

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.

NIST RADIO STATION NOW TRANSMITTING AT FULL POWER

As a result of a recently completed upgrade, NIST's standard time and frequency radio station WWVB now broadcasts at over 50 kW, five times more power than previously.

The upgrade, which included adding more powerful transmitters and thoroughly refurbishing the system antennas, extends the usable range of the 60 kHz station near Fort Collins, CO, to most of the North American continent. It means that clock and watch manufacturers can install tiny WWVB-receiving antennas in their products that will automatically reset to track official U.S. time. Similar receivers can be designed into almost any appliance that contains a clock, such as computers, kitchen ranges, microwave ovens, thermostats, televisions and video cassette recorders. One nice feature the clock will reset automatically after a power outage once it has received the WWVB signal.

World War-II-era transmitters were replaced with more modern, reconditioned Navy transmitters, which allow WWVB to operate with greater reliability as well as increased power. Antenna system improvements included replacing 35-year-old, pole-mounted transmission lines with underground lines; redesigning and refurbishing two huge antennas and their mounting systems; and improving the antenna tuning coils and their servo controllers.

Technical questions regarding this project should be directed to Wayne Hanson, NIST, MC 847.40, Boulder,

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NEW NIST EFFORT SEEKS TO IMPROVE UTILITY OF PROPERTY DATA

Much of science and technology owe their progress to the careful collection, logging and interpretation of data. And as information technology becomes more efficient, so do the methods scientists use for sorting and accessing data. Now hoping to improve the utility of electronic materials property data, NIST scientists have just embarked on a project to standardize the way such information is posted on the World Wide Web.

NIST is inviting others in the materials property data community to join this effort called Materials Property Data Markup Language, or MatML. The goal of MatML is to create a standard markup language for web-based materials property data collections. While current hypertext markup language specifies elements of web page design, it contains no mechanism for tagging or specifying any of the hundreds of materials properties that materials scientists and engineers need to know. MatML will address interpretation and interoperability of this information.

The goal is to develop a markup language that will describe the data source, the material and its properties. Ultimately, this project could allow researchers to easily use electronic materials property data from multiple sources in models, simulations or distributed databases. For more information or to join the MatML effort, contact project leader Ed Begley at NIST, (301) 975-6118, begley@nist.gov. The MatML web site can be found at www.ceramics.nist.gov/matml/matml.htm.

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NEW FEATURES FOR THE NIST ATP ALLIANCE NETWORK SITE

The NIST Advanced Technology Program (ATP) has unveiled several new features and services on its Alliance Network website. The Alliance Network was established 2 years ago to help companies establish and manage joint R&D projects by providing information on the business, managerial, administrative and legal resources necessary for a successful joint venture.

Now, in addition to browsing such resources as a collection of joint venture “best practices” and hints on navigating the ATP process, visitors to the Alliance Network web pages can:

- use anonymous posts and replies on the Alliance Network Collaboration Bulletin Board to seek potential joint venture partners without immediately revealing company R&D interests;
- join the Alliance Forum, a new list serve (Internet-based discussion group) on R&D alliances; or
- visit a special section on partnerships with universities and non-profit organizations, including the latest data on university participation in ATP; the benefits to companies and non-profits of collaborating in ATP projects; the rules regarding intellectual property when non-profits are involved; and some best practices for collaborative R&D between companies and non-profits.

Access the ATP Alliance Network web site at www.atp.nist.gov/alliance.

General information on the NIST Advanced Technology Program, including policy, procedures and projects funded to date, can be found on the ATP web site at www.atp.nist.gov.

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OPTICAL FIBER POWER MEASUREMENTS EXPLAINED

To meet the needs of the optoelectronics industry, NIST offers measurement services for the calibration of optical fiber power meters. A new paper from NIST explains these services and their traceability to primary standards. The services consist of absolute power calibrations using either parallel-beam or optical fiber/connector configurations. In addition, NIST provides measurements of non-linearity, spectral responsivity (based both on tunable lasers and white-light sources) and uniformity. Calibrations are available at the three principal wavelength regions used by the optical fiber

telecommunications industry—850 nm, 1300 nm, and 1550 nm. Other optical power meter users, such as compact-disc player manufacturers and users of erbium-doped fiber amplifiers, are interested in wavelengths at 670 nm, 780 nm, and 980 nm. These wavelengths have been incorporated into NIST’s absolute power calibration program as well.

The paper discusses a new laser power and energy measurement system based on a commercial cryogenic radiometer designated the Laser Optimized Cryogenic Radiometer. It provides laser power measurements with a relative combined standard uncertainty of 0.02 % or less.

Copies of paper No. 55-99, “Optical Fiber Power Measurements,” are available from Sarabeth Harris, NIST, MC 104, Boulder, CO 80303-3337; (303) 497-3237; sarabeth@boulder.nist.gov.

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ON-LINE INSPECTION OF BARS

During the past 2 years NIST staff members have been issued patents on noncontacting ultrasonic transducers that induce resonant vibrations in cylindrical objects such as found in tubes and bars. By changing the shape of the coils and permanent magnets used to construct these transducers, specific radial, torsional or flexural modes can be excited and detected. Furthermore, the vibrations can be made independent of the mechanical constraints that support the cylinder and they can be made to subject the cylinder to different displacement distributions. Because the supports do not affect the frequency of the resonance, it is possible to make a very sensitive load cell that has a larger than normal dynamic range, produces a digital output, and can be made nearly independent of temperature. Because the displacement distributions are different for different resonant modes, surface layers can be characterized and flaws on the surface of a bar can be distinguished from internal defects during the high speed production of rods, bars and billets. A small business licensee has now incorporated these features into an instrument package that is being used to perform on-line inspections of aluminum bar produced by a continuous extrusion process and to monitor the incoming steel rods at a stamping plant that produces automotive fasteners. The latter application prevents costly production delays when a flaw in the starting material causes a partially formed fastener to shatter in the stamping die.

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ON-WAFER CALIBRATIONS APPLIED TO THE CHARACTERIZATION OF HIGH-SPEED DIGITAL TRANSISTORS

Over the past 2 years, a NIST scientist has collaborated with a private company to apply on-wafer calibrations to measurements of high-speed digital transistors. After much effort and several interlaboratory visits, the first phase of the project has culminated in success. The new NIST developed methods provide the means to quantify device performance with a significant improvement in precision.

The key technological hurdles addressed in this work were the high RF losses encountered in commercial CMOS technology and the measurement of three port devices when the three ports are connected in different metalization layers. To address the three port problem, the NIST scientist designed two sets of calibration standards and devised a calibration sequence to acquire calibrated data at the three ports of the devices. The private company fabricated the coplanar waveguide standards on three generations of transistor test wafers and worked with NIST in verifying the artifacts and methods. This project also relied on new software written by a NIST scientist for removing contact pad effects from characteristic impedance calculation. This significantly improved the accuracy of the extracted device parameters.

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DIFFUSE REFLECTANCE SPECTROSCOPY IMPROVES TEMPERATURE ACCURACY FOR SEMICONDUCTOR WAFERS

NIST researchers have achieved a more accurate measure of compound semiconductor wafer temperature by implementing diffuse reflectance spectroscopy (DRS), a sensor that detects the absorption of light at the surface and requires only fractions of a second for data acquisition. With the new sensor, it is now possible to reach an uncertainty of 1 °C during the growth of ultrathin layered films at high temperatures, compared with 25 °C to 70 °C previously possible. Accurate growth control is important to the industry, because it provides a direct way to improve the yield and process cost reduction of advanced high-frequency circuits for wireless applications.

Measurement and control of temperature is a common difficulty, particularly in the molecular beam epitaxy growth of multilayered heterostructures (pHEMTs). The conventional approach depends on reading thermocouple sensors placed in contact with the back surface of the wafer and must allow for time delays for the back and front surfaces to equilibrate.

This may be several minutes or more, which is longer than the time to grow the entire structure.

By comparison, DRS data can be acquired in less than a second, because it senses changes in the absorption of light reflected from the wafers surface. Selective absorption depends on the bandgap of the material, and this in turn is related to temperature just at the outer surface where growth is taking place. DRS has made it possible for the first time to realistically monitor the temperature continuously and implement growth rate corrections in a rapid response feedback mode.

The experiment revealed that temperature changes as high as 70 °C can occur during growth monitored by thermocouples and that such excursions often may go undetected. Preliminary data indicate that extreme differences alter the conductance, as well as other electrical properties of the sample. Plans are to validate these findings and quantify the effects of more accurate temperature control on material properties such as phase segregation, desorption, dopant activation, and the parametrics of fabricated wireless devices.

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NIST EXPANDS XML CONFORMANCE TEST-SUITE TO INCLUDE DOM TESTS

With the advancement of the Extensible Markup Language (XML), a number of related technologies are emerging and their importance is impacting XML technology, electronic commerce, and the web. One such technology is the Document Object Model (DOM). The DOM is a W3C API (Application Programming Interface) recommendation, approved in October 1998. Defining a set of APIs for both Java and JavaScript, the DOM is intended to dynamically manage and manipulate XML and HTML documents.

In a continuing effort to develop conformance tests for XML technologies and enable interoperability, NIST developed an XML DOM test suite. The test suite complements the previously released XML Conformance Test suite, developed by NIST in partnership with the Organization for the Advancement of Structured Information Standards. The DOM and XML test suites are available at www.nist.gov/xml/.

The DOM test suite contains just over 800 tests for both XML (Fundamental and Extended) and HTML. The testing approach focuses on defining XML and HTML conformant files and using the DOM to retrieve specific elements and/or attributes that are further evaluated in light of the DOM-defined behavior. Tests are available for the JavaScript and Java bindings. The DOM test suite was introduced and demonstrated at the

XML Conference in December 1999 and received high marks from the XML community.

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REFERENCE MATERIAL 8983 COMPLETED FOR NITROGEN, OXYGEN, AND CARBON IN SILICON NITRIDE POWDER

A new Reference Material intended primarily for use as an analytical standard for the determination of nitrogen, oxygen, and carbon in silicon nitride powders has been completed. Silicon nitride is a widely used high-temperature ceramic for industrial applications requiring high fracture and wear resistance and is manufactured by compaction and sintering of powders. Any chemical impurities present in the starting powders will adversely affect the final properties of the material. Therefore, both metallic and non-metallic impurities such as nitrogen, oxygen, and carbon in the powder must be controlled to within certain limits.

A review of analytical methods used in the determination of these three elements was conducted and the high-temperature combustion method based on the ASTM E 1019 test method was selected for analysis and certification. However, it was necessary to modify the standard test method originally developed for metal powders before it could be applied to silicon nitride.

One unit of RM 8983 consists of a bottle of approximately 4.5 g of silicon nitride powder. The reference mass fraction values in % for total nitrogen, oxygen, and carbon, with expanded uncertainties u at the 95% level of confidence, are 39.23 ± 1.06 , 1.20 ± 0.14 and 0.107 ± 0.015 %, respectively.

The modified tests method has been submitted to ASTM C28.05 (Advanced Ceramics) for approval as a new ASTM method dedicated to the analysis of ceramic powders. The combination of this new RM and the ASTM test method fulfill the industrial need for a calibration standard and measurement protocol for analysis of impurities in silicon nitride.

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HIGH PRECISION CAPACITANCE CELL DEVELOPED FOR THIN FILM OUT-OF-PLANE EXPANSION

Two NIST researchers have developed a high-precision capacitance cell for measuring the expansion of dielectric, semiconducting, or conducting films between 5 μm and 0.5 cm thick due to changes in temperature and humidity. The new apparatus allows accurate measurements on semiconducting and conducting

materials that were not possible with a previous NIST design. The capacitance cell technique is expected to provide researchers in the microelectronics industry with a means of determining the coefficient of thermal expansion of thin film interlevel dielectrics. This metrology was designed to measure films with thicknesses that are between the measurement capabilities of thermo-mechanical analysis (lower limit of 2 mm) and x-ray reflectivity (upper limit of 0.1 μm).

The previously reported design produced accurate values for the coefficient of thermal expansion of a 0.5 mm thick single crystal $\langle 0001 \rangle$ oriented Al_2O_3 sample. The previous design also was shown to have the ability to measure thin (14 μm) polymer films. Values determined for the thin polymer film were comparable to those obtained by a combination of in-plane expansion measurements and volume dilatometry. The relative expanded uncertainty in the thickness for the previous and current designs is 0.1×10^{-6} upon thermal cycling under dry conditions (i.e., 0 % relative humidity). The limitation of the previous cell was that it was unable to measure conducting or semiconducting samples. Measurements with the previous design on single crystal silicon resulted in damage to the capacitance cell. This damage was due to the creation of a Schottky junction (silicon/nichrome interface) that functioned as a frequency multiplier and took the 1 kHz measurement frequency into the ultrasonic region, thereby breaking the conducting epoxy contacts. The new design electrically isolates the sample using a guard ring on the top and bottom electrodes. The bottom electrode was designed so that its inner electrode diameter was half that of the top to minimize the problems associated with electrode alignment. Measurements on single crystal $\langle 100 \rangle$ oriented silicon reproduced recommended literature values within the aforementioned experimental uncertainty. This metrology has a variety of other applications as an extremely sensitive displacement sensor.

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GUIDE FOR THE SELECTION OF CHEMICAL AGENT AND TOXIC INDUSTRIAL CHEMICAL DETECTION EQUIPMENT FOR EMERGENCY RESPONDERS

As part of its work in support of the national domestic preparedness against terrorism, NIST's Office of Law Enforcement Standards, in collaboration with the Department of Defense's Soldier Biological and Chemical Command, completed work on a "Guide for the Selection of Chemical Warfare Agent and Toxic Industrial Chemical Detection Equipment for Emergency Responders."

This document is now out in circulation for review and comments. The primary purpose of this guide is to provide emergency responders with information to aid them in the selection and utilization of chemical agent and toxic industrial chemicals (TIC) detection equipment. The guide is thus more practical than technical, emphasizing advice about the capabilities of different technologies and what technologies are likely to work best in various applications. A wide variety of factors are considered that may be important to purchasers of detection equipment, including cost, sensitivity, portability, ease of use.

Due to the high number of chemical agent and TIC detectors identified, the guide is separated into two volumes. Volume I represents the actual guide while Volume II serves as a supplement to Volume I since it contains the detector/instrument information sheets only. This guide contains information that should aid emergency responders in the selection and utilization of chemical agent and TIC detection equipment. Some technical information is included in sections describing how the various detection technologies work. For each technology, a short description is provided along with photographs of specific equipment that fall within the technology discussed. The guide also discusses various characteristics and performance parameters used to evaluate chemical agent and TIC detection equipment. These characteristics and performance parameters are referred to as evaluation criteria. Twenty-two evaluation criteria have been identified. These criteria are grouped and discussed within four categories: operational, physical, logistical, and special. Weights for each of the criteria also are provided. Finally, the guide presents the assessment process and corresponding results of assessing each device against the evaluation criteria.

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UNCERTAINTY ANALYSIS OF FOUR TERMINAL-PAIR (4TP) CAPACITANCE AND DISSIPATION FACTOR MEASUREMENT SYSTEM COMPLETED; SPECIAL TEST SERVICE OFFERED

NIST staff have completed the uncertainty analysis on an impedance measurement system that has been under development for making accurate measurements of 4TP capacitance and dissipation factor. A NIST Special Test service now will be offered to the public for these types of measurements. Two papers describing the results of these efforts were presented at the Instrumentation and Measurement Technology Conference in Venice, Italy, in May 1999.

The capacitor industry (\$9 billion worldwide) has requested measurement services in the megahertz frequency range; however, there are no impedance standards in this range (the NIST Calculable Capacitor operates at 1592 Hz and the NIST Calculable Air Lines operate above 1 GHz). NIST has taken the lead among national metrological institutes in offering this service for 4TP capacitance and dissipation factor to support LCR meter calibrations and chip capacitor testing.

This new service covers the characterization of capacitance and dissipation factor for standard 4TP air-dielectric capacitors with nominal values of 1 pF, 10 pF, 100 pF, and 1000 pF, in the frequency range from 1 kHz to 10 MHz. First, three-terminal capacitance measurements are taken at 1 kHz for each capacitor under test, thus linking these values to the NIST Calculable Capacitor. Single-port complex impedance measurements then are taken at frequencies in the 100 MHz range, linking these values to the NIST Air Line Standard. Next, a mathematical extrapolation algorithm is used to predict the 4TP resistance and inductance at the intermediate frequency of interest, and finally the 4TP capacitance and dissipation factor of the capacitor under test is then computed at the test frequencies.

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MODIFIABLE INPUT CAPACITANCE AND SENSITIVITY DISCOVERED IN SET TRANSISTORS

SET devices are based on nanoelectronic devices 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. One of the classes of applications often cited for SET transistors is that of ultrasensitive charge electro-meters. Nominally, such a transistor can sense a change in charge of about $10^{-3} e$; this is about 10^5 times better than the best conventional microelectronic FET-type transistors, operating at room temperature. However, this sensitivity is often drastically reduced by the stray capacitance to ground between the charge source and the SET transistor; this stray capacitance is typically at least one order of magnitude bigger than the input capacitance of the transistor (which must be kept below about 1 fF to observe SET behavior). For instance, in the electron-counting capacitance standard which NIST is pursuing using SET pumps and transistors, the sensitivity of the SET transistor used as a null detector is decreased by about 10^4 due to the stray capacitance effect.

Recently, NIST scientists have shown theoretically that the input capacitance of the SET transistor is not a

constant but in fact changes with the gate and bias voltages applied to the transistor. These changes mean that the sensitivity of the transistor as a null detector varies by the same amount. The effect varies with device parameters and can in some cases enhance the sensitivity by a factor up to one third. In addition, it turns out that if one uses applied voltages that are only slightly off from the optimum values, the input capacitance (and the sensitivity) may be degraded by a much larger factor (up to 100). This work may have subtle implications for the electron-counting capacitance standard being pursued by NIST, in terms of the optimum choice of applied voltages for the SET null detector.

This work has been submitted for publication in the *Journal of Applied Physics*.

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WIDEBAND MEASUREMENTS APPLIED TO EMISSION AND IMMUNITY CHAMBERS

NIST researchers used a NIST-developed ultra wide-band measurement system to perform measurements of a precompliance emissions and immunity chamber at a well-known manufacturer of chemical analysis equipment. The data obtained will be highly useful for developing rapid techniques for evaluating chambers for electromagnetic compatibility (EMC) testing—a key requirement for both domestic and foreign commerce in all electronic products. In addition, the data obtained will assist compliance engineers at the manufacturing company in performing a future retrofit of their EMC facility. The NIST scientists also advised the engineers regarding basic enhancements of the chamber to improve its performance. Chamber performance measurements were performed before and after the treatments.

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NIST'S CRYPTOGRAPHIC MODULE VALIDATION PROGRAM ADDS FOURTH TESTING LABORATORY

The Cryptographic Module Validation Program (CMVP) of the U.S. and Canadian governments achieved another milestone by adding a fourth National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory. The addition of COACT Inc. CAF Laboratory is the first new laboratory added to the program in five years. The four CMVP laboratories test cryptographic modules to the requirements of Federal

Information Processing Standard (FIPS) 140-1, Security Requirements for Cryptographic Modules. In addition, the CMVP continues its exponential growth by issuing the programs 86th certificate, which increased the total number of validated modules by 26 since September 1999.

The FIPS 140-1 Validated Modules List has become a “Whos Who” of cryptographic and information technology vendors and developers from the United States, Canada, and abroad. The list contains a complete range of security levels and a broad spectrum of product types including secure radios, Internet browsers, VPN devices, PC Postage equipment, cryptographic accelerators, secure tokens, and others. Federal agencies now have greater choices of tested and validated cryptographic products for use in securing sensitive information. The CMVP is a joint effort between NIST and the Canadian Security Establishment (CSE).

For more information on FIPS 140-1, validated modules, and the accredited laboratories, see <http://csrc.nist.gov/cryptval>.

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WWVB UPGRADE COMPLETED

NIST's multiyear program to upgrade and increase the output power of WWVB from 10 kW to 50 kW was completed in December 1999. The station has been operating at the new broadcast power of since October 1999, but complete auto tuning of the transmitters to the antenna systems was implemented only recently. A major portion of this upgrade was done by the stations staff, however, some design and component-fabrication work was done by U.S. Navy staff and Navy contractors, which retains the best U.S. expertise in low-frequency broadcast systems.

WWVB broadcasts are now delivered at full power using two separate in-phase transmitter-antenna systems; a third backup transmitter can be switched into service should either of the primary transmitters fail. The transmitters were obtained several years ago from the Navy at no cost. The final phase of work that brought this upgrade to completion involved rebuilding the networks that match the antennas to the transmitters, installing safeguards to protect staff from high voltages, and implementing auto tuning of the antenna impedance matching network. A new generator capable of assuring continuity of operation at full power has been delivered to the site, but is not yet installed. Until that installation is complete, the available backup power is not sufficient to allow operation at full power.

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NIST MEASUREMENTS AID IN DEVELOPMENT OF NEW RADIATION THERAPY DEVICE

A private company is developing a new radiation treatment technique to prevent the recurrence of aggressive brain tumors after surgical resection. The American Cancer Society projects 18 000 U.S. patients will be diagnosed each year with malignant brain tumors, and nearly all experience tumor re-growth after initial treatment. Most tumors recur within a short period of time. This new treatment modality involves the implantation of a small balloon device, named the “GliaSite,” in the cavity that remains after the tumor is removed. The balloon is subsequently filled with a solution containing radioactive ^{125}I , which is marketed under a trade name. Treatment planning for brachytherapy of resected brain tumors with the GliaSite and iodine solution requires dosimetry estimates based on accurate ^{125}I activity measurements using commercially available dose calibrators.

The iodine solution is shipped to the hospital in 2 mL conical vials and assayed/administered in 5 mL syringes. A correct calibration factor is required for each source geometry and dose calibrator model. NIST has experimentally analyzed the response of several commercial dose calibrators to NIST-calibrated iodine solutions. New calibration factors and dial settings were determined from these data, which significantly improve the accuracy of iodine assays. The results indicate that the use of the dose-calibrator manufacturers previously recommended dial setting may produce errors in the activity assay of up to +16 % and –55 % for the syringes and vials, respectively. Furthermore, these data constitute an important part of the documentation that must be submitted in order to receive FDA approval for the device.

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NIST HOSTS FIRST ANNUAL OPTICAL PROPERTIES OF MATERIALS CONSORTIUM WORKSHOP

The first annual Optical Properties of Materials Consortium Workshop was held at NIST in December 1999. The consortium was established as a Cooperative Research and Development Agreement (CRADA) through NIST. The consortium partners have the option to actively participate in projects at NIST involving the development of Standard Reference Materials and specific calibration services. The development of Standard Reference Materials suitable for use in the wavelength range of 193 nm to 30 μm , in accordance

with U.S. regulatory protocols and accepted standard protocols, is an integral part of the consortiums mission. Representative industries participating in the consortium include manufacturers and processors of pharmaceuticals, consumer health products, food and beverages, cosmetics, paper, textiles, chemicals, optical devices and instruments, and lasers. Key optical materials issues in diverse applications, such as color standards for color film and printer paper, lens index of refraction for ultraviolet photolithography, and low-level absorption in infrared sensor windows, were discussed.

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NIST METROLOGISTS WORK WITH THE AMERICAN PETROLEUM INSTITUTE ON TRACEABILITY ISSUES

NIST has been working closely with the American Petroleum Institute (API) to improve procedures for establishing traceability of API gages to the NIST/API grand master gages. As a first step and at API's request, NIST metrologists reviewed and updated a history of the testing and certification of API regional master gages. This review was finished in December.

API, a trade association representing the entire petroleum industry, works with NIST to ensure uniformity in fittings used worldwide for oil drilling operations. NIST is the custodian of the API grand master gages, which are the pinnacle of the traceability chain the standard to which all fittings are indirectly compared to ensure uniformity. Regional master gages are sent to NIST for comparison to the grand masters. CONTACT: Bryon Faust, (301) 975-4351; bryon.faust@nist.gov.

NIST LEADS THE WAY IN OPTICAL FIBER MEASUREMENTS

Persons interested in the metrology of optical fibers will want to get a new technical paper from NIST that explains the variety of artifact standards that NIST offers to industry. The NIST standards, known as Standard Reference Materials (SRMs), fall into two categories for optical fibers: geometrical properties and propagation characteristics. These standards allow a fiber to be described based either on its physical dimensions or the way in which light propagates within it. In the area of physical dimensions, NIST offers SRMs for fiber cladding diameter, fiber coating diameter, connector ferrule (both inner and outer diameter), and mode-field diameter. In the field of propagation characteristics, NIST offers SRMs for chromatic dispersion, polarization-mode dispersion, and polarization-

dependent loss. NIST's web site, www.nist.gov, provides information on other SRMs and calibration services that support the optical communications industry.

Copies of the paper, "NIST Artifact Standards for Fiber Optic Metrology," (03-00) can be obtained from Sarabeth Harris, MS 104, NIST, Boulder, CO 80303-3337; (303) 497-3237; sarabeth.harris@boulder.nist.gov.

For more information on the optical fiber artifacts and other SRMs, contact Lee Best, 100 Bureau Dr., Stop 2320, NIST, Gaithersburg, MD 20899-2320; (301) 975-2027; lee.best@nist.gov.
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WHAT'S UP, DOCS? FIND OUT AT CONFERENCE

Exactly what is a document? And what is an electronic document? A conference at NIST's Gaithersburg, MD, headquarters in March 2000, examined what standards are needed to encourage the smooth exchange of the documents of the future.

Among the topics discussed were the generation and transmission of trans-media documents, such as e-mail messages converted to voice mail.

Other kinds of "documents" examined included:

- three-dimensional content expressed as software, such as DNA structures and other molecular designs, holographs and computer-aided design files;
- video and multimedia objects; and
- audio documents such as voice mail messages.

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NEW REGISTRY SEEKS END TO NAMING CONFLICTS

Imagine two software developers in different parts of the country who both need to come up with a filename extension for a program. Since such tags are generally abbreviations or acronyms (.glo for glossary or .pwl for password list, for example), the programmers could select the same name and never know it—that is, until the duplication causes both softwares to run ineffectively or crash after reaching the market.

Avoiding such conflicts when choosing identifiers—the entities that distinguish filename extensions, HTML tags, Java top-level packages, Dynamic Link Libraries,

variables, port numbers and the like in programming languages—is the main purpose for the NIST Identifier Collaboration Service (NICS), a free, online registry. Users can browse the database for identifiers in 22 domain types, determine that theirs is original and then add it to the repository.

Unlike simple lists of identifiers, the NICS registry has the additional benefit of allowing other developers to peer review new names and warn the owner about potential problems. And if a conflict does occur, both the person trying to register the name and the authors of its already registered twin are automatically contacted so that negotiations toward an agreement can commence.

The NICS was created by NIST after encountering identifier naming difficulties during the development of STEP (now known as ISO 10303), the global Standard for the Exchange of Product model data. The registry proved so valuable that its natural expansion to other programming languages was inevitable. NIST, as a neutral party, is the perfect sponsor for the service since the agency has no vested interest in the success or failure of any specific users.

To access the NICS, go to <http://pitch.nist.gov/nics> on the World Wide Web. For technical information, contact Don Libes, (301) 975-3535, libes@nist.gov.

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2000 CRITERIA NOW AVAILABLE; NEW COMPETITION BEGINS

Your organization should have a copy of the newly updated *Baldrige Criteria for Performance Excellence*. One of the nation's most popular and influential organizational improvement publications, the criteria are tailored for three different audiences—profit businesses, health care providers, and education organizations.

The 2000 criteria booklet is easy to use and includes a series of questions covering seven key areas—leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management, and results. Over the years, NIST has revised and streamlined the criteria to focus more sharply on overall performance excellence and results as integral parts of today's management practice.

Thousands of U.S. organizations use the criteria to assess and improve their overall performance. Since 1988, almost 2 million copies of the *Baldrige Criteria for Performance Excellence* have been distributed, and wide-scale reproduction by companies and electronic access add to that number significantly.

Single copies of the *Baldrige Criteria for Performance Excellence* are available from NIST by calling (301) 975-2036; faxing a request to (301) 948-3716; sending e-mail to nqp@nist.gov; or by downloading from the World Wide Web at www.quality.nist.gov. Packets of 10 or more copies, as well as other Baldrige-related materials (such as case studies and videos on Baldrige Award recipients) may be ordered for a fee from the American Society for Quality, (800) 248-1946; www.asq.org.
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UPGRADED SYSTEM MEANS BETTER DATA, LOWER COSTS FOR BUILDINGS

Comparing how much it costs to build and maintain different buildings allows developers and owners to make a host of improved decisions—especially the cost-effective selection of building designs and materials. However, making accurate and reliable comparisons of data collected during a building's life cycle is impossible unless everyone uses the same system to define elements. Elements are the major components common to most buildings that usually perform a given function whatever the design specification, construction method or materials used. Examples include foundations, exterior walls, sprinkler systems and lighting.

NIST has refined and expanded its UNIFORMAT II system for standardizing these building-related classifications. A new report (NIST Interim Report 6389) describes the improvements to the 1992 NIST system adopted as a standard by the American Society for Testing and Materials (ASTM).

The proposed changes in UNIFORMAT II—designed to be implemented in the near future as a revised ASTM standard—would enable the development of more detailed comparisons among buildings. They advance the use of the UNIFORMAT II classification system in three ways (1) adding a fourth level of elements to the current ASTM standard; (2) describing applications for the system that were not anticipated in earlier versions (such as life-cycle electronic tracking of project data); and (3) presenting a standard format for summarizing an elemental cost estimate.

Applying UNIFORMAT II at each step of the building process provides significant saving to industry. Data entered in a consistent format will not have to be reentered at different phases of the building life cycle. This means better, inexpensive information that is easily accessed and compared.

For technical questions or to request the report, contact Harold Marshall at NIST, 100 Bureau Dr., Stop 8603, Gaithersburg, MD 20899-8603; (301) 975-6131;

harold.marshall@nist.gov. NIST IR 6389 also is available in Adobe Acrobat format from the World Wide Web at www.bfrl.nist.gov/oe/publications/nistirs/6389.html.

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EFFECTIVE USE OF COMMON CRITERIA

The 3 day First International Common Criteria Conference took place at the Baltimore Convention Center in May 2000. Executives from information technology companies learned about the international computer security arrangement that makes it easier for American companies to sell their products in other countries.

The International Common Criteria Mutual Recognition Arrangement is a pact that establishes a concise but common language specifying security requirements in information technology products and systems. Seven nations, including some of the world's largest markets, now participate in the Common Criteria (also known as ISO/IEC 15408). They are Australia, Canada, France, Germany, New Zealand, the United Kingdom, and the United States.

In the United States the evaluation and validation program is managed jointly by NIST and the National Security Agency.

The signatory nations recognize the results of security evaluations conducted by each other's accredited testing laboratories. This eliminates the need for costly and time-consuming testing by different countries. As the arrangement creates a standardized evaluation process across borders, it fosters a barrier-free, worldwide market for IT security products.

While private-sector laboratories do the testing of computer security products, the governments involved accredit the participating laboratories and certify or validate the resulting tests. For more information, or to register electronically, go to the World Wide Web at <http://niap.nist.gov/cc-scheme/iccc>.

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NBS-DEVELOPED METHOD NAMED "ALGORITHM OF THE CENTURY"

A mathematical algorithm developed at NBS (the National Bureau of Standards, now NIST) during the 1950s has been identified as one of the "Top Ten Algorithms of the Century" by *Computing in Science & Engineering (CS&E)* magazine. Actually a class of methods, the algorithm known today as Krylov subspace iteration saw its genesis in work done by two NIST mathematicians and a Swiss mathematician at the

Institute for Numerical Analysis operated by NBS at UCLA in the late 1940s and early 1950s.

Krylov methods can be used to solve very large systems of linear equations. Early Krylov methods were called the conjugate gradient method. These methods have the advantage of not requiring an array of matrix elements to be stored and are of great interest in solving very large, sparse systems. The first reports on these methods were published in the *Journal of Research of the National Bureau of Standards* in 1952. Since then, many thousands of papers have been published on this topic, and Krylov methods remain the most popular and effective techniques for solving such problems today.

The January/February 2000 issue of *CS&E* in which this algorithm was cited set out to identify the “ten algorithms with the greatest influence on the development and practice of science and engineering in the 20th century.”

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NIST MEASUREMENT METHOD ADAPTED TO INDUSTRIAL PROCESS

In collaboration with a private company, a NIST-developed method for noncontact measurement of temperature has been adapted to processing reactive polymer resins. The measurements showed the resin temperature variation across the exit die of a reactive extruder that revealed new information about the process. The noncontact temperature measurements made on the Dow reactive extruder revealed that the temperature of the resin at certain locations was much higher than that measured by conventional thermometry. Temperature is a critical processing parameter that in reactive extrusion is affected not only by shear heating, common to other extrusion processes, but also by the exothermic chemical reactions. The temperature must be maintained in a certain range to optimize processing without degrading the polymer by exposure to excessive temperatures.

The noncontact temperature method was developed at NIST to address industry’s need for a way to measure temperature of a hot resin as a function of its position in the processing equipment. The method is based on fluorescence measurements of a fluorescent dye that is added to the resin in minute amounts. The spectral characteristics of the fluorescence changes with temperature in a manner that can be determined in separate experiments. Another advantage of the temperature sensor is that no special modifications of the processing equipment are required. The confocal optical device threads into existing extruder ports that accommodate other types of sensors.

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MAGNETIZATION CONTROL

For a large class of magnetic devices, including read heads in hard drives and magnetic random access memory (MRAM) cells, it is important to control the direction of the magnetization in thin films of magnetic metals such as cobalt and Permalloy ($\text{Ni}_{80}\text{Fe}_{20}$). NIST researchers have come up with an alternative to the common practice of using antiferromagnetic materials for this purpose. The new method provides an anisotropy (directional magnetization) that is very strong and very homogeneous and that is expected to show high thermal stability. The large anisotropy is found in thin magnetic films deposited on top of obliquely deposited tantalum underlayers. The oblique deposition of the tantalum produces a corrugated tantalum surface as ripples running perpendicular to the atom flux are amplified through shadowing effects. The cobalt, nickel, or iron atoms, deposited at normal incidence, are more mobile than the tantalum atoms, so they fill the 5 nm wide grooves in the tantalum surface and then form a relatively smooth upper surface, resulting in a magnetic film which carries the corrugated imprint of the underlayer.

The low energy states of this structure have the magnetization lying in either direction along the corrugations, parallel to the wavy surface, for the same reason that it is easy to magnetize an iron needle parallel to its length: magnetostatic energy is minimized when the magnetization lies parallel to an interface. Cobalt films 30 nm thick have been deposited on a corrugated tantalum surface and found to take as much as 0.16 T to rotate the magnetization perpendicular to the corrugations. A second cobalt film, separated from the first cobalt layer by 4 nm of copper, required only 13 mT. The anisotropy generated by the obliquely deposited tantalum underlayers is very uniform, with local anisotropy axis directions varying less than 2°, and anisotropy fields varying by less than 5 mT. Since the anisotropy field is magnetostatic in origin, it is expected to be as thermally stable as the magnetization itself.

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NEUTRON STUDIES OF NOVEL FERROELECTRIC MATERIALS SHED LIGHT ON ORIGIN OF REMARKABLE PIEZOELECTRIC PROPERTIES

Piezoelectric materials expand in the presence of an electric field. Conversely they generate an electric field.

Conversely they generate an electric field when compressed. This property forms the basis of operation in solid state transducers that convert mechanical energy into electrical energy, and vice versa. The present day material of choice for the fabrication of high-performance electromechanical actuators is the ceramic $\text{Pb}(\text{Zr}_{1-x}\text{Ti}_x)\text{O}_3$ (PZT).

Recently scientists at the NIST Center for Neutron Research (NCNR) and Penn State University have developed a program to study single crystals of the ferroelectric relaxor-based materials $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})_{1-x}\text{Ti}_x\text{O}_3$ (PZN- x PT) and PMN- x PT ($M=\text{Mg}$) that exhibit remarkably large piezoelectric coefficients (>2500 pC/N). Strain levels as high as 1.7 % have been achieved, with little dielectric loss, that are an order of magnitude larger than those presently achievable with PZT. Such exceptional piezoelectric properties make these materials leading candidates in the next generation of solid state transducers that are crucial for industrial and defense applications.

Neutron scattering measurements at the NCNR have revealed information about the nature of the atomic vibrations in these novel materials that are related to their unusual piezoelectric properties. In particular, a key vibrational mode is found to be largely inhibited due to an underlying structure of nanometer-sized polarized domains, unlike in normal ferroelectric materials. Future neutron measurements are planned to probe these vibrations in the presence of an applied electric field to further elucidate the microscopic origin of these enhanced piezoelectric properties.

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FERRITE STANDARDS ENTER NIST INVENTORY

NIST has completed certification of a new batch of Secondary Ferrite Standards, RM 8480 and RM 8481. The reference materials are intended for the calibration of instruments used to measure weld metal ferrite content in accordance with ANSI/AWS Standard A4.2 and ISO Standard 8249. These standards are designed for use in welding construction and repair applications where the ferrite content of austenitic stainless steel welds must be controlled in tight ferrite number (FN) ranges. RM 8480 consists of a low range (eight specimens distributed in the range of 0 FN to 30 FN) and RM 8481 is the corresponding high range (eight specimens distributed in the range of 30 FN to 120 FN). The certification process required the development of an advanced calibration procedure and included over 25 000 individual magnetic measurements, before the data could be reduced into statistical summaries. The

calibration procedure and statistical summaries are included in the RM certificates and in NIST SP260-141 "Secondary Ferrite Reference Materials: Gage Calibration and Assignment of Values."

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NIST COMMISSIONS NEW X-RAY INSTRUMENT AT ADVANCED PHOTON SOURCE FOR CHARACTERIZATION OF ANISOTROPIC MATERIALS

As part of a collaboration, known as UNICAT, with the University of Illinois, Oak Ridge National Laboratory, and a private company, NIST researchers have developed novel small-angle x-ray scattering (SAXS) methods at the Advanced Photon Source (APS) to characterize anisotropic alloy and ceramic microstructures such as found in coatings, laminates and highly textured materials. While pinhole-geometry SAXS and small angle neutron scattering (SANS) instruments, with their two-dimensional detectors, can characterize anisotropic microstructures in the nanometer to 0.1 micrometer scale regime, this range is not easily extended to larger sizes unless multiple scattering methods are used. Double-crystal Bonse-Hart ultrasmall-angle x-ray scattering (USAXS) instruments can extend the scale regime to several micrometers, but the data are intrinsically slit-smearred, and the standard USAXS configuration is not suitable for anisotropic studies.

To remove this limitation, transverse crystal reflections orthogonal to the plane of the main USAXS monochromator/collimator and analyzer crystal reflections were introduced. While the data in a single scan are still associated with one azimuthal direction in the plane of the sample, the transverse crystal reflections remove the slit-smearing and effectively restore a pinhole geometry. To study an anisotropic microstructure, the sample must be measured repeatedly for different azimuthal orientations with respect to the incident beam. However, this is not a disadvantage for highly anisotropic microstructures because the resolution of the azimuthal rotation increments can be made almost vanishingly fine. Indeed, the anisotropic resolution of the new instrument can surpass that of conventional SAXS or SANS instruments with a two-dimensional detector.

The anisotropic USAXS configuration also takes advantage of innovations previously introduced into NIST's standard USAXS design, including a continuously tunable x-ray wavelength, and a photodiode detector with a 10-decade linear dynamic range that enables a primary absolute intensity calibration to be made with respect to the incident beam. Early anisotropic studies

have focused on the microstructural characterization of plasma-sprayed coatings and of cracking in highly textured brittle ceramics. However, it is envisaged that the anisotropic USAXS capability could open up a potentially wide field of quantitative microstructure characterization in thin films and coatings on substrates, using a glancing-angle reflection geometry.

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IMAGED AUDIO TAPES USING SCANNING MAGNETO-RESISTIVE MICROSCOPY

NIST researchers in collaboration with a scientist from the Institute of Telecommunication Sciences, have imaged audio tapes using scanning magneto-resistive (MR) microscopy and reconstructed the audio signals from the images. Four test tracks were produced, imaged, and reconstructed. Two of the test tracks were sine wave tones of 500 Hz and 700 Hz and the other two had test phrases such as “NIST” and “FBI.” This work addresses the need of forensics analysts to search for traces of tampering and/or characteristic sounds (gunshots, etc.) in recorded evidence. The microscope is based on commercial MR heads from computer hard drives, and has a resolution of ≈ 20 nm downtrack and ≈ 1 μm track width. The required sample rate for these reconstructions was only 5.9 μm ; however, the higher resolution available with the MR heads is needed for media such as digital audio tapes and other computer storage media.

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JOSEPHSON ARBITRARY WAVEFORM SYNTHESIZER DEMONSTRATED

NIST researchers have demonstrated 127 mV peak-to-peak voltage and operating margins for ac waveforms with a Josephson Arbitrary Waveform Synthesizer. This device is capable of digitally synthesizing any waveform from dc to 10 MHz. This is the first demonstration of the device as an ac voltage standard source with operating margins. The output voltage, frequency, and relative phase between synthesized tones are stable and precisely calculable as a result of digital synthesis using perfectly quantized voltage pulses from superconducting Josephson junctions. The recent improvements in operating margins (previously zero for ac waveforms) and output voltage (previously 52 mV peak-to-peak) are a result of improved broadband 60 MHz to 20 GHz on-chip filters and larger arrays of 4096 Josephson junctions. The device has synthesized 127 mV peak-to-peak voltage waveforms with harmonic distortion

better than -75 dB below the fundamental. Demonstration of the potential -140 dB theoretical harmonic distortion is presently limited by existing instrumentation.

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OPTICAL PROPERTIES OF MATERIALS FOR DEEP ULTRAVIOLET LITHOGRAPHY

The single most significant productivity improvement factor in semiconductor manufacturing has been the continuing reduction in feature size, enabling ever greater scales of integration, higher speed performance, and lower power consumption. To date this feat has been accomplished by using systems with shorter and shorter wavelength illumination. The “illumination” goes through a mask, exposing a photoresist on the integrated circuit, in order to pattern the circuit. Lithography tools operating at 193 nm are currently being introduced into manufacturing. The next generation tools need to operate at 157 nm. A major unanswered question to date has been whether or not refractive systems can be designed and built that have chromatic aberration correction, allowing the use of laser sources with enough optical power to permit economically useful wafer throughput. NIST has answered that question in the affirmative with recent optical data on barium fluoride. This work has shown that the index and dispersion properties of barium fluoride near 157 nm are such that the material can be used in combination with calcium fluoride for the optics of refractive lithography tools with sufficient chromatic aberration correction for operation at 157 nm. Two-material, all-refractive lithography tools are now being designed by the major lithography tool manufacturers based on these results.

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NIST IMPROVES TRACEABILITY OF EXPOSURES FROM MAMMOGRAMS MEASURED AROUND THE WORLD

NIST recently calibrated a secondary-standard ionization chamber for the International Atomic Energy Agency (IAEA), Dosimetry and Medical Radiation Physics Section. This section serves as the central measurement and administrative laboratory of the IAEA/WHO network of Secondary Standard Dosimetry Laboratories (SSDLs) and provides traceable calibrations, free of charge, to all SSDLs in the 76-member network. The chamber will be used to improve the quality of mammograms taken worldwide. Member laboratories have been established in countries from

Algeria to Yugoslavia and include many in South and Central America, Scandinavia, Eastern Europe, Africa, and the Near, Middle and Far East.

The calibrations were performed at the NIST Mammography Calibration Facility, and were conducted for 17 NIST mammography x-ray beam qualities, since the IAEA laboratory has modeled their available mammography beam qualities after the NIST facility. The calibrations will allow the IAEA to transfer the NIST standards for exposure (air-kerma) to the IAEA/WHO SSDL network.

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NEW MEASUREMENT SYSTEM WILL IMPROVE RADIOMETRIC SCALES

NIST metrologists have developed a new laser-based calibration facility designed to reduce the uncertainties in measurements of power, irradiance, and radiance responsivity for optical detectors. The facility for Spectral Irradiance and Radiance Responsivity Calibrations using Uniform Sources (SIRCUS) was used, for example, to reduce the relative uncertainty in irradiance responsivity calibrations from 0.5 % to 0.1 % in the visible wavelength range. As NIST continues to move from source-based to detector-based radiometry and photometry, reducing the uncertainties in the responsivities of filter radiometers will directly impact NIST's radiometric and photometric scales.

Recently, these metrologists used SIRCUS to calibrate a photoelectric pyrometer (PEP). The PEP is used to determine radiance temperatures of blackbodies and tungsten filament lamps by comparison against the gold fixed-point blackbody. Smaller wavelength uncertainties and the larger dynamic range of measurements on SIRCUS contribute to a reduction in the combined standard uncertainty in the relative response of the PEP. In addition, because measurements on SIRCUS are inherently "narrow-band," deconvolution of the responsivity to eliminate finite-bandwidth effects associated with conventional lamp-monochromator systems is no longer necessary. Such measurements will reduce the uncertainty in NIST radiance temperature measurements and will similarly impact other detector-based radiometric and photometric scales maintained at NIST. CONTACT: Steven Brown, (301) 975-5167; steven.brown@nist.gov or George Eppeldauer, (301) 975-2338; george.eppeldauer@nist.gov.

NEW OPTICAL MEASUREMENT TECHNIQUE FOR THE CALIBRATION OF CCD CAMERAS

Digital cameras presently are used for a wide variety of applications including astronomical observations, geological and earth-resource management, machine and inspection processes, archeology, and imaging collection and dissemination in the television and movie industries. A common type of detector used in digital cameras is a two-dimensional array of charge-coupled device (CCD) elements. The CCD elements are lithographically fabricated on a silicon wafer, and the number of individual elements in the array can be greater than 1 million.

NIST metrologists recently calibrated a commercial photometric digital camera used to measure the performance of lamps and light-emitting diodes as well as to quantify material-appearance characteristics such as reflectance and haze. The calibration of CCD cameras is a difficult endeavor, however, since the response of individual detector elements can vary, and is often nonlinear. Utilizing the unique capabilities of the facility for Spectral Irradiance and Radiance Responsivity Calibrations using Uniform Sources (SIRCUS), NIST scientists have simultaneously calibrated the more than 300 000 individual elements in the camera's 640 pixel by 480 pixel CCD array. The camera's pixel-to-pixel uniformity, nonlinearity, and absolute spectral responsivity were measured on SIRCUS over the visible spectral region with a relative combined standard uncertainty of 3 %. Commercial cameras that are calibrated against broadband incandescent sources typically have uncertainties on the order of 5 %.

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A SILICON TUNNEL-TRAP TRANSFER STANDARD FOR SPECTRAL POWER AND IRRADIANCE RESPONSIVITY DEVELOPED

NIST physicists have developed a high-accuracy light-trap radiometer in cooperation with a private company. This new six-element device will be used as a high-level transfer standard to reduce NIST's measurement uncertainties for spectral irradiance and spectral responsivities. The heart of the device contains two medium- and four large-size silicon photo-diodes that were packed tightly to obtain a minimum field-of-view of 6°. The device features a precision input aperture whose area was measured with high accuracy in NIST's Optical

Area Measurement Facility. The radiometer can be calibrated for spectral power responsivity against the primary standard high accuracy cryogenic radiometer when both measure the same total power in stabilized laser beams. A second light trap is attached to the output of the device to collect the transmitted light and to minimize pickup of ambient light. The expected combined standard uncertainties of the radiometer in the power measurement mode and irradiance measurement mode are 0.03 % and 0.05 %, respectively.

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NIST CONSULTS ON COORDINATE MEASURING MACHINE INTENDED FOR LARGE MILLIMETER TELESCOPE

The University of Massachusetts went to the experts when they recently needed help evaluating the metrology capability of a very large coordinate measuring machine (CMM) being developed by the Mexican research institute Instituto Nacional de Astrofísica, Óptica, y Electrónica (INAOE), Tonantzinla, Puebla, Mexico. Recognized for their experience and expertise in CMM technology, NIST scientists were contracted by the University of Massachusetts to perform a technical evaluation of this CMM in January 2000. The INAOE CMM is intended to measure the 3 m × 5 m panels of the Large Millimeter Telescope (LMT), a 50 m diameter radio telescope being constructed in Mexico. This radio telescope is being developed as a joint venture of the University of Massachusetts, the national government of Mexico, and the Defense Advanced Research Projects Agency of the United States.

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FIPS 186-2, DIGITAL SIGNATURE STANDARD (DSS), ADOPTED

The Secretary of Commerce accepted NIST's recommendation and approved Federal Information Processing Standard (FIPS) 186-2, Digital Signature Standard (DSS), which supersedes FIPS 186-1, DSS. FIPS 186-2 expands the Digital Signature Standard by specifying two voluntary industry standards for generating and verifying digital signatures. This action will enable federal agencies to use the Digital Signature Algorithm (DSA), which was originally the single approved technique for digital signatures, as well as two American National Standards Institute (ANSI) that were developed by the financial community. These

latter standards are ANSI X9.31, Digital Signatures Using Reversible Public Key Cryptography, and ANSI X9.62, Elliptic Curve Digital Signature Algorithm (ECDSA). FIPS 186-2 specifies an 18 month transition period, during which agencies may continue to use their existing digital signature systems and acquire additional equipment that may be needed to interoperate with these legacy digital signature systems. In addition, FIPS 186-2 specifies recommended elliptic curves for use by the federal government when using X9.62 Digital Signature techniques. See <http://csrc.nist.gov/cryptval> and select FIPS 186-2.

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NIST ANALYZES VENTILATION IN U.S. MANUFACTURED HOMES

NIST has completed a project for the U.S. Department of Housing and Urban Development (HUD) to address issues related to the ventilation of manufactured housing. The HUD Manufactured Home Construction and Safety Standards contain requirements intended to provide adequate levels of outdoor air ventilation in manufactured homes. However, in the implementation of these standards, questions have arisen regarding the actual ventilation rates in homes built to the standards and the approaches being employed to meet the rates in homes built to the standards and the approaches being employed to meet the requirements of the standards. Other questions have arisen as to how specific ventilation system components such as duct leakage, local exhaust fans and ventilation inlets affect ventilation rates, air movement patterns, and building pressures.

In order to obtain some insight into these issues, NIST's multizone airflow and indoor air quality program CONTAM was used to simulate a double-wide unit under several different ventilation scenarios. Simulations were performed to predict outdoor air ventilation rates into the house due to infiltration and mechanical ventilation, interzone airflow rates between the rooms, building air pressures, and ventilation air distribution. Annual simulations were performed in three cities to assess ventilation rates and energy consumption associated with these scenarios. The results show that despite the assumption in the HUD standards that infiltration contributes 0.25 h⁻¹ (air changes per hour), the predicted infiltration rates are lower than this value for many hours of the year. The supplemental ventilation systems investigated in this study provide ventilation rates that meet or exceed the total ventilation requirement of 0.35 h⁻¹, but the impacts of such systems are dependent on their operating schedules. In addition, in these simulations, the impacts of a whole house exhaust

fan are independent of whether this fan is located in the main living area or in a bathroom off the main living area. Also, for the case of ventilation with a whole house exhaust fan, the inclusion of passive inlet vents is not critical given the level of envelope airtightness used in these simulations. The results of these simulations are presented and discussed and recommendations are made for changes to the HUD standards and for future research. The results are described in detail in the final report (NISTIR 6455).

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FIRE DYNAMICS SIMULATOR

In cooperation with industry, a numerical fire model, Fire Dynamics Simulator, is being developed at NIST to evaluate the performance of fire protection systems in buildings. The model has been used to generate predictions of fires in industrial facilities protected entirely or in part by automatic fire sprinklers. Because the model provides far more detailed simulations than zone models can, it requires more detailed information about the fuels, building materials and fire protection systems. NIST has supported efforts, both internally and through its grants program, to develop measurement techniques to generate this information. These measurements include droplet size distributions, spray patterns, droplet trajectories, and heat transfer coefficients.

NIST recently has released version 1.0 of the Fire Dynamics Simulator (FDS). Previous versions of the model were referred to as LES, LES3D, and most recently IFS (Industrial Fire Simulator). More information about the model and its applications can be found at <http://fire.nist>.

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LARGE SCALE COORDINATE METROLOGY GROUP HAS MAJOR EFFECT ON ISO MEETINGS

A NIST scientist participated in the ISO Technical Committee 213 (TC213) Dimensional & Geometrical Product Specifications, Working Group 10 (WG10) Coordinate Measuring Machines (CMMs) meetings from Jan. 12-17, 2000, in Clearwater, Fla. This group is attempting to define calculational techniques and methodologies affecting CMM uncertainty. As the U.S. subject matter expert, the NIST scientist presented the U.S. and its allies position that successfully delayed the adoption of the flawed concepts in ISO WD 17450-2 from infecting WG10. Additionally, the United States

was assigned the important job of chairing the long-term revision of 10360-2, a project that the United States has been trying to organize for 5 years. Assignments for completing the 15530 series were allotted; the United States picks up three of the six sections of this series. Finally, the United States was assigned the task of developing the “metrological characteristics” of CMMs as assigned by TC213.

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INTERNET SITE INITIATED FOR HALL MEASUREMENT TECHNIQUE

To address an identified gap in the metrology of semiconductor materials, NIST has prepared an Internet site to describe Hall measurement techniques and practices. It projects a simple tutorial style, with fundamental equations and concepts relevant to the practicing industrial engineer, and includes worksheets and references for data acquisition and reduction. To encourage user participation and to increase awareness of the technique, an electronic bulletin board is also included, where those interested in the methodology can exchange ideas and information.

Over a century ago, Edwin Hall discovered that a small transverse voltage appears across a current-carrying thin metal strip in an applied magnetic field. Today, this effect bears his name (the Hall effect), and has since evolved in the form of an indispensable characterization tool, capable of determining the density and mobility of free carrier electrons and holes in semiconductor materials and devices. The broad acceptance of the technique in both academic and industrial laboratories is attributed to its simplicity, low cost, and minimal time required for analysis. In spite of such a key role, only a single ASTM document (ASTM F-76) was previously available for outlining standard procedures and practices for the Hall measurement of semiconducting materials.

The appearance of modern equipment and new engineering graduates in industrial laboratories has opened this opportunity for a more readily available and user-friendly presentation of the Hall effect, which encompass simple theory, modern equipment, and measurement practices. This was one of the major findings of recent survey of industrial users and was identified as an important gap in the industrial metrology roadmap formulated for the SED project in compound semiconductor materials.

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NIST HOSTS WORKSHOP ON MEASUREMENT AND STANDARDS NEEDS OF A DEREGULATED ELECTRIC POWER INDUSTRY

NIST researchers organized and hosted the “Workshop on Challenges for Measurements and Standards in a Deregulated Electric Power Industry” in Arlington, VA in December 1999. The purpose of the workshop was to bring together world experts to discuss the impact of deregulation on the electric power industry's measurement and standards infrastructure. The workshop was opened by the deputy under secretary for technology, U.S. Department of Commerce, who presented a call to industry members to become involved in the international standards-making process. The workshop enjoyed significant industrial support with technical co-sponsorship by the Electric Power Research Institute, the National Electrical Manufacturers Association Power Equipment Division, the IEEE Power Engineering Society, the National Science Foundation, and the U.S. Department of Energy.

Significant conclusions from the workshop included (1) that new standards are needed for nearly every aspect of the industry (control, pricing, access, security, distributed generation, brokering, etc.) as multiple players become involved in the production, distribution, and selling of power; (2) that there is a significant risk that emerging international standards will not reflect the needs or situation of the U.S. electric power industry; (3) that additional low-uncertainty measurements are needed to ensure the accurate sale of power; and (4) that the electric power industry may become, in the near future, the largest e-commerce industry in the world. A report of the impact of these conclusions on research programs at NIST is forthcoming. Many of the speakers presentations are available on the workshop web site (www.eeel.nist.gov/deregulation-workshop).

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NIST'S PROTOCOL MODELING OF BLUETOOTH SPECIFICATION PAYS OFF

Following a year of review, comment, and modeling the specifications of the Bluetooth Special Interest Group (SIG) as a non-SIG member, the group asked a NIST scientist to collaborate on further development of the Specification and Description Language (SDL) models for the Bluetooth specification. When the SIG submitted its specification for consideration as a standard to the IEEE 802.15, the NIST scientist, with help from a guest scientist, quickly developed SDL models. These protocol models clearly showed the problems that need to be addressed in the Bluetooth specification before the

IEEE 802 can adopt it as a standard. Currently, the Bluetooth Specification is under consideration for standardization within the IEEE 802.15 expert group working on Wireless Personal Area Networks.

The NIST scientist's work stems from the Networking for Smart Spaces project, which examines the most recent and future developments on networking technologies (e.g., wireless) that provide access to resources. These resources can be printers, personal computers, cellular telephones, and network access points. The Bluetooth SIG (www.bluetooth.com) is an international consortium developing specifications for pico-cellular network systems. The specification addresses wireless, network, self-discovery, and application areas.

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NIST SPONSORS PERSVASIVE COMPUTING 2000 CONFERENCE

In January 2000, NIST sponsored the Pervasive Computing 2000 Conference in Gaithersburg, MD. The purpose of the conference was to explore the directions that industry is taking in the emerging area of pervasive computing and smart spaces. Topics discussed included human-computer interaction in pervasive computing, pico-cellular wireless communication, information access and management for smart spaces, dynamic service discovery in networking, integration and interoperability of human-centered technologies, programming pervasive computing applications, and innovative pervasive computing hardware.

Pervasive computing refers to the emerging trend toward numerous, easily accessible computing devices connected to an increasingly ubiquitous network infrastructure. This trend likely will create new opportunities and challenges for the information technology marketplace, placing high-performance computers and sensors in virtually every device, appliance, and piece of equipment; in buildings, homes, workplaces, and factories; and even in clothing. Pervasive computing will require innovative approaches to human-computer interaction and information access technologies, as there will be a shift toward interacting with small, distributed, and often invisible devices.

This conference supported a new pervasive computing initiative at NIST. As a first step in this initiative, several experimental smart spaces are currently being prototyped. These are focusing on advanced forms of human-computer-interaction, integrating pico-cellular wireless networks with dynamic service discovery, automatic device configuration, and software infrastructures required to successfully program pervasive computing applications.

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OPEN ELECTRONIC BOOK FORUM FORMED TO DEVELOP STANDARDS FOR e-BOOKS

Representatives from more than 30 companies and non-profit organizations met recently with members of the Open Electronic Book (OEB) Standards Initiative Authoring Group to facilitate the next step forward in promoting the growth of the electronic book industry. Held in December 1999 in San Francisco, the meeting resulted in the formation of the Open Electronic Book Forum (OEBF). A preliminary charter for the newly formed organization was composed and ratified. The purpose of the OEBF is to create and maintain standards to promote the successful adoption of electronic books.

Charter members elected an Interim Board to guide the organization in its nascent stages; a NIST staff member chairs the board.

Formation of the OEBF continues the yearlong effort of the Open e-Book Authoring Group. Its purpose was to develop a specification for electronic content, based on existing standards, that allows such content to be viewed over reading systems on various devices and platforms, while still guaranteeing fidelity and accessibility of that content. The Open e-Book Publication Structure is a specification that enables content providers to convert once and publish anywhere. The Authoring Group at Electronic Book 99 introduced this specification at the second NIST-sponsored workshop in September 1999.

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NIST HOSTS KEY MANAGEMENT STANDARD WORKSHOP

NIST hosted a workshop in February 2000, to examine public key-based management techniques as specified in several private industry standards under development. Approximately 90 people from government and private industry participated in the workshop. The federal government currently has no public key-based standard for the establishment of cryptographic keys for unclassified applications. Since the government relies heavily on commercial off-the-shelf products, federal agencies need to understand the options that will be available in industry standards. Agencies must decide which techniques are suitable for protecting sensitive federal information and promoting interoperability among government agencies, between the government

and the private sector, and between the U.S. government and the governments of other countries. The workshop reviewed the options and techniques contained in draft standards and discussed related issues. See <http://www.nist.gov/kms>.

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STEP AND OMG PRODUCT DATA MANAGEMENT SPECIFICATION: A GUIDE FOR DECISION MAKERS

On Nov. 12, 1999, the standards group ISO TC184 on Industrial Automation Systems and Integration, SC4 on Industrial Data (TC184/SC4) unanimously adopted a resolution identifying the white paper "STEP and OMG Product Data Management Specifications: A Guide for Decision Makers," as a guideline for the complementary use of the two international standards for Product Data Management (PDM) interfaces. These interfaces are the STEP (STandard for the Exchange of Product model data) PDM Schema and the OMG (Object Management Group) PDM Enablers. On Nov. 19, 1999, the Domain Technical Committee of the Object Management Group unanimously adopted the same white paper. This white paper identifies the two standards, shows how the same major PDM concerns are reflected in the two standards, identifies conceptual differences, and describes common manufacturing scenarios for which the use of each standard is appropriate. The white paper was developed by a joint activity of the developers of the STEP PDM Schema and the developers of the OMG PDM Enablers Metaphase. NIST experts contributed about 25 % of the text of the white paper. This is seen as the first successful effort in a program for harmonization of several standards activities for interfaces between product data management systems and other engineering software systems. CONTACT: Ed Barkmeyer, (301) 975-3528; edward.barkmeyer@nist.gov.

NIST CRAFTSMAN CO-AUTHORS ARTICLE

A NIST fabrication craftsman prepared information for an article in *Fusion: The Journal for the American Scientific Glassblowers Society*. The article reports on an octagonal glass vacuum chamber for Bose-Einstein condensates that he made. This very complicated glass assembly involved making 14 different quartz parts that then were fused together to make an octagonal cell with four quartz tubes projecting from the sides. The tubes are 32 mm diameter by 100 mm long. All the octagon parts are made from 2 mm thick quartz. This cell involved optically fusing the components together at an

elevated temperature to produce the complete vacuum tight cell. This cell is being used by a group of physicists at NIST to experiment with laser cooling and trapping of atoms.

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Standard Reference Materials

LOW-LEVEL RADIONUCLIDE ASHED BONE STANDARD REFERENCE MATERIAL

Bone tissue is one of the most important biological sinks for a number of long-lived radionuclides. Accurate determination of the radionuclides in bone specimens is essential for improving biokinetics modeling and assessing occupational and public internal radiation dose. However, lack of a bone standard for method validation and quality control in analytical measurements limits the reliability of the current analytical results and the data comparability among national and international laboratories. In collaboration with the International Committee on Radionuclide Metrology, NIST led an international group of experienced laboratories to develop a unique ashed bone Standard Reference Material (SRM 4356) for low-level radionuclides in bone. The SRM is a composite material containing 4 % occupationally contaminated human bone and 96 % bovine bone.

The massic activities of ^{90}Sr , ^{226}Ra , ^{230}Th , ^{232}Th , ^{234}U , ^{238}U , ^{238}Pu , $^{(239+240)}\text{Pu}$, and $^{(243+244)}\text{Cm}$ were certified using a variety of radiochemical procedures and detection methods, and the analytical results were evaluated using several statistical techniques. The data analysis indicates that heterogeneities of the certified radionuclides are undetectable down to a sample size of 5 g. A unique character of this SRM material is the disequilibrium of U and Th decay chains, which is the result of mixing occupationally contaminated human bone with natural bovine bone, and results from fractionation during internal biological processes. Radionuclide disequilibria prevented the certification of the U and Th daughters, ^{210}Pb and ^{228}Th .

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NIST ISSUES NEW STANDARD FOR MITOCHONDRIAL DNA SEQUENCING

Since its development, medical researchers and law enforcement agencies have embraced DNA testing as a key tool in diagnosing diseases, pinpointing criminal suspects, and identifying the remains of soldiers and accident victims undistinguishable by other means. While current DNA typing requires a sample of the DNA found in the nucleus of nearly every living cell, a newer procedure makes use of a different kind—mitochondrial DNA.

Mitochondrial DNA, inherited only from your mother, is a small circular strand of genetic material located within a cell's mitochondria, a sausage-shaped organelle that converts nutrients into energy. Since a single cell can have thousands of these structures, mitochondrial DNA persists long after the DNA that makes up chromosomes has degraded. This makes it an attractive target for genetic sleuths examining old evidence. Certain diseases, such as Alzheimer's, Parkinson's, neuromuscular dis-orders and some forms of blindness, are associated with mutations in mitochondrial DNA, making it a potential source of valuable data for medical researchers.

In order to ensure accuracy of mitochondrial DNA testing and sequencing, NIST has just issued Standard Reference Material 2392, Mitochondrial DNA Sequencing. Designed to help labs verify their mitochondrial DNA results, SRM 2392 also can be used as a control when sequencing any DNA.

The SRM contains DNA extracted from two cell lines plus cloned DNA from a region that is difficult to sequence. It is accompanied by a certificate detailing the base pair sequences of the DNA, so labs can check their own results against the values determined by NIST. The certificate also provides the sequences of 58 unique primer sets which permit the amplification and sequencing of any specific area or all of the mitochondrial DNA.

The new Mitochondrial DNA Sequencing SRM is available from the NIST Standard Reference Materials Program for \$766. For ordering information, call (301) 975-6776; fax (301) 948-3730; or send e-mail to srminfo@nist.gov.

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NEW NIST STANDARD FOR REFRACTOMETRY ISSUED

Refractometry is used in the food and chemical industries as a rapid and simple technique for the measurement of solute concentrations. The most common applications of refractometry are for measurements of sucrose in corn syrups and beverages, and ethylene and propylene glycol in antifreeze solutions. These two applications alone have a large industrial impact, as small variations in sucrose concentration control the market price of corn syrup, and small variations in the concentrations of ethylene and propylene glycol affect the deicing capabilities of a solution. SRM 1922 was issued recently as a mineral oil with a certified refractive index comparable to sucrose and ethylene or propylene glycol solutions. The standard was characterized using the minimum deviation technique, which is the preferred method for refractive index measurement as it depends only on angular measurements and does not require reference to a material of known refractive index. A goniometer capable of angular measurements of 1 second of arc or better is required for precise measurements, and it also must be coupled with a spectrometer. NIST fortunately maintained an instrument of this type, as they are now quite rare and expensive. A specially designed hollow glass prism enclosed in a temperature-controlled housing was used for the measurement of the mineral oil. The choice of a liquid as the standard limited the uncertainty of the certified values to a few $\times 10^5$ times the refractive index, but still an order of magnitude better than most commercial refractometers can achieve. A liquid was chosen for the standard for comparability with sucrose and ethylene or propylene glycol solutions. For solid materials NIST is able to make refractive index measurements at an uncertainty level that competes with the best in the world.

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calculated or measured IMFPs are available for a material of interest, values can be estimated from predictive formulae. A user can select data from different sources and can display this information graphically (i.e., a plot of IMFP versus electron energy) or as values for one or more user-specified electron energies. IMFP data from different sources or for different materials can be compared graphically.

The IMFP is a key parameter in the widely used techniques of Auger-electron spectroscopy and x-ray photoelectron spectroscopy for surface analysis. For these applications, IMFPs are needed for quantitative surface analyses (to correct elemental sensitivity factors for variations of IMFP with chemical state), for determination of effective attenuation lengths (to measure film thicknesses), for determination of mean escape depths (to find the average depth of analysis), and for simulations of the transport of signal electrons (to correct for the effects of elastic-electron scattering and to determine surface compositions in specimens with complex morphologies). The IMFPs also are needed for defining the surface sensitivity of other surface-characterization methods in which electron beams are employed (e.g., low-energy electron diffraction and appearance-potential spectroscopy).

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Standard Reference Data

NEW DATABASE OF ELECTRON INELASTIC MEAN FREE PATHS RELEASED

A new NIST database (SRD 71) containing data for the inelastic mean free paths (IMFPs) of electrons with energies between 50 eV and 10 000 eV in solids has been recently released. This database includes IMFPs calculated from experimental optical data and IMFPs measured by elastic-peak electron spectroscopy. If no

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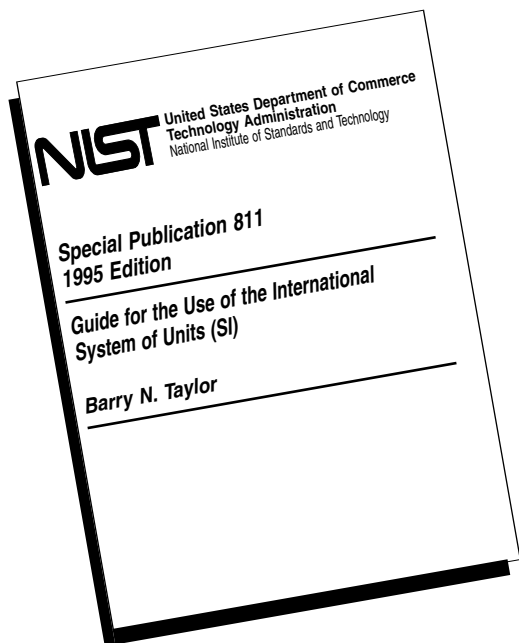
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The International System of Units (SI)

The Modern Metric System



Uncertain about the International System of Units (universally abbreviated SI), the modern metric system used throughout the world? Do you need to know the proper way to express the results of measurements and the values of quantities in units of the SI? Do you need to know the NIST policy on the use of the SI? Then you need the 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*.

The 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*, by Barry N. Taylor, is now available.

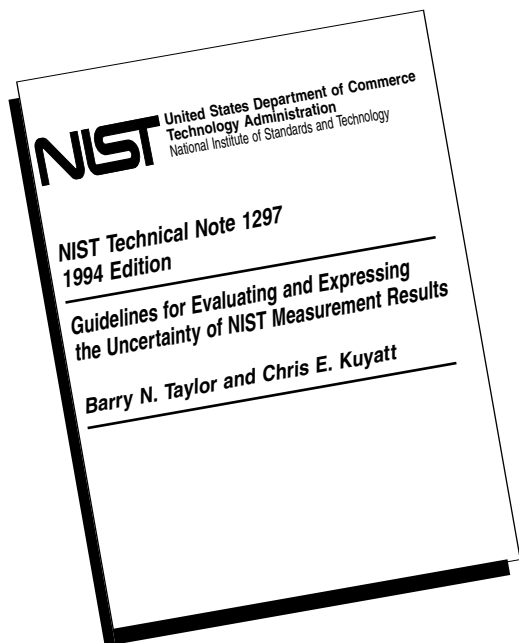
The 1995 edition of SP 811 corrects a number of misprints in the 1991 edition, incorporates a significant amount of additional material intended to answer frequently asked questions concerning the SI and SI usage, and updates the bibliography. The added material includes a check list for reviewing the consistency of written documents with the SI. Some changes in format have also been made in an attempt to improve the ease of use of SP 811.

The topics covered by SP 811 include:

- NIST policy on the use of the SI in NIST publications.
- Classes of SI units, those SI derived units that have special names and symbols, and the SI prefixes that are used to form decimal multiples and submultiples of SI units.
- Those units outside the SI that may be used with the SI and those that may not.
- Rules and style conventions for printing and using quantity symbols, unit symbols, and prefix symbols, and for spelling unit names.
- Rules and style conventions for expressing the results of measurements and the values of quantities.
- Definitions of the SI base units.
- Conversion factors for converting values of quantities expressed in units that are mainly unacceptable for use with the SI to values expressed mainly in units of the SI.
- Rounding numbers and rounding converted numerical values of quantities.

Single copies of the 84-page SP 811 may be obtained from the NIST Calibration Program, 100 Bureau Dr., Building 820, Room 236, Stop 2330, Gaithersburg, MD 20899-2330, telephone: 301-975-2002, fax: 301-869-3548.

Evaluating and Expressing the Uncertainty of Measurement Results



Uncertain about expressing measurement uncertainty? Do you need to know how NIST states the uncertainty of its measurement results and how you can implement their internationally accepted method in your own laboratory? Then you need the newly available 1994 edition of the National Institute of Standards and Technology Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*.

The 1994 edition of the National Institute of Standards and Technology Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, by Barry N. Taylor and Chris E. Kuyatt is now available.

The 1994 edition of TN 1297 includes a new appendix—Appendix D—which clarifies and gives additional guidance on a number of topics related to measurement uncertainty, including the use of certain terms such as accuracy and precision. Very minor word changes have also been made in a few portions of the text of the 1993 edition in order to recognize the official publication in October 1993 by the International Organization for Standardization (ISO) of the *Guide to the Expression of Uncertainty in Measurement* on which TN 1297 is based. However, the NIST policy on measurement uncertainty, Statements of Uncertainty Associated with Measurement Results, which is reproduced as Appendix C of TN 1297, is unchanged.

It is expected that the 1994 edition of TN 1297 will be even more useful than its immediate predecessor, the 1993 edition, of which 10 000 copies were distributed worldwide.

Those United States readers who wish to delve into the subject of measurement uncertainty in greater depth may purchase a copy of the 100-page ISO *Guide* from the Sales Department of the American National Standards Institute (ANSI), 105-111 South State Street, Hackensack, NJ 07601. Copies may also be purchased from the ISO Central Secretariat, 1 rue de Varembé, Case postale 56, CH-1211 Genève 20, Switzerland.

Single copies of the 20-page TN 1297 may be obtained from the NIST Calibration Program, 100 Bureau Dr., Building 820, Room 236, Stop 2330, Gaithersburg, MD 20899-2330, telephone: 301-975-2002, fax: 301-869-3548.

NIST Technical Publications

Periodical

Journal of Research of the National Institute of Standards and Technology—Reports NIST research and development in those disciplines of the physical and engineering sciences in which the Institute is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Institute's technical and scientific programs. Issued six times a year.

Nonperiodicals

Monographs—Major contributions to the technical literature on various subjects related to the Institute's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NIST, NIST annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NIST under the authority of the National Standard Data Act (Public Law 90-396). NOTE: The Journal of Physical and Chemical Reference Data (JPCRD) is published bimonthly for NIST by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements are available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

Building Science Series—Disseminates technical information developed at the Institute on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NIST under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NIST administers this program in support of the efforts of private-sector standardizing organizations.

Order the following NIST publications—FIPS and NISTIRs—from the National Technical Information Service, Springfield, VA 22161.

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NIST pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NIST Interagency Reports (NISTIR)—A special series of interim or final reports on work performed by NIST for outside sponsors (both government and nongovernment). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Service, Springfield, VA 22161, in paper copy or microfiche form.

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