

# News Briefs

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## General Developments

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

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### BIOASSAY REFERENCE VALUES ESTABLISHED FOR THREE NIST SRMs

Short-term bioassays are being used in many countries to evaluate the exposure of humans to complex mixtures of mutagens and potential carcinogens in air, water, soil and from various emission sources. The salmonella mutagenicity assay developed by Professor Bruce Ames and coworkers in 1925 is the mutagenesis bioassay most frequently used in such studies.

In 1987, the International Programme on Chemical Safety, in collaboration with the Environmental Protection Agency and NIST, initiated an international collaborative study to determine the variability of data being generated by labs using the Ames Bioassay. The study involved 20 laboratories from North America, Europe, and Japan that used the Ames test on a regular basis. Three NIST SRMs that are certified for chemical composition were used in the study: 1597, Complex Mixture of Polycyclic Aromatic Hydrocarbons from Coal Tar; 1649, Urban Particulate Matter; and 1650, Diesel Exhaust Particulate Matter.

The results from this study revealed an interlaboratory variability (approaching 100 percent coefficient of variation) among the twenty study participants. Representatives from these expert laboratories agreed that the variation found represented the current state-of-the-art practice for these assays. While a true value exists for chemical and physical properties that can be measured with a relatively high degree of accuracy and precision,

bioassays are inherently more variable in part because the living organisms that serve as detection devices are constantly undergoing dynamic processes of growth, replication, metabolism, and interaction.

The data from the collaborative study has been used to establish two types of reference values. One, expressed as a 95 percent confidence interval, defines the actual mutagenic activity as measured by the Ames bioassay test. The other, expressed as an 80 percent tolerance interval, characterizes the differences in reported mutagenic activity and establishes a realistic target for comparing individual laboratory results with the state-of-the-practice. With these Ames Mutagenicity reference values, SRMs 1597, 1649, and 1650 can now be used by the international bioassay measurement community as powerful tools for reducing the variability of Ames bioassay data.

### ANALYTICAL METHOD DEVELOPED TO INVESTIGATE THE ROLE OF VITAMIN C IN CANCER PREVENTION AND JUVENILE ARTHRITIS

The role of selected vitamins in the prevention of certain diseases, such as cancer, has been the subject of great interest in recent years. Scientists at NIST and the National Cancer Institute recently developed a method for the accurate and precise measurement of vitamin C in human plasma. Procedures also were developed for stabilizing calibration standards and for preparing stable and homogeneous quality control materials (70 °C). The results of studies conducted to assess the long-term stability of vitamin C in preserved frozen plasma and the short-term stability in whole blood (4 °C) indicated that plasma samples containing vitamin C can be stored for at least 1 yr without measurable analyte degradation. In addition, vitamin C remains intact for at least 6 h in whole blood. These studies also were used to assess the

performance of laboratories participating in NCI studies designed to examine the role of vitamin C in carcinogenesis.

This accurate method for the measurement of vitamin C has proven to be useful in a collaborative study with the Children's Hospital National Medical Center and George Washington University, where the vitamin C content of the serum of patients with juvenile arthritis was measured. The results indicate that the serum vitamin C levels correlate well with the pathological types of arthritis exhibited by the patients.

Each of these studies, the multilaboratory study on relationship of vitamin C to cancer incidence and the grouping of pathological states as a function of serum vitamin C levels, requires the use of accurate and precise trace organic measurement technology.

#### **INTRAMOLECULAR VIBRATIONAL ENERGY REDISTRIBUTION STUDIED BY PICOSECOND IR SPECTROSCOPY**

Measuring molecular vibrational energy redistribution rates and extracting transfer mechanisms are key steps toward understanding energy involvement in all chemical transformations. Obtaining this dynamical information is especially difficult for polyatomic molecules in high temperature condensed media since such processes occur on the picosecond and femtosecond timescales. NIST scientists have been able to examine these events in real time by developing novel ultrashort pulsed infrared techniques which monitor transient energy population in specific vibrational modes. Careful selection of the molecular species and surrounding environment has enabled them to directly probe fundamental transfer events after energy has been selectively deposited in a vibrational mode. The scientists have recently measured for the first time vibrational energy transfer rates for a meta-carbonyl-nitrosyl molecule,  $\text{Co}(\text{CO})_3\text{NO}$ , in the gas phase and as dissolved in  $\text{CFCl}_3$  solution. The rates increased by factors of two to five for the molecule in solution and the measurements indicate that populated lower energy states readily relax by depositing energy into solvent motions. These energy transfer mechanisms are now being studied by selecting buffer gases with specific acceptor vibrational energies (e.g., CO, NO,  $\text{CFCl}_3$ ) and measuring vibrational energy transfer processes as a function of pressure and density.

#### **FREQUENCY AND WAVELENGTH STANDARD FOR THE FAR INFRARED**

Visiting scientists at NIST recently completed a high-resolution study of the far-infrared spectrum of gaseous carbon monoxide (CO). The frequencies of pure rotational transitions in the ground state of the molecule were measured using their laser-synthesized, tunable far infrared spectrometer. A complete set of frequencies was calculated from these data with an accuracy of about 5 parts in  $10^9$ . This is 10 times more accurate than the previous best measurements.

Accurate measurements of the spectrum of carbon monoxide are important for two reasons. First, CO is an abundant interstellar molecule, and many astrophysical measurements and tests of theory depend on the accuracy of CO rotational frequencies. Second, CO is often used as a reference standard to calibrate spectrometers (especially Fourier transform spectrometers) in the far infrared. With the completion of this work, the CO transitions are now the most accurate far-infrared frequencies available in the frequency range from 100 to 4300 GHz (wavelength of 300 to 7  $\mu\text{m}$ ).

#### **IN SITU CHARACTERIZATION OF THE PULSED LASER DEPOSITION OF THIN FILMS**

Pulsed laser deposition (PLD) has been shown to be an effective means of depositing thin films from refractory targets. Excimer and Nd/YAG lasers are being used by NIST to deposit thin films of high  $T_c$  superconductors, high dielectric constant  $\text{BaTiO}_3$ , ferroelectric  $\text{PbZr}_{.53}\text{Ti}_{.47}\text{O}_3$  (PZT), and magnetic thin films of  $\text{Fe}_3\text{O}_4$  and  $\text{Ag-Fe}_3\text{O}_4$ . During the PLD of these thin films, optical emission spectroscopy is used to determine the identity and energy (temperature) of the excited state species present in the laser induced plumes. These results, combined with the results of in situ molecular beam mass spectrometric analysis of the plumes, permits determination of both the minor and major species present during the PLD process, including nonexcited neutral species and complex molecular species. Correlations are being made with the film's stoichiometry, morphology and electric or magnetic properties.

#### **NEW COMPUTATIONAL METHOD FOR PATTERN FORMATION DURING ALLOY SOLIDIFICATION**

A new model has been developed that predicts the growth and resulting segregation patterns of solid

particles forming from a melt during alloy solidification. These segregation patterns are responsible for defects that limit the mechanical and corrosion properties of many alloys. This new approach was previously developed for pure materials but, through work at NIST has now been applied to the more useful case of binary alloys. The system is treated in its entirety with a continuous field variable describing the state (liquid or solid) of the various regions of the system. Classical methods previously used to calculate these growth morphologies have required numerical tracking of the free boundary that separates the liquid from the solid and individual treatment of each phase. By contrast, the present approach greatly simplifies the calculations, making predictions for practical alloys feasible.

#### **FIBER LASER OFFERS WAVELENGTH STANDARD**

NIST has successfully stabilized the wavelength of an erbium-doped fiber laser to a narrow atomic absorption line in the 1.5  $\mu\text{m}$  region, offering industry a highly accurate optical wavelength standard. The work is critical to the development of advanced optical communication systems utilizing cables smaller in size and cheaper to operate than conventional wire lines. Narrow wavelength operation permits many optical channels to be packed into a single fiber. To create a system like this, an adequate laser wavelength standard is necessary. NIST's proposed standard uses both a diode laser operating near 0.78  $\mu\text{m}$  and a fiber laser near 1.53  $\mu\text{m}$  to drive transitions in rubidium. Additionally, the fiber laser already has been used successfully in high-resolution spectroscopy, aiding researchers in their investigations of atomic and molecular behavior. For technical information, contact Sarah Gilbert, Div. 814.02, NIST, Boulder, CO 80303, 303/497-3120.

#### **NIST RESEARCH LEADS TO SIGNIFICANT YIELD IMPROVEMENT IN THE MANUFACTURE OF MEMORY CHIPS**

Research by a NIST scientist has directly contributed to a significant improvement in yield in the manufacture of integrated circuit memory chips in SIMOX material. SIMOX material is made by implanting oxygen in silicon wafers to form a silicon dioxide layer beneath the silicon surface. Because of the smaller volume in which hole-

electron pairs can be generated, electronic circuits fabricated in SIMOX material are much more resistant to radiation effects than bulk silicon.

If there are particles on the wafer surface during implanting, conducting channels or pipes form between the silicon layer on the top and the substrate. Devices made on such a SIMOX wafer do not work properly. The scientist developed a potassium hydroxide etching procedure which made the pipes visible using optical microscopy. Further investigation showed that the number of surface particles could be reduced from 10/cm<sup>2</sup> to 0.1/cm<sup>2</sup> by taking certain steps to reduce contamination within the implanter. Two private companies adopted these procedures for producing SIMOX material. One company used its material to manufacture SIMOX-based static random-access memories (SRAMs) and reports a significantly increased yield in 64 kilobit SRAMs. The company also reports that use of the new SIMOX material made manufacture of a 1 megabit SRAM possible.

#### **NIST LEADS INDUSTRY TO ACCORD IN X-RAY MASK SPECIFICATIONS**

A NIST scientist in his capacity as chairman of the X-Ray Program Mask Standards Committee established by the Defense Advanced Research Projects Agency, has led industry to adopt a standard limiting set of dimensions (the envelope) of the masks used for manufacturing integrated circuits defined through x-ray lithography. This accomplishment satisfies the charge given to the committee on its formation. An x-ray mask consists of a thin silicon membrane supported by a heavier frame; x-ray lithography extends the capabilities of optical lithography to finer dimensions, permitting the production of smaller integrated-circuit elements. The agreement constitutes an important step toward bringing x-ray lithography from the laboratory to the production line.

The committee also concluded that there is insufficient motivation for developing commonality between masks used with point (lower flux) and collimated (higher flux) sources, that there is no technical advantage anticipated from the concept of employing differing standards for primary master patterns and working x-ray mask copies, and that it would be neither necessary nor advantageous to impose any further dimensional constraints on x-ray masks until the technology becomes further advanced.

### NEUTRON REFLECTOMETRY HELPS CHARACTERIZE POLYMER BRUSHES

Polymer brushes are central to many important problems in polymer science and biophysics, including colloid stabilization, polymeric surfactants, and polymer compatibilizers. Understanding the brush structure of the polymer chains is important in predicting the behavior of each of these systems.

Recently NIST scientists, in collaboration with researchers from two universities, have made a significant advance in determining the polymer segment density profile of these brushes using neutron reflectivity. The polymers used in this study are so-called “sticky foot” polystyrene in which one end of the polystyrene molecule has a functional group which adsorbs strongly onto the surface from the solution. This gives a very large density of adsorption of polymer near the surface, thus making neutron reflectivity measurements possible. NIST scientists use a technique unique to neutrons wherein the neutron beam traverses a large single crystal of silicon and reflects from the silicon-polymer solution interface, with the reflected beam again traversing the silicon crystal. For the first time, the neutron data show very strong minima and maxima in reflectivity, thereby significantly increasing the precision with which the structure of the polymer brushes adsorbed on the silicon-solution interface can be determined.

### FAST RESTORATION OF IMAGES

Two NIST scientists have demonstrated the speed and flexibility which modern parallel computing can provide in restoring blurred images from a noisy background. Their restoration procedure, on a massively parallel machine (the Connection Machine at the University of Maryland Institute for Advanced Computer Studies), takes advantage of what the operator may know in advance and can recognize in the image as it is recovered.

Starting from a  $512 \times 512$  image sample, the scientist first artificially blurred it, by convolution with a Gaussian-like point spread kernel, and then added random noise. This produced a blurred image, which resembled typical raw image data on a medical diagnosis system.

The recovery was undertaken by the method of “Tikhonov regularization”—using a low-pass spatial filter with an interactively set regularization parameter. In the presence of noise, the recovery of the image is a mathematically ill-posed problem. The computer by itself, not knowing the features of the image that are most important, may wander from the desired solution. The operator can

sharpen important details in the recovered image by resetting the regularization parameter interactively.

In the recovered image, most of the significant detail from the original is present, plus a background pattern which originated with the noise component of the blurred data. These extraneous details can be easily ignored because the operator can distinguish them visually.

Massively parallel processing is fast, in this case making it possible to run the restoration process with many different settings of the regularization parameter.

### NEUTRON FOCUSING USING CAPILLARY OPTICS

NIST researchers have been collaborating with researchers from the Kurchatov Institute for Atomic Energy Institute in Moscow and from the State University of New York at Albany on the use of multicapillary fibers for the focusing of neutrons. Recently, the researchers at NIST demonstrated the focusing of cold neutrons from the Cold Neutron Research Facility using a simple lens comprising a dozen of these capillary fibers. These neutron measurements were performed in conjunction with a newly developed charge transfer device neutron detector having a few tens of micrometers spatial resolution. A cooperative research and development agreement to develop multicapillary optical fibers for the transmission and focusing of cold neutrons has been signed with a private company.

These multicapillary fibers, which were developed at the Institute for Roentgen Optical Systems in Moscow, consist of thousands of parallel channels within a glass fiber of sub-millimeter diameter. Neutrons are guided down numerous open channels that are only  $6 \mu\text{m}$  in diameter, a concept that has proved successful with x rays. Low-energy neutrons have optical properties analogous to those of photons and may be focused to produce significantly higher fluxes using the principle of mirror reflection from smooth surfaces at small grazing incident angles. The lens is formed by bending and orienting the fibers in such a way that the beams that emerge from each fiber point to the same spot, and so increase the neutron current density. Narrowly focused beams allow greater spatial resolution for neutron absorption measurements than previously available and suggest microprobe capabilities to complement other radiation techniques for multidimensional analysis in materials science.

**NIST DEVELOPS METHODS FOR HIGH-PRECISION PHASE NOISE MEASUREMENTS**

In response to new requirements of the U.S. aerospace industry for tighter phase noise specifications, NIST has developed the first measurement systems that yield high-precision phase noise measurements over a broad frequency range. Phase noise has been rising in importance in radars, telecommunications, and other systems where high spectral purity of signals is critical. Its presence in signal channels degrades the spectral purity and thus the performance of the system. The NIST phase noise measurement systems operate at carrier frequencies from 5 MHz to 26 GHz and 33 to 50 GHz with bandwidths up to 10 percent of the carrier frequency. The measurement precision ranges from about 1 to 2 dB depending on the operating conditions.

Commercial equipment for phase noise measurements have been available for several years, but there has been no satisfactory method for assuring that such systems were indeed giving accurate readings. The commercial systems are substantially more limited in dynamic range and precision. The NIST measurement systems have uncovered a number of measurement errors, some ranging from 5 to 20 dB.

**HUBBLE DATA SUGGEST NO END FOR UNIVERSE**

A team of scientists using NASA's Hubble Space Telescope (HST) has made the most precise measurement to date of the percent of deuterium (heavy hydrogen) in space. Led by a NIST astronomer and fellow of the Joint Institute for Laboratory Astrophysics in Boulder, CO, the researchers used HST's Goddard High Resolution Spectrograph to determine that the ratio of deuterium to hydrogen in space is 15 parts per million ( $15 \times 10^{-6}$ ). If the assumptions of the Big Bang theory for the universe's creation are correct, this ratio accounts for the maximum possible density of ordinary matter that can be present in the universe. The Hubble data also suggest that unless large amounts of some exotic form of matter exist in space, there is not enough matter present to halt the expansion of the universe. If true, the universe had a brilliant beginning but will have no end.

**NEW "MEASURES" NEEDED TO BOOST PRODUCTIVITY**

As American electronics firms strive to produce top-notch products, one factor emerges as a key to boosting domestic semiconductor productivity:

measurement technology. This is the theme of a new NIST report, *Metrology for the Semiconductor Industry*. The 46-page document explains the importance of measurement in integrated circuit fabrication and how it enables manufacturers to better understand and control processes. The report says reliable measurement factors, such as circuit component dimensions and properties at various steps during the production process, are crucial. This ensures that processing errors are avoided and that faulty products are eliminated early in the production process. Besides presenting its measurement message, the report also details, in lay language, the semiconductor manufacturing process. For a free copy, contact Jane Walters, B344 Technology Building, NIST, Gaithersburg, MD 20899, 301/975-2050.

**MEASUREMENT SERVICE FOR CW WATTMETERS COMING**

NIST expects to establish a measurement service for high power continuous wave (cw) wattmeters in the near future. Measurements will be available at several points from 2 to 30 MHz (1 to 1,000 W) and 30 to 400 MHz (1 to 500 W). Advance notice is being provided because use of this service will require prearrangement with NIST. Wattmeters must be controllable via an IEEE-488 bus, have a type N male input connector, and either have a type N female output connector or be supplied with a load. At each measurement point, the customer will receive a calibration factor for the wattmeter, defined as the ratio of the wattmeter reading to the power incident on it. The measurement uncertainty for the new service is expected to be less than plus or minus 2 percent, depending on the frequency, power level, and electrical characteristics of the wattmeter/load combination. For more information, contact Gregorio Rebuldela or Jeffrey Jargon, Div. 813.01, NIST, Boulder, CO 80303, 303/497-3561.

**NEW GLOSSARY OF COMPUTER SECURITY TERMINOLOGY**

Computer security practitioners will be interested in *The Glossary of Computer Security Terminology* (NISTIR 4659), a collection of terms and definitions used by federal departments and agencies in their policies and standards. The 176-page document was developed under the auspices of the National Security Telecommunications and Information Systems Security Committee and published by NIST as part of its effort to distribute federally sponsored work. This glossary provides more than

one definition for many computer and communications security terms, reflecting the various uses by different federal agencies. Technical information on the publication is available from Edward Roback at 301/975-3696. The publication is for sale by the National Technical Information Service, Springfield, VA 22161 for \$26 (hard copy) and \$12.50 (microfiche) prepaid. Order by PB 92-112259/AS.

#### **NEW PROCEEDINGS ISSUED ON HIGH INTEGRITY SOFTWARE**

The Proceedings of the Workshop on High Integrity Software (NIST Special Publication 500-190) presents the results of a recent Assurance of High Integrity Software workshop sponsored by NIST. Participants addressed techniques, costs and benefits of assurance, controlled and encouraged practices, and hazard analysis. The workshop prepared a preliminary set of recommendations and proposed future directions for NIST to coordinate an effort to produce a comprehensive set of standards and guidelines for the assurance of high integrity software. Technical information on the workshop is available from Dolores R. Wallace at 301/975-3340. The publication is for sale by the National Technical Information Service, Springfield, VA 22161 for \$17 (hard copy) and \$9 (microfiche) prepaid. Order by PB 92-109040/AS.

#### **AUTOMATED MANUFACTURING STARS IN NEW VHS PROGRAM**

A new videotape describing information management strategies developed for NIST's Automated Manufacturing Research Facility (AMRF) was recently released. The AMRF is a prototype small-batch manufacturing facility used for integration and measurement-related standards research. "Information Management in the AMRF, November 1991," a 12 1/2 min tape describes five major manufacturing functions: design, process planning, off-line programming, shop floor control, and materials processing. Special emphasis is placed on how the AMRF manages information flow between these functions. The video is available on free loan by requesting title number 24798 from Modern Talking Picture Service Inc., 5000 Park St. North, St. Petersburg, FL 33709, 800/237-4599. VHS copies are \$12 (shipping included) and may be purchased from Video Transfer Inc., 5709-B Arundel Ave., Rockville, MD 20852, 301/881-0270.

#### **NIST REPORTS ON ISO 9000 STANDARD SERIES**

Answers to many commonly asked questions about quality, quality systems, and the use and application of such systems are found in Questions and Answers on Quality, The ISO 9000 Standard Series, Quality System Registration, and Related Issues (NISTIR 4721). The report briefly describes the contents of the ISO 9000 standards that were published in 1987 by the International Organization for Standardization (ISO) in Geneva, Switzerland. The five international standards, along with the terminology and definitions contained in ISO Standard 8402, Quality-Vocabulary, provide guidance for industry decision makers on the selection of an appropriate quality management program or system. Among other topics, the report describes the conformity assessment scheme of the European Community (EC) for EC-regulated products. To obtain a copy of NISTIR 4721, send a self-addressed mailing label to the Standards Code and Information Program, A629 Administration Building, NIST, Gaithersburg, MD 20899, 301/975-4031.

#### **SOFTWARE PACKAGE FOR ANTENNA METROLOGY AVAILABLE**

A demanding task in antenna metrology is developing computer programs to process the massive amounts of measurement data needed to determine antenna performance characteristics. NIST scientists are currently creating a comprehensive and easy-to-use personal computer software package for conducting advanced research related to near-field antenna metrology. Ultimately, it will simplify methods for precisely determining the far-field properties of state-of-the-art antennas based on laboratory measurements. The software will isolate common computational themes and develop dedicated modules for use in performing computational tasks (involving real or simulated data for research and error analysis in antenna metrology). A recent NIST publication describes a software system that achieves a high degree of power, modularity, and flexibility for studying planar near-field measurements. The package consists of many FORTRAN modules that can be called from DOS to achieve a variety of computational tasks. For a copy of Personal Computer Codes for Analysis of Planar Near Fields (NISTIR 3970), contact the National Technical Information Service, Springfield, VA 22161. Order by PB 92-112283; the price is \$19 prepaid.

**NEW GUIDE DESIGNED TO HELP FEDERAL GOSIP USERS**

Federal managers, procurement personnel, and technical specialists seeking to buy or evaluate Government Open Systems Interconnection Profile (GOSIP) products should find a new users guide helpful. The guide is a valuable reference designed to help federal users interpret GOSIP technical information. It also can aid users in setting up GOSIP-compliant products in the workplace. Persons with little or no experience in Open Systems Interconnection (OSI)—which allows unrelated computer systems to communicate in an open network environment—should be able to understand all portions of the guide. The guide also contains worthwhile information for the experienced OSI user. Government Open Systems Interconnection Profile Users' Guide, Version 2 is available for \$26 prepaid from the National Technical Information Service, Springfield, VA 22161. Cite order number PB 92-119676/AS. (Note: This users guide serves as a companion document to Version 2 of GOSIP, issued as Federal Information Processing Standard (FIPS) 146-1. It is best used in conjunction with GOSIP and/or OSI documents.)

**BOOK REVIEWS SUPERCRITICAL FLUID EXTRACTION**

Two NIST researchers have authored and edited a definitive book that reviews the theory and applications of supercritical fluid technology. Over the past 5 years, there has been renewed interest in supercritical fluid extraction (SFE) methods. SFE has many industrial applications, but the systems must be carefully chosen. The best candidates for extraction are high-cost, low-volume commodities that require the use of a non-toxic solvent in their processing. The researchers have collected a series of reviews covering theoretical and experimental work geared toward the more exact requirements of current SFE applications. *Supercritical Fluid Technology: Reviews in Modern Theory and Applications* contains 16 chapters written by some of the foremost experts in this technology. For more information, contact Tom Bruno at Div. 838, NIST, Boulder, CO 80303, 303/497-5158.

**VIDEO HIGHLIGHTS 1991 BALDRIGE AWARD WINNERS**

What is quality management? Why is it important to U.S. competitiveness? How is it achieved? In a new 20 min video, representatives from the three 1991 winners of the Malcolm Baldrige

National Quality Award answer these questions and others on quality and quality management strategies. The 1991 winners are Solectron Corp., San Jose, CA; Zytec Corp., Eden Prairie, MN; and Marlow Industries, Dallas, TX. The award, named for the late secretary of commerce, was established by federal legislation in August 1987. It promotes national awareness about the importance of improving quality management and recognizes quality achievements of U.S. companies. However, the award is not for specific products or services. The award program is managed by NIST, with the active involvement of the private sector, including the American Society for Quality Control (ASQC). The 1991 winners video is available from ASQC for \$15. Item TA996 in ASQC's inventory, it can be ordered by calling 1-800/952-6587.

**RADIO WAVES "LOWER THE BOOM" ON BURIED MINES**

NIST has completed a 6 year effort to help the U.S. Army detect buried land mines (either plastic or metal) using electromagnetic (EM) technology. The method involves sending radio waves into the soil and analyzing the reflections received. A new report, *Qualifying Standard Performance of Electromagnetic-Based Mine Detectors* (NISTIR 3982), discusses the best ways of conducting controlled tests of portable detectors under varying soil conditions and recommends means for establishing a stable test range. Topics covered include: theoretical relationships between EM fields and matter; critical EM performance factors for portable mine detectors; measuring EM properties of materials relevant to EM mine detection; EM properties of soils and recommendations for simulated soil standards; desired properties and recommendations for simulated mine standards (both plastic and metal); recommended mine detector testing strategy; maintenance of test records and a test range; and recommendations for future work. Copies of NISTIR 3982 are available from the National Technical Information Service, Springfield, VA 22161. Order by PB 92-116292; the price is \$26 (\$9 microfiche).

**PHOTONIC PROBES DEVELOPED TO MEASURE EM FIELDS**

Photonic probes using lasers and fiber optics offer many advantages in electromagnetic field measurements, especially when measuring electromagnetic pulses (EMP) and high-power microwaves. These probes provide the wide bandwidth and low dispersion needed to measure EMP signals. They are free

from EM interference and provide minimal disturbance of the field being measured. NIST's interest has been in passive probes, where the probe head contains no active electronics or power supplies. A recent paper discusses the characteristics of photonic probes, presents an overview of system design (with emphasis on the transfer functions of appropriate antennas and electro-optic modulators), and details three photonic systems NIST has developed. For a copy of paper 61-91, contact Jo Emery, Div. 104, NIST, Boulder, CO 80303, 303/497-3237, fax: 303/497-5222.

#### SHAPING NEW DESIGNS FOR WAVE PROBES

There is a growing need for basic measurement support at millimeter wave and upper microwave frequencies. One requirement is for transfer standard probes—electric or magnetic field probes used for comparing standard electromagnetic fields generated in calibration laboratories. Another requirement is for radiation hazard meters. NIST scientists are using an optical sensor to measure the temperature rise of a resistive element in an electromagnetic field. In a recent paper, they report on the analyses and evaluations of numerous configurations for the resistive element. A sphere was chosen as the most promising shape. Several probe tips of this design were made and tested for sensitivity, frequency response, and linearity. Test results were very encouraging, with one design providing adequate performance for a transfer standard for millimeter waves. Report 54-91 is available from Jo Emery, Div. 104, NIST, Boulder, CO 80303, 303/497-3237.

#### IC DEVICE OFFERS IMPROVED SPEED, ACCURACY

NIST researchers have created a novel integrated circuit "comparator" that samples electrical signals faster and with less error than existing devices. Potential uses for the circuit include measuring performance of video display integrated circuits, where output voltage must change and settle rapidly to assure a crisp image. The NIST device eliminates thermal effects that can cause errors and affect voltage settling time. More than twice as fast as most other available comparators, it makes decisions with 0.1 percent accuracy within 2 ns following an abrupt input change. Unlike other comparators, the NIST device is intended for use only in a "strobed" or sampling mode (in which an unknown signal and a reference signal are compared on command). The circuit's inventors have applied to patent the device. For more

information, contact Michael Souders, B162 Metrology Building, NIST, Gaithersburg, MD 20899, 301/975-2406.

#### ALASKA MARINE MAMMAL POLLUTION DATA AVAILABLE

Tissue samples from seals and whales in Alaska contain varying levels of pesticides, PCBs and trace elements, according to a new report by scientists from NIST and the National Oceanic and Atmospheric Administration (NOAA). The document presents baseline data from analyses of selected tissue samples in the Alaska Marine Mammal Tissue Archival Project (AMMTAP). The publication also describes the current inventory of tissue samples in the AMMTAP and methods used to analyze the samples. Since 1987, NIST and NOAA scientists have collected marine mammal tissue samples on subsistence hunts with Native Alaskans. The samples are stored at NIST's National Biomonitoring Specimen Bank in Gaithersburg, MD. The publication, AMMTAP: Sample Inventory and Results of Selected Samples for Organic and Trace Elements (NISTIR 4731), is available from the National Technical Information Service, Springfield, VA 22161 for \$26 prepaid. Order by PB 92-143718.

#### SUPERCONDUCTOR ABSTRACTS COMPILED IN SINGLE VOLUME

The abstracts of 243 papers published by NIST authors in the field of high critical temperature superconductors have been collected and reprinted in *High-Temperature Superconductivity: Abstracts of NIST Publications, 1987–1991* (NIST SP 826). These papers—which appear in proceedings of meetings, scientific and technical journals, and as NIST publications—represent work from nine of the institute's divisions. Many are the result of collaborations with researchers in industry, academia, and other government agencies. Abstracts are grouped in the following categories: compositional analysis; critical current and critical temperature; crystal structure; elastic constants and phonon spectra; electrical contacts; electronic structure; energy gap and tunneling spectra; Josephson effect and devices; magnetic measurements; phase equilibrium; processing—bulk material; and processing—thin films. SP 826 is available from the National Technical Information Service, Springfield, VA 22161, for \$19 (paper) or \$9 (microfiche) prepaid. Order by PB 92-126564/AS.

**REPORT DETAILS RISKS, HANDLING CARE FOR 3480 TAPE**

Since the mid-1980s, data centers have used 3480-type magnetic tape to archive information. Some users have saved critical data on literally thousands of 3480 cartridges. But what kind of shelf life can users expect from these magnetic media? Are 3480 tapes a dependable way to save crucial material? NIST researchers recently examined these issues and published their results in a new report, *The 3480 Type Tape Cartridge: Potential Data Storage Risks, and Care and Handling Procedures to Minimize Risks* (NIST SP 500-199). Under sponsorship of the National Oceanic and Atmospheric Administration, NIST appraised potential risks in using 3480 materials, studying factors such as chemical, mechanical, and magnetic failure mechanisms. The report summarizes reasonable procedures for the care and handling of the tapes to minimize risk. Also included are recommendations from applicable scientific literature and opinions from other tape experts. Available for \$3.50 prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325. Cite stock number SN 003-003-03127-5.

**NIST ISSUES "HOW-TO" MANUAL ON SMOKE CONTROL**

Smoke is the killer in most fires. Flowing silently through corridors, elevator shafts, and stairwells, it can be deadly even to those far removed from the fire. For example, most of the 85 people who died in the 1980 fire in the Las Vegas MGM Grand Hotel were far above the first floor where the fire started and was contained. Researchers at NIST have worked with private industry for several years to find ways to prevent such tragedies. The result is a new "how-to" manual for designing systems to control or contain smoke. The systems described in the manual use pressurization produced by mechanical fans. Such techniques have been used for at least 50 years to control the flow of airborne products such as dangerous gases or bacteria. However, only recently have they been considered for controlling smoke. The project was funded by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. Technical assistance came from the National Research Council of Canada and numerous industry experts. The *Design Manual for Smoke Control Systems* (NISTIR 4551) is available from the National Technical Information Service, Springfield, VA 22161 for \$43 prepaid. Order by PB 92-144104.

**BETTER SOLUTIONS FOR WAVE EQUATIONS OFFERED**

NIST has published a tutorial monograph that features an improved method for deriving solutions to one of the basic equations of mathematical physics, the wave equation. *Modified Airy Function and WKB Solutions to the Wave Equation* (Monograph 176), defines the Modified Airy Function (MAF) method. The MAF method is more useful than the WKB method developed in the 1920s and long used for approximate solutions to problems in quantum mechanics and optical waveguides with a non-uniform refractive index. The monograph discusses and compares the WKB and MAF methods, drawing examples from the optical waveguide community. It also deals with eigenvalue and initial value problems. Single copies of Monograph 176 are available at no charge from R.L. Gallawa, Div. 814.02, NIST, Boulder, CO 80303, 303/497-3761. Multiple copies may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402-9325, for \$5.50 each. Order by stock no. 003-003-03123-2.

**NEW MICROSCOPE OFFERS UNPRECEDENTED RANGE**

Imagine a camera that can image individual flowers in a Philadelphia tulip bed and then expand to successively larger frames until the 170 km expanse between Philadelphia and Baltimore is in view. By analogy, a novel scanning tunneling microscope (STM) designed by NIST researchers accommodates a comparable range for material surfaces. Sixty times better than the span of ranges achieved with standard STMs, the 600 000 times difference in the field permits greater viewing flexibility. One can attain a resolution of 1 nm—fine enough to scrutinize a cluster of molecules—or enlarge the field to survey a square area measuring 600  $\mu\text{m}$  on a side. Researchers at NIST report the magnification range and zooming capabilities of their long-range STM rival that of a scanning electron microscope (SEM). Also, high-magnification viewing does not require placing samples in a vacuum chamber like an SEM. For more information, contact Theodore Vorburger, A117 Metrology Building, NIST, Gaithersburg, MD 20899, 301/975-3493.

**NEW TEST IMPROVES UNDERSTANDING OF SMOKE DANGER**

NIST researchers have developed the first comprehensive method for determining the toxic potency of smoke from burning materials. The technique provides a more realistic way of analyzing the potential hazard to humans of a burning product, such as a chair or wall covering. As manufacturers, code officials, and others gain experience and confidence with this method, say NIST researchers, the toxic potency of some products, such as those with similar chemical makeups, could be assessed without testing. This could speed the development of new products without adding risk to the consumer and will reduce the need for animal testing. The test includes a unique small-scale instrument for gathering accurate smoke toxicity data in conjunction with a method of predicting smoke toxicity that is faster and less costly than current toxicity tests. NIST is working with standards groups to have the NIST method accepted both in the United States and abroad as a standard smoke toxicity measurement. A report, Toxic Potency Measurement for Fire Hazard Analysis (NIST Special Publication 827), is available from the National Technical Information Service, Springfield, VA 22161 for \$26 prepaid. Order by PB 92-137546.

**NEW DETECTOR FOR GAS CHROMATOGRAPHY PATENTED**

A NIST researcher has been granted a patent (U.S. Patent No. 5,070,024) for a hydrocarbon detector designed for use during gas chromatography in harsh industrial process environments. The research was sponsored by, and the patent assigned to, the Gas Research Institute, Chicago. The device indicates the presence and quantity of hydrocarbons in the exit stream of a gas chromatography column by sensing catalytic cracking of the hydrocarbons. It is much simpler in construction and operation than commonly available commercial detectors. By recording the temperature difference between gas flowing past a catalyst-coated thermopile (a linked group of thermocouples) and a similar uncoated thermopile, the device can determine the proportions of chemical components, identify unknowns, and distinguish between straight chain and branched hydrocarbons. The new device uses simple voltage-measuring instrumentation and is estimated to cost about one-tenth as much to fabricate as existing detectors. The detection cavity is very small, so minute amounts of hydrocarbons can be detected. For licensing information, contact Jeffrey Savidge,

Gas Research Institute, 8600 W. Bryn Mawr Ave., Chicago, IL 60631, 312/399-8100. For technical information, contact Thomas Bruno, Div. 838.02, NIST, Boulder, CO 80303-3328, 303/497-5158.

**GUIDE MAKES SRMs USEFUL TOOLS IN CHEMISTRY LABS**

NIST chemists describe how analytical laboratories can assess the accuracy of their chemical analyses in a new publication describing the use of Standard Reference Materials (SRMs). The publication, Use of NIST Standard Reference Materials for Decisions on Performance of Analytical Chemical Methods and Laboratories (NIST Special Publication 829), guides laboratory managers on the most effective ways to use SRMs. SRMs serve as quality control standard samples for laboratories analyzing organic and inorganic compounds in a wide variety of materials. The NIST publication gives quality control managers specific guidelines for using SRMs to design measurement methods and interpret the accuracy of data. Copies are available from the Chemical Science and Technology Laboratory, A317 Chemistry Building, NIST, Gaithersburg, MD 20899, 301/975-3146.

**CARB SOLVES SECOND SUGAR TRANSPORT PROTEIN**

Researchers at the Center for Advanced Research in Biotechnology (CARB) have defined the three-dimensional structure of a second bacterial sugar-transport protein. The protein, known as histidine-containing phosphocarrier protein HPr, is essential for transporting energy from the environment into bacterial cells. The same CARB team solved the structure of a related bacterial sugar-transport protein last fall. Both proteins are involved in the same chain reaction that brings glucose molecules into bacterial cells. With protein structures such as these in hand, pharmaceutical companies may soon be designing drugs that prevent sugar transport and, in turn, starve infectious bacteria by cutting off their energy supply. Researchers from NIST, the University of Maryland, and the University of California at San Diego collaborated on the protein studies at CARB. A paper describing the new structure appears in the March 15, 1992, issue of Proceedings of the National Academy of Sciences. CARB was established in 1984 by NIST, the University of Maryland, and Montgomery County, MD, as a unique center for government, academic, and industry scientists.

### PAPERS REQUESTED FOR FALL OPTICS SYMPOSIUM

NIST, in cooperation with the Institute of Electrical and Electronics Engineers (IEEE) Lasers and Electro-Optics Society and the Optical Society of America, will sponsor the 7th Biennial Symposium on Optical Fiber Measurements on Sept. 15-17, 1992, in Boulder, CO. Symposium sessions will cover measurements for things such as telecommunications fibers, fiber lasers and amplifiers, fibers for sensors, couplers, connectors, multiplexers, integrated optics, sources, detectors, modulators, switches, long-haul systems, LANs, subscriber loops, field and laboratory instrumentation, and standards. Experimental and analytical papers currently are being solicited on all aspects of the measurement of guided-lightwave technology. Summaries of proposed papers must be submitted by May 29, 1992, to Gordon W. Day, Program Chairman, Symposium on Optical Fiber Measurements, NIST, Div. 814.02, Boulder, CO 80303-3328. For more information on the symposium, contact the general chairman, Douglas L. Franzen, at the same address, or call 303/497-3346.

### CONFORMITY ASSESSMENT PROGRAM PROPOSED

NIST is seeking public comments on a proposal to establish a voluntary conformity assessment systems evaluation (CASE) program. CASE will enable the Department of Commerce, acting through NIST, to assure foreign entities that U.S. conformity assessment activities related to laboratory testing, product certification, and quality systems registration satisfy international guidelines. NIST proposes to prescribe criteria and a system to evaluate and, when requested or directed, recognize specified conformity assessment activities. Program operation will be fully fee supported. Deadline for remarks is May 26, 1992. Comments or requests for information should be sent to Stanley I. Warshaw, Director, Office of Standard Services, A603 Administration Building, NIST, Gaithersburg, MD 20899, 301/975-4000, fax: 301/963-2371.

### NEW ATLAS IMPROVES INFRARED SPECTROMETRY CALIBRATIONS

NIST recently published the most accurate atlas to date for the calibration of infrared spectrometers. Several hundred spectral maps and tables (with data based on frequency rather than wavelength techniques for absolute references) are presented for various calibration molecules. The text portion

of the atlas contains a description of heterodyne frequency measurement techniques, details of the analysis, and calculation procedures. Intensities and lineshape parameters also are included. To order multiple copies of Wavenumber Calibration Tables from Heterodyne Frequency Measurements (NIST Special Publication 821), contact the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Order by number 003-003-03136-4 for \$31 prepaid.

### COMMENTS SOUGHT FOR LANGUAGE C TEST METHOD

NIST is soliciting the views of industrial, public, and federal computer users about its choice of a method for testing C compilers for conformance to Federal Information Processing Standard (FIPS) 160. This FIPS, which adopts ANSI Standard X3.159-1989 Programming Language C, applies to C compilers acquired for federal use after Sept. 30, 1991. NIST has chosen the Perennial ANSI C Validation Suite as its test method and needs feedback to assess the method's suitability for appraising FIPS compliance. NIST also is using a trial validation service to verify the accuracy and completeness of its C validation procedures. The C standard is designed to permit portability of C applications across a variety of hardware configurations. NIST's test method and the results from its validation service will be especially helpful to federal agencies that require FIPS 160 conformance. Written comments on the NIST method should be sent to the Computer Systems Laboratory, Attn: C Test Service, A266, Technology Building, NIST, Gaithersburg, MD 20899.

### REPORT EXAMINES "BRIDGING" SGML/ODA STANDARDS

Standard Generalized Markup Language (SGML) and Office Document Architecture (ODA) are the two most prominent international standards for markup and interchange of electronic documents. However, the two are incompatible. Documents encoded in SGML cannot be used directly in an ODA-based system, and vice versa. Users of one standard must learn the other before importing or exporting material encoded in the other standard. In a new report, NIST researchers explore creation of a "bridge" between the two standards. The report evaluates Office Document Language (ODL), an SGML application specifically designed for ODA documents. Also described is a translation program that converts SGML documents to ODA and back. The report concedes that both

standards have loyal users and will likely be around for some time, so it suggests ways to minimize costly duplication efforts and allow users of each standard to take advantage of features offered by the other. On the Interchangeability of SGML and ODA (NISTIR 4681) is available for \$17 (print) or \$9 (microfiche) prepaid from the National Technical Information Service, Springfield, VA 22161. Order by number PB 92-149830/AS.

#### **SUMMER TECHNOLOGY OUTREACH CONFERENCES SCHEDULED**

An updated schedule has been announced for the eight remaining National Technology Initiative (NTI) meetings. The new schedule includes a date, July 9, for the 10th meeting in Gaithersburg, MD, and plans for an 11th meeting on July 22 in Princeton, NJ. Co-sponsored by the Departments of Commerce, Energy, and Transportation, and NASA, NTI is designed to promote industry/government collaborations and commercialization of federal R&D technologies. Meetings cover two topics of regional interest (listed below) and include core sections on manufacturing partnerships, financing, and cooperative research and development relationships. The remaining schedule for NTI meetings is: May 14, Seattle, WA (transportation, environment); May 28, Pasadena, CA (aerospace, biotechnology); June 11, Denver, CO (natural resources, communications); June 25, Kansas City, MO (agricultural technology, advanced manufacturing); July 9, Gaithersburg, MD (life sciences, systems integration); and July 22, Princeton, NJ (transportation, electronics).

#### **NIST LABORATORY METROLOGY SEMINAR HELD AT THE UNIVERSITY OF PUERTO RICO (UPR), MAYAGUEZ**

The NIST Office of Weights and Measures (OWM) sponsored a laboratory metrology seminar at UPR in Mayaguez Feb. 10-14, in cooperation with the Puerto Rican Weights and Measures Division, Department of Consumer Affairs. The seminar was coordinated through the Center for Cooperation in Education and Research in Engineering and Applied Science (Co-Hemis), also representing national agencies in charge of technological research in Argentina, Canada, Costa Rica, Cuba, Chile, Guatemala, Mexico, Peru, Dominican Republic, Trinidad-Tobago, Uruguay, and Venezuela.

The seminar was taught in English by a member of NIST OWM and in Spanish by a representative of the P.R. Department of Consumer Affairs. They covered basic measurement concepts and procedures in mass, volume, statistics, and measurement control programs as part of laboratory quality assurance. Most of the participants represented legal metrology or legal weights and measures jurisdictions (U.S. Virgin Islands, St. Lucia Bureau of Standards, Direccion General de Normas of Mexico, Jamaica Bureau of Standards, Grenada Bureau of Standards, and Barbados National Standards Institution); private industry also was represented (National Standards of Puerto Rico, Inc., and Advanced Instruments, also of Puerto Rico). Participants were excited about this opportunity for training; plans are being made for inter-laboratory measurements in mass calibration during the next year. Another meeting is being planned for February 1993, with the objective of creating an ongoing Regional Measurement Assurance Program Group.

#### **SPHERICAL-WAVE EXPANSIONS OF PISTON-RADIATOR FIELDS, ALGORITHM DERIVED**

Researchers from NIST and the Air Force have derived simple spherical-wave expansions of the continuous-wave fields of a circular piston radiator in a rigid baffle and presented their derivation in a paper recently published in the Journal of the Acoustical Society of America. The team also has produced an accurate and efficient algorithm for numerical computation of the near field, based upon the spherical-wave expansions. This work represents a key step toward the solution of an important electromagnetic field problem and, at the same time, constitutes a significant contribution to the science of acoustics. The motivation for the research was the need for a model electromagnetic field radiator that is both totally understood and physically realizable, for use in validating methods for measuring radiated fields. Through their calculations, the researchers have shed new light on the long-standing problem of determining the near field of a piston radiator transducer. This is the (scalar) acoustic analog of the (vector) electromagnetic field problem of analytically determining the radiated field of a uniformly excited circular aperture. The entire field, both near field and far field of the piston radiator is, therefore, completely characterized. The work provides the scientific community with

the first exact spherical wave expansion that makes possible a complete understanding of the near-field structure of the piston radiator from a theoretical point of view. The expansions are of considerable interest since there are relatively few non-trivial problems for which a complete development in spherical-wave modes can be given.

#### **NIST TO APPLY PROBE POSITION-ERROR CORRECTION IN NEW NEAR-FIELD SPHERICAL SCANNING RANGE**

NIST scientists have developed methods for correcting for positional errors of the probes used in near-field spherical scanning. These methods are both theoretical and computational in nature and will be used in the measurements to be made in the NIST near-field spherical scanning range now under development and have general applicability to other spherical ranges. In near-field scanning, amplitude and phase measurements are made close to (i.e., in the near field) the antenna being measured, and the resulting data are mathematically transformed into plots of the antenna's far field. In the NIST spherical range, position errors, defined as differences between the actual positions of the probe and mathematically defined regular grid points lying on the surface of a true sphere (or spherical segment), will be measured accurately by means of angle encoders and a state-of-the-art laser positioning system. Position errors in any of the three spherical coordinates introduce phase errors in the near-field data, leading to significant errors in the calculated far field. The removal of position errors from the near-field data therefore improves the accuracy of the determination of the far field. This process becomes increasingly important and necessary at higher frequencies, where position errors are a significant fraction of the wavelength.

#### **NIST SCIENTIST REPORTS FINDINGS OF NASA'S AIRBORNE ARCTIC STRATOSPHERIC EXPEDITION II**

A NIST scientist reported the preliminary findings of the NASA Airborne Arctic Stratospheric Expedition II. He is the acting manager of the NASA Upper Atmosphere Research Program and served as program manager/scientist for the airborne expedition.

The expedition took place between October and January and involved sampling the upper atmosphere from aircraft flying out of Fairbanks, Alaska, and Bangor, Maine. The expedition team sought information about the causes of widespread stratospheric ozone decreases over mid-latitudes in the first part of the calendar year and about the effects of volcanic debris on the chemical processes which govern stratospheric ozone depletion.

The researchers found elevated levels of reactive intermediates known to be responsible for ozone destruction over a wide area ranging from eastern Canada to the southernmost latitudes examined in the study, the central Caribbean. Evidence was obtained that reactions on aerosol surfaces reduce the concentration of reactive forms of nitrogen oxides, which act as a brake on ozone destruction by ClO and BrO. Volcanic debris from the eruption of Mt. Pinatubo was shown to facilitate the rate of ozone loss, leading to a conclusion that the volcanic eruption may lead to enhanced ozone layer reduction for several years.

#### **FLUID EQUILIBRATION IN LOW GRAVITY**

Two NIST scientists participated in an experiment flown on the space shuttle Discovery Jan. 22-30. Direct and interferometric images were used to record the equilibration of a small sample of fluid sulfur hexafluoride (SF<sub>6</sub>) following changes in the temperature. Since the density and temperature of this fluid are near the critical point, this process, which ordinarily takes place in seconds, can take as long as 1 hour. It is known that on Earth, gravity greatly affects the final density distribution; however, the influence of gravity on the way the fluid achieves this equilibrium is unclear. Once the data from the microgravity experiment are analyzed, the results should provide a better theoretical understanding of this process and guide the design of future low-gravity critical point experiments.

The experiment team was headed by a NASA scientist and included participants from the University of Maryland and the Technical University in Munich. This team was one of three using the Critical Point Facility developed through the European Space Agency's microgravity program. Participation in the mission, named International Microgravity Laboratory-One, included researchers from 14 countries.

### **NIST RADIO BROADCASTS TO SUPPORT INSPIRE PROGRAM FOR HIGH SCHOOL SCIENCE STUDENTS**

NIST time and frequency broadcast station WWV will provide short broadcasts of scheduling information to high school science students participating in the Interactive NASA Space Physics Ionosphere Radio Experiment (INSPIRE). This unique program will involve radio reception of signals produced by a beam of accelerated electrons modulated at various audio frequencies. The beam of electrons will be guided by the Earth's magnetic field producing a large virtual antenna. The experiment requires reception of the signals on Earth with a geographically diverse network of receivers. This network will be provided by INSPIRE, which is a group made up of physicists, amateur radio enthusiasts, scientific experimenters, and teachers. One objective is to involve a large number of high school students in the program.

Equipment for the satellite-signal broadcasts was carried on the space shuttle in March in the first of 10 ATLAS (ATmospheric Laboratory for Applications and Science) missions. Taped observations made by the INSPIRE network will be gathered to determine the footprint of the arriving signals, providing information on the propagation of signals through the ionosphere and magnetosphere. Since the schedule of broadcasts from space was subject to changes, a means for communicating these changes to the observers was needed. With its broad geographic coverage, the NIST shortwave broadcasts can meet this need. Furthermore, automated methods for recording messages for broadcast are already in place providing special announcements (e.g., marine storm warnings) for other agencies.

### **IONOSPHERIC RECEIVER TECHNOLOGY TRANSFERRED TO INDUSTRY**

NIST scientists have successfully transferred the technology for a codeless GPS ionospheric receiver to a local Colorado company that deals in atmospheric measurement technology. The general idea of a codeless GPS receiver had been conceived by several organizations including the Jet Propulsion Laboratory, but no implementation to date has been as simple and versatile as the NIST receiver.

NIST developed the receiver in order to provide for continuous measurement of the ionospheric delay involved in time transfer using the common-view method (also developed by NIST). The receiver picks up signals from two different

frequencies broadcast by the GPS satellites and, from the phase difference of the signals, determines the ionospheric delay and thus the free electron content along the path to the satellite. The receiver stores a catalogue of all GPS satellites and identifies each from its Doppler signature. It can track approximately 10 satellites, simultaneously providing ionospheric measurements for each.

While the market for receivers that measure the ionospheric time-delay is significant, the systems can potentially be used for improving the accuracy of geophysical GPS surveying and for studies of the ionosphere. In fact, this latter application is important, because the current measurement method for studying the ionosphere involves expensive and cumbersome use of reflected radar signals which then only provide a measure of the vertical ionospheric component.

### **OBSERVATION OF "QUANTUM PROJECTION" NOISE**

NIST scientists have completed and published theoretical and experimental work describing a previously unrecognized noise source they have called "quantum projection" noise.

In spectroscopy, "technical noise," such as laser amplitude fluctuations caused by an unstable power supply, often dominates the noise. These sources of noise can be eliminated by careful engineering. Two examples of more fundamental noise sources are the detection shot noise in a laser absorption spectroscopy experiment and the fluctuations in signal caused by the fluctuations in the number of atoms in an atomic beam experiment. These sources of noise also can be eliminated or significantly reduced. For example, laser shot noise can, in principle, be reduced by use of squeezed light. In a stored-ion experiment, the number of ions can be held constant, thereby reducing the atomic number fluctuations to zero. Also, when absorption is detected using electron shelving, the detection noise approaches zero since 100 percent detection efficiency is possible. Because of this immunity from some sources of noise, the NIST scientists have been able to observe this "quantum projection" noise in a clear manner. Basically, this source of noise is caused by the statistical fluctuations in the number of atomic absorbers (ions in this case) that are observed to make the transition in an absorption spectroscopy experiment.

#### **APPARATUS FOR MEASURING THERMAL CONDUCTIVITY AT LOW TEMPERATURES**

A guarded-hot-plate apparatus has been developed to measure the thermal conductivity of insulating materials in the temperature range 10 to 400 K. NIST is using the new apparatus to perform measurements for a private company on foam insulations with environmentally acceptable fill gases. The specimen environment may be vacuum or non-condensing gas and the mechanical load on the specimen may be varied from 222 N to 8896 N during a test. Specimen diameter is 30.5 cm and thickness up to 5 cm can be accommodated. Initial test results suggest an uncertainty of 2 percent for polymeric foam insulations. The apparatus was designed to optimize operation at low temperatures, e.g., a variable heat switch is used to provide refrigeration from a static cryogenic bath. Data acquisition and temperature control are completely automated so that extensive data sets can be generated with minimal operator interaction.

#### **PROPOSED CONSORTIUM ON CASTING OF AEROSPACE ALLOYS**

NIST scientists recently met with industrial representatives to initiate the planning for a NIST-administered consortium on casting of aerospace alloys. The meeting, which was sponsored by the Aerospace Industries Association, the National Center for Advanced Technologies, and the NIST Office of Intelligent Processing of Materials, took place on Jan. 16 at the Aerospace Industries Association in Washington, DC. There were 31 attendees from a wide variety of aerospace companies and universities. There were also representatives from NSF, DARPA, and the Bureau of Mines.

A consensus was reached at the meeting that a consortium should be formed to carry out precompetitive generic research to improve the processing of aerospace metal alloys by casting. Further planning by the potential consortium members is currently under way in the areas of process modeling, process sensing, and thermophysical properties data. A tentative consortium initiation date of July 1 has been set.

#### **ELECTRODEPOSITION OF COMPOSITIONALLY MODULATED ALLOYS**

Nanostructural alloys are a new class of materials whose unusual properties are a result of the large volume fraction of atoms either in, or close to, an interface within the structure. These materials may be both compositionally and structurally modulated

and include both metals and ceramics. Studies at NIST show that it is possible to produce compositionally modulated alloys with layers as thin as two monolayers using electrochemical techniques. The virtually atomic-scale control of composition allows the production of alloys with tailored (or designed) magnetic, optical, and mechanical properties. It has been demonstrated that microlayered alloys produced electrochemically exhibit a much higher degree of perfection than comparably produced sputtered alloys and that large-scale structures can be electroformed with near atomic control over properties. Microlayered alloys have clear applications to electrical contacts, magnetic recording, and semiconductor devices.

#### **TECHNOLOGY OF GLASS-CERAMIC INSERTS TRANSFERRED TO DENTAL MATERIALS INDUSTRY**

Glass-ceramic inserts for composite dental restorations, a technology invented by an American Dental Association research associate, were recently introduced to the dental materials marketplace. Appropriate premolded sizes and shapes of tooth-colored beta-quartz solid-solution glass-ceramic are inserted into dental composite fillings prior to polymerization. The inserts decrease polymerization shrinkage, increase the modulus of elasticity, and may improve the dimensional stability of occlusal and interproximal restorations. Insert kits were introduced in fall 1991 to the United States and world markets.

The inventor is director of the Paffenbarger Research Center in the dental and medical materials group at NIST. NIST scientists advised the inventor and his research team and provided glass melts.

#### **PREDICTING PERFORMANCE OF ADHESIVE BONDS**

A new study at NIST shows that the fracture energy of adhesive bonds loaded in shear can be predicted from a knowledge of the stress-strain behavior of the adhesive. This is an important result because the inability to predict failure in adhesive joints is a major factor limiting their use, particularly in structural applications where adhesives offer the significant advantages of lower weight and design flexibility. The recent work successfully treats the critical role played by the bond thickness. Restricting the adhesive to thin layers significantly changes its mechanical properties, which are important in the fracture of bonded joints. The study used video microscopy to record

the details of the deformation behavior in the crack-tip region during fracture and compared these data with results from stress-strain experiments conducted on the same adhesive confined to a thin layer with a thickness equal to that in the adhesive bond. The strain to failure in thin-layer specimens was found to be much greater than that obtained from experiments on bulk samples because of the inability for flaws to develop in very thin layers. The area under the stress-strain curve of a thin layer adhesive was found to correlate very well with the adhesive fracture energy. This new understanding will help improve the design of new adhesive systems and increase the ability to predict the lifetimes of bonded structures.

#### **NIST STUDY OF STAGING AREAS FOR PERSONS WITH MOBILITY LIMITATIONS**

NIST has completed a project for the General Services Administration (GSA) to evaluate the concept of a staging area as a means of fire protection for persons with disabilities. GSA has modified six buildings as test installations with staging areas. Staging areas are intended as spaces in which people with disabilities can safely wait during a fire. Spaces that were turned into staging areas included passenger elevator lobbies, service elevator lobbies, sections of corridor, and rooms. The NIST project consisted of field tests, human behavior studies, and threat analysis. The threat analysis evaluated tenability in route to staging areas and within staging areas due to transport of smoke from post flashover fires, sprinklered fires, and smoldering fires. The sprinklered fires were based on a model of post-sprinkler heat release recently developed by a NIST scientist.

It was concluded that staging areas can be either a haven of safety or a death trap. The difference is highly dependent on details of design, the type of fire exposure, outside wind and temperature conditions, and the capability and reliability of the smoke control pressurization system. Without pressurization, all staging areas studied are subject to lethal failure. In many cases, the persons most needing the staging area protection may be unable to reach that area before their pathway (corridor or aisle ways) becomes lethal. Further, it was concluded that the operation of a properly designed sprinkler system eliminates the life threat to all occupants regardless of their individual abilities and can provide superior protection for people with disabilities as compared to staging areas.

#### **NIST COLLABORATES WITH THE NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA) ON OPTICAL DISK TECHNOLOGY**

Development of a Testing Methodology To Predict Optical Disk Life Expectancy Values (NIST SP 500-200) reports the results of a cooperative research effort to develop a methodology for determining how long records may be safely stored on optical disk media. Partially sponsored by NARA, NIST researchers set up an optical media measurement laboratory to test and analyze optical disk media characteristics and to produce a testing methodology that can be used to derive life expectancy values for optical disks. A standardized test methodology and standards for measuring media characteristics would assist federal managers in selecting the right media for the storage of permanent records.

#### **NIST PROPOSES FEDERAL INFORMATION PROCESSING STANDARD (FIPS) FOR SECURE HASH STANDARD**

A FIPS for Secure Hash Standard has been proposed which specifies a Secure Hash Algorithm (SHA) for use with the proposed Digital Signature Standard. For applications not requiring a digital signature, the SHA would be required whenever a secure hash algorithm is needed for federal applications.

The hash standard provides a formula for producing a numeric value (called a "message digest") of a message (or more generically, any digital information). The formula is devised so that virtually any change to the message results in a change to the message digest. The message digest can be recalculated at any time and compared to the original. If they are not identical, the information has been changed. This mechanism verifies the integrity of data.

#### **SPATIAL DATA TRANSFER STANDARD IMPLEMENTATION WORKSHOP ATTRACTS LARGE TURNOUT**

NIST, in cooperation with the National Mapping Division, United States Geological Survey, and the Standards Working Group, Federal Geographic Data Committee, held a Spatial Data Transfer Standard (SDTS) Implementation Workshop Feb. 18–21 at NIST. The workshop attracted about 150 participants from government, industry, and academia.

SDTS recently completed the Federal Register comment and review period of the FIPS approval

process. SDTS is the result of major efforts by federal and national organizations during the past 10 years. Specifications are provided for the organization and structure of digital spatial data transfer, definition of spatial features and attributes, and data transfer encoding.

Following in-depth tutorials on SDTS implementation, the workshop featured a demonstration of encoding and decoding test data. Other sessions covered the refinement of the Federal Vector Profile with Topology and an initiation in developing a SDTS Raster Profile. This is the first of a series of workshops designed to educate the vendor community on the implementation of SDTS.

#### **INTERNATIONAL WORKSHOP ON HARMONIZING CONFORMANCE TESTING OF PROGRAMMING LANGUAGE STANDARDS HELD**

NIST recently convened the sixth in a series of international workshops on harmonizing validation procedures for testing implementations for conformance to programming language standards. The Istituto Italiano del Marchio di Qualita hosted the workshop in Milano, Italy; countries represented included the United Kingdom, France, Italy, Japan, Germany, and the United States. The workshop brought together conformance testing experts for the programming languages of COBOL, Pascal, Ada, FORTRAN, MUMPS, C, and the graphical standards of Graphical Kernel System, Computer Graphics Metafile, and Computer Graphics Interface.

The European participants briefed participants on an application that has been made to the European Committee for IT Testing and Certification to register a new agreement group, the Graphics and Languages—Agreement Group for Testing and Certification (GLATC). The GLATC group is using documents produced in previous workshops as the basis for developing the GLATC recognition arrangement. Expanding the format of workshops to include graphic standards validation activities also was considered.

Attendees focused on updating guidelines for vendors to register equivalent hardware and software environments and on developing a procedural model for coordinated maintenance and control of test suites. A proposal was made to register test reports rather than certificates for products found to have areas of non-conformance. Finally, the workshop updated the Areas of Agreement document, which covers test laboratory accreditation, test reports, registration, certification, and mutual recognition.

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## **Calibration Services**

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### **UPDATED CALIBRATION SERVICES USERS GUIDE AVAILABLE**

More than 500 different calibration services, special test services, and measurement assurance programs (MAPs) are listed in the NIST Calibration Services Users Guide 1991 (SP 250). The services referenced are the most accurate calibrations of their type in the United States. These calibrations directly link a customer's precision equipment or in-house transfer standards to national standards. Services are listed in the following seven areas: dimensional; mechanical (including flow, acoustic, and ultrasonic); thermodynamic quantities; optical radiation; ionizing radiation; electromagnetic (including direct current, alternating current, radio frequency, and microwave); and time and frequency measurements. Copies of the guide are available from the Calibration Program, A104 Building 411, NIST, Gaithersburg, MD 20899, 301/975-2002.

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## **Standard Reference Materials**

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### **EASY ACCESS TO MATERIALS STANDARDS OFFERED**

Thanks to a group of new NIST brochures, producers and manufacturers of plastic, rubber, glass, ceramic, and metal products now have rapid access to special listings of Standard Reference Materials (SRMs). The brochures list more than 400 available SRMs with certified chemical and physical properties for calibrating instruments and evaluating measurement systems. These SRMs help industry achieve greater quality assurance of materials and goods by improving measurement accuracy. The group of six brochures lists SRMs for polymers; glass and related materials; ferrous metals; non-ferrous metals; cast iron; and ores, minerals, and refractories. Copies of the brochures (part of a series of 16 on select SRMs), as well as information on more than 1,200 other certified calibration standards on nutrition, clinical health, engineering materials, and environmental standards, are available from the Standard Reference Materials Program, Rm. 204, Building 202, NIST, Gaithersburg, MD 20899, 301/975-6776.

**SRM IMPROVES LEAD POISONING DIAGNOSIS ACCURACY**

Public health officials warn that lead poisoning—from household paints, dust, and water pipes in 57 million American homes—is a serious environmental threat facing U.S. children. The Centers for Disease Control (CDC) responded to this issue in October 1991 by lowering the tolerable threshold for lead in blood to 10  $\mu\text{g}/\text{dL}$  (100 parts in  $10^9$ ), and recommending lead screenings for all 12-month olds. In order to help labs more accurately measure low lead levels (less than 50 parts in  $10^9$ ), NIST has issued a new Standard Reference Material (SRM) for lead in blood. The SRM contains four vials of frozen cow blood, each with a certified lead concentration between 5 and 55  $\mu\text{g}/\text{dL}$ . NIST scientists collaborated with environmental health specialists at the CDC in preparing SRM 955a, available for \$261. To order, contact the Standard Reference Materials Program, Rm. 204, Building 202, NIST, Gaithersburg, MD 20899, 301/975-6776.

**SAMPLE AVAILABLE FOR HUMAN HAIR DRUG ANALYSIS**

Researchers seeking an alternative to urinalysis for identifying drug abusers are looking strongly at using human hair. Studies show that after ingestion, drugs are incorporated into hair and remain detectable for long periods of time. This gives law enforcers a method sensitive enough to reveal drug use from months past instead of just within a few days of the test date. In addition, only a small amount of hair is required and samples can be obtained from the scalp without cosmetic effect. This could help avoid privacy issues often associated with urinalysis. NIST researchers have created a reference material (Reference Material 8449) to help ensure hair test accuracy, making the analysis more reliable and, hopefully, more admissible as legal evidence. The product is a bottled sample of human hair in powdered form that contains known amounts of each of four different drugs: cocaine, morphine, codeine, and benzoylecgonine. Because the drug quantities are fixed, investigators can use the sample to check analytical instruments or ensure measurement compatibility among laboratories. One unit of RM 8449 costs \$276 from the Standard Reference Materials Program, Rm. 205, Building 202, NIST, Gaithersburg, MD 20899, 301/975-6776.

**STANDARD REFERENCE MATERIAL 893 AND 1295—STAINLESS STEEL (SAE 405)**

The Standard Reference Materials Program announces the availability of Stainless Steel (SAE 405) Standard Reference Materials (SRMs) 893 and 1295. SRM 893 is in the form of chips sized between 0.5 and 1.18 mm, and is intended for use in chemical methods of analysis. SRM 1295 is in the form of a disk, approximately 32 mm in diameter, and is intended for use in optical emission and x-ray spectrometric methods of analysis. These SRMs are certified for chromium at 13.5 weight percent and for 10 other elements which occur at concentrations of less than one weight percent.

They were developed and certified under the auspices of the ASTM-NIST Research Associate Program.

**STANDARD REFERENCE MATERIAL 2708—ZINC SULFIDE THIN FILM ON POLYCARBONATE**

The Standard Reference Materials Program announces the availability of a zinc sulfide thin film standard, Standard Reference Material (SRM) 2708. It is intended primarily for use in the standardization of x-ray fluorescence spectrometers for sulfur determinations in applications where measurements are made of particulate matter collected on filter media or on thin films. It consists of a single layer of zinc sulfide, about 0.02  $\mu\text{m}$  thick, deposited on a polycarbonate filter and mounted on an aluminum ring to maintain uniform geometry. Certification for sulfur is based on isotope dilution thermal ionization mass spectrometry; an informational (non-certified) value is provided for zinc.

**STANDARD REFERENCE MATERIAL 2034—HOLMIUM OXIDE SOLUTION WAVELENGTH STANDARD 240 TO 650 nm**

The Standard Reference Materials Program announces the availability of a renewal lot of Standard Reference Material (SRM) 2034. This SRM is a certified transfer standard intended for the verification and calibration of the wavelength scale of ultraviolet and visible absorption spectrometers having nominal bandwidths not exceeding 3 nm. Certification is for wavelength location of minimum transmittance of 14 bands at each of six

bandwidths, in the range 240–650 nm. SRM 2034 is an aqueous solution of four percent (by weight) holmium oxide in 10 percent (V/V) perchloric acid, flame sealed in a non-fluorescent fused-silica cuvette of optical quality. The square cuvette has a nominal 10 mm pathlength and will fit into the sample compartments of most conventional absorption spectrometers.

#### **REFERENCE MATERIALS 8506 AND 8507—MOISTURE IN TRANSFORMER OIL AND IN MINERAL OIL**

The Standard Reference Materials Program announces the availability of Reference Materials (RMs) 8506 and 8507, primarily intended for use in calibration of equipment used to determine water in transformer oils, mineral oils, and/or materials of a similar matrix. RM 8506 is a petroleum electrical insulating oil containing 21 mg/kg water, while RM 8507 is a petroleum lubricating oil containing 47 mg/kg water. Coulometric Karl Fischer measurements from two round-robin analytical programs were used to assign the reference concentration values; chromatographic and Karl Fischer measurements made at NIST were used for confirmation.

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## **Standard Reference Data**

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#### **NEW PC PACKAGE SPEEDS CHEMICAL MICROANALYSIS**

Scientists using electron microscopy to analyze chemical composition can save hours of laboratory work with a new software and database package from NIST and the National Institutes of Health. The system, called the Desktop Spectrum Analyzer and X-Ray Database (DTSA), can simulate experiments and evaluate electron microscopy data. It allows scientists to design effective experiments quickly without using trial and error to find the best experimental conditions. With a special acquisition board installed in the desktop computer, the DTSA also can collect data directly from an electron microscope. The DTSA sells for \$790 through the Standard Reference Data Program at NIST. It is designed for Apple Macintosh II series computers and requires a minimum of 4 megabytes of memory. For more information, contact the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899, 301/975-2208, fax: 301/926-0416.