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News Briefs

General Developments

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

CONSORTIUM TO DEVELOP CERAMIC MACHINING DATA

Ten manufacturers that produce or use components made from silicon nitride and silicon carbide are joining NIST in a program to develop machining data and guidelines to improve grinding processes for advanced structural ceramics. The consortium will focus on cost-effective production. Machining information will be developed in two phases. The first calls for consortium members to machine test bars using in-house procedures and then send specimens to NIST for characterization and testing. During the second phase, test bars will be ground in accordance with a detailed plan that specifies grinding wheel type, grinding fluid, wheel surface speed and other conditions. Finished specimens will be tested by NIST for surface quality and fracture strength. Fracture surfaces of selected samples will be examined for critical flaws and probable sources. Two federal research groups are co-sponsoring parts of the effort, and a university is participating in theoretical studies of the machining process. For information, contact Said Jahanmir, A329 Materials Building, NIST, Gaithersburg, MD 20899, (301) 975-3671.

INDUSTRY/NIST TO IMPROVE ADVANCED POLYMER SYSTEMS

A private company and NIST have established a cooperative program to improve the performance and manufacture of advanced systems using composite polymer materials. Researchers from the private company will work with NIST scientists to use a NIST-developed neutron reflection technique to examine the molecular level structure of polymers and how it affects adhesion with a second material (or substrate). Proper interface structure of polymers at solid interfaces controls the durability, mechanical performance, and environmental resistance of advanced polymer systems. The NIST measurement method will help producers in the automotive, aerospace, and electronics industries improve their ability to characterize protective coatings of polymers on metals, the adhesion of polymer matrices to reinforcing fibers in composites, and the bonding of polymer thin films to various components in electronic packaging. For information, contact Wen-li Wu, A209 Polymer Building, NIST, Gaithersburg, MD 20899, (301) 975-6839.

FREQUENCY CALIBRATIONS USING LORAN-C EXPLAINED

For companies needing very accurate frequency calibrations at low cost, using the U.S. Coast Guard's LORAN-C long-range navigation system may be the answer. A new paper from NIST explains the system and how it can be used for automated frequency calibrations. LORAN-C is the world's most accurate ground-based radio system, producing a frequency "good enough to meet the requirements of nearly any calibration laboratory," the paper reports. LORAN-C consists of 20 networks of stations (all broadcasting on 100 kHz) covering most of the United States, Canada, Europe, the North Atlantic, the Central and West Pacific, and the Philippines and Japan. The NIST paper discusses types of receiving equipment, how to use a certain receiver pulse as the reference frequency, creation of an automated frequency calibration system, and the expected performance from LORAN-C. For a copy of paper 34-92, contact Jo Emery, Div. 104, NIST, Boulder, CO 80303, (303) 497-3237.

TECHNOLOGY CENTERS CREATED FOR CALIFORNIA, MINNESOTA

NIST has selected Los Angeles, CA, and Minneapolis, MN, as sites for two new Manufacturing Technology Centers (MTCs). The California MTC, headquartered at El Camino College in Torrance, CA (in Greater Los Angeles), is sponsored jointly by the California Community Colleges and the California Department of Commerce. Its primary focus will be supporting the thousands of hard-pressed aerospace industry suppliers in the region. The Upper Midwest MTC will use the existing facilities of its sponsor, Minnesota Technology Inc., a public, non-profit corporation. Its main clients are expected to be from the computer, industrial machining, and metal and plastics/composites fabrication industries. The NIST MTCs are designed to help small and mid-sized manufacturers become more competitive by adopting modern technologies. NIST provides up to half of a center's funding for the first 3 years and then reduces funding for the following 3 years. MTCs must be self-supporting by the seventh year of operation.

CRADA PARTNERS TO STUDY CONCRETE FAILURE DURING FIRE

NIST and the Portland Cement Association have signed a cooperative research and development agreement (CRADA) to examine the effect fire has on concrete building partitions such as walls, ceilings and floors. In particular, the researchers are interested in predicting how long it takes for a concrete partition to fail during a fire. Current fire computer models, such as NIST's HAZARD I, focus on the fire and the effect it has on the building's environment and occupants. For example, HAZARD I can predict the temperature, smoke concentrations, and toxic gas levels in each room of a building. It also can be used to predict the behavior and movement of the building occupants, as well as their ultimate fate. However, little information is available concerning the fire behavior of building partitions, so models like HAZARD "assume" they are impenetrable and do not change during a fire. Under the CRADA, a computer model will be developed that can predict a fire's effect on concrete. The NIST researchers believe this future model, and one currently being tested for wooden walls, can be extended to other materials as well. For information, contact Walter Jones, B356 Polymer Building, NIST, Gaithersburg, MD 20899, (301) 975-6887.

HAVE YOU HEARD? NEW NOISE STANDARD DEVELOPED

NIST has created a new portable standard to evaluate the accuracy of phase modulation (PM) and amplitude modulation (AM) noise measurement equipment at 5, 10 and 100 MHz, as well as the noise floor (minimum level of noise) for such devices. The new standard should benefit both companies that make equipment for calibrating noise measurement apparatus and industrial laboratories (such as those in the aerospace industry) that conduct these calibrations. Previously, calibration equipment had to be sent to NIST for accuracy and noise floor evaluation, or users had to rely on a manufacturer's specifications. Comparisons of measurement systems in different laboratories using commercially available oscillators as transfer standards were limited to a typical repeatability of plus or minus 3 dB. The accuracy of the portable standard for both PM and AM noise is plus or minus 0.14 dB. Additionally, the temperature coefficient is less than 0.02 dB/K and the stability is better than 0.4 dB over 1 year. A patent is pending for this new standard. A paper, number 35-92, describing the standard is available from Jo Emery, Div. 104, NIST, Boulder, CO 80303, (303) 497-3237.

"SUPERCONDUCTIVITY REPORT" NOW AVAILABLE ON VHS

A new videotape, "Superconductivity: A Report from NIST," which highlights NIST research in both high- and low-temperature superconductivity, was recently released. The 12 min tape describes the two goals of the superconductivity program: to establish techniques and standards for characterizing superconducting materials, and to use these materials in advancing the art of electrical measurements and standards. VHS copies are $12 (shipping included) and may be purchased from Video Transfer Inc., 5709-B Arundel Ave., Rockville, MD 20852, (301) 881-0270.

TWO VIEWS OF PROTEIN PUZZLES PROVE BETTER THAN ONE

Protein molecules are like giant puzzles that scientists solve with one of two methods: showering laboratory-grown protein crystals with x rays or placing dissolved proteins in magnetic fields to get a picture of where individual atoms lie. While both techniques are very useful, scientists find discrepancies between the crystal and solution models, and, therefore, have not previously integrated the two methods. But a new study by the National Institutes

of Health and the Center for Advanced Research in Biotechnology (CARB) shows for the first time that combining data from both techniques can produce clearer pictures of protein structures than is obtainable by either single method. To achieve this conclusion, scientists at NIH and CARB pooled data from studies of interleukin-1 beta, a lymphokine that stimulates the body's immune response. Their work, described in the Aug. 14, 1992, issue of Science, opens a new door for accurately solving the structures of large biological molecules. CARB is operated jointly by NIST and the University of Maryland.

NEW BIOSENSOR CONSORTIUM SEEKS MEMBERS

Biosensors are small electronic devices that use biological molecules (such as enzymes, antibodies, antigens or nucleic acids) to detect a specific substance. Industry and government scientists are teaming up to hasten the development of advanced biosensors that could change dramatically the laboratory analysis of medical, environmental, and industrial samples by the end of the century. More than a dozen companies are joining NIST in the Consortium on Advanced Biosensors (CAB). To meet CAB's goal of fostering biosensor development and commercialization, the consortium will support generic research projects to solve the common problems biosensor producers face. For more information, contact Howard Weetall, Biosensor Technology Group, A353 Chemistry Building, NIST, Gaithersburg, MD 20899, (301) 975-2628, fax: (301) 330-3447.

NIST/INDUSTRY TO STUDY CRYPTOGRAPHY INFRASTRUCTURES

NIST and a private company are investigating the merits and cost implications of various infrastructures that will support planned federal cryptography standards. There are several possible alternatives for such infrastructures, elements of which include support organizations, distribution systems, directory services and message authentication. NIST's proposed Digital Signature Standard (DSS), which allows users to "sign" an outgoing message digitally and verify signatures in incoming messages, requires such support. Before DSS technology can become operational, a sound infrastructure must be implemented to ensure efficient, secure use of resources for government agencies and the public customers they serve. The NIST/industry study aims to identify the best and most cost-effective infrastructure alternatives. Numerous government agencies, including the U.S. Postal Service, the Internal Revenue Service, the Federal Bureau of Investigation and the Defense Department, support the infrastructure study.

STANDARDS NEEDS ON DIAMOND FILMS CITED

Foremost among conclusions from a recent NIST workshop on diamond films is the need to characterize methods so that experimental data, measured at different sites by different workers, may be meaningfully compared. At the meeting, producers and potential users of diamond films made by chemical vapor deposition methods, focused on two technical topics: measurement of thermal conductivity or thermal diffusivity for heat dissipation applications, and measurement of mechanical properties of diamond for cutting tools. Researchers gave presentations on topics relevant to commercial applications, and companies described their needs for standards. The workshop was held in response to a recommendation in a NIST report assessing diamond technology in Japan (Workshop on Characterizing Diamond Films, NISTIR 4849) that called for increased information exchanges among members of the U.S. diamond community. NISTIR 4849 is available for $19 prepaid from the National Technical Information Service, Springfield, VA 22161, (800) 553-6847. Order by number PB 92-205426.

CRITICAL TECHNOLOGIES DOMINATE ATP PROPOSALS

The NIST Advanced Technology Program (ATP) received 140 proposals for the first of two recently announced competitions, according to program officials. Nearly half of the proposals were for research on advanced materials or electronics. Significant numbers of proposals in manufacturing, information technology and computing, energy technologies, biomedical and biotechnology, and chemistry also were logged. The ATP funds research on generic, precompetitive technologies with the potential to enhance the competitiveness of U.S. industry. A second ATP competition will accept proposals from Jan. 25, 1993, to Feb. 24, 1993. An estimated $15 million to $20 million will be available for ATP awards in each competition. Full application packages are available from the Advanced Technology Program, A430 Administration Building, NIST, Gaithersburg, MD 20899, (301) 975-2636.

EXPLORING MATH AND MANUFACTURING IN THE CLASSROOM

Mathematics teachers say awareness of their subject's practical value needs to grow. Meanwhile, manufacturers maintain that technical pursuits do not receive adequate emphasis in U.S. schools. "Technology Learning Modules" being developed by a NIST mechanical engineer working with a software firm, aim to respond to both concerns. Intended initially for seventh- and eighth-graders, the lessons begin with students sketching out part designs on graph paper and end with computer programs that instruct a tabletop milling machine to make wax renderings of the children's creations. In between, students explore and use mathematical concepts, as well as experiment with 3-D computer modeling and design programs that rival the graphic capabilities of even the best video games. Still in the prototype stage, the modules were evaluated this summer by four Washington, DC-area teachers and could be ready for a trial run in classrooms by late fall. "Technology Learning Modules" for high-schoolers are in the works. For more information, contact Denver Lovett, Rm. 136 Shops Building, NIST, Gaithersburg, MD 20899, (301) 975-3503.

MOBILE MACHINERY GROUP DEFINES STANDARDS ISSUES

Private-sector panelists at a recent workshop co-sponsored by NIST and the Equipment Manufacturers Institute identified several important issues to U.S. industry as they relate to international standards development and conformity assessment. This was the fourth in a series of meetings to determine how the Federal government can increase U.S. industry acceptance within other markets such as the European Community (EC). Panelists cited the following needs: mobile machinery technical standards need international harmonization, information on EC standards and directives needs to be disseminated adequately in the United States, U.S. regulatory bodies should harmonize their regulations with EC directives, U.S. public and private sectors must adopt international standards whenever possible, and improved coordination is needed between the public and private sectors in developing U.S. positions on EC 92 issues. The report, Conformity Assessment Workshop: Mobile Machinery (NISTIR 4853), is available from the National Technical Information Service, Springfield, VA 22161, (800) 553-6847 for $26 (print) and $12.50 (microfiche) prepaid. Order by PB 92-205368.

PROPOSALS SOUGHT FOR PRECISION MEASUREMENT GRANTS

NIST is seeking project proposals for its 1994 Precision Measurement Grants. The grants are for $50,000 for 1 year, and may be renewed for up to two additional years. Prospective candidates must submit summaries of their proposed projects and biographical information to NIST by Feb. 1, 1993, to be considered for the current grants, which will run from October 1993 through September 1994. NIST's Precision Measurement Grants are awarded each year to scientists in U.S. academic institutions for work in determining values for fundamental constants, investigating related physical phenomena, or developing new, fundamental measurement methods. For further information, contact Barry N. Taylor, B160 Physics Building, NIST, Gaithersburg, MD 20899, (301) 975-4220.

SECURITY TRAINING COMPENDIUM AVAILABLE FROM NIST

As part of its mandate under the Computer Security Act of 1987, NIST has issued a catalog of computer security training and awareness courses available from a variety of vendors nationwide. The document lists hundreds of courses aimed at executives, managers, security and audit personnel, ADP management and operations, and end users. Course subject categories include computer security basics, security planning and management, contingency planning, computer security policy and procedures, and systems life cycle management. Course topics range from disaster recovery to auditing fraud to detecting and preventing viruses. Computer Security Training & Awareness Course Compendium (NISTIR 4846) is available on-line through the NIST computer security bulletin board by dialing (301) 948-5717 or (301) 948-5140 (9600 baud only).

FIFTEEN INVENTIONS NOW AVAILABLE FOR LICENSING

NIST recently announced that the following 15 government-owned inventions are now available for licensing:

- Method for Production of Predetermined Concentration Graded Alloys (Docket No. 86-001);
- Predetermined Concentration Graded Alloys (Docket No. 86-008);
- Ultrasensitive Force Detector Employing Servo-stabilized Tunneling Junction (Docket No. 87-026);

- A Method for Making Single Crystals (Docket No. 88-022);
- Process for the Preparation of Fiber-Reinforced Ceramic Matrix Composites (Docket No. 88-044);
- Tunnel-Stabilized Magnetic Reading and Recording (Docket No. 90-002);
- Matrix Modification in the Electrophoretic Separation of Nucleic Acids (Docket No. 90-014);
- Method and Apparatus for Assessment of Surface Smoothness Using Reflected Energy (Docket No. 90-016);
- Localized Plasma Processing (Docket No. 90-021);
- Hard X-Ray Magnification Apparatus and Method with Submicrometer Spatial Resolution of Images in One, Two or Three Dimensions (Docket No. 90-038);
- Azeotropic Refrigerant Comprising Bis-(Difluoromethyl) Ether and 1,1,2-Trifluoroethane (Docket No. 91-003);
- Two-Dimensional, Josephson-Array, Voltage-Tunable, High-Frequency Oscillator (Docket No. 91-005);
- Object/Anti-Object Neural Network Segmentation (Docket No. 91-011);
- Apparatus and Method for Evaporative Concentration of a Liquid Sample (Docket No. 91-012); and
- Calibration System for Determining the Accuracy of Phase Modulation and Amplitude Modulation Noise Measurement Apparatus (Docket No. 91-014).

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

NIST AND AUTO INDUSTRY COOPERATE ON WELDING RESEARCH

To assist industries that use welding, NIST has developed arc current/voltage signal monitoring systems and arc diagnostics software to improve the control of automated gas metal arc welding. Recently, a research associate from an automobile manufacturer spent 6 months working with NIST researchers to learn about this welding technology hardware/software, study weld droplet transfer characteristics, and determine how NIST's weld-sensing strategies might be applied to automotive exhaust system (catalytic converter) manufacturing processes. The manufacturer hopes that a welding research laboratory similar to NIST's can be set up at its research center. The Cooperative Research and Development Agreement (CRADA) under which this program operates is expected to be a model for future cooperation between NIST and other industrial partners in the field of welding research.

NIST TO LEAD DEVELOPMENT OF NEW IEEE STANDARD FOR POWER-FREQUENCY FIELD-MEASURING INSTRUMENTS

A NIST scientist will lead the development and drafting of a new document for specifications of instruments for measuring electric and magnetic power-frequency fields.

The IEEE activity responds to increasing societal interest in the effects of power-frequency and power-frequency harmonic electric and magnetic fields and new interest in the measurement of these fields in practical environments, such as in homes, in business and industry, and in transportation systems. A number of instruments having a range of capabilities have been developed and marketed for carrying out these measurements, but at present there are no standards prescribing specifications for instrumentation used in the various environments. The Magnetic Fields Task Force and the Subcommittee 1 working group will jointly prepare the draft of the proposed standard P1308, "Recommended Practice for Instrumentation: Specifications for Electric Field Strength and Magnetic Flux Density Meters—10 Hz to 2 kHz." The resulting draft standard will be submitted to the IEEE Standards Board.

NIST SCIENTIST SHARES PATENT AND R&D 100 AWARD ON DIAMOND-TURNING OF FERROUS METALS

A NIST scientist along with two co-workers at Los Alamos National Laboratory (LANL), has been awarded a U.S. patent for a process for diamond-tool machining of materials that react with diamond. Development of the long process allows diamond turning of mirror-like surface finishes on ferrous materials. One application is direct machining of stainless steel to optical-quality tolerances as molds for aspheric lenses. In the process,

controlled cryogenic cooling of the tool post and workpiece prevents detrimental temperature-dependent chemical interaction of the workpiece material with the carbon in the diamond cutting tool. The process has been named a winner of the 1992 R&D 100 Award.

NON-METHANE ORGANIC COMPOUND GAS STANDARDS DEVELOPED TO SUPPORT ATMOSPHERIC MEASUREMENTS OF AUTO EMISSIONS

Scientists at NIST have developed a series of gas mixtures consisting of trace level concentrations of 15 different organic compounds in nitrogen. The compounds are constituents of automobile exhaust and have been identified as reactants in the formation of ozone. The standards are difficult to produce since some of the reference compounds are gases under normal conditions, and others are liquids. To prepare these standards, scientists had to develop a procedure to quantitatively weigh and blend numerous substances in two different physical states, gas and liquid, into one complex mixture so the amount of each substance could be determined with an uncertainty of 1 percent. These standards are also difficult to analyze since the concentration levels are low, approximately 5 ppb (0.0000005 percent), and the analyzers are not sensitive enough to directly detect the substances. Therefore, the organic constituents in the samples had to be preconcentrated, and parameters such as cryogenic temperature and substrate material needed to be optimized for both the gaseous compounds and the liquids.

These standards allow scientists to better understand and follow the complex atmospheric chemistry of ozone formation. Ozone at high altitudes is essential to regulating the Earth's atmosphere. However, ozone at ground level is a pollutant that adversely effects human health and is a major contributor to plant and crop damage. Ground-level ozone is formed by complex interactions involving hydrocarbons, oxygen, and sunlight, and is one of the constituents of photochemical smog. Current concern with high pollution levels has caused environmental agencies to embark on studies to determine sources and levels of pollutants so they can recommend remediation steps and measure whether these steps are effective. The standards developed at NIST contain the hydrocarbon compounds involved in the reactions to form ozone and will calibrate instruments used to accurately measure these components in the atmosphere.

CARBONYL SULFIDE MEASURED IN AUTOMOTIVE EMISSIONS USING TUNABLE DIODE LASER ABSORPTION SPECTROSCOPY

Carbonyl sulfide (COS) is the most abundant gaseous sulfur species in the Earth's unpolluted atmosphere. This gas is believed to be the primary precursor of the stratospheric aerosol sulfate layer during non-volcanic time periods. Modeling studies have raised the concern that long-term perturbations to this layer from increasing COS emissions could significantly influence the Earth's radiative budget and climate through increased solar scattering. The possibility of increased heterogenous reactions on such aerosols also may increase stratospheric ozone destruction.

COS measurements were made over several years both at NIST and at the National Center for Atmospheric Research (NCAR) in Boulder, CO. Groups at both locations used tunable diode laser absorption spectroscopy because of its high selectivity and sensitivity for detecting COS. Measurements were made on ambient COS as well as on the emissions of numerous automobiles, both gasoline and diesel powered. The measurements at NIST were made using the P(24) or P(25) transition in the 100-000 band of COS. The primary technique used was to split a portion of the infrared beam off to a line locking cell (containing COS) and use a first derivative frequency lock. The majority of the beam was passed through a long path multipass cell (up to 200 m) and detected in the second derivative mode. The measurements were calibrated using low COS emitting permeation devices. The determined value of COS in clean ambient air was 500 ± 10 ppt ($1\ \text{ppt} = 1 \times 10^{-12}$). Measurements of automobile emissions of COS made both at NIST and NCAR, ranged between 2 and 300 ppb ($1\ \text{ppb} = 1 \times 10^{-9}$). Based on NCAR data concerning the average emission of the vehicles studied (about 50 ppb), and the total number of automobiles and trucks (about 200 million worldwide), the increase to the atmospheric budget per year from automobile and truck emissions will not exceed 0.1 percent of the global concentration of 500 ppt.

GOLD-PLATINUM THERMOCOUPLES: A NEW HIGH-STABILITY, HIGH-ACCURACY INDUSTRIAL TRANSFER STANDARD

Scientists at NIST recently completed a study of the stability of gold-platinum thermocouples to determine their applicability as accurate and rugged secondary reference thermometers, and as transfer standards at temperatures up to 1000 °C. This effort includes the determination of a new, highly accurate

reference function based on the International Temperature Scale of 1990. The thermocouples were fabricated from 0.5 mm diameter wires of the highest purity material commercially available. These thermocouples were determined to be stable to within 0.016 °C when heated for 1000 h at about 965 °C. This is an order of magnitude improvement over the stability of currently available reference standard thermocouples (types S, R, and B), and is at least 10 times better than the stability of industrial platinum resistance thermometers at temperatures above 550 °C. These thermocouples also compare favorably with high-temperature standard platinum resistance thermometers at temperatures above 900 °C. This type of thermocouple will be useful for measuring and controlling temperature in semiconductor production, for determining the efficiency of gas turbines used by the electric utilities, for aerospace applications, and for general laboratory and industrial use.

This work was reported to the scientific and industrial community at the recently held Seventh International Symposium on Temperature.

DARK-STATE VIBRATIONAL QUASI-CONTINUUM PROBED WITH MOLECULAR "SEARCHLIGHT" TECHNIQUE

As part of a project to develop new methods for studying energy migration and transfer in medium to large sized molecules, NIST scientists have discovered a novel method of using an electric field to tune a spectroscopically accessible "bright" state across a wide range of inaccessible "dark" states belonging to the vibrational quasi-continuum. This new method is in some ways analogous to sweeping through a dark sky with a searchlight until the desired objects are lit up by reflected radiation and come into view. The method will permit a much more controlled study of the vibrational continuum, including the transition from Poisson statistics to Wigner statistics which is involved in the passage of vibrating molecular systems from periodic to chaotic motion. The present observations also help explain the unexpected "disappearance" of electrical polarity (i.e., the electric dipole moment) in excited vibrational states embedded in the quasi-continuum. Further experiments are being carried out to determine the full potential of this new method, particularly the relationship of these measurements to the reaction dynamics of highly excited molecules.

MAGNETISM IN NANOMETER-SIZED IRON PARTICLES

The dynamics of domain rotation in single-domain particles can be much faster than in materials where this process is dominated by domain-wall motion. This domain switching by coherent rotation has potential applications for high-speed data storage media. A collaborative research effort between the neutron scattering group at NIST and Johns Hopkins University has prepared nanometer-sized iron particles embedded in alumina, so that the interparticle magnetic interactions are very weak. Small-angle neutron scattering has characterized this material as having a mono-dispersed particle size distribution with the average particle size at about 4 nm. This is well below the critical size for single domain formation and allows detailed studies of the dynamics to be performed. Recent inelastic neutron scattering results suggest that the spins at the surface of the nanometer-sized iron particles tend to become thermally disordered with increasing temperature, while the interior spins remain ordered. Future high resolution inelastic scattering studies at the CNRF are expected to measure the coherent single-domain fluctuation times and to determine the influence of surface melting and anisotropy on the domain fluctuation process.

THIRD INDUSTRY WORKSHOP IDENTIFIES CHALLENGES FOR IMPROVED POLYMER COMPOSITE PROCESSING

A group of 22 industry experts, representing companies that make or use polymer composites, gathered at NIST to review the NIST program in composite processing and to identify the important scientific and technical barriers preventing more cost-effective fabrication with these materials. The attendees represented automotive, aerospace, and electronic companies, as well as organizations involved in the supply, design, and manufacture of materials. The group expressed strong support for the NIST program and its priorities, particularly the emphasis on liquid molding which the two previous NIST workshops had identified as a most important fabrication method for the future. These experts then identified four critical issues where advances are needed: process monitoring and control technology, knowledge and control of the fiber-matrix interface, recycling, and standardized test methods and data reporting procedures (databases). In the area of liquid molding, they identified two topics as particularly critical: mold filling

and preform preparation. Mold filling was singled out because of the need for both improved process simulation models and better characterization data for input to these models. Attendees considered better preform technology as critical to reduce the time required for preform preparation and improving reliability. The workshop's conclusions will guide the NIST program in composite processing.

PULSED LASER DEPOSITION OF NANOCOMPOSITE THIN FILMS

Nanocomposite magnetic thin films of Ag-Fe_3O_4 have been prepared by researchers at NIST using, for the first time, a pulsed laser deposition technique. Initial results were presented at a special laser materials processing symposium of the Materials Research Society. Depending on the processing conditions, the films exhibited either ferromagnetic or superparamagnetic behavior. The films were formed by condensation of vapors generated by excimer laser excitation of Ag-Fe_3O_4 targets. The composition of the laser induced vapor plumes was determined using molecular beam mass spectrometry, in conjunction with optical emission spectroscopy. Both neutral and ionic species were found to be present. The plume composition was found to correlate well with that of the target. A uniform target stoichiometry was found to be crucial to the successful deposition of a nanocomposite structure, which was verified using Mössbauer spectroscopy. Currently, correlations are being made between the plume species temporal and spatial distributions and the film's stoichiometry, morphology and magnetic properties for the purpose of modeling and optimizing the deposition process.

GAS-COUPLED ACOUSTIC MICROSCOPE

The first images were obtained with a high-pressure, gas-coupled, transmission, scanning, acoustic microscope that was designed and built by NIST. The gas-coupled system enables high-resolution ultrasonic inspection of complex material systems such as electronic packages without the need for immersion in a liquid. Images of a ceramic lead frame were obtained at 20 MHz in nitrogen gas at 3 MPa. The use of high pressure reduces acoustic losses to a manageable level (50-60 dB). A resolution of 25 μm was achieved; however, lens improvements and higher frequencies offer promise of improving resolution tenfold. The novel system consists of a pressure chamber (30 cm diameter, 60 cm long); a precision (±0.05 μm) computer-controlled, six-axis, sample stage; impedance matched transducers; and associated electronics.

HIGH-RESOLUTION EXPERIMENTAL MECHANICS BY E-BEAM MOIRÉ

The resolution of strain measurements has been improved fivefold at NIST by using a scanned-electron-beam moiré technique. This new method uses electron-beam lithography to write a grating of regularly spaced lines at a density of 10 000/mm on a flat, sensitized specimen surface. The specimen is loaded mechanically under the scanning electron microscope. Moiré fringes of high contrast are produced in the SEM image when the pitch of the raster scan nearly matches the pitch of the line grating. One fringe corresponds to a relative displacement of 100 nm.

In the first study, deformation at the interface between plies of longitudinal and transverse fibers in a fiberglass-epoxy composite was examined under tensile loading. Next, NIST will use this technique to study the mechanical behavior of interfaces in various fine-scale interconnect structures found in electronics packaging, for example, the plated-through-hole structure commonly used in printed wiring boards.

NON-INTRUSIVE TECHNIQUE DEVELOPED FOR SURFACE COOLING STUDIES

NIST scientists have developed an infrared thermographic technique to study surface cooling induced by the evaporation of an impinged droplet. This is a first step in better understanding the reduction in the burning rates of materials as they are subjected to sprays of a fire suppressant. In the study, a single drop of purified water is reproducibly deposited on a cleaned ceramic surface of known initial, elevated temperature. Digitization of time-dependent 2D video imaging of the surface provides data on the difference in the radiance level between a reference surface of known emissivity and temperature and the unknown target surface of interest. Calibrations against point surface probes indicate agreement of 1–2 °C. Typical results show a sharp temperature drop in the initial portion of the evaporative transient. Such an induced thermal stress can affect the material's physical characteristics and even its local structural integrity. The method, including typical results, appears in Experimental Thermal and Fluid Science **5**, 136–141 (1992).

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NIST DEVELOPS FINGERPRINT CLASSIFICATION SYSTEM FOR THE FEDERAL BUREAU OF INVESTIGATION (FBI)

NISTIR 4880, Massively Parallel Neural Network Fingerprint Classification System, describes an automated system for fingerprint classification that uses image-based, ridge-valley features; Karhunen Loeve (K-L) transforms; and neural networks to perform pattern-level classification. On a massively parallel computer, the system achieves a speed of classification of 0.54 s per fingerprint and is capable of 88 percent classification accuracy with 10 percent rejects. As part of the FBI-sponsored development activity, a sample of 4000 fingerprints (2000 matched pairs) was collected and publicly released as NIST Special Database 4.

Neural networks have had the potential for massively parallel implementation for some time, but system-level, image-based applications employing neural networks have been realized only recently due to the complex requirements for an image system, including image isolation, segmentation, and feature extraction as well as recognition. The NIST developed system uses two neural-network-based methods for feature extraction and classification. Researchers used the K-L technique for feature extraction; this is a self-organizing method that uses no class information to select fingerprint characteristics. The image processing prior to classification takes more than 99 percent of the total processing time, while classification requires only 0.03 percent of the system's time.

RASTER GRAPHICS VALIDATION PROGRAM DEVELOPED

In support of the Department of Defense's Computer-aided Acquisition and Logistics Support initiative, NIST has been developing conformance testing programs for various standards including raster graphics conformance testing. NISTIR 4848, Raster Graphics Validation, describes the guidelines for establishing and managing raster graphics validations, which include conformance testing and, when conformance is demonstrated, the issuance of a certificate of validation. The publication provides policies, procedures, and general information needed to establish a conformance testing program for FIPS 150, Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus, a planned FIPS (Open Document Architecture [ODA] Raster Document Application Profile [DAP]), and related DoD standards and specifications. Federal agencies may specify raster graphics validation as a part of their procurement requirements.

HARDWARE DESCRIPTION LANGUAGE APPROVED AS FIPS

The Secretary of Commerce has approved FIPS 172, VHSIC Hardware Description Language (VHDL), for federal agency use. To be effective Dec. 31, 1992, FIPS 172 adopts American National Standard Hardware Description Language VHDL (ANSI/IEEE 1076-1987), which specifies the form and establishes the interpretation of programs expressed in VHDL. The new standard will promote the portability of VHDL programs for use on a variety of data processing systems.

VALIDATED PRODUCTS LIST EXPANDED

NIST has expanded the scope of its Validated Products List (VPL) which identifies information technology products tested for conformance to various FIPS in accordance with NIST's conformance testing procedures. Conformant products are issued a current validation certificate or a registered test report.

The expanded VPL includes computer language processors for programming language Ada, C, COBOL, Fortran, MUMPS, Pascal, and database language SQL; computer graphics implementations for Graphical Kernel System and Computer Graphics Metafile; operating system implementations for POSIX; open systems interconnection implementations for GOSIP; and computer security implementations for the Data Encryption Standard, the Message Authentication Code, and Key Management.

The testing of products to assure conformance to FIPS may be required by federal agencies in accordance with the FIPS, Federal Information Resources Management Regulations (FIRMR), and the associated Federal ADP and Telecommunications Standards Index issued by the General Services Administration. The VPL is updated and published quarterly; the current version is NISTIR 4871, Validated Products List 1992 No. 3, dated July 1992.

GUIDANCE ON COMPUTER SECURITY TRAINING PUBLISHED

NISTIR 4846, Computer Security Training & Awareness Course Compendium, assists federal agencies in locating computer security training resources nationwide. The publication is a compilation of information on training courses supplied by the vendors of the courses. Target audiences for training include executives, managers, and users. Requirements to conduct computer security training and awareness activities are mandated under the Computer Security Act of 1987.

77TH NATIONAL CONFERENCE ON WEIGHTS AND MEASURES MEETS IN NASHVILLE

The 77th Annual Meeting of the National Conference on Weights and Measures (NCWM), which is sponsored by NIST, was held in Nashville, Tenn., July 19–23. The meeting was attended by 316 delegates, including voting delegates representing 42 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. The status of EC 92 from the perspectives of Germany and the United Kingdom was provided. Canada's Legal Metrology Branch participated in substantial portions of the technical committee work.

The conference:

- established a Petroleum Subcommittee under the Laws and Regulations Committee to focus on issues relating to petroleum and motor fuels;
- adopted a new section on Home Food Service Sales Plans for inclusion in the Uniform Method of Sale of Commodities Regulation. The new section establishes requirements for the sale of any food item or items, alone or in combination with nonfood products or services, in a consumer's home; formed a Metric Working Group under the Laws and Regulations Committee to help guide NCWM response to recent amendments made to the Fair Packaging and Labeling Act;
- postponed voting on a proposal to establish minimum criteria for electronic audit trails used in connection with weighing and measuring devices;
- exempted certain scrap commodities from NIST Handbook 44 requirements for minimum net load to be weighed on a vehicle scale; the exemption permits smaller loads of scrap to be weighed on vehicle scales and, consequently, will reduce expensive handling costs and help to keep down the costs of recycling; and
- adopted a certification program for trainers participating in the conference's National Training Program for weights and measures officials.

NIST TRANSFERS MEASUREMENT EXPERTISE TO POWER ELECTRONICS INDUSTRY

Recent activities at NIST have resulted in three transfers to industry of NIST-developed methods of characterizing and modeling power electronic devices, in one case resulting in the development of a commercial product. A private company has announced the introduction of a power device thermal test system based upon measurement procedures developed by NIST scientists.

In the second transfer, a NIST scientist provided consultation for a private company which is interested in applying his work to industrial and commercial motor control systems. The NIST scientist presented a half-day tutorial on insulated-gate bipolar transistor (IGBT) modeling, circuit simulation, and parameter extraction. The IGBT is a significant device for applications such as motor control. As a result of his visit, company members expressed interest in supporting NIST work relating to a new class of power device, the metal oxide-semiconductor controlled thyristor.

In the third instance, a seminar was presented on the NIST power device and thermal characterization work. The private company is developing power integrated circuits for aerospace and automotive applications. One of the goals is to develop a compound semiconductor-on-silicon process using wafer-bonding techniques in order to fabricate electro-optic devices.

NIST ASSISTS INDUSTRY WITH MEASUREMENTS OF MEDIA AND HEADS FOR HIGH-DENSITY MAGNETIC RECORDING

A NIST scientist has used the recently acquired atomic force microscope (AFM) to help a private company in a study of the friction properties of high-density storage magnetic hard disks. These disks are of polished aluminum with the magnetic media applied in a spin-coating step; the resulting roughness of such a disk is in the range of 30 nm. The drive for increased storage density of hard disks leads to smaller bit sizes and, consequently, reduced distance between the head and disk. The reduced spacing (known as flying height) in turn increases the likelihood of direct contact between the head and the disk (head crash). To make a head crash less disastrous, private companies are applying very thin films of a lubricating material; for example, in the past a few tenths of a nanometer of sputtered carbon have been used. The private company is investigating both the use of lubricants and the effects of surface texture; the NIST scientist has used the AFM to image the surfaces of specimen disks that have different observed friction qualities, including disks with and without the lubricating layer. Radial line scans of the surface provide a measure of roughness that can be correlated with disk performance. The NIST scientist also has provided AFM images of

the insulating gap between pole pieces from a thin-film head; the resulting measurement of 0.25 μm is in good agreement with other methods. NIST and the company are considering a joint paper describing the work to date; future interactions with the company are likely to involve studies of disk and head topography and their magnetic signatures.

NIST HELPS ASSURE LOTTERY FAIRNESS

The mass group examined the weight of 430 ping-pong balls used by the Federal Communications Commission (FCC) to issue new licenses. With the rapid growth in communications, lotteries are conducted by the FCC as an unbiased means to give the public access to new opportunities in cellular phone communications, cable TV, and low power TV ventures that create about $1 billion worth of new business each year. The ping-pong balls are used by the FCC field offices as mechanical random number generators for lottery drawings and arrived at NIST as 17 discrete sets. NIST provides the data that give the FCC assurance that the within group weight variation is within acceptable limits.

ROBOT CHAUFFEUR

Using a video camera on the windshield and motors attached to the steering wheel, brake, and throttle, control computers are driving a vehicle along NIST's roads. This work is being performed by NIST and Florida University in support of the Department of Transportation's Intelligent Vehicle Highway System and the Department of Defense's Robotic Testbed programs. The goal is to increase highway safety, increase traffic flow, and reduce driver workload, if not replace him altogether.

The primary challenge in autonomous driving is to detect and locate the road, other vehicles, and obstacles. The system must be quick to allow high-speed driving and must be reliable under extreme variation in outdoor conditions.

The current system uses the following steps to track the painted stripes on the road and steer the vehicle along the center of the lane: First, edges are extracted from the video image. Edges occur where the brightness of the image changes, such as where the image changes from the gray road to the white stripe. Then, two quadratic curves that represent each lane boundary as it appears in the video image are updated. The system computes the coefficients of the curves using a recursive least-squares fit that filters out edges caused by shadows and other image noise. Finally, the steering wheel angle that steers the vehicle along the center of the perceived lane is calculated by steering an amount proportional to the horizontal position of the lane at a given distance in front of the vehicle. This process cycles at 15 Hz and can drive the vehicle at 40 km (25 mph) in bright sunlight, cloudy days, and at night.

RATE OF KEY PHYSIOLOGICAL REACTION DETERMINED

NIST scientists have determined the rate constant and reaction product for the key physiological reaction of nitric oxide, NO, with the superoxide anion, O_2^-. Previous studies had concluded that the reaction was too slow to be of physiological importance in biological systems. The results of this study, soon to appear in Free Radical Research Communications, demonstrate that this reaction is very fast and could be biologically significant.

The NIST work showed that this rapid reaction leads to the formation of the unstable species peroxynitrite ($^-$OONO), which then decomposes to produce highly reactive free radicals. This finding is significant because the relatively unreactive O_2^- species generates a highly reactive product radical that may be of considerable physiological importance in the cell-killing activity of macrophages and neutrophils, which are key defense mechanisms in the body.

NIST PARTICIPATES IN X-RAY BEAMLINE DEVELOPMENT AT THE ADVANCED PHOTON SOURCE

A NIST scientist recently participated in a workshop for the Synchrotron Radiation Instrumentation Collaborative Access Team at Argonne National Laboratory. The workshop's purpose was to lay out the initial design principles for x-ray beamlines that will be built at the newest synchrotron light source under construction, the Advanced Photon Source.

The Advanced Photon Source will ultimately be the national facility for experiments that require intense high energy x-ray beams, such as for x-ray diffraction. The collaborative access team (known as CAT) is a consortium of scientists from academia, government, and industry laboratories who have joined forces to submit a funding proposal to build a series of beamlines at the synchrotron light source when it comes on line in 1997. The initial proposal from a smaller number

of scientists interested in x-ray physics was combined with proposals from several groups with related interests at Argonne National Laboratory to create the CAT, which encompasses a total of six beamlines, one of the largest collaborative efforts so far. The beamlines will be dedicated to research on high resolution x-ray spectroscopy, materials microanalysis, x-ray diffraction, and x-ray optics.

The NIST scientist will coordinate the design of a beamline dedicated to x-ray diffraction and efforts to use x-ray standing waves to analyze the structure of interfaces and surfaces on an atomic scale.

SUBPICOSECOND PROBES OF LASER SURFACE HEATING

NIST scientists used femtosecond laser techniques to measure the coupling of visible light pulses to molecules bound to a metal surface. The measurements represent the first time-resolved characterization of electronic energy transfer between an excited solid and the molecules bound to its surface, and are critically important in determining new procedures to modify surfaces at low temperatures.

In these experiments, a clean Pt(111) crystal is prepared under ultrahigh vacuum conditions. Two laser pulses arrive at the crystal: an initial visible pulse that excites the crystal and a time-delayed infrared probe. Absorption of the visible pulse initially excites electrons in the metal, which rapidly relax and heat the crystal. When the experiment is repeated with a chemisorbed monolayer of CO (carbon monoxide) on the crystal, the high energy (261.0 meV) CO stretching vibration does not couple directly to the excited electrons. Rather, the data show that energy is transferred to the low frequency Pt-CO bending or rocking motions of the CO layer on the same time scale as thermal heating of the lattice.

Understanding and controlling the coupling of optical radiation to surface reactions is receiving considerable attention in catalysis, semiconductor processing, and solar energy conversion. Much of the current interest arises from the need to develop low-temperature processing methods, where the selective coupling of energy is used to modify the surface rather than in unwanted heating. These measurements demonstrate the potential of femtosecond laser diagnostics for tracking interface processes and determining whether they are electronically or thermally driven.

USING LASERS TO CONFINE ATOMS ON A LATTICE OF LIGHT

NIST scientists recently observed the quantized, oscillatory motion of atoms trapped in microscopic potential wells formed by interfering light beams. This kind of atomic behavior was predicted as long ago as 1968, but its observation has only recently been made possible by new techniques of laser cooling and spectrum analysis developed at NIST. Rubidium atoms are trapped and cooled using laser beams so their temperature is reduced to only a few microdegrees above absolute zero. These ultra cold atoms are then placed in a counter-propagating pair of interfering laser beams that create a periodic potential well. The oscillation of atoms in the wells creates a phase modulation of the light emitted by the atoms and appears as sidebands in the spectrum of that light. The spectrum has features almost a thousand times finer than the linewidth of the optical transition and contains information about the temperature of the atoms and their spatial distribution. At the lowest temperature of 2 μK, the atoms are localized to 1/15 of the optical wavelength. Using a different technique, workers in Paris have made similar observations.

The NIST work was described in the July 6 issue of Physical Review Letters.

BROADBAND PICOSECOND INFRARED SPECTROSCOPY OF SOLUTION-PHASE PHOTOCHEMISTRY

A long-standing goal in chemistry is to unravel the detailed mechanisms and energetics of how complex molecular reactions occur. Of particular interest is the development of experimental methods to probe directly short timescale reaction dynamics of industrially relevant chemical processes and biological functions. NIST scientists have pioneered a novel spectroscopic technique for directly monitoring energy flow in reaction intermediates and the appearance of products in real time with up to 10 fs (10^{-14} s) time resolution.

This method has been used to measure extremely rapid events, such as fragment ejection, product solvation, and vibrational energy flow in photochemical reactions of inorganic metal-carbonyl species in room temperature solution. Metal carbonyls are important because they function as homogeneous catalysts and are models for heterogeneous catalysis. Using a picosecond laser, a UV light pulse is absorbed by molecules such as $Cr(CO)_6$, $Rh(CO)_2(C_5H_7O_2)$ and $Co(CO)_2(C_5H_7)$ in

Hexane (C_6H_{14}). The appearance of products is observed with vibrational and structurally sensitive infrared time-resolved spectroscopy. A broadband IR pulse tuned to the CO-stretching region of the spectrum interrogates the excited sample, is subsequently upconverted into the visible spectral region, and dispersed onto a CCD multichannel detector. In this way, spectroscopic "snapshots" of the transient and product species are obtained. In all cases, CO fragment ejection occurs and solvated species are formed in 30 ps or less. The $Cr(CO)_5(C_6H_{14})$ product is found to contain CO bond excitation and cooling of this species takes about 100 ps. While the other two product species are not comprised of many more atoms or internal degrees of freedom, they surprisingly show no evidence for being formed vibrationally hot. Studies underway at higher time resolution should determine the position and energy content of chemical bonds in the reactants and products before and during solvation, thus leading to a fundamental understanding of the reactivity of these and related molecules.

NIST/NPL INTERCOMPARISON OF RADIANCE TEMPERATURE SCALES

An equivalency agreement for radiance temperature calibrations has existed since 1986 between NIST and the National Physical Laboratory (NPL) in the United Kingdom. This agreement states that the radiance temperature scales realized by NIST and NPL are equivalent over the temperature range of 630 to 1500 °C to within 0.3 K (one standard deviation estimate), and from 1500 to 2200 °C to within 1.0 K. For the first time since the 1971 radiometric intercomparison of ribbon filament lamp standards at 660 nm, the uncertainties stated in the equivalency agreement have been verified for the temperature range 1000 to 2500 °C.

In May 1992, NIST and NPL scientists intercompared the radiance temperature scales at 1000 nm using a commercially available near-infrared pyrometer, with modified optics and electronics, as the transfer standard. A second intercomparison, for the temperature range 800 to 2200 °C at 660 nm, using high-stability vacuum and gas ribbon filament standard lamps is planned for this fall.

NIST STRONGLY REPRESENTED AT SOLID STATE DOSIMETRY CONFERENCE

NIST researchers made substantial contributions to the 10th International Conference on Solid State Dosimetry held at Georgetown University, July 13–17, 1992. More than 200 participants from 30 countries attended. An invited paper on electron spin resonance dosimetry by a NIST scientist reviewed new trends and expanding applications in clinical radiography, bone dosimetry in nuclear medicine, the detection and analysis of irradiated foods, quality control for industrial radiation processing, investigations of radiation accidents such as Chernobyl, radiation imaging and microscopy for materials and biological studies, and dating of geological, archeological artifacts.

Other NIST contributions included an invited paper on the development of NIST alanine dosimeters for use as a reference standard; a report on radiation dose to bone in patients administered radiopharmaceuticals internally; a presentation on the high-resolution measurement of radial dose distributions around small beta-particle sources; and a poster paper on imaging and response characteristics of novel radiochromic films irradiated by electrons and proton beams. A paper by a NIST scientist raised considerable interest. It described a collaboration between NIST and private industry dealing with the development of novel bubble detectors for real-time imaging of gamma-ray and alpha- and beta-particles from low-level radioactive sources.

ANOMALIES IN RESONANCE IONIZATION MASS SPECTROMETRY MEASUREMENTS EXPLAINED

Resonant ionization mass spectrometry (RIMS) plays an important role in isotopic analysis, especially when the quantity of sample to be studied is very small. By combining the advantages of both lasers and mass spectrometers, RIMS has become a technique with high sensitivity and selectivity.

However, NIST scientists previously observed anomalous isotopic ratios of even and odd isotopes using broad-band radiation. This led to some doubts about the widespread applications of the technique. Stimulated by this observation, Lambropoulis and Lyras provided a theoretical explanation of the anomalous isotopic ratios observed in the tin transitions (286.3 nm), and predicted the dependence of this odd-even effect with laser intensity.

The effect is essentially due to the intensity-dependent nature of the atomic state from which the atom is ionized. For intermediate intensities, the atomic populations are equally distributed among the ground and excited states. Because the relative number of (degenerate) states differs from

odd to even, the fraction that can be ionized is also different from odd to even. In the case of tin, the odd to even ratio is approximately 4/3.

Using a RIMS system at NIST, the odd to even responses in tin samples were examined for a range of laser intensities from 10^5 to 10^{10} W/cm^2. The results agreed well with the theoretical predictions. This result is convincing evidence that the effect is now understood physically and that the resonance ionization method can be applied with significantly improved accuracies to ultrasensitive measurements of trace elements in biological or environmental samples.

NIST DEVELOPS TRANSPORT STANDARDS FOR PHASE NOISE MEASUREMENT SYSTEMS

A NIST scientist has developed the first convenient transfer standards for testing phase noise measurement systems. Phase noise considerations have been rising in importance in radars, telecommunications, and other systems where high spectral purity of signals is critical. Its presence in signal channels degrades the spectral purity and thus the performance of the system. The scientist's measurement concept is very general and can be applied from subaudio to visible frequencies. The transfer standards operate at 5, 10, and 100 MHz and are the first systems with verifiable phase noise ever produced. The accuracy is nominally 1 dB and can be improved to 0.1 dB with special calibration. The phase noise is constant in amplitude to 0.2 dB from about 1 Hz to 10 percent of the carrier frequency. This is extremely important since most commercial phase noise measurement systems have frequency dependent errors. The system also produces a standard for amplitude noise with similar flatness and accuracy. This too is a first for this area of metrology.

Commercial systems for phase noise measurements have been available for several years, but there has been no satisfactory method for assuring that such systems were indeed giving accurate readings. User measurements with these new transfer standards could eventually be used in a measurement assurance program since the transfer standard provides for testing of the entire measurement process. The measurements are currently being offered as a special test, since evaluation of the full range of user needs has not yet been completed.

SYNCHRONIZATION INTERFACE STANDARDS FOR TELECOMMUNICATIONS NETWORKS

NIST has just completed a special "Workshop on Synchronization Standards for Telecommunications Systems." A key objective of the event was to familiarize industry representatives with new, NIST-developed measures of system performance recently adopted as standards by both U.S. industry and the international telecommunications community.

The performance measures developed for specification of phase noise in components of telecommunications systems are variations of the two-sample variance developed by NIST to deal with the nonwhite noise processes found in all clocks and oscillators. Traditional statistical measures cannot be applied to such devices. NIST developed the new measures in response to an industry request for assistance arising from a recognition that traditional industry measures could not adequately support specifications for new optical fiber telecommunications systems now entering the market.

The response of the industry to NIST work in the field has been very positive, suggesting that NIST will remain heavily engaged with the industry in this area for some time to come.

ENHANCED MAGNETOCALORIC EFFECT IN IRON-DOPED GARNET MATERIALS

A class of materials with enhanced properties for cryogenic magnetic refrigeration was developed at NIST; they show a much larger field-induced entropy change than $Gd_3Ga_5O_{12}$ (GGG), the most commonly used refrigerant material for cryogenic magnetic refrigeration. This material is the first material to confirm the results of Monte Carlo and mean field calculations which predict that materials containing superparamagnetic magnetic clusters can have significant field-induced entropy changes over a range of temperatures. The new materials are formed by replacing nonmagnetic Ga atoms in GGG with Fe atoms that interact magnetically with nearby Gd atoms. At temperatures below about 30 K, the Gd moments are thought to form magnetically aligned clusters which give rise to the enhanced magnetocaloric effect.

Currently, cryogenic magnetic refrigerators have been operated in the temperature range below ~15 K, where the specific heat of GGG is low and the field-induced entropy change is large. Under an applied field of 0.9 T, the iron-doped garnet materials exhibit a field induced entropy change that is nearly five times greater than that of GGG

at 20 K, opening an avenue for development of higher temperature magnetic refrigerators having potential importance for the manufacture of liquid hydrogen in a hydrogen economy.

SMALL-ANGLE NEUTRON SCATTERING STUDIES OF NANOSTRUCTURED CERAMICS

Nanostructured powders are of technological interest because they can be processed to small-grained, fully dense ceramics that exhibit novel properties related to their unique microstructures. NIST scientists followed the microstructure evolution during sintering of nano-structured yttria using small angle neutron scattering (SANS). The results have shown that pores in the 70 nm range are clearly present in the as-pressed compacts (60-65 percent theoretical density) and in the material that had been sintered at temperatures up to 600 °C. Higher sintering temperatures produced material with increasingly larger pore sizes until, at 1200 °C, the measured scattering curve resembled that of a conventional ceramic material containing micrometer-sized pores. In contrast, compacts that had been hot-pressed (550 °C) to a higher density without sintering retained the original 70 nm pores. Further SANS studies of isochronally and isothermally sintered nanostructured yttria as well as preliminary studies of nanostructured zirconia are presently underway at the NIST Cold Neutron Research Facility. A new collaboration with a participating company in NIST's Advanced Technology Program, will result in a systematic SANS investigation of nanophase microstructure evolution during processing of extremely small-grained alumina and silicon nitride.

NIST RECOMMENDS MOISTURE CONTROL MEASURES FOR MANUFACTURED HOUSING

A NIST scientist has used his finite-difference simulation model MOIST, which predicts combined heat and moisture transfer through multilayer structures, to recommend moisture control guidelines for walls and ceiling/roofs of manufactured housing. The Department of Housing and Urban Development (HUD) is responsible for the nation's Manufactured Home Construction and Safety Standards. HUD is currently revising the standards and asked NIST to determine if changes were needed in the moisture control provisions. For controlling winter moisture accumulation in walls, manufacturers currently are allowed to install a vapor retarder at the interior wall surface, use permeable sheathing and siding, or provide an outside ventilated cavity between the siding and wall insulation.

Through yearly simulations in four cold U.S. climates, NIST found only the first practice to be effective in all climates and has recommended the others be eliminated. For ceiling/roofs, the manufacturer is required only to install a ceiling vapor retarder. Using similar simulations, NIST found that a detrimental amount of moisture accumulates in the roof sheathing of homes located in cold winter climates even with ceiling vapor retarders unless the penetrations and openings in the ceiling construction are sealed and outdoor ventilation openings are provided to the ceiling/roof cavity.

NIST AND TAIWAN COLLABORATE ON OPEN SYSTEMS INTERCONNECTION (OSI) ROUTING PROTOCOLS

In a cooperative venture with the Telecommunication Laboratories (TL) of the Directorate General of Telecommunications, Ministry of Transportation and Communications of Taiwan, NIST researchers designed and prototyped a reference implementation of and a test system for the Intermediate System to Intermediate System (IS-IS) Intra-Domain Routing Exchange Protocol. IS-IS is an OSI protocol designed to dynamically facilitate effective routing and to help provide connectionless data communications services.

Major accomplishments of the 2 year project included expediting the progression of the IS-IS protocol from a draft standard to an international standard; using a formal description technique (FDT) and developing FDT tools to automate the development of an IS-IS Protocol reference implementation; and using a FDT and NIST-developed tools to automate the development of the IS-IS Multi-Party Conformance Test System (IS-IS MPCTS). The system was used to test commercial IS-IS products for conformance to the IS-IS standard in NIST's Cooperative Routing Laboratory.

SPATIAL DATA TRANSFER STANDARD APPROVED AS FEDERAL INFORMATION PROCESSING STANDARD (FIPS)

On July 29, 1992, the Secretary of Commerce approved the Spatial Data Transfer Standard (SDTS) as FIPS 173. To be effective Feb. 15, 1993, FIPS 173 will facilitate the transfer of digital spatial data between dissimilar computer systems.

The SDTS provides specifications for the organization and structure of digital spatial data transfer, definition of spatial features and attributes, and data transfer encoding. The standard was developed through a government and industry cooperative effort headed by the Department of the Interior. In addition to serving as the national spatial data transfer mechanism for federal agencies, the SDTS is being made available for use to state and local governments, the private sector, and academia.

NEW PUBLICATION FOCUSES ON GRAPHICAL USER INTERFACES (GUIs)

NISTIR 4876, An Introduction to Graphical User Interfaces and Their Use by CITIS, describes GUIs and the options for their use within the Contractor Integrated Technical Information Service (CITIS). A GUI is a powerful tool used for simplifying a computer environment. The report provides a tutorial on the various meanings of the term GUI, describes the usefulness of GUIs, identifies problems with GUIs, and recommends that the X Window System GUI be used within the CITIS specification. The work supports the Department of Defense (DoD) Computer-aided Acquisition and Logistics Support (CALS) initiative.

CATALOG OF CODE SETS UPDATED

Federal Information Processing Standard (FIPS) 19-1, Catalog of Widely Used Code Sets, has been updated and is being published as FIPS 19-2. The catalog lists and briefly describes code sets in wide use in the United States that may be useful in federal data systems. The standard format that describes each code set specifies code characteristics, maintenance agency, source document, and other relevant data. FIPS 19-2 will assist federal agencies and other organizations in selecting appropriate code sets and in avoiding duplication.

MAINFRAME COMPUTER TAPES SUBJECT OF NEW PUBLICATION

NIST Special Publication 260-118, Calibration of NIST Standard Reference Material 3202 for 18-Track, Parallel, and 36-Track, Parallel Serpentine, 12.65 mm (0.5 in), 1491 cpmm (37871 cpi) Magnetic Tape Cartridge, focuses on the square cartridge tapes used by mainframe computers. The report describes the testing methodology, the measurement system, the procedure for selection of a Master Standard Reference tape, and the procedure for use of the Standard Reference Material.

Standard Reference Materials

ACCURATE DNA FINGERPRINTS ASSURED BY NEW SRM

To help ensure DNA profiles are as accurate as possible, NIST has developed a new quality assurance standards set, the first of its kind for forensic and medical labs. Known as Standard Reference Material 2390, it was developed at NIST with support from the National Institute of Justice. DNA profiles, also called "DNA fingerprints," are being used with increasing frequency as evidence in criminal cases involving rape or murder, in civil suits over paternity, and as "DNA dog tags" for soldiers. Eventually, the improved accuracy in DNA typing established by the SRM could make this new technology acceptable in more courtrooms. The SRM contains male and female DNA molecules extracted from living cells, as well as precut fragments of a viral DNA that can be used as a genetic ruler. It also includes tubes, each containing 3 million human cells from which DNA can be extracted and tested. SRM 2390 is available for $374 from the Standard Reference Materials Program, Rm. 205, Building 202, Gaithersburg, MD 20899, (301) 975-6776, fax: (301) 948-3730.

STANDARD REFERENCE MATERIAL 1842, X-RAY STAGE CALIBRATION BOARD

Automated x-ray inspection systems frequently are used to assure the quality of mechanical parts. Individual turbine blades destined for assembly in jet engines serve as one example.

This new SRM is intended as a reference standard for checking the operation of automated x-ray inspection systems. It is used to establish the accuracy of the X and Y stage encoders and for measuring long-term drift in the drives or encoders. It also is used to calibrate variable magnification systems. The board contains a calibrated pattern of through-thickness holes which can be imaged by the x-ray system. It is expected that various x-ray system manufacturers will develop software routines that will perform automatic evaluation of their systems and generate reports that can be used to monitor system performance.

STANDARD REFERENCE MATERIAL 676, ALUMINA INTERNAL STANDARD FOR QUANTITATIVE ANALYSIS BY X-RAY POWDER DIFFRACTION

X-ray powder diffraction long has been the primary technique for obtaining information about the crystalline structure of materials, such as ceramics. In turn, this information can be used to predict material characteristics and performance in order to select the best process for production.

The Standard Reference Materials Program announces the availability of Standard Reference Material (SRM) 676 for use as an internal standard for quantitative analysis and I/I_c determinations by x-ray powder diffraction. The SRM is composed of phase-pure alumina (corundum structure) powder that is characterized by sub-micrometer equi-axial grains that have been de-aggregated and calcined to eliminate preferred orientation effects and to ensure homogeneity. An extensive study determined the character of this material to be optimal for accurate x-ray powder diffraction intensity measurements.

Certified lattice parameters, a and c, and certified relative intensity data at various scan angles (low/high) 2θ over the scan range are given. The lattice parameter values were determined by means of the least-squares refinement of measurements from 40 peak positions. The relative intensity data were collected and processed with an algorithm that scans specific peaks for an integrated intensity measurement.

STANDARD REFERENCE MATERIAL 659, PARTICLE SIZE DISTRIBUTION STANDARD FOR SEDIGRAPH CALIBRATION

The Standard Reference Materials Program announces the availability of Standard Reference Material (SRM) 659 for calibrating and evaluating equipment used to measure particle size distributions in the 0.2 to 10 μm range. Measurement of such powders is important to the success of industries making products as diverse as Portland cement and cosmetics. The SRM's primary impact will be in the advanced ceramics industry where knowledge of the particle size distribution is necessary for process control.

The SRM is composed of silicon nitride powder that is characterized by equi-axial primary particles with a mean dimension of ~1 μm and a minimal amount of large agglomerates. Certified size distribution values are reported at five selected cumulative weight percentiles (20, 25, 50, 75, and 90) and were established with measurements generated on two x-ray sedimentation instruments.

STANDARD REFERENCE MATERIAL 2579 – LEAD PAINT FILM ON MYLAR SHEET FOR PORTABLE X-RAY FLUORESCENCE ANALYZERS

Portable hand-held x-ray analyzers are being used to field test building surfaces, both interior and exterior, to identify buildings requiring lead abatement treatment. Abatement is a national priority, to reduce lead poisoning, as public health officials now recognize that serious adverse affects from lead exposure occur in children at blood levels previously believed to be safe. Most of the exposure cases originate from the home environment and are directly related to the extensive past use of lead-based paint.

The Standard Reference Materials Program announces the availability of Standard Reference Material (SRM) 2579 for checking the calibration of portable x-ray analyzers used in mandated lead screening programs. The SRM consists of a series of five color-coded mylar sheets, one a blank, and the other four coated with lead paint at different concentration levels. The lowest of these is 0.29 mg/cm^2, and the highest is 3.53 mg/cm^2. The sheets are over-coated with a lead-free lacquer to protect the surface from damage in field use.

Standard Reference Data

CHEMICAL KINETICS PC DATABASE EXPANDED

A major resource for research chemists, environmental scientists, and combustion engineers now includes information on 6900 chemical reactions with more than 20 000 individual data entries. The Chemical Kinetics Database, NIST Standard Reference Database 17, Version 4.0, is an important tool for modeling combustion systems or chemical processes occurring in the atmosphere. These data are necessary, for example, in predicting the atmospheric lifetimes of chemicals that may impact on the depletion of the Earth's ozone layer. The database provides the bench scientist with fast, easy access to information. In a few minutes, a user can examine all available data for many different

reactions, compare the rates measured to their own data, generate files for inclusion in a modeling program, or produce literature citations that can be used in a word processor. NIST SRD 17, Version 4.0, is available for $390 from the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899, (301) 975-2208, fax: (301) 926-0416. Owners of a previous version can update for $125.

PC DATABASE AVAILABLE ON TRANSIENT MOLECULES

NIST has expanded the personal computer (PC) database for spectroscopic information on short-lived molecules. Information on the sequence of chemical reactions is important to physical chemists, environmental researchers, combustion engineers and others concerned with complex chemical processes. The Vibrational and Electronic Energy Levels of Small Polyatomic Transient Molecules Database (VEEL), Version 2.0, now contains more than 1300 transient molecules with 3 to 16 atoms. The program has been improved from an earlier version to permit faster searches and provide more flexible formula entry requirements. The expanded VEEL database is available for $390 from the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899, (301) 975-2208, fax: (301) 926-0416. Owners of a previous version can upgrade for $50.