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News Briefs

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, Building 101, Room E215, Gaithersburg, MD 20899-2500; telephone: (301) 975-3577.

UNITED STATES, JAPAN SIGN PACT FOR "GOOD MEASURE"

Adding momentum to recent initiatives to reduce measurement-related barriers to international trade, NIST and Japan's Agency of Industrial Science and Technology agreed on Nov. 2, 1999, to undertake joint efforts to demonstrate the equivalence of measurement capabilities in both organizations.

Signed by NIST Director Raymond G. Kammer and AIST Secretary Koji Kajimura, the new "implementing arrangement" enables NIST's Measurement and Standards Laboratories and AIST laboratories to cooperate on efforts to realize the pact's aims. NIST and three AIST units—the National Research Laboratory of Metrology, Electrotechnical Laboratory, and National Institute of Materials and Chemical Research—will develop an agenda of research and other activities in areas such as measurement standards and calibrations.

In 1998, the value of merchandise traded between the United States and Japan totaled $180 billion. Regulatory and voluntary standards unique to one country or the other may compel exporters to submit their products for additional testing so that they can demonstrate compliance with the governmental or customer requirements of the importing nation. The inability to show that measurements made on either side of the Pacific Ocean are comparable sometimes leads to duplicative testing, adding to the cost of imported goods.

The NIST-AIST agreement is similar to one signed early last month by NIST and the executive body of the 15-nation European Union. Both will further a global effort to achieve "mutual recognition of national measurement standards." This effort was initiated by an agreement signed on Oct. 14, 1999, by 38 nations during the international Conference on Weights and Measures. All three agreements aim to help establish the technical means for a global chain of measurement trace-ability, intended to streamline procedures for proving compliance with product requirements in export and domestic markets.

For more information on the NIST-AIST "implementing arrangement for cooperation in the fields of metrology and measurement standards," contact Magdalena Navarro, Office of International and Academic Affairs, (301) 975-2130, mnavarro@nist.gov.

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INTERNATIONAL EFFORT STARTS "CRACKING" DOWN ON REACTOR EMBRITTLEMENT

At a recent conference held at NIST's Boulder, CO, laboratories, researchers from university and government laboratories in the United States, Europe, and Japan described their programs for developing nondestructive techniques for detecting embrittlement in the steels used for nuclear reactor pressure vessels. Experts believe that this embrittlement occurs when small amounts of copper—used as an alloy to increase the strength and hardness of steel—decrease the fracture toughness of the steel in pressure vessels following long-term exposure to neutrons.

Reports at the conference detailed how researchers in the participating nations are using very sophisticated microscopy techniques to determine the mechanisms of embrittlement on the atomic level and lay the foundation for developing nondestructive testing procedures. At the end of the 3 day workshop, attendees began to develop a roadmap to guide future research. The hope is that

mutually agreed-upon non-destructive evaluation methods can be introduced into the maintenance programs of existing nuclear power plants in order to increase their safety and extend the life of their pressure vessels.

For more information on the results of the conference, contact George Alers, NIST, MS 853.06, Boulder, CO 80303; (303) 497-7899; alers@boulder.nist.gov. For the latest NIST research paper on this subject, Nondestructive Characterization of Reactor Pressure Vessel Steels: A Feasibility Study (NIST Technical Note 1500-4), contact Sarabeth Harris, NIST, MS 104, Boulder, CO 80303; (303) 497-3237; sarabeth.harris@nist.gov.
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BIBLIOGRAPHIES OF ELECTRONICS-RELATED WORK NOW AVAILABLE

Each year the optoelectronics, electronics and electromagnetic research programs of NIST laboratories publish bibliographies of technical work in those programs dating back to 1970. The 1999 edition of those bibliographies is now available.

- *Metrology for Radio-Frequency Technology: A Bibliography of NIST Publications* (NISTIR 5084) lists the publications by the staff of the Radio-Frequency Technology Division (formerly the Electromagnetic Fields Division) from January 1970 through July 1999. Topics covered include antennas, dielectric measurements, electromagnetic interference, microwave metrology, microwave power, impedance and attenuation, near-field antenna measurement, noise, non-ionizing radiation, radiation hazards, standards, time domain and waveform metrology.

- *A Bibliography of the NIST Electromagnetic Technology Division* (NISTIR 5085) lists the publications of the staff of this division from January 1970 through July 1999. It is divided into two sections: Cryoelectronic Metrology and Superconductor and Magnetic Measurements. Topics covered include cryoelectronics, electromagnetic metrology, x-ray detectors, voltage standards, Josephson junctions, superconductivity, magnetics, magnetic recording, and magnetic imaging.

- *Bibliography of the NIST Optoelectronics Division* (NISTIR 5086) includes most of the papers published by this division and its predecessor organization since 1970. Topics covered include high-speed measurements, laser radiometry, optical fiber metrology, optical fiber sensors, fiber and discrete components, dielectric materials and devices, and semiconductor materials and devices.

Copies of all three bibliographies are available at no charge from Sarabeth Harris, MC103, NIST, Boulder, CO 80303-3337; (303) 497-3237; sarabeth@boulder.nist.gov.
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LASER LIGHT PULSES MAKE NEW ULTRASENSITIVE CHEMICAL DETECTOR

Its components are exquisitely simple: a tiny translucent cube, two adjacent prisms, a laser and a detector, yet this system represents a powerful new way to detect chemicals. Although applications are years away, it eventually could lead to miniature detectors for explosives or chemical weapons. Developed at NIST, the method can sense trace amounts of a chemical present in the vicinity of the device.

Described in a recent *Physical Review Letters* article (Oct. 11, 1999), the system is a new approach to cavity ring-down spectroscopy. In this case, the cavity is a solid cube made of ultrapure fused silica with four ultrasmooth surfaces. One of the surfaces is curved to refocus circulating light as it travels around in the square path defined by the cube's four faces. A laser pulse tunnels into the cube and loops around the path, sustained entirely by total internal reflection for a distance of over a kilometer before its intensity degrades.

The time it takes the light to degrade (or ring-down) is altered in the presence of a chemical capable of absorbing the light as it passes briefly outside the cube in the form of an evanescent (fading) wave. Changes in the ring-down time can be used to identify and quantify specific molecules.

Companies are invited to apply for a license to use this new technology. All licensing inquiries should be directed to J. Terry Lynch, (301) 975-2691, fax: (301) 869-2751, jtlynch@nist.gov.
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NEW HIGH-POWER RF MEASUREMENT SYSTEM DEVELOPED

To meet the demand for higher power calibrations, NIST has developed a new system for measuring up to 1 kW of radio-frequency power in the range from 2 MHz to 1000 MHz. The technique makes use of calibrated low-power sensors, called bolometers, and a calibrated chain of up to five 10 dB couplers. The

couplers reduce the high-power level to be measured down to the 1 mW to 10 mW level of the sensors.

A comparison of results from the new system with those of NIST's older low-frequency measurement system shows that there is good agreement in the area of overlap, up to 30 MHz. Analysis indicates that overall, the typical relative uncertainty is between 1 % and 2 %, with a small increase above 850 MHz.

The new system and a mathematical analysis of its operation and uncertainties is described in Technical Note 1510, Switched-Coupler Measurements for High-Power RF Calibrations, available from Sarabeth Harris, MC 104, NIST, Boulder, CO 80303-3328; (303) 497-3237; sarabeth@boulder.nist.gov. Ask for paper no. 47-99.
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GUIDELINES AIM FOR BETTER COORDINATION, MANAGEMENT

NIST proposed first-ever conformity assessment guidelines to help federal agencies improve management and coordination of testing, inspection, certification and other activities to determine whether products or services meet regulatory or procurement requirements.

Comments on the proposed guidelines were accepted until Jan. 18, 2000. Published in the Nov. 3, 1999 *Federal Register,* the four-page document can be downloaded from NIST's conformity assessment web site at ts.nist.gov/ts/htdocs/210/216/216.htm.

Under the National Technology Transfer and Advancement Act of 1995, Congress assigned NIST responsibility for coordinating efforts to improve the federal standards and conformity assessment activities.

About 80 agencies and other federal units have regulatory or procurement responsibilities. Many have developed their own schemes for evaluating processes, products and services against their requirements. The proposed guidelines focus on federal agencies' eliminating unnecessary duplication and complexity in their conformity assessment activities and making greater use of private-sector and state programs in this area. The guidelines call for more systematic evaluation of the effectiveness of conformity assessment practices, mutual recognition of the results of other agencies' testing procedures, and harmonization of requirements for quality and environmental management systems. Broader, more effective sharing of audit results and related information are among other recommendations that NIST proposes.

In addition to saving time and money, a less complicated system would benefit trade negotiations and respond to industry's call for streamlining testing requirements in the United States and other countries.

For more information on NIST's Proposed Guidance on Federal Conformity Assessment Activities, contact Maureen Breitenberg, Global Standards Program, (301) 975-4031, maureen.breitenberg@nist.gov.
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THERMODYNAMIC PROPERTIES OF NITROGEN AVAILABLE IN NEW FORMULATION

Nitrogen has been one of the most important reference fluids for tests of physical models and for calibrations of experimental equipment and meters for measuring fluid flow. More than 14 000 experimental data points for many types of thermodynamic properties are available in the fluid region of nitrogen. Together with water, argon, methane, ethylene, and carbon dioxide, nitrogen belongs to the group of substances possessing the most extensive published data sets.

A new formulation for the thermodynamic properties of nitrogen has been developed by researchers at NIST and three other institutions. It replaces a reference equation of state that has been in use since 1973. Because of changes in density calculations between the two equations, it will have an impact on the buying and selling of liquid nitrogen and other cryogenic fluids.

The range of validity of the new equation of state for nitrogen is from the freezing line to 1000 K at pressures to 2200 MPa. In addition to the equation of state, ancillary functions are given for the vapor pressure, the densities of the saturated liquid and vapor, the ideal gas heat capacity and the melting pressure.

For more information, contact Eric Lemmon, NIST, MS 838.08, Boulder, CO 80303-3328; (303) 497-7939; ericl@boulder.nist.gov. A graphical user interface containing the new reference equation of state along with Fortran sub-routines implementing the new equation and standards for other fluids is scheduled to be released in the spring of 2000 from the NIST Standard Reference Data Program. To learn more, check out www.nist.gov/srd on the World Wide Web at that time.
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STANDARD IONIZATION CROSS SECTIONS FOR HELIUM OFFERED

A new theory developed at NIST was used to derive the cross sections for total ionization and energy distribution of secondary electrons ejected from the helium

atom by electron impact. The theory provides simple analytic expressions for the two types of cross sections, which have relative uncertainties of 5 % over the energy range from threshold to 1 keV in the energy of the incident electron. The theory covers arbitrary combinations of the incident and secondary electron energies, which are often difficult to attain in experiments, and reproduces the best available theoretical and experimental data without the fluctuations that are inherent in experimental data. This is the first time such standard cross sections have been offered by NIST. These standard cross sections can be used not only to test other theories but also to normalize experimental ionization cross sections for other atoms and molecules. Electron-impact ionization cross sections are used widely in the modeling of plasma processing of semiconductors, radiation damage, combustion chemistry, plasmas in fusion devices, and pressure gauges and also in many applications involving mass spectrometry.
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CHARACTERIZATION OF FREE-ROTATION ABOUT THE CARBON-CARBON SINGLE BOND

A quantitative understanding of the internal rotation about the carbon-carbon single bond is essential for predicting the thermodynamic, spectroscopic, and conformational properties of organic and biomolecules. Indeed, a large effort in chemical physics has been devoted to the investigation of internal rotation, particularly when the motion is highly hindered, so that standard molecular spectroscopy and quantum chemistry techniques are directly applicable. Recently, NIST scientists have started a detailed investigation of the internal rotation about carbon-carbon single bonds when the motion is effectively free, using the molecule paratolualdehyde as a model. Nearly free rotation has received little previous attention by researchers, primarily due to the plethora of excited free-rotor quantum states assessable by thermal excitation, making a spectroscopic analysis challenging. Moreover, the accurate calculation of the small energy barriers inhibiting the motion are presently beyond the capabilities of quantum chemistry. The scientists have used a Fourier-transform microwave spectrometer to assign the rotational spectra of paratoluadehyde and its various mono-^{13}C isotopic forms in natural abundance at a rotational temperature of 2 K. The data are being analyzed to determine the threefold and sixfold symmetry contributions to the internal rotation potential energy function. The analysis will address the contributions of charge delocalization, resonance-structure asymmetry, zero-point motion, and long-range electrostatics and van der Waals forces to the three- and sixfold potential-energy terms. A further understanding of these various effects will help improve the molecular modeling force fields used in the development of new chemicals and pharmaceuticals.
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DECOHERENCE STUDIES OF MOTIONAL STATES OF TRAPPED IONS

Quantum-state-engineering of trapped atomic ions uses motional states entangled with the internal states of the trapped ions. Since trapped ions form a charged oscillator, the motion of this oscillator is very susceptible to the influence of fluctuating electric fields. Currently, such fields limit the fidelity of engineered states, and this has prompted a study of various forms of motional decoherence.

Certain superpositions of motional states, commonly called “Schrodinger cats,” are especially sensitive to the strength and nature of the fluctuating fields. NIST scientists have studied the decoherence of these cat states under different kinds of impressed noise as well as that arising from ambient fields. These studies indicate the ambient fields are uniform and stochastic with a relatively large bandwidth. Additional studies correlating the magnitude of these fields with the trap electrode dimensions indicate that the source of this noise is not due to thermal electronic noise (e.g., Johnson noise) and is consistent with fluctuating patch fields on the electrode surfaces. Such studies will be used to identify and eliminate this source of decoherence. For the first time, the group has shown experimentally that the rate of decoherence scales exponentially with the size of the cat state.
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AUTOMATED COMPUTER TIME SERVICE EXPANDED

NIST staff members recently have doubled the capacity of the Automated Computer Time Service (ACTS), which delivers time setting signals to computer systems over the telephone network. The expansion, which involved adding two more servers and doubling the number of telephone lines from 12 to 24, was needed to meet increasing demands placed upon the system by new commercial systems that are using the service for setting clocks used in stock trading. There is an increasing need to assure the accuracy of time/date stamps used to identify every transaction. While demand for this service has

increased steadily to about 10 000 calls per day, a recent increase in activity of 50 % was stimulated by the adoption of a Securities and Exchange Commission approved rule requiring traceability of time/date stamps to NIST by the National Association of Stock Dealers. As implementation of this rule proceeded, NIST personnel noted a sharp rise in ACTS calls.

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BLUE-LIGHT GENERATION USING RUBIDIUM VAPOR AND LOW-POWER DIODE LASERS

Using two diode-laser beams in the near infrared (780 nm and 795 nm), a NIST scientist and a guest researcher discovered that it was possible to convert the diode laser light into coherent blue light at 420 nm in a rubidium vapor cell. The blue light is generated by coherent multiwave mixing near resonance in the atomic vapor. With a single pass of the laser beams through the vapor cell, the output power of blue light is still fairly low; however, the actual conversion efficiency from the infrared to the blue is relatively high compared to that obtainable in non-linear optical crystals. For example, this system produces 10 μW of blue light for an input of two infrared beams of 10 mW each. This unexpected result could prove useful for generating shorter wavelengths of blue or ultraviolet light using low-power diode-laser sources and resonant atomic or molecular systems.

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PULSED MICROWAVE PM AND AM NOISE MEASUREMENT

NIST scientists, along with a guest researcher, have developed a new approach to the measurement of phase modulation (PM) and amplitude modulation (AM) noise in pulsed amplifiers. There long has been a difficulty in characterizing the noise performance of high-power amplifiers used in systems such as radars, because such amplifiers cannot remain on for very long or they will burn up. The new system dramatically improves the resolution, noise floor, and time required for making pulsed measurements of noise close to the carrier frequency. A significant aspect of this work is the reduction in measurement time by two orders of magnitude; however, the order-of-magnitude improvement in uncertainty and three order-of-magnitude reduction in the noise floor also are noteworthy. The new system will allow manufacturers to evaluate the performance of pulsed amplifiers directly, rather than on inferring amplifier performance from the overall performance of the system.

The measurement system is based on a two-channel cross-correlation concept and uses special filters in the intermediate-frequency amplifiers to reduce noise in the measurement process substantially. Another important feature is the rapid (few seconds) *in situ* calibration of the gain of the phase or amplitude detectors as a function of frequency offset from the carrier.

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NIST ENHANCES INFORMATION SECURITY FOR FEDERAL AGENCIES

On Oct. 25, 1999, Secretary of Commerce William M. Daley approved Federal Information Processing Standard (FIPS) 46-3, Data Encryption Standard (DES), for use by federal agencies. Many industry organizations also use DES on a voluntary basis. Effective March 25, 2000, FIPS 46-3 provides for the use of Triple DES as specified in American National Standard (ANSI) X9.52. NIST expects that Triple DES will provide federal agencies with strong protective measures against associated risks until the Advanced Encryption Standard (AES) is available, probably in 2001.

First issued in 1977, FIPS 46, DES, specified the Data Encryption Algorithm, to be implemented in hardware devices, for the cryptographic protection of computer data. The standard has been reviewed and reaffirmed every five years since that time. The review in 1993 resulted in FIPS 46-2, which provided for software as well as hardware implementations of the DES. When the DES was reaffirmed in 1993, NIST stated that it would "consider alternatives which offer a higher level of security" at the next review in 1998. There was concern that the DES 56 bit key was not long enough to prevent an attack by trying all of the possible keys.

NIST believed that the key was sufficiently long for the expected life of the standard and that the security could be increased, when needed, by using the DES for three sequential encryption operations with different keys. This approach is called Triple DES. Triple DES was documented and specified as an American National Standard (ANSI X9.52) by Accredited Standards Committee X9 for Financial Services, which develops cryptography and public key infrastructure standards. Triple DES was developed by the private sector with NIST assistance and is used by many government and private sector organizations, particularly in the financial services industry. In 1997, NIST advised federal organizations that they could use Triple DES if they needed security beyond that provided by the DES.

FIPS 46-3 requires federal agencies to acquire cryptographic products that support the use of Triple DES. Agencies also will plan to phase out the use of single DES in legacy systems. FIPS 46-3 is available at http://csrc.nist.gov/fips.

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NIST LAUNCHES NEW SMART CARD SECURITY INITIATIVE

NIST is leading a major new initiative to establish user-based security standards and test methods for smart cards on behalf of the National Information Assurance Partnership (NIAP), a joint activity of NIST and the National Security Agency. The smart card security work currently focuses on the financial industry but soon will be extended to other major card-user communities. NIST helped form and is currently chairing the Smart Card Security Users Group (SCSUG), which includes companies with nearly 100 % of the financial-card market worldwide. The SCSUG was set up to apply the Common Criteria (CC) for IT Security (the new ISO/IEC 15408), to specify minimum standards from the card issuer and user perspective, and to measure security for integrated circuit chips on hundreds of millions of payment cards. The SCSUG recently developed a draft CC-based Protection Profile (PP) stating common security specifications for the smart card chip and the operating system used as a secure platform. This PP also may be useful as the basis for other sensitive applications, such as health care and network access control. In the future, the group will be defining accreditation criteria for private-sector testing laboratories and specific smart card tests so that a consistent and uniform level of security evaluation exists for all payment cards worldwide. The draft PP is available at http://csrc.nist.gov/cc/sc/ sclist.htm.

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NANOCOMPOSITIONAL MAPPING AND STRUCTURE ANALYSIS

Barium strontium titanate (BST) is the leading candidate material for the replacement of silicon dioxide dielectrics in the next-generation dynamic random access memory (DRAM) devices. The dielectric properties of BST have been found to be strongly dependent upon composition; the dielectric constant decreases by about 50 % when the Ti mole fraction is increased from 51 % to 53.5 %. To understand this strong composition dependence, MSEL researchers have conducted high-resolution electron microscopy and high-spatial resolution electron energy loss spectroscopy measurements to study the microstructure and chemistry of BST films with Ti mass fractions ranging from 50.7 % to 53.4 %. The films were deposited on $Pt/SiO_2/Si$ substrates by metal-organic chemical vapor deposition. The measurements showed that the grain boundaries in all of the films had a higher Ti/Ba ratio than the grain interiors. In addition, films with greater than 52 % Ti contained an amorphous Ti-rich phase at some of the grain boundaries and multiple grain junctions. Quantitative spectrum imaging studies have indicated that Ba/Sr cation vacancies segregate to the grain boundary regions. These nanocomposition and structure results are important for understanding the dielectric constant dependence on composition, and for optimizing the deposition process of BST-DRAM films.

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USING PROCESSING CONDITIONS TO OPTIMIZE MATERIAL PROPERTIES FOR DIELECTRICS

Recent progress in microwave telecommunication has necessitated the development of dielectric materials with stringent specifications: the largest possible dielectric constant, the lowest dielectric loss, and near-zero temperature coefficient of the dielectric constant. Most of the best materials are based on complex perovskite oxides. Such materials often have an elaborate microstructure of domains and interfaces. The dielectric properties of these materials are sensitive to the structural and micro-structural features and, therefore, the understanding of the properties/structure interrelation is paramount in further development of these materials. NIST is working toward a resolution of some of these issues.

Transmission electron microscopy (TEM) is extremely well suited for study of complex perovskite oxides because of the great sensitivity of electron scattering to structural features such as ordering, and for the technique's ability to image domains and interfaces. The researchers' recent TEM studies have resulted in complete characterization of several complex systems, including layered structures of $Sr_n(Nb,Ti)_nO_{3n+2}$ and ordered $Ca(Ca,Nb,Ti)O_3$. The $Ca(Ca,Nb,Ti)O_3$ system was found to be very rich with respect to different types of ordering. This system, which had not been studied by other research groups, offers a rich variety of order/microstructure states and, thus, opportunities to change the dielectric properties. These states can be well controlled and are expected to have a significant effect on the dielectric properties of interest.

For the TEM study, phase diagrams and structural models of unknown compounds were developed. Neutron and ray diffraction results helped refine the structural models. Changes in the temperature coefficient of the dielectric constant from positive to negative were identified and related to the structural details. As a direct result of this work, the researchers were able to explain, for the patented $Ca_5Nb_2TiO_{12}$ composition, how the dramatic effect of sintering temperature on the dielectric constant and its temperature coefficient could be attributed to changes in the type of ordering and microdomain state of the material. This type of information serves as a guide to using processing conditions to optimize material properties.

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A PROTECTED SINGLE-ELECTRON TUNNELING (SET) DEVICE: THE NANO-FARADAY CAGE

NIST scientists have designed, fabricated, and begun testing SET devices with a new feature: the device is completely encased in a cage of metal layers above and below. This modification is intended to address two problems in SET devices: their vulnerability to environmental and electrostatic discharge (ESD) damage, and their low-frequency noise.

SET devices are based on ultrasmall tunnel junctions operated at low temperatures, in which the motion of single electrons are sensed or controlled. They are of interest to NIST for standards of capacitance or electrical current, and to the electronics industry as design rules continue to shrink. The most commonly used materials system for SET tunnel junctions is that of $Al/AlO_x/Al$; aluminum is used because it forms a self-limited oxide of the appropriate thickness (1 nm to 2 nm) for tunneling. One difficulty with this materials system is that it is vulner-able to environmental degradation: if left in air for a few days or weeks, the devices will become unusable (tunnel junction resistances increase to unworkably large values). In addition, most SET devices, by virtue of their small size, are very vulnerable to destruction by electrostatic discharge (ESD); in essence, they are the worlds most sensitive (and expensive) fuses!

The scientists have made SET devices inside a "nano-Faraday cage," which consists of metal layers above and below the critical areas of the device, with intervening insulating areas for electrical isolation. This more complicated device required substantial modifications to the fabrication sequence, in particular in using a very large (more than 1 μm) undercut for the lithographic stencil; these modifications also may be useful for other innovative nano-lithographic designs which need a very large undercut. Tests of these nano-Faraday cages have shown that they are quite insensitive to both environmental and ESD damage. In addition, the first nano-Faraday cage has just been tested at low temperatures and shows Coulomb blockade behavior, indicating its usefulness as a SET transistor. Measurements and fabrication may proceed on two fronts: the first is to make devices with smaller total capacitance, so that they will operate at higher temperatures and/or with larger Coulomb blockade behavior. The second stems from the main motivation of the nano-Faraday cage design: the surrounding cage will electrostatically shield the device, which may substantially decrease the low-frequency noise (the limiting factor for use as sensitive charge electrometers). Measurements of the noise, and comparisons between caged and uncaged devices, are just beginning.

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CALIBRATION CUSTOMERS CAN CHECK CALIBRATION STATUS VIA WEB PAGES

The Information System to Support Calibrations (ISSC), software developed by NIST, now generates a web page detailing status information about each device in for calibration at NIST. When a customer sends a device in for calibration, they can check the status via the web page at any time. The information is protected by a username/password combination sent to the customer on the form accepting the device for calibration. Pages are generated for up to 60 days after the calibration is completed to ensure the item is back to the customer before the page is no longer needed. Pages are generated only for active calibrations. Customers also can provide feedback to NIST on the usefulness of the service via an automated survey form on the web page. Customers not wishing to advantage of this service can have the web access turned off for their company by notifying the NIST Calibration Program.

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PULSE PARAMETER COMPARISONS MADE WITH NPL

An informal comparison has been made between NIST and the National Physical Laboratory (NPL) in the United Kingdom regarding high-speed electrical pulse parameters. High-speed electrical pulses are used in digital communications and computing (both are multi-billion dollar a year industries). Only NIST and NPL provide formal measurement services in this area, but

other national metrology institutes (NMIs) are developing the capability. It is essential for U.S. companies that sell products abroad that results of the calibration methods employed by the United States are consistent with those accepted by other NMIs. The initial set of comparisons was performed to determine the effects of different measurement systems and methods and pulse parameter extraction algorithms. Also studied were the time-base and signal gain correction algorithms on the estimated pulse parameter values for the NIST-measured repetitive fast-pulse waveforms. The results so far indicate that there is no substantial change in pulse parameters (less than one-tenth of NIST-reported uncertainties) of a corrected waveform compared to those of an uncorrected waveform. This information was provided to the collaborating staff at NPL. NPL does not perform waveform corrections in its pulse calibration services but simply includes the effects of time-base and gain errors in its reported uncertainties. Consequently, the NIST uncertainty analysis will be re-examined because the insignificance of the effect of these correction algorithms may not warrant the additional complexity otherwise required. It was determined that the time-base sampling intervals for the commercial 20 GHz, 3 dB bandwidth samplers used is 0.244 125 ps and not 0.25 ps as previously assumed from their specifications. NPL was informed of this discrepancy as well. To reduce time-base errors in the acquired waveforms, only those sampling instances that are integer multiples of 0.244 125 ps will be allowed in the NIST-measured waveform samples.

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EXTENSIVE REVIEW COMPLETED ON ELECTRON INTERACTIONS WITH EXCITED ATOMS AND MOLECULES

NIST researchers recently have completed a comprehensive review of the available data related to the interaction of electrons with gas-phase atoms and molecules in excited states. The interaction of electrons with excited species is receiving significant attention due to the high density of excited atoms and/or molecules in many discharges used for the fabrication of microelectronic devices. Normally, the rate of reaction of electrons with excited species is significantly greater (often by many orders of magnitude) than the rate of reaction with the equivalent ground state species.

This thorough review of the data contained in nearly 400 papers will provide guidance to researchers who are performing measurement of these processes and to modelers who are attempting to include these processes in their plasma models. The review indicates that while a significant amount of data exist for simple systems, there are few data available for the more complex gases commonly used in semiconductor plasma processing. An extensive manuscript, containing over 70 figures, has been written to present the results of the review and has been accepted for publication in *Advances in Atomic, Molecular and Optical Physics.*

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STUDY OF THE FUNDAMENTAL BURNING VELOCITIES COMPLETED

NIST scientists recently completed a study of the fundamental burning velocities for a private company. These measurements were particularly challenging because the flame speed of some of the halocarbons was so low that natural convection rendered traditional measurements methods unworkable. The NIST scientists were able to complete the flame velocity measurements of a half-dozen compounds for a range of initial conditions by modifying and expanding the existing facilities in the NIST fire suppression chemistry laboratory. These data were key for the company's computer modeling of potential vapor cloud explosions.

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DEFINITIVE BOOK ON THE DEVELOPMENT OF STEP PUBLISHED

NIST recently announced its book publication, "STEP the Grand Experience," which summarizes the development of a significant international standard for digital product data exchange. Plans are already under way by the STEP Research and Awareness Committee of the Japan STEP Center to translate the book into Japanese to further international awareness of STEP.

The standard itself is known formally as the International Standard 10303, Industrial automation systems and integration—Product data representation and exchange (ISO 10303); however, throughout its history, as it is today, it is most popular by its informal name, STEP—STandard for the Exchange of Product model data. The book starts with a background history recapping earlier standardization efforts for product data exchange and introduces the developmental history of STEP itself. Several of the remaining chapters highlight various innovations contributing to the end product of STEP, as well as contributing toward the way standardization is done today. Interspersed throughout the book are anecdotes from several of those who have been involved over the years. During the making of STEP,

NIST played many important leadership, technical, and facilitation roles, working alongside industrial representatives from around the world.

Today, companies in the aerospace and automotive industries use STEP in production. All of the top 10 leading computer-aided design vendors support STEP in their commercial software application products.

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NIST AND SI2 DEMO SOFTWARE FOR QUICKDATA STANDARD AT DAC

At the Design Automation Conference (DAC) '99 held in June 1999 in New Orleans, LA, NIST staff demonstrated a new software tool, QuickData, co-developed with members of the Silicon Integration Initiative, Inc. (Si2). Si2 is organization of industry-leading silicon systems and tool companies focused on improving productivity and reducing cost in creating and producing integrated silicon systems. The NIST software is a reference implementation of the QuickData 1.0 standard being developed with Si2 as part of their Electronic Component Information Exchange (ECIX) suite of protocols for the electronics industry. To facilitate Electronic Commerce, the QuickData standard allows electronic parts suppliers to make parts databases accessible over the Internet to customers. The QuickData standard provides a mechanism by which customers can easily query a number of parts databases and get the needed parts information returned in a standard format for easy comparison of application suitability, performance, and price. Information such as timing diagrams, Very High-Level Design Language (VHDL) simulation files, and data sheets, along with pricing information, can be returned to the customer via a web browser. The NIST-developed tool was used to query parts suppliers databases on the show floor to provide a real live demonstration of the tools capabilities.

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U.S.-CHINA BUILDING AND CONSTRUCTION SECTOR WORKSHOP HELD

NIST sponsored a 2 week workshop for representatives of the Chinese building and construction sector in September-October 1999. The workshop objective was to promote understanding of, and confidence in, the U.S. approach to relevant standardization and conformity assessment issues. The workshop supported the Presidential U.S.-China Housing Initiative, which is administered jointly by the Department of Commerces International Trade Administration and the Department of Housing and Urban Development.

The 26 workshop participants came from government and private-sector organizations located in Beijing, Shanghai, and Guangzhou. They specialize in fire safety, building materials, research, urban planning, and construction equipment. Participants heard lectures on various aspects of the U.S. system, including a description of U.S. codes and standards, issues regarding building materials, building evaluation and occupancy processes, an overview of the U.S. housing market, and the U.S.-China Housing Initiative. The Chinese participants made presentations on elements of their system.

Participants resolved to continue the collaborative discussions and efforts begun during the workshop through: (a) the continuation of the U.S.-China Housing Initiative to advance discussions on building and residential codes; (b) collaborative research projects between Chinese research institutes and NIST; (c) future exchanges and workshops in specific areas of the sector, including fire safety and building materials research areas in which NIST is currently very active; and (d) continued information exchange on new developments in areas of mutual interest.

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CRADA ON SILSESQUIOXANE CHARACTERIZATION

NIST has signed a Cooperative Research and Development Agreement (CRADA) with a private company on a new measurement procedure developed at NIST for characterizing a class of materials called silsesquioxanes. The private company is a leading supplier of polymeric silsesquioxanes that have application in a wide array of industries from microelectronics to dental implants. Silsesquioxanes are based on a trifunctional silicon-oxygen monomer having pendant organic side groups. The trifunctional property of the monomer results in condensation polymers with a wide variety of possible three-dimensional configurations. However, industry lacked methods to accurately determine the structure, how the structure develops during manufacture and how the structure influences properties.

NIST researchers have developed a method using matrix-assisted time-of-flight mass spectrometry (MALDI-TOF-MS), along with autocorrelation analysis of the resulting mass spectra, to determine the topological nature of the molecules as a function of molecular mass. For any molecule having a particular number of silicon atoms the method can determine the relative number that show a closed topology, that is, are polyhedral in shape, versus the number that show an open

topology, that is, are highly branched in shape. The CRADA's objectives are to apply this method to some of the most advanced silsesquioxanes that defy analysis by traditional methods.
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SUMMER SCHOOL HELD ON METHODS AND APPLICATIONS OF NEUTRON SPECTROSCOPY

With three high-resolution cold neutron spectrometers, unique in the United States, at or very near completion at the NIST Center for Neutron Research (NCNR), the timing could not have been better for the NCNR/NSF 1999 Summer School on Methods and Applications of Neutron Spectroscopy. The principal purpose of the 4 1/2 day school, held in August 1999, was to introduce research students and others to the uses and techniques of neutron spectroscopy, and to demonstrate concepts learned in the lecture room with several practical examples. Most of the 32 participants, from almost as many institutions across the nation, chosen from 60 applicants, were graduate and postdoctoral students; there also were junior faculty members and one scientist from industry.

The summer school comprised 14 in-house lectures by NCNR staff, three invited talks, a 2 hour tour of the experimental facilities, and four 3 hour sessions at instruments in the guide hall. The first day was devoted to talks about the wide range of research fields that have benefited from neutron inelastic scattering and about the fundamental formalism and concepts of nuclear and magnetic neutron scattering. Later lectures covered the reactor and cold source, specific neutron scattering techniques, *ab initio* theory and computer modeling calculations, and the principles of operation of the spectrometers used in the experimental sessions: the Fermi chopper spectrometer, the spin polarized inelastic neutron spectrometer, the high-flux backscattering spectrometer, and the neutron spin echo spectrometer. Together, these instruments are used to probe motions and excitations in materials and macromolecules over six decades in time (from $\approx 10^{-7}$ s to $\approx 10^{-13}$ s) and two orders of magnitude in distance (10^{-8} cm to 10^{-6} cm). Test samples included normal water, a geometrically frustrated antiferromagnetic system, solid methyl iodide, and a system of spherical micelles. These experiments illustrated incoherent quasielastic scattering, inelastic magnetic scattering, tunneling, and coherent scattering measurements. The lectures will be placed on the web in order to make them available to a wide audience, and a short report will be published in *Neutron News*.
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NIST CO-SPONSORS EIGHTH TEXT RETRIEVAL CONFERENCE (TREC-8)

NIST and the Defense Advanced Research Projects Agency (DARPA) co-sponsored the eighth conference in the Text REtrieval Conference (TREC) workshop series in November 1999, at NIST. Sixty-six groups participated in TREC-8, including representatives from 16 countries: Australia, Canada, France, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Russia, Singapore, Switzerland, Taiwan, Thailand, the United Kingdom, and the United States. Twenty-two of the participating groups were companies.

Two new tracks were introduced into TREC this year, a question-answering track and a web track. In the question-answering track, participants received a 2 GB document set and a list of 200 questions. The questions were fact-based, short-answer questions such as "How many calories are there in a Big Mac?" and each question was guaranteed to have at least one document in the collection that contained the complete answer. Participants returned answer strings with a maximum length of 50 bytes in response to each question, which then were judged for correctness by human judges. The track was the first large-scale evaluation of systems designed for domain-independent question answering.

The second new track used a collection of web pages as the document collection. The web differs from the documents used elsewhere in TREC in a variety of ways. For example, many documents contain non-English text (either other languages or other types of files such as data files); there are explicit links among documents; and the web is very large and dynamic. The last two differences make it difficult to form a good test collection of web documents, which is needed so that repeatable experiments can be performed to compare the quality of different retrieval techniques. This years track was an initial attempt to develop such a test collection.
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NIST TAPPED TO ASSIST THE MPEG-4 INDUSTRIAL FORUM (MP4IF)

Past efforts on digital video have relied on a frame-by-frame coding and transmission of moving images and related audio information. Industry standards-setting

groups now are preparing technical specifications for a future where such multimedia data will be composed, transmitted, and rendered in an object-based form. Object-based representations of multimedia will enable the strengths of automated computer processing to be applied more effectively to digital video information. For example, given an object-based representation, a computer-rendering program can more easily adapt multimedia information to the limitations of wireless network bandwidth or the characteristics of handheld display devices.

In October 1999, during the 49th International ISO/IEC JTC1/SC 29/WG 11 MPEG (Moving Picture Experts Group) meeting in Melbourne, Australia, the MPEG-4 working group created a spin-off industrial forum called MP4IF (MPEG-4 Industrial Forum). MP4IF will work specifically to transfer MPEG-4 technologies to industry, whereas the MPEG-4 working group is developing the technical specifications and international standards for object-based compression, decompression, processing, and coded representation of moving pictures and audio.

MP4IF has three primary objectives: informing and educating industry about MPEG-4 technologies; promoting MPEG-4 technologies to other international standards bodies such those working on cellular telephony, the Internet, and digital video broadcasting; and creating industrial focus, so common ideas and plans can be exchanged and implemented for adopting MPEG-4 technologies. To achieve these goals, MP4IF has created five working groups: Organization, Publicity and Information, Patents, Industrial Focus, and Tools & Software. Currently, there are more than 200 participants from more than 150 companies around the world participating in this forum.

Because NIST has expertise in most of the test tools for MPEG-4 and already hosts tools and test data sets for MPEG-4, the chairman of MP4IF asked NIST to host (on the web) all the MPEG-4 related tools and test data and to chair the Tools & Software Group. The charter of this working group is to collect, maintain, and make available a freely accessible collection of working tools, players, utilities, and tested bitstream data sets to demonstrate the MPEG-4 features and capabilities and to test MPEG-4 conformance to applicable implementation profiles. By actively participating in this forum, NIST will be able to work closely with a wide range of industries to promote the next generation of standard digital audiovisual and multimedia technology. The MPEG standards group has a successful track record in industry. For example, MPEG received an Emmy Award for Outstanding Achievement in Technological Development. In addition, MPEG-2 is the de facto content standard for DVD (Digital Video Disk) products.

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COLLABORATIVE RESEARCH IN SEM/AFM IMAGE OVERLAY INITIATED

NIST has initiated a collaborative research project with the University of North Carolina (UNC), Chapel Hill. The goal of this project is to investigate the potential advantages of advanced image overlay techniques, currently under development at UNC, in conjunction with simultaneous scanning electron microscope (SEM) and scanned probe microscope (SPM) datasets of dimensional test structures. The groups generated SEM and SPM images of NIST magnification and sharpness Standard Reference Materials 2090 and 2091 recently here at NIST. Both groups now are evaluating initial image-overlay results, obtained at UNC. The collaborative research team envisions that algorithms that can automate SEM intensity calibration of test feature height or SPM tip width subtraction will be useful to NIST's SEM semiconductor metrology program.

This software is expected to provide a foundation for further joint development of combined SPM/SEM analytical tools and techniques, since NIST and UNC now have similar combined research systems of SPM and field-emission SEM instruments.

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NATURAL CONSTANTS GET FIRST MAKEOVER IN 13 YEARS

Need to know the charge of an electron? Or the gravitational constant? Or the mass of a proton? Updated values of these and more than 300 other fundamental constants of nature now are available on the NIST World Wide Web site at physics.nist.gov/constants. The international Committee on Data for Science and Technology, also known as CODATA, recently recommended these new values. The constants will also be published in the *Journal of Physical and Chemical Reference Data* by early 2000 by two NIST physicists.

The NIST physicists spent much of the past 4 years evaluating experimental measurements and theoretical calculations relevant to the constants from researchers worldwide. They considered all results that were available as of Dec. 31, 1998. The last official CODATA revision to the fundamental constants was issued in 1986.

Upon completion of the NIST physicist's review and analysis, the CODATA Task Group concurred that it represented the world's current knowledge of the values of the constants. The Task Group is a 13-person committee whose members are precision measurement experts from Europe, the United States, Canada, Japan, China, and Russia.

While the changes in the recommended values of the fundamental constants are not dramatic—many just have more decimal places—it is the changes in uncertainties assigned to the values that are most noteworthy. Most have been significantly decreased, meaning that scientists are much more confident in their knowledge of the values.

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NEW DATABASE SEEKS "MEASURED ONCE, ACCEPTED EVERYWHERE"

Measurement-related questions and disputes, including those that can hinder global commerce, soon may be resolved with a click of a computer mouse thanks to a new international database of measurement comparisons recently unveiled by NIST and the International Bureau of Weights and Measures (also known as BIPM) in Sèvres, France.

Developed by NIST, the Internet-accessible International Comparisons Database will enable companies, regulators and others to evaluate the equivalence of calibrations and other measurement services performed by national metrology institutes (known as NMIs) in nearly all parts of the globe. In turn, the database will make it easier for businesses and other organizations that rely on these services to prove compliance with the measurement-related requirements of regulations and standards, which affect an estimated 80 % of global product trade.

An October 1999 agreement between 38 nations called for "mutual recognition of national measurement standards" and established a formal system of "key" measurement comparisons among the NMIs, or chief measurement organizations, of the signer nations. These multinational exercises determine how closely a particular measurement (of voltage, length or mass, for example) performed by one NMI agrees with results achieved by other participating NMIs.

Initially, the new database will record and display results of completed and ongoing key comparisons among the NMIs of nations that signed the October mutual recognition pact. About 130 of these round-robin measurement exercises are now under way, according to BIPM, which is responsible for promoting use of the international system of measurements and for furthering the system's development. International teams of measurement experts will evaluate the reliability of the results before entering them into the database.

Later, the database will be expanded to include all other NMIs through their participation in one of the world's six regional metrology organizations.

The International Comparisons Database can be accessed from the BIPM web site at www.bipm.fr. It also can be viewed on the NIST web site at icdb.nist.gov.

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GOT A SECOND? NOTHING COUNTS THEM BETTER THAN NEW NIST CLOCK

There's an old joke that says a man with one watch always knows what time it is while a man with two watches is never sure. Now, everyone in the United States can be certain that his or her time is accurate to 1 s in nearly 20 million years, thanks to the startup of NIST F-1, the new cesium atomic clock at NIST's Boulder, CO, laboratories.

F-1 began its role as the nation's primary frequency standard in December by making its first contribution to an international pool of atomic clocks used to define Coordinated Universal Time, the official world time.

NIST F-1 shares the distinction of being the world's most accurate clock with a similar device in Paris. It is approximately three times more accurate than its predecessor, NIST-7, also located at the Boulder facility. NIST-7 has been in service since 1993 and is among the best time standards in the world.

NIST F-1 is referred to as a fountain clock because it uses a fountain-like movement of atoms to obtain its improved reckoning of time. First, a gas of cesium atoms is introduced into the clock's vacuum chamber. Six infrared laser beams gently push the atoms together into a ball. In the process of creating this ball, the lasers slow down the movement of the atoms and cool them to near absolute zero.

Two vertical lasers are used to gently toss the ball upward (the "fountain" action), and then all of the lasers are turned off. This little push is just enough to loft the ball about a meter high through a microwave-filled cavity. Under the influence of gravity, the ball then falls back down. As the atoms interact with the microwave signal—depending on the frequency of that signal—their atomic states might be altered. The entire round trip for the ball of atoms takes about a second.

At the finish point, another laser is directed at the atoms. Only those whose atomic states are altered by

the microwaves are induced to emit light. The emitted photons (tiny packets of light) are measured by a detector. This procedure is repeated many times while the microwave energy is tuned to different frequencies. Eventually, a frequency is achieved that alters the states of most of the cesium atoms and maximizes their fluorescence. This frequency is the natural resonance frequency for the cesium atom—the characteristic that defines the second.

More information, including graphics, photos, fact sheets and a downloadable video (with an animation and B-roll footage), is available on the World Wide Web at www.nist.gov/fountainclock.

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KALEIDOSCOPE IS MODEL FOR OPTICAL TUNNEL-TRAP DETECTOR

Remember when you were a kid looking through a kaleidoscope? These days, you'd probably say that while the rotating, changing patterns were pretty, there wasn't any practical science involved. Not so fast, say NIST researchers.

The principle of the kaleidoscope is the model for a new, NIST-developed instrument used as a transfer standard for laser power measurements. Called an optical-trap detector, it is a triangular tube with two relatively inexpensive photodiodes on each side in the place of a kaleidoscope's mirrors. Where the mirrors would trap light and reflect it back and forth to create images, the photodiodes either absorb the laser light or reflect it to the other diodes for absorbtion. With each absorbtion, the photons are converted to electrical energy and a measure of laser power is made.

One version of the detector incorporates six 10 mm by 10 mm square silicon photodiodes in a detector having a 7 mm diameter aperture; it has an efficiency greater than 99 %. Another version incorporates six 18 mm by 18 mm square photodiodes in a detector having a 12 mm diameter aperture; it has an even greater efficiency, with variations that are less than 0.05 %. The NIST researchers hope to continue their work in order to develop simpler trap designs with fewer diodes and larger fields of view.

Copies of a paper (54-99) discussing the design and fabrication of the detector are available from Sarabeth Harris, MC104, NIST, Boulder, CO 80303-3337; (303) 497-3237; sarabeth@boulder.nist.gov. Technical details are available from John Lehman, MC815.01, NIST, Boulder, CO 80303-3337; (303) 497-3654; lehman@boulder.nist.gov.

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NIST PHYSICISTS DEVELOP NEW TOOL TO VALIDATE PROTEIN MODELING

Proteins intrigue industry for their potential applications in designing new pharmaceuticals, improving agriculture and processing food, chemical and materials. They also are large and highly complex molecules that present difficult puzzles to the biochemists who try to understand and define their structures. Now, NIST physicists have a new tool that could help solve protein structures by verifying the accuracy of protein modeling software.

One of the problems in deciphering protein structures is the large number of possible spatial orientations that atoms can occupy when bonded together, much as a chain of beads can be twisted or rotated into numerous positions. In fact, the number of possible conformations of a long chain of atoms is so great that current computer speed is not fast enough to calculate all of them.

Using a NIST-developed Fourier transform microwave spectrometer, NIST physicists have determined several conformational isomers of small alkene molecules ranging in size from 5 to 12 carbon atoms. Since the bonds in these chains are similar to the bonds in protein molecules, software designers could use the NIST data to verify the accuracy of their protein modeling algorithms. The advantage of the NIST Fourier transform microwave spectrometer is its ability to resolve different conformers of the same molecule very clearly. For example, the NIST instrument has identified 15 conformers of 1-octene, an 8-carbon chain, more than have been observed experimentally ever before.

The NIST alkene data represent the first large experimental conformational data set that protein modelers and software designers can use as a check on the accuracy of their methods and codes.

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"RETURN OF THE CRYOGENICS DATABASE" NOW PLAYING AT NIST

NIST, along with the Chemical Propulsion Information Agency, Columbia, MD, and a private company, has reconstructed and updated the database of the National Bureau of Standards (now NIST) Cryogenic Data Center. The center, which housed on a mainframe computer a bibliography of cryogenic literature and thermophysical property data that covered 100 years, was discontinued in the early 1980s.

After a 1997 survey showed there was substantial interest by industry and government researchers in a revived database, the three organizations created a Cryogenic Information Technology Database, available on CD-ROM with over 133 000 document citations.

The CD-ROM is planned for semi-annual release with additional citations from current literature. A specialized technical staff has been trained to establish a clearinghouse of cryogenic information, acquire hard copies of documents, store computerized records of bibliographic data for retrieval and update the record base continuously. The goal is to establish an information center capable of providing technical analyses, state-of-the-art reviews, enhanced fluid and material property software routines, current-awareness services and Internet accessibility. In other words, the renewed database is a one-stop resource for cryogenic documents and technical data.

Information on the Cryogenic Technology Database is available from Eric D. Marquardt, NIST, MS 838, Boulder, CO 80303-3337; (303) 497-5467; ericm@boulder.nist.gov. A paper (no. 52- 99) outlining the database program is available from Sarabeth Harris, MC 104, NIST, Boulder, CO 80303-3337; (303) 497-3237; sarabeth@boulder.nist.gov.
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INDUSTRY FUNDS COMMERCIALIZATION OF NIST MODELING TECHNOLOGY

Currently, there are about 20 kg of powder metallurgy parts in automobiles. These are extremely cost-effective parts, and there is a great desire in the industry to increase the number of parts made by powder metallurgy. There also is an intention to switch to aluminum based powder metallurgy to reduce the weight and increase the efficiency of automobiles. For several years, NIST has been working with a consortium formed by the U.S. Automotive Manufacturing Partnership (USAMP, a subset of USCAR, U.S. Council for Automotive Research) to develop modeling technology that could shorten the time required to launch new powder metallurgy parts in autos and decrease their production costs. The modeling research was done as a collaborative effort between Cambridge University and NIST. With the completion and validation of a model that accurately describes the consolidation behavior of reinforced metal powders into parts such as gears, rotors, sprockets, or connecting rods, a need arose to make this approach available in user-friendly software where the computational and scientific complexities would be transparent to the user. USAMP has recently funded a private company to carry out this task and NIST is interacting with their technical staff to assure correct implementation of the model. The software will be available to the USAMP consortium members in a few months and, if successful, to the U.S. powder metallurgy industry in a year or two.

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FIR SPECTROSCOPY OF BENDING TRANSITIONS IN CARBON-CHAIN MOLECULES

NIST scientists, in collaboration with university researchers, have recently used far-infrared (FIR) laser-magnetic-resonance (LMR) spectroscopy to make observations of bending vibrational spectra of a number of important carbon-chain molecules. The accurate determination of bending spectra can provide insight into the structure of these simple, substituted carbenes, and enable testing of theoretical models. The excellent sensitivity of FIR LMR spectroscopy allows for the detection of transitions that are roughly 100 times less intense than a pure rotational or electronic transition and the method is especially useful when the number density of such highly reactive species is low.

The group has just reported on the first direct observation of the ν_2 bending fundamental of the CCN radical and have observed and fit the spectra for the ν_5 bending fundamental of the HCCN radical. In addition, they have conducted survey scans in the region of the ν_5 bending fundamental of the DCCN radical and have now made assignments on nearly all of the predicted resonances. They also have initiated studies on HC_3, HC_4, $HC_5 \ldots HC_{11}$, a series of important interstellar molecules. The goal is to extend measurements of the low-lying bending fundamentals in this series out as far as the sensitivity of the spectrometer will allow.
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NIST'S OPTICAL APERTURE AREA MEASUREMENT FACILITY

Knowledge of the area of apertures for optical radiation measurements is one of the critical factors needed for accurate flux measurements. NIST has developed an optical aperture area measurement facility for measuring apertures with mean diameters in the range of 3.5 mm to 25 mm. The facility was built to measure apertures used to limit the optical flux in radiometers and consists of two instruments. The first instrument is a microscope-based absolute device utilizing a two-pass dual-wavelength laser-interferometer in which the aperture is positioned on an air-bearing supported stage that eliminates any hard physical contact. The instrument is capable of high-accuracy measurements of aperture areas with maximum relative uncertainty of 0.0013 % for round knife-edge apertures having a smooth profile. The second instrument uses flux transfer techniques to

measure the effective area under specific conditions. This instrument is capable of measuring the effective area with a relative uncertainty of 0.01 % for 25 mm diameter apertures and 0.15 % for 3.5 mm diameter apertures. The edge quality of the aperture affects the area measurement and can increase the uncertainty; a correction can be applied that compensates for the increase. This instrument is used to measure large groups of similar apertures.

The aperture-measurement facility is being used by NIST in its role as the pilot laboratory for the Consultative Committee for Photometry and Radiometry, International Committee for Weights and Measures, Supplementary International Intercomparison CCPR-S2.

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MAGNETIC TRAPPING OF NEUTRONS DEMONSTRATED FOR THE FIRST TIME

A collaboration between researchers at NIST, Harvard University, the Hahn-Meitner Institute, and Los Alamos National Laboratory recently demonstrated, for the first time, the magnetic trapping of neutrons. This work demonstrates the loading, trapping, and detection techniques necessary for performing a neutron-lifetime measurement. Further refinements of this method should lead to an improved precision in the measurement of the neutron lifetime, an important parameter for understanding the weak nuclear force and the creation of matter during the Big Bang.

Ultracold neutrons (UCN: neutrons with energies $\approx$100 neV) are produced in a superfluid ^{4}He bath inside the trapping region using the "superthermal process." A beam of cold neutrons from the NIST Center for Neutron Research is introduced into the helium, in which neutrons with wavelength near 0.9 nm scatter to UCN energies by creation of a single phonon. By cooling the helium to less than 250 mK the inverse process is highly suppressed. UCN produced within the trapping region and in the appropriate spin state are magnetically confined and travel undisturbed within the helium until they beta decay. Neutron decays generate scintillations in the helium, which allow their detection. The exponential decay rate is recorded as a function of time. Another important result is the direct confirmation of the theoretical prediction of the UCN density in the trap. This provides the opportunity for development of a high flux steady-state source of ultracold neutrons. Potential applications of superthermal UCN sources include searches for time-reversal violation and new methods of neutron scattering especially suited for the study of large (biological-scale) molecules.

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THE SAGE EXPERIMENT LIMITS NEUTRINO OSCILLATIONS IN VACUUM

Data from 8 years of measurements of the solar neutrino flux by SAGE, the Russian-American Solar Neutrino Experiment, have been analyzed for its implication on vacuum neutrino oscillations. Several types of neutrinos exist in nature, and the possibility that neutrinos borne in the sun of one "flavor" oscillate (or change) into neutrinos of another flavor during their transit to the Earth is one of the leading theories for resolving the long-standing discrepancy between measurements of the solar neutrino flux and the predictions derived from the Standard Solar Model. It is important to determine whether the discrepancy is due to a deficiency in understanding solar physics or in understanding fundamental particle physics.

A NIST scientist is one of the U.S. collaborators on this experiment. A paper published in a December issue of *Physical Review Letters* presents the limits imposed by the SAGE data on vacuum oscillation parameters.

A direct consequence of any oscillation theory is that the neutrino, currently assumed to have zero mass, is actually a particle with finite mass. Although existing neutrino detectors are not able to distinguish between neutrino flavors, one can nevertheless examine the allowed regions of neutrino mass and oscillation mixing angle using the annual variations in the measured solar neutrino flux, averaged over the 8 years of running. The overall minimum occurs at a difference in the square of the neutrino mass equivalent to 1.2×10^{-9} eV^2 and an oscillation mixing angle of $\sin^2(2\theta) = 0.94$. Although the limit does not definitively prove the existence of vacuum neutrino oscillations, it is consistent with limits produced by other solar neutrino experiments.

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COMPILATION OF ASTM STANDARDS ON BUILDING ECONOMICS

Eleven of the 14 standards included in the recently published fourth edition of the compilation of ASTM standards on building economics are based on NIST technical reports written by NIST economists. The compilation provides a comprehensive resource for evaluating the economic performance of investments in buildings and building systems. It helps users decide whether to accept or reject a given investment, how to design and size building systems, and how to establish priority when budgets are limited. Standard methods are

included for measuring life-cycle cost, benefit-to-cost and savings-to-investment ratios, internal rates of return, net benefits, and payback. Standard guides recommend techniques for treating uncertainty and risk and help users match technically appropriate economic methods with the different types of design and system decisions that require economic analysis.

Users of the compilation include manufacturers; federal, state, and local government agencies; builders; building code bodies; architectural/engineering firms; facilities managers; consumer groups; trade associations; research groups; consulting firms; and universities. Although the focus is on buildings and building components, the standards are equally applicable to evaluating capital budget expenditures in non-building investments. In addition to writing most of the technical reports on which the standards are based, NIST economists have chaired the ASTM Subcommittee on Building Economics since its inception in 1979 and played a major role in the drafting and balloting of each standard. The subcommittee has been the preeminent forum for NIST to identify industry's economic measurement needs, to create collaboratively with industry the standard measurement practices to answer those needs, and to implement those standard practices through the voluntary consensus standards process.
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UNIFORMAT II CLASSIFICATION FOR BUILDING ELEMENTS

NIST and Concordia University staff members completed NISTIR 6389 on the UNIFORMAT II elemental building classification. The building community needs a common elemental classification for the description, economic analysis, and management of buildings over their life cycle. Elements are major components, common to most buildings, that usually perform a given function regardless of the design specification, construction method, or materials used. Examples of elements are foundations, exterior walls, sprinkler systems, and lighting. While the traditional building classification based on products and materials is useful when preparing detailed cost estimates, the collection and evaluation of data at other phases of the building life cycle require a less detailed and costly data set organized by functional elements. Standard elements become crucial as more and more new buildings have their life- cycle data stored electronically.

The NISTIR advances the use of the UNIFORMAT II classification of elements in three ways. First, a new, fourth level of classification for building elements and related sitework is recommended for expanding the current three-level classification provided in ASTM E-1557-97. Second, applications of UNIFORMAT II are described for the preparation of specifications and estimates that are required during the programming and design phases of the building life cycle. Third, a standard format for summarizing an elemental cost estimate based on UNIFORMAT II is presented. Applying UNIFORMAT II at each step of the building process provides significant savings to industry. Data entered in a consistent format will not have to be reentered at subsequent phases of the building life cycle. Users will understand and be able to compare information at every phase because it is linked to a standardized, elemental classification structure. Better information, generated at lower cost, will help owners, project managers, designers, builders, and facility managers construct and manage their buildings ore cost effectively.
CONTACT: Harold E. Marshall, (301) 975-6131; harold.marshall@nist.gov.

NIST DEVELOPS REFERENCE IMPLEMENTATION FOR DIGITAL TV

NIST announced its work-in-progress release of the reference implementation for the Digital TV Application Software Environment simulation platform. The work has evolved from an invitation NIST received in 1998 to participate in the Digital TV Application Software Environment (DASE) specialist subcommittee T3/S17, of the Advanced Television Systems Committee (ATSC). An industrial consortium of consumer electronics manufacturers, broadcasters, computer manufacturers, software companies, advertisers, and content providers, ATSC has defined the formats for high-definition digital television in the United States.

ATSC is developing a standard DASE Application Programming Interface (API). Digital TV content providers can build an application using the API standard and it will run on any conforming manufacturer's TV set-top unit, which is the TV's communications computer. A typical application might be an advertisement scene for automobile leasing augmented with a "send details" button on the screen. Viewers activating this button can interactively view details immediately; they can get information about local leasing companies by entering their zip codes.

The specialist subcommittee requested that NIST develop a reference implementation (RI) for their API; ATP supports NIST's participation in this effort. The RI is a tool to demonstrate proof-of-concept of the DASE standard, aid the design and development of other DASE implementations, and provide an environment for developing and testing DASE contents/applications. The RI will serve as the benchmark against which other

implementations can be compared in establishing their adherence to the DASE standard specification. The current implementation accounts for approximately 25 % of the DASE API specification. In addition to components of the API, the release includes a simulation environment and some sample applications. An ATSC bitstream parser, also a work-in-progress, is available; this component comes into play with later emulation versions of the RI.

Reference implementation code is available, without charge, for use, distribution, or incorporation into other related projects. Code and documentation are available via http://www.dase.nist.gov/.

CONTACT: Alan Mink, (301) 975-5681; alan.mink@nist.gov or Robert Snelick, (301) 975-5924; robert.snelick@nist.gov or Wayne Salamon, (301) 975-4432; wayne.salomon@nist.gov.

NIST ANNOUNCES DRAFT FIPS 140-2, *SECURITY REQUIREMENTS FOR CRYPTOGRAPHIC MODULES*

A Federal Register notice of Nov. 17, 1999, announced the draft Federal Information Processing Standard (FIPS) 140-2, *Security Requirements for Cryptographic Modules.* Now available for public review and comment, the proposed FIPS 140-2 specifies the security requirements that need to be satisfied by a cryptographic module utilized within a security system protecting sensitive information. Following approval by the Secretary of Commerce, FIPS 140-2 will supersede FIPS 140-1 and must be used in designing and implementing cryptographic-based security systems that federal agencies operate or are operated for them under contract.

First published in 1994, FIPS 140-1 specified that it be reviewed within 5 years. In 1998, NIST solicited industry and public comments on reaffirming the standard. Comments received by NIST supported maintaining and updating the standard due to advances in technology. The proposed revision is available at http://csrc.nist.gov/fips/dfips140-2.pdf.

The Cryptographic Module Validation Program (CMVP) is a joint effort between NIST and the Government of Canadas Communications Security Establishment (CSE). NIST and CSE serve as the validation authorities for the program. Currently, there are three National Voluntary Laboratory Accreditation Program accredited laboratories that test cryptographic modules. See the web site at http://csrc.nist.gov/cryptval.

CONTACT: Ray Snouffer, (301) 975-4436; stanley.snouffer@nist.gov.

NEW METHOD FOR MEASURING THE INTERNAL FRICTION IN SOLIDS

Internal friction describes the mechanisms of dissipation of mechanical energy inside a solid. It is an important physical property needed for materials characterization because it often exposes atomic level phenomena that control such important physical properties as mechanical strength, hardness, and atomic diffusion. In order to measure it, all other sources of energy loss must be eliminated by careful control of the experimental conditions. This seldom can be achieved outside a laboratory environment so its application to nondestructive evaluation of a structure or a device is limited severely. NIST recently has performed research on a technique called “diffuse field ultrasonics” in which ultrasonic waves in the 0.1 MHz to 10 MHz frequency range are allowed to diffuse throughout a solid body of arbitrary shape while their decay in amplitude is monitored as a function of time. The results obtained on a commercial aluminum alloy show that the intrinsic internal friction observed in this way is comparable to that observed by noncontacting methods which minimize the effects of contacting transducers. In addition, results on steel alloys used in nuclear reactor pressure vessels show a systematic relationship between the internal friction and the hardness. These results represent a significant step towards utilizing the diffuse field technique for nondestructive evaluation of in-service structures as well as for elucidating the relationship between internal friction and hardness.

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COMPARISON OF ADAPTER CHARACTERIZATION METHODS

Precision adapters are in widespread use throughout the microwave measurement community. They greatly increase the versatility of equipment by enabling connections between equipment and devices having different connectors. The use of adapters, however, requires that they be characterized to enable the user to correct for their effect. Failure to properly account for adapter effects can lead to measurement errors in microwave measurements by as much as 6 % to 7 %.

NIST staff have reviewed and compared three different methods for characterizing precision microwave adapters. The intrinsic efficiencies of several different adapters, both coaxial-to-waveguide and coaxial-to-coaxial, were measured with each technique, and the results were compared. The results usually agreed within about 0.005 for efficiencies near 1. In all cases,

the differences were consistent with the estimated uncertainties of the techniques, which range from about 0.002 to about 0.012, depending on the method, the connectors, and the frequency. The work was presented at the 1999 IEEE MTT-S International Microwave Symposium (June 1999), as well as in a paper to be published in *IEEE Transactions* on MTT (Microwave Theory and Techniques).
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PASSIVE INTERMODULATION MEASUREMENT INTERCOMPARISON

In response to requests by U.S. industry and members of the International Electrotechnical Commission (IEC), NIST researchers conducted the first phase of the Passive Intermodulation Measurement Intercomparison for U.S. Wireless Industry. The goal of this comparison has been to determine the level of agreement in passive intermodulation (PIM) measurements made by U.S. manufacturers and suppliers of passive components for wireless communication base stations. This study not only reveals the difficulties industry is having in making PIM measurements but also provides U.S. companies with a tool to improve their measurement capabilities as they deal with PIM-related trade barriers.

This work addresses a direct need expressed to NIST by U.S. equipment and base station manufacturers: there is a critical need for accurate measurements of passive intermodulation in wireless communication base station components. Passive intermodulation can adversely affect digital communications in cellular phones and personal communication systems, and the industry is currently limited in their ability to assess agreement in PIM specifications and measurements, particularly in regards to trade between the United States and the European Community. The PIM round-robin allows each participant to assess their capabilities in a nonthreatening way, while it allows NIST to evaluate the urgency in any PIM meas-urement problems that may exist within the industry.

Since last August, 10 U.S. companies have participated in the PIM intercomparison, They measured four round-robin artifacts and contributed 19 data sets for four different commercial communication bands. The NIST researchers wrote a draft report summarizing the U.S. study to date. The report preserves company anonymity and allows each participant to determine how well their measurements compare to ensemble averages for each of the four devices in each of the four communication bands. While the study shows the majority of participants reporting PIM levels within one standard deviation of the mean values, it also reveals significant discrepancies reported by others. One participant reported PIM levels nearly 20 dB below the mean values. The PIM comparisons report is already assisting this and other companies as they improve their capabilities.

The intercomparison results were presented at the June 1999 meeting of the IEC Technical Committee 46, Working Group 6.
CONTACT: Robert M. Judish, (303) 497-3380; judish@boulder.nist.gov.

2.4 mm COAXIAL NOISE-TEMPERATURE MEASUREMENT SERVICE

NIST scientists have developed a new measurement service for the noise temperature of sources with 2.4 mm coaxial connectors. The new meas-urement service offers continuous frequency coverage from 8 GHz to 40 GHz, with the exception of two small gaps, and is capable of measuring sources with noise temperatures over a range from approximately 50 K to 15 000 K. Typical relative expanded uncertainties (two standard deviation estimates) are expected to be between 1 % and 1.4 % up to 26 GHz and between 1.5 % and 1.7 % from 26.5 GHz to 40 GHz, for sources with a noise temperature of about 5000 K to 10 000 K and a reflection coefficient of less than about 0.1. The 2.4 mm coaxial connector and transmission line can be used up to 50 GHz, and it is the most common coaxial size for the 26.5 GHz to 50 GHz frequency range. This connector geometry also is used extensively in measurement and test equipment, high-speed digital logic, and components such as switches, amplifiers, and mixers.
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MULTIPORT ON-WAFER SCATTERING PARAMETER MEASUREMENTS

Microwave measurements previously made in coaxial or other waveguides are now made directly on-wafer whenever possible. However, implementation of some of the more complex multiport measurements required to characterize complex electrical packages, multiconductor transmission lines, and multifunction circuits in the on-wafer environment has been hampered by limitations of available probing systems, which do not allow direct connections between orthogonal probes during the calibration step.

In response to these difficulties, NIST scientists developed a four-port test set and software for measuring fully corrected four-port on-wafer scattering and impedance parameters. The software is unique as it only requires two in-line calibrations, resolving an important

difficulty with existing four-port calibration schemes. The additional hardware required to implement this method is inexpensive and easy to construct.

This new procedure allows calibrations for multiport measurements to be performed using well understood conventional in-line calibrations and provides the first solution to this long-standing problem. The method not only is well suited to industrial environments but also can be used to evaluate ad hoc methods commonly used in the industry to address this important measurement problem.

This software will primarily impact the electronics packaging industry, which often must characterize multiport circuits. The method also may find application in the characterization of multiport wireless circuits and digital transistors.

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NIST PUBLISHES PROPOSED GUIDANCE ON FEDERAL CONFORMITY ASSESSMENT ACTIVITIES

NIST published "Proposed Guidance on Federal Conformity Assessment Activities" in the Nov. 3, 1999, edition of the *Federal Register.* This proposal was open for public comment until Jan. 18, 2000, and was prepared in response to new duties conferred on NIST under section 12 of the National Technology Transfer and Advancement Act of 1995. The act directed NIST to coordinate conformity assessment (CA) activities of federal, state, and local entities, thus eliminating unnecessary duplication of CA activities. OMB Circular A-119, which was revised and reissued on Feb. 19, 1998, also recognized the CA requirements and obligations defined in the act and the role of the Department of Commerce in this area.

The guidance outlines federal agencies' responsibility for evaluating the efficacy and efficiency of their CA activities. Agencies are reminded that each is responsible for coordinating its CA activities with those of other government agencies and of the private sector to make more productive use of increasingly limited federal resources available for the conduct of CA activities, and to eliminate unnecessary duplication. The proposed guidance is available on NIST's new CA website at: http://ts.nist.gov/ca.

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COLLABORATIVE DIELECTRIC MEASUREMENTS DEMONSTRATE WEAK ANISOTROPY IN COMPOSITE SUBSTRATE MATERIAL AT MILLIMETER WAVELENGTHS

NIST collaborated with a leading microwave substrate and printed wiring board manufacturer to measure accurately the dielectric properties of a new composite material that consists of randomly oriented ceramic particles in a polymer filler. The manufacturer needed measurements performed in the millimeter wave frequency range to meet the needs of electronic designers working at these frequencies. The measurement approach also provided an additional benefit of being able to demonstrate that the material is weakly anisotropic. Previously, the manufacturer had attempted to obtain such data at millimeter wavelengths from both industrial and academic testing laboratories, but the results proved inaccurate and inconclusive.

In preparation for these tests, the manufacturer etched 1.52 mm thick laminar sheets of the test material free of copper cladding and subsequently heat-bonded these together into a 48 stack layer to form a block 120 mm×106 mm×65.3 mm in size. Six slabs, approximately 12 mm thick, then were cut from the block along its three orthogonal *x-y, y-z,* and *z-x* planes and subsequently machined into discs, 60 mm in diameter and about 3 mm in thickness.

NIST subsequently measured the complex permittivity, $\varepsilon'-j\varepsilon''$ of the six disc specimens in a Fabry-Perot semi-confocal resonator at 60 GHz. Each specimen was measured four times, such that the resonator electric field was oriented either parallel or normal to the discs principal diameter, which was defined as being parallel to the *x-y* plane of the laminar sheets. This yielded eight measurements each of the *x-, -y,* and *z-*directed components of complex permittivity. The measurement data then were returned to the manufacturer for further processing. After adjusting for variations in specimen densities, the manufacturer detected differences between the three components that were highly significant at a 98.5 % or greater confidence level, using the Students *t*-test. The differences between the *x-* and *y-*components of complex permittivity, relative to the *z-*component were determined to be +1.8 % and +2.8 %, respectively, for relative permittivity, ε' and +2.4 % and +4.3 %, respectively, for loss factor, $\tan\delta = \varepsilon''/\varepsilon'$.

This work is an excellent example of how NIST was able to collaborate with an industry manufacturer in performing some very specialized material characterization measurements that the manufacturer was unable

to perform independently. By making full use of NIST meas-urement capabilities and expertise, the manufacturer succeeded in reliably and accurately characterizing this particular material in the frequency range desired. CONTACT: Robert Judish, (303) 497-3380; judish @boulder.nist.gov.

MAGNETISM BEYOND 2000

Two papers from NIST researchers were invited for publication in "Magnetism Beyond 2000," a special issue of the *Journal of Magnetism and Magnetic Materials,* commemorating the publication of its 200th volume, and which features invited papers that address the current status of magnetism research and highlight questions for future research.

Recent NIST research focused on the coupling between two magnetic thin films separated by a non-magnetic spacer layer. These thin film structures have been of interest since the discovery of the giant-magnetoresistance (GMR) effect in 1988, and of significant commercial importance since their use in read heads for magnetic disk drives in 1998. The invited paper, "Effect of Roughness, Frustration, and Antiferromagnetic Order on Magnetic Coupling of Fe/Cr Multilayers," reviews experimental and theoretical work on Fe/Cr multilayers. It explains the complex behavior in Fe/Cr multilayers with a unified picture, based on the delicate interplay between interfacial dis-order and the antiferromagnetic order. The invited paper "Interlayer Exchange Coupling," reviews multilayer systems, with emphasis on the comparison of predictions of a "quantum-well" model with experimental measurements. For most lattice-matched systems, where the physical structure of the multilayers approaches the theoretical ideal, theory and experiment are in good agreement. The best agreement, based largely on NIST work is found for Au/Fe multilayers. The widely studied Fe/Cr system, on the other hand, still presents difficulties. While many of the important discoveries in this field have occurred in Fe/Cr, the many experiments on this system also have led to conflicting and sometimes puzzling results.
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***PHYSICS TODAY* FEATURES NIST WORK ON BOSE-EINSTEIN CONDENSATION**

The December 1999 issue of *Physics Today* features a review article authored by an Oxford University scientist and two NIST scientists on recent work on progress in the theory of Bose-Einstein condensation (BEC). The cover illustration for the issue was supplied by NIST personnel.

Predicted by Albert Einstein in 1924, and first observed in 1995, BEC is a phase transition in which virtually all atoms of a gas are forced to occupy the lowest quantum state, even at temperatures that would permit the population of many excited states. A purely quantum-mechanical phenomenon with no counterpart in classical thermodynamics, BEC provides a practical mechanism for the production of macroscopic numbers of atoms in identical, well-defined quantum states. A reservoir of such atoms can be used to amplify matter waves, by employing an analogue of the laser principle used to amplify light waves. It also provides the brightest known source of ultracold atoms, for applications in atom interferometry, precision spectroscopy, and quantum information processing. For these reasons, BEC has become one of the most active research topics in physics, which has stimulated well over a thousand scientific papers since 1995.

The review describes the evolution of theoretical understanding of BEC since the breakthrough experiments of 1995. It concludes that whereas there now exists an accurate first-principles theory of the structure and dynamics of the very coldest condensates, there still is difficulty in describing their properties near the phase transition temperature. It also notes that a number of the aspects of superfluidity that condensates are expected to exhibit have yet to be observed in the laboratory.
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OOF NAMED TECHNOLOGY OF THE YEAR

Industry Week magazine has named NIST as one of its 1999 Technology of the Year award winners for the development of OOF. OOF is an object-oriented finite-element system for the modeling of real material microstructures. The announcement of *Industry Week's* 7th annual Technology and Innovation Awards appears in its Dec. 6, 1999, issue.

Each December *Industry Week* profiles promising new technologies to "celebrate the link between technological creativity and economic progress," naming some 25 innovations as Technologies of the Year. The 1999 winners, who represent a wide range of technologies from both industry and national laboratories, are listed at http://www.industryweek.com/Tech&Innovation/.

OOF is designed to help materials scientists calculate macroscopic properties from images of real or simulated microstructures. It is composed of two cooperating parts: ppm2oof and oof. ppm2oof reads images in the ppm (Portable Pixel Map) format and assigns material properties to features in the image. oof conducts virtual experiments on the data structures created by ppm2oof to determine the macroscopic properties of the

microstructure. Currently, the programs calculate stresses and strains, but work is under way to add thermal field calculations.

In its description of OOF, *Industry Week* says, "The OOF advantage to corporate R&D could be significant. Because OOF replaces weeks of laboratory experiments with quick computational assays, it can help researchers run their labs more strategically." For more information about OOF, see http://www.ctcms.nist.gov/oof/.

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Standard Reference Materials

NIST PARTICLE SIZE SRMS REMAINING STABLE

After a question arose about the long-term dimensional stability of polystyrene microsphere SRMs (standard reference materials) stored as aqueous suspensions, an Inventory Test Project was carried out. Its purpose was to measure the average diameter of four microsphere SRMs, numbered 1690 (1 μm), 1692 (3 μm), 1960 (10 μm), and 1961 (30 μm). Array-sizing optical microscopy was used to recheck the diameters of all four SRMs. This technique had been used during the original certifications. The results of the inventory test show that during the shelf-life period, ranging from 7 to 14 years, each SRM maintained its certified average diameter to within the original uncertainty.

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Standard Reference Data

PERMEABILITY DATABASE NOW AVAILABLE ONLINE

Industrial researchers, engineers and others who manufacture polymers now have free, online access to a valuable resource once sold only on diskette. The NIST Standard Reference Database on Reinforcement Permeability Values is now available on the World Wide Web at srdata.nist.gov/permeability.

Though databases containing information on structural and other properties of composites exist, the NIST Standard Reference Database on Reinforcement Permeability Values is the first of its kind to support the design and implementation of liquid composite molding, which is an important manufacturing technique for modern reinforced polymers.

Permeability is the most important parameter governing resin flow through a composite preform mold because it can be used to compute flow behavior easily in large complex molds. Taking flow measurements is often difficult and the number of different preform materials is quite large. This database currently serves as a repository for permeability measurements, containing more than 100 data points measured at NIST for different woven, random, stitched, and unidirectional glass fabrics. Fiber volume percentages range from about 10 % to over 55 %.

Version 2 of the database will be released shortly on the web with a much larger number of records.

For more information, contact Richard S. Parnas, Polymer Composites Group, Materials Science and Engineering Laboratory, (301) 975-5805, richard.parnas@nist.gov, or Joan Sauerwein, Standard Reference Data Program, (301) 975-2208, joan.sauerwein@nist.gov.

Media Contact: Michael E. Newman (301) 975-3025; michael.newman@nist.gov.

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Calendar

April 13–14, 2000
THIRD ADVANCED ENCRYPTION STANDARD (AES) CANDIDATE CONFERENCE

Location: New York Hilton and Towers
New York, NY

Sponsors: National Institute of Standards and Technology (NIST).
Audience: An international audience consisting of cryptographers and other interested parties, who wish to participate in the evaluation and analysis of the five finalist candidate algorithms being considered for the Advanced Encryption Standard (AES). This conference is being held immediately following the Fast Software Encryption Workshop 2000 (FSE2000), scheduled for April 10-12, 2000 at the same venue.
Format: Primarily panels and paper presentations, with discussion by experts who have analyzed the finalist algorithms for security, efficiency, and other algorithm characteristics. Audience members and algorithm submitters will have an opportunity to question the panelists and presenters regarding their findings.
Purpose: In August 1999, NIST announced five finalist candidate algorithms (MARS, RC6TM, Rijndael, Serpent, and Twofish) which are being considered for incorporation in the future AES Federal Information Processing Standard (FIPS). NIST has solicited public comments on the candidates and has also been conducting its own efficiency and statistical analysis. During the conference, attendees will hear results of experts' study of the five AES finalist algorithms and recommendations for the selection of the winners. To further ensure a constructive and lively dialogue, submitters of the finalist algorithms will also have an opportunity to provide their comments on the analysis of their algorithms (and on the other candidates). Simply put, the purpose of this conference will be to help answer the questions: "Which algorithm(s) should NIST include in the AES FIPS, and why?"
Topics: At the conference NIST will invite speakers who have prepared particularly insightful and useful analysis of the candidates. This will include security analysis, efficiency analysis, as well as other germane comments (e.g., intellectual property, possible selection of multiple winners, etc.).
Registration Contact: Lori Phillips Buckland, NIST, 100 Bureau Dr., Stop 3461, Gaithersburg, MD 20899-3461, phone: 301/975-4513, fax: 301/948-2067, email: phillips@nist.gov.
Technical Contacts: Jim Foti, NIST, 100 Bureau Dr., Stop 8930, Gaithersburg, MD 20899-8930, phone: 301/975-5237, fax: 301/948-1233, email: james.foti@nist.gov, or Elaine Barker, NIST, 100 Bureau Dr., Stop 8930, Gaithersburg, MD 20899-8930, phone: 301/975-2911, fax: 301/948-1233, email: elaine.barker@nist.gov.
Website: http://csrc.nist.gov/encryption/aes/round2/conf3/aes3conf.htm.

May 16, 2000
2000 MALCOLM BALDRIGE NATIONAL QUALITY AWARD REGIONAL CONFERENCE-CHICAGO

Location: Swissotel Chicago
Chicago, IL

Sponsors: National Institute of Standards and Technology (NIST), Baldrige National Quality Program, The Conference Board.
Audience: Senior managers, education and health care leaders, heads of operating units, line managers, directors of staff functions, and quality practitioners.
Format: Conference, lecture, breakout sessions and Q&A.
Purpose: The 1999 Baldrige Award recipients, along with Award recipients from past years, will share key success strategies for improving organizational performance and the benefits of using the Baldrige process.
Topics: The Leader's perspective on performance excellence, the benefits of the Baldrige process, and key success strategies in the seven Criteria Categories.
Technical Contact: Baldrige National Quality Program-NIST, phone: 301/975-2036, fax: 301/948-3716, email: nqp@nist.gov.
Website: http://www.quality.nist.gov/regs2000.htm.

June 6, 2000

2000 MALCOLM BALDRIGE NATIONAL QUALITY AWARD REGIONAL CONFERENCE-BOSTON

Location: Le Meridien Hotel
Boston, MA

Sponsors: National Institute of Standards and Technology (NIST), Baldrige National Quality Program, The Conference Board.
Audience: Senior managers, education and health care leaders, heads of operating units, line managers, directors of staff functions, and quality practitioners.
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Website: http://www.quality.nist.gov/regs2000.htm.

June 21, 2000

2000 MALCOLM BALDRIGE NATIONAL QUALITY AWARD REGIONAL CONFERENCE-SAN FRANCISCO

Location: Mark Hopkins Inter-Continental
San Francisco, CA

Sponsors: National Institute of Standards and Technology (NIST), Center for Theoretical and Computational Materials Science/Metallurgy Division and Pacific Northwest National Laboratory (PNNL).
Audience: Researchers from industry, government laboratories, and universities who are interested in the fundamental mechanisms of plastic deformation.
Format: International conference with plenary speakers, invited speakers, and poster sessions. The invited speakers will be selected from the submitted abstracts.
Purpose: To facilitate international cooperation in the field and to identify useful directions for future research.
Topics: Fundamental research on dislocations in all types of materials and their role in plasticity.
Registration Contact: Lori Phillips Buckland, NIST, 100 Bureau Dr., Stop 3461, Gaithersburg, MD 20899-3461, phone: 301/975-4513, fax: 301/948-2067, email: phillips@nist.gov.
Technical Contact: Lyle Levine, NIST, 100 Bureau Drive, Stop 8553, Gaithersburg, MD 20899-8553, phone: 301/975-6032, fax: 301/975-4553, email: lyle.levine@nist.gov.
Website: http://www.quality.nist.gov/regs2000.htm.

June 26-29, 2000

2000 INTERNATIONAL CONFERENCE ON CHARACTERIZATION AND METROLOGY FOR ULSI TECHNOLOGY

Location: National Institute of Standards and Technology Gaithersburg, MD

Sponsors: National Institute of Standards and Technology (NIST), Semiconductor Manufacturing Technology (SEMATECH), National Science Foundation (NSF), American Vacuum Society (AVS), Semiconductor Equipment and Materials International (SEMI), American Physical Society (APS), Electrochemical Society (ECS), and Semiconductor Research Corporation (SRC).

Audience: Scientists and engineers interested in all aspects of the technology and characterization techniques for silicon device research, development, manufacturing, and diagnostics.

Format: Conference.

Purpose: The Conference is dedicated to summarizing major issues and giving critical reviews of important semiconductor techniques that are needed by the semiconductor industry. It provides a forum to present and discuss critical issues, problems and limits, evolving requirements and analysis needs, future directions, and key measurement principles, capabilities, applications, and limitations.

Topics: The Conference will address silicon characterization and metrology for : 300 mm metrology, device manufacturing, front- and back-end processes, thin-film metrology, diagnostics, interconnects, critical analytical techniques, novel measurement methods, key bottlenecks in lithography, cutting edge manufacturing, breakthrough metrologies, modeling/simulation, defects, ultra-shallow junctions, wafer fab metrology, integrated metrology, alternative gate dielectrics, and MEMS metrology applications.

Technical Contact: Dr. David G. Seiler, NIST, 100 Bureau Drive, Stop 8120, Gaithersburg, MD 20899-8120, phone: 301/975-2054, fax: 301/975-6021, email: david.seiler@nist.gov.

General Information: Brenda Main, NIST, 100 Bureau Drive, Stop 8120, Gaithersburg, MD 20899-8120, phone: 301/975-2054, fax: 301/975-6021, email: brenda.main@nist.gov.

Manuscript Preparation Information: Erik Secula, NIST, 100 Bureau Drive, Stop 8120, Gaithersburg, MD 20899-8120, phone: 301/975-2050, fax: 301/975-6021, email: erik.secula@nist.gov.

Website: 2000 International Conference on Characterization and Metrology for ULSI Technology Homepage.

June 27, 2000

2000 MALCOLM BALDRIGE NATIONAL QUALITY AWARD REGIONAL CONFERENCE-NEW YORK

Location: The Waldorf-Astoria Hotel New York, NY

Sponsors: National Institute of Standards and Technology (NIST), Baldrige National Quality Program, The Conference Board.

Audience: Senior managers, education and health care leaders, heads of operating units, line managers, directors of staff functions, and quality practitioners.

Format: Conference, lecture, breakout sessions and Q&A.

Purpose: The 1999 Baldrige Award recipients, along with Award recipients from past years, will share key success strategies for improving organizational performance and the benefits of using the Baldrige process.

Topics: The Leader's perspective on performance excellence, the benefits of the Baldrige process, and key success strategies in the seven Criteria Categories.

Technical Contact: Baldrige National Quality Program-NIST, phone: 301/975-2036, fax: 301/948-3716, email: nqp@nist.gov.

Website: http://www.quality.nist.gov/regs2000.htm.

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