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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, Building 820, Room 126, Gaithersburg, MD 20899-0001; telephone: 301/975-3572.

IMPLEMENTATION OF THE ACCREDITATION BODY EVALUATION PROGRAM (ABEP)

The Office of Standards Services is preparing to implement the regulations developed under the Fastener Quality Act (P.L. 101-592). The Accreditation Body Evaluation Program (ABEP) has been established to evaluate laboratory accreditation bodies for NIST recognition; they, in turn, may accredit competent fastener testing laboratories. All laboratories accredited in accordance with procedures set forth in the act may issue test reports acceptable under the act and governing regulations. Under the ABEP program, NIST evaluates both foreign and domestic laboratory accreditation bodies that apply for recognition. A training session was conducted recently for five contracted technical experts who will serve as on-site assessors, technical advisers, and members of review panels for the ABEP program. Once the final regulations are published, ABEP staff and these technical experts will begin performing assessments of applicant accreditation bodies.

U.S.-CHINA WORKSHOP ON CONFORMITY ASSESSMENT

A delegation of officials from the China State Bureau of Technical Supervision (CSTBS) recently participated in a one week workshop at NIST, on conformity assessment practices and issues. The workshop, co-sponsored by NIST and the American National Standards Institute (ANSI), followed a visit to China by a delegation (including a NIST representative) organized by ANSI. CSTBS, the Chinese national body responsible for standardization, metrology, and quality assurance, sought an exchange of information on standards-related matters that can significantly influence trade and Chinese industrial policy as it reforms its economy. The workshop discussions included the roles of the public and private sector in developing standards and regulations, the conduct of laboratory accreditation and certification, and trade policy. NIST and CSTBS agreed to pursue further exchanges of information and cooperation in these areas.

ENERGY-RELATED INVENTIONS PROGRAM MAKES RECOMMENDATIONS

During July 1996, NIST recommended an innovative technology for commercialization to its Department of Energy partner under the Energy-Related Inventions Program.

- Apparatus and Method for Filtering Molten Metal. An automated means of filtering slag, dross, and other non-metallic impurities from molten metals, through the use of refractory filter cloth, in the process of casting metal parts on injection metal casting machines. Laboratory data to date indicate that the process will reduce rejects by about 5 % and the improved strength properties resulting from removal of non-metal particulates will permit making substantial reductions in part weights while maintaining required physical properties.

USTTI-NIST WORKSHOP ON STANDARDS AND CONFORMITY ASSESSMENT FOR TELECOMMUNICATIONS

In cooperation with the U.S. Telecommunication Training Institute (USTTI), NIST provided a one-week workshop from July 15–19, 1996, on standards and conformity assessment for telecommunications to a group of nine participants from eight developing nations on four continents. The participants from Cambodia, Honduras, Georgia, Moldova, Philippines, Romania, Suriname, and Zimbabwe work for the

telecommunications regulatory body or national telecommunications provider in their countries. The workshop included presentations by the staffs of NIST and several private-sector standards organizations, plus visits to local laboratories and companies, providing technical and conformity assessment concepts to the participants. Their goals include deregulation of telecommunications, policy setting, planning for building their telecommunications infrastructure, and standards development and management.

NEW METHOD FOR CHARACTERIZING UNIFORMITY OF $LINBO_3$ OFFERS ORDER-OF-MAGNITUDE IMPROVEMENT IN SENSITIVITY

A NIST scientist working with industrial collaborators, has demonstrated that a method he developed for characterizing the uniformity of lithium niobate substrates is an order of magnitude more sensitive than methods previously available. Use of the method, known as Maker fringe analysis, as a diagnostic tool will provide material suppliers with new opportunities to improve their products. Modulators based on lithium niobate modulators are used widely in optical communications systems, particularly where their ability to operate at very high speeds is important, and are a key component in optical fiber gyroscopes. Harmonic generation in lithium niobate waveguides is a potential source of blue light for optical data storage.

For many years, inadequate material uniformity and consistency has been one of the major complaints of manufacturers of integrated optic devices based on lithium niobate. Variations in the Li/Nb mole ratio of as little as 10^{-4} can lead to changes in the extraordinary refractive index of the order of 10^{-5} and can have a substantial impact on the way light is guided in these devices. Some of the nonuniformities arise in crystal growth, but lithium ion migration during the electric poling of the ferroelectric material is also known to affect uniformity. Stress is another cause of nonuniformity. For examining compositional variation, commonly used methods such as Curie point measurements are 10 times less sensitive than the Maker fringe method.

Nonlinear optical interactions are extremely sensitive to material characteristics. The Maker fringe method of examining a nonlinear optical material involves recording the dependence of the transmitted second harmonic light on the angle of incidence of the fundamental pump beam. The data are typically oscillatory with angle and are called a Maker fringe pattern, after the scientist who first reported the effect. The character and envelope of the fringe pattern are dependent on a number of parameters, including birefringence, index of refraction, and sample thickness, and it is from these quantities that the scientist is able to identify extremely small nonuniformities. His measurement allows mapping of the properties of lithium niobate wafers 100 nm in diameter by scanning the wafers through the pump beam. The NIST scientist and his collaborators are correlating the wafer maps from the Maker fringe technique with x-ray topography data and $LiNbO_3$ device measurements, with the goal of increasing device performance and yield.

NIST PROVIDES CALIBRATION MEASUREMENTS OF NEW NASA REVERBERATION CHAMBER TEST LABORATORY

A new high-intensity radiated fields (HIRF) test facility at NASA Langley Research Center was brought one step closer to full operation earlier this summer when a team of engineers from NIST arrived to calibrate and characterize the facility's three electromagnetic reverberation chambers. The reverberation chambers, also known as mode-stirred chambers, with volumes ranging from 17.0 m^3 to 291.0 m^3, are a major component of the High Intensity Radiation Laboratory at NASA. The unique capabilities of the chambers allow these NASA units to conduct electromagnetic interference and electromagnetic compatibility research, which currently cannot be carried out in private industry, in pursuit of the improvement of commercial and general aviation reliability and safety. Specifically, this research provides assistance to the Federal Aviation Administration and the aerospace community in the development of cost-effective methodology, assessment, and measurement techniques for the HIRF certification and testing of aircraft such as the Boeing 777.

As a requirement for becoming fully operational, the chambers had to be characterized and calibrated with measurements traceable to national electromagnetic field standards maintained by NIST. The NIST team worked onsite for a little over a month to carry out a sufficiently detailed characterization to permit comparison with other established chambers and give credibility to subsequent testing performed in the chamber, backed by a detailed calibration report. The characterization measurements that the NIST team conducted are under an interagency agreement for sharing technology and research expertise and will hallmark the validity, accuracy, and reliability of all measurements conducted in the reverberation chambers of NASA's facility. These chambers are capable of simulating electromagnetic environments that may exist in aircraft cavities at any frequency above 80 MHz. Much evidence exists to

suggest that aircraft cavities behave as electromagnetic reverberation chambers, and this view supports the use of these chambers as one of the most practical and cost-effective methods to generate electromagnetic fields for testing airborne systems for HIRF susceptibility, together with other desirable features of reverberation chambers such as the ability to generate high-level fields for modest amounts of input power.

NIST DEMONSTRATES NOISE FIGURE MEASUREMENTS FOR LOW-NOISE AMPLIFIERS

In response to industry needs, NIST scientists have developed methods for determining the noise figure of low-noise amplifiers (LNAs) and recently demonstrated NIST capabilities by measuring the noise figures of two state-of-the-art commercial LNAs. The availability of inexpensive, very low noise amplifiers has contributed greatly to the boom in the communications industries, as exemplified in the sales of such items as cellular telephones and personal receivers for satellite television. It is crucial to know the noise properties of LNAs accurately, especially noise figures, to be able to use them in commercial applications. Measurement of low noise figures is a very difficult task, requiring special techniques, both because of the low noise powers involved and because the noise figure varies dramatically with the impedance of the source.

The amplifiers were measured at 2 GHz, 3 GHz, and 4 GHz, and the noise figures were near 0.4 dB, with uncertainties as low as 0.04 dB for amplifiers whose connectors match those of NIST's primary standards (0.08 dB when an adapter was required). In terms of an effective input noise temperature, this value corresponds to about 30 K to 40 K, with uncertainties as low as 3 K, within 20 % of the limit set by the accuracy of the NIST primary noise standard. These are the first noise-figure measurements NIST has issued to the public.

NIST RESEARCHER CHAIRS FLAT-PANEL DISPLAY MEASUREMENTS STANDARDS GROUP

A NIST researcher has been appointed to chair the Video Electronics Standards Association (VESA) Flat Panel Display (FPD) measure-ments working group. This appointment provides an opportunity for NIST to foster the incorporation of sound metrological practices in VESA FPD standards. U.S. electronics manufacturers need to be able to evaluate displays to be incorporated in their products, but accurate, reliable methods are not available for measuring parameters such as contrast ratios, luminance, and uniformity.

As the number of products incorporating FPDs continues to increase, the problem becomes even more critical. These unmet needs for specific measurements and standards affect a wide portion of the industry: manufacturers of displays, manufacturers using displays in their products, and users or consumers. As a result, there is general agreement that the U.S. electronics industry stands to benefit greatly from the development of internationally recognized standards for the measurement of FPD parameters. Given its laboratory-based capabilities, NIST is in a unique position to respond to these needs; the NIST approach is to build upon existing tests for cathode-ray-tube displays for parameters such as uniformity, luminance, contrast, and screen loading, and to make appropriate adaptations to the characterization of FPDs. VESA is considered to be a formative influence in the PC industry, with standards development in three groups: display, interactive media, and systems (for example, recent VESA standards were designed to support monitor, FPD, and unified memory architecture technologies).

NIST COMPLETES DIAMOND TURNING PROJECT WITH PENN STATE RESEARCHERS

A NIST scientist, working with Pennsylvania State University researchers, completed a study of chip formation in high-speed machining. The study included chip formation and segmentation in the diamond turning of aircraft-grade titanium alloy, chatter stability in single point turning, and high-speed grinding of titanium.

The chip formation study revealed a disturbance in the cutting force that corresponds to the segmentation of titanium chips during turning. These high-frequency force oscillations, which are much higher than can be measured with conventional instrumentation, were measured experimentally with a specially designed tool holder containing a thin piezoelectric film.

The exploration of chatter in diamond turning provides additional data on the stability of single-point machining. A number of theories regarding the limiting depth of cut have been developed in recent decades, but few researchers have obtained experimental verification. This work yielded cutting-test measurements from a specially designed cutting tool flexure, which were used in a new cutting model that incorporates nonlinearities in the material removal process.

High-speed grinding of titanium demonstrated that titanium alloy can be ground using new superabrasive grinding wheels. These wheels have diamond or cubic boron nitride plating and are typically run at speeds several times higher than conventional grinding practice allows, resulting in almost double the material removal rate.

ELECTROCHEMICALLY DRIVEN BIOTRANSFORMATION

Stereospecific hydroxylations have applications in the production of pharmaceutical intermediates, the production of optically pure agrochemicals, and the production of novel monomers for use in producing polymers. Biocatalysis is emerging as an alternative to traditional organic syntheses for making these compounds, but these reactions are not easy to optimize to industrial scale. Sources of reducing power such as complex biochemical co-factors can be costly, and cells often can not turn the reactions over fast enough to achieve economical rates of production.

Researchers at NIST have developed a solution to these problems by using functionalized electrodes to replace the co-factor NADH and one or more of the protein partners used by cells to achieve the electron transfer required for hydroxylation reactions. They are demonstrating the technique using the hydroxylation of camphor as a model system. This reaction is catalyzed by the cytochrome $P450_{cam}$ system, which consists of three enzymes: putidaredoxin reductase (flavin reductase), putidaredoxin (ferredoxin), and $P450_{cam}$ monooxygenase (hydroxylase). These subunits pass electrons around, providing reducing power to fix diatomic oxygen at the reducing center. By using a functionalized metal-oxide electrode instead of NADH, the researchers have shown that an electrode can be intervened at the point where an electron is passed to ferredoxin, bypassing the reductase protein with no loss in reaction stereospecificity. The system provides a generic approach to bringing oxidation/reduction equivalents into a reaction. The group is developing new, advanced spectroscopic methods for measuring electron transfer in proteins that will be useful in monitoring and optimizing the electrochemical process. They also are putting together a patent on the use of the electrode with putidaredoxin. Commercialization opportunities exist where stereospecific reactions are important for reducing side effects in pharmaceuticals and agrochemicals, and for reducing the environmental burden in chemical manufacturing.

NIST REALIZES ITS-90 FROM 0.65 K TO 5 K WITH UNPRECEDENTED ACCURACY

NIST recently has completed the most accurate realization to date of the International Temperature Scale of 1990 (ITS-90) from 0.65 K to 5.0 K using vapor-pressure thermometry with ^{3}He and ^{4}He. The results will be published in an upcoming edition of the journal Metrologia. The vapor-pressure realizations were performed in a new NIST facility designed to realize ITS-90 from 0.65 K to 83.8058 K in a single copper block. The block has separate cells for ^{3}He and ^{4}He. From 0.65 K to 3 K. ITS-90 is defined by the vapor-pressure/temperature relations of ^{3}He and from 1.25 K to 5 K it is defined by those of ^{4}He. The overlap of definitions from 1.25 K to 3.2 K results in a possible nonuniqueness of the scale over this range, since both definitions are considered equally valid.

The expanded uncertainties (coverage factor k=2) of NIST's ITS-90 temperature realizations are 0.12 mK or less over 97 % of the ranges of the ITS-90 definitions and reach a maximum value of 0.16 mK. From 1.8 K to 5.0 K, they are 0.05 mK or less. Contributions to the uncertainties in the realizations come from the pressure measurement system, pressure corrections accounting for aerostatic pressure head and thermomolecular effects, temperature control of the cells, and the resistance measurement system used for calibrating the thermometers. The two published realizations from other national laboratories have corresponding uncertainties of 0.3 mK and 0.5 mK. The small uncertainties of NIST's realizations will allow thermometer calibrations at NIST with considerably higher accuracy. Additionally, the NIST results are sufficiently accurate to demonstrate a nonuniqueness of approximately 0.2 mK in the ITS-90 definition in the overlap region (1.25 K to –3.2 K).

As part of this work, three rhodium-iron resistance thermometers, which held NIST's previously maintained wire scale, were calibrated in terms of ITS-90. The NIST measurements indicate that the previous wire scale differs from the current ITS-90 scale by as much as 0.9 mK below 1 K and by as much as 0.5 mK (in the opposite direction) above 1 K. These comparison measurements clarify the relation between the past and present scales disseminated by NIST and show the degree of self-consistency of the ITS-90 scale that is expected to be the international standard for many years to come.

NEW ANALYTICAL CHEMISTRY MEASUREMENT CAPABILITIES AFFORDED BY COLD NEUTRON RESEARCH FACILITY UPGRADE

The cold-neutron prompt-gamma activation analysis (PGAA) and neutron depth profiling (NDP) spectrometers have been rebuilt to take advantage of the newly installed cold neutron source at the Cold Neutron Research Facility at the NIST Research Reactor. The new source, a spherical shell of liquid hydrogen 32 cm in diameter and 2 cm thick, produces a higher neutron density at a longer wavelength than did the old D_2O ice source that had been in use since 1987.

At the PGAA spectrometer, located 41 m from the cold source on neutron guide NG7, the effective neutron fluence rate is a factor of six higher than before. The sample-detector assembly has been re-designed for improved precision in sample positioning and also to provide the additional radiation shielding required by the more intense neutron beam. Exchangeable collimators adjust both the size of the neutron beam and the field of view of the gamma detector as the nature of the sample requires. Using a tapered lead collimator, shaped so that gamma emission from the entire 2 cm sample diameter illuminates the full diameter of the detector, the new geometry gives a fourfold higher analytical sensitivity than previously reported. In order to change samples, a stepping motor translates the approximately 1000 kg sample-detector assembly perpendicular to the neutron beam, giving unobstructed access to the sample for alignment. A neutron focusing lens based on capillary optics has been installed to perform high-sensitivity spatially resolved PGAA with submillimeter resolution. Early measurements with the improved instrument include hydrogen in a wide variety of materials at levels down to 10^{-5} g/g, and boron in ultrapure quartz.

The cold-neutron depth-profiling instrument has been placed on a curved supermirror guide, NG–0. The neutron guide acts as a lightpipe, with the longer wavelength neutrons being preferentially conducted to the NDP chamber. Because the guide is curved, the NDP chamber does not directly view the reactor core and its associated fast neutrons and gamma rays. Therefore, the 13.5 cm thick sapphire filter previously used in the beam is no longer necessary. There are additional positive aspects of the use of the neutron guide over the previous collimated beam. A larger beam area is now available (15 cm^2 increased from 8 cm^2); the beam is uniform over this entire area whereas there previously was a noticeable penumbra effect, and the full divergence of the beam has been reduced from 3° to 2°. These beam characteristics enable the use of a neutron lens for NDP, and a prototype has already been tested. A neutron lens will permit the analysis of submillimeter sample areas. The increase in the effective cold neutron fluence rate at the end of the curved guide leads to an improvement in the detection limit of more than a factor of four over that of the previous depth profiling instrument. The increased neutron fluence rate and decreased gamma-ray background makes nitrogen profiling much more feasible. Depth profiles of TiN already have been performed with the new beam.

NEW THEORY FOR SMALL METAL CLUSTERS

A new theory has been developed at NIST for treating the pseudorotation problem observed in high-resolution double-laser measurements on supersonically cooled beams of the metallic Na_3 cluster. Pseudorotation in Na_3 refers to a process in which the role of the middle sodium atom is played in turn by each of the three members of the cluster. A study of pseudorotation represents a study of one manifestation of the important property of atom mobility in small clusters. Mid-sized transition metal clusters are important as industria catalytic sites, but their energy level structure (which strongly influences their catalytic activity) is difficult to study at the present time. The small-sized alkali cluster studied here in detail for the first time offers the chance to refine both the experimental and theoretical techniques necessary to extend metal cluster research.

CHEMISTRY OF THE COSMOS

How do scientists on Earth do chemistry experiments in outer space? Just as traditional astronomers use light from the stars to map out the galaxies, radio astronomers listen to radio signals to map out the chemicals found in interstellar space. Radio telescopes are used to pinpoint the sources of these microwave radio signals, in which each chemical species transmits a characteristic spectral signature, unique as a fingerprint. This information, combined with basic knowledge of chemistry, allows inferences to be made about what reactions are occurring, and where.

Using an array of radio telescopes more sensitive than those used in the past, researchers from the University of Illinois, working with NIST, have made the first discovery of acetic acid, the essence of vinegar, in a cloud of dust and gas near the center of our galaxy, the Milky Way. This important discovery is the latest step in the search for glycine, the simplest amino acid and a building block of protein. Since acetic acid can react with ammonia (also found in space) to form glycine, the search continues for direct evidence of biomolecules elsewhere in the cosmos. These remote sensing experiments have added to the growing body of information about the role of organic chemicals (those associated with life on Earth) in space.

NIST has been measuring molecular spectra of interest to astronomers for many years. NIST measured the microwave spectra of acetic acid nearly a decade ago and was the first to measure the spectrum of the most stable form of glycine. Based on its work and the work

of other laboratories, NIST compiles for the astronomical community a critically evaluated catalog of the spectra of the compounds that they might discover in their explorations.

HIGH-ACCURACY SCALE FOR ABSOLUTE SPECTRAL RESPONSE

A central problem in optical metrology is to link optical power, in watts, to other forms of power, such as electrical, mechanical, and thermal. The exacting process of realizing a principal NIST optical power scale, that of spectral responsivity, has been described in a series of recent papers.

In the March 1, 1996, edition of Applied Optics, the story begins with the detailed analysis of the primary standard, the high-accuracy cryogenic radiometer (HACR), which measures optical power in terms of electrical power. This paper describes the construction, operation, and measurement uncertainties of the HACR, which has a combined relative standard uncertainty of 0.02 % under the proper conditions. An article in the Aug. 1 edition of Applied Optics tells the next chapter in the story, how the HACR data are used to realize the NIST absolute spectral response scale over the entire spectral range from 406 nm (ultraviolet) to 920 nm (infrared). Typical relative standard uncertainties are 0.03 % over this range. Finally, the measurement services that NIST offers, based on the scale, are explained in the March–April 1996 issue of the *NIST Journal of Research*. These services are backed by a quality system that conforms to ANSI/NCSL Z540-1-1994. The expanded relative uncertainty in the calibration of customer detectors is typically 0.22 % (coverage factor k=2), owing to the nature of these detectors. While these results represent a substantial improvement in the basis and the delivery of the services, NIST continues to explore new detector designs to improve the measurement uncertainties at each stage of the process.

FIFTH SIRREX HELD AT NIST

NASA's SeaWiFS Project (sea-viewing, wide field-of-view sensor) will use satellite observations to measure the spectral radiance (the color and magnitude of the light) reflected from the oceans. From this, scientists from the oceanographic community will be able to map the concentrations of chlorophyll and photoplankton. These microorganisms are essential to the process of reclaiming carbon dioxide from the atmosphere, which affects the modeling of global warming. Photoplankton are sensitive to the temperature, salinity, and chemical makeup of their ocean environment, and measurements of them from space can be used to document the patterns of ocean currents and the climatic changes in the water.

The fifth SIRREX (SeaWiFS Intercalibration Round-Robin Experiment) was held at NIST recently. Forty-seven scientists from the U.S. Government, industry, academia, and other nations (Taiwan, Japan, England, Germany, Italy) used the NIST facilities to validate the radiometric accuracy and the long-term stability of the SeaWiFS instruments and to validate the atmospheric correction models that convert measured radiances to normalized water-leaving radiances. Some experiments were performed at a NIST pond; others were performed at a reservoir at Little Lake Seneca dam in Germantown, MD. This lake was deep enough to submerge instruments, and it had chlorophyll and sediment that provided realistic data.

The SeaWiFS satellite is expected to be launched this winter. SIRREX-6 will be held next summer (1997) in the Atlantic Ocean, off the coast of Nova Scotia.

NEW OBSERVATION OF SPECTRUM OF IRON ION

A NIST scientist along with researchers from Oxford University and the University of Bonn, recently made the first direct observation of a far-infrared fine-structure transition of the Fe^+ ion. They used laser magnetic resonance spectroscopy to make their observation of the $J = 3/2 \rightarrow J = 1/2$ transition at 86.7 μm. The ground state of this ion is a ^6D state. Their direct observation of this transition yields a frequency with an uncertainty some 100 times smaller than that of indirect observations made using differences of optical-wavelength measurements.

Iron is presumed to be an abundant interstellar species and its spectrum is prominent in solar observations. However, it has never been observed in interstellar space. This new observation provides radio astronomers with a reference for a search for this particular species.

PAPERS ON TRAPPED IONS AND LASER COOLING PUBLISHED

The ion storage group at NIST recently published a collection of 22 of their papers in a single volume. Trapped Ions and Laser Cooling IV (NIST Technical Note 1380) covers the period from May 1992 to January 1996. The primary focus of the ion storage group is high-resolution spectroscopy, especially as it pertains to the development of extremely accurate and stable atomic frequency standards. The group also performs research in related areas such as laser stabilization, quantum state control, quantum noise, quantum logic gates, light scattering from single atoms, ion plasmas, and single-electron dynamics. This is the fourth in a

series of Technical Notes covering the output of this NIST research program.

COMPUTER TIME SERVICES EXPAND

NIST operates two time services: one through the telephone system and one through the Internet. Both systems have been expanded recently to accommodate increased usage. The Automated Computer Time Service (ACTS), which provides digital signals through the telephone system, has been expanded to 14 telephone lines, 12 for use with high-speed modems and two for use at low speed where the modem delay is more predictable. Since this system provides a mechanism for measuring telephone transmission delay, the latter option provides lower uncertainty (1 ms to 3 ms). ACTS now handles more than 10 000 calls per day, and usage is still growing.

The NIST Network Time Service, introduced less than 2 years ago, also has grown dramatically. Three servers are now handling nearly 200 000 calls per day, and three new servers will be added this year, bringing the total to six. Two will be in Boulder, two in Gaithersburg, and two on the West Coast. This will allow users in the United States to select a server in reasonable proximity, thus minimizing transmission delay. A NIST scientist recently developed a Windows® program, NISTIMEW, for using the network service. This user-friendly program will be available for distribution upon completion of testing. An increasing number of commercial software programs are being written for accessing time through these services, so large growth in usage is expected to continue.

NIST CONSORTIUM FORMED TO DEVELOP MEASUREMENT METHODS FOR ORTHOPEDIC DEVICES

Six companies that manufacture total joint replacements such as artificial hips and knees have entered into Cooperative Research and Development Agreements (CRADAs) with NIST as a consortium to identify methods for accelerated screening tests of new materials. The companies are among the principal orthopedic implant manufacturers, and they collectively account for about 70 % of the U.S. production of artificial joints. Orthopedic implant business is about $3.5 billion annually, with American manufactures holding a commanding share. A major concern of the medical device community is the degradation of implant materials through wear processes. Wear debris from artificial joint materials may contribute to the dissolution of bony tissue, which leads to loosening of artificial joints in approximately 10 % of patients. The development of new, more wear-resistant materials is, therefore, a major priority.

Prior to clinical applications, new materials are currently evaluated through expensive and time-consuming simulation studies using complex biomechanical simulators. This serves to limit the number of new materials which may be evaluated and, therefore, reduces the likelihood of rapid improvement in joint implant prostheses. Other methods for screening potential improvements in materials, such as pin-on-disk tests, are faster, but the results correlate poorly with those from simulators. These methods are not considered highly reliable and may also overlook promising materials. Moreover, there is no industry-wide agreement on which test methods hold the most promise for accelerated screening for wear-resistant materials so each company has been independently pursuing its own approach. To help alleviate this problem, NIST will coordinate a research plan consisting of a technology survey, round-robin testing, data analysis, and investigation into new test methods. Two material suppliers have pledged to assist the research by supplying materials and sharing test information. A NIST scientist will serve as technical director and another as manager of the CRADA-formed consortium.

FIRST DIRECT OBSERVATION OF FIXED ELECTRO-OPTIC GRATINGS IN PHOTOREFRACTIVE MATERIALS

Fixed (enduring) photorefractive gratings have been imaged for the first time, both in barium titanate and in strontium barium niobate, by means of synchrotron x-radiation. These materials are widely considered to have unusual promise for increased capacity in the storage of digital information. Data that are encoded in them in the form of photorefractive gratings can be read out rapidly by lasers. The longevity and uniformity of these gratings are keys to success in this new technology. Diffraction images of the fixed photorefractive gratings, made at the National Synchrotron Light Source at Brookhaven National Laboratory, are enabling NIST to examine the critical influences of the various material irregularities on these gratings as well as their causes and their influence on the duration of the stored data. Principal challenges in the exploitation of these materials for high-density information storage appear to be inefficiently arranged anti-parallel ferroelectric domains and periodic variations in the lattice uniformity, striations which interfere with laser read-out of the data.

INTERNATIONAL CONFERENCE HIGHLIGHTS PROGRESS IN NANOSTRUCTURED MATERIALS

NIST provided the major support for the Third International Conference on Nanostructured Materials (NANO'96), held in Kailua-Kona, Hawaii, July 8–12, 1996. The Office of Naval Research, Department of Energy, National Science Foundation, and Defense Advanced Research Projects Agency joined NIST in sponsoring this major conference. This was the third in a biennial series of conferences on materials with characteristic dimensions on the order of nanometers. It included a mix of invited and contributed oral presentations with evening poster sessions and attracted over 225 participants from 27 countries.

Key issues associated with the science and the technology of these materials were addressed, and it was obvious that commercialization of this new class of materials for both near and long-term applications is now occurring. Mechanical, magnetic, chemical, catalytic, electrical, optical, thermal, and tribological properties were discussed. Several new processes for the preparation of such materials (including a flame process developed at NIST) were unveiled; descriptions of new techniques available for characterizing materials on the nanometer-size scale also were presented. Atomic structure models were described for use in the prediction of material properties, new information on the exciting properties possessed by these materials was disseminated, and new applications were introduced. One of the most significant new uses reported was the in-situ repair of corroded Canadian power plant pipes via the electrodeposition of nanocrystalline coatings. Also of high interest at the conference was new information from NIST indicating that, contrary to common thought, multilayers do not always provide a reduction in thermal conductivity of the material despite the many interfaces in multilayer coatings. More complete information on the conference will appear in a future issue of the *NIST Journal of Research.* A NIST scientist was the co-chairman of the conference.

NEUTRON SCATTERING MEETINGS HELD AT NIST

"Neutron Scattering," a satellite meeting to the XVII International Union of Crystallography Congress, was held at NIST Aug. 5–7, 1996. The meeting was attended by 130 scientists from industry, universities, and government laboratories worldwide. The purpose of the meeting was to discuss recent developments in neutron scattering instrumentation and detection; advances in data analysis techniques; recent applications to crystallography, materials science and molecular biology; and the status of present and future neutron sources. Tours of the NIST Research Reactor and Cold Neutron Research Facility (CNRF) were provided for all interested attendees.

There were 41 invited lectures and 61 posters presented covering many diverse techniques such as powder and quasi-laue diffraction, reflectometry, small-angle scattering, and inelastic scattering. Since the future of neutron scattering research worldwide was a topic of great concern to attendees, the meeting concluded with invited lectures concerning the future of neutron scattering in Asia and pulsed neutron sources in the United States. In addition, the keynote address at the meeting banquet was devoted to the future of neutron research in Europe. Both the invited lectures and the posters gave opportunities for lively discussions.

In conjunction with the neutron scattering meeting, the CNRF researchers group held their annual meeting at a nearby hotel in Gaithersburg on Aug. 5, 1996. The group provides a forum for the concerns of all external users of NIST's CNRF. Presentations were made by NIST staff on the status of the instrumentation and proposal submission and review, followed by an open discussion period.

Following the neutron scattering meeting, the annual meeting of the Neutron Scattering Society of America was held at NIST on Aug. 7, 1996. The meeting, attended by both NSSA members and interested neutron scattering scientists from other parts of the world, was devoted to important issues facing the future of the field. In particular, the need for upgraded neutron facilities in the United States was discussed. A report on recent DOE Panels on Neutron Facilities was presented. An open discussion followed in which concern for the future of neutron scattering was the primary theme.

NIST TO WORK WITH AUTO MANUFACTURER ON SAFER CARS

NIST has joined forces with a major automobile manufacturer in a 2-year project to improve motor vehicle fire safety. Under terms of the recently signed Cooperative Research and Development Agreement, researchers from NIST and the auto manufacturer will evaluate the fire safety aspects of vehicle crash and fire tests, identify potential mechanisms by which fires could start, and create laboratory models of these mechanisms. The data derived will enable researchers to characterize fire properties of potential combustibles in vehicles, determine fire growth paths and time lines, and evaluate fire hazards to vehicle occupants. The auto manufacturer and NIST will then use this knowledge to study both passive protection measures (e.g., less flammable materials in critical locations and improved fire barriers) and active fire suppression technologies.

NIST PREDICTS CARBON MONOXIDE PRODUCTION IN FIRES

Most fatalities from building fires result from breathing the toxic combustion products and not burns, and the principal chemical species responsible for fire deaths is carbon monoxide (CO).

A NIST scientist has led a team in developing the first predictive capability for the amount of CO formed. Fatal levels of CO are mostly formed during intense, flashed over enclosure fires, where insufficient air enters the enclosure to ensure complete combustion. The scientist combined the results of in-house experiments and modeling with findings from NIST-sponsored research at Harvard University, Virginia Polytechnic Institute and State University, and the California Institute of Technology to identify four distinct mechanisms for the formation of CO in these enclosure fires: (1) quenching of a turbulent fire plume upon entering a rich upper layer; (2) mixing of oxygen directly into a rich, high-temperature upper layer with subsequent reaction; (3) pyrolysis of wood in a high-temperature, vitiated environment; and (4) approach to full thermodynamic equilibrium combustion product distributions in rich, high-temperature upper layers.

These results have been incorporated into an algorithm that allows fire researchers to determine which mechanisms are responsible for the generation of CO for a given fire scenario and to develop estimates for the amounts of CO that will be generated. It is now clear that small-scale toxicity tests on samples of furnishings, wall coverings, etc. alone are not sufficient for characterizing the toxicity of smoke from real fires, and regulation of products based on such tests is unlikely to improve fire safety. Ongoing efforts are aimed at characterizing the fate of combustion gases once they exit the room of fire origin.

ECONOMIC METHODS HELP BRIDGE THE GAP IN USE OF NEW-TECHNOLOGY CONSTRUCTION MATERIALS

Economists from NIST, in support of the 10-year construction materials initiative, recently have developed economic methods for assessing the life-cycle cost effectiveness of new-technology construction materials such as high-performance concrete, high-performance steel, and fiber-reinforced-polymer (FRP) composites. This method includes a simple but comprehensive cost classification scheme that insures all project costs are accounted for—including the costs to bring new construction materials such as FRPs from the material science laboratory to full field application. This methodology was tested in a case study of a new North Carolina bridge in which the life-cycle costs of three different FRP bridge deck materials were compared to the cost of the conventional concrete specified in construction drawings. One of the FRP decks was found to be life-cycle cost effective when all project costs were considered, most notably the delays for and hazards to highway drivers during bridge construction, maintenance, repair, and replacement.

A NIST report that describes the methodology and case study was just published. It forms the basis for software now under development that will aid bridge officials in the selection of cost-effective construction materials and for the development of an ASTM standard classification of bridge elements to be used by cost estimators and analysts.

NIST INITIATES PARTNERSHIPS WITH INDUSTRY TO DEVELOP ELEMENTS OF A PUBLIC KEY INFRASTRUCTURE (PKI)

NIST established Cooperative Research and Development Agreements (CRADAs) with industry partners to develop a minimum interoperability specification for organizations to use in building PKI components. A PKI is essential to facilitate the use of digital signatures and other forms of public key cryptography by industry and government users of information systems. By working together to develop a PKI, industry and government users help to ensure that future PKI components from different manufacturers can interoperate.

NIST STAFF PARTICIPATE IN WORKSHOP ON STATISTICS IN METROLOGY IN MEXICO

NIST scientists participated in a Workshop on Statistics in Metrology as part of a series of workshops on industrial statistics sponsored by the Centro Investigacion de Mathematica (CIMAT) of Mexico in Guanajuato, Mexico. Staff members from NIST, CIMAT, and the Centro Nacional de Metrologia (CENAM) presented a week-long program on principles of measurement, statistical thinking, design of calibration experiments, control of measurement processes, reliability, and uncertainty analysis with emphasis on electrical and temperature measurements. The program attracted engineers from several U.S. companies with facilities in Mexico, as well as metrologists from Mexican laboratories.

NEW PUBLICATION DESCRIBES EVALUATION EXPERIMENT OF TRUSTED MACH (TMACH) SYSTEM

NISTIR 5810, The TMach Experiment Phase I—Preliminary Development Evaluation, presents a multi-national evaluation experiment of the TMach system, a secure server-based operating system designed to support information systems security and control requirements. The system provides users with both high-level trust and a UNIX interface. The report describes the evaluation of TMach against both the Information Technology Security Evaluation Criteria and the Trusted Computer System Evaluation Criteria to understand how the criteria and their accompanying evaluation processes compared. NIST coordinates and oversees the TMach evaluation work being done by Germany and the United Kingdom.

FUELS LAW CHANGES TO PROTECT CONSUMERS

Changes to the Uniform Engine Fuels, Petroleum Products and Automotive Lubricants Inspection Law and Regulation will make it illegal for fuel suppliers and sellers to misrepresent the "brand" of a product and will provide consumers with the information they need to choose appropriate gasoline/petroleum products for their vehicles. The changes, now ready for passage by the states, were adopted by weights and measures officials at the July 1996 annual meeting of the National Conference on Weights and Measures (NCWM is sponsored by NIST). One recommendation affects the labeling requirements for oxygenates in gasoline. The NCWM recommends that all gasoline blends with mass fractions of oxygen of at least 1.5 % be identified as "with" or "containing" the specific type of oxygenate included (such as "contains ethanol" or "with methyl t-butylether"). Where oxygenate mixtures are present, the predominate additive must be listed first. For more information, contact the NCWM, P.O. Box 4025, Gaithersburg, MD 20885, (301) 975-4004, fax: (301) 926-0647, e-mail: owm@nist. gov.

UPDATE OF POPULAR MASS SPECTRAL DATABASE AVAILABLE

Analytical chemists now can upgrade to the newest version of the NIST/EPA/NIH Mass Spectral Database for Windows™, the most comprehensive program available to aid in the identification of unknown compounds. Version 1.5 of the Mass Spectral Database includes four new tools for mass spectral interpretation and four new aids for automation and reporting. Some of the new features help in dealing with spectra not included in the database library. New features also automate searches and save prior search results. The easy-to-use program provides quick access to more than 62 000 compounds whose chemical spectra were determined or critically evaluated at NIST. The PC version is available on disk for $1590 or on CD-ROM for $1490. Users of a previous DOS version may upgrade for $300 for 3.5-inch disks or $200 for CD-ROM. Purchasers of a previous Windows version may upgrade for $75. For information on the NIST/EPA/NIH Mass Spectral Database, Standard Reference Database 1A, contact the Standard Reference Data Program, Building 820, Room 113, Gaithersburg, MD 20899-0001, (301) 975-2208; fax: (301) 926-0416; e-mail: srdata@nist.gov. Information also is available at http://www.nist.gov/srd/ on the World Wide Web.

"SOUNDING OUT" IMPROVED MATERIALS

An inexpensive acoustic wave transducer developed by NIST mechanical engineers soon may make it easier for researchers to decide if new composite materials or film coatings have the right mechanical properties for specific applications. The transducer sends a pulsed sound wave through a test sample that is submerged in water. The speed of the reflected wave provides a measure of the material's elasticity (its ability to flex under stress), while the direction of the reflected wave provides details about crystal planes or defects within the material. Current acoustic microscopes use "lenses" and may cost hundreds of thousands of dollars. The NIST device uses off-the-shelf parts costing less than $20,000, yet can provide similar information about materials' properties. Rather than use a lens, the NIST instrument uses a curved transducer made with an inexpensive piezoelectric, plastic film. For more information, contact Nelson Hsu, A147 Sound Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6630, e-mail: nelson.hsu@nist.gov.

TWO MANUFACTURERS, TWO SERVICE FIRMS WIN BALDRIGE

President Clinton and Commerce Secretary Mickey Kantor announced four companies as the winners of the 1996 Malcolm Baldrige National Quality Award on Oct. 16, 1996. They are: ADAC Laboratories, Milpitas, CA (manufacturing category); Dana Commercial Credit Corp., Toledo, OH (service category); Custom Research Inc., Minneapolis, MN (small business category); and Trident Precision Manufacturing Inc., Webster, NY (small business category). The award

recognizes achievements in quality and business performance. It is not given for specific products or services. Since 1988, 28 companies have won the award. Criteria for the award are widely accepted as the standard for business performance and excellence. In addition to serving as the basis for applying for the award, the criteria are used by thousands of organizations of all kinds for self-assessment, planning, training and other purposes. More than a million copies have been distributed since 1988. Further information on the 1996 award winners and the award is available on the World Wide Web at http://www.quality.nist.gov.

BALDRIGE AWARDEES DISCUSS WINNING WAYS AT QE IX

The four companies recently announced as winners of the 1996 Malcolm Baldrige National Quality Award will present details of their exceptional management practices at the Quest for Excellence IX conference. the conference takes place on Feb. 10-12, 1997, at the Washington Hilton & Towers, Washington, DC. For registration information, contact ASQC, (800) 248-1946, fax: (414) 272-1734, e-mail: asqc@asqc.org.

NIST, FTC REPORT SCANNERS ARE MORE ACCURATE

In the 22 years since the first checkout scanner was installed in a supermarket in Troy, OH, automated price checkers have increased checkout productivity, and improved sales and inventory records. Electronic price scanners tally a large portion of the $2 trillion in U.S. annual retail sales; however, consumers and retailers have concerns about errors at the checkout. A new study on checkout scanner accuracy contains fairly good news for consumers. The study, prepared by the Federal trade Commission, NIST, and state weights and measures enforcement agencies, found a total error rate of 4.82 % for 17 928 items checked. More items were undercharged (2.58 %) than overcharged (2.24 %), and the total dollar amount of undercharges exceeded overcharges. Food stores as a group had a lower error rate than nonfood stores. Among nonfood stores, department stores had the highest rate of pricing errors. The National Conference of Weights and Measures, located at NIST, has adopted a sampling and inspection procedure which state weights and measures officials can use to conduct price verification inspections in retail stores. Copies of "Price Check, A Report on the Accuracy of Checkout Scanners," as well as brochures for retailers and consumers, are available from Public Reference, Federal Trade Commission, Washington, DC 20580, (202) 326-2222. Electronic copies are available on the Internet at http://www.ftc.gov.

FedCIRC HELPS PROTECT GOVERNMENT'S ONLINE INFO

To help Federal Government agencies deal with security threats that can compromise critical computer networks, NIST has established a Federal Computer Incident Response Capability, or FedCIRC, thanks to start-up funding from the Government Information Technology Services Innovation Fund. Resulting information will be shared with companies and others concerned about protecting their own data. The new initiative combines the experience and expertise of the Defense Advanced Research Projects Agency's CERT(SM) Coordination Center located at the Software Engineering Institute and the Department of energy's Computer Incident Advisory Capability located at the Lawrence Livermore National Laboratory. FedCIRC expands its reach to offer coordinated incident-response services to the whole civilian Federal Government. Agencies now have quicker access to expertise and support services they need to protect their electronic information from security threats such as computer viruses and hackers. On-site security evaluations, 24-hour emergency support, coordination with other agencies, incident advisories and other services will be available to FedCIRC subscribers. Additional information is available from the FedCIRC office at (301) 975-4369 or on the World Wide Web at http://csrc.nist.gov/fedcirc.

NEW TESTER TAKES THE MEASURE OF THIN FILMS

A NIST scientist has developed a machine for assessing the tensile strength and other mechanical properties of thin films that eliminates many of the problems incurred by other test devices. The piezoelectric-actuated microtensile test machine avoids the need to manually part the thin film specimen (fabricated on silicon substrates by photolithography procedures used in the semiconductor industry) from the substrate, thus preventing tension and deformation on the specimen. Other advantages include mechanical rigidity that allows testing of silicon-framed specimens, piezoelectric actuation for precise control of the applied tension, cantilevered moving parts for frictionless operation, and closed loop control to accurately control and change load and displacement rates. The microtensile tester can be reproduced at a very reasonable cost using simple mechanical components and off-the-shelf piezoelectric stacks, power supply and sensors. Scientists are working on two main shortcomings of the tester—lack of the ability to measure strain in the gauge length and limited resolution of the force measurement. For paper no. 31-96 describing the tester, contact Sarabeth Harris, Div. 104, NIST Boulder, CO 80303-3328, (303) 497-3237, e-mail: sarabeth@micf.nist.gov.

COLLABORATORS SEEK MORE ONLINE RESEARCH RESULTS

Electronic publication of scientific and engineering research relating to technology, measurement, and standards is the objective of new NIST collaborations with the American Physical Society and the American Astronomical Society. The shift from traditional print publishing to electronic publishing is expected to speed NIST research results and information to scientists, engineers, and researchers worldwide. NIST information products include approximately 1550 scientific reports published in professional books and journals, and approximately 350 NIST-published scientific reports annually. NIST will partner with APS and AAS to further the development of emerging strategies and techniques for publishing scientific and technical information in electronic formats, including the Internet and World Wide Web. The development efforts are spearheaded by NIST's Office of Information Services. Initially, NIST and its collaborators will focus on developing a standard for absolute identification of electronic documents, version control, and new software and computer protocols—termed "documents type definitions"—for use by authors of scientific and mathematical articles. For more information, contact Paul Vassallo, E106 Administration Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2786, e-mail: paul.vassallo@nist.gov.

GO ONLINE TO LEARN ABOUT QUALITY PROCUREMENT PANEL

Information on the Government and Industry Quality Liaison Panel (GIQLP), a group of government and industry representatives who are developing the quality standards for a government-wide procurement policy, can now be found on the World Wide Web at http://ts.nist.gov/ts/htdocs/210/216/giqlp.htm. An Adobe PDF file reader is required to view the GIQLP documents (instructions on how to download the Adobe Reader software at no charge are found at http://ts.nist.gov/ts/htdocs/210.htm). The website features the GIQLP's vision for quality in the 21st century and an outline of the strategy planned to achieve this vision. The aims of the GIQLP cooperative effort (involving 12 federal agencies, three major industry associations, and representatives from ASQC and the American National Standards Institute) are to establish a single quality system within a contractor's facility that will have demonstrated capability for meeting both government and private industry customer needs; promote the recognition and use of advanced quality concepts in procurement processes by both government and industry; and help develop uniform criteria and mechanisms within government agencies whereby audits of basic quality system requirements performed by one agency will be accepted by all others.

MEP CENTERS GET BOOST IN ADDRESSING INFO TECH NEEDS

Small and medium-sized manufacturers soon will find it easier to resolve their information technology needs through a network of resources being established for field agents of NIST's Manufacturing Extension Partnership. Led by the Utah Manufacturing Extension Partnership in Orem, Utah, the group of MEP affiliates with information technology expertise will aid other affiliates in dealing with areas such as material resource planning, computer-aided design and manufacturing, electronic commerce and electronic data interchange. The Georgia Manufacturing Extension Alliance in Atlanta and the Great Lakes Manufacturing Technology Center in Cleveland will act as technical consultants to the other centers in the information technology network.

NEW ANALYSIS ENHANCES STRESS MAPPING TECHNIQUE

A new theoretical analysis supports a patented technique for detecting internal stress in materials ranging from microelectronic packaging to welds in steel sheet. In the Nov. 7, 1996, issue of Nature, a NIST scientist and a colleague from Cambridge University demonstrate that the ultrasound technique is more sensitive than previous approaches because, as they state in the article, "It depends on an aspect of acousto-elasticity not exploited in other work: amplitude modulation between polarized modes." The technique relies on computer analysis of acoustic waves that are radiated into the material and detected by an out-of-focus, spherical transducer in an acoustic microscope. Stressed areas of the material change the amplitude of the reflected polarized waves compared to the unstressed areas. The microscope, a digital PC-based ultrasonic scanning microscope, can produce quantitative, three-dimensional maps of stresses and, unlike some other methods, does not harm the sample being measured. Metals producers, semiconductor manufacturers and others could use this technique to weed out defective manufactured parts as well as those with internal stress that could lead to cracks. More information is available on the World Wide Web at http://www.ctcms.nist.gov/~kfrankli/stresses.html or by contacting Eva Drescher-Krasicka, B164 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6141, e-mail: dre@nist.gov.

BETTER WELDS POSSIBLE WITH ARC SENSING AND CONTROL

Can process sensing and control replace a skilled welder so that high-quality welds are consistently made under a variety of conditions? Yes, say NIST researchers, particularly for gas metal arc welding. The areas where they believe arc sensing and control systems can improve weld quality are: (1) in semi-automatic welding where control systems can detect and correct problems faster than a human, and (2) in fully automatic welding where control systems can emulate the eyes and ears of a skilled welder. In a recent paper, the NIST researchers say the control systems are only as good as the sensing information they receive. "The wider the range of sensory data, the better the ability to maintain weld quality," they report. The paper shows how arc current and voltage signals and arc light intensity can be used to monitor and control contact tube wear, degradation of shielding gas, wire feed interruptions, arc length and droplet transfer. For a copy of paper no. 34-96, contact Sarabeth Harris, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-3237, e-mail: sarabeth@micf.nist.gov.

IMPROVED ACCURACY IN OPTICAL RADIATION REPORTED

Accurate measurements of infrared, visible, and ultraviolet light are critical to our national defense, in monitoring environmental changes and for a variety of industrial processes. NIST provides optical radiation standards to ensure the accuracy of these measurements. For many years, photometric units were established using optical sources, such as standard lamps available through the NIST Calibration Program. Now, technological advances have enabled NIST to switch to a more accurate, detector-based system for transferring standards for radiometry, photometry, and pyrometry. NIST is encouraging all of its customers to switch to this improved method of calibration. A National Measurement System for Radiometry, Photometry, and Pyrometry Based Upon Absolute Detectors (NIST Technical Note 1421) describes the more accurate measurement methodologies in detail. A limited number of copies are available from the Optical Technology Division, A207 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2316, e-mail: parr@nist.gov.

U.S. ACTIVITIES DOCUMENTED IN NEW DIRECTORY

The 1996 edition of a popular NIST directory summarizes the standards activities of more than 700 organizations in the United States, including approximately 80 federal agencies and 620 private-sector groups. The new directory is the seventh in a series started in 1941. Its largest section contains an alphabetical listing of approximately 620 nongovernment organizations that develop standards or contribute to the standardization process by working with other organizations, or are sources of documents and information. Each listing includes the type of organization, the scope of its standards and standardization activities (whether voluntary or mandatory), the availability of its standards and its other conformity assessment activities. The directory also contains a section on sources for standards and related information; a subject index; and listings that cover organizational acronyms and initials, former names and groups listed in the previous directory that are no longer involved with standards. Copies of *Standards Activities of Organizations in the United States* (NIST Special Publication 806) are available for $58 prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, (202) 512-1800. Order by stock no. 003-003-03427-4.

NEW WEBSITE CUTS METRIC QUESTIONS DOWN TO SIZE

U.S. businesses and organizations are increasing their use of the metric system, realizing its importance in science, international trade and manufacturing. The metric system, or International System of Units (abbreviated SI from the French "Système International d'Unites"), is the preferred system of weights and measures for U.S. trade and commerce. To assist SI users, NIST recently created a special home page on the World Wide Web at http://physics.nist.gov/SI. From this page, computer users can access three NIST publications on SI units and a helpful diagram. The *Guide to the International System of Units* gives definitions of the SI units and guidance on how to use them. The International System of Units is an English language translation of a brochure published by the International Bureau of Weights and Measures. The third document, Metric System of Measurement: Interpretation of the International System of Units for the United States,

was published in the Federal Register in 1990, and gives the Department of Commerce interpretation of the SI for the United States. The diagram shows how the 21 SI-derived units with special names are related to the seven SI base units. The new SI home page is expected to be the most definitive and up-to-date site for information on the SI.

ENERGY-RELATED INVENTIONS PROGRAM RECOMMENDATIONS

Recently NIST recommended two innovative technologies for commercialization to its Department of Energy partner under the Energy-Related Inventions Program.

- Liquid Leak Detection System—an innovative and low-cost method for detecting leaks in such liquid storage reservoirs as swimming pools, retention ponds, and underground tanks.
- Thermal Energy Storage for Small Packaged Terminal Air Conditioning Units—a patented thermal energy storage system for use with rooftop air conditioning units or small unitary air conditioning systems in general; either with old existing air conditioning units or with new installations to reduce the installed capacity, duct sizes, and air flow rates.

JOINT PROGRAM DEVELOPS COMPACT JOSEPHSON VOLTAGE STANDARD

NIST, the National Aeronautics and Space Administration, and Sandia National Laboratory are jointly developing a compact Josephson voltage standard that is easily transportable and intended for use by metrology technicians. The new standard is 30 % lower in cost and reduced by more than a factor of three in size and weight compared to conventional Josephson voltage standards.

In phase I of the 3-year program, the standard will operate in a user-supplied liquid helium Dewar. The phase I prototype is complete, and in September it was air shipped overnight to Sandia National Laboratory. Software to self-test and self-adjust the system allowed it to operate immediately without any user adjustment. Within 1 day the system was generating calibration results that agree with the Sandia laboratory standard to within the 0.02×10^{-6} relative uncertainty of the system. In phase II of the program, scheduled for completion next year, a small cryocooler will replace the helium Dewar to make the standard truly a "turn-key" system. The transportability of the new system will allow NASA to circulate it among eight of its standards laboratories, thus benefiting from access to the accuracy of the Josephson standard in eight different standards laboratories for the cost of a single system.

NEW REFRACTOMETER REDUCES UNCERTAINTY IN DETERMINATION OF REFRACTIVE INDEX OF AIR

Two NIST scientists and a guest researcher have developed a new refractometer for measuring the refractive index of air. The refractive index of air is a basic physical quantity used to determine the optical wavelength in air. Accurate knowledge of its value is indispensable for precision laser interferometers and becomes critical for nanometer-scale and picometer-scale displacement measurements. Although there is a reliable formula to calculate the index from air pressure, temperature, humidity, and the carbon dioxide level, with a relative uncertainty of 0.03×10^{-6}, the actual fractual change in the value can be as much as 0.1×10^{-6} depending on the gas composition.

The newly developed refractometer directly measures the index by changing optical path lengths both in the air of interest and in a vacuum simultaneously. This variable-length principle eliminates the systematic errors due to the deformations in optical windows, the largest systematic error source in conventional refractometers. Since the available change in the optical path difference is only about 10 optical fringes, an optical phase modulation technique and a dark-fringe-detection method are implemented to divide a single optical fringe into several thousands, achieving a very high resolution in the interferometric measurement of the index. A double-pass Michelson interferometer and a variable-length mechanism carefully designed for this purpose are all set on a compact 30 cm×60 cm baseboard. Measurement results have shown that the relative uncertainty in the index is 0.005×10^{-6}. This very accurate refractometer is now being used in the NIST SI watt experiment, and its implementation and successful operation minimizes one barrier to the achievement of the "electronic kilogram," which has the goal of substituting a mass determined through electronic quantum standards for the present kilogram artifact standards. In use, the size of the refractometer permits it to be placed near a moving coil to determine the index as the coil velocity is measured by precision laser interferometers.

PROTOTYPE WIDEBAND SAMPLING VOLTMETER DEVELOPED

NIST scientists have demonstrated a prototype wideband ac voltmeter that is based on a sampling method and promises state-of-the-art performance, with lower uncertainties than any commercially available instrument. Accurate ac rms voltage measurements are needed for such diverse applications as production-line testing of electrical and electronic devices and systems to reading the output signals of precision sensors and transducers. The most accurate ac rms voltage standards

are thermal voltage converter (TVC) devices, in which the average power produced by the applied ac voltage is equated with the power produced by an equivalent dc voltage. However, typical TVCs have a number of performance constraints, such as limited dynamic range (e.g., 2:1), low input impedance, and long time constants (e.g., greater than 1 s), which limit their low-frequency performance and lengthen the time needed for high-frequency measurements. Wideband voltmeters are preferable for many practical ac voltage measurement applications in which the requirement is not for the highest accuracy, but for wide dynamic range, fast response time, and wideband frequency response.

Recent gain-versus-frequency flatness measurements of a breadboard version of the instrument have shown that the performance is approaching the demanding design goals set in conjunction with the U.S. Air Force sponsor. The fractional change in gain-flatness measured using a NIST-calibrated TVC is within 50×10^{-6} to 100 kHz (the goal is 20×10^{-6}), and 115×10^{-6} to 1 MHz (the goal is 100×10^{-6}). Measurements made at selected higher frequencies to 20 MHz indicate a maximum relative uncertainty of 1500×10^{-6}, about three times larger than the design goal. Refinements in the time-base, together with installation of a recently completed time-base auto-calibration circuit, are expected to result in the performance goals being met over the entire frequency range. Other design goals include a measurement rate of at least one reading per second, and ease of use equivalent to that offered by popular commercial voltmeters.

NIST AND INDUSTRY COLLABORATE TO DEVELOP REFERENCE ARTIFACT NEEDED FOR MAGNETIC FORCE MICROSCOPY

NIST researchers have been working with colleagues at a U.S. manufacturer of disk drives to develop a reference specimen for magnetic force microscopy (MFM). Recent increases in the use of MFM in the magnetic storage industry have resulted in the need for a physical standard that can be imaged for comparison purposes by a number of different magnetic imaging techniques. The challenge is to be able to image repeatedly the exact same area on the written-on magnetic media. This is important because one area is not necessarily equivalent to another since there are a number of variables that can affect the magnetization written to the disk, even though the "bit" pattern is the same.

In the collaboration, company researchers first write magnetic information "bits" on a new-technology hard disk, similar to disks incorporated in the latest hard drives in personal computers. A NIST researcher then removes the thin lubrication and carbon wear layers on the surface of the disk to expose the magnetic layer where the bits were written. Next, he creates a pattern of numbered squares on the surface of the disk that are in scale with the bits. These squares are used during the imaging process to identify repeatedly the same position on the disk. Another NIST researcher then images a number of these squares for comparison to other MFM techniques. The reference specimen is expected to help resolve claims of sensitivity and resolution made by the MFM manufacturers and provide prospective MFM buyers with a means to compare competitive instruments.

MAGNETIC MEDIA NOISE SUBJECT OF NIST, INDUSTRY JOINT STUDY

A NIST scientist has been working with a disk-drive manufacturer to analyze magnetic media noise. The "hard" disk drive inside personal computers is composed of several disks coated with magnetic media. The media is comprised of small magnetic domains, which are oriented in a selected direction by the writing process to create "bits. " Before the bits are written, the domains are randomly magnetized and impose a magnetic texture to the disk, called media noise. An analogy is writing on sandpaper with a pencil; with very fine sandpaper, the task is as easy as writing on paper and the pencil lines can be made just as fine and as close together. In the analogy, the texture of the sand grains corresponds to the media noise and the pencil marks to the information. The disk drive industry is striving to decrease the size of the bits to crowd more information on each unit area of disk surface. As the size of the bits decreases, media noise limits how closely they can be spaced. It follows that understanding the magnetic structure of media materials is crucial in increasing the storage density of the next generation hard disks; one way to address the restriction imposed by media noise is to produce media that has smaller domains and, therefore, higher inherent bit density.

The NIST scientist has used magnetic force microscopy (MFM) to image areas of a hard disk specimen written at the company. During the writing process the data were also read, and the corresponding oscilloscope traces were saved. By using a special procedure for formatting the hard disk, it was possible to image with the MFM the same position on the disk corresponding to a given oscilloscope trace. This method made it possible to evaluate the sources of media noise on the read-back signal. In one instance, it was possible to decide whether a large spike in the head response resulted from a single domain or a cluster of domains that coincided in a particular way with the head geometry.

GRAPHICAL USER INTERFACE SOFTWARE DEVELOPED FOR AWAMS

The Automatic Waveform Analysis and Measurement System (AWAMS) is the waveform sampling hardware platform and computer software environment used to provide NIST special test services for characterizing the time-domain performance of fast pulse generators, impulse generators, and precision time-delay lines. Recently, NIST scientists have upgraded the core capabilities of the testing software incorporated in the AWAMS and enhanced user-friendliness by adopting a proprietary graphics language interface. Instead of dealing with an abstract software routine, a user now can view on a computer display a simulated front panel of an instrument. Manipulating the instrument settings on screen equates to selecting the settings for a given test condition for the actual instrument.

The overall system plan calls for a main program control approach and file structures to set up and control the commercial sampling oscilloscopes employed in the AWAMS, to read the data, and to call routines to calculate pulse parameters from the measurement data Routines include virtual instruments (VIs). LabVIEW™ VIs (callable from the main program) have been written and tested to calculate the histogram of pulse measurement data and to extract pulse parameters from it, including topline and baseline, transition duration, overshoot, and undershoot. Algorithms and LabVIEW™ software also were developed to model jitter data in a form that can be deconvolved readily from the pulse measurement data.

Previously, the AWAMS used software testing routines written in Rocky Mountain Basic. Through the graphical interface, the new software greatly facilitates the programming of instrument settings for acquiring measurement data and analyzing information.

NEW ASME/ANSI STANDARD FOR SURFACE TEXTURE PUBLISHED

The American Society of Mechanical Engineers (ASME) recently published the American National Standard ASME B46.1-1995, entitled "Surface Texture (Surface Roughness, Waviness, and Lay)." This is a comprehensive revision and augmentation of the ASME standard B46.1-1985 on the same subject. NIST scientists led the editorial committee that oversaw the revision, and provided editorial assistance and graphics support. In addition to a comprehensive discussion of definitions and procedures for the use of contacting stylus-type techniques to measure surface texture, the present revision contains several new sections that encompass advanced area profiling techniques, such as atomic force microscopy and phase shifting interferometry, which also provide valid and useful descriptions of surface topography at the nanometer and subnanometer levels of resolution. The standard, therefore, will be useful to engineers in a number of industries, including mechanical parts, semiconductors, and optics.

STAINLESS STEEL STANDARDS

A NIST scientist completed the final report on work performed by NIST for the international comparison of stainless steel kilogram standards organized by the Working Group on Mass Standards of the Consultative Committee for Mass and Related Quantities of the International Committee for Weights and Measures (CIPM). The pilot laboratory is the International Bureau of Weights and Measures (BIPM), which will be responsible for preparing a final report on the international intercomparison. Other participating countries are Canada, Japan, China, Australia, Italy, Netherlands, United Kingdom, Russia, Slovakia, Germany, and France.

The intercomparison provides traceability between the participating countries' secondary stainless steel standards from which are derived the working standards used for the dissemination of the mass unit; it also benchmarks the countries' research capabilities in disseminating the mass unit from the primary platinum-iridium standards to the secondary stainless steel standards.

WORKSHOP ON DEVELOPMENT OF A STEP APPLICATION PROTOCOL FOR INSPECTION

NIST sponsored a workshop to assess industry interest in development of standards for manufacturing inspection data. The September 4, 1996 workshop was attended by representatives of 12 national and international corporations. The attendees, all manufacturing inspection domain experts, developed a list of the most significant problems in the area of inspection planning and inspection data exchange faced by their organizations. The attendees postulated that standard models of inspection information are very important to the successful implementation of advanced inspection systems. The process for developing standard models of information was adopted from the ISO Standard for the Exchange of Product Model Data (STEP). The development of STEP information models, or Application Protocols begins with a scoping activity. The attendees developed an initial draft scope and activity model. This initial work will be published this fall, and NIST personnel will solicit comments from other industry

experts. A follow-on workshop to continue collaborative development of standard manufacturing inspection information models will be held in early 1997.

NEW EXHAUST METER CALIBRATION FACILITY IS COMMISSIONED

During an August meeting of the American Industry/Government Emissions Research (AIGER) group held at NIST, members of the fluid flow group demonstrated the capabilities of the recently commissioned NIST Exhaust Meter Calibration Facility (EMCF). The AIGER group is composed of representatives from the major American automobile and truck manufacturers, the Environmental Protection Agency, and the California Air Resources Board. In addition to touring the EMCF and other NIST labs, the AIGER group and NIST researchers reviewed progress in projects designed to assist them in their goal of making accurate and economical measurements of the flow and composition of vehicle exhaust.

The EMCF tests exhaust flow meters by accurately mixing component gases to generate a simulated vehicle exhaust and varying the simulated mixture's temperature between 290 K and 700 K. The combined flow is known with an uncertainty of approximately 1 % of reading. The flow range for the simulated exhaust is 60 l to 2000 l at standard conditions. Each of the component gas streams (nitrogen, carbon dioxide, and argon) is metered with a bank of three critical flow nozzles sized to cover the broad range of flows. The nozzles have been calibrated with existing flow facilities for pure, dry gas. The facility also can provide humidified air flows from 60 l to 6200 l at standard conditions. In the EMCF, the nitrogen (or air) gas stream is pre-heated (to the desired dew point temperature of the final mixture), then passed through a humidifier vessel to introduce the desired amount of water vapor. The resulting water vapor concentration is measured using an optical hygrometer. The other gaseous components are then added, and the final gas stream is heated to the desired test temperature by a large electric circulation heater before entering the meter under test.

The EMCF is the first calibration facility for flows of variable composition and temperature. It is expected to be a focal point for research designed to enable accurate exhaust flow measurements by the automotive industry and should be invaluable in developing predictive models for the response of flow measurement technology to composition and temperature variations, which are widely and necessarily encountered in typical industrial applications.

APPROACH DEMONSTRATED FOR OPTIMIZING RESPONSE OF MICRO-HOTPLATE CHEMICAL SENSORS

Researchers at NIST and the University of Maryland have succeeded in demonstrating a systematic approach for predicting operational temperature schedules that optimize differences in responses for similar analytes in micro hot-plate sensors. An invention disclosure recently has been submitted on the methodology, which involves three components. First, experimental training databases, typically containing 5000 to 10 000 points, are collected from a sensor operated with a semi-random temperature program. Next, wavelet neural networks are used to develop a dynamic model of the sensor's response that can be used to predict sensor outputs from any input temperature profile. Finally, optimization theory is applied to determine the best temperature profile for maximally separating the responses of two or more gases.

The recent findings stem from a NIST program aimed at developing active films and detection schemes for chemical microsensor arrays. Prototype devices have micromachined silicon sensor platform structures called micro-hotplates, each about 100 μm×100 μm, and the capability of controlling the temperature on an over-deposited sensing film, while also monitoring the conductance of such a film. Gas-induced conductance changes serve as the detection principle for these solid state microsensors, and multiple elements are used for analyzing gas mixtures. Selectivity is attained not only by including differing active coatings within an array but also by employing dynamic variation of the temperature on each element.

For example, the recently developed technique has predicted that a pulsed, oscillatory temperature schedule would produce conductometric response patterns for two similar alcohols, ethanol and methanol, that are entirely out of phase. The success of the modeling approach was confirmed experimentally when the predicted out-of-phase conductance signatures were measured as an output for the optimal temperature schedule input. Findings such as these represent a critical step toward designing application-tuned microsensor arrays for a variety of process control, safety, and environmental monitoring uses.

PROGRESS IN DEVELOPING INTERNATIONAL STANDARDS FOR SURFACE ANALYSIS

Surface analysis is in widespread use throughout the world for the characterization and development of advanced materials and processes in many technologies. Although surface analysis has been of great value in many applications, standards are needed to assist

analysts in making efficient and reliable analyses and to facilitate the development of quality management systems required for ISO 9000 certification. ISO Technical Committee (TC) 201 on Surface Chemical Analysis was formed in 1991 to develop international standards for surface analysis. This committee currently has 12 P-members (full participating members), including the United States, and 16 O-members (observer members).

Meetings of ISO/TC 201, its seven subcommittees, and 15 working groups were held in Arundel, United Kingdom, on July 11-13, 1996. These meetings were attended by over 50 delegates, with representation from China, Germany, Hungary, Japan, Korea, Sweden, United Kingdom, and United States, and two liaison organizations. Three NIST staff members participated in these meetings.

The subcommittees and working groups of ISO/TC 201 are developing international standards for techniques in common use for surface analysis. At present, seven new work items have been approved formally, and one of these has advanced to the draft international standard stage. In addition, 12 draft standards have been prepared, and formal ballots for these potential new work items are expected shortly.

The following examples illustrate the range of work under way: terminology for surface chemical analysis; calibration of the energy scales of x-ray photo-electron spectrometers; determination of relative sensitivity factors for secondary ion mass spectrometry from ion-implanted reference materials; measurement of surface elemental contamination on silicon wafers by total reflection x-ray fluorescence spectroscopy; use of glow discharge optical emission spectrometry; a data dictionary for the description of data records in Auger electron spectroscopy and x-ray photoelectron spectroscopy; specimen handling and preparation for Auger electron spectroscopy, x-ray photoelectron spectroscopy, and secondary ion mass spectrometry; and measurement of sputtered depth in sputter depth profiling.

NIST DESKTOP SPECTRUM ANALYZER WORKSHOP

An intensive instructional workshop highlighting the latest release of desktop spectrum analyzer (DTSA) was held at NIST Sept. 23-26, 1996. The workshop, taught by NIST scientists, was attended by 25 people representing industry, academia, and national laboratories. DTSA was developed by NIST scientists, and is an advanced, highly flexible software engine for comprehensive use in electron-excited x-ray spectrometry. It includes the capability for spectrum (data) collection, background correction, peak deconvolution, qualitative analysis (peak recognition), quantitative matrix correction for elemental analysis, and ab initio spectrum simulation. Spectrum simulation enables the analyst to model any hypothetical composition as measured with silicon or germanium energy dispersive x-ray spectrometers or with a wavelength dispersive x-ray spectrometer. The incident electron beam energy can be specified ranging from low energy (e.g., 1 keV to 30 keV), typical of bulk specimen applications in the scanning electron microscope, to high energy (e.g., 100 keV to 500 keV), typical of analytical electron microscopy of thin foil specimens.

The next DTSA instructional workshop is scheduled for March 26-28, 1997, at NIST. Places for this workshop can be reserved by contacting Dale Newbury, (301) 975-3921, or dale.newbury@nist.gov.

NIST PROVIDES FIRST DEFINITIVE EVIDENCE FOR TRANSCONTINENTAL TRANSPORT OF CARBONACEOUS AEROSOL ("SOOT") FROM NORTH AMERICAN FOREST FIRES TO SUMMIT, GREENLAND

In a NASA-sponsored, cooperative project with the University of New Hampshire, NIST scientists have provided the first definitive evidence of the transport of biomass burning carbonaceous aerosol from forest fires in the lower Hudson Bay to Summit, Greenland, the remote site of the Greenland Ice Sheet drilling program. Others have suggested that soot produced by biomass burning may have a profound effect on health, visibility, and climate. The pyrosynthetic organic components of soot may include mutagens and carcinogens, and it has been demonstrated that the graphitic carbon component has a major impact on the absorption and scattering of radiation in the Earth's atmosphere. In addition, the small particle size of combustion aerosol makes possible its transport for thousands of kilometers.

A major atmospheric event at Summit on Aug. 5, 1994, provided the opportunity and the challenge to establish the link between aerosol carbon pollution and long-range transport of biomass burning particles. The evidence for transcontinental transport of soot was accomplished by utilizing the unique capability of NIST to measure ^{14}C in microgram levels of aerosol carbon and the direct measurement of ultratrace aerosol organic compounds by supercritical fluid extraction chromatography developed by NIST. From Aug. 3-7, 1994, the ^{14}C measurements showed relatively small and comparable levels of industrial fossil and biomass carbon particles at Summit except on Aug. 5, when the biomass component increased by nearly an order of magnitude. Back-trajectory analysis linked the Aug. 5 Summit,

Greenland, event with an air mass that passed through a specific region of major biomass burning in Canada one week earlier. The direct evidence from ^{14}C, which is a unique tracer for biomass carbon, also served to validate indirect tracer inference of biomass burning aerosol based on potassium, ammonium, and organic acids observed in the atmospheric aerosol, snow, and ice at Summit.

WORKSHOP ON APPEARANCE OF COATINGS AND COATED OBJECTS

Color and appearance of coatings and coated objects play many roles in our lives and, in fact, it is well known that color and appearance sell! However, the whole notion of "appearance" is complex: color, gloss, haze, texture, distinctness of image, luster, orange peel, and more are all attributes of appearance. The appearance of any object, then, is a mixture of attributes. Much work has been done through the years by industrial scientists and engineers to establish criteria for measuring aspects of coatings and coated surfaces. Colorimeters, color coordinate systems, shade-match monitors, and electron microscopy all have been pressed into service in attempts to get a firm grip on color and appearance. Lately, the speed and utility of computational physics and chemistry have been used to further understanding of this complex area, with applications ranging from computer control of instruments to rendering of display scenes.

The need for appropriate characterization, measurements, metrics, standards, and tools has been felt by the industry for some time. The need for standards resulted in a recent Council on Optical Radiation Measurements report calling for NIST to become more involved in optical quality measurements. To be compliant with such standards as ISO9000, much must be understood about such phenomena as particle size and shape, refractive index, reflectance spectra, binder characteristics, and physical and chemical changes wrought by interactions with the environment, including oxygen, water, temperature, and incident radiation, most notably in the ultraviolet.

To help meet these needs, a Workshop on Advanced Methods and Models for Appearance of Coatings and Coated Objects was organized by NIST. The May 1996 workshop assessed the need for new appearance measurement methods, introduced NIST's proposed research on advanced scattering and rendering models and radiometric measurements, and obtained feedback from industry and academic representatives on program directions. The workshop provided the foundation for continuing work with all aspects of the appearance and color industry, from coating constituent manufacturers (pigments and binders, etc.), to computer renderers, equipment manufacturers, and testing laboratories.

LOCAL MICROSTRUCTURAL CHARACTERIZATION OF STRESS-INDUCED VOIDING IN NARROW METALLIZATIONS

Recent research conducted by NIST in collaboration with workers at Cornell University and the University of Michigan has demonstrated that local characterization of microstructures associated with stress voids is necessary to gain a proper understanding of the mechanisms contributing to stress-induced voiding in microcircuit metallizations. Voiding occurs because thermal processing leads to the development of significant triaxial tensile stresses which may relax by void formation and result in circuit failure. Measurements by electron backscatter diffraction have shown that there are significant local variations in microtexture within individual interconnect lines. This can be correlated directly to variations in grain boundary structure on a local level. The work showed that void formation and growth are preferred at those sites within copper lines where grain boundaries exhibit high misorientation angles and where twist structures are present. Such boundaries have generally higher atomic diffusivities in the film plane than boundaries that exhibit low misorientation angles and tilt structures. These results show that both void energetics and kinetics are strongly dependent on local variations in line microstructure. Further efforts directed toward characterizing interactions among groups of intersecting grain boundaries are being conducted, with the goal of predicting which specific sites in a line are predisposed to stress voiding failure.

NIST ESTABLISHES COOPERATIVE AGREEMENT WITH SUNY STONY BROOK ON MOLECULAR SIEVE RESEARCH

A cooperative agreement between NIST and the State University of New York at Stony Brook has been established for the study of zeolites and related microporous materials. These materials have numerous industrial applications, including their use as catalytic substrates for production of gasoline and other petroleum products; as ion exchange agents widely used in detergent formulations; and as selective sorbants for gas separation. In this project, SUNY will participate in the crystallographic characterization of zeolite Standard Reference Materials using synchrotron and neutron diffraction. Other goals for the project include the development of novel instrumentation to make in situ neutron spectroscopic and

diffraction measurements of adsorbates in zeolite pores. Computational models will be developed for comparison to results from the experimental studies of both structure and dynamics. This project will result in a better understanding of these systems and may allow tailoring of new materials. Discussions have been opened with possible industrial partners in this effort.

UNITED STATES AND JAPAN COOPERATE ON ALUMINUM NITRIDE RESEARCH

Due to increasing demand for high power components, commercial opportunities for aluminum nitride (AlN) are rapidly expanding. While generally not a limiting factor, enhancing the mechanical properties of AlN could provide even greater penetration into this field. However, until now, there have been only limited activities to examine the critical strength-determining features in AlN substrates. A joint project involving both government and industry in Japan and the United States has been established to study the strength of AlN substrates. NIST and a private company from the United States will work with the National Industrial Research Institute of Nagoya and a private company in Japan. This effort is one of several activities that emerged from a Memorandum of Understanding signed in 1994 between Japan's Agency of Science and Technology of the Ministry of International Trade and Industry and the U.S. Department of Commerce to promote cooperation in the field of civil industrial technology. The objectives of this research effort are: (1) to determine the effects of microstructure and grain boundary chemistry on the strength of AlN substrates; and (2) to establish appropriate tests for measuring strength consistent with standard electronics environmental testing. The tasks in each of the participating laboratories specifically build on the core competences of the participants. This collaboration between Japan and the United States represents one of the first formal partnerings of government and commercial institutions in these two countries.

NIST CO-SPONSORS WORKSHOP ON LIQUID COMPOSITE MOLDING

NIST joined with private industry and the National Science Foundation to sponsor the "Second Workshop on Liquid Composite Molding." The recent workshop, brought together experts in liquid composite molding from industry, government, and academia to review recent progress and current technical challenges in the field. The most notable development since the first workshop, held at NIST in 1993, is the development of a nascent liquid composite molding industry supporting the railroad, trucking, marine, and aerospace sectors of the U.S. economy. A total of 91 people attended the workshop, including 43 from industry, 38 from academia, and 10 government representatives.

The workshop opened with a session on industrial practice, which highlighted the success stories in several industrial sectors as well as limitations of existing technologies for automotive applications. Liquid composite molding consists of injecting resin into a mold filled with the reinforcement fiber preform. Despite progress in the manufacture of the fiber preform, only the fastest and most flexible preforming methods in the R&D stage appear able to deliver the performance required for automotive production. Moreover, process variability and control, both during preforming and molding, were identified as issues that limit liquid composite molding in production environments. New technologies for forming and handling fiber reinforcements that show promise for rapid preform manufacture were presented in subsequent sessions. Reviews of developments in materials, characterization, processing, and modeling completed the technical program. The workshop concluded with an innovative software demonstration session where the NIST permeability database and the NIST finite-element flow model were shown along with other software packages from both universities and private companies.

During the workshop, it became clear that a new set of technical goals must be met to ensure the continued growth of liquid composite molding. A challenge repeated throughout the workshop was reducing process variability and obtaining consistent product quality. The currently successful molders achieve consistent product quality by processing very slowly, an unacceptable solution for high volume manufacturing.

ELECTRODEPOSITION OF METALLIC STRAINED-LAYER SUPERLATTICES

A series of Cu-Co and Cu-Ni strained-layer superlattices has been fabricated by electrodeposition at NIST. These high interfacial area materials are known to exhibit interesting physical properties ranging from enhanced mechanical strength to the giant magnetoresistance effect. The films are synthesized from a nickel or cobalt-based electrolyte (about 1 mol/L) into which a dilute concentration of copper (about 0.008 mol/L) is added. The multilayered structure is derived by depositing copper at one potential followed by stepping the potential to a more negative value where cobalt or nickel is deposited. Process control is implemented by integration of the faradic current associated with the respective deposition reactions. Copper deposition occurs under mass transport control

while nickel/cobalt deposition proceeds under charge transfer control. This scheme results in pure copper layers separated by cobalt or nickel alloy layers incorporating approximately one atomic percent copper. However, the limitations of mass transport or copper deposition tends to degrade the flatness of the films, and growth of nickel/cobalt is often associated with crystallographic twinning. Fortunately, the nickel/cobalt deposition reactions appear to exhibit a degree of leveling such that the roughness developed in the copper layers is not necessarily cumulative. This phenomenon enables high-quality, nickel/cobalt-rich epitaxial films to be grown on the (100) crystal plane of copper.

NIST SUPPORTS IMPLEMENTATION OF STRATEGIC HIGHWAY RESEARCH PROGRAM TECHNOLOGY

NIST is supporting implementation of results from the Strategic Highway Research Program (SHRP). SHRP, a 5-year, $150 million research program to improve the performance and durability of the nation's highways, was completed in 1993. New technology developed by SHRP is being implemented by the Federal Highway Administration (FHWA), state transportation departments, and the private sector. One form of implementation is through the development of standard methods for testing materials used in highways. NIST has assisted the AASHTO Subcommittee on Materials in processing over 50 standards, and NIST laboratory inspection and proficiency sample programs are being modified to include new asphalt binder and bituminous concrete standards. These materials are used in almost 80 % of the nation's highways. There are over 100 laboratories using these new NIST services, which will improve the acceptance and precision of the new test methods. NIST also has set up a laboratory of SHRP testing equipment with funding from the FHWA.

NIST RECEIVES PATENT FOR HEAT PUMP PERFORMANCE ENHANCING DEVICE

NIST has received a patent on a device to improve the cold weather performance of residential and light commercial air-source heat pumps. The device was invented by a NIST scientist.

Fundamentally, heat pumps utilize electrical power to extract heat contained in the outside air to heat the dwelling. However, the rate at which the heat pump is able to bring this heat energy into the house is directly proportional to the outside temperature. Consequently, on a cold day, heat pumps are unable to pump enough heat to match the heat loss of the dwelling. For this reason, heat pumps are equipped with auxiliary electric resistance heaters, which are turned on automatically when needed. This resistance heating is expensive for the homeowner and often causes a peak demand problem for the utility.

The patented device is a distillation column that when utilized with a zeotropic refrigerant mixture is capable of changing the refrigerant mixture composition. By controlling the mixture composition, the heat pump capacity can be modulated in response to changes in the outdoor temperature. Thus, the distillation column enables the heat pump to maintain acceptable performance over a much wider temperature range and reduces the need for resistance heating. An additional benefit of the device is that the necessary zeotropic refrigerant mixture can be formulated from environmentally acceptable components.

STRATOSPHERE "TOWER" IN LAS VEGAS OPENS WITH HELP FROM NIST

The results of NIST studies of elevator evacuation of office buildings and air traffic control towers during fires published in NISTIR 4870 and NISTIR 5445, have been utilized by industry to deal with the unique challenge of high-rise building fire safety in the design of the Las Vegas Stratosphere Hotel and Casino. This facility, which includes a 350 m-tall tower with hotel and amusement rides, does not fit into any of the existing occupancy classes in the building codes used in the United States. To show the building had adequate fire safety provisions, a leading U.S. fire protection consulting firm used the results of the NIST studies on evacuation by elevators during fires as part of an overall safety performance analysis for the tower. This analysis was sufficient to show local authorities that the building had adequate fire safety provisions. The hotel and casino opened for business on April 30, 1996.

NIST WORK ON IMAGE DEBLURRING FEATURED AT GORDON CONFERENCE

A NIST scientist presented a research talk entitled "L,vy Densities, Inverse Diffusion, and Image Deblurring" at the 1996 Gordon Conference on Fractals at New England College, Henniker, NH, June 16-20, 1996. L,vy probability distributions are currently a hot topic in many branches of physics. An astonishing variety of electro-optical devices have point spread functions that are L,vy probability density functions. These devices are important in night-vision systems, medical imaging, astronomical imaging, underwater imaging, surveillance, and numerous other applications.

Of special interest is the deblurring of images obtained through such systems. The scientist pointed out that theoretical understanding of these particular L,vy processes would enable the design of electro-optical devices that facilitate subsequent image deblurring. He showed the importance of his "slow evolution" constraint in image deblurring problems where smoothness assumptions on the image cannot be applied. This is the case in medical imaging where small tumors, lesions, microcalcifications, and other singularities are of vital significance. The appearance of L,vy blurring kernels enables efficient implementation of the slow evolution constraint in his procedure. The deblurred image is obtained by reversing the time direction in a generalized diffusion equation associated with these L,vy kernels. Statisticians at NIST anticipated these developments by more than 20 years; an authoritative study, providing tables and graphs of the L,vy distributions, appeared in the NBS Journal of Research in 1973.

GUIDANCE ON INFORMATION TECHNOLOGY (IT) SECURITY PRINCIPLES AND PRACTICES PUBLISHED

NIST Special Publication 800-14, Generally Accepted Principles and Practices for Securing Information Technology Systems, gives a foundation that organizations can reference when conducting multiorganizational business as well as internal business. The foundation begins with generally accepted system security principles and continues with common practices that are used in securing IT systems. Federal and industry organizations can use the document as a baseline to establish and review their IT security programs. The publication is available online at http://csrc.nist.gov/nistpubs.800-14.

BALDRIGE CRITERIA REDESIGNED FOR BETTER PERFORMANCE

Like a house that has undergone remodeling, the 1997 edition of the Malcolm Baldrige National Quality Award criteria has a new look reflecting its widespread acceptance as a standard for performance and business excellence. Changes include a new name ("Criteria for Performance Excellence"), reordering (and in some cases, renaming) of the categories, a redesigned framework and a more readable format. Consolidation has reduced the number of criteria from 24 to 20 and the number of areas to address in the criteria from 52 to 30. Since 1988, more than a million copies of the Baldrige criteria have been used by thousands of organizations for self-assessment and training and as a tool to develop performance and business processes. Individual copies of the 1997 criteria are available from the Office of Quality Programs, (301) 975-2036, fax: (301) 948-3716, e-mail: oqp@nist.gov. The criteria also are available online at http://www.quality.nist.gov.

MANUFACTURERS HAVE NEW RESOURCE FOR INFO TECH

Small and medium-sized manufacturers soon will find it easier to resolve technology needs through a network of resources being established for field agents of NIST's Manufacturing Extension Partnership. Led by the Utah Manufacturing Extension Partnership in Orem, Utah, a network of MEP affiliates with expertise in a particular area of information technology for manufacturing is being established. The network will help field agents at MEP-affiliated centers in all 50 states and Puerto Rico solve smaller manufacturers' information technology-related problems, help clients in the selection of manufacturing-related software, and provide a process to keep centers up to date on new developments in information technology. Examples of topics that the new network will handle include material resource planning, computer-aided design and manufacturing, electronic commerce and electronic data exchange. For more information, access the MEP at the phone number or www address listed in the previous item.

COLOR IS CLUE TO OCEAN ORGANISMS

A new portable light source and detector system developed by NIST researchers is helping assess the accuracy of field instruments used in global warming and climate research. The rugged, table-top instrument is a specialized light source designed for use aboard seafaring research vessels. It provides a stable source of white light and uses high-accuracy detectors to monitor the source. British and American researchers aboard the British vessel James Clark Roth currently are using the radiometer to calibrate submersible light-measuring instruments. Such instruments determine the color and magnitude of light reflected from and within the depths of the oceans. Scientists use such data to map concentrations of chlorophyll and phytoplankton, microorganisms essential to the absorption of carbon dioxide from the atmosphere. Light measurements taken by researchers on ships in the ocean are correlated with data taken by satellites orbiting Earth. By monitoring changes in data gathered remotely, scientists can gather important information about fluctuations in ocean currents and micro-organisms that affect the amount of carbon dioxide in the atmosphere and thus global warming. The National Aeronautics and Space Administration soon

will launch a new satellite called SeaWiFS (sea-viewing, wide field-of-view sensor) that will increase greatly the amount of ocean color data collected. NIST recently held a workshop to validate the accuracy of SeaWiFS instruments and is working with NASA to help ensure the accuracy of SeaWiFS data. For technical information, contact Carol Johnson, B208 Physics Building, NIST, Gaithersburg, MD20899-0001, (301) 975-2322, e-mail: bjohnson@nist.gov.

FLAME RETARDANTS CONSORTIUM FORMED

Nylon, polypropylene and other polymers often are used in building furnishings like upholstered furniture, electrical cables, and insulation materials. To lower flammability and improve fire safety, chemicals are generally added to these materials. Some of the most common additives contain halogens, chemicals that have raised environmental concerns, especially in Europe. U.S. manufacturers are seeking new, environmentally friendly flame retardants in order to manufacture the same products for export as well as domestic sale. NIST recently launched a new industry/government consortium to help in the search. One strong contender is the combination of silica gel and potassium carbonate. When added to nylon and other polymers, these chemicals reduce heat release rates by as much as two thirds, while significantly reducing production of smoke and carbon monoxide. The new flame retardant combination works by maximizing crosslinking of chemical bonds when exposed to heat, causing charring rather than burning. New polymer-silicate nanocomposites also have shown excellent promise. For more information on the fire retardants consortium, contact Takashi Kashiwagi, B258 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6699, e-mail: takashi.kashiwagi@nist.gov.

Standard Reference Materials

"OLD PAINT" IS NEW STANDARD FOR MEASURING LEAD

A small loss for Akron, OH, is a big gain for chemists monitoring lead in the environment. NIST's newest Standard Reference Material for measuring lead in paint was made from paint scraped from old homes in Akron. The paint, mostly from homes built before 1945, contains high levels of lead and, therefore, was an ideal choice to become NIST's highest level lead-in-paint SRM. The paint, ground to a very fine powder, has a mass fraction of lead of 10 %. Environmental chemists will use this SRM to calibrate their instruments and verify the accuracy of their analytical methods. This new SRM was developed in conjunction with the Environmental Protection Agency and is one in a series of SRMs designed to help monitor paint, soil and dust as sources of lead. NIST also currently sells a very low level lead powdered paint SRM (number 2582) and expects to offer 0.5 % and 4 % lead powdered paint SRMs by the end of the year. SRM 2589 Powdered Paint Nominal 10 % Lead is available for $142. To order it or any other NIST lead SRM, contact the NIST Standard Reference Materials Program, Building 202, Room 204, Gaithersburg, MD 20899-0001, (301) 975-6776, fax: (301) 948-3730, e-mail: srminfo@ enh.nist.gov.

STANDARD REFERENCE MATERIAL 5M—CAST IRON

The 16th renewal of SRM 5m, Cast Iron, is now for sale, ushering in the 90th year of the availability of this Standard Reference Material. In 1906 under an agreement with the American Foundrymen's Society, NIST (then the National Bureau of Standards) took charge of the preparation, characterization, and distribution of a series of four reference materials, Cast Irons A, B, C, and D. In 1908 these cast irons were renamed Standard Samples 3, 4, 5, and 6, respectively, and they joined the rapidly growing list of reference materials available from NIST. In 1967 the 15th renewal of this cast iron, Standard Sample 5L, was renamed Standard Reference Material 5L. The iron and steel industry has always been the backbone of the U.S. metals industry and, therefore, it is essential that NIST continues to make available cast iron SRMs and plain-carbon steel SRMs.

SRM 5m, Cast Iron, is certified for 12 elements including carbon, chromium, copper, manganese, molybdenum, nickel, nitrogen, phosphorus, silicon, sulfur, titanium, and vanadium. This SRM is in the form of chips sized between 0.50 mm and 1.40 mm sieve openings (35 mesh and 14 mesh, respectively) and is intended primarily for use in chemical methods of analysis.

STANDARD REFERENCE MATERIAL 728—INTERMEDIATE PURITY ZINC

SRM 728, Intermediate Purity Zinc, is again for sale. This SRM has proven useful to the zinc industry because the impurity levels in this SRM lie in a useful range for the analysis of zinc that will be used in the manufacture of dry-cell batteries. Environmental

concerns have necessitated the elimination of mercury in today's dry-cell batteries. However, mercury-free dry cell batteries must be manufactured with powdered zinc containing low concentrations of first-row transition elements, especially iron. If the iron concentration of the battery zinc is too high, hydrogen gas is produced, causing the battery to rupture and damage the unit it is powering.

The certified value for iron in SRM 728 has been re-established by isotope dilution mass spectrometry, and all information values have been re-established by Glow Discharge Mass Spectrometry (GDMS) and Inductively coupled Plasma Mass Spectrometry (ICPMS). In total, SRM 728 is certified for five elements: cadmium, copper, iron, lead, and silver. Non-certified values are provided for thallium and tin, and information values are given for 29 additional elements. This SRM provides a homogeneous, well-characterized material for the analysis of pure zinc and zinc alloys, and it is intended primarily for the calibration of instruments and the evaluation of chemical methods used in the analysis of zinc materials. One unit of SRM 728 consists of 450 g of material in the form of pellets approximately 3 mm (0.125 in) in diameter.

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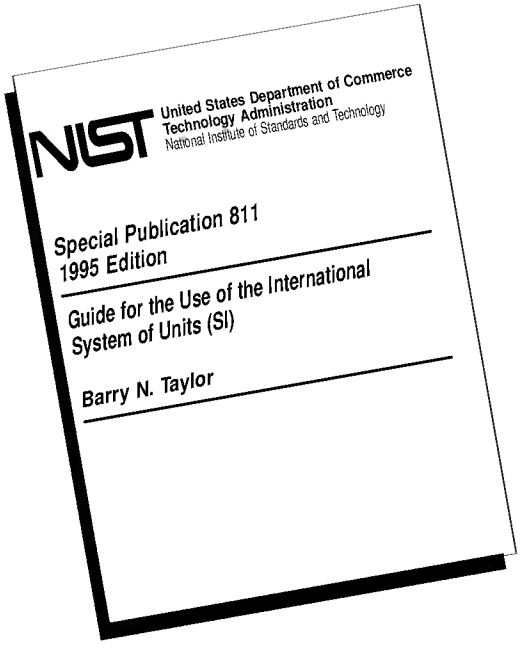
The International System of Units (SI)

The Modern Metric System



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

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

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

The topics covered by SP 811 include:

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

Single copies of the 84-page SP 811 may be obtained from the NIST Calibration Program, Building 820, Room 232, Gaithersburg, MD 20899-0001, telephone: 301-975-2002, fax: 301-948-3825.

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

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

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

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

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