standard Reference Materials Program announces the availability of Standard Reference Material (SRM) 2520 for calibrating video microscopes or gray-scale systems used for fiber geometry measurements. Certified values, in micrometers, are given for the diameter of a bare, cleaved end of a single-mode fiber measured with a contact micrometer approximately 1 mm from the fiber end. Individual diameters at four angular orientations, 0, 45, 90, and 135 are given in addition to the mean diameter.

SRM 2520 consists of a short length of bare optical fiber in an aluminum housing constructed with a barrel mechanism which allows the certified end of the fiber to be pushed out and rotated into position for use and then retracted back into its protective housing for storage. The entire housing and an attached 102 m length of fiber pigtail are mounted in an aluminum block equipped with a screwdown cover. Each SRM unit measures 14 × 8.2 × 2 cm and is individually serialized.

**STANDARD REFERENCE MATERIAL 2063a—  
TRANSMISSION ELECTRON MICROSCOPE  
THIN FILM**

Microanalysis using a range of analytical techniques based on x-ray spectrometry is playing an increasing role in many fields of science. Accurate calibration of chemical composition in microanalysis cannot be performed using Standard Reference Materials developed for bulk chemistry, primarily because of homogeneity considerations.

The Standard Reference Materials Program announces the availability of Standard Reference Material 2063a, replacing SRM 2063 which has been out of stock for a number of years. SRM 2063a consists of a mineral glass film that has been deposited onto a 20 nm carbon support film on a 3 mm diameter copper transmission electron microscope grid. The film is certified for the concentrations of Mg, Si, Ca, Fe, and O, which are nominally 8, 25, 12, 11, and 43 weight percent, respectively. An information value is given for weight percent Ar, and information values are also given for film density and thickness.

**STANDARD REFERENCE MATERIAL 3144—  
RHODIUM SPECTROMETRIC SOLUTION**

The automotive industry and the precious metals industry have long recognized the need for highly accurate calibration solutions for valuation of the precious metals which are the active agents in automotive catalytic converters. Rhodium catalyzes the conversion of nitrogen oxide emissions to harmless nitrogen gas. While it is the least abundant of the precious metals in a catalytic converter, its value equals that of the Pt and Pd, by virtue of its greater scarcity in precious metal ores.

The Standard Reference Materials Program announces the availability of Standard Reference Material (SRM) 3144, rhodium spectrometric solution, to meet this need. The platinum and palladium spectrometric solutions (SRMs 3140 and 3138) also required for this purpose have been available since 1986. NIST collaborated with industry in verifying the stoichiometry of rhodium salts and in establishing totality of the dissolution of rhodium metal to provide two alternate routes to the preparation of the solution, agreeing within the required few parts per thousand. SRM 3144 is available in 50 mL units of solution containing 1000 µg/mL of Rh in 10 percent (V/V) HCl.

**CERTIFICATION OF HIGH-PURITY SILVER AS  
STANDARD REFERENCE MATERIAL 1746—  
A FREEZING-POINT STANDARD**

Scientists at NIST, with support from the Standard Reference Materials Program, recently completed the certification of Standard Reference Material (SRM) 1746 as a freezing-point standard. This new SRM of high-purity silver (99.999 97 percent) can be used for realizing one of the defining thermometric fixed points (961.78 °C) of the International Temperature Scale of 1990 (ITS-90) for the calibration of standard platinum resistance thermometers and optical radiation thermometers. The fixed point is realized as the plateau temperature (or liquidus point) of the freezing curve of the high-purity silver at 101325 Pa.

The thermal tests used to confirm the purity of the silver, and to ascertain that the silver is suitable as a freezing-point standard, involved the evaluation of three silver freezing-point cells, each containing 1400 g of the silver. The freezing and melting curves obtained for these cells were compared directly with the NIST laboratory standard. Based on the random samples of silver tested, the range of the melting temperatures for this material should not exceed 0.003 °C. The plateau temperatures for freezing curves of this silver should not differ by more than 0.001 °C from each other, nor by more than 0.002 °C from the assigned temperature.

The metal is in the form of millimeter-size "shot" and is packaged in 300 g units in the presence of argon in plastic envelopes. The "shot" form of the silver minimizes the need to handle the metal during freezing-point cell construction. This material provides a valuable measurement tool for those industries, ranging from aerospace to chemicals, which require accurate temperature standards to monitor a wide variety of industrial processes.

**STANDARD REFERENCE MATERIALS 1710—  
1715—ALUMINUM ALLOYS 3004 AND 5182**

When using recycled aluminum in the food canning industry, it is essential that the aluminum be free of toxic heavy metals such as Pb and Cd. Quality control procedures designed to limit the concentration of Pb and Cd in food cans require the availability of aluminum standards whose concentrations of Cd and Pb are accurately known at very low concentration levels.

The Standard Reference Materials Program announces the availability of six aluminum alloys, SRMs 1710–1715, specially prepared to include certified low levels of Cd and Pb to meet this need. Three (SRMs 1710–1712) are prepared of aluminum alloy 3004, spiked to cover the Pb content range of approximately 18 to 156  $\mu\text{g/g}$ , and the Cd content range of approximately 8 to 51  $\mu\text{g/g}$ . SRMs 1713–1715 cover the same Pb and Cd ranges in alloy 5182. Isotope dilution thermal ionization mass spectrometry analyses were performed as the primary certification analyses. This method is the most precise and accurate of the methods available at NIST. Additional analyses were performed by a number of atomic spectrometric methods that might be utilized in SRM user laboratories.

The SRMs are available in the form of discs approximately 63 mm (2.5 in) in diameter and 19 mm (0.75 in) thick. The industry will use these SRMs primarily as calibration standards for optical emission and x-ray fluorescence analyses monitoring recycling plant operations.

#### **REFERENCE MATERIALS 8412–8418 AND 8432–8438 AGRICULTURAL/FOOD REFERENCE MATERIALS**

To meet the requirements of nutritional labeling and food safety programs, it is necessary to have reference materials for which “best estimate” concentrations of essential nutrients and toxic contaminants are well-established.

The NIST Standard Reference Materials Program announces the availability of 10 new Agricultural/Food Reference Materials (RMs) to complement previously available RM 8412 Corn Stalk and RM 8413 Corn Kernel. These RMs are: 8414–Bovine Muscle Powder, RM 8415–Whole Egg Powder, RM 8416–Microcrystalline Cellulose, RM 8418–Wheat Gluten, RM 8432–Corn Starch, RM 8433–Corn Bran, RM 8435–Whole Milk Powder, RM 8436–Duram Wheat Flour, RM 8437–Hard Red Spring Wheat Flour, and RM 8438–Soft Winter Wheat Flour.

Each RM is accompanied by a report of investigation that gives the “best estimate” concentrations in addition to methods and procedures employed to arrive at the recommended value. These reports list “best estimate” or information only concentrations for more than 30 elements in each material.

RMs 8412–8418 and 8432–8438 are available in units of approximately 35 g, depending on the individual RM.

#### **STANDARD REFERENCE MATERIAL 931e— LIQUID ABSORBANCE STANDARD FOR ULTRAVIOLET AND VISIBLE SPECTROPHOTOMETRY**

Since more than 90 percent of the determinations in the clinical laboratory involve photometric measurements, an important task of the laboratory worker is to ensure that the instrument is performing properly and reliably in both the UV and visible regions of the photometric scale. The implementation of the new Clinical Laboratory Improvement Amendments of 1988 in clinical labs makes this task vital. The types of calibrations needed for quality assurance documentation require reference standards having certified absorbances at differing concentration levels.

The Standard Reference Materials Program announces the availability of the renewal issue of Standard Reference Material (SRM) 931e, for the routine critical evaluation of daily working standards used in spectrophotometry. The SRM also is used to calibrate and verify the accuracy of the photometric scale of narrow effective spectral bandpass spectrometers.

SRM 931e is certified as solutions of known net absorbencies, for a 10.00 mm measurement pathlength, at four specific spectral wavelengths: 302, 395, 512, and 678 nm. Four known absorbencies, for a 10.00 mm pathlength nominally 0.0 (blank), 0.3, 0.6, and 0.9 are provided.

SRM 931e is provided as three sets of the above four liquid filters; each set is packaged in its own tray. Each set consists of four ampoules containing approximately 10 mL each of the individual liquid filter solutions. Each ampoule is prescored for ease in opening and transferring to the measurement cell.

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### **Standard Reference Data**

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#### **NEW BIOTECHNOLOGY DATABASE ON LIPIDS OFFERED**

Detailed properties on more than 900 lipids are just a few keystrokes away thanks to a new database available from NIST. The system, known as LIPIDAT, holds a library of information on lipid molecules in a single, easy-to-access database. The personal computer database lets a user select lipids from among the 50 more common lipid structures, or search for lipids by traits such as chain, head-group and backbone types. LIPIDAT was developed at Ohio State University with a grant from

the National Science Foundation through NIST. The database is designed for IBM-compatible computers with MS-DOS or PC-DOS version 2.1 or later, and with at least 512 kB memory. It also can be run on Macintosh computers having a PC emulator program or card. LIPIDAT is available from the NIST Standard Reference Data Program for \$265. For more information contact the SRDP, A320 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2208, fax: (301) 926-0416.

#### **1993 SRD PRODUCTS CATALOG PUBLISHED**

The NIST Standard Reference Data Program has been providing critically evaluated, high-quality data for a wide range of applications to industry, government and academic institutions for more than 30 years. The NIST Standard Reference Data Products Catalog 1993 (SP 782, 1993 Edition), lists 80 data publications and computerized databases available from SRDP and other sources. Data compilations are available in the following areas: analytical chemistry, atomic physics, biotechnology, chemical kinetics, materials properties, molecular structure and spectroscopy, thermodynamics and thermochemistry, and thermophysical properties of fluids. Also provided are special databases of binary images, structured forms and optical character recognition. For a copy of SP 782, 1993 Edition, send a self-addressed mailing label to the SRD Program, A320 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2208, fax: (301) 926-0416.

#### **NIST CHEMICAL KINETICS DATABASE UPDATED**

The best-selling Standard Reference Database, Number 17, has been updated. Version 5.0 of the Chemical Kinetics Database contains 23500 rate constants, 7800 reactions, 3800 compounds, and 6000 literature references. This database is a valuable tool for producers and users of gas-phase kinetic data and allows searching by reactants, author, reactions in a particular paper, and reactions producing a given product. The literature is current through 1992.

#### **NIST SURFACE STRUCTURE DATABASE RELEASED**

Standard Reference Database 42 is a new and powerful tool for scientists to assess and compare detailed atomic-scale structures of surfaces and interfaces obtained from experiments. Nearly 600 structure analyses are included, covering a wide variety of materials of scientific and technological importance, including catalysts. Extensive search facilities enable the user to locate desired structures rapidly. The database may be searched by chemical element(s) in substrate or adsorbate, crystallographic face of substrate, substrate lattice, surface superlattice, substrate or overlayer space-group symmetry, experimental technique, author, journal, or year of publication.