

# 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 20899-0001; telephone: 301/975-3572.*

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### SETTING PRIORITIES, MEASURING RESULTS: REPORT TELLS HOW

How does the government select where to invest public resources in technology development and application, and how does it measure the results of those investments? A new report by NIST describes how the institute answers those questions for its four major programs: the Advanced Technology Program, Laboratory Research, the Manufacturing Extension Partnership and Quality. In the foreword to the report, Commerce Under Secretary for Technology Mary Good and NIST Director Arati Prabhakar say, "Judgments are an inherent part of the process of setting priorities and measuring results, but these judgments must be guided by comprehensive qualitative and quantitative information that captures customers' needs and accurately portrays how efficiently and effectively NIST is responding to those needs." They also state that "... efforts to develop better processes and metrics are fundamental to accomplishing NIST's objective of continuously improving and increasing the value of our programs." To request copies of the document, which is being distributed for public comment, contact NIST at (301) 975-2608, fax: (301) 216-0529 or e-mail: [jewett@micf.nist.gov](mailto:jewett@micf.nist.gov) (via Internet). The document also is available electronically on the NIST Gopher ([gopher.nist.gov](http://gopher.nist.gov)) under "what's new."

### CRADA GOAL: BETTER MATERIALS QUALITY ASSESSMENT

NIST has signed a cooperative research and development agreement with a private company to develop automated, ultrasonic instrumentation for evaluating the quality of advanced composite materials. The company now sells ultrasonic instruments that rely on direct contact between the transducer and the material being assessed. Building on previous NIST research, the private company hopes to develop a non-contact transducer for real-time, on-line measurements. NIST has demonstrated the capability of air-coupled transducers for inspecting advanced composite materials. The private company will evaluate this technology and, if appropriate, incorporate it into a commercial product. The company has concluded there is a market for noncontact, real-time measurements that can be used for in-process quality control of advanced composite materials. Such materials are used typically in the aerospace and automotive industries. For more information, contact Chris Fortunko, Materials Reliability Division, NIST, Boulder, CO 80303-3328, (303) 497-3062, e-mail: [fortunko@bldrdoc.gov](mailto:fortunko@bldrdoc.gov) (via Internet).

### UNITED STATES/RUSSIA TRADE TO BENEFIT FROM NEW PROGRAM

In an effort to expand trade, an international laboratory accreditation program will be established to provide U.S. manufacturers and exporters with product test results that comply with mandatory Russian certification requirements. The program is being created in response to a joint communiqué on cooperation in conformity assessment issued Dec. 16, 1993, by Vice President Albert Gore, Jr., and Russian Prime Minister Viktor Chernomyrdin. It commits NIST and the State Committee of the Russian Federation for Standardization, Metrology

and Certification, also known as GOSSTANDART, to develop mutual recognition agreements for the acceptance of test data required for product certification. Procedures will be established whereby the Russian government will accept U.S. government accreditation of labs found competent to test for compliance with the Russian Consumer Protection Law of 1993. By the end of 1994, a program will be implemented so that GOSSTANDART officials can accept test results from U.S. labs accredited under the International Laboratory Accreditation Program, or INTERLAP, operated by NIST's National Voluntary Laboratory Accreditation Program. For information, contact Lawrence Galowin, NVLAP, A162 TRF Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4016, e-mail: galowin@micf.nist.gov (via Internet).

#### **GROUP DEVELOPING STANDARDS FOR USE IN LAPTOPS**

NIST and the Video Electronics Standards Association will lead an effort to develop a new voluntary interface standard for the way flat panel displays are connected to their computer controllers. Following recommendations of a recent NIST workshop on the computer interface to flat panel displays, VESA has formed a special interest group to establish the standard or series of standards. Graphics chip makers, LCD panel makers, and laptop and notebook manufacturers all contributed to the decision to seek a new standard. VESA is currently seeking new industry participants for the Flat Panel Display Interface Special Interest Group. For more information on the group, contact VESA at (408) 435-0333. For technical information on NIST's work with flat panel display interfaces, contact Mark Williamson, A61 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3160, fax: (301) 216-1369, e-mail: mark@pegasus.ncsl.nist.gov (via Internet).

#### **PRECISE VOLTAGE STANDARDS ARE "CURRENT-LY" AVAILABLE**

Calibration laboratories and others wishing to maintain precise voltage standards now may obtain them from NIST's Standard Reference Materials Program. Standards for 1 V and 10 V are available as SRMs 2590 and 2591, respectively. Both standards consist of Josephson arrays (3600 junctions for 1 V and 20208 junctions for 10 V) mounted with a WR-12 band waveguide input and solder pad direct current connections. When cooled to 4.2 K or less and irradiated with a millimeter wave input of approximately 10 mW at 75 GHz, these

devices generate the quantized voltages that define the international practical standard. The technical work behind the SRMs was performed by NIST. SRMs 2590 and 2591 may be purchased from the NIST SRM Program, Rm. 204 Engineering Mechanics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6776, fax: (301) 975-3730.

#### **PAPER DISCUSSES "HOW TO MAKE NII HAPPEN"**

Coverage of plans for the National Information Infrastructure usually highlights the potential for exciting new applications of information technology in education, commerce, health care and other areas. But will the NII be ready for those services and features? The Committee on Applications and Technology of the President's Information Infrastructure Task Force has assembled a basic list of 16 key issues that must be resolved to enable NII applications in education, libraries, manufacturing, electronic commerce and telecommuting, environmental monitoring, health care and government services. Typical issues include questions of privacy, equitable access, information security and interoperability standards. Printed copies of "What It Takes to Make it Happen: Key Issues for Applications of the National Information Infrastructure" are available by sending a preaddressed mailing label to NII Issues, A1000 Administration Building, NIST, Gaithersburg, MD 20899-0001. The report also is available on Internet from the IITF gopher (iitf.doc.gov), under "IITF Committee Reports and Minutes—Applications and Technology Committee Report 01/25/94," or from the IITF computer bulletin board at (202) 501-1920.

#### **NEW POLICY FEATURES ESCROWED ENCRYPTION STANDARD**

Recommendations from an interagency review of encryption and telecommunications security strike a balance between the needs for strong encryption technology and effective law enforcement, Clinton Administration officials recently announced. To help implement these recommendations, NIST announced the approval of the voluntary Escrowed Encryption Standard, a Federal Information Processing Standard that can be used by government agencies or the private sector to provide strong encryption protection for sensitive but unclassified voice, fax, and data communications over telephone lines. To ensure law enforcement officials have access to data encrypted by the otherwise unbreakable system, key escrow encryption allows for two key components, strings of computer

data of length 80 bit, to be held by separate government agencies. The attorney general named NIST and the Automated Services Division of the Treasury Department as key escrow agents, and issued strict procedures for agents to follow when asked to provide the keys to authorized agencies. In related announcements, NIST committed to ensure a royalty-free, public-domain Digital Signature Standard and called for partners in developing computer hardware with integrated cryptographic key escrowing techniques. For more information on the consortium, contact Dennis K. Branstad, A126 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2913, e-mail: branstad@st1.nsl.nist.gov (via Internet).

#### **PARTNERS LOOK TO THIN FILMS FOR DATA STORAGE**

NIST and a private company have signed a 2-year cooperative research and development agreement to study the structural topography and magnetic properties of thin magnetic films for their use in storing data. The goal is to produce computer hard-drive storage disks with higher densities and greater reliability than current models. The disks being studied are constructed in layers, with a thin film deposited upon an underlayer of chromium. However, the film cannot react with the underlayer crystals or the magnetic properties will be adversely affected. For their part in the CRADA, the private company will prepare thin films of varying compositions under different conditions, then measure the magnetic properties of the samples. NIST, in turn, will examine the films' structures using transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, and x-ray diffraction. For more information, contact Alexana Roshko, Div. 845.05, NIST, Boulder, CO 80303-3323, (303) 497-5420, e-mail: roshko@bldrdoc.gov (via Internet).

#### **NEW SPECTROMETER MAY PAVE ROAD TO CLEANER CARS**

In their quest to build cleaner cars, automobile manufacturers require advanced measurement methods to precisely monitor what goes in and comes out of a car's engine. A new, NIST-developed automated microwave spectrometer that can analyze trace gases quickly and accurately with very high sensitivity may fit the bill. Among the instrument's potential applications are monitoring auto exhaust, factory emissions and industrial processes. The NIST device can accurately measure gases in concentrations as low as 10 parts per billion.

Another advantage is that it measures gases very quickly, several times a second, as they are emitted from a source. The instrument uses microwaves to excite gas molecules and measures the energy the molecules emit as they relax. Researchers at NIST are currently scaling down the spectrometer's size for field use.

#### **NIST HANDBOOK 44 REVISED FOR 1994**

Major changes in NIST Handbook 44-1994, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, include:

- new criteria defining minimum forms of audit trail that allow electronic alternatives to physical security seals for scales and liquid measuring devices;
- recognition of automatic and semi-automatic self calibration of weighing and measuring devices;
- requirements for the accuracy of on-board weighing systems when the vehicle is out of level up to at least 5%, and to inhibit weighing when vehicle is out of level to the extent it can no longer weigh accurately;
- the requirement that all new vehicle tank meters for fuel and gasoline deliveries to homes and farms must have ticket printers to record deliveries by Jan. 1, 1995 (scheduled for all vehicle tank meters by Jan. 1, 1999); and
- numerous changes in the "Grain Moisture Meter Code" to improve the accuracy of meters so that they more closely relate to U.S. Department of Agriculture grain samples used to calibrate meters that measure moisture in grains for export.

Handbook 44 is available for \$16 prepaid from the U.S. Government Printing Office, Washington, DC 20402, (202) 783-3238. Order by stock no. 003-003-03242-5.

#### **PRIMER PROVIDES HELP FOR COMPUTERPHOBIC ENGINEERS**

Are you a welding engineer who has put off purchasing or operating a computer because the technology scares you? Researchers at NIST have put together a computer primer for welding engineers. Although it was designed for this specific group, the paper also can be useful to others having difficulty understanding computers. In simple language, the authors explain the intricacies of computer

hardware, software and applications. They define terms such as motherboard, expansion boards, drive controllers, general-purpose software and specific software, primarily as they relate to the welding industry. A list of reference books and an extensive glossary also are provided. For a copy of this primer, contact Sarabeth Moynihan, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-7765, e-mail: moynihan@bldrdoc.gov (via Internet). Order paper no. 50-93.

#### **CAPILLARIES CAPTURE NEW WAVE IN NEUTRON PROBES**

NIST and a private company are teaming up to study how well the company's glass capillaries transmit and focus neutron beams to probe elements in advanced materials. NIST and the company recently signed a cooperative research and development agreement to study some of the company's products. The company manufactures fiber optic components, medical and veterinary endoscopes, and other industrial and scientific imaging systems. The private company's glass capillaries will be tested by NIST for their ability to focus slow neutron beams. NIST scientists use slow neutrons from the NIST research reactor to profile elements in a variety of advanced materials, such as semiconductor chips, superconductors, and ceramic powders. Some of the neutrons are absorbed by atoms in the materials. The resulting collisions give off characteristic radiation that identifies the elements. NIST scientists have demonstrated that focused neutron beams give higher spatial resolution than an unfocused beam.

#### **CRADA PARTNERS TARGET WELD SPATTER REDUCTION**

Spatter, the scattering and splashing of metal droplets that occurs when welding steel, has been a continual problem in automated welding systems. Under a cooperative research and development agreement, a private company and NIST will combine the institute's arc sensing and diagnostic techniques with the company's advanced welding equipment to determine the causes of spatter and fumes. With the data gained, NIST researchers hope to design intelligent control systems for welding automation that will reduce weld spatter significantly. Ultimately, the private company would like to market an automated welding system utilizing such systems. If successful, the project also may lead to further collaborations to reduce welding

noise and fumes at higher deposition rates. For more information, contact Tom Siewert, Div. 853, NIST, Boulder, CO 80303-3323, (303) 497-3523, e-mail: siewert@bldrdoc.gov (via Internet).

#### **FINAL PROJECTS FOR FY 1993 TRP AWARDS CHOSEN**

On Feb. 23, 1994 the Defense Department announced the final set of 50 awards under the fiscal year 1993 Technology Reinvestment Project. Over 360 private companies, universities, and state and local government organizations are involved in the projects, which will receive \$190 million in federal matching grants. Nine of the projects will be managed by NIST's Manufacturing Extension Partnership. These grant recipients are: the Defense Enterprise Empowerment Project (affecting western Ohio, eastern Indiana and northern Kentucky), the Michigan Industrial Extension Partnership (a planning grant), the Southern Missouri Regional Office of the Mid-America Manufacturing Technology Center, the Nebraska Industrial Competitiveness Service, the Oregon Technology Exchange Consortium, the Tennessee Manufacturing Extension Program, the Northwest Wisconsin Manufacturing Outreach Center, the Virginia Alliance for Manufacturing Competitiveness and Technology Deployment Through Manufacturing Networks (affecting wood and metal-working firms in Arkansas). TRP projects generally are funded for 1 to 2 years, after which they may receive additional support from the NIST MEP.

#### **UNITED STATES, CANADA RENEW TESTING LAB AGREEMENT**

NIST and the Standards Council of Canada renewed an agreement on Feb. 22, 1994, that provides mutual recognition of testing laboratories located within the territorial United States that are accredited by the NIST National Voluntary Laboratory Accreditation Program, and for testing laboratories within Canada that are accredited by SCC's Program for Accreditation of Laboratories, Canada. NIST and SCC base their decision to accredit a testing laboratory on similar but not always identical criteria. Both programs meet the requirements of international standards under ISO/IEC Guides 25 and 58. Officials responsible for administering each system have participated in assessment visits to testing laboratories accredited under the other national program. NVLAP currently accredits more than 900 labs in 16 fields of testing, and the Canadian PALCAN program has

granted accreditation to 150 labs in 14 areas. For information on PALCAN, contact, Manager, Testing Division, SCC, 1200–45 O'Connor St., Ottawa, Ontario, Canada K1P 6N7, (613) 238-3222, fax: (613) 995-4564. Contact NVLAP at A162 TRF Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4016, fax: (301) 926-2884.

#### **CONSORTIUM TO "BREAK ICE" BETWEEN BUILDING SYSTEMS**

Nine control system manufacturers and one software company have joined NIST in a cooperative research and development consortium to help overcome communication barriers among building systems, making it possible for such systems to share data and work together. The partners will be testing a standard communication protocol—known as the Building Automation and Control Network, or BACnet—created by NIST and building industry experts. Tests conducted at NIST during the next 2 years will verify that BACnet can enable different manufacturers' products to communicate and identify any problems before it becomes an industry standard. For more information, contact Steven Bushby, B114 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5873, e-mail: [stbushby@enh.nist.gov](mailto:stbushby@enh.nist.gov) (via Internet).

#### **SYSTEM IMPROVES PERMITTIVITY MEASUREMENTS**

Accurately measuring the permittivity of high-permittivity materials requires special considerations. The conventional method uses a 7 mm-diameter coaxial air line, but the unavoidable air gap between the inner conductor and the sample can introduce a relatively large error. Techniques have been developed to compensate and correct for this error, but the correction is not perfect. Recently, NIST researchers have developed and evaluated a 77 mm-diameter coaxial air line system that reduces this error substantially. This is because the air gap is much smaller in proportion to the dimensions of the coaxial line. For example, a commercial ceramic that had a nominal value of the real part of the complex permittivity of 270 (at 50 MHz to 1000 MHz) was measured as 275 after air-gap correction. The researchers hope to extend the method to the low-frequency range of 0.1 MHz to 50 MHz. For technical information, contact Claude Weil, Div. 813.08, NIST, Boulder, CO 80303-3328, (303) 497-5305.

**NIST VIBRATIONAL AND ELECTRONIC ENERGY LEVELS OF SMALL POLYATOMIC TRANSIENT MOLECULES (VEEL) UPGRADED**  
NIST Standard Reference Database 26—VEEL Version 3.0 now provides rapid access to experimental data on the ground-state vibrational fundamentals of transient molecules having 3 to 16 atoms. Also covered are the electronic energy levels of excited-state vibrational fundamentals of transient molecules having 3 to 6 atoms and of selected transient molecules with 7 to 16 atoms. This version includes 1569 molecules, an increase of 242 molecules from the previous version. In addition, data for the fully deuterium-substituted counterparts of these molecules are included where available. The database upgrade is available from the Standard Reference Data Program.

#### **NATIONAL CONFERENCE ON WEIGHTS AND MEASURES INTERIM MEETING HELD IN BETHESDA, MD, JAN. 9–13**

Over 200 delegates from business and industry in the United States, Canada, and the EC met to resolve several items of interest for national trade practices in the United States and Canada. A full report will be available in May from the Office of Weights and Measures prior to voting at the National Conference on Weights and Measures (NCWM) annual meeting in July in San Diego. The executive committee will recommend an NCWM policy to mutually recognize type evaluations conducted by either Canada or the United States as acceptable for issuing a National Type Evaluation Program Certificate of Conformance. The program began in April 1994. Alternative fuels have been mandated under the revised Clean Air Act. One popular alternative is compressed natural gas (CNG). Existing internal combustion engines that normally operate on gasoline require very little modification to operate on CNG. In order to facilitate retail sales of CNG for dual-use vehicles that can run on gasoline or on CNG, the NCWM Laws and Regulations Committee is proposing that CNG be sold on the basis of the "Gasoline Gallon Equivalent (GGE)." The proposed method of sale defines a GGE as 5.660 pounds of CNG; field testing and verification will be conducted using mass measurement. The NCWM Specifications and Tolerances Committee is recommending several requirements for dispensers to promote the understanding of this marketing unit and preclude problems of mathematical agreement if

the cost of natural gas goes over \$1 per GGE (state and federal tax adds considerably to the unit price of natural gas as an engine fuel). A draft examination procedure for price verification has been prepared for field testing over the next year. The draft represents the cooperative efforts of retailers and state/local weights and measures officials. It will help to achieve accurate correspondence between human-readable posted prices and the prices actually charged using scanning devices reading bar codes that recall computer-stored prices.

#### **NIST DEMONSTRATES PASSIVELY Q-SWITCHED SOLID-STATE WAVEGUIDE LASER**

Two NIST scientists have demonstrated what is believed to be the world's first passively Q-switched solid-state waveguide laser. The NIST device makes unique use of an organic dye saturable absorber embedded in a thin polymer sheet to accomplish the Q-switching function; the absorber is attached to the rear facet of the neodymium-doped waveguide device. As a result, the otherwise passive glass-waveguide laser can be Q-switched (and possibly mode locked) without requiring any electronic drive circuits. Both these functions are required for a variety of applications. Actively Q-switched and mode-locked lasers have been fabricated in neodymium-doped lithium niobate waveguide lasers, but these devices depend on the inherent electro-optic effect in this material and require the separate fabrication of complex modulation electrodes and drive electronics. The special glass used in the NIST device allows a high-powered pulsed output in the glass. This feature is very attractive since the glass is much more efficient as a laser host than lithium niobate.

Lasers based on the NIST development should be inexpensive and easy to manufacture since the Q-switching function is performed by the passive saturable absorber which can be bonded readily to the waveguide. In combination with a laser diode pump, the finished laser package could be quite compact; potential applications are envisioned in laser radar, sensors, biotechnology, and medicine. The laser waveguide was fabricated in a neodymium-doped phosphate glass developed in the context of a Cooperative Research and Development Agreement with a private company. The device was optically pumped at a wavelength near 800 nm. Typical operating conditions for the demonstration device are 1mW average power,

Q-switched peak power in excess of 1 W, and a pulse width of 20 ns.

#### **TEST DEMONSTRATES THE USE OF PRECISION DIGITAL MULTIMETERS FOR AUDITING**

NIST researchers recently carried out performance tests on a set of special resistance standards and a precision commercial digital multi-meter in an exercise that shows that these instruments can be used as the basis for carrying out an assessment, or audit, of the capabilities of a laboratory to make measurements of quantities such as ac and dc voltage and current and dc resistance. A U.S. commercial calibration laboratory had requested accreditation by the United Kingdom National Measurement Accreditation System (NAMAS); NIST cooperated with NAMAS in this process.

NIST scientists used the multifunction calibration system to calibrate the precision multimeter, which has a short-term stability good enough to justify its calibration to accuracies approaching those of laboratory standards, such as Zener-based dc voltage references. Once calibrated, the multimeter was used as the principal component of a technical audit package in an accreditation process for the measurement of electrical quantities, replacing a multiplicity of working transfer standards previously required. As part of the process, officers of NAMAS invited two NIST staff members to be observers of the 2-day preassessment visit to the commercial calibration laboratory by NAMAS, concerned primarily with the laboratory's quality manual and a technical evaluation of the company's laboratory facilities.

#### **PAPERS ON MASS DETERMINATION AND GRAVIMETRIC APPLICATIONS**

A NIST scientist has recently completed a series of five definitive papers on mass measurement and gravimetric applications. The titles of the papers are: (1) "Examination of Parameters That Can Cause Error in Mass Determinations," (2) "The Determination of Density of Mass Standards; Requirement and Methods," (3) "The Electronic Balance and Some Gravimetric Applications (The density of solids and liquids, pycnometry, and mass)," (4) "The Mass Unit Disseminated to Surrogate Laboratories using the NIST Portable Mass Calibration Package," and (5) "The Piggy-back Balance Experiment; An Illustration of Archimedes' Principle and Newton's Third Law."

This series is part of a sequence of papers, with several more to come. The first paper examines the parameters that can cause error in mass determinations and estimates the magnitude of consequent errors. The uncertainties in the embodiment of the kilogram in the platinum-iridium (Pt-Ir) artifact are examined, the propagation of uncertainties is traced from the Pt-Ir artifact to the system of stainless steel artifacts through mass comparison. The last of these papers will be useful as an instruction tool for the study and demonstration of the concept of buoyancy. These papers indicate, through the proper use of the modern electronic balance, the diminishing need for calibrated weight sets in mass determination, density determination, pycnometry, glassware calibration, and other gravimetric applications. The proper determination and application of uncertainty statements, application of analytical techniques, and the selection and use of balances are indicated. Several other definitive papers in this sequence are in preparation.

#### **NIST PARTICIPATES IN DEFENSE CONVERSION AWARD FOR GEAR METROLOGY PROGRAM**

The Precision Engineering Division (PED) of NIST is a partner in a program to assist the American gear industry in improving the quality assurance of the production of precision gears. The White House recently announced the selection of this gear metrology program for funding as part of the Advanced Research Projects Agency's Defense Conversion Program.

The PED program, "The Deployment of a National Infrastructure for Gear Metrology," involves a partnership with the American Society of Mechanical Engineers (ASME), the American Gear Manufacturers Association (AGMA), the Department of Energy (DOE) Y-12 Plant, and the Pennsylvania State University Applied Research Laboratory. One of the goals of the program is to (re-)establish traceability to the international standard of length, through NIST, for the precision dimensional measurements made by the American gear industry in the production of gears.

The program seeks to accomplish its goals by establishing a joint NIST-DOE Center for Gear Metrology at the Y-12 Plant in Oak Ridge, TN. This Center for Gear Metrology will provide a primary calibration service for gear artifacts and master gears for industry. The calibration service will provide measurements that are directly traceable to measurements of standard reference

artifacts made by NIST. The Center for Gear Metrology also will serve as a conduit of information in gear metrology by acting as a user facility for the industry and by promoting training and education in gear metrology. NIST, along with its partners, also will take steps toward improving the measurement standards associated with, and needed by, this industry.

The program has created an ASME Committee on Gear Metrology (COGM) that is chaired by the AGMA and vice-chaired by NIST. The COGM presently has about 40 members from the industry and is the primary means by which the industry can provide input toward the development and direction of this program.

#### **VERSION 4.0 OF REFPROP RELEASED**

An update to the NIST Thermodynamic Properties of Refrigerants and Refrigerant Mixtures database, better known as REFPROP, was released in November 1993. The database, developed by NIST scientists, calculates the thermodynamic and transport properties of refrigerants and refrigerant mixtures with up to five components; it is being widely used in the refrigeration industry to evaluate alternatives to ozone-damaging chlorofluorocarbon and hydrochlorofluorocarbon refrigerants. The database can be used in an interactive mode on a personal computer, or the FORTRAN source code can be used to access property data directly from a user-written application. With version 4.0, 12 new fluids, including several of the "natural refrigerants" have been added, bringing the total to 38. New data for additional refrigerant mixtures also have been added. The most significant enhancement is the addition of special high-accuracy equations of state for 11 pure fluids, including many of the leading new refrigerants. The database is distributed by the NIST Standard Reference Data Program.

#### **CORRELATED PHOTONS FOR STANDARDLESS DETECTOR CALIBRATION**

NIST has begun a program to develop correlated photon methods for radiometric applications. This method allows photon counting detectors to be absolutely calibrated without reference to any calibrated standard detector. Correlated photons are produced by the process of parametric down conversion where a photon decays within an appropriate non-linear material into a pair of photons under the restrictions of energy and momentum conservation. Two detectors, A and B, are placed

to intercept each of the photons in the pair. Since these photons are created at the same time, the detection of one photon of the pair indicates the existence of the second photon. Whenever detector A registers a count, a photon is also incident on detector B so the ratio of the coincidence count rate to the single count rate of detector A is the absolute efficiency of detector B. The prior knowledge of the efficiency of detector A is not needed for this measurement, but it could be determined from the measurement as easily as the efficiency of detector B. An apparatus to produce correlated photons and detect coincidences has been set up. Tests are under way to calibrate the efficiencies of avalanche photodiodes and the quantum efficiencies of photomultipliers.

#### **INFRARED CALIBRATION MEASUREMENTS IN SUPPORT OF NASA CASSINI MISSION**

NIST scientists have characterized the infrared spectral absorptance of NASA calibration detectors. The spectral measurement covers a wavelength range of 2 m to 20 m using a Fourier transform infrared spectrometer in combination with an integrating sphere and a HgCdTe detector. The spectral absorptance data are required to determine the absolute response of NASA's detectors. These detectors are being used to calibrate the detector systems that will be placed on board the Cassini satellite. The Cassini Mission will involve placing a satellite into orbit around Titan, one of Saturn's large moons. Infrared detector-based systems on the satellite will be employed to study Titan's surface and atmosphere.

#### **STRUCTURES OF TRIGLYCERIDE MICROEMULSIONS FOR PROCESSED FOOD**

Interest in microemulsions is substantial because of their ubiquitous presence in nature and applications in the food, petroleum, and pharmaceutical industries. A microemulsion is a stable dispersion of several components (usually oil, water, and surfactant) with characteristic lengths less than 100 nm to 200 nm. Small-angle neutron scattering (SANS) is capable of probing the structure of materials on this distance scale.

Using the SANS spectrometer in NIST's Cold Neutron Research Facility, scientists from the U.S. Army Research Development and Engineering Center, the U.S. Department of Agriculture Research Center, and NIST have completed a first study of a prototype microemulsion found in many food products using small-angle neutron scattering.

The phase diagram of this system at 20 °C shows several regions of stability (as a function of the fraction of soybean oil, water, and surfactant components) separated by compositions which do not produce stable microemulsions. The details of the microstructure of several stable compositions which allow use in food and food processing were accomplished by small-angle neutron scattering using different contrasting conditions for the several components. A geometric model was constructed and used to extract key quantitative features of the structure for different emulsion conditions and has demonstrated the existence of bicontinuous and other connected structures over a wide range of component and surfactant concentrations, which are surprising and not in line with expectations. Further studies are under way with the goal of aiding development of improved properties and stability of microemulsions used in many processed food products.

#### **CONSORTIUM ON CERAMICS POWDER AND SLURRY CHARACTERIZATION**

Five producers of silicon nitride powder or finished components, an instrument manufacturer, and a federal laboratory have joined an industry/government consortium to be conducted at NIST in an effort to improve the processing of ceramic powders and slurries.

The overall goal of the program is to develop the nondestructive evaluation tools that industry needs for the intelligent processing of ceramic powders and slurries. This will be accomplished by generating information on powder and slurry behavior during processing, and by producing models and sensor techniques for on-line measurements and process controls during the manufacture of materials. A further goal of the consortium is to develop process models for various sub-processes involved in the production of ceramic powders. Combining all of these research results should enable a company to process ceramics more reliably and economically.

#### **NIST HELPS PRIVATE COMPANY OPTIMIZE MANUFACTURING PROCESS**

NIST and a private company are developing the technology needed to optimize the use of resin transfer molding (RTM) to fabricate composite parts for commercial aerospace applications. The private company is interested in RTM to replace the expensive and labor intensive autoclave process. In RTM, the fiber reinforcement is placed into the



mold, often as layers of fabric shaped into the form of the part. A liquid resin is then injected into the mold, and heat is applied to convert the resin to a rigid polymer. Proper filling of the mold is critical if the fabrication is to be successful. NIST has developed process simulation models that make it possible to rapidly and easily examine a wide range of mold designs and processing conditions so the best combination can be determined. Without the aid of such simulations, expensive and time-consuming experiments, often using full-scale equipment, are required to select an acceptable mold design and processing cycle. To help test and refine the simulation models, the company is conducting flow visualization experiments using molds with transparent sides. The first major test of the simulation's predictions has now been completed, and the model successfully predicted the filling pattern and time to fill for test plaques made with different reinforcements. Although the overall predictions were very good, some of the details in the fill pattern were not predicted correctly, and these results are being used to refine and improve the simulation programs.

#### **GIANT MAGNETORESISTENCE EFFECTS IN ELECTRODEPOSITED MULTILAYERS**

As part of a cooperative program with the University of Maryland, NIST researchers have completed development of a very fast coulometer-potentiostat that in principle allows layers of copper to be produced as thin as one monolayer. Using high-angle x-ray diffraction, the researchers have verified that layers as thin as three monolayers have been grown. They also have developed and tested an automated data acquisition system utilizing a four-point probe to measure magnetoresistance and have used this system to measure the magnetoresistance of a wide variety of both copper/nickel and copper/cobalt alloy multilayers as a function of copper thickness, the thickness of the ferromagnetic layer, and the field orientation. They have demonstrated that electrochemically produced alloys of cobalt-nickel-copper/copper exhibit a significant giant magnetoresistance effect and have measured the sensitivity (slope) of the magnetoresistance curve. For the first time they have demonstrated that electrochemically produced multilayers exhibit spin valve behavior, oscillation in the magnetoresistance, oscillations in the full width at half maxima of the resistivity curve, and, for the copper/nickel system, exhibit oscillations in the sensitivity (slope). In addition, the researchers have

measured the period of this oscillation to be 1.2 nm for copper/nickel, have measured an oscillation in the magnetoresistance of cobalt alloy/copper electrochemically produced multilayers, and have identified a Langevin scattering mechanism at high field strength.

#### **FIRE SAFETY OF PASSENGER TRAINS: A REVIEW OF EXISTING METHODS AND OF NEW CONCEPTS**

High-speed trains are being used increasingly around the world and are particularly popular in Europe. Currently, there are several pilot studies to evaluate their feasibility for use in the United States. Recent advances in passenger-guided ground transportation, fire-test methods, and hazard analysis necessitate re-examination of requirements for safety in general and fire safety in particular. Several studies have indicated nearly random ability of current tests to predict actual fire behavior. Fire safety in any application, including transportation, requires a multifaceted approach. The effects of vehicle design, material selection, detection and suppression systems, and emergency egress on the overall fire safety of the transportation system are considered.

A new report, *Fire Safety of Passenger Trains: A Review of Current Approaches and New Concepts* (NIST TN 1406), compares the approaches used in the United States, Germany, and France. With the strengths and weaknesses of current methods for measuring the fire performance of rail transit systems reviewed, a direction is suggested in which most fire-science-oriented organizations in the world are clearly headed toward fire hazard and fire risk assessment methods supported by measurement methods based on heat release rate.

#### **NEW PUBLICATION FOCUSES ON SECURITY IN ELECTRONIC COMMERCE**

NIST Special Publication 800-9, *Good Security Practices for Electronic Commerce, Including Electronic Data Interchange*, presents security procedures and techniques that constitute good practices in the design, development, testing, and operation of electronic commerce systems. Electronic commerce uses documents in electronic form, rather than paper, for business or government functions that require interchange of information, obligations, or monetary value between organizations. The document discusses the content of the trading partner agreement and the components of electronic commerce systems, including

the networks connecting the partners. Security techniques considered include audit trails, contingency planning, use of acknowledgements, electronic document management, activities of supporting networks, user access controls to systems and networks, and cryptographic techniques for authentication and confidentiality.

### **IMPROVED MACHINE TOOL HEADS FOR THE FACTORY**

A computer model developed by NIST researchers can substantially improve the cutting accuracy of an advanced piston-turning machine used by U.S. automakers. That's the conclusion of a 13-month phase of a collaboration between NIST, and two automobile manufacturers, and the maker of a high-precision machine tool. The project was organized, managed, and funded by the National Center for Manufacturing Sciences. The piston-turning machine, introduced by the machine tool manufacturer in mid-1992, already cuts automobile engine pistons so precisely that, over a range of operating conditions, dimensions vary by less than half the diameter of a human hair. With NIST's accuracy enhancement software (which compensates for temperature-caused changes and other errors) incorporated, dimensional variation was reduced to less than one-tenth the diameter of a human hair. The machine tool manufacturer intends to incorporate the NIST software into new versions of the piston-turning machine. The improved accuracy will provide auto manufacturers the flexibility to make small batches of different-sized pistons, while satisfying increasingly stringent dimensional tolerances. The software also should produce energy savings, since the error-compensating software eliminates the hour or so required to warm up the machines until they reach a steady operating temperature.

### **INVENTION TO IMPROVE IR CHEMICAL ANALYSIS**

A newly patented NIST device and technique may lead to dramatic improvements in infrared spectroscopy, a process used to identify and quantify components making up a chemical sample. Making the improvements possible is a NIST-designed sample-holding cell, which provides a simple, efficient, and cost-effective means of cooling samples (to temperatures as low as  $-40^{\circ}\text{C}$ ) during the

measurement of their infrared radiation absorption spectra. Such cooling is important because during IR spectroscopy, the sample is heated by the radiation, causing evaporation of solvents and chemical samples in the cell and yielding inaccurate readings. Moreover, many samples are thermally sensitive and may be degraded by the heat. Conventional chilled sample cells produce unfavorable temperature gradients within the sample and allow heating to occur through the window where the IR radiation enters the sample cell. The new NIST cell is chilled with a cold air stream that minimizes heating from the IR beams. It is much smaller than the conventional cell, is easier to use, and will fit any spectrophotometer. For more information, contact cell inventor Thomas J. Bruno at Div. 838.01, NIST, Boulder, CO 80303-3328, (303) 497-5158, e-mail: bruno@bldrdoc.gov (via Internet).

### **FEMTOCHEMISTRY SEES QUICKEST ATOMIC MOTIONS**

Using ultrafast optics and lasers, physicists and chemists are opening a portal through which they can view the subtlest and quickest changes in atomic motions. Understanding these ultra-small, ultrafast changes could lead to new avenues for controlling chemical reactions at surfaces, say scientists at NIST. Speaking at the recent American Physical Society annual meeting, NIST surface scientists explained that the emerging field of femtosecond ( $10^{-15}$  s) chemistry could enable scientists to break chemical bonds selectively, spur reactions and choose desired products. Scientists are using precisely timed laser pulses to see femtosecond changes in various parts of atoms and molecules. Measuring these changes gives scientists a glimpse of the various stages atoms go through in a reaction. Just as a photographer uses a shutter faster than his subjects to freeze action in an Olympic race, scientists have devised a very fast shutter based on the speed of light to measure molecular motions. Laser pulses, which travel approximately  $3 \times 10^8$  m/s, can freeze action in atoms that vibrate about as fast as sound travels. The experiments are helping scientists understand how quickly energy is transferred between different molecules on a surface.

### **GUIDE HELPS MANAGERS “AIR OUT” ENERGY PROBLEMS**

Building owners and operators often walk a tightrope trying to bring in enough outdoor air for the comfort and health of occupants while controlling the energy required to heat or cool the air. To balance these two requirements, they need to understand both how the ventilation system is designed to operate and how it is actually performing. NIST scientists have written a practical guide for those wishing to assess their building's ventilation system. It could be used, for example, by a building operator to develop a preventive maintenance program. The manual also could be used by an industrial hygienist attempting to solve an air-quality problem. The guide, *Manual for Ventilation Assessment in Mechanically Ventilated Commercial Buildings (NISTIR 5329)*, includes easy-to-follow information on airflow and building ventilation, measurement techniques and assessment procedures. NISTIR 5329 is available for \$27 prepaid from the National Technical Information Service, Springfield, VA 22161, (800) 553-6847. Order by PB 94-145653.

### **PAPER HIGHLIGHTS LIGHTWAVE STANDARDS DEVELOPMENT**

Researchers, technicians, and businessmen associated with the field of lightwave communications will be interested in a new paper describing NIST's activities in developing standards for the industry. Research and service programs highlighted include those in optical fiber geometry, fiber chromatic dispersion, absolute optical power, detector frequency response and wavelength division multiplexing. One example from the paper: NIST's development of highly calibrated fibers—sold as Standard Reference Materials—to improve fiber geometrical tolerances. High tolerances will be needed as optical fiber begins to replace copper wire in homes and offices. Numerous splices and connectors in optical fiber can result in signal loss unless there is precise fiber alignment. For a copy of paper no. 9-94, contact Sarabeth Moynihan, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-7765, e-mail: moynihan@bldrdoc.gov (via Internet).

### **NEW SHIELDING FOR RADIOTHERAPY DEVELOPED**

A new shielding material and method created by a NIST dental researcher protects healthy body

tissues near areas targeted for radiation therapy. The shielding is easy to fabricate and can be used during the treatment of tumors or lesions in the mouth or on the body. The shields are made from two layers of elastomeric polymers such as those commonly used for dental impressions. One layer is filled to approximately 95 percent by weight with heavy metal powders of silver, tin or copper that diffuse the radiation. Easily molded, it can be altered to fit the contours and configurations required by dentists and radiotherapy technicians. “The new technique is simpler and less time consuming than current shielding processes,” says inventor and associate director of the American Dental Association Health Foundation Paffenbarger Research Facility at NIST. He says the shielding material fulfills two critical dental requirements. First, patients need protection for the salivary glands (important in helping reduce oral decay) that can be destroyed by radiation. Secondly, dentists and therapists need a shielding device that can be made easily in outpatient facilities. For more information, contact Frederick Eichmiller at A153 Polymer Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6813, e-mail: powder@enh.nist.gov (via Internet).

### **NIST ANSWERS INDUSTRY'S CALL FOR MEASUREMENT PROGRAM**

Development trends for semiconductors—the building blocks of products and services in such diverse areas as air traffic control, patient diagnostics and electronic funds transfer—are racing toward smaller dimensions in integrated circuits, greater circuit complexity and higher speeds. Fast-paced development requires dramatic, challenging steps in creating measurement tools to keep advanced microelectronic manufacturing competitive. NIST's new National Semiconductor Metrology Program will help U.S. industry meet these challenges. The Semiconductor Industry Association called for the program in developing its national semiconductor technology roadmap, which charts the technical course for the semiconductor industry through 2007. NIST has a long history of working in semiconductor measurement science and technology. For technical information about the National Semiconductor Metrology Program, contact Robert Scace, A323 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4400, fax: (301) 948-0978, e-mail: scace@micf.nist.gov (via Internet).

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#### **NEW SPIN ECHO INSTRUMENT TO BE FIRST IN THE UNITED STATES**

A new device for studying advanced materials will be the only one of its kind in the United States when it comes on line by the end of 1994. The neutron spin echo spectrometer, one of 15 experimental stations at NIST's Cold Neutron Research Facility, will reveal how the microscopic, time-dependent processes in polymers, proteins and magnetic materials influence the physical properties of such materials. The instrument will be able to measure very small energy changes in the motion of polymer chains, biological molecules, and other advanced materials. Several European countries, as well as Japan, India, and Russia, already have neutron spin echo spectrometers. The instrument detects molecular or magnetic motions within a sample by measuring the change in spin of a neutron after it scatters from a sample. The instrument essentially consists of two precisely matched paths through magnetic fields, which adjust to cause a polarized neutron beam to rotate in mirror-image fashion before and after the sample. A private company recently signed a cooperative research and development agreement to support the development and operation of the new spectrometer. For more information, contact Nick Rosov, E151 Reactor Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5254, e-mail: [nrosov@enh.nist.gov](mailto:nrosov@enh.nist.gov) (via Internet).

#### **INDUSTRY TO IMPROVE NIST'S MOLECULAR-LEVEL VISION**

Materials researchers will gain a better view of certain molecular structures following improvements to a neutron scattering instrument at NIST. A private company recently agreed to support upgrades to one of NIST's small-angle neutron scattering, or SANS, instruments. In exchange for this support, the company will receive a percentage of instrument time for nonproprietary research. According to its cooperative research and development agreement with NIST, the company will provide financial and scientific support for operation of the SANS instrument. The SANS improvements, which are expected to be complete by early 1995, will extend the device's measurement range and add additional automation. The SANS instrument, completed in 1991 with support from a private company and the University of Minnesota, allows researchers to examine micro-structures of various materials such as polymers, biological macromolecules, ceramics, metals and alloys. The instrument is now capable of measuring structures between 6 nm and 600 nm in size. Improvements will allow it to view features as small as 1 nm. Qualified U.S. researchers may apply for instrument time. For more information, contact Charles J. Glinka, E151 Reactor Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6242, e-mail: [glinka@enh.nist.gov](mailto:glinka@enh.nist.gov) (via Internet).

#### **NIST, DOE NOW OFFER PRECISION MEASUREMENT SERVICE**

Once available only from foreign laboratories, a precision measurement, service for manufacturers of automobiles, aircraft, farm equipment and other large products is now being offered in the United States, thanks to a growing collaboration between NIST and the Department of Energy's Centers for Manufacturing Technologies at the Oak Ridge (Tenn.) Y-12 Plant. Staff at the Y-12 Plant will calibrate end standards and step gauges up to 1.35 m in length with an uncertainty of 0.7  $\mu\text{m}/\text{m}$ . This is equivalent to about one-hundredth of the diameter of a human hair. All measurements performed at Y-12 are certified as to their uncertainty

by NIST. Plans call for extending the upper limit for one-dimensional measurements to 1600 mm and to add services for grid and ball plates. For more information, contact Dennis Swyt, A107 Metrology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3463, e-mail: swyt@micf.nist.gov (via Internet).

#### **MICELLE COMPLEXES TO BE FOCUS OF CRADA RESEARCH**

NIST and a private company have signed a cooperative research and development agreement to study the interaction between the company-developed cylindrical micelles (super complexes formed when a cationic surfactant/acid complex is placed in solution) and inorganic materials such as clay. One result of the collaboration could be the construction of a novel composite material composed of inorganic silica-based particles from the clay embedded in an organic matrix formed from the micelles. The micelle/clay samples will be prepared by NIST using organic ingredients provided by the company. The mechanical structure of the samples will then be investigated by various methods, including light, x ray, neutron scattering, and chromatography. The company also will attempt to polymerize the samples. For more information, contact Howard J. M. Hanley, Div. 838, NIST, Boulder, CO 80303-3323, (303) 497-3320, e-mail: hanley@bldrdoc.gov (via Internet), or S. K. Sinha, Exxon Research and Engineering, Clinton Township, Annandale, NJ 08801, (908) 730-2875.

#### **IN-HOUSE DESIGNED CUSTOM COMPARATOR CHIP PROVIDES NEW CAPABILITIES TO NIST WIDEBAND SAMPLING PROBE**

Two NIST scientists have developed an improved waveform sampling probe that can serve as the sensor for a wideband sampling voltmeter. The heart of the probe is a custom-made analog comparator chip designed by division staff and fabricated at a private company. The comparator provides a 3 dB bandwidth of 2.5 GHz and a settling-time accuracy of 0.1 percent in 2 ns. By contrast, commercial comparators have bandwidths of about 1 GHz and may take as much as 150 ns to settle with the same accuracy. The chip is directly wire bonded to traces on a four-layer circuit board to eliminate the parasitic reactances that would result from the use of a package leadframe. Additional reference-level scaling and time-delay circuits are included to "enable" the comparator at a precise time interval

prior to strobing the comparator. To provide shielding from the effects of electromagnetic interference, the scientists enclosed the probe electronics in a machined brass housing small enough to permit the probe input to be connected directly to the signal source without intervening cables.

Although developed initially for high-speed time-domain signal sampling, the probe also supports accurate measurement of wideband frequency-domain signals. Activation of the input transistors only 2 ns before each new comparison virtually eliminates differential heating of these transistors and results in eliminating "thermal tail" errors to significantly improve the accuracy of frequency-domain measurements in the range 100 kHz to 10 MHz. To extend the utility of the probe to higher voltages, the division team designed a custom attenuator that facilitates voltage measurements to  $\pm 20$  V. The team tested the attenuator/probe combination and showed it to have a nearly flat gain characteristic with frequency (less than 70  $\mu$ Hz/Hz deviation) over the range 100 Hz to 1 MHz. Specimen sampling probes have been supplied to industry for evaluation and to sponsoring organizations. Additional tests are being carried out at NIST.

#### **NIST DEVELOPS DIGITAL PARTIAL DISCHARGE RECORDING AND ANALYSIS SYSTEM**

NIST scientists have developed a new digital partial discharge recording and analysis system, extending the capabilities of the analog system previously developed and recognized with an R&D 100 award. Society depends on electric power transmission and distribution networks having high reliability; partial-discharge analysis provides a capability for detecting incipient failures before widespread disruption of the power grid occurs. The ability to analyze partial discharge data also contributes to better understanding of failure mechanisms in insulating systems, such as those used in equipment for the grid. This enhanced understanding makes possible the design of more reliable and efficient equipment that is competitive in world markets because it avoids the overdesign that contributes to high operating losses.

Since operation of the new analysis system results in the generation of binary files representing the raw partial-discharge data, the data in these files can be processed at any later time by software implementing stochastic methods of analysis. Thus, the system offers the capability of new types of

analysis not possible with a real-time system limited to carrying out analysis as the partial discharge events occur; an example is determining the distribution in number of partial discharge pulses per cycle. The generated files can be regarded as archival records, providing an opportunity not only to make multiple analyses of the same segment of data but also to reanalyze the data in the future in the light of new understanding of the partial-discharge phenomena or for comparison with later records from the same apparatus. NIST scientists have demonstrated these benefits in connection with aging studies and validated the performance of the digital system by comparison with results from the analog system. The system incorporates a custom two-channel digitizer (one channel for positive-going pulses, one for negative) coupled to a 16 bit parallel interface installed in a personal computer. The digitizer is under software control and digitizes a partial-discharge pulse stream as a series of 16 bit words recording polarity, amplitude, and time since the last positive-going zero crossing of the applied alternating voltage.

#### **STUDY OF DEGRADATION OF HIGH-TEMPERATURE SUPERCONDUCTOR THIN-FILM SURFACES EXPOSED TO VARIOUS GASES AND VACUUM SUPPORTS DEVELOPMENT OF PRACTICAL SUPERCONDUCTING ELECTRONICS**

Three NIST scientists have completed a study of surface degradation of superconducting YBCO [ $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ ] thin films as a result of exposure to air, carbon dioxide, nitrogen gas, oxygen gas, and vacuum. The results are important for the development of contact technologies for applications of high-temperature superconducting electronics, including superconducting microwave components and superconducting multichip modules. A requirement for cooling with liquid nitrogen, or to the liquid-nitrogen temperature of 77 K, means that high-temperature superconductors can be considered for practical applications outside the cryogenic laboratory, compared to the demanding requirement for cooling with liquid helium required by conventional low-temperature superconductors.

The scientists studied surface degradation with reflection high-energy electron diffraction (RHEED), scanning tunneling microscopy, and contact resistivity measurements. They monitored the formation of an amorphous surface reaction layer with

RHEED and correlated this formation to an increase in contact resistivity. They also found that the contact resistivity of specimens exposed to air increased exponentially with the square root of exposure duration. The team members concluded from their results that interface conduction occurs by tunneling through a diffusion-limited surface reaction layer. They further concluded that some YBCO surface degradation occurs during in-situ processing and that interfaces having contact resistivities of  $10^{-8} \Omega \cdot \text{m}^2$  still do not exhibit the intrinsic conductivity expected of the interface between a superconductor and a normal metal.

#### **ABSORPTION OF NASA WEDGES TESTED IN NIST IMPEDANCE TUBE**

NIST scientists characterized the acoustical absorption of a number of configurations of wedges and fiberglass sections of varying density backed by air spaces of varying thickness. The different configurations of wedges, fiberglass sections, and air spaces were implementations of wedge designs under consideration for use in a new wind tunnel currently under construction at the NASA Langley Research Center. Absorption coefficients were determined for the wedge designs over a frequency range of 50 Hz to 300 Hz using the large NIST impedance tube measuring 9.4 m in length.

The NIST scientists worked with staff of the NASA Langley Research Center in analyzing the measurement results during testing so that new wedge designs could be conceived and implemented while the testing took place. The test results enabled personnel of the NASA Langley Research Center to evaluate the low-frequency acoustical performance of a wide variety of wedge designs prior to large-scale fabrication and installation in the wind tunnel. Additional tests to characterize the high-frequency absorption of panels fabricated using a limited set of the more successful design approaches are anticipated.

#### **ASTM CONSIDERS USING NIST DATA TO ADJUST TOLERANCE LIMITS ON ALUMINUM ULTRASONIC REFERENCE BLOCKS**

The American Society of Testing and Materials (ASTM) Committee E07-06-02 on Ultrasonic Standards and Reference Blocks is working with NIST scientists to tighten the standard tolerance limits on ultrasonic flat-bottom-hole reference blocks. The ultrasonic echo-amplitude reflected from flat-bottom-holes drilled in aluminum blocks is measured as a function of metal-path distance and

hole-size. These blocks, after calibration, can be used by ultrasonic NDT personnel to evaluate ultrasonic instrumentation or to estimate the size of material defects. ASTM standard E127, Standard Practice for Fabricating and Checking Aluminum Alloy Ultrasonic Standard Reference Blocks, describes the reference blocks and the procedures and instrumentation used for calibrating them. The ultra-sonics group has performed this calibration service for industrial clients for the past 17 years. During this time, NIST has accumulated a large database containing over 4800 individual calibration measurements. ASTM E07-06-02 is interested in using this database to adjust the current E127 tolerance limits on the ultrasonic response values from E127-type reference blocks. A new document titled NIST Calibration of ASTM E127-Type Ultrasonic Reference Blocks, which describes the ultrasonics group's calibration of these standards and the ultrasonic reference block database, will be published this year.

#### **INTERACTIONS WITH THE NATIONAL CENTER FOR METROLOGY (CENAM) OF MEXICO**

NIST scientists have been helping their counterparts at CENAM set up premier metrology laboratories for thermometry, fluid flow, and pressure since the creation of CENAM in November 1990. NIST scientists helped to design laboratories and provided advice on instrumentation requirements. They also provided training in metrology for the staff of CENAM by presenting lectures and short courses as part of an international symposium on quality and metrology organized by CENAM. Additionally, the NIST guest researcher program has been used to provide extensive experimental and administrative training for CENAM staff.

To further help CENAM, the thermometry group of NIST is providing thermometric fixed-point cells containing the high-purity metals required for the defining fixed points of the International Temperature Scale of 1990 (ITS-90), CENAM will thus have the capability to realize the ITS-90 from 0 °C to 962 °C and will be able to perform the required calibrations. Also, some special NIST reference thermometers (gold versus platinum thermocouples) for use up to 1000 °C are being provided to CENAM for precise high-temperature measurements.

#### **CHEMICAL MECHANISM DEVELOPED FOR FLUOROCARBONS**

A collaborative effort by NIST scientists and a researcher from the University of Massachusetts, has resulted in the first detailed chemical-kinetic mechanism for fluorocarbon destruction and flame suppression. The work done was part of a larger effort at NIST, which sought to find alternative chemical extinguishers for the widely used Halon 1301 (CF<sub>3</sub>Br). The new mechanism includes over 70 species and more than 800 reactions. It was developed through a heavy reliance on computational-chemistry methods for calculating thermochemical and kinetic values for those situations where experimental data were unavailable.

The kinetic mechanism has been applied to several reactor geometries in which increasingly sophisticated fluid dynamic and transport effects were modeled, in conjunction with the chemistry. By using different fluorocarbon agents in the simulations, the mechanism of fluorocarbon destruction and the influence on flame structure, temperature, and speed were calculated. The results obtained to date are in qualitative agreement with preliminary measurements obtained at NIST and other laboratories outside of NIST. This work will guide further experimental investigations and will provide a rational basis for the design and choice of agents that are alternatives to Halon 1301.

#### **NIST PROGRAMS IN SUPPORT OF THE NATIONAL CANCER PROGRAM**

The President's Cancer Panel conducted an open meeting on January 31, 1994 at the National Cancer Institute to review the role of government agencies in the research mission of the National Cancer Program. Information on the many NIST measurement programs that support the war on cancer was presented by a NIST scientist. Sixteen NIST projects were described, organized into the areas of cancer prevention, diagnosis, and therapy.

Projects in cancer prevention include the development of measurement techniques and Standard Reference Materials (SRMs) for environmental carcinogens, methods to measure a number of biomarkers to screen for high cancer risk, and a measurement program for micronutrient chemopreventive agents. Projects in cancer diagnosis include the development of accurate measurement methods for key physical parameters in x-ray

mammography and of well-characterized radio-pharmaceutical SRMs for nuclear medicine procedures used to detect tumors. The cancer treatment projects include a program on dosimetry measurement quality assurance for radiation therapy, development of dosimetry techniques for new radiation treatment modalities, and the development of a procedure based on two-dimensional electrophoresis to monitor the level of cancer proteins during the course of chemotherapy.

#### **NOAA-NIST COLLABORATION ON ATMOSPHERIC CHEMISTRY**

In a continuing collaboration between NOAA and NIST, red diode lasers are being used to detect  $\text{NO}_3$  radicals. This molecule plays an important role in atmospheric photochemistry. In the stratosphere its photochemistry affects ozone depletion, and it acts as a strong oxidizer in the troposphere.

$\text{NO}_3$  has a strong electronic absorption band at 662 nm that can be reached with commercial red diode lasers. In these experiments, a solitary diode laser is used to detect the time-dependent concentration of  $\text{NO}_3$  in an excimer-laser photodissociation experiment. Good detection sensitivities are achieved with simple absorption measurements. Current sensitivity for  $\text{NO}_3$  molecules is about  $5 \times 10^{10} \text{ cm}^{-3}$  with a 1 m, single-pass absorption path length. The sensitivity could be improved by subtracting residual low-frequency AM noise, using high-frequency modulation, or multipassing the beam in the absorption cell.

The experiment illustrates the potential of very simple diode laser systems for detecting reactive molecules that play an important role in the laboratory and in the Earth's atmosphere.

#### **DIRECT OBSERVATION OF MAGNETIC FLUX FLOW IN HIGH-TEMPERATURE SUPERCONDUCTORS**

The use of high-temperature superconductors in high-field applications such as motors and magnets requires the magnetic flux lines be immobilized or pinned as an electrical current is passed through the material. Defects in the material may act as flux pinning centers (thereby increasing the critical current density  $J_c$ ) or as easy paths for flux flow (leading to low  $J_c$ ). A high-resolution, magneto-

optical measurement system at NIST has been used to obtain the first direct, real-time observations of magnetic flux flow in polycrystalline samples of the  $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$  superconductor. Quantitative, microscopic maps of the flux distribution generated by means of an image processing system were compared directly with optical micrographs of the sample to correlate flux flow to the microstructure. It was observed that flux penetrated along many grain boundaries at very low applied magnetic fields of 1 to 2.5 mT. Some very low angle grain boundaries were found to pin the flux lines and impede flux flow. These results provide important guidelines for tailoring the microstructure of polycrystalline  $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$  for high  $J_c$  applications.

#### **EVALUATION OF PHASE DIAGRAMS FOR PB-FREE SOLDER ALLOYS**

Phase diagrams calculated and evaluated at NIST have been critical to an industrial consortium developing new Pb-free solder alloys that meet stringent manufacturing, performance, and environmental standards for commercial applications. In this program, NIST researchers are determining which property data and measurement techniques are necessary to predict ultimate solder performance in manufacturing and use. This work is part of a large research and development program, organized by the National Center for Manufacturing Sciences with collaboration and in-kind contributions from nine corporations, Sandia National Laboratories, Rensselaer Polytechnic Institute, and NIST, focused on Pb-free solders. Because of its special expertise, NIST is responsible for solderability measurements and for evaluating the phase diagrams of the candidate binary, ternary, and quaternary solder systems. From an extensive list of possible Pb-free solder alloys, alloy systems have been selected for detailed laboratory and manufacturing evaluation based on the NIST phase diagram calculations. NIST researchers determined specific composition regimes where the temperature difference between liquidus and solidus fulfills the requirements for solder alloys, thus significantly reducing the number of alloys to be tested and leading to the development of new alloys for consideration.



### **NEW NEUTRON METHODS FOR SURFACE CORROSION AND ELECTROCHEMISTRY**

In collaboration with electrochemists from the University of Minnesota and materials scientists from Johns Hopkins University, NIST scientists have developed neutron reflectivity and small-angle neutron scattering as probes for investigating the structure of metal oxide films in situ under electrochemical control. Reflectivity offers a spatial resolution unobtainable with any other in situ probe, and small-angle scattering is ideally suited to studying the evolution of electrode surface morphology. The techniques have been used recently to monitor a variety of electrochemical processes of fundamental and practical importance, including oxide growth and homogeneity, dynamic roughening of electrode surfaces, repassivation and healing phenomena, and heterogeneous dissolution of metals and semiconductor materials.

### **ULTRASONIC MONITORING OF FATIGUE LOADING OF HIGHWAY BRIDGES**

NIST and the Constructed Facilities Center of West Virginia University are collaborating on the development of a fatigue loading monitor for installation on bridges. The device uses non-contacting ultrasonic transducers developed by NIST to generate and receive ultrasonic waves propagating along the stressed member. The presence of stress causes small but measurable changes in ultrasonic velocity. A research associate at the university came to NIST, learned about noncontact transducers and ultrasonic measurements of stress, and conducted proof-of-concept experiments on loaded I-beams to simulate the field application. Results to date indicate that the required stress resolution will be achievable in a properly designed field device. The next steps are to develop an instrument suitable for use on bridges and to conduct large-scale verification tests. These steps will be taken at the Constructed Facilities Center with technical assistance from NIST.

### **HUD ISSUES NEW WIND LOAD REQUIREMENTS FOR MANUFACTURED HOME DESIGN**

In response to the widespread damage caused by Hurricane Andrew in 1992, the Department of Housing and Urban Development has issued new requirements for the design of manufactured homes to resist extreme winds. The amended rule, which is to become effective on July 13, 1994 will

require higher design loads for manufactured homes located in hurricane-prone areas and in the coastal regions of Alaska. For example, a design wind speed of 49 m/s will be required for Dade County, FL, where more than 5000 manufactured homes were destroyed or rendered uninhabitable by Hurricane Andrew. The current Manufactured Home Construction and Safety Standards, which have been in effect since 1976, require a design wind speed of 36 m/s for Dade County. The new requirements follow closely the recommendations developed by NIST in a study carried out at the request of HUD in the aftermath of Andrew. Wind load requirements for nonhurricane regions of the United States are not affected by the amended rule; however, these requirements are under review.

### **WORKSHOP SHOWS IMPACT OF NIST OIL SPILL STUDIES**

On behalf of the Department of Interior, NIST conducted a workshop recently to assess the needs of local authorities for information about the effects of intentional burning of oil spill. In the first workshop of its type, over 80 participants from equipment manufacturers, regional oil spill response teams, state environmental agencies, and federal agencies with research programs in oil spill response worked for 2 1/2 days to develop priorities for future work. Technical papers reviewed results of research conducted over the past decade to measure the effects of oil spill burning. Three cases of practical use of intentional burning of oil spills for clean up were presented. Results of smoke-plume modeling performed by NIST using the emerging large-eddy simulations techniques were presented formally to this user group. These models (NISTIR 5273) show that beyond 10 km from typical oil spill burns ground level concentrations of smoke particulate are within the limits of permissible ambient air quality standards specified by most states. Results obtained from these models have been used by the states of Alaska, Texas, and Louisiana to set proposed limits on the use of in-situ burning near populated or environmentally sensitive areas. Before this study was completed, working limits for in-situ burning were considered to be more than 100 km.

The technical papers presented at the workshop and listings of research and information needs developed by the participants will be published in a proceedings available by early summer 1994.

### **NIST STUDIES INDOOR AIR QUALITY IMPACTS OF RESIDENTIAL HVAC EQUIPMENT**

NIST has published a report (NISTIR 5346) describing a project to assess the impact of existing HVAC technology on residential indoor air quality and the potential for using HVAC systems to reduce indoor pollutant levels. Despite the increasing interest in residential indoor air quality, little research has been conducted to analyze the impact of residential HVAC system design and operation on indoor pollutant levels. The limited research to date has employed very simple models of buildings that ignore the multizone nature of the airflows involved, the numerous factors affecting building ventilation rates, and the complexity of pollutant sources. The use of such simple modeling approaches has limited understanding of the impact of HVAC systems on residential indoor air quality and the possibility of using these and other systems to mitigate indoor air quality problems.

The current project is using the multizone airflow and contaminant dispersal model CONTAM93, developed at NIST, to predict indoor pollutant levels in four single-family residential buildings subjected to selected pollutant sources. Simulations will be performed with CONTAM93 to study the effectiveness of several technologies for controlling residential indoor air quality. The NISTIR describes the tasks conducted during the first phase of the two-phase project: a literature review of published literature on residential indoor air quality and HVAC systems and development of a plan for the computer simulations being performed in Phase II of this project. This project is being sponsored by the U.S. Consumer Product Safety Commission.

### **NEW FINGERPRINT STANDARD APPROVED**

On Nov. 22, 1993, the Board of Standards Review of the American National Standards Institute (ANSI) approved the ANSI/NIST-CSL 1-1993 Data Format for the Interchange of Fingerprint Information standard. This revision to ANSI/NBS-ICST 1-1986 defines the content, format, and units of measurement for the exchange of information that may be used in the fingerprint identification of a subject. The information consists of a variety of mandatory and optional items, including related record data, digitized fingerprint information, and compressed or uncompressed fingerprint images.

NIST coordinated the development of the voluntary industry standard using the Canvass Method. More than 100 federal, state, local, and international law enforcement agencies, criminal justice administrations, and other organizations participated in the development of the standard. The standard will be integral to agencies using Automated Fingerprint Identification Systems that rely on fingerprint images being electronically interchanged between remote locations.

### **NIST COLLABORATES WITH THE U.S. NAVY ON NEXT GENERATION COMPUTER RESOURCES**

NIST, the Software Engineering Institute, and the U.S. Navy are working together on the Next Generation Computer Resources program to fulfill the Navy's need for standard computing resources. The program revolves around the selection of interface standards in six areas, which will be based on existing industry standards with multivendor support. NIST Special Publication 500-213, Next Generation Computer Resources: Reference Model for Project Support Environments (Version 2.0), presents a reference model that describes the full scope of functionality that is expected of a project support environment. The reference model is an initial step in the Navy's program to utilize new commercial advances to best advantage and to reduce cost and duplication of computer resources.

### **ESCROWED ENCRYPTION STANDARD APPROVED AS FEDERAL INFORMATION PROCESSING STANDARD (FIPS)**

On Feb. 4, 1994 NIST participated in announcements made by the White House Office of the Press Secretary on encryption. The administration announced that the secretary of commerce had approved FIPS 185, Escrowed Encryption Standard, for voluntary federal agency use. Effective March 11, 1994 FIPS 185 provides a strong encryption algorithm for protecting unclassified information. The standard also provides that the keys used in the encryption and decryption processes are escrowed to assist law enforcement and other government agencies, under the proper legal authority, in the collection and decryption of electronically transmitted information. Also announced were the Department of Justice's procedures for release of keys, the appointment of escrow agents, and new procedures of the Department of State on export of encryption products.

### **NIST HOSTS WORKSHOP ON ADVANCED SOFTWARE TECHNOLOGY REQUIREMENTS**

On Feb. 1, 1994 NIST and software industry executives met to discuss requirements for advanced software technologies needed in the next century and, in particular, for the National Information Infrastructure (NII) to reach full potential. The group cited three key objectives for advanced software technologies: sustain and revitalize the U.S. manufacturing base; ensure continued success of the U.S. software industry; and provide U.S. business with information access and dissemination on a worldwide basis.

The group identified technology requirements important to the success of the NII, key applications for different user groups (e.g., consumer, government, industry, education), enabling technologies, and barriers to progress. Important NII requirements include interactive visual applications, intelligent services that adapt to varying user skills and needs, high-quality software services and reusable components, and flexible standards that support current integration requirements while allowing for changes in technology and needs.

Barriers to progress include too few colleges offering software engineering curriculums, insufficient precision in specifying software requirements and services, and numerous legal issues (e.g., intellectual property rights, fair and open access, etc.) that must be addressed before the NII can take advantage of advanced software technology. The panel encouraged NIST to foster standards that provide for openness and expansion of NII services, to provide techniques for measuring conformance to these standards, and to work with industry in advancing software technology. A report of the meeting will be issued shortly.

### **NIST PARTICIPATES IN CONFERENCES ON OPEN SYSTEMS IN RUSSIA AND THE UKRAINE**

On Jan. 20–26, 1994 NIST participated in a series of conferences sponsored by the American Consortium of Information Systems Technology, a DOC CABNIS project (Consortium of American Business in the Newly Independent States), held in Moscow, Russia, and Kiev, Ukraine. The conferences provided information on building enterprise systems and developing application environment profiles based on international open systems standards. Participants attending the conference were high-level officials from government agencies responsible for information technology standards and the privatization of major state-controlled industries.

Presentations were given on developing an enterprise application profile, transitioning to an open systems environment, and establishing a consensus-based forum for building implementation agreements for interoperable products. Additionally, small group meetings were held with officials from various Russian and Ukrainian government organizations interested in developing open systems.

### **SOFTWARE ENGINEERING ENVIRONMENTS SUBJECT OF NEW GUIDE**

NISTIR 5295, Guide to Software Engineering Environment Assessment and Evaluation, outlines general approaches to software engineering environment assessment and evaluation. A software engineering environment is an interconnected collection of computer-aided software engineering tools providing automated support for software engineering development activities. The approaches presented in this guide focus on accurately defining the integration and functional capabilities of candidate software engineering environments and the requirements of the customer.

### **NIST STAFF LEAD DISCUSSIONS ON IMPROVING INDUSTRIAL MEASUREMENT**

At the 1994 Measurement Science Conference, two NIST scientists gave a short course on "Measurement Strategies for Product Improvement" based on their experiences at the National Research Laboratory of Metrology in Japan. One presentation, "Off-line Experimentation," addressed optimization of measurement systems in the situation where carefully characterized test materials do not exist and described a procedure requiring only that test materials be remeasurable. Problems relating to on-line maintenance of measuring instruments and their integration with manufacturing processes, as articulated by the audience of industrial metrologists, were addressed by the other. The discussion of the effects of real-time measurement conditions on uncertainty and the determination of correction limits and optimal re-calibration intervals for minimizing economic loss due to measurement error followed the Japanese Industrial Standard on Calibration Systems.

A NIST scientist organized and chaired a technical session on "Progress and Problems with the Implementation of the ISO Guide to the Expression of Uncertainty in Measurements." Topics addressed in the presentations included progress on the adoption of the guide at NIST and industrial

laboratories; interpretation of the ISO procedure from a statistical viewpoint and its possible incompleteness for making statements about calibration curves and inhomogeneous reference materials; problems and possible solutions for making NIST uncertainty statements consistent with the ISO guide using mass, blackbody calibrations, and wavelength standards as examples.

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## Standard Reference Materials

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### STANDARD REFERENCE MATERIAL 2551— OXYGEN CONCENTRATION IN SILICON STANDARD

The measurement of interstitial oxygen content of semiconductor silicon is important for manufacturers of silicon and of semiconductor devices. The concentration of interstitial oxygen in silicon affects the formation of Si-O precipitates which serve as gettering sites for unwanted fast-diffusing impurities. It also affects distortions during thermal treatment, which silicon wafers undergo during the manufacture of integrated circuits. For these reasons, highly reproducible measurements are needed to assure that oxygen levels are controlled by both suppliers and users of silicon wafers. Industry measurements of oxygen levels are based on infrared spectrometry, which provides highly precise and non-destructive measurements that are related through Beer's Law to absolute oxygen levels.

The Standard Reference Materials Program announces the availability of SRM 2551 certified for absolute oxygen, to enable calibration of the industry infrared measurement system. The SRM unit is a set of four 25 mm × 25 mm × 2 mm polished specimens that are certified individually for their differing oxygen levels. One specimen of the set has a ratio of number of oxygen atoms to number of Silicon atoms of less than  $1 \times 10^{-7}$ ; the other three are Czochralski specimens, whose ratios cover the range of  $15 \times 10^{-6}$  to  $30 \times 10^{-6}$ .

### STANDARD REFERENCE MATERIAL 1921— INFRARED TRANSMISSION WAVELENGTH STANDARD

In the development of infrared (IR) spectroscopy, it has long been realized that a stable material for wavelength calibration of infrared spectrophotometers was required. The manufacturers of IR spectrophotometers, as well as the many users of IR equipment in the chemical and petroleum industries, have needed a traceable standard for quality assurance documentation and currently ISO 9000 certification.

The Standard Reference Materials Program announces the availability of SRM 1921. This SRM is a matte-finish polystyrene film, intended for use in calibrating the wavelength scale of spectrophotometers in the IR-spectral range of wavelengths from 3  $\mu$ m to 18  $\mu$ m (wavenumbers of  $540 \text{ cm}^{-1}$  to  $3200 \text{ cm}^{-1}$ ). The IR-absorption spectrum of the film consists of numerous peaks; for 13 of these, peak positions are certified as wavenumbers. The SRM unit consists of five batch-certified cards measuring 5 cm × 11 cm with a 25 mm diameter polystyrene aperture.