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News Briefs

General Developments

SEVENTH INTERNATIONAL TEMPERATURE SYMPOSIUM PLANNED

A symposium on Temperature, Its Measurement and Control in Science and Industry will be held in Toronto, Ontario, in April 1992. The symposium, seventh in the series that began in 1919, will provide a showcase for the major advances in thermometry since the Sixth Symposium in 1982. The symposium will take place in the Toronto Convention Center, in conjunction with the semi-annual exposition of the Instrument Society of America. Sponsors for the symposium include NIST, the American Institute of Physics, the Instrument Society of America, and the National Research Council of Canada. The General Committee that is planning the symposium is headed by Lawrence G. Rubin of the Francis Bitter National Magnet Laboratory at the Massachusetts Institute of Technology. James F. Schooley of NIST is the chairman of the program committee. It is expected that the Proceedings of the Seventh Temperature Symposium, like those of earlier meetings, will become a primary reference for the field of thermometry.

LESL STANDARD FOR FM RECEIVERS WILL ASSIST LAW ENFORCEMENT AGENCIES

The National Institute of Justice (NIJ) recently published NIJ Standard-0206.01, Fixed and Base Station Receivers. This publication is based on NIST research and is a revision of a standard published in September 1975. It includes requirements and test methods for units operating in the 800-MHz frequency band. In addition, it provides updated requirements for receiver sensitivity, closing time, and audio response and describes modified tests for spurious and harmonic response and intermodulation attenuation. Thirteen different tests are specified by the standard.

PRECISION SOURCE OF CALCULABLE DIGITALLY SYNTHESIZED AC VOLTAGES MADE AVAILABLE

In response to industry needs, NIST scientists have developed a reference digitally synthesized source (DSS) of ac voltages. These sources are capable of serving as transfer standards at the 3-7 V level with accuracies of 10-20 ppm from 10 Hz to 10 kHz, and even greater accuracies below 10 Hz. The significance of the DSS is that the rms value of its stepped output waveform can be calculated, based on accurate dc voltage measurements.

Applications have demonstrated that the DSS constitutes an effective overall reference that takes into account losses due to connectors, cables, switches, and other sources of error in a complete ac voltage measurement instrument or system. It has been used to verify the performance of the ac measurement section of a new multimeter having a claimed accuracy of 100 ppm.

The division is prepared to loan the developmental DSS on a trial basis to organizations that have the metrology capability to use it effectively. Division staff have described the DSS at the Conference on Precision Electromagnetic Measurements, at two other major conferences, and in a paper to appear in the *IEEE Transactions on Instrumentation and Measurements*.

DEPARTMENT OF AGRICULTURE TO ADOPT NIST HANDBOOKS

The U.S. Department of Agriculture (USDA), Food Safety and Inspection Service, has published a proposal in the *Federal Register* to incorporate by reference, *Checking the Net Contents of Packaged*

Goods (NIST Handbook 133,) and *Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices* (NIST Handbook 44) into their regulations.

Incorporation will bring federal and state regulations into conformity. Since 1984, USDA, the Food and Drug Administration, and representatives of consumers and the meat and poultry industries have been working through the NIST-sponsored National Conference on Weights and Measures (NCWM) to resolve the net weight issue.

The proposal contains the agreements worked out by the interested parties through the NCWM. It will amend the federal meat and poultry products inspection regulations to provide uniform net weight labeling requirements, including reasonable variations for label statements of net contents of meat and poultry products.

In the notice, the USDA states that "The National Conference on Weights and Measures has become the principal forum for building a consensus on how to determine the net weight of meat and poultry products."

SELF-LUBRICATING COMPOSITES STUDIED FOR WEAR AND FRICTION PROPERTIES

Ceramic-matrix and metal-matrix composites are being prepared and studied in sliding wear in the tribology group of the Ceramics Division. The composite materials include a soft, solid lubricant phase, $NiCl_2$ intercalated graphite. During wear of the composite, some of the soft phase is retained in the sliding contact to maintain an effective solid lubricating film. Matrix materials being studied include alumina, silicon nitride, and copper. The composites were slid against hardened steel.

Friction coefficients in sliding were reduced by factors up to 4 (copper 0.6 to 0.15, silicon nitride 0.45 to 0.17) by this approach. Wear rates were also significantly reduced. Studies of the worn surface morphology showed three significant mechanisms at work: (1) the formation of a lubricating interfacial film from the exit boundary of the soft phase regions; (2) recession from the average surface height at the soft phase regions; and (3) collection of wear debris in the recess at the entrance region of the soft phase. Further understanding of these and other mechanisms that control wear and friction should permit alteration of composite composition and microstructure to further improve the tribological properties. Self-lubricating composites can be used in applications where liquid lubricants cannot be used to control friction and wear. A patent disclosure concerned with the composite fabrication methods that were developed in the project, has been submitted.

NIST-INDUSTRY COLLABORATION ON AN ADVANCED COMPOSITE MATERIAL

Graphite-epoxy composite rods are being considered as tethers for a new type of offshore oil platform called the TLP, or tension leg platform. The tethers connect the floating platform to the seabed. For tethers 1 km or more in length, the mass of conventional steel tethers becomes a significant consideration in the design. Unidirectional graphite-epoxy offers the possibility of tethers of only one-sixth the mass of steel tethers for equivalent strength.

Because advanced composite materials have no service history on offshore oil platforms, designers are reluctant to use them to replace steel. At a meeting to explore NIST-industry collaboration, it was suggested that optical fibers could be embedded in the fibers to provide warning of damage. The availability of diagnostic information on the condition of the composite tethers could compensate for lack of experience with these materials.

The result was the tether prototypes with embedded optical fibers have been produced cooperatively by industry and samples have been supplied to NIST. Preliminary tests have verified the high strength and stiffness of the rod, and that the optical fiber survived the manufacturing process intact. Experiments to explore the correlation between changes in the optical behavior of the embedded fiber and mechanical loading and damage on the rod are under way.

A NOVEL DILATOMETER FOR POLYMER STUDIES

A high-precision torsional dilatometer has been constructed in the Polymers Division to study the effects of deformations on the physical aging and rejuvenation of polymeric glasses. The instrument is fully automated with the capability of simultaneously measuring the torque, normal force, angular displacement, temperature, and volume change of a polymeric glass subjected to torsional deformations.

The volume of a polymeric glass contracts spontaneously toward the equilibrium value in a slow process referred to as physical aging. These small volume changes cause large changes in the mechanical properties, which makes the rate and extent of physical aging of practical importance. On

the other hand, the mechanical stimulus of deformation has been postulated to cause changes in the structure (volume) of the glass and therefore bring about rejuvenation. Because the magnitude of the relative volume changes required to cause rejuvenation are of the order of 10^{-3}, experiments such as tension or compression, which cause large (of the order of 5×10^{-3}) volume changes, cannot be used to test the hypothesis.

Preliminary measurements performed on epoxy glasses aged into equilibrium show that torsional deformations induce an increase in relative volume of the order of 1×10^{-4} to 1×10^{-3}. The volume increase scales approximately as the square of the deformation and the kinetics of the volume recovery after the deformation differ from the relaxation kinetics of the torque and normal force. These results are unexpected and, if confirmed, will lead to renewed interest in theories of physical aging of glasses.

The low machine compliance and 5 mK temperature stability of the torsional dilatometer make possible relative volume change measurements of $1\times10^{-5}\pm10^{-7}$ to be made over time periods in excess of several hours. Volume change measurements at times as short as 10^{-3} s are possible, although the system mechanics currently limit the practical measurement range in isothermal experiments to approximately 0.1 s. The temperature stability of the dilatometer and the ability to study short time phenomena will be exploited in the future to study the effects of deformations on the phase behavior and kinetics of phase separation of two-phase polymer systems near the critical point.

MAGNETIC MEASUREMENTS OF SINGLE-CRYSTAL HIGH-TEMPERATURE SUPERCONDUCTORS

Single crystals of $YBa_2Cu_3O_{7-x}$ (YBCO) have many properties of great interest for the development and application of high-temperature superconductors. For example, when fully oxygenated ($x=0$), such crystals have very sharp transitions to the superconducting state and the highest critical currents reported for any of the new superconductors. High-quality crystals with dimensions up to $0.3\times0.3\times0.2$ mm have been grown. These crystals, having volumes on the order of a few millionths of a cubic centimeter, make the characterization of their superconducting properties a difficult task. However, NIST scientists have been able to characterize them using the high-measurement sensitivity available with a Superconducting Quantum Interference Device (SQUID). As with all YBCO material studied to date, the as-grown single crystals are not perfect, but are highly twinned. Perfect untwinned crystals will allow anisotropy to be fully characterized, the role of twins to be determined, and theories concerning the role of oxygen chains to be investigated. Therefore, the current goal of this effort is to produce perfect, untwinned, and fully oxygenated single crystals and to charac terize their properties in all three directions. Single crystals, which are more than 99 percent twin-free, have been produced. The first magnetic moment measurements on untwinned crystals have been accomplished. Further work is in progress in order to fully oxygenate and maintain a twin-free state.

NIST SCIENTISTS PROVIDE RADIATION DATA FOR INTERNATIONAL REPORT ON TISSUE SUBSTITUTES

A new authoritative report, *Tissue Substitutes in Radiation Dosimetry and Measurement,* Report 44 (1989) of the International Commission on Radiation Units and Measurements (ICRU) includes radiation interaction data that, for the most part, was provided by Ionizing Radiation Division scientists at NIST. The report is important because of the need to measure absorbed doses on both macroscopic and microscopic scales within and around irradiated body tissues. These measurements require the use of carefully selected materials from which radiation detectors and phantoms (substitutes for portions of the body) are constructed. The 133-page radiation interaction data table includes photoelectric, coherent, Compton and pair production cross sections, mass attenuation coefficients, mass energy absorption coefficients, electron stopping powers, proton stopping powers, and neutron kerma factors. Data are given for 24 actual tissues, plus 53 solid and liquid tissue substitutes and 10 gaseous tissue substitutes.

DOUBLE-AMPLIFICATION FLOW-INJECTION IMMUNOASSAY DEVELOPED AT NIST

Analyses based on immunological (antigen-antibody) recognition have, because of their high specificity, become one of the most widely used techniques in the clinical laboratory. When combined with radioactive, fluorescent, or enzyme tags, these immunoassay techniques are also among the most sensitive. At NIST, scientists have developed an even more sensitive, and quantitative,

immunoassay based on a regenerable, computer-controlled flow-injection system incorporating a novel double-amplification approach.

The double amplification is achieved by means of peroxidase enzyme molecules encapsulated in analyte-derivatized liposomes. The enzyme is released subsequent to a competitive immunological reaction between analyte molecules (theophylline, a drug used for treating asthma) and immobilized antibodies. The released peroxidase enzymatically cleaves, from an organofluorine substrate, fluoride ions which are then potentiometrically measured. By means of immunoreactor column regeneration and calibration, accurate quantitation can be achieved; a feature missing from conventional batch-type immunoassays.

By this liposome/enzyme double-amplification approach, theophylline was determined over a range of concentrations from 0.2 to 4000 ng/mL. The detection limit of 200 pg/mL corresponds to about 100 fmol (10^{-15} mol) of theophylline measured in the 100 μL sample injected. The system is currently undergoing further development to optimize its operating characteristics.

ULTRAFAST ENERGY TRANSFER AT SURFACES

Ultrafast lasers have been used at NIST to measure the vibrational population relaxation time, T_1, for small molecules bound to platinum or rhodium particles, typical materials used as catalysts. These experiments provide the first direct evidence for the role of substrate electronic states in transferring energy initially localized in specific molecular bonds. The results suggest that vibrationally excited adsorbed molecules may play a more important role in laser-controlled surface chemistry than had previously been anticipated.

Specifically, a stretching vibration in carbon monoxide, CO, bound to Pt or Rh was strongly excited by a resonant picosecond (1 ps$=10^{-12}$ s) laser pulse. The subsequent decay of the CO($v=1$) population was then detected by the transient change in absorption of a weak, time-delayed ps probe pulse at the same frequency. The decay time for CO on these particles, which consisted of about 1,000 metal atoms, was found to be $T_1=7$ ps, one to two orders of magnitude shorter than that in small metal carbonyl molecules. The dramatic increase in relaxation rate suggests that the metal particles provide a new and rapid pathway for the decay of energetic surface species.

The exceptional ability of metal surfaces for increasing molecular relaxation rates beyond those found in solution or on insulator surfaces had previously been predicted. However, the observed increase is still a factor of 10 less than predictions based on indirect evidence such as spectral linewidths.

TIME- AND STATE-RESOLVED STUDIES OF MOLECULAR DECOMPOSITION

Experiments performed with pump-probe, picosecond laser techniques have now produced new insights into the nature of molecules that contain sufficient vibrational energy to decompose. The experiments indicate that molecular product states and appearance rates are highly dependent upon the initial vibrational motion and energy. For example, two vibrational states of HN_3 with nearly identical energies exhibit dissociation lifetimes different by a factor of 2.

The unprecedented scope of these measurements makes HN_3 a benchmark system in our understanding of unimolecular decomposition. The observations of state mixing and mode-specific decay have profound implications for laser-selective chemistry.

NCSL TO TEST INTEROPERABILITY OF OSI X.500 DIRECTORY SERVICES

National Computer Systems Laboratory and other participants in OSINET begin interoperability testing for the Open Systems Interconnection (OSI) X.500 Directory Services this year. OSINET is a network established by NCSL to test and demonstrate the OSI protocols. The X.500 standards provide a directory database of all devices or users on a network. The directory access protocol within X.500 provides a way for naming and addressing devices on a network and a way to have multiple directories exchange information so messages can be routed around networks. Vendors and users participating in the project will test the various implementations of the X.500 protocol.

NIST DEVELOPS NEW FABRICATION METHODS FOR FIBER CURRENT SENSORS

NIST scientists have developed repeatable fabrication methods, involving the use of special forms, for fiber current-sensor coils; coils of about 200 turns and 1 cm in diameter have been made. Polarization effects in single-mode fiber, primarily stress-induced birefringence resulting from bending, have

previously made it impossible to produce fiber current sensors smaller than about 10 cm in diameter or with more than a few turns. Birefringence before annealing one of the new coils is on the order of 7000 degrees (0.6 radians per turn); after annealing, an entire coil will typically have a birefringence of only 10 to 20 degrees (sensor application requires birefringence of less than 50 degrees). The NIST sensors are the smallest and most sensitive fiber current sensors reported to date. NIST scientists believe they have refined the fabrication process, including packaging, to the point that successful commercialization can take place.

CBT COMPLETES THOROUGH ANALYSIS OF THE INDOOR AIR QUALITY IN A NEW GOVERNMENT OFFICE BUILDING

At the request of the General Services Administration, NIST researchers completed an analysis of indoor air quality of a seven-story federal office building in Portland, OR, that was constructed during 1986 and 1987 and has been occupied for the past 18 months. The purpose of this evaluation was to document the effect of various design, construction, and operation parameters on indoor air quality. This evaluation was done using a special diagnostic center on the building's first floor with instrumentation connected to sensors throughout the building. Measurements were made of air infiltration, ventilation rates, building envelope tightness, interzone air movement, and levels of indoor contaminants. The contaminants measured were carbon monoxide, carbon dioxide, respirable particulates, formaldehyde (HCHO), radon, and volatile organic compounds. Results of the study indicated: (1) adequate ventilation under most operating conditions; (2) excessive uncontrolled building air exchange by infiltration; (3) levels of carbon dioxide, HCHO, radon, and respirable particles well within established guidelines; (4) high levels of carbon monoxide in the vicinity of elevator shafts and stairwells coming from the underground garage; and (5) no evidence of significant outgassing of pollutants from building materials and furnishings, but the existence of at least 37 volatile organic compounds which appear related to activities occurring within the building.

CFR DEVELOPS SMOKE TOXICITY SCREENING TEST FOR THE NAVY

NIST researchers have developed a new screening test method for the toxic potency of smoke. The Navy will use this method as part of a hazard analysis to control the potential danger from combustible materials on-board submarines. The new "N-Gas Model Smoke Toxicity Screening Test" builds on research over the past 7 years. The principle behind the method states that the toxicity of fire smoke is due only to a few chemical species. This is in spite of the fact that smokes contain hundreds of compounds. In addition to reduced oxygen, scientists have identified the principal toxicants, CO, CO_2, and HCN, and generated data on their toxicities, individually, and in combination. Compared to current smoke toxicity methods, this approach is faster, less expensive, and significantly reduces the dependence on laboratory animals.

NOVEL BIOASSAY FOR MEASURING TOXICANTS IN ENVIRONMENT

A novel laser-bioassay system developed by a private company has been modified during collaboration with Polymers Division scientists for the rapid detection of toxicants in environmental samples. Ultimately, the bioassay method may provide a simple, rapid method for identification and measurement of bioavailability of toxicants in the environment. The system employs strains of genetically defined bacteria which change their growth rate and morphology in response to bioavailable toxicants in samples. The system also provides evidence for the mode of toxicity, based on differential responses of the strains of bacteria which vary only in their ability to repair DNA damage.

Extension of the technique to organometals has been successfully undertaken at NIST in the past year with the demonstration of differential response of bacterial strains to organotin additives and toxicants used commercially as catalysts, plastics stabilizers, and biocides. Responses of bacteria to microgram levels of organotins were measured and several strains were found to respond differently to various organotin compounds. The goal of the joint research is to compare quantitative bioassay measurements with conventional gas chromatographic methods developed at NIST for ultratrace detection and speciation of organotin compounds in environmental samples. The technique is potentially extendable to measurement of other materials including metals, polymers, biocides, and pharmaceuticals. It also offers prospects for standards for bioavailability of molecules in a variety of matrices.

THIRTEEN DECADE PHOTOCURRENT MEASUREMENTS

A high transfer gain, low-noise amplifier and a silicon photodiode have been combined to measure optical radiant power over 13 orders of magnitude at NIST. Since the impedance of the photodiode must be 10 GΩ, the manufacturer must select individual diodes from batch-processed diodes to satisfy this requirement. The high impedance of the photodiode results in low amplification of amplifier noises and drifts which are of comparable magnitude. The low-voltage amplification allows the device to operate at normal laboratory conditions without the complexity of temperature control. The input $1/f$ noise of the amplifier was equalized to the source resistance noise at this high detector impedance in a bandwidth of 0.01 Hz. In this bandwidth, the best measured short-circuit current limit sensitivity was 0.44 fA, which corresponds to a noise equivalent power of 0.73 fW at the 900 nm peak response.

The detector amplifier package can replace photomultipliers in some applications where low-level optical radiation monitoring is required at slow response. The detector package can exhibit better signal-to-noise ratio in these applications and hence can significantly reduce the time for a sequence of measurements. The silicon detector package also allows an absolute calibration of spectral responsivity of the instrument to be provided in those circumstances where the absolute value of the light flux is of interest. The device has application in a large number of situations where sensitivity or wide dynamic range would be important. These include astronomical observations, night vision, photometry, and optical density measurements.

MODEL DEVELOPED FOR ELECTRON TRANSPORT AT METAL-SEMICONDUCTOR INTERFACES

Metal-semiconductor interfaces with large electron transmission probabilities are necessary for the development of high-speed transistors and faster computers. NIST scientists have developed, in collaboration with private industry, a method for calculating "ballistic" electron transport behavior at atomically abrupt coherent interfaces. This method has been applied to interface structures between silicon and nickel silicide, materials typical of those being investigated for high- transmission properties. A surprising result is that the two interface structures that occur in silicon-nickel silicide (the so-called A and B type interfaces) have transmission properties about a factor of three different. Also important to the overall transmission is the degree of match of the important wavefunctions in the two constituent bulk materials. The results provide a theoretical basis for scientists and engineers who are experimenting with related systems and interfaces in the search for ultimate performance electronic devices.

NIST-DESIGNED CRYOGENIC MICROWAVE NOISE STANDARDS PROVIDED TO INDUSTRY

Three primary standard microwave noise sources have been designed, fabricated, evaluated, and delivered by NIST, as an example of the first cryogenic noise standards based on NIST design principles that have been made available directly to U.S. industry. These sources were designed for use with WR10 (75-110 GHz), WR15 (50-75 GHz), and WR22 (33-50 GHz) waveguide systems; the noise temperature for each is 77 K, the temperature of the liquid-nitrogen cryogen. These horn-type sources are very similar to the cryogenic national standard thermal noise sources previously developed that are now in operation supporting measurement services.

Cryogenic noise source standards offer significant advantages in fabrication, operation, and analysis and control of uncertainties over high-temperature sources used previously at NIST and in widespread use elsewhere. The contractual agreement called for a source accuracy of ±2 percent; NIST was able to deliver sources with uncertainties approximately half this: 1.3 percent for WR10, 1 percent for WR15, and 1 percent for WR22.

A COMPARISON BETWEEN PARTICLE SIZE STANDARDS FROM NIST AND BCR

NIST is developing a series of Standard Reference Materials (SRMs) for particle size covering the range of 0.1 to 100 μm. The SRMs consist of aqueous suspensions of monosize polystyrene microspheres. The Bureau Community Reference (BCR), a standards organization for Western Europe, is developing similar standards covering the range of 2 to 10 μm. SRM 1960 (10 μm "Space Beads") was calibrated at NIST using three unrelated techniques: optical and electron microscopy, and light scattering, giving agreement to 0.01 μm.

Recently a comparison was made between SRM 1960 and BCR 167 (9.6 μm), in which each party measured the mean diameter of a sample of the

other party's Standard Reference Material. The samples were known to be uniform at the 0.1 percent level. The measurements used optical microscopy (center distance finding by NIST and array sizing by BCR) for which the base line was provided by interferometrically calibrated stage micrometers. The found agreement was well within the stated calibration accuracies.

CBT COMPLETES NEW COMPUTER MODEL FOR PREDICTING WATER VAPOR SORPTION AT INTERIOR BUILDING SURFACES

The prediction of latent space cooling loads and interior humidity levels in buildings cannot be predicted to the accuracy of many other energy-related quantities. This is due to moisture sorption at interior surfaces of the structure and furnishings being neglected in state-of-the-art energy analysis programs. This phenomena is particularly important when a building is operated with night ventilation to reduce cooling loads. The relative humidity of night outdoor air, however, is often considerably higher than that of the conditioned indoor air during the daytime. Since the amount of moisture stored in building materials depends directly on relative humidity, a significant incremental moisture adsorption occurs during night ventilation with a corresponding desorption during the daytime. Researchers have now completed the development and experimental verification of algorithms that predict moisture sorption rates at interior building surfaces. The model accounts for all surface phenomena including the effect of surface coatings such as paints. This research project involved measuring the basic properties for common materials such as wood and gypsum board. Desorption experiments were then completed with the various materials in desiccator chambers and excellent agreement was obtained between measured and predicted drying rates.

CBT DEVELOPS NEW COMPUTER MODEL FOR REFRIGERANT EVAPORATORS

In order to develop meaningful testing and rating procedures for refrigeration systems that are assembled in the field and cannot be laboratory tested as a complete system, sophisticated simulation tools are required to test components and/or estimate their performance. One such tool just developed by NIST is the computer program EVSIM for modeling refrigerant-to-air heat exchangers used exclusively in residential air-conditioning as an evaporator. The model accounts for any specified air distribution pattern entering the heat-exchanger and a wide variety of refrigerant circuit patterns within the tubes. The model uses a detailed tube-by-tube thermodynamic and heat transfer calculation scheme, and is best suited for mini- and main-frame computers. However, it has been successfully used on an IBM AT-compatible machine. EVSIM has been distributed to leading air-conditioning manufacturers for their use.

USE "ZIP" TO FIND MOST ECONOMIC LEVELS OF INSULATION

How much insulation should be installed in a house? A new computer program called ZIP can help find the answer. Quick and easy to use, ZIP can provide customized estimates of the most economic levels of thermal insulation for building components such as attics, walls, floors, crawlspaces, and basements. ZIP determines these estimates by searching internal data files containing local weather information and energy and insulation costs all keyed to the user's postal ZIP code. The program and supporting files are contained on a single diskette and will run on MS-DOS systems with 256 K of RAM. ZIP was designed by NIST in conjunction with the Department of Energy's Oak Ridge National Laboratory. The disk is available from several sources including MTS Software, St. Louis, MO for $5 and PC-SIG, Sunnyvale, CA for $6. It also is available from the National Technical Information Service, Springfield, VA 22161; call 703/487-4600 for ordering information.

TILTMETER STUDIES IN COLORADO AND WYOMING

Scientists at the NIST-University of Colorado Joint Institute for Laboratory Astrophysics (JILA) have completed field studies of specially-designed tiltmeters in Erie, CO, and Yellowstone National Park, WY. Tiltmeters are highly sensitive devices which are sunk deep into the earth and which are designed to measure the slightest tilt in the earth's surface. They might be used, among other things, as early-warning predictors for earthquakes. The JILA scientists found good agreement between their measurements and measurements of earth tides on the Colorado plains but wide disagreements between these measurements in Yellowstone Park where the instruments were placed above a collapsed caldera. "Only near a fault zone in

Germany have comparably large tilt anomalies been observed," they report. For copies of two papers explaining their work, contact Fred McGehan, NIST, Division 360.2, Boulder, CO 80303.

NIST TESTING SMOKE CONTROL SYSTEMS

Do smoke control systems really protect building occupants from deadly fumes? NIST researchers are conducting the first known full-scale tests on these systems. Smoke is the killer in most fires, which each year take nearly 6,000 lives in the United States. The idea behind smoke control systems is to help protect life and property by containing or diverting the smoke. NIST's research results will be used to evaluate current guidelines for smoke control systems, including those developed in 1983 by NIST in conjunction with the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Inc. The data also will be used to develop and validate computer models to predict fire and smoke movement through a building and the vulnerability of occupants to fire.

INDUSTRY COOPERATION SOUGHT FOR NEW IPM PROGRAMS

NIST scientists are seeking researchers in industry, universities, and other organizations who are interested in participating in collaborative programs on the intelligent processing of materials (IPM). The IPM concept is a new computer-based approach for producing advanced polymer, ceramic, and metal alloy materials that are far superior to those used today. An IPM facility with on-line nondestructive evaluation (NDE) sensors and process models can carefully monitor and control the processing conditions required to give advanced materials their special properties. Currently, there are two IPM pilot demonstrations at NIST: researchers are working to automate the production of metal powders by both high-pressure gas atomization and hot isostatic pressing. Plans call for IPM programs in polymers, ceramics, and the thermomechanical processing of metals. For information, contact the Office of Nondestructive Evaluation, NIST, B344 Materials Bldg., Gaithersburg, MD 20899; telephone: 301/975-5727.

NEW TECHNIQUE FOR MEASURING STRESS AND STRAIN

NIST scientists have developed a computer-controlled, optical technique for measuring deformations in materials. The system, which utilizes a laser, video cameras, and still photography, measures all three components of strain as well as rigid body rotations. The system can measure strains at 16,000 locations in a 2.5-in square grid in about 5 h. It currently is being used to study the initiation and growth of cracks in composite panels in conjunction with an automobile manufacturer. Several papers are available from Jo Emery, NIST, Division 104, Boulder, CO 80303; telephone: 303/497-3237.

MAKING MOVIES TO SIMULATE STRESS WAVES

Using supercomputers and computer-generated graphics NIST researchers are trying to understand better how new composite materials—particularly graphite epoxy—stand up under stress and strain. With sophisticated mathematical modeling techniques, they are able to simulate a stress wave moving through a piece of graphite epoxy and, for the first time, view the progression of this wave in three dimensions from different planes and perspectives. They developed a simulated block of graphite epoxy containing 80,100 elements. A sound wave was "passed through" the block, taking almost 3 h and using virtually all the supercomputer's memory. When the results of the computer simulation were compared with theoretical models, there was a difference of less than 2 percent. New numerical techniques have reduced the time to 40 s and use much less computer memory. Working with NIST are two computer graphics companies.

CLINICAL INSTRUMENTS CAN BE STERILIZED IN SECONDS

The time required to sterilize dental and medical instruments can be reduced from hours to seconds by an innovative process developed at NIST. The new method disinfects instruments completely in 30 s when they are treated by a microwave-generated gas plasma produced in a container that holds the instruments inside a conventional microwave oven. The new technique should help health-care professionals improve patient care, and it may reduce the damage to expensive instruments caused by repeated exposure to traditional sterilization methods. A patent application has been filed, and NIST scientists hope to work with industry to

develop a practical appliance in which a gas plasma can be used routinely in a health-care facility. For information, contact: Dr. Waldemar de Rijk, NIST, A143 Polymer Bldg., Gaithersburg, MD 20899; telephone: 301/975-6803.

PROTOTYPE SYSTEM DEVELOPED ON STRUCTURAL CERAMICS

NIST scientists have developed a prototype computerized database system of critically evaluated data on structural ceramics. Designed for personal computers (PCs), the current focus is on the physical, chemical, and performance properties of structural ceramics expected to have near-term applications for the design of heat exchangers, radiant tube heaters, and engine components such as valves. Users can specify a material by generic and trade name, by composition and microstructure, or by desired property values. For information on the PC prototype, which is now being field tested, contact: Dr. Ronald G. Munro, NIST, A256 Materials Bldg., Gaithersburg, MD 20899; telephone: 301/975-6119.

LOOKS ARE NOT EVERYTHING

Does a change in the appearance of paint, such as fading, chalking, or yellowing, mean the coating can no longer protect the base material? Not necessarily, found researchers in the NIST Center for Building Technology. For the past several years, NIST has been investigating ways to predict the "service life" of building materials, including coatings. Knowing how long a material will remain serviceable can help in selection and use and in developing cost-effective maintenance strategies. But no quantitative test method exists to predict durability of coatings, and questions have been raised whether changes in appearance can be used as early indicators that the coating is deteriorating. The NIST researchers concluded that changes in appearance are not necessarily related to changes in the protective properties of a coating. A report, Relationship Between Appearance and Protective Durability of Coatings: A Literature Review (NISTIR 88-4010), is available from the National Technical Information Service, Springfield, VA 22161 for $15.95. Order by PB #89-162598/AS.

1989 ANNUAL DIRECTORY PUBLISHED FOR NVLAP LABORATORIES

The 1989 Directory of NVLAP Accredited Laboratories (NISTIR 89-4056), lists 200 laboratories nationwide and abroad that are accredited by NIST for specific test methods in various fields of testing as of April 1, 1989. The current fields are acoustics; carpet; commercial products—paint, paper, plastic, and seals and sealants; computer protocols; construction testing services—concrete, cement, aggregates, soil and rock, admixtures, geotextiles, road and paving; personnel radiation dosimetry; electromagnetic compatibility and telecommunications; solid fuel room heaters; and thermal insulation. The laboratories are listed alphabetically by name, field of testing, and state. For information on NVLAP programs, including the new bulk asbestos analysis program, contact: National Voluntary Laboratory Accreditation, NIST, A124 Bldg. 411, Gaithersburg, MD 20899; telephone: 301/975-4016. Information also is available by computer on the NVLAP electronic bulletin board at 301/948-2058. Copies of NISTIR 89-4056 are available prepaid for $15.95 from the National Technical Information Service, Springfield, VA 22161. Order by PB #89-189278.

TIPS FOR UTILIZING TEM CELLS

Transverse electromagnetic (TEM) cells are used widely to establish a known electromagnetic field for susceptibility testing and antenna calibrations. A recent NIST publication offers theoretical information and some practical tips for using TEM cells. The report addresses mechanical requirements for positioning the test equipment inside the cell, problems associated with cables, single- frequency and multi-frequency measurements, and use of a computer system for automated measurements. Theory and Measurements of Radiated Emissions Using a TEM Cell (NIST TN 1326) is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. The cost is $2.25; order by stock number 003-003-02932-7.

USING EMATs FOR WHEEL INSPECTION

For several years NIST, at the request of the Federal Railroad Administration, has studied ultrasonic detection of cracks in the treads and residual tensile stresses in the rims of steel railroad wheels. These defects are two main causes of wheel failure, with catastrophic consequences to personnel,

rolling stock, tracks, and schedules. NIST's research program has concentrated on using electromagnetic-acoustic transducers (EMATs) for the nondestructive evaluation of wheels. These noncontact devices are more reliable and easier to automate than conventional transducers. Two instruments under development at NIST should be an improvement on the visual inspection methods now used, which have unacceptably high error rates. One instrument can detect cracks as the wheels roll by, enabling more frequent and thorough inspections than is now feasible; the second performs quantitative stress determination while the wheel remains on the axle. A collection of seven papers published over the past 2 years, Report No. 18: Ultrasonic Railroad Wheel Inspection Using EMATs (NISTIR 88-3906), is available from the National Technical Information Service, Springfield, VA 22161, for $15.95. Order by PB #89-189229.

NIST, AIR FORCE, INDUSTRY CONDUCT OSI/ISDN TRIAL

NIST and six companies recently conducted a trial at Mather Air Force Base in California to demonstrate the use of OSI applications over an ISDN transport network. OSI—Open Systems Interconnection—standards provide a set of rules, known as protocols, which enables information processing devices to communicate with one another in a network. ISDN—Integrated Services Digital Network—is a telecommunications technology that makes it possible to send and receive voice, data, and image signals simultaneously over existing digital telephone lines. NIST will release the results of the trial this summer. The results are expected to show that off-the-shelf computer products from different manufacturers can be connected through a variety of communications technologies, including ISDN. NIST has been working with private industry—users and manufacturers—and other organizations to help overcome problems inhibiting the growth of both OSI and ISDN technologies in the United States.

PROCESS DEVELOPED TO REMOVE TWINS IN YBCO CRYSTALS

A new technique for removing the twins in yttrium-barium-copper-oxygen (YBCO) single crystals may help scientists to understand better the performance of high-temperature superconducting materials. Twins are the interchange of the crystallographic *a* and *b* axes of a single crystal that occurs during processing as the material cools. These defects may contribute to superconductivity, but they also are barriers to information on the structure and properties of materials. The detwinning process uses pressure and heat to align the *a* axis parallel to the direction of applied stress. By characterizing untwinned single crystals, scientists will be able to determine the *a/b* structural and property anisotropy or directionality, and the effects of twin boundaries on superconductivity. Polarized light, optical microscopy, and x-ray studies were used to verify the new technique. For a copy of a report on the NIST detwinning process, send a self-addressed mailing label to Dr. Frank W. Gayle, NIST, A153 Materials Bldg., Gaithersburg, MD 20899.

IGNITION OF STEEL IN OXYGEN ATMOSPHERES TESTED

Many high-strength alloys burn readily in pressurized oxygen atmospheres, a fact of interest to many in science and engineering, but of particular consequence to the aerospace community. For several years, NIST has conducted studies sponsored by NASA of the ignition and combustion of various iron-, aluminum-, nickel-, and cobalt-based alloys in oxygen. The purpose of the work is to gain a fundamental understanding of the ignition characteristics of broad classes of metals in oxygen atmospheres. The results of the latest tests on a stainless steel alloy (UNS S66286) are now available. The details of the tests are presented in Ignition Characteristics of the Iron-Based Alloy UNS S66286 in Pressurized Oxygen (NISTIR 88-3904), available from the National Technical Information Service, Springfield, VA 22161, for $13.95 prepaid. Order by PB #89-189336.

RESEARCH RECOMMENDED TO IMPROVE OIL SPILL RESPONSE

Research, new tests, and improved techniques are needed to advance oil spill response capabilities in the Arctic, concludes a panel of experts in a recently issued NIST report. These findings were reached at a November 1988 workshop, which was coordinated by NIST for the Minerals Management Service of the U.S. Department of the Interior. It was held to discuss all aspects of oil spill response under Arctic conditions, to describe existing research programs, and to identify future research needs and priorities. Among the recommendations is that additional research, including field testing, is needed to evaluate combus-

tion of oil spills on water. The NIST Center for Fire Research is conducting laboratory tests to measure burning rate, smoke emission and movement, and particulate deposition. A report, Alaska Arctic Offshore Oil Spill Response Technology Workshop Proceedings (NIST SP 762), is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Order by stock no. 003-003-02935-1, for $11 prepaid.

COMPOSITION OF EARTH STUDIED WITH CUSTOM TECHNIQUE

Using a custom-made chemical measurement system, researchers at NIST are helping to unlock secrets about the earth's composition, evaluating the origins of precious metal ores, and determining the contributions of extraterrestrial material to the earth's makeup. At the heart of the NIST-developed system is a powerful technique known as resonance ionization mass spectrometry (RIMS). Among other things, RIMS enables scientists to measure rhenium and osmium, two difficult-to-detect elements found in the earth's rocks. By gauging the abundance of these two elements in a rock sample, scientists can determine the age of a rock and learn much about the history of the earth at the site where the sample was taken. The RIMS technique of measuring rhenium and osmium has been used successfully in studies that examine how deposits of platinum, gold, and other precious metals were created. For example, the method played a key role in a study showing that the movement of water mobilized certain components of very old rocks, creating gold deposits in the Kolar Region of India. RIMS also has been employed for other types of chemical analyses, such as measuring impurities in the thin films that coat semiconductors.

NEW DEVICE SAVES ELECTRONIC COMPONENTS

A new instrument that non-destructively tests electronic switching components has been developed by a NIST electronics engineer. The instrument—an automated power transistor switching test system—determines the maximum voltage and current levels that the device under test can switch without destroying it. The idea behind the new instrument is that the temperature rise which actually destroys the transistor, or other power electronic device, occurs slightly after the electrical breakdown of the device. The breakdown occurs when the electric current reaches a point where the device can no longer stand the voltage in the circuit. The trick is to remove the power before the device heats up enough to be damaged. Knowing the performance limits of transistors can reduce a user's costs because users often make their transistor specifications more stringent than necessary to ensure system reliability. Power transistors are vital components in control systems for applications ranging from the main engines of the space shuttle to your automobile. They are essential to electronic amplifiers, modern switching power supplies, and electric motor drives.

NIST PROBE ADAPTED FOR COMMERCIAL USE

A tiny, broadband electric field probe designed, tested, and calibrated by NIST engineers has been adapted into a commercial product. The probes are used for electromagnetic interference testing and non-ionizing radiation hazard measurements. NIST developed ultra-broadband resistively loaded dipoles and used the Denver Research Institute, Denver, CO, to provide the sensor element. NIST fabricated an ultra-broadband electric field probe using these dipole elements, which can measure fields of 1 to 1600 V/m over a range of 100 kHz to 18 GHz. NIST first announced development of the probe in the IEEE Transactions on Microwave Theory and Techniques, February 1987, in a paper titled "An Isotropic Electric-Field Probe with Tapered Resistive Dipoles for Broadband Use, 10 kHz to 18 GHz." For a copy of the original NIST paper, contact Dr. M. Kanda, NIST, Division 723.03, 325 Broadway, Boulder, CO 80303; telephone: 303/497-5320.

Standard Reference Materials

NEW MATERIAL CAN HELP GAUGE SULFUR EMISSIONS

Two new standard reference materials (SRMs 2730 and 2731), developed to help ensure that laboratories make accurate analyses of sulfur emissions produced by U.S. pulp and paper industries, are now available from NIST. The SRMs are intended for calibrating laboratory instruments and for evaluating the methods used for determining the concentration of hydrogen sulfide emitted into the atmosphere. Supplied in aluminum cylinders, the SRMs represent two concentrations of hydrogen

sulfide: 5 and 20 parts per million. The materials cost $730 per cylinder and may be ordered from the Office of Standard Reference Materials, NIST, B311 Chemistry Building, Gaithersburg, MD 20899; telephone: 301/975-6776.

STANDARD REFERENCE MATERIAL 1845—CHOLESTEROL IN WHOLE EGG POWDER

The Office of Standard Reference Materials announced the availability of Standard Reference Material (SRM) 1845, Cholesterol in Whole Egg Powder. This SRM is intended primarily for use in developing and validating analytical methods for the determination of cholesterol in an egg or other food matrix.

NIST obtained commercially the dried whole egg powder for SRM 1845 from M. Ihnat, Land Resource Research Centre, Agriculture Canada. The certified concentration for cholesterol in this material as provided in the Certificate of Analysis is 19.0±0.2 mg/g. This certified concentration and associated uncertainty was derived from data generated at NIST from a definitive method for cholesterol based upon isotope dilution gas chromatography/mass spectrometry. Details of the analytical methodology including extraction procedures are given in the Certificate of Analysis.

One of the effects of dietary factors on disease being studied is the relationship of increased cholesterol to heart disease. Since egg is an important source of cholesterol in the diet, this SRM should assist investigators in developing more accurate data for the concentration of cholesterol in egg and other foods.

Standard Reference Data

A NEW METHOD FOR IDENTIFICATION OF SOLID-STATE MATERIALS

The Crystal Data Center has developed a highly accurate analytical procedure that will greatly extend identification techniques, particularly for electron diffractionists. The method opens new opportunities in the identification of solid-state materials, in that crystalline samples in the size range 10 μm to 10 Å can be accurately characterized.

Research with NIST CRYSTAL DATA (a large database with chemical, physical, and crystallographic data on solid-state materials) has proved that a material can be uniquely characterized on the basis of its crystal lattice and chemical composition. To characterize a material, it is sufficient to determine the primitive cell and to determine the element types present. Using a modern analytical electron microscope (AEM), the experimentalist can collect the required data on an unknown sample. The lattice information is obtained by rotation of the sample to obtain two planes of data, from which a unit cell defining the lattice can be deduced. The chemical data is determined by energy dispersive x-ray spectroscopy (EDS). Once the experimental data are measured, the unknown can be identified against the database of knowns using well-developed lattice/element-type matching techniques.

Rapid and accurate identification of the unknown against lattices in the database with 140,000 entries is due: 1) to the development of a universal classification scheme for all lattices independent of crystal system and lattice centering; 2) to theoretical work that has led to algorithms that can deduce the relationship, if it exists, between any pair of lattices; and 3) to the creation of computer algorithms and search software to carry out lattice matching in a highly efficient manner when an extremely large number of lattices are involved.

Plans are under way to build this procedure directly into the workstations associated with commercial analytical electron microscopes, through technology transfer with private-sector groups. This strategy, then, provides an automated identification technique since data collection, NIST CRYSTAL DATA, and the identification software will all be integrated into the same instrument. The methodology is also useful for the identification of unknowns by means of neutron and x-ray diffraction data.