

# 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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### PRESIDENT HONORS BALDRIGE WINNERS

President George Bush presented five U.S. companies with the Malcolm Baldrige National Quality Award during a ceremony on Dec. 14, 1992, at the Department of Commerce in Washington, DC. The 1992 recipients are: AT&T Network Systems Group/Transmission Systems Business Unit (Morristown, NJ) and Texas Instruments Inc. Defense Systems & Electronics Group (Dallas, TX) in the manufacturing category; AT&T Universal Card Services (Jacksonville, FL) and The Ritz-Carlton Hotel Co. (Atlanta, GA) in the service category; and Granite Rock Co. (Watsonville, CA) in the small business category. The ceremony was held in the Commerce Department's Malcolm Baldrige Great Hall.

### FAA ASKS NIST TO MEASURE HIGH-FLYING EMFS

NIST has received an 18 month contract from the Federal Aviation Administration to determine the best techniques for measuring electromagnetic fields within aircraft. The FAA award was made at the urging of the General Aviation Manufacturers Association. As the aircraft industry adopts more and more electronic control systems, the FAA is interested in knowing the electromagnetic envi-

ronment within the airframe. These fields come from radar pulses beamed toward a plane, entering via windows and other apertures. Electromagnetic susceptibility is now part of the FAA certification process for all new electronic aviation systems and aircraft. NIST will perform theoretical, modeling and field studies for the FAA to determine the best ways to measure radiation properties outside and within an aircraft frame, as well as analyzing the shielding effectiveness of the airframe. Measurements will be made over the frequency range of 400 MHz to 18 GHz. The field study will utilize a general aviation airframe on a turntable at a U.S. Army facility at Fort Huachuca, AZ. For more information, contact Moto Kanda, Div. 818.03, NIST, Boulder, CO 80303-3328, (303) 497-5320

### CERTIFICATION PLAN ASSESSES ANTENNA PERFORMANCE

Companies and agencies planning to construct near-field ranges to measure the performance of phased-array antennas will be interested in a new NIST publication outlining a certification plan that tests such facilities for various parameters. Titled A Certification Plan for a Planar Near-Field Range Used for High-Performance Phased-Array Testing (NISTIR 3991), the document discusses policy issues, measurement requirements, and various test required to characterize errors associated with measurements. Tests include those for alignment accuracy, errors caused by the instrumentation, and errors caused by radio-frequency energy traveling undesired paths. NISTIR 3991 is available from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650 for \$17 (print) or \$9 (microfiche). Order by PB 92-213305.

**MICROWAVE USERS: NEW NOISE STANDARDS AVAILABLE**

Three new thermal noise measurements are being offered by NIST that can benefit manufacturers and users of microwave equipment. The first of these services measures noise standards at discrete frequencies of 12.4, 13.5, 14, 15, 16, 16.5, 17, and 18 GHz using type N and 3.5 mm connectors in coaxial cable. The second service measures noise standards from 18 to 26 GHz in WR42 waveguide, while the third measures noise from 18 to 26 GHz using 3.5 mm connectors in coaxial cable. There are specific requirements for reflection coefficient, temperature, and excess noise ratio. For additional details on these new services, contact J. Wayne Allen, Div. 813.01, NIST, Boulder, CO, 80303-3328, (303) 497-5871.

**NIST/INDUSTRY TO WORK ON SUPERCONDUCTING MATERIALS**

A private company and NIST will cooperate in the development of materials for practical superconducting devices. Under a cooperative research and development agreement, the company will provide samples of high-temperature superconductors for the testing of various magnetic characteristics. NIST will test these materials with the Institute's equipment and computer programs. Tests such as onset temperature for superconductivity, sharpness of the superconducting transition, and flux pinning characteristics revealed through hysteresis loops will be carried out. NIST and the private company will exchange technical expertise concerning testing and results, and will develop new suggestions for processing the material. For information on the 3-year program, contact Lawrence H. Bennett, B152 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5966.

**ISDN DEMO DUBBED A "MILESTONE"**

At a Nov. 17, 1992, demonstration that helped usher in the "information highway" known as the Integrated Services Digital Network, it was stated that the technology "can revolutionize the communications market in the same way the personal computer promoted a new computing [ideal]." This statement was made at NIST as part of the week-long Transcontinental ISDN Project '92. This event, for the first time, bridged over 150 American and foreign sites, inaugurating the network that soon will be available nationwide to businesses, schools and the general public. ISDN allows voice,

data and images to be sent simultaneously in digital form over one telephone line. On display at NIST was a sneak preview showing 20 ISDN applications. Attendees could, for example, talk to someone in England while watching that person on a PC screen and simultaneously exchange data. Another demonstration showed how ISDN users could access medical images such as pathology specimens, x rays and cardiology studies sent from hospitals. Also on view were futuristic tax filing, desktop conferencing, and high-resolution facsimiles.

**ASSESSORS WANTED FOR FASTENER ACCREDITATION**

Mechanical engineers, metallurgist, chemists, physical scientists, and technical experts in industry, universities, and government with experience in evaluating the performance of materials are needed by NIST to conduct on-site assessments of laboratories that perform testing and inspection of metals and fasteners. The assessors are required for a new National Voluntary Laboratory Accreditation Program to meet the requirements of the Fastener Quality Act of 1990. NVLAP will accredit laboratories to test and inspect metals and fasteners using techniques in mechanical and physical testing, chemical analysis, dimensional inspection, metallographic analysis, and non-destructive inspection. Individuals with a background in the testing and inspection of metals and fasteners, and with experience in laboratory management and operations, are invited to send a resume to S. Wayne Stiefel, Fastener Program Manager, NVLAP, Rm. A162, Building 411, NIST, Gaithersburg, MD 20899-0001, (301) 975-4016, fax: (301) 926-2882.

**AWARD TO ADVANCE DIAMOND FILM TECHNOLOGY**

The NIST Advanced Technology Program (ATP) has announced support for a joint research project to develop an efficient, high-volume commercial production technology for diamond films. The award to private companies, could total \$2.4 million over the 3 years of the project. Diamond is the hardest known substance, has the highest thermal conductivity of any known material, is extremely transparent from infrared wavelengths into the far ultraviolet, has high electrical resistivity, is an excellent electrical barrier, is corrosion resistant, has a low coefficient of friction, and even has some useful semiconductor properties. The project's target application is coatings that would substantially extend

the life of solid carbide tooling. The private companies will study the problem of scaling up the promising—but experimental—arc plasma chemical vapor carbide tooling. The private companies will study the problem of scaling up the promising “but experimental” arc plasma chemical vapor deposition process to levels high enough to demonstrate commercial potential. Project managers estimate that a successful scale-up would ultimately cut the cost of thin-film diamond coatings from today’s level of about \$150 per gram to less than \$25 per gram, giving U.S. industry an important lead toward capturing a significant share of the emerging diamond film market.

#### **NVLAP TEST PROGRAM ADDS WOOD-BASED PRODUCTS**

The commercial products program of NIST’s National Voluntary Laboratory Accreditation Program recently added the testing of wood-based products. This was done at the request of the American Plywood Association and with support by the National Particleboard Association and concurrence by the Department of Housing and Urban Development. The commercial products program was established by NIST in 1984 at the request of the International Coalition for Procurement Standards, an association of more than 100 federal, state and local purchasing officials. The program offers buyers a list of laboratories that can test products important to the purchasing community. Currently, the commercial products testing program includes paint, paper, plastics, plumbing, and seals and sealants. For information, contact Lawrence Knab, (301) 975-6712, or Lawrence S. Galwin, (301) 975-4016, fax: (301) 926-2884, NVLAP, A124 Building 411, NIST, Gaithersburg, MD 20899-0001.

#### **FIELD STRENGTH COMPARISON STATUS UPDATED**

In 1991, NIST initiated an international intercomparison of measurements of electric field strengths for the International Bureau of Weights and Measures. The goal: to ensure electromagnetic compatibility among products traded internationally. To accomplish this, NIST supplies each participating country with five electric field sensors to be tested at a minimum of four frequencies. The results are analyzed by NIST. To date, an intercomparison has been completed with two government and several industrial laboratories in Japan. In 1993 and 1994,

NIST plans to perform intercomparisons with the United Kingdom, Germany, France, Italy, Poland, Austria and Korea. Switzerland, Russia and China also are expected to participate at a later date. The entire intercomparison project, which should take another 4 or 5 years to complete, is needed to show traceability among national standards laboratories. This traceability will become important in 1995 when the 12 nation European Economic Community requires imports to meet standards for electromagnetic compatibility. For information, contact Motohisa Kanda, Div. 813.03, NIST, Boulder, CO 80303-3328, (303) 497-5320.

#### **ELEVEN INVENTIONS READY FOR LICENSING**

NIST recently announced that the following 11 government-owned inventions are now available for licensing:

- High- $T_c$  Superconducting Unit Having Low Contact Surface Resistivity and Method of Making (Docket No. 87-028);
- High- $T_c$  Superconducting Unit Having Low Contact Surface Resistivity (Docket Nos. 87-029 and 88-040);
- High- $T_c$  Superconductor Contact Unit Having Low Interface Resistivity (Docket No. 88-041);
- A System for Detecting Transition and Rare Earth Elements in a Matrix (Docket No. 88-038);
- Process for Forming Alloys in situ in Absence of Liquid-Phase Sintering (Docket No. 91-018);
- Intermetallic Thermocouples (Docket No. 92-001);
- Apparatus for Detecting Transition and Rare Earth Elements in a Matrix (Docket No. 92-003);
- Bi-Flow Expansion Device (Docket No. 92-006);
- Method and Apparatus for Detecting Guided Leaky Waves in Acoustic Microscopy (Docket No. 92-030); and
- Liposome Immunoanalysis (Docket No. 92-054).

For technical and licensing information on these inventions, contact Bruce E. Mattson, B256 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3084.

## **TWENTY-ONE GRANTS ANNOUNCED FOR ATP'S THIRD YEAR**

The Department of Commerce announced on Dec. 17 the third set of grants under the Department's Advanced Technology Program. The NIST-administered grants to private industry are designed to stimulate research and development of cutting-edge, generic technologies with significant commercial promise. Twenty-one new programs were selected for funding under the ATP, including proposals in technology areas such as machine tools, biotechnology, electronics, optics, materials engineering, lighting technology, and refrigeration. Two-thirds of the awards are to projects led by small businesses, and three are from newly formed joint ventures. The awards will help finance the multiyear R&D projects with a projected total cost of more than \$94 million, of which some \$48 million will be funded by the ATP.

## **WEIGHTS AND MEASURES HANDBOOKS UPDATED FOR 1993**

Two NIST handbooks have been revised and a supplement to a third one has been issued to reflect changes adopted at the July 1992 Annual Meeting of the National Conference on Weights and Measures. Established in 1905, NCWM is an organization of state, county and city weights and measures enforcement officials and associated federal, business and consumer representatives. NCWM is sponsored by NIST, a non-regulatory agency, and receives technical support through the institute's Office of Weights and Measures.

NIST Handbook 44-1993, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices. A major change in the new edition is the incorporation of the modernized metric system, the International System of Units (known as SI), into most of the codes. In addition, the Scales Code was revised to specify a new minimum load requirement for vehicle scales used to weigh scrap material for recycling and to include a definition, specifications and test notes for vehicle on-board weighing systems. The liquid-measuring devices codes now include a separate tolerance for electronic temperature-compensating systems. Repeatability tolerances have been added to several different codes for liquid meters. Additionally, effective Jan. 1, 1994, liquefied petroleum gas meters must be equipped with ticket printers and a copy of the delivery ticket must be left with the customer following bulk deliveries of LP gas through vehicle-mounted meters.

Handbook 130-1993, Uniform Laws and Regulations. A labeling exception for decorative wallcovering borders has been added to the Uniform Packaging and Labeling Regulation. Requirements for standard sizes of bread loaves were deleted from the Uniform Method of Sale of Commodities Regulation; however, bread is still required to be sold by mass. Another change to the UMSCR was the addition of a new section on Home Food Service Plan Sales. This section establishes contract and disclosure requirements for home food service plans and provides guidelines for advertising. Method of sale requirements for baler twine and potpourri were also added to the uniform regulation.

Supplement 3, 1993, to Handbook 133-Third Edition, 1988, Checking the Net Contents of Packaged Goods, now includes moisture loss requirements for dry pet foods. In addition, the supplement contains test procedures and a worksheet for use in checking the net contents of packages of baler twine.

Copies of the handbooks are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Order NIST Handbook 44-1993 by stock No. 003-003-03185-2, \$14 prepaid; NIST Handbook 130-1993 by stock No. 003-003-03184-4, \$13 prepaid; and Supplement 3, 1993, to NIST Handbook 133-Third Edition, 1988, by stock no. 003-003-03183-6, \$2.75 prepaid. For information on NIST Handbook 133-Third Edition, 1988, and supplements 1 and 2, contact the Office of Weights and Measures, A617 Administration Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4004.

## **FUTURISTIC WAVEGUIDES DETECT CHEMICALS WITH LIGHT**

Researchers at NIST and a private company are combining cutting-edge technologies from physics and biology to create new biosensors based on optical computer technology. Their aim is to develop highly sensitive and specific biosensors for measuring chemicals in medical and environmental samples. Called optical waveguides, these futuristic devices direct a laser beam through a film on the surface of a silicon or glass chip of 4  $\mu\text{m}$  thickness. The wave-guide is coated with an antibody, a protein that binds only to specific chemicals. When a sample containing one of these chemicals is placed in contact with the waveguide, the molecules interact, and some of the light passing through the wave-guide is altered. Interference of this light with

an unaltered reference beam can measure drugs, chemicals such as hormones, or viruses in the sample. NIST and the private company recently signed a cooperative research and development agreement for this work.

#### **EXPORT WORKSHOP ANNOUNCED ON ADVANCED MATERIALS**

Exploring the international marketplace will be the focus of an industry workshop, "Advanced Materials—The International Trade Dimension," on May 10, 1993, at NIST in Gaithersburg, MD. Co-sponsored by NIST, the Federation of Materials Societies, and the Department of Commerce's International Trade Administration, the workshop will focus on how DoC can help U.S. firms to become more competitive overseas. The program is designed for large, medium-sized, and small producers and suppliers of advanced ceramics, polymers, composites, and metal materials. Topics will include U.S. policy on the advanced materials industry, export controls, financing, and DoC services to industry. The day after the meeting, participants will have an opportunity to visit research facilities at NIST and have meetings with officials at the Small Business Administration, the Export-Import Bank and others at the Commerce Department. For information, contact Daniel B. Butrymowicz, B309 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5656, fax: (301) 926-8349.

#### **U.S. JOINS JAPAN'S REAL WORLD COMPUTING PROGRAM**

The White House Office of Science and Technology Policy has announced that the U.S. and Japanese governments have agreed "to undertake a joint prototyping project to further the design and development of advanced computing technologies that combine lightwave and electronic components." Part of Japan's Real World Computing program "a 10 year, \$500 million initiative to develop next-generation information processing technologies" the new optoelectronics project will involve researchers and processing facilities in both nations. The hybrid systems to be worked on would serve as a bridge between today's electronic computers and the fully optical, parallel-processing machines that are envisioned for the future. A 10-member joint management committee, composed of five representatives from each nation, will guide the project. A NIST scientist chairs the U.S.

portion of the committee. For more information, contact OSTP, Old Executive Office Building, Rm. 428, Washington, D.C. 20500, (202) 456-7710.

#### **ILAC 92 MEETING**

During Oct. 12-16, 1992 over 150 attendees from 33 countries, including 21 from the United States, participated in ILAC 92, the 15th meeting of the International Laboratory Accreditation Conference (ILAC). This biennial conference provides an opportunity for those interested in their national programs to share information and experience with one another. Topics receiving attention were uncertainty estimates in test reports, traceability of measurements, reference materials, proficiency testing, surveillance and monitoring activities, assessor qualifications, and some issues concerning the use of ISO/IEC Guide 25 on requirements for the acceptance of calibration and testing laboratories. ILAC will produce a guidance document on the relationship between Guide 25 and the ISO 9000 Quality Standards Series, and a second guidance document for interpretive guides to be used in conjunction with the application of Guide 25 to specific areas of testing. The first of these documents is needed to eliminate user confusion over whether a laboratory should be accredited or 9000-registered; the latter will deal with the anticipated proliferation of documents in specialized fields of application, e.g., information technology. A detailed report on the meeting is available.

#### **NASA PRAISES NIST WORK SUPPORTING ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE**

The Flight Segment Office of the National Aeronautics and Space Administration's Lewis Research Center has acknowledged the "outstanding contribution" made by NIST scientists in support of the Advanced Communications Technology Satellite (ACTS), scheduled to be launched next June. The scientists investigated possible sources of error arising from measurements of the ACTS multibeam antenna (MBA), a pair of offset Cassegrain antennas with 50 transmit and 50 receive beams. The MBA was measured on a newly constructed antenna near-field spherical-scanning range by a NASA contractor. In addition to work at NIST, both researchers took part in numerous meetings with the contractor and NASA Lewis. The scientists are credited with identifying a subtle error in the contractor's version of the program for trans-

forming measured near-field data to computed far-field performance (broadly based on NIST original principles and NIST developments for near-field scanning). They also provided suggestions for improving the measurement techniques. The result was “good agreement between predicted and measured antenna performance and . . . antenna measurements in which we have confidence.” The MBA measurement program now has been completed.

#### **NIST CARRIES OUT FIRST DEMONSTRATION OF INTEGRATED-OPTIC WAVEGUIDE LASER FABRICATED IN LITHIUM TANTALATE**

NIST scientists have carried out the world's first demonstration of an integrated-optic waveguide laser fabricated in ferroelectric lithium tantalate; the results were published in the journal *Optics Letters*. The device is optically pumped near 750 nm and lases near 1090 nm. These results are the first step to obtaining visible light from the waveguide laser, and experiments are now under way to force the laser to self-double the 1090 nm emission and to parametrically mix the laser output and the pump input. The result should be a waveguide laser that simultaneously can produce infrared, green, and blue light. The team expects the new laser to have significant impact in application areas such as optical recording, optical computing, medical diagnostics, and chemical sensing.

#### **SENSOR TO DETECT AND CLASSIFY SUB-MICROMETER PARTICLES NOW AVAILABLE FOR LICENSING FROM NIST**

NIST recently received a Notice of Allowance from the U.S. Patent and Trademark Office for the solid-state sensor capable of detecting particles having dimensions down to 0.1  $\mu\text{m}$ ; the next step is the formal issuance of a patent. This invention is now available for licensing from NIST, and NIST's Office of Technology Commercialization is currently seeking one or more commercial companies with which to collaboratively develop and evaluate the sensor for specific industrial applications and to which to grant an exclusive license for manufacture and marketing. The target application is for detecting particles in the ultra-clean environment required for the manufacture of integrated circuits. Present methods using anomalous scattering of laser light beams also are able to detect 0.1  $\mu\text{m}$  particles, but the proposed sensor is expected to offer advantages in terms of cost, compactness, and in some applications, safety.

Companies presently being contacted are informed that the potential applications extend beyond integrated circuit manufacturing and that the sensor could be configured for use in gas, liquid, vacuum, or plasma environments confined within small vessels or fluid feed lines. As conceived, the sensor consists of a dime-sized “monolithic” array of individually addressable, photosensitive pixel cells connected to a hardware/software electronic subsystem. The array is activated by illumination with an electronically alterable spectrum of electromagnetic radiation. When a particle of opacity at some wavelength comes to rest on the sensor surface, a degraded video signal from the underlying pixel or pixels indicates the presence of the particle. A key claim of the patent application is an opaque screen patterned with apertures of different sizes and geometries designed to facilitate the extraction of the incident particle size distributions using neural network algorithms.

#### **NIST DEVELOPS METHOD FOR PRODUCING MICROMACHINED GAS SENSOR ARRAY BY CMOS POST-FABRICATION PROCESS**

NIST researchers have developed a method for fabricating micromachined gas sensors that takes advantage of a commercial complementary metal oxide-semiconductor (CMOS) process. Arrays of thin-film gas sensors hold great promise for improving the selectivity and reliability of commercial gas sensing devices. An optimized array element would include a heater, a thermometer, and a gas-sensitive film; previously, such structures have been fabricated only by specialized micromachining processes in research laboratories using expensive lithographic equipment.

The NIST team has built a device that has demonstrated sensitivity to hydrogen. The results have importance for the commercial development of micromachined devices, improved and low-cost gas sensors, and applications requiring processing of materials on a microscopic scale. Three patent disclosures relating to this work have been filed. The team specified the layout of the devices as instructions to a CMOS foundry which fabricates application-specific integrated-circuit chips. The team treated chips received from the foundry with an anisotropic silicon etch which produces thermally isolated microbridges. Each microbridge contained a polysilicon heater, an aluminum hotplate (which also was used to measure temperature),

and aluminum contact pads. The team completed the sensor structure by depositing gas-sensitive tin oxide over the aluminum pads. The team also was able to enhance sensor performance through temperature control of array elements during tin oxide deposition and device operation.

#### **METHOD DEVELOPED FOR ELECTRICAL CHARACTERIZATION OF MULTICARRIER SEMICONDUCTORS**

NIST scientists have developed an improved method for determining the carrier density and mobility of each carrier component in multicarrier semiconductor systems. The method can be applied to gallium arsenide-based layered structures, such as high-electron-mobility transistors used for high-speed integrated circuits, and to structures fabricated from other compound semiconductors, such as mercury cadmium telluride used for infrared detectors. The electrical conduction process in these materials is often associated with more than one type of carrier, each component having a distinct mobility and density, resulting in a multicarrier system. By contrast, in silicon electric current is carried primarily by one type of carrier, either electrons or holes, and the carrier density and mobility can be determined by measuring conductivity and Hall effect at a fixed magnetic field. However, this conventional method becomes ineffective and the results often misleading for multicarrier systems. The team's method involves measuring both the parallel and transverse components of the conductivity tensor as a function of magnetic field and fitting the measurements to a multicarrier model to extract the density and mobility of each carrier component. The work includes the development of software to normalize the data and iterate the fitting parameter. The method is easy to implement and is expected to provide a better understanding and characterization of a range of compound semiconductors.

#### **PRODUCT DATA HYPERMEDIA OVERVIEW**

NIST scientists have produced Version 2 of a brief hypermedia introduction to the who, what, how, and why of STEP (Standard for the Exchange of Product Model Data). The hypermedia document, STEPing into the 21st Century-Product Data for a Changing World, presents a broad, non-technical overview of STEP for a wide audience.

The program runs under Windows 3.1 using a run-time version of Toolbook, the multimedia

authoring system used to create the presentation. Because technology transfer is vital to the success of STEP, it is important to meet the varying information needs of managers, engineers, and others involved in the development and implementation of STEP.

#### **ASME Y14.5.1 STANDARD NEARS COMPLETION**

ASME Working Group Y14.5.1 on Mathematical Definition of Dimensioning and Tolerancing Principles is nearing completion of a standard for establishing mathematically precise definitions of dimensional tolerances that appear on mechanical part drawings. The working group met during October and resolved all outstanding technical issues for the standard. A NIST scientist is overseeing the process of assembling the components of a document into a complete draft. When the new standard is issued by ASME sometime this year, it will be a companion to the existing Y14.5 Standard on Dimensioning and Tolerancing.

The Y14.5 standard, in use since 1966, is intended for use in traditional drafting practice. In recent years, computer software has become much more important in manufacturing. Software engineers have had to interpret Y14.5 when developing computer-aided design, analysis, inspection, and more recently, product data exchange systems. Because these new users of Y14.5 are from a different culture than the traditional users of Y14.5, ambiguities in Y14.5 have led to conflicting interpretations, and systems do not work well together. The new Y14.5.1 standard is expected to resolve these problems. It is scheduled for release for public comment early in 1993. The standard will also be submitted as a Committee Draft Standard within ISO/TC10 and will form the basis of the Shape Tolerance Model for STEP within ISO/TC184/SC4.

#### **NIST RESEARCHERS ESTABLISH ENVIRONMENTAL PROPERTIES OF MTBE, POPULAR OXYGENATE FUEL ADDITIVE**

Starting Nov. 1, 1992 federal law required that automobile fuels in about 40 urban areas of the United States must contain added "oxygenates" during the winter months. These new regulations are for those areas where air quality standards for carbon monoxide emission are exceeded.

An oxygenate is a liquid fuel component such as an ether or alcohol that contains oxygen. Oxygenate additives also increase the octane rating of the gasoline. Most of the fuel in use in the Washington-Baltimore area will contain the oxygenate MTBE "methyl tertiary-butyl ether" a compound whose atmospheric chemistry was established by research carried out at NIST.

Four years ago, NIST scientists reported the first temperature-dependent absolute value for the rate constant for the reaction of MTBE with the hydroxyl radical. The major tropospheric loss process for organic compounds released to the atmosphere is the reaction with hydroxyl radicals. The results of this study established that the atmospheric lifetime of MTBE is about 4 days, indicating that MTBE is not highly reactive and, therefore, does not contribute significantly to photochemical air pollution in urban areas.

#### MOLECULAR BEAMS AND DIODE LASERS PROBE ATMOSPHERIC DIMER MOLECULES

The oxides of nitrogen,  $\text{NO}_2$ ,  $\text{N}_2\text{O}_3$ ,  $\text{N}_2\text{O}_4$ ,  $\text{NO}_3$ ,  $\text{N}_2\text{O}_5$ , play an important role in atmospheric chemistry, with  $\text{NO}_2$ ,  $\text{NO}_3$ , and  $\text{N}_2\text{O}_5$  having been detected in the stratosphere with spectroscopic techniques. For chemical systems rich in  $\text{NO}_x$  species, the concentrations of these species are all interrelated. Because of this inter-relationship, it is important to have remote sensing techniques to measure the spatial and temporal concentrations of the various nitrogen oxides simultaneously. Infrared spectroscopy using satellite or ground-based spectrometers is a non-intrusive technique that allows accurate measurements of these species concentrations in the atmosphere. To use these capabilities requires measurement and interpretation of the infrared spectra of the relevant molecules.

NIST recently has examined the infrared spectra of two important  $\text{NO}_x$  species, the dimer of  $\text{NO}_2$  ( $\text{N}_2\text{O}_4$ ) and the mixed dimer of  $\text{NO}$  and  $\text{NO}_2$  ( $\text{N}_2\text{O}_3$ ). Spectra were recorded using a newly constructed diode-laser molecular-beam spectrometer, in which the dimers are formed by co-expanding  $\text{NO}$  and  $\text{NO}_2$  gas mixtures with argon through a 10 cm long by 25 m wide slit nozzle. In the resulting molecular beam the molecules are rotationally and vibrationally cold, with a measured rotational temperature of approximately 20 K. The molecular beam is interrogated with a frequency-tunable diode laser. The cold molecular beam conditions

dramatically simplify the spectra, making analysis possible while still yielding a high signal-to-noise ratio. The spectra have been analyzed to obtain accurate spectroscopic constants and structural information. For example, for  $\text{N}_2\text{O}_4$  we find a N-N bond length of 1.753 Å, which is intermediate between a van der Waals separation and a covalent bond. Future efforts will include measurement of the strong infrared bands of  $\text{N}_2\text{O}_5$ .

#### MEASUREMENTS WITH NIST GAMMA-RAY SPECTROMETER FEATURED IN INTERNATIONAL WORKSHOP

On Oct. 5-7, a Workshop on Applications of High-Resolution Gamma Spectroscopy in Studies of Atomic Collisions and Nuclear Lifetimes was held at the Institut Laue-Langevin (ILL), Grenoble, France. An international collection of 61 scientists gathered to hear invited presentations on precision gamma-ray spectroscopy, nuclear lifetimes, and atomic collisions. A NIST scientist served as external chairman of this workshop and helped to introduce the workshop by lecturing on "The History of High Resolution Gamma Spectroscopy."

The workshop emphasized precision measurements of Doppler-broadened gamma-ray profiles and the use of these profiles to determine nuclear lifetimes and atomic collision parameters. The recent interest in Doppler-broadened gamma-ray profiles stems from the fact that the small broadening resulting from nuclear recoil can be measured precisely with the NIST high-resolution double flat crystal spectrometer. Originally the NIST spectrometer was installed at the ILL to measure high-energy gamma-ray wavelengths because the ILL high-flux reactor is the only facility in the world which provides intense gamma-ray beams and specialized source changing facilities.

The features of the NIST spectrometer that make it a uniquely suited instrument for Doppler-broadened profile measurements are the very high resolution ( $10^5$  to  $10^6$ ) and the very well-characterized instrument function. More than 20 non-NIST scientists have been associated with the Doppler-broadened profile measurements, and during the past 2 years, 75 percent of the available gamma-ray beam time at the ILL has been scheduled on the NIST spectrometer. Another NIST scientist described the NIST spectrometer and its performance in detail and conducted tours of the NIST/ILL gamma-ray facility.



**NIST DEDICATES NEW HIGH-DOSE COBALT-60 FACILITY FOR RADIATION PROCESSING APPLICATIONS**

In October, NIST installed a new, cobalt-60, GammaCell 220 source as the main 1.2 MeV gamma-ray irradiator in a new user facility for research and calibrations. The self-shielded irradiator contains 24000 curies of the cobalt-60 radionuclide, which decays with a half life of 5.27 years. This very strong gamma-ray source gives NIST the capability of irradiating samples with a dose rate of 5 Gy/s. The facility also includes two other cobalt-60 irradiators with dose rates of 1.5 Gy/s and 0.5 Gy/s. Total doses for typical industrial radiation processing applications are in the range 100 to 10000 Gy.

The GammaCell irradiators are used to administer accurate gamma-ray doses to transfer and reference standard dosimeters such as radiochromic films and alanine, which are used in the NIST high-dose calibration services. The main users are in the areas of industrial radiation processing and medical device sterilization. These irradiators are also used by other NIST laboratories for radiation-hardness testing of electronics, polymers research, radiation chemistry, and the study of radiation-induced changes in biomolecules. The new facility at NIST is equipped with modern spectrophotometers, laser scanning densitometers, and associated computers for reading irradiated radiochromic films. Provisions can be made for proprietary use by industrial investigators.

**NIST PROVIDES RADON STANDARDS TO UNITED KINGDOM AND ITALY**

In the past year, NIST, at the request of two other national metrological laboratories, the National Physical Laboratory and the Ente per le Nuove Tecnologie L'Energia e L'Ambiente, provided the necessary radium-226 transfer standards that will serve as the national radon standards for the United Kingdom and Italy, respectively. NIST is the only national metrological laboratory in the world that disseminates radium and radon standards that have continuous calibration links to the international primary radium mass standards prepared by Marie Curie in 1911 and Otto Hönigschmid in 1934. Despite the passage of so many intervening years, these links to artifact standards are still of great significance. Unlike the calibration of many other radionuclides, there is no currently available activity standard for radium-226. Radium-226 is the progenitor of radon-222, and much of its continuing importance is due to

widespread concern for the potential health hazards of naturally occurring indoor radon levels. The radioactivity group serves in many ways as the primary reference laboratory and "keeper" of international radium solution and radon gas standards.

**COUNCIL ON IONIZING RADIATION MEASUREMENTS AND STANDARDS (CIRMS) MEETS AT NIST**

The Council on Ionizing Radiation Measurements and Standards conducted its first meeting at NIST Oct. 22–23, 1992. The organization represents tens of thousands of users engaged in industrial radiation processing and sterilization, medical radiation therapy and diagnostics, nuclear power radiation programs, and radiation worker protection programs. CIRMS provides a forum for discussing ionizing radiation measurements and standards issues, defining and prioritizing needed work, disseminating information on standards, and organizing workshops and meetings to advance ionizing radiation technology. Sixty-two participants attended the meeting. Invited lectures were given on the status and needs for radiation technology in nuclear medicine, radiation oncology, diagnostic radiology, industrial processing, industrial radiography, radioactivity monitoring at nuclear power stations, nuclear power materials dosimetry, environmental radioactivity assessments, and radon measurements. Needs from other agencies such as DOD, DOE, and USDA were also presented. A workshop on Measurement Quality Assurance for Ionizing Radiation will be sponsored by CIRMS and other interested organizations in March 1993.

**NIST QUANTIFIES OXIDES ON INTERMETALLICS COMPOUNDS FORMED AT ELECTRONIC INTERCONNECTS**

The oxides that form on Sn-based intermetallics can determine the solderability of electronic components and the reliability of electronic interconnects. NIST researchers working with the Naval Research Laboratory combined the electrochemical techniques of cyclic voltammetry, impedance spectroscopy, and chrono-coulometry with the surface chemical analysis techniques of Auger electron spectroscopy and x-ray photoelectron spectroscopy to study the oxides that form on  $\text{Cu}_3\text{Sn}$ ,  $\text{Cu}_6\text{Sn}_5$  and  $\text{Ni}_3\text{Sn}_4$  intermetallics under different exposure conditions. Combining these techniques allows for the identification of the oxide phases and quantification of the thickness of the phases that form for different exposures. The

results of this work were presented at the Corrosion and Reliability of Electronic Materials and Devices Symposium at the 182nd meeting of the Electrochemical Society in Toronto, Canada.

#### **CALCULATIONS SUGGEST STRAIN REDUCES STERIC HINDRANCE IN ENVIRONMENTALLY ENHANCED FRACTURE OF SILICA AND SILICON**

The presence of active environmental molecules, e.g., water, has long been known to cause bond rupture in ceramics at applied stresses well below the theoretical strength of the material. In this process, the presence of both stress and environment are necessary. It has been thought that stress causes polarization of the crack tip bonds which attracts the environmental molecule, leading to bond rupture. However, molecular orbital calculations made on silica and silicon systems at NIST suggest that an equally important aspect of the applied stress is the removal of steric hindrances which prevent environmental molecules from reaching the crack tip bonds in the absence of stress. Calculations indicate that these hindrances are caused by the presence of the atoms neighboring the crack tip which prevent the passage of the environmental molecule. Application of stress widens the crack, thereby reducing the blockages caused by these atoms.

#### **NIST-ACC COLLABORATION ON ENVIRONMENTAL DEGRADATION IN GLASS-FIBER-BASED COMPOSITES**

A NIST report on environmental degradation in glass-fiber-reinforced composites has been distributed to the U.S. Automotive Composites Consortium (ACC). The report identifies the most important technical and scientific issues in this area and will be used to formulate a joint NIST-ACC experimental program to address the key concerns.

The ACC was formed by the automotive industry to develop the generic technology necessary to use polymer matrix composites in structural applications. Requirements for mechanical performance and cost dictate the use of glass fibers in the majority of composites used in the automotive industry. Environmental stability of glass-fiber-reinforced composites is critical to increased use of these lightweight materials.

The report identifies degradation of the glass/polymer interface to be a critical concern. To deal with this problem, NIST has initiated studies of the effects of glass-fiber surface treatments on strength

of the interface and how the strength degrades upon exposure to moisture. Facilities to measure interface strength are available at NIST and, in fact, were used by research scientists from one automobile manufacturer to quantify the effects of processing and surface treatments on interface strength.

#### **NIST WORKS TO IMPROVE U.S. PASSPORT SECURITY**

NIST and the State Department hosted a meeting of industry and government experts to discuss test methods for evaluating the durability and security of the U.S. passport. Each passport has a plastic laminate that covers the personal data and photograph and protects this information from wear, dirt, moisture, discoloration, and tampering. A series of nine tests was developed by the State Department and NIST to evaluate potential laminate systems and determine which best serves the needs of the government.

The meeting, attended by representatives from all potential suppliers of security laminates, provided an opportunity for industry to get a detailed description of the tests and make suggestions for improvements. Overall, the tests were viewed by industry as appropriate, but several important modifications were suggested. As a result of the meeting, better test methods are now available, information on testing gained by the companies will assist them in making better products, and representatives from several other government agencies with security concerns learned of the latest developments.

#### **NIST COMPLETES STUDY ON FUNDAMENTAL BOILING MECHANISMS OF OZONE-SAFE REFRIGERANT/LUBRICANT MIXTURES**

A NIST scientist completed a NIST/DOE project that investigated the fundamental parameters of nucleate flow boiling of refrigerant R11 and its temporary replacement R123, with and without the addition of oil. The bubble frequency, the bubble diameter, the site density, the contact angle, and the heat transfer coefficient for these fluids were measured for boiling inside a horizontal tube. The heat transfer effectiveness of the replacement R123 was up to 8 percent better than that of R11 under some operating conditions and was enhanced 20 percent with the addition of 0.5 percent alkylbenzene oil, which is typically used in refrigeration applications. The purpose of the study was to establish the ground work for a generic boiling model that can be used to predict the heat transfer

coefficient based on known parameters. A general boiling model will enable refrigeration companies to accurately design efficient evaporators for the ozone-safe refrigerants. A reliable model will reduce the number of hours spent on heat exchanger research and development. This work is presented in NISTIR 4948, Simultaneous Visual and Calorimetric Measurements of R11, R123 and R123/Alkylbenzene Nucleate Flow Boiling.

#### **ACOUSTIC EMISSION OF STRUCTURAL MATERIALS EXPOSED TO OPEN FLAMES**

Recent experiments by NIST scientists have shown that acoustic emission (AE) can be used as an early indicator of hidden structural fires. By mounting piezoelectric transducers directly on beams of materials such as wood, plastic, and gypsum board, the ultrasonic events that result from the relief of stress created by changing temperatures can be measured. The number of AE events in a minute and the cumulative energy released when the material is exposed to a flame provide a good measure of the overheated state of many materials well before a temperature increase is registered at the same location. Wood is particularly susceptible to acoustic emission, producing more than 1000 events/min in a solid fir board and 30/min in 13 mm thick plywood when exposed to a 1.0 kW flame. Gypsum board produces about half as many events per minute, which is still 50 times greater than the background activity.

The advantages of this new technique for sensing a fire are that a deep-seated fire may be detected quickly and obscuration by dust and smoke would not degrade performance. Critical issues that remain to be investigated are the signal-noise-ratio in a field installation, the extent of coverage possible with a single transducer, and the economics of installation and maintenance.

#### **FIRST TEXT RETRIEVAL CONFERENCE (TREC) HELD**

On Nov. 4-6, 1992 NIST and the Defense Advanced Research Projects Agency co-sponsored the first conference to examine text retrieval methodologies. Participants represented government, industry, and academia with 28 text retrieval systems evaluated. The goal of the conference was to encourage research in text retrieval from large document collections by providing a large test collection, uniform scoring procedures, and a forum for organizations interested in comparing

their results. NIST will publish the conference proceedings this year.

The test collection, which will be made available for further research, was based on over 740000 documents (about 2 gigabytes of data) from newspapers, wire services, and other standard text, and 100 topics were used as test topics. Results from each system were passed by human assessors for correctness, and tables showing individual system performance were compiled. Participants gave presentations on their systems and attended workshops on areas of common interest among the systems. A major strength of the conference was the wide range of methods used for retrieval. NIST will co-sponsor a second TREC conference next year and anticipates that the conference series will continue for several years.

#### **NIST PUBLISHES RESULTS OF FIRST OPTICAL CHARACTER RECOGNITION SYSTEMS CONFERENCE**

NISTIR 4912, The First Census Optical Character Recognition Systems Conference, discusses the results and conclusions of this conference held at NIST in May 1992.

Following the 1990 Census, NIST and the Bureau of the Census joined forces to sponsor a scientific experiment and conference to determine the state of the art in the optical character recognition industry. Twenty-nine groups from North America and Europe participated in the experiment, which involved a comparison of image data bases. NIST scored the results and the conference convened to discuss findings and share ideas on the ongoing research into machine recognition of handprint, specifically the machine recognition of individual or segmented characters without context.

#### **NIST COLLABORATES WITH THE DEPARTMENT OF THE ARMY ON THREATS TO COMPUTER SYSTEMS**

As a participant in the U.S. Army Computer Vulnerability/Survivability Study Team, NIST was asked to assess the threats to computer systems that use commercially available hardware and software. NISTIR 4939, Threat Assessment of Malicious Code and External Attacks, provides an assessment of the threats from malicious code (viruses and worms) and human threats (hackers). The report gives the history of each type of threat, describes current protection methods, and projects future threats.

## **PROGRAMS FOR NEURAL NETWORK CALCULATIONS**

Software developed by NIST will enhance the efficiency, and thus the feasibility, of industrially important systems based on neural network computations. Neural networks are an active area of research and development for numerous applications, particularly for automatic character recognition systems. For example, at least a dozen U.S. companies, several companies in Europe, and other research groups are developing optical character recognition systems for deciphering handwritten characters. The time-consuming task of "training" the neural networks has for some years been done by a method known as backpropagation. Mathematically, "training" corresponds to minimizing an error function. Backpropagation is known to be a slow method, and better methods (such as conjugate gradient methods) have been known for years, but backpropagation continues to be used.

A NIST scientist has written an easy-to-use training program using conjugate gradients, which runs from 10 to 100 times faster than backpropagation. He has made the program available to users via electronic mail. To date, over 50 copies have been distributed to users in universities, government, and industry in the United States and 11 foreign countries.

NIST scientists have used his training program as part of a state-of-the-art recognition system that correctly recognizes over 96 percent of handwritten digits.

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## **Standard Reference Materials**

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### **STANDARD REFERENCE MATERIALS 2709-2711 SOIL SAMPLES**

EPA has been monitoring a number of toxic metals in the environment for a number of years under the Resource Conservation and Reclamation Act and the Superfund clean-up programs. To ensure accurate detection and quantitation of toxic metals of interest, and to know the reliability and comparability of data across regions and local sampling sites, accurate standards are needed.

The Standard Reference Materials Program announces the availability of three soil Standard Reference Materials (SRMs) specifically designed to meet these needs. The first, SRM 2709, is a

San Joaquin Valley soil having the toxic metals at concentrations which generally reflect their occurrence in uncontaminated environments. The soils, SRM 2710 and SRM 2711, collected in Montana, were selected to reflect soils heavily contaminated and moderately contaminated, respectively, with toxic metals. For example, lead occurs at 18.9 mg/kg in SRM 2709, at 5532 mg/kg in SRM 2710, and at 1162 mg/kg in SRM 2711. Antimony, arsenic, cadmium, copper, manganese, mercury, molybdenum, silver, and zinc also occur at unusually high levels in SRMs 2710 and 2711. However, other environmentally important metals like chromium, nickel, and selenium are at similar levels in all three materials.

In addition to being certified for the environmentally significant trace elements, the soils are also certified for the major constituents. Each of the soil SRMs is issued in 50 g units of powdered material.

### **STANDARD REFERENCE MATERIALS 458-460 BERYLLIUM-COPPER ALLOYS**

The explosive growth in the computer and electronics industries has created a greatly increased demand for beryllium copper. This electronic material is found in essentially all electronic systems, as a spring material in contacts and connectors linking electronic components together. The quality of these devices depends on the metallurgy and chemistry of the beryllium copper alloys. Accurate standards are needed to help producers of these materials control the quality of their products.

The Standard Reference Materials Program announces the availability of three new Standard Reference Materials to help meet these needs. SRMs 458-460 are intended for use in chemical analysis of beryllium-copper alloys. In all three, the copper concentration exceeds 97 percent and is reported as an information value. The analytical effort is focused on establishing the present best estimate of "true" concentration of 11 constituents occurring at concentrations below 2 percent. The SRM is issued in units of 50 g of chips sized between 0.50 mm and 1.18 mm sieve openings.

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## Standard Reference Data

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### **DATA ON CHEMICAL REACTIONS IN SOLUTIONS AVAILABLE**

Research chemists, environmental scientists, pharmacologists and others in the health care field now have rapid access to information on the reactions of more than 6400 chemicals in water and other solvents via the NIST Solution Kinetics Database for personal computers. It holds information on the rates of 7800 free radical reactions derived from more than 10300 experimental determinations. The PC database was compiled from the available printed literature through 1990 by the Radiation Chemistry Data Center. The NIST Solution Kinetics Database, Standard Reference Database 40, is available for \$190 from the Standard Reference Data Program, A320 Physics Building NIST, Gaithersburg, MD 20899-0001, (301) 975-2208, fax: (301) 926-0416. Yearly updates are planned.

### **NEW PC DATABASE CALIBRATES INFRARED SPECTROMETERS**

High-accuracy data files are now available for the calibration of infrared spectrometers used in chemical research and environmental monitoring. NIST Wavenumber Calibration Tables, Standard Reference Database 39, for personal computers, is a supplement to NIST Special Publication 821, Wavenumber Calibration Tables from Heterodyne Frequency Measurements, an atlas of spectral maps and tables. In preparing the tables, far more transitions were calculated than could possibly be published. The PC database includes ASCII files for the separate molecules listing wavenumber, uncertainty, lower-state energy level, intensity, descriptive quantum numbers, and band identification. The primary calibration molecules are the linear triatomic carbonyl sulfide and nitrous oxide that cover portions of the infrared spectrum ranging from 488 to 3120 wavenumbers. Gaps in the coverage are covered by nitric oxide, carbon monoxide and carbon disulfide. The text of SP 821, as printed in the NIST Journal of Research, is included in the database package. NIST Standard Reference Database 39 is available for \$165 from the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2208, fax: (301) 926-0416.