Volume 102, Number 1, January–February 1997
Journal of Research of the National Institute of Standards and Technology

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.

NIST TO PLAY LEADERSHIP ROLE IN ILAC

A NIST representative was unanimously elected vice-chair of the International Laboratory Accreditation Cooperation at the 14th meeting of ILAC in Amsterdam, the Netherlands, recently. As a result, the NIST representative becomes the chair-elect and will assume that position when the group meets in Australia in 1998. ILAC was established in 1977 as the International Laboratory Accreditation Conference. The name was changed to "cooperation" at the recent meeting, and a more formal structure was established in recognition of the importance of laboratory accreditation worldwide. Under the World Trade Organization and provisions of the agreement on Technical Barriers to Trade, conformity assessment practitioners are required to create an efficient, transparent, fair, and harmonized means for the international acceptance of trade goods. The laboratory accreditation community has been cited as a crucial element in a worldwide system needed to facilitate trade.

DIRECTORY OF U.S. STANDARDS ORGANIZATIONS UPDATED

One of NIST's most popular and widely distributed publications, Standards Activities of Organizations in the United States (NIST SP 806), has been updated and will be available shortly. This is the seventh edition in a series begun in 1941 and was prepared for the NIST Office of Standards Services. The new directory lists governmental and non-governmental organizations engaged in mandatory and voluntary standards activities at the national level. It includes more than 700 descriptive entries concerning the development of more than 93000 U.S. standards. Other standards-related activities (e.g., testing, certification, or accreditation) also are indicated. There is a section on sources for standards and related information, a subject index, listings of acronyms and initials, former names of some organizations, and other relevant information. In many sectors, particularly in sectors with rapidly developing technologies, consortia, user groups, and ad hoc task groups have emerged as significant forces in standards development and adoption activities. Most of these non-traditional standards developers function outside the formal standards development framework. Special effort has been made to identify and include them.

DIRECTORY OF PRIVATE-SECTOR PRODUCT CERTIFICATION PROGRAMS UPDATED

The revised Directory of U.S. Private-Sector Product Certification Programs now lists 178 organizations that provide product certification services in the United States. NIST Special Publication 903 is designed to meet the needs of federal agencies and standards writers as well as manufacturers, engineers, purchasing agents, distributors, and others concerned with product-related certification procedures. The directory summarizes the activities of organizations that operate within the United States, those that operate at both the U.S. and international levels, and those that operate as the U.S. component of an international program. It includes organizations that administer a certification program and certify that products meet some criteria; administer a program using an independent, third party certifier; or serve as the independent, third party certifier for a program administered by another organization. Entries describe the type and purpose of each organization, the nature of the activity, products certified, standards used in the assessment, certification requirements, any accreditation or recognition by a U.S. or foreign private-sector or government agency, availability of

services, methods of cost determination, and other relevant details. Where available, a representation of the organization's mark is for the first time included with each entry along with a pictorial index of all such marks.

GIQLP INFORMATION NOW ON-LINE FOR PROCUREMENT OFFICIALS AND GOVERNMENT SUPPLIERS

Information on the Government & Industry Quality Liaison Panel (GIQLP), a government and private-sector effort to develop a government-wide procurement policy for quality management system requirements, is now available on-line through the World Wide Web. This interagency and industry partnership involves 12 Federal agencies, three major industry associations, and representatives from the American Society for Quality Control and the American National Standards Institute. The GIQLP home page describes the panel's vision for quality in the 21st century and outlines a strategy to achieve this vision. The aim of the cooperative effort is to establish a single quality system within a contractor's facility with demonstrated capability for meeting both government and industry customer needs; recognition and use of advanced quality concepts by government and industry in their procurement processes; and the development of uniform criteria and mechanisms within government agencies whereby audits of basic quality system requirements performed by one agency will be accepted by all others.

Those with access to the World Wide Web can find information on GIQLP through the NIST Technology Services' home page at http://ts.nist.gov/ts/htdocs/210/216/giqlp.htm.

NIST TBT AGREEMENT ACTIVITIES REPORT PUBLISHED

TBT Agreement Activities of the National Institute of Standards and Technology 1995 (NISTIR 5898) describes the role of NIST's National Center for Standards and Certification Information (NCSCI) in support of the World Trade Organization (WTO) Agreement on Technical Barriers to Trade (TBT Agreement). NCSCI staff operate the U.S. WTO TBT inquiry point for information on standards, technical regulations, and conformity assessment procedures that might affect U.S. trade. Center staff also coordinate comments on foreign regulations, arrange for translations of foreign technical regulations and standards, and maintain the WTO (GATT) hotline (301) 975-4041 that provides the latest information on proposed foreign government technical regulations issued by the WTO Secretariat in Geneva. In 1995, NCSCI staff responded to 329 requests for TBT-related information, received 378 notifications of proposed technical regulations, and participated in activities to improve implementation of the TBT Agreement.

Copies of the annual report may be obtained by contacting NCSCI, Room 164, NIST North, ext. 4040.

ENERGY-RELATED INVENTIONS PROGRAM MAKES RECOMMENDATIONS

During September 1996, NIST recommended two innovative technologies for commercialization to its Department of Energy partner under the Energy-Related Inventions Program. Viringe—a one-piece, plungerless, prefilled, sealed, and sterile syringe to be used to inject drugs into humans or to flush hospital equipment such as catheters, and to replace traditional two-piece plunger-type syringes. Harvesting Technology for Chinese Tallow Tree Oil Seeds—a machine for harvesting oil seeds from Chinese tallow trees. The oil bearing seeds are processed to obtain valuable oils than can be added to diesel fuel to extend supply.

FIRST FABRICATION OF HIGH-TEMPERATURE SUPERCONDUCTING JOSEPHSON JUNCTIONS ON SAPPHIRE BICRYSTAL SUBSTRATES

NIST scientists have fabricated the first grain-boundary Josephson junctions on sapphire bicrystal substrates. The motivation for the work is to fabricate junctions in high-critical-temperature superconductors (HTS) for applications requiring a large number of junctions, such as voltage standards and programmable arrays. Successful operation at or near the temperature of liquid nitrogen, rather than at or near the temperature of liquid helium, would enhance greatly the practicality and applicability of Josephson-junction circuits. To date, most approaches to fabricating HTS junctions have not produced devices with sufficiently uniform critical currents for circuits containing more than a few junctions. Junctions fabricated across the grain boundary of a bicrystal substrate have shown the promise of more uniform properties. However, the substrate usually used for bicrystal junctions, $SrTiO_3$ (STO), has very poor microwave properties, which disqualifies it for voltage-standard applications. Sapphire is a candidate substrate for such high-frequency applications because it has a low dielectric constant and loss tangent.

The team fabricated junctions on commercial r-cut sapphire bicrystal substrates with a 24° grain boundary down the center. To prevent reaction with the sapphire, an epitaxial CeO_2 buffer layer was deposited prior to the growth of the $YBa_2Cu_3O_7$ superconducting film. The films were patterned into microbridges using standard photolithography and ion milling. The resulting devices

demonstrated "resistively shunted junction" characteristics with parameters comparable to bicrystal junctions on STO substrates but with somewhat larger spreads in critical currents. The team also demonstrated that a gold overlayer can be used to reduce the resistance of the junctions without adversely affecting the critical current. Further, the layer protects the grain-boundary junction from environmental degradation. So far, the team has produced junctions on sapphire that have the characteristic voltages necessary for voltage-standard operation at a frequency of 20 GHz and an operating temperature of 60 K. However, further work is required to achieve the degree of critical current uniformity necessary to fabricate a voltage standard demonstration circuit.

NIST LEADING INTERNATIONAL COMPARISON OF CAPACITANCE AT CCE REQUEST

The Consultative Committee on Electricity (CCE) of the International Bureau of Weights and Measures asked NIST to serve as the lead laboratory for an international comparison of the electrical unit of capacitance, the farad, and this comparison is under way. Its results, together with the results of a small number of comparisons for other electrical quantities, are intended to provide the basis for measurements supporting international trade in electronic and electrical products, including electronic instrumentation. The effort is being organized by a NIST scientist. The measurements and analysis of results are expected to take 3 years to complete and will involve 13 countries in the four geographical regions of Western Europe, Eastern Europe, the Asia-Pacific region, and North America. There has been unusually high interest in participating, with more requests to participate than could be accommodated because of the 3-year time limit stipulated by the CCE. Both the request and the interest reflect recognition of NIST's leading position and expertise in capacitance measurements. To date, the standards have been measured by the National Measurement Laboratory in Australia and the National Physical Laboratory in the United Kingdom and are now at the National Research Council in Canada.

The traveling capacitance standards that are used in this comparison—two 10 pF fused-silica dielectric capacitors in hermetically sealed, metal containers filled with dry nitrogen—were developed and fabricated at NIST and are recognized as among the most stable and precise capacitance standards in the world. Their SI capacitance values have been determined from the NIST calculable capacitor, which is characterized by the lowest uncertainty assignment of any laboratory. These standards have been used in international comparisons before, but difficulties with shifts in the capacitance values were experienced. These shifts were attributed to temperature hysteresis effects induced by the large changes in temperature associated with travel between laboratories. To address this problem, a prescription for temperature cycling was developed by NIST scientists that returns the standards to their normal state. In the present comparison, this temperature-cycling treatment is being given to the standards as soon as they arrive at a participating laboratory.

NIST-ORGANIZED CONFERENCE ON THE FUTURE OF WIRELESS COMMUNICATIONS BRIEFS PARTICIPANTS WITH 50 PRESENTATIONS

The wireless communications industry is evolving so rapidly that engineers and others involved are experiencing difficulty keeping abreast of developments. To help address this situation, a NIST scientist recently organized and served as chair of the 1996 Wireless Communications Conference. This event was designed to provide a broad and integrated view of the technology to its participants, with the goals of accelerating industry's gravitation to superior technologies and the promotion of standardization. Keynoter Federal Communications Commission Chairman Reed E. Hundt addressed the conference by videotape and emphasized that industry, not government, is responsible for developing standards for the new wireless services. Fifty presentations detailed developments to the 180 attendees on a range of wireless technologies, including systems, active and passive components, measurements, packaging, antennas, and propagation. Many of the world's major wireless companies were represented in the program, which included two Japanese and two European speakers, and an exhibit offered a look at new commercial technology. A conference proceedings book was provided. Conference co-sponsors in addition to NIST were ISHM—The Microelectronics Society; the IEEE Components, Packaging, and Manufacturing Technology Society of the Institute of Electrical and Electronics Engineers (IEEE); and the IEEE Microwave Theory and Techniques Society.

A conference highlight was the session held at NIST's Boulder Laboratories, which featured four on-site laboratory presentations by NIST scientists. These talks highlighted new developments in measurements for wireless communications. The closing session provided an overview of efforts to roadmap the wireless future.

M^3 MEASURES GRATINGS FOR NASA'S AXAF PROJECT

Using the NIST Molecular Measuring Machine (M^3), two gratings have been measured for NASA's Advanced X-ray Astrophysical Facility (AXAF) Project. The gratings have lines that are nominally at 200 nm and 400 nm pitches respectively. They are to be used as primary standards in the production of high energy transmission gratings (HETG) by the Center for Space Research at the Masschusetts Institute of Technology. The HETGs are an important component of the x-ray spectrometer system on the AXAF-I space telescope. Launch of the AXAF-I satellite on the shuttle is scheduled for September 1998.

To measure the average pitch of these primary standard gratings, M^3 used a single line scan operating mode to count lines across a 10 mm span. This line count was divided into the total distance, given by M^3's high-resolution, Michelson interferometers, to yield highly precise measurements of the pitch. The analysis and cross checking of the pitch measurement data is still in progress, but the preliminary measurement results have a fractional uncertainty of only 40×10^{-6}, far exceeding the capabilities of any commercially available scanning probe microscope. Further, the feature size is not resolvable with most optical metrology systems and its long distance is outside the range of most electron microscope metrology systems.

HEAT-TREATED STEELS WITH ROCKWELL-C-HARDNESSES

Many precision components that must resist wear in harsh mechanical, thermal, and chemical environments are manufactured from heat-treated steels with Rockwell-C-hardnesses in the range of 50-65. Typically, to attain increased precision and good surface finishes, it is better to machine these components in the hardened state. In the past, the only reliable method for doing so has been grinding. Due to the high costs associated with grinding, other methods are sought. Recent development of new, tougher tools has made it possible to turn and mill steels in their hardened state. However, attainable precision and surface finish is limited by large cutting forces that can cause static and dynamic distortion of machine, rapid tool wear, and unsteady material flaw. Understanding these effects is necessary if hard turning is to become an effective method for producing high-precision components.

NIST scientists recently examined the dynamics of material flow in finish hard turning. They demonstrated that, for most practical machining conditions, material flow is dominated by the formation of segmented chips due to the formation of localized shear bands that form at frequencies in the range of 50 kHz to 120 kHz. To measure the corresponding temporal variations in the stresses acting on the tool during cutting, a polyvinylidine difluoride film was sandwiched between the tool insert and the tool holder to provide a high-frequency sensor. Frequencies measured with this sensor corresponded well with estimates of segmentation frequencies made from the study of the geometry of chip segments. The sensor developed for this purpose potentially may be used as a process monitoring device for the detection of undesirable events such as tool wear and built-up edge.

CHARACTERIZATION AND HYBRIDIZATION REACTIONS OF SURFACE-IMMOBILIZED DNA

Scientists at NIST have developed a process for immobilizing single stranded DNA (probes) on metallic surfaces, with precise control achieved over surface coverage. The orientations and conformations assumed by the surface-bound probes were determined, and the role of surface coverage on hybridization (defined as the pairing of complementary, single-stranded DNA molecules) was examined. Hybridization reactions of DNA molecules immobilized on surfaces are currently of great interest in the development of novel genetic screening and sequencing technologies.

Self-assembled monolayer technology was exploited in the formation of a monolayer of surface-bound DNA. Thiol-derivatized, single-stranded DNA molecules were adsorbed on gold surfaces. The DNA molecules were diluted on the surface by co-adsorbing another thiol molecule, which served as a spacer on the surface. Significantly enhanced hybridization could be achieved by varying the relative surface concentrations of the thiol-derivatized DNA and the diluent thiol molecule. It also has been determined that the adsorbed DNA molecules interact with the surface primarily through the thiol functionality. The nucleotide bases of the DNA molecule do not interact directly with the surface, with the result that they are free to hybridize with complementary DNA. The hybridization efficiencies obtained from thiolated DNA/diluent thiol surfaces are much greater (two to five times more hybridization events) than have been observed for other DNA immobilization strategies.

^{14}C MEASUREMENTS TO INVENTORY ATMOSPHERIC VOLATILE ORGANIC COMPOUNDS THAT CONTRIBUTE TO OZONE FORMATION

Researchers from NIST, the Environmental Protection Agency, and the Oregon Graduate Institute have developed a method to isolate the volatile organic compound fraction from whole air by chemical and cryogenic means and to measure its ^{14}C content accurately. Atmospheric volatile organic compounds (VOC) can be ozone precursors, reacting with nitrogen oxides (NO_x) in the presence of sunlight to produce ozone. The process, known as photochemical smog, produces ozone levels that often exceed the National Ambient Air Quality Standard (NAAQS) in many urban centers and rural areas throughout the United States. The NAAQS for ozone is 0.12 μL/L daily maximum over a 1 h period. The problem in regulating ozone concentrations lies in knowing to what extent do natural vegetative emissions contribute to ozone formation. Accurate chemical measurements to determine the radiocarbon (^{14}C) content of atmospheric VOC can give an accurate inventory of fossil and vegetative contributions and thus aid in more effective regulation of these ozone precursors.

The scientists reported on the first exploratory ^{14}C-VOC results from two composited urban tropospheric air samples, collected during the summer (1992) in Atlanta, GA. The upper limits of the percentage of VOC originating from vegetative sources during the morning and evening hours in Atlanta were 9 % and 17 %, respectively, measurements reported at the 95 % confidence level. Thus, at a minimum, 83 % of the VOC were produced by fossil fuel emissions and could be reduced by effective control strategies. In these experiments designed to evaluate the entire VOC-^{14}C measurement process and obtain reliable estimates of biogenic contributions to atmospheric VOC, high process blanks (with concomitant high uncertainty) were measured. This emphasizes the importance of controls throughout the multiple-step chemical measurement process to ensure data quality. Additional measurements on samples collected in Houston and Nashville are under way to provide a measurement infrastructure for the accurate determination of these important atmospheric chemical species.

ACOUSTIC VIBRATIONS OF A BOSE-EINSTEIN CONDENSATE

A NIST/University of Colorado team at its joint institute JILA has recently observed collective excitations of a Bose-Einstein condensate (BEC). The BEC produced at JILA consists of several thousand rubidium atoms confined in a magnetic trap. When the trap is shaken, the BEC oscillates with characteristic frequencies, much like a bell rings with its natural tone when struck.

A theory that predicts the characteristic frequencies was formulated by the Russian physicist Bogoliubov in the 1950's. Although Bogoliubov's method is one of the cornerstones of the quantum theory of superfluids, it is strictly applicable only to weakly interacting Bose systems. The gaseous BECs first produced at JILA in 1995 are the first such systems in which it can be put to a stringent test. A theoretical group applied a modified version of the Bogoliubov theory to the JILA BEC, and their predicted values of the characteristic frequencies agree to within a few percent with the experimental measurements. The experimental and theoretical results were published in separate papers in Physical Review Letters last summer; a team at MIT subsequently found a similar result for a BEC of sodium atoms. This work lays a foundation for quantitative exploration of the physics of BECs.

MONITORING ULTRAVIOLET IRRADIANCE FROM THE SUN

The third North American Interagency Intercomparison of Ultraviolet Monitoring Spectroradiometers, organized by NIST, was held June 17-24, 1996, at Table Mountain, a plateau north of Boulder, CO. Its purpose was to characterize parameters that affect the accuracy of instruments deployed in solar ultraviolet (UV) monitoring networks and to compare the different instruments by making synchronized solar scans. Such monitoring networks, operated by the Environmental Protection Agency, the National Science Foundation, the Smithsonian Institution, the Department of Agriculture, and the Atmospheric Environmental Service of Canada, are used to measure the UV irradiance that may be associated with changes in atmospheric ozone, the incidence of skin cancer, changes in the growth patterns of crops and forests, and other effects.

There was as much as 10 % variation between the spectral irradiance scales used by the networks and the scale maintained by NIST. Even with a common scale and bandwidth, variations of approximately 4 % were obtained among solar ultraviolet irradiances measured by different instruments during the synchronized measurements. The results indicate the need to maintain a consistent spectral irradiance scale over the long term within and between networks and to determine the responsivities using this scale at the sites where the instruments are deployed.

NIST DEVELOPS HIGH-CONTRAST BROADBAND INFRARED POLARIZER

Development of polarization metrology in the infrared at NIST is being driven by the needs of such diverse fields as optical communication, pharmacology, and infrared imaging. Each of these applications depends on the quality and calibration of polarization components. NIST has constructed and tested a linear polarizer for use with a broad range of visible and infrared radiation. The device uses Brewster angle reflections from four germanium plates arranged in a chevron geometry. Tests with 0.633 μm (visible) and 3.39 μm (infrared) wavelength lasers have shown very good extinction ratios, and the ratios are expected to be good out to wavelengths up to at least 25 μm. The high-quality linear polarizer that has been developed will be used as a standard for calibrating commercially available polarizers.

INFRARED TRANSFER STANDARD DETECTORS DEVELOPED

Infrared detectors are now available that can provide NIST traceability for the wavelength range of 2.5 μm to 30 μm. The detectors have a blocked impurity band design employing arsenic-doped silicon. They were developed at the NIST Low Background Infrared Calibration Facility (LBIR) in conjunction with a private company. Operating at 12 K, these detectors are unique in their spectral range; they have a high degree of spatial uniformity and ultralow noise. These detectors meet the requirements of the aerospace industry and other government agencies to perform radiometric calibrations of satellite sensors for a wide range of needs from environmental remote sensing to military applications. The LBIR facility provides the basis for a number of activities in the low-background infrared, such as the calibration of cryogenic blackbody sources and spectral characterization of infrared optical components such as filters and windows.

WORKSHOP HELD ON BONE PALLIATION RADIOPHARMACEUTICALS

An estimated 80 000 people die of breast or prostate cancer in the United States every year. A significant number (60 % to 80 %) of these cases will experience the excruciating pain associated with bone metastases. Many new drugs in a class of radiopharmaceuticals, called bone palliation agents, are being developed in an effort to relieve this condition. On Sept. 27, 1996, NIST and the Council on Ionizing Radiation Measurements and Standards held a workshop to discuss the current status of research in bone palliation radiopharmaceuticals and to identify future measurement needs in nuclear medicine in general. Among the invited speakers were representatives from the three nuclear reactor facilities in the United States as well as representatives from the two largest isotope-production facilities in Russia. Together, these facilities produce most of the radioisotopes used in nuclear medicine in this country.

The workshop also was attended by representatives of several radiopharmaceutical and instrument manufacturers as well as the U.S. Government agencies involved with radiopharmaceutical production and regulation. Talks by the invited speakers allowed NIST's radioactivity group to set priorities for radionuclides to be standardized in the next 2 to 3 years. The workshop concluded with an open session to discuss attendees' concerns regarding measurement and regulation of radiopharmaceuticals. Standardization of measurement protocols can result in increased safety to the patient and to the hospital staff and can help to reduce patient costs.

NIST-INDUSTRY COLLABORATION LEADS TO IMPROVED RHEOLOGICAL MEASUREMENT CAPABILITY

A joint effort between NIST and a private company has resulted in a new transducer being marketed by this leading manufacturer of rheological and thermal testing equipment. One of the major problems in rheological measurements is the large range of force or torque variation in a single experiment, often covering three or more orders of magnitude.

Accurate measurements require both good temperature control of the sample and excellent long-time zero stability of the force transducer. One solution to the zero stability problem was the development of a force rebalance transducer (FRT) by the private company. Prior joint research between NIST staff and engineers from the private company demonstrated anomalies in normal force measurements with the force rebalance transducer under certain experimental conditions. NIST and the company worked jointly to develop an interim solution to the problem and informed, via joint publications and presentations at technical meetings, the rheology and polymer communities (major users of the FRT) of potential pitfalls in normal force measurements with the FRT as well as methods to work around the problem until a transducer upgrade was produced. The private company has now brought to market a new transducer that not only greatly improves the transducer normal force capabilities but also increases the dynamic torque range by more than an order of magnitude.

HIGH-RESOLUTION THERMAL IMAGING SYSTEM DEMONSTRATED ON METAL ATOMIZATION PLUME

A new high-resolution thermal imaging system was used to measure thermal emission from the spray plume of NIST's supersonic inert gas metal atomizer (SIGMA). Temperature and emissivity variations were measured with a spatial resolution of 100 μm and a temperature resolution of 10 K. This new technology, developed through the NIST Small Business Innovation Research (SBIR) program, uses a novel approach to capture two simultaneous thermal images each at different wavelengths in the near IR wave bands, at video framing rates (30 frames per second). The technology is targeted at process measurement and control for a variety of materials processing devices such as atomization, spray forming, thermal spray coating and welding where noncontact thermography of surfaces with varying emissivity is required.

NEW NEUTRON REFLECTOMETER INSTALLED AT THE COLD NEUTRON RESEARCH FACILITY

A neutron reflectometer recently was relocated from a thermal beam tube in the NIST reactor hall to a cold neutron guide position in the Cold Neutron Research Facility (CNRF). This has resulted in a factor of five increase in intensity with lower background—by far the best achieved to date worldwide for this technologically important measurement method. This significant enhancement in performance is possible because of the increased flux delivered by the new liquid hydrogen cold source and the use of supermirror guide tubes, which effectively extend the angular range of reflection. This makes it possible to measure (for the first time with neutrons) reflectivities approaching 10^{-8} so that, for example, it is now possible to probe the compositional profile across the thickness of single lipid bilayer films with a resolution of several tenths nanometers. In addition, non-specular reflectivity measurements on such systems, which can reveal critical structural information in these lipid layers, will now become feasible.

With the installation of new supermirror transmission polarizers, the reflectometer now has a polarized beam capability where polarization efficiencies better than 95 % can be achieved. These polarizers also have high transmission efficiencies so that intense beams can be obtained. As a consequence, magnetic multilayer systems that exhibit giant magnetoresitive behavior, such as Fe/Cr, can be studied more effectively than ever before to reveal, in microscopic detail, the magnetic moment magnitudes and orientations. The observed magnetic behavior then can be correlated with the measured structure, which can aid in the intelligent design of better layered materials for use in retrieving information stored magnetically on discs and tapes.

Other areas of important application for this improved cold neutron measurement capability include studies of different oxide layers on silicon surfaces, which are of interest to the semiconductor industry, and the effect of hydrogen interdiffusion on both the structural and magnetic properties of a variety of thin film and multilayer systems.

NIST STUDIES CARBON MONOXIDE IN RESIDENTIAL BUILDINGS

NIST recently completed a study of carbon monoxide in residential buildings for the National Fire Protection Research Foundation (NISTIR 5906). This study focused on the distribution of CO in residential buildings as it relates to the installation of CO detectors. The study was conducted to assess existing information related to the questions of how many CO detectors should be installed in homes and where they should be installed to warn building occupants of a typical CO concentrations from, for example, furnace venting failures and attached garages. The study included a literature review of the technical issues related to CO detection in homes, including residential CO sources, air movement and contaminant distribution in single-family residential buildings, and air and contaminant mixing in buildings.

While a number of studies relevant to CO mixing in homes have been performed, the information is not sufficiently comprehensive to determine the appropriate location of these detectors in residential buildings. An experimental plan was developed for field measurements and computer modeling to obtain the technical information necessary to make technically sound recommendations on the installation of CO detectors in homes. The project was overseen by a Technical Advisory Committee consisting of detector manufacturers, organizations representing fire officials and building code officials, and the Consumer Product Safety Commission.

NIST SOFTWARE IMPROVES THE ACCURACY OF BRAIN PROBES

NIST software recently proved to be a crucial factor in resolving unexplained accuracy issues discovered in the calibration process and equipment at a Boulder, CO firm that designs, manufactures, and sells three-dimensional optical localizers for medical and industrial applications. Their localizer is primarily used in neurosurgery to allow a surgeon to track the location of a

location of a probe within a patient's skull. Obviously, such localizers must be calibrated to high accuracy.

ODRPACK, software developed by NIST, is uniquely well-suited for modeling three-dimensional data such as the data produced by localizers. By applying ODRPACK to their problem, the Boulder company was able to find and correct problems with their process. In addition, ODRPACK enabled them to develop new models for the optical properties of their system. Now, every system they ship is tested and certified for accuracy using software built on ODRPACK.

ODRPACK solves the extended nonlinear least squares problem where both the explanatory as well as the dependent variables have errors, a procedure sometimes known as Orthogonal Distance Regression. The algorithm and the software were developed at NIST; the software is available using the NIST Guide to Available Mathematical Software (http://gams. nist.gov/).

NEW PUBLICATION FEATURES EXPERIMENTAL MODELS FOR SOFTWARE DIAGNOSIS

NISTIR 5889, Experimental Models for Software Diagnosis, explores the methods of collecting information within the software engineering community and describes the applicability of each method toward an understanding of the software development process. Experimentation and data collection are becoming accepted practices within the software engineering community to determine the effectiveness of various software development practices. The document clarifies the concept of experimentation and identifies the best data collection techniques needed to validate software methods that are effective. This understanding fosters a better technical exchange of information between scientists and engineers in the software community.

ITL OFFICIALLY LAUNCHED AT NIST

U.S. industries and companies that produce and use information technology will benefit from NIST's new Information Technology Laboratory, which will produce tests that encourage companies to develop quality products and thus expedite technology's entrance into the marketplace. NIST's information technology research will concentrate on developing tests and test methods for information technologies still in the early stages of development. Research is under way in such areas as speech recognition, virtual reality modeling language, digital video, cryptography, and mathematical modeling. The ITL works to promote the development and use of information technology systems that are interoperable, easily usable, scalable and secure. The ITL combines and expands the roles of two previous NIST entities: the Computer Systems and the Computing and Applied Mathematics laboratories. In addition to working with partners in U.S. industry, ITL maintains its roles in serving other federal government agencies and in helping NIST's own researchers effectively use information technology. More information about ITL is available on the World Wide Web at http://www.nist.gov/itl.

CONSORTIUM REPORTS ON INSTALLATION EFFECTS

Small inaccuracies in flow meter measurements translate into million-dollar errors for utility companies, fuel suppliers, and manufacturers. That is why NIST's Flow Meter Installation Effects Consortium is working to help improve the accuracy of flow meters installed in actual practice. The consortium's newest report, Flowmeter Installation Effects Due to a Generic Header (NIST Technical Note 1419), describes how flow metering accuracy can be altered by an upstream header with one inlet and two outlets. Headers are used to subdivide large pipe flows into several smaller flows to improve the measurement, reduce the cost of the metering or both. The new NIST report will help engineers compensate for pipe configurations that do not allow for ideal flow meter placement. Scientists studied the effects of the header using laser Doppler velocimetry, an optical technique that can detect flow velocities without inserting instrumentation into the flow. TN 1419 is available for $9 prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, (202) 512-1800. Order by number 003-003-03415-1.

DIGEST AVAILABLE ON OPTICAL FIBER MEASUREMENTS

Researchers interested in the characterization of optical fiber and related components will want a copy of the technical digest of the Ninth Symposium on Optical Fiber Measurements held at NIST's Boulder, CO laboratories Oct. 1-3, 1996. Measurements of polarization mode dispersion (PMD) and nonlinear processes in optical fibers are two of the topics covered by symposium papers. In the case of PMD, its statistical nature complicates measurement and makes accuracy verification difficult. Many of the papers, therefore, focus on comparisons of measurement techniques. In wavelength division multiplexed systems employing optical

amplification, high powers can lead to problems from nonlinear processes such as Brillouin scattering and four-wave mixing. These issues are included in several papers on the measurement of non-linear coefficients and effective area. Technical Digest, Symposium on Optical Fiber Measurements, 1996, is available at no charge while supplies last. Contact the NIST Optoelectronics Division at (303) 497-5342.

NEW ANNEALING TECHNIQUE FOR OPTICAL FIBER CURRENT SENSORS

A NIST scientist recently completed work on a new technique for annealing optical fiber that permits the virtually complete elimination of linear birefringence, even in moderately high birefringence fibers. Linear birefringence is the condition in which specific orthogonal linear polarizations of light propagate at slightly different velocities, with the result that, in most cases, the polarization state will vary with propagation distance. This condition is a problem in many optical fiber applications, including the optical fiber current sensors that were the focus of the scientist's work. Annealing to reduce birefringence in fiber was demonstrated at NIST in the mid 1980's and subsequently developed sufficiently so that the process could be used in the fabrication of commercial current sensors. One company is beginning to manufacture sensors based on this technology, and several others are developing products. Unfortunately, not all optical fibers have been found to be amenable to annealing, although the reason why was not well understood.

The scientist's work has resulted in a new understanding that the ellipticity of the fiber core adds significantly to fiber birefringence, even in fibers in which the ellipticity is too small to measure directly. Annealing effectively eliminates stress birefringence but has no effect on birefringence related to noncircular geometry. A solution is to twist the optical fiber prior to annealing. The geometric birefringence is thereby averaged to zero, and the birefringence of almost any ordinary optical fiber effectively can be eliminated. A model of the twisted and annealed fiber has been developed that fits experimental results for a variety of fiber types and twisting rates and shows that the twisting rate needs to equal the geometric birefringence to achieve an isotropic fiber. Isotropic fiber coils provide the best opportunity to evaluate the sensitivity of a fiber current sensor, which is governed by a material parameter known as the Verdet constant. Using a variety of twisted and annealed coils, the NIST scientist has been able to measure the Verdet constant of specific optical fibers with a relative uncertainty of about 0.5 %, about a factor of six better than had been possible previously.

ELECTRON-COLLISION DATABASE DEVELOPED FOR GASES USED BY THE SEMICONDUCTOR INDUSTRY

NIST is in the process of building a new database of collision cross sections and transport data for electrons interacting with gases used for the manufacturing of semiconductor devices. The data in this new database will be used primarily in the development of sophisticated plasma models for predicting the performance of plasma processing reactors. Additionally, the in-depth analysis associated with the synthesis of the data within the database will: (i) aid in the understanding of the properties of low-temperature plasmas and the role played by collision processes, (ii) help the development of more sophisticated in situ nonintrusive plasma diagnostic techniques and plasma-reactor modeling, and (iii) impact our ability to provide a scientific underpinning to the existing processing technologies and promote the development of new plasma-assisted processes.

For this project, the available data are comprehensively synthesized, critically assessed, and distilled to a recommended set of cross sections and transport data that accurately reflect the current state of knowledge for the interactions of electrons with plasma processing gases. Work has been completed on the gases CF_4 and CHF_3. The former is used widely in manufacturing semiconductor devices and other applications, and the latter has been proposed as a substitute of CF_4 in these applications because the lifetime of CHF_3 in the environment is much shorter (250 years) compared to that of CF_4 (50 000 years). The completed work on both gases soon will appear in two separate articles in the Journal of Physical and Chemical Reference Data and have been presented at the 1996 International Conference on Plasma Science and at the 49th Annual Gaseous Electronics Conference. Sufficient data were available for CF_4 to allow the synthesis of a complete set of experimental cross sections; however, only a very limited amount of data were available for CHF_3. The significant gaps in knowledge concerning electron interactions with CHF_3 that were exposed by this work have prompted programs at several universities and national laboratories to begin performing measurements of unknown cross sections and transport processes. The recommended data for both molecules have been made available via the World Wide Web (at http://www.eeel.nist.gov/811/refdata) for easy access by all interested users.

NEW DETERMINATION OF SI OHM YIELDS IMPROVED VALUE OF FINE-STRUCTURE CONSTANT

In the International System of Units (SI), the unit of resistance is the ohm. A new determination of the ohm using the NIST calculable capacitor has recently been completed by NIST scientists. Comparison of the ohm with the quantum Hall resistance (QHR) yields a value for the von Klitzing constant R_K. Assuming the theoretical relationship $R_K = h/e^2$, where h is the Planck constant and e is the elementary charge, a value for the fine-structure constant can be derived directly from the NIST calculable capacitor. The fine-structure constant is a fundamental measure of the interaction between atomic particles and atomic electromagnetic fields; it also can be obtained with high accuracy from certain experiments using quantum electrodynamic (QED) theory. Thus, the new NIST determination of the fine structure constant can help test QED. The latest value is the result of almost 3 years of work by NIST scientists. The ohm determination involves a long chain of precision measurements that start at the calculable capacitor, where its capacitance value of 0.5 pF is determined from a length measurement directly referred to the meter. This SI value is then transferred to higher value capacitance standards, then to resistance standards, and eventually to a 1000 Ω transportable resistor using ac transformer bridges. An ac-dc conversion then is made to obtain the dc value of the resistor. The comparison of the QHR with the realization of the ohm through the calculable capacitor is made through the dc measurement of this 1000 Ω transportable resistor.

The latest NIST value for the fine-structure constant α^{-1} is $137.036\,003\,7 \pm 0.000\,003\,3$, which was presented at the 1996 Conference on Precision Electrical Measurements. It compares favorably with a new similar experimental determination by a scientist at the National Measurement Laboratory in Australia and a new value based on QED and the experimental determination of the anomalous moment of the electron. The new NIST result is believed to be more reliable than the previous NIST result, since that result was based on a single measurement and the new result is based on a series of measurements. The NIST work will provide data for the least-squares adjustment of fundamental constants in 1997. Any decrease in uncertainty for the experimental value of the fine-structure constant enhances one's ability to determine many of the other fundamental constants and to test several of the basic physical laws of nature.

NIST STANDARD RETARDER INCLUDED IN THE OPTICAL SOCIETY OF AMERICA'S TIME CAPSULE

A prototype standard optical retarder developed by NIST scientists was included in a time capsule recently sealed by the Optical Society of America in commemoration of its 80th anniversary. The capsule will sit in the lobby of the OSA headquarters in Washington until the society's 100th anniversary in 2016. Seventy items were selected by the Anniversary Committee from suggestions offered by society members.

An optical retarder is a device for providing a phase shift between two orthogonal polarizations of light and can be used to modify or determine the state of polarization. The NIST standard retarder was developed at the request of several companies. Manufacturers of retarders (sometimes called waveplates) often have difficulty in agreeing with their customers on the performance of their products. Manufacturers of polarization measuring instrumentation need a calibration standard. The NIST device is intended to meet both of these needs. It was developed in part through a joint Cooperative Research and Development Agreement with two private companies and is expected to be available soon as Standard Reference Material 2525. One of the companies will manufacture the SRMs; NIST will perform the characterization.

The NIST retarder derives its phase shift from total internal reflection in a glass specially chosen to minimize the effect of stress. It consists of two concatenated Fresnel rhombs carefully aligned so that the input and output beams are collinear. The retardance is stable to within 0.1° retardance over input angle variations of ±1°, wavelength variations exceeding 50 nm, and temperature variations greater than 10 °C. The devices are designed to be nominally quarterwave retarders (90°±2°) at 1.3 μm and have an accurately measured retardance within an expanded uncertainty of 0.1°.

MANUFACTURER'S STEP TRANSLATION CENTER RECEIVES CALS IMPLEMENTOR AWARD

A major automobile manufacturer received the CALS Implementor Honor Roll Award from the U.S. CALS Industry Steering Group for using the new international standard STEP (Standard for the Exchange of Product model data, officially ISO 10303) to transfer product designs between teams using different computer-aided design (CAD) systems. STEP replaces less effective

methods of data exchange that have been barriers to streamlining the process of developing new products. As a result of STEP, the automobile manufacturer and its suppliers are realizing reductions in costs and time to market, while enhancing the quality of their products and agility of their processes. The auto manufacturer's STEP Translation Center is the means for exchanging designs for new products among its divisions, their customers, and their suppliers. The center is increasing the degree of cooperation on the design of new products, which will move the products into production in less time and at a reduced cost.

NIST holds the Secretariat of the International Organization for Standardization Subcommittee on Industrial Data (ISO TC184/SC4) under which STEP was developed and has been a heavy technical contributor to this international standard. Further, software tools developed under the Systems for Integrated Manufacturing Applications (SIMA) STEP Conformance Testing project have been used extensively by industry. These tools isolate and enable rapid resolution of implementation issues found in the commercial CAD translators that are used by this center and others who are adopting STEP.

SMART TRANSDUCER INTERFACE DEMO AT SENSORS CONFERENCE

NIST, in cooperation with IEEE's Technical Committee on Sensor Technology of its Instrumentation and Measurement Society, is developing a smart transducer interface standard. A reference implementation of a draft protocol standard for digital communication between sensors or actuators and microprocessors was developed and demonstrated to the public on Oct. 22-23, 1996 at the SENSORS Conference and Exposition in Philadelphia, PA. The demonstration consisted of the integration of a NIST-implemented smart transducer object model to two smart transducer interface modules (STIM). The STIMs were developed separately, by an instrumentation builder, and a sensor producer. The proposed standard is anticipated to have a significant impact. The instrumentation builder announced it will market an STIM development kit in the spring of 1997 in support of the standard. A private company revealed the design of an interface chip that implements the standard, and an aircraft manufacturer disclosed that it will implement the standard interface in its aircraft testing system.

LASER-DRIVEN THERMAL REACTOR DEVELOPED FOR CHARACTERIZING WASTES AND FUELS

In a collaboration with a private company, scientists at NIST have developed a new capability to determine the thermal properties and chemical reaction characteristics of solid, liquid, and multiphase substances, such as chemical wastes, through rapid and controlled heating with laser radiation. The laser-driven thermal reactor (LDTR), for which the company holds a U.S. patent, is an off-line analytical device capable of providing nearly real time analyses of fuel streams.

The NIST LDTR is the first operational system to be assembled in the United States. Unlike conventional thermal analysis techniques, which are designed to measure a selected thermal or chemical property in a nominally constant temperature environment, the LDTR measures an integrated thermal response, representing the effects of multiple thermal and chemical properties, in a dynamic environment characteristic of real-world reactors where the temperatures are high and rapidly changing. Temperatures in the LDTR range up to 2000 K and the heating rate can be as high as several hundred kelvins per second. This integrated, total response of a substance to this dynamic temperature environment is precisely the data needed to predict its performance in a full-scale chemical reactor.

The LDTR is composed of a disk-shaped substrate, on which rests the sample to be tested, that is contacted by a thermocouple and sits inside a sphere-shaped reactor. The assembly is mounted in a chamber and heated by an infrared laser from opposing sides to achieve uniform temperature. Temperature measured by the thermocouple is the response signature of the substance. Additional information on the chemical reaction can be gained from chromatography of the gases released during the process. The LDTR has been demonstrated on nitro-compounds absorbed by activated carbon, sulphur compounds in heavy fuel oil, and coals. The LDTR has the potential for becoming an on-line process control sensor that could be used to optimize a thermal process, such as thermal oxidation or combustion, by monitoring the varying properties of the feed stream. An improved understanding of the effects of heat rate and temperature on substance reactive behavior, which will be gained from the LDTR, will suggest ways to enhance the energy efficiency of a process and control the formation of chemical byproducts.

FUNDAMENTAL CONSTANTS BIBLIOGRAPHIC DATABASE ONLINE

Fundamental physical constants, such as the speed of light c, the Planck constant h, the Avogadro constant N_A, and the mass of the electron m_e, are the links in the chain that binds science and technology together. While improved values of the constants are required to challenge the basic tenets of physics, they also are required for a wide variety of practical computations, for example, the calculation of the excited states of atoms and molecules that play an important role in atmospheric chemistry and energy generation. Further, the sophisticated techniques that researchers must develop to better determine the values of the constants have significant impact in the field of metrology, where they change the nature of fundamental standards. The 1983 redefinition of the meter in terms of the speed of light and the 1990 introduction of practical representations of the volt and of the ohm based respectively on the Josephson and von Klitzing constants are recent examples.

To aid researchers in industry and academia, NIST recently put online a bibliographic database on the constants (http://physics.nist.gov/fundconbib). This searchable database gives citations for the most important theoretical and experimental publications in the field since the mid-1980's (with growing coverage of earlier work). The database, which currently contains about 1600 entries, is updated regularly.

The new bibliographic database complements the database that gives the recommended values of the constants themselves (http://physics.nist.gov/fundcon). This database has been online since October 1994 and receives about 3000 queries each month.

SI ON THE INTERNET

The International System of units, universally abbreviated SI (from the French Le Système International d' Unités), is the modern metric system of measurement. By law, "the metric system of measurement [is] the preferred system of weights and measures for United States trade and commerce."

To aid the ever increasing number of SI users in the United States, NIST recently established an SI page on the World Wide Web (http:// physics.nist.gov/SI). There, three important NIST publications on the SI may be accessed directly: NIST Special Publication 811 (SP 811), *Guide to the International System of Units (SI)*; NIST SP 330, *The International System of Units (SI)*; and the *Federal Register* notice of Dec. 20, 1990 (55 FR 52242-52245), which restates the interpretation of the SI for the United States by the Secretary of Commerce. It is anticipated that this page, which also contains information on the role of the CGPM and the CIPM in maintaining the SI internationally, will become recognized throughout the country as the place to go for the most definitive and up-to-date information on the SI and its proper use.

NIST COLLABORATES ON INSTRUMENTATION FOR THE SOHO SATELLITE

The far UV physics group at NIST recently collaborated with researchers in the United States and Europe in the development and calibration of an instrument now in operation aboard the Solar and Heliospheric Observatory (SOHO) satellite. The instrument, called the Solar Emission Monitor (SEM), is a filtered radiometer designed to monitor the extreme-UV solar flux in space by observation of He II 30.4 nm emission, as well as the integrated flux from 0.1 nm to 82 nm. It uses a transmission grating, aluminum filters, and special silicon photodiodes, all optimized for this task. The photodiodes evolved from a prior collaboration between NIST and industry.

The flight SEM, several engineering versions of it, and the individual components (gratings, filters, and detectors) were calibrated both monochromatically and with undispersed radiation at the SURF II facility.

The satellite was launched in December 1995, and the SEM, part of the Charge, Element, and Isotope Analysis System, is now providing valuable data from which calibrations of other instruments can be derived. Details of the satellite, its experiments, and samples of data can be found on the World Wide Web at http://sohowww.nascom.nasa.gov/.

ELECTRONIC STRUCTURE CALCULATION DATABASE RELEASED

For calculating the structure of materials from first principles, density functional theory is increasingly becoming the method of choice. It has had great success recently in explaining the properties of fullerene and amorphous and ferroelectric materials, and it requires less demanding computations than do traditional methods of electronic structure calculation. However, its implementation relies on an approximation to the total electronic energy that is not uniquely defined in practice. This makes it difficult for different practitioners to compare their results on a common basis.

NIST scientists addressed this problem by producing a World Wide Web accessible database that provides high-precision numerical data for all elements from hydrogen through uranium, as computed in several approximations that are specified clearly. It may be found at http://math.nist.gov/DFTdata/.

THREE TUNABLE X-RAY SPECTROMETERS DELIVERED TO NASA

NIST scientists have designed and delivered x-ray monochromators to support three NASA missions in x-ray astronomy. The AXAF (Advanced X-ray Astronomy Facility), XTE (X-ray Timing Explorer), and Astro-E (scheduled for launch by Japan around the year 2000) require widely tunable monochromatic x-radiation for pre-flight calibrations and subsystem development.

The AXAF instrument covers the range from 0.3 keV to 12 keV; it was installed at Marshall Space Flight Center in late 1995. Scientists at the center credit the NIST-designed double-crystal monochromator to be a very useful calibration tool for AXAF and have posted test results and photographs of the hardware on the World Wide Web (http://wwwastro.msfc. nasa.gov/xray/xraycal/xssrr/dcm/).

The large proportional counter array for the XTE mission was launched successfully on Dec. 30, 1995. One of the NIST-designed monochromators (1 keV to 60 keV) is installed at Goddard Space Flight Center where it is used to evaluate the performance of a duplicate instrument package.

NIST also supplied hardware for the Astro-E mission including, in addition to the basic monochromator, a multi-anode target array and electron gun to produce low intensity calibration points from 0.3 to 12 keV. All monochromators had dual pentagonal turrets for the diffraction crystals which were individually characterized, and in some cases crystals and multilayers were produced in the group.

FIELD EMITTER ARRAYS FOR FLAT-PANEL DISPLAYS

Field emission displays are being pursued by U.S. companies as a leap-frog technology with the potential of negating the off-shore manufacturing advantage in active matrix, liquid crystal flat-panel displays. In support of this developing industry, NIST scientists study the physics of the field-emission cathodes used in such displays.

One recent project modeled and tested the electron emission and electron trajectories from gated field emitter arrays. In another, field emitter cathodes were fabricated with integrated lenses co-planar to the gate electrode for collimating electron beams from tips of gated field emitter arrays. Linear planar lens electrodes on both sides of a line of emitters were demonstrated to provide focusing by application of appropriate voltages. With focusing, the resulting line image was less than 0.035 mm wide at 10 mm to 20 mm from the anode, compared to an unfocused image about 100 times larger. This was the first demonstration of electron-beam focusing from field emitter arrays with an integrated planar lens design in a well-documented study with calibrated image registration.

LATTICE CHANGES IN SI EPILAYERS AND SI SUBSTRATES

Certain high-performance microprocessors are fabricated using epitaxially deposited thin silicon layers grown on highly doped silicon wafers. In at least one case, it was found that material from different vendors gave differing production yields although all sources met stated electrical criteria and appeared consistent using the manufacturer's current metrology toolbox.

In order to help diagnose this problem, NIST scientists examined the substrate crystal lattices using high-resolution x-ray techniques developed at NIST. Measurements of the lattice spacing showed among the sources and even a rather large difference between nominally identically processed samples from different diameter boules. In a second set of measurements, the lattice constant of the epilayer was measured with respect to that of the substrate using conventional high-resolution double-crystal diffractometry. Fractional differences obtained in these measurements range from 20×10^{-6} to 100×10^{-6}. The two measurements can be combined to obtain the lattice parameter of the epilayer itself.

There is some indication that the lattice parameter differences correlate with device yield, although the needed control studies have not yet been undertaken.

NEW REPORT DESCRIBES IMPROVED ACCURACY IN OPTICAL RADIATION

Accurate measurements of infrared, visible, and ultraviolet light are critical to our national defense, for remote sensing of environmental conditions, and for a wide variety of industrial processes. NIST provides optical radiation standards and tests to ensure the accuracy of these measurements, and over the past few years, an accumulation of technological advances has enabled NIST to switch to more accurate methods of transferring calibration information to its customers.

NIST Technical Note 1421, A National Measurement System for Radiometry, Photometry, and Pyrometry Based Upon Absolute Detectors, has just been released. In it, the author describes these more accurate measurement methodologies in detail. For many years, calibrations have been performed on sources of optical radiation, such as standard lamps that are available through the NIST Calibration Program. However, calibrations made on detectors of optical radiation are often able to

improve the accuracy of the measurement of the radiometric, photometric, and pyrometric quantities of interest. As part of its responsibility to enable industry to adopt improved methods of metrology, NIST is encouraging its calibration customers to switch to detector-based methods of calibration, as described in the Technical Note.

NEW PHOTOMETRIC CALIBRATION CAPABILITIES

NIST is responsible for the realization of the candela, one of the SI base units, and other photometric units for luminous flux, illuminance, luminance, and color temperature. The NIST photometric units are based on standard photometers traceable to NIST's high-accuracy cryogenic radiometer (HACR). Using detector-based methods to realize the photometric scales has reduced uncertainties of photometric calibrations and has resulted in the availability of additional photometric calibration services. Specifically, a new luminous flux unit was realized recently using an innovative integrating sphere method. Using this method, the NIST lumen, with improved accuracy, is now also traceable to the HACR.

A publication that provides extensive information on the realizations of the NIST detector-based photometric units and new calibration procedures for luminous intensity, illuminance, luminance, luminous flux, and color temperature is now available. NIST Special Publication 250-37, Photometric Calibrations, replaces the previous SP 250-15 (1987). These improved photometric measurements have been required for maintaining safety standards in the automotive and aircraft industries. Improved photometric standards also are driven by the lighting, display, and optical instrumentation industries.

OPTICAL STANDARDS AID SEMICONDUCTOR MANUFACTURERS

During integrated circuit manufacturing, measurements of the optical scatter of silicon wafers are often employed in production-line diagnostics. However, the geometry of commercial optical scatter instrumentation lacks standardization, making if difficult to compare values obtained by instruments made by different manufacturers. The bidirectional reflectance distribution function, on the other hand, is a well-defined quantity and can be related to the power spectral density (PSD) of silicon wafer surface roughness and to the production-line optical measurements currently being made.

Researchers at NIST have developed an approach for characterizing low-level optical scatter instrumentation using a spatial frequency response function. This function gives the sensitivity of an instrument with a specified geometry to microroughness on different length scales, allowing the signal measured by the instrument to be treated as an integration of the PSD with the instrument's response function. Algorithms were developed for calculating this response function for different geometries; and a computer program will be made available, which will allow different instrument manufacturers to calculate the response function for each of their products. This methodology is being incorporated into ASTM documents describing the standard practice for calibration of scanning surface inspection systems.

CIRMS HOLDS FIFTH ANNUAL MEETING AT NIST

The Council on Ionizing Radiation Measurements and Standards (CIRMS) held its fifth annual meeting at NIST Nov. 12-14, 1996. The organization represents thousands of users of ionizing radiation and radioactive sources, who are engaged in industrial radiation processing and sterilization, medical radiation diagnostics and therapy, nuclear power, worker radiation protection, and environmental measurement programs. CIRMS provides a forum for discussing ionizing radiation issues; identifying, defining, and prioritizing needed work; disseminating information on standards; and organizing workshops and meetings to advance ionizing radiation technology. The thrust of this year's annual meeting was to discuss and prioritize the needs identified in the CIRMS Report on National Needs in Ionizing Radiation Measurements and to develop specific roadmaps for the most important needs in each of four areas: radiation effects, medical applications, public and environmental radiation protection, and occupational radiation protection.

More than 100 participants attended the meeting, which highlighted university contributions in radiation dosimetry and radioactivity measurements. Representatives attended from 15 corporations, eight federal and state agencies, four national laboratories, and 20 universities. A special session was included in this annual meeting on standards activities in other professional societies: ASTM, ANSI, the American Association of Physicists in Medicine, the Health Physics Society, and the National Council on Radiation Protection and Measurements.

OPTICAL FREQUENCY DIVISION BY A FACTOR OF THREE

NIST scientists, along with colleagues from the University of Colorado, the University of Bonn, and the University of Arizona, have developed a new scheme for coherently connecting optical frequencies in a 3:1 ratio. They have demonstrated the method by locking the output of a Nd:YAG laser at 1064 nm with a CO overtone laser at 3192 nm. This is a significant step in the development of simpler frequency-synthesis chains, since in combination with divide-by-two systems more rapid division convergence and greater flexibility in design are achieved.

There are a number of examples where division by three is advantageous. For example, the optical frequency standard in Hg^+ will use a very high-Q ultraviolet transition at 282 nm, and this will be excited with a twice-frequency-doubled Nd:FAP laser at 1126 nm. When this is divided by a factor of three, it results in a wavelength of 3378 nm, which is close to a very important methane reference that can serve as a bridge to the microwave region.

This work is part of a larger NIST effort to develop new methods and components that can contribute to the simplification of optical frequency measurement and the construction of much simpler frequency synthesis chains. The long-term objective is a robust and simple chain linking the cesium frequency standard to the optical region.

CALCIUM OPTICAL MOLASSES

NIST scientists have achieved cooling and trapping of calcium using frequency-doubled diode lasers. Previous high-resolution spectroscopic studies of the 657 nm line in calcium were limited by the Ramsey-method, interaction-time linewidth to a few kilohertz. However, the cooled and trapped atoms should now allow measurements to the intrinsic linewidth of 400 Hz. Furthermore, the use of diode lasers at 423 nm for the cooling and trapping of the atoms and for interrogation of the 657 nm transition results in a relatively small system that could be made transportable.

The system that generates the 423 nm radiation is particularly efficient. Infrared diode-laser radiation is doubled to 423 nm using a potassium niobate crystal. The fortuitous matching of this laser and nonlinear crystal is such that the blue output is down in power from the IR laser by only a factor of three.

This is a particularly attractive optical frequency standard because the first-order Doppler shift is removed by the trapping, the second-order shift is reduced substantially by cooling, and the 657 nm line is only slightly sensitive (in second order) to electric and magnetic fields. In addition, the frequency (and hence vacuum wavelength) of the 657 nm transition is now known with a relative uncertainty of less than 1×10^{-12}, so it is immediately useful as a wavelength standard at this uncertainty.

CRYSTALLINE NON-NEUTRAL PLASMAS

An atomic frequency standard with good signal-to-noise performance can be constructed using large numbers of ions ($>10^5$) contained in a Penning trap (which achieves trapping using static magnetic and electric fields). However, to date it has been difficult to precisely characterize and control the Doppler shifts associated with the magnetron rotation of such a stored ion plasma. Recently, scientists at NIST have cooled such a plasma to form a rigid solid and have developed a method for controlling the rotation rate of this rotating solid. Their methods bring promise for the development of a frequency standard of high accuracy and excellent short-term stability. In addition, they now have strong indications that their plasmas are sufficiently large that they exhibit bulk behavior and are characteristic of infinite, strongly coupled one-component plasmas. This is significant because such plasmas are models of dense astrophysical matter and this is the first laboratory system with the potential of generating them in the strongly coupled regime.

The group had previously observed Bragg scattering of laser light from crystallized plasmas, but the rotation of the plasma converted the usual Laue dot pattern to one of concentric rings. In recent experiments, they have gated (gate time small compared to the rotation period) an imaging system synchronously with the plasma rotation. This has allowed them to recover the Laue dot pattern and helped identify the favored lattice type as body centered cubic. This is the predicted lattice for an infinite, strongly coupled one-component plasma. The group also has used a “rotating wall” to precisely control the magnetron rotation of the crystalline plasma. The rotating wall is a rotating electric field generated by six electrodes arranged around the equator of the trap. Bragg scattering studies show that the crystalline plasma orientation can be phase locked to the rotating electric field. This allows precise reproduction of the same rotation rate from experiment to experiment, an important step in controlling the time dilation shift due to the plasma rotation. Other conditions that need to be controlled to produce a constant time dilation shift are the number of trapped ions and the strengths of the trapping fields.

DETECTION OF METHANE IN AIR

In a collaborative program with Rice University and the National Oceanic and Atmospheric Administration, NIST has developed a laser-spectroscopy-based system that can determine methane concentration in air to 1 n mol/mol. The approach is dramatically simpler and the system is much more portable than the chemical processing and gas chromatography methods used currently. Furthermore, the new spectroscopic method is a nondestructive, real-time measurement as opposed to the laborious analytical techniques now employed.

Methane in the atmosphere is believed to contribute to the greenhouse effect, so simpler methods for long-term monitoring are especially important. The normal concentration of methane in air is about 2 μ mol/mol, and measurements over the past decade indicate that, for reasons that are not yet well understood, the average concentration has been increasing at a rate of about 10 n mol/mol per year.

The spectroscopic system operates at a laser wavelength of approximately 3.3 μm on a methane line that is well separated from those of water, making the measurements undisturbed by varying water concentrations. The 3.3 μm radiation is generated by difference-mixing the outputs of a diode-pumped YAG laser at 1.06 μm and a diode laser operating at 805 nm. The system easily could be designed to be transportable and also could be installed at fixed locations to provide continuous monitoring. An additional benefit of spectroscopic monitoring is that the system can be tuned to be sensitive only to methane containing ^{13}C rather than the usual ^{12}C atoms. Thus, it should be possible to use this nonradioactive species in a method similar to radioactive labeling to monitor the movement of ^{13}C-labeled methane through any type of system.

HIGHER FREQUENCY OBSERVATIONS USING LASER MAGNETIC RESONANCE

A NIST scientist and co-workers from Oxford University and the University of Bonn recently have made spectral observations of the FeD_2 molecule near 6.9 THz (43 μm) using laser magnetic resonance (LMR) spectroscopy. This required modification of their spectrometer so that it could be operated at these high frequencies. To date, these are the highest frequency FIR LMR observations and the first FIR observations of a vibrational bending spectrum made using LMR spectroscopy. The FeD_2 observations are important because they provide accurate spectral information for searches for the presence of iron in the interstellar medium where iron has never been observed.

Aside from the immediate value of this particular observation, the development of a capability for higher frequency observations opens up significant new opportunities for measurements of importance to radio astronomy and upper-atmospheric research. The modification to the spectrometer allows measurements at frequencies as high as 9 THz, just about the same upper limit for radio astronomy measurements. This expanded range of LMR measurement now covers fine-structure transitions in a number of atoms and molecules, providing the potential for making the exacting laboratory frequency measurements needed to support searches for these atoms in space. Furthermore, ClO, a very important molecule in the upper atmosphere, has a fine structure transition at 8.2 THz. This transition might provide the best means for determining the abundance of this species in the upper atmosphere, thus contributing needed information on atmospheric chemistry relating to depletion of the ozone layer.

HISTORIC BOSE-EINSTEIN EXPERIMENT PRESERVED BY SMITHSONIAN INSTITUTION

The apparatus in which Bose-Einstein condensation (BEC) was first created in June 1995 will soon be on its way to the Smithsonian Institution. Called JILA-1, it was constructed in the JILA instrument shop for NIST and University of Colorado scientists who worked together on the successful experiment. The first BEC "blob" contained about 2000 rubidium atoms. When JILA-1 was "retired" recently, it was able to condense about 8000 atoms at about 3 minutes per data point. The newest generation of equipment, also constructed in the JILA instrument shop and called JILA-3, can condense close to 1 million atoms in less than 1 minute.

The Smithsonian sent two of its staff to JILA to photograph and familiarize themselves with the experiment and the apparatus. The data gathered will preserve the record of the various steps leading to the experiment's final success.

The Smithsonian has no immediate plans to display JILA-1 but will hold it in quality storage either on the Mall or at a well-maintained warehouse in Fairfax County, VA.

NIST COORDINATES INTERNATIONAL PROJECT ON CHARACTERIZATION OF CERAMIC POWDERS

An international project on ceramic powder characterization has been completed recently. Countries participating in the joint project were Belgium, Sweden, Germany, Japan, and the United States. The project

(Subtask 8) was conducted under the auspices of the International Energy Agency's Implementation Agreement for a Programme of Research Development of High Temperature Materials for Automotive Engines, with the U.S. Department of Energy as the operating agent. The objective of the project was to evaluate the reliability and reproducibility of measurement methods for primary and secondary properties of six industrially important ceramic powders and involved round-robin testing in industrial and government laboratories in the various countries. Primary properties are defined as direct measurements on powders, e.g., particle size distribution, specific surface area, density, chemical composition, and phase analysis. Secondary properties are those determined for powders suspended in water and include surface chemistry, rheology, sedimentation, flow and compaction of granules, and the bulk density and porosity of compacts. All studies of primary properties have been completed, and the results are being used to develop international standards and Standard Reference Materials (SRMs). Studies of secondary properties will be continued in a subsequent project, which is now being initiated (Subtask 10).

CONSTITUTIVE EQUATIONS FOR STEELS AT HIGH TEMPERATURES

Constitutive equations for steels at high temperatures have been developed for the C-Mn and microalloyed steels. These equations are used to calculate the stress-strain curves for a given steel as a function of temperature, strain rate, and austenite grain size, in ranges typically encountered in steel rolling mills or forging shops. The stress-strain response of a steel is important because it determines the power requirements for rolling or forging, and it also reveals microstructural changes of the steel during deformation. Researchers at NIST developed these equations in collaboration with the University of British Columbia (Canada) and the steel industry under a joint project, "Microstructural Engineering in Hot-Strip Mills," sponsored by the American Iron and Steel Institute.

A computer program has been written to facilitate the stress-strain calculations, with input of steel grade, temperature, strain rate, and austenite grain size. The program is being used by the steel industry as a stand-alone tool for the calculation of stress-strain curves and the determination of critical strain for dynamic recrystallization. The program also has been incorporated successfully into a process model that simulates the steel rolling process in hot-strip mills and calculates the mechanical properties of the hot-rolled products.

METALLURGICAL ASPECTS OF THE SINKING OF THE RMS TITANIC

On April 14, 1912, the "unsinkable" RMS Titanic collided with an iceberg in the north Atlantic southeast of Newfoundland and sank with a loss of more than 1500 lives. In 1985, Robert Ballard, on board the Alvin from the Woods Hole Oceanographic Institute, found her unexpectedly broken in half under 12 000 m of water. This discovery concentrated scientific study of the sinking on the properties of the hull steel. Materials recovered in 1991 were subjected to a limited analysis by laboratories in Canada, looking at microstructure and fracture toughness. The steel was found to be extremely brittle at ice-brine temperatures.

NIST is cooperating with the Defense Research Establishment Atlantic in Canada, the University of Missouri − Rolla, Bethlehem Steel, and the Society of Naval Architects and Marine Engineers in a study to determine more thoroughly the structure and properties of the hull steel used in the construction of the Titanic. Material recovered in August of 1996 is being tested for tensile strength and fracture toughness, and the microstructure is being characterized thoroughly using optical metallography, as well as scanning and transmission electron microscopy. The Titanic material is being compared to hull steel from the RMS Nomadic (a tender for the Titanic), the RMS Olympic (a sister ship to the Titanic), and after recovery of a fragment this summer, the RMS Luisitania. All of these vessels were built by the same shipbuilder with steel from the same foundry within 5 years of each other, and a comparison will determine whether the steel used for the hull of the Titanic was of standard quality for 1912. Results of this study will form part of a broadcast on the science of the sinking of the Titanic to be aired in April on the Discovery Channel.

NIST COLLABORATES ON COMPOSITES PROCESS MONITORING

NIST has started a collaboration with a major car manufacturer to test a fast optical fiber process monitoring system in an industrial composites processing environment. The system was developed in response to a series of industry workshops in which process monitoring and control were identified as critical needs for composites manufacturing in the commercial marketplace. Research at NIST led to the development of a fluorescence method that was able to monitor the curing of several types of industrial resin systems under laboratory conditions. The next step is to demonstrate the measurement system on processing equipment similar to that used in production.

The auto manufacturer's laboratory is ideally suited to test the capabilities of the NIST monitoring system because it is engaged in molding trials as part of an Advanced Technology Program effort. The collaboration will test the NIST technology on at least two different resin systems, includinga private company's cyclic polyester and a commercial polyurethane during the molding of several hundred parts. The auto manufacturer is particularly interested in the capability of the NIST method to monitor processing of the polyester. Conventional methods based on temperature measurements are ineffective in this polymer because this resin polymerizes without heat release, an unusual characteristic. Preliminary work indicates that the NIST system may be able to reduce the time required to determine a critical property of the polyester, the molecular weight, from the currently required 8 h to less than 10 s.

For both resin systems processing speed is paramount, and the process monitoring system is designed to obtain complete spectra in less than 0.1 s and perform data processing to provide a control variable within another three seconds. The monitoring system also has been designed to interface with liquid molding facilities unobtrusively, and, therefore, no modifications were required to any processing equipment at the auto manufacturer. The optical fiber sensor is introduced into the molds through a standard thermocouple port and is reusable for many molding cycles.

A NIST scientist is spending 6 months at the auto manufacturer to participate in molding trials. The important scientific issues to be addressed include assessing the ability of the sensor system to provide the molecular weight of the private company's material, the degree of cure of the polyurethane system, the ruggedness of the system, and the ease with which the auto manufacturer can make use of the information measured.

NIST HOSTS DARPA IC&V EVALUATION TEAM

On Nov. 4, 1996, NIST hosted a working meeting of the Evaluation Working Group (EWG) of the DARPA Intelligent Collaboration and Visualization (IC&V) Program. Working with other EWG participants from private industry, and the National Intelligence Mapping Agency, NIST will develop methodologies, metrics, and testing tools to evaluate generation-after-next collaboration systems and supporting infrastructural technologies. NIST's EWG efforts focus on the development of testing and instrumentation technology that will enable collaboration systems developed through the DARPA IC&V program to be evaluated in terms of objectives for task performance, scalability, heterogeneity, and interoperability.

CRADA PROJECT TO DEVELOP A MINIMUM INTEROPERABILITY SPECIFICATION OF PKI COMPONENTS COMPLETED

As part of its efforts to assist in the development of a Public Key Infrastructure (PKI), NIST produced a Minimum Interoperability Specification of PKI Components (MISPC) in cooperation with 10 industry partners through Cooperative Research and Development Agreements (CRADAs), which provides a basis for interoperable PKI components from different vendors.

The MISPC specifies a minimal set of features, transactions, and data formats for the various certificate management components that make up a PKI. The specification addresses certificate generation, renewal, and revocation; certificate and certification path validation; signature generation and verification; and cross-certification. The goal of the specification is to further interoperability among heterogeneous public key certificate management systems, thus enabling large user communities to take advantage of digital signature technology.

NEW PUBLICATION FOCUSES ON TECHNOLOGY REQUIRED FOR A COMPUTER TO READ HANDPRINTED PARAGRAPHS

NISTIR 5894, Teaching Computers to Read Handprinted Paragraphs, presents a set of algorithms required for a computer to read a paragraph of unconstrained handprint. The process involves isolating the lines of handprint, segmenting the lines into character images, classifying the character images, and spell-correcting the classifications. Applications that could benefit from this technology include the automated reading handprinted messages sent via facsimile machine and the processing of forms that contain multiple-line responses to open-ended questions.

NIST HOSTS PROTOTYPE CONFERENCING PRODUCTS INTEROPERABILITY EVENTS

More than 20 hardware and software firms, telephone companies, and network service providers participated in the recent Event-120, the industry's second interoperability testing event for providers of data conferencing products and services. The event tested T.120-compliant, multipoint data conferencing applications. Of more than 3000 tests performed, 95 % resulted in successful links between vendors.

The International Multimedia Teleconferencing Consortium, Inc. (IMTC) organized the event to facilitate the rapid development and delivery of T.120 standards-based conferencing products and services,

and to continue promoting the importance of industry-wide interoperability as a base for building consumer confidence. Conferencing technologies are used in applications such as distance learning, telemedicine, corporate training, and working collaboratively with distant colleagues. T.120 applications currently include shared whiteboarding and multipoint file transfer. Consumer-oriented applications that require real-time, multipoint data delivery, such as multiplayer games, on-line chat programs, and virtual reality simulations, also are expected to incorporate the T.120 standards, a series of standards for real-time, multipoint data exchange. The evolving series, initially adopted by the International Telecommunication Union in March 1995, continues to be extended. Programs such as Event-120 ensure that the standards are interpreted and implemented by different vendors in a way that advances industry-wide interoperability of their products. As has been proven with other successful technologies, such as electronic mail and fax machines, interoperability of products and services is essential to widespread acceptance. A second test event was held concurrently, IMTC's third H.324 Interoperability Test Event. During the session, participants performed structured interoperability tests between products based on the ITU-T H.324 standard for videoconferencing. H.324 protocols tested were G.723, H.263, H.245 and H.223.

OPTICAL FINGERPRINT RECOGNITION IN FINANCIAL AND INTERNET SECURITY APPLICATIONS

NIST researchers combined optical correlation methods and digital neural networks to provide more accurate real-time fingerprint matching for financial, credit, and Internet security applications. The Information Storage and Interconnect System Project, sponsored by the Federal Bureau of Investigation (FBI), explored how optical methods of image storage and three-dimensional holography can support various correlation methods recognizing unique patterns such as fingerprints. Such methods would be more accurate and user friendly than current optical correlation or retinal scanning, in which a laser beam is shot from a charged-couple device into the subject's eye for identification.

Fingerprints are differentiated by a process known as minutia matching, in which the coordinates of the ridge ending of the fingertips are used for differentiation. However, this method tends to result in a number of false positives. In the past, when the FBI took a fingerprint, it was compared with others that were filed, based on basic physical characteristics, a time-consuming, costly, and inexact process.

In optical pattern recognition, the fingerprint image is loaded onto a liquid crystal spatial light modulator and is Fourier transformed into a three-dimensional hologram by a system lens developed by a NIST scientist. Then, the correlation of the input is analyzed via the output plane. The optical system can more accurately enter the input pattern into the neural network system, which in turn can recognize and differentiate a pattern when it is introduced to the system again. When used in addition to minutia matching, the technology adds another dimension to the identification specifications, allowing a more detailed search of the neural network.

Possible commercial applications include the use of fingerprint images for credit card verification, automatic teller machine access, and Internet access in place of or along with passwords. NIST researchers are seeking industry collaborators to move into the project's next phase of refining the neural network and testing the prototype system in industry. NIST plans to work with the Financial Services Technology Consortium, an organization of banks, financial service providers, technology companies, national laboratories, universities, and government agencies to advance the commercialization of the technology.

PROCESS TO DEVELOP ADVANCED ENCRYPTION STANDARD BEGINS

NIST recently launched a participatory process with American industry to develop an Advanced Encryption Standard, a means of scrambling data to protect vital electronic information with a high level of security. A notice in the Jan. 2, 1997, issue of the *Federal Register* invites security product manufacturers, voluntary standards organizations, government computer users, and others to comment on the draft minimum acceptability requirements and draft evaluation criteria described. These will help lay the groundwork for evaluating and choosing the mathematical formula, or algorithm, to be specified publicly by the standard.

The AES will be a Federal Information Processing Standard, which applies to agencies of the Federal Government, and will be available for voluntary use by companies and others who wish to use a strong encryption standard backed by the Federal Government. The Data Encryption Standard, for example, is a current federal standard that is used extensively by many organizations, including the financial industry. Written comments on the draft criteria may be sent by April 2, 1997, to the director of the Information Technology Laboratory, FIPS for AES Comments, A231 Technology Building, NIST, Gaithersburg, MD 20899-0001, e-mail: aes@nist.gov.

INTERNATIONAL FIBER MEASUREMENTS COMPARISON DONE

An international round robin to assess the quality of measurements of polarization mode dispersion in optical fibers has been coordinated by NIST and carried out by 16 participants in the fiber manufacturing and instrumentation industries.

Polarization mode dispersion can limit transmission capacity of optical fiber communication links. PMD results when birefringence in the fiber causes a light pulse's propagation speed to be a function of its polarization state. Over long distances, these pulses may interfere with the pulse ahead or behind, causing errors.

Accurate measurement of PMD in both optical fibers and other components is essential to determine a communication system's capacity and to design long-haul systems with optimal spacing between signal-conditioning amplifiers. The manufacturers in the United States, Europe and Japan who participated in the round robin each measured PMD in three specimens using up to four different measurement methods. A report of the results is available from Paul Williams, MC 815.02, NIST, Boulder, Colo. 80303-3328, (303) 497-3805, fax: (303) 497-3387, e-mail: paul.williams@nist.gov.

UPDATED "ONE-STOP" INDUSTRY GUIDE TO NIST AVAILABLE

The new *Guide to NIST*, an update of the popular 1993 "one stop" information resource, is now available to those interested in the agency and its industrial partnership opportunities. The 164-page volume describes hundreds of different research projects, grants, industry outreach programs, services, and facilities.

To facilitate finding specific data about NIST, the guide is divided into sections covering each of the agency's four major programs: the Advanced Technology Program, the Manufacturing Extension Partnership, the National Quality Program and the multidisciplinary Laboratory Program (describing cooperative research efforts, research facilities and services for each of NIST's laboratory units).

Individual items include contact names, addresses, phone numbers, e-mail addresses and where present, World Wide Web URLs. A detailed subject index clearly maps all paths to topics addressed in more than one NIST program area. For a free printed copy, send a self-addressed mailing label to NIST Public and Business Affairs, A903 Administration Bldg., NIST, Gaithersburg, Md. 20899-0001 or fax requests to (301) 926-1630. An electronic version of the Guide to NIST will be online later this year at http://www.nist.gov.

MICROMECHANICAL TESTER AVAILABLE WITHOUT A LICENSE

A micromechanical machine developed by NIST for assessing the tensile strength and other mechanical properties of thin films is available for commercial use without a license. The tester is operated in digital closed-loop control through a laboratory computer, which records such parameters as force and displacement five times per second. It is reproducible from commercially available or readily machinable components at reasonable cost.

The piezoelectric-actuated machine can apply force up to 2 N with a measurement resolution of 0.0001 N and can impose displacements of up to 50 μm (with a measurement resolution of 25 nm).

NIST uses the device to measure the mechanical properties of thin metal films produced by physical vapor deposition (known as PVD) and electrodeposition.

In this application, the tester uses a specially designed silicon-frame tensile specimen that has been fabricated using microlithography. A special clamp holds the silicon frame during cutting so that no tension is applied to the thin film suspended across it. Force is measured indirectly using an eddy-current sensor near a flexible measuring beam cantilevered above the base plate. Grip displacement is measured using two similar displacement sensors.

NEW SYSTEM TAKES TEMPERATURES ON A ROLL

During the processing of all commercial metals, an accurate knowledge of the processing temperature is critical to achieving the final product's desired properties. This is particularly true during the rolling of sheet aluminum where temperature can influence formability, surface appearance and mechanical strength.

Under a cooperative research and development agreement, NIST and the Aluminum Association have devised and eddy current probe that can operate in the harsh rolling mill environment and take a sheet's temperature with making contact with the metal.

NIST uses the aluminum sheet itself as the basic element of a resistance thermometer. The temperature is deduced from the relationship between electrical resistivity and temperature. A standard deviation of plus-or-minus 3 °C was achieved for exit temperatures (the temperature of the sheet as it leaves the rolling stand and is coiled for cooling and shipment).

NIST's prototype measurement system was tested online in an aluminum rolling mill. the eddy current technique—that does not require metal contact or

restrict metal movement during processing—achieved accuracies approaching those of contact thermocouples applied to processed metal held stationary at the exit stand of the rolling mill. To obtain a copy of report no. 38-96, which describes the new temperature measurement system, contact Sarabeth Harris, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-3237, e-mail: sarabeth@micf.nist.gov.

RESEARCHERS COLLIDE VIRUSES, CELLS WITH LASER TWEEZERS

Cells stick together, viruses stick to cells, and white blood cells stick to invading organisms. This ability to stick to another entity is what makes much of biology work. To evaluate the ''stickiness'' of cells and viruses, researchers at NIST and Harvard University have developed a new measurement technique.

Using two optical tweezers laser beams that trap a particle at their focal point the researchers held a red blood cell and virus-coated microsphere stationary. While one optical tweezer kept the blood cell motionless, the other moved a microsphere covered with virus particles into a collision with the cell. In this way, the researchers evaluated the effectiveness of highly potent viral inhibitors to block viruses from attaching to red blood cells.

Results of the OPTCOL (for optically controlled collision) experiment show that in low concentrations of inhibitors, the moving microsphere captured the red blood cell, pulling it out of the trap, while high concentrations prevented adhesion.

Optical tweezers were developed at a private laboratory in the 1980's, but this new research marks the first time they have been used for this type of measurement. The new technique allows measurements that could not be performed using conventional methods.

CHICAGO CENTER HELPS FIRM INCREASE SALES, JOBS

Centers throughout the country affiliated with NIST's Manufacturing Extension Partnership (MEP) are helping America's smaller manufacturers improve their competitiveness by adopting new technologies and modern business practices.

For example, the Chicago Manufacturing Center (CMC), an MEP affiliate since 1994, recently helped a private manufacturing company achieve QS 9000 certification. QS 9000 is a stringent quality certification process designed especially for automotive equipment manufacturers. CMC provided the company with an initial performance audit and then guided it through the certification process. The company says it is the first circuit board company in the world to attain QS 9000 certification.

The quality improvement effort has helped the company achieve new levels of satisfaction among its customers, win supplier awards and reduce customer returns to fewer than 100 parts per 1 million parts. In 1996, sales increased 11 % and the company hired 15 new employees.

NEW MEASUREMENT GIVES SHARPER LOOK TO FLAT PANELS

NIST researchers have devised a technique that offers both manufacturers and industrial customers a way to more accurately measure the contrast ratios of displays in laptops, airplane cockpits, home entertainment centers, and other applications.

The simple-to-implement measurement tool consists of one or more specially designed, glossy black plastic cones that technicians place between the display and the measuring device. The cones substantially shield the measurement of dark areas from illumination by lighter areas. Additional cones can be inserted to reduce the glare to an insignificant amount.

Without the cones, illumination from nearby lighter areas on the display surface introduces reflections into the lens of the measuring instrument. Contrast-enhancing techniques, such as anti-reflection coatings or newer display technologies exhibiting darker blacks, further increase the error from conventional measurement methods due to glare. The varying results have fueled complaints and made comparisons between brands or different technologies difficult.

The Video Electronics Standards Association will vote later this year to include the NIST technique in its new flat-panel display measurement standard.

NACLA PROPOSAL ACCEPTED AT RECENT MEETING

Representatives of the nation's conformity assessment community decided at an open forum on Jan. 7, 1997, to go forward with a proposal to establish the National Council for Laboratory Accreditation. NACLA will be a cooperative partnership between the public and private sectors to provide a comprehensive U.S. national laboratory accreditation infrastructure.

In the resulting system, the testing and calibration data from a laboratory accredited by a NACLA-recognized body will receive worldwide acceptance based on the laboratory's competence. The open forum, co-sponsored by NIST, ANSI and ACIL, was attended

by more than 350 interested stakeholders from laboratories, accreditors and those who require accreditation, both from industry and government. Immediate plans call for the election of a balanced, interim board of directors made up of members from the various stakeholders. The board will lay out a proposal for NACLA functions and a permanent structure. These proposals will be reviewed by stakeholders at future public meetings.

OPTOELECTRONICS WORK HIGHLIGHTED IN NEW BOOK

A comprehensive overview of NIST's optoelectronics research is provided in a new publication entitled Optoelectronics at NIST (NISTIR 5054).

This work is spread through 18 divisions in six research laboratories. The publication describes 49 projects involving some 170 NIST staff. Each description details the project's size, objectives, constituency and major current tasks.

A limited number of copies are available from the Optoelectronics Division, NIST, Boulder, CO 80303-3328, (303) 497-5342, e-mail: optoelectronics@boulder.nist.gov. It also is available electronically at http://www.nist.gov/div815.

PLAN TO COORDINATE U.S. STANDARDS NOW ONLINE

In recent years, the competitiveness of the United States in the global marketplace has become more and more dependent on the standards and conformity assessment systems used by its industries. This growing link between standards and competitiveness makes it vital that U.S. systems become more coordinated, work toward an agreed-upon standards infrastructure, and blend public and private responsibilities and participants.

To help make the desired improvements, President Clinton signed the Technology Transfer and Advancement Act of 1995 (Public Law 104-113) on March 7, 1996. The act directs NIST to lead a national effort to coordinate standards and conformity assessment activities among federal, state and local government agencies, and the private sector.

The implementation plan for this private/public team effort was submitted to Congress and is now available on the World Wide Web. The plan describes an approach to devising a U.S. system in and procedures for the areas of voluntary standards, product certification, accreditation of testing and calibration laboratories, registration of quality and environmental management systems, and formal recognition of qualified private-sector bodies enhancing U.S. competitiveness in world markets. The implementation plan for P.L. 104-113 is available on the NIST Office of Standards Services home page at http://ts.nist.gov/ts/htdocs/210/plan.htm.

Standard Reference Materials

REVISED STANDARD TO HELP CURB DRUNK DRIVERS

NIST issued its first Standard Reference Material for ensuring the accuracy of breathalyzer and blood alcohol concentration tests in 1985. Since then, laws regarding drunk driving have become more sophisticated. All states have set presumptive blood alcohol concentration limits above which a driver is presumed drunk. Federal laws set limits for pilots, truck and bus drivers, and even specify separate levels for drivers carrying hazardous materials. Newly issued Standard Reference Material 1828a (Ethanol in Water Solutions) will verify the accuracy of breath and blood alcohol measurements over the wide range of legal limits used by federal and state law enforcers. Crime labs can use the SRM as a benchmark to check the accuracy of breathalyzer and blood alcohol analyses. Medical laboratories can use this SRM for checking the accuracy of clinical blood alcohol tests. In addition, the food industry has found SRM 1828a useful in determining the alcohol content of foods. SRM 1828a can be purchased for $165 from the NIST Standard Reference Materials Program, Room 204, Building 202, Gaithersburg, MD 20899-0001, (301) 975-6776, fax: (301) 948-3730, e-mail: srminfo@enh.nist.gov.

Standard Reference Data

NIST COMPLETES NEW VERSION OF HIGH-TEMPERATURE SUPERCONDUCTORS PROPERTY DATABASE

Standard Reference Database 62: High Temperature Superconductors, Version 2.0, has been completed by NIST scientists. This database provides evaluated thermal, mechanical, and superconductor property data

for the class of materials commonly called high temperature superconductors, including cuprates (e.g., $YBa_2Cu_3O_{7-x}$), bismuthates (e.g., $Ba_{1-x}K_xBiO_3$), and the relatively new borocarbides (e.g., YNi_2B_2C). The materials are described by specification and characterization information that includes processing details and chemical compositions. Physical characteristics such as density and crystal structure are given in numeric tables. All measured values are evaluated and supported by descriptions of the measurement methods, procedures, and conditions. In all cases, the sources of the data are fully documented in a comprehensive bibliography.

Especially significant in Version 2.0 is an unusual collection of data from the Science and Technology Agency (STA) of Japan. The STA data were produced in a Japanese study of the processing and properties of high-T_C materials and involved a unique coordination of the efforts of government laboratories, academia, and industry. The result was a unique collection of property and characterization data for single batches of materials. The STA data were compiled by Japan's National Research Institute for Metals, in Japanese, and those results were provided to NIST as part of a NIST-NRIM data exchange agreement.

Calendar

March 3, 1997
USABILITY ENGINEERING 2: MEASUREMENT AND METHODS

Location: National Institute of Standards and Technology
Gaithersburg, MD

Purpose: To bring together industry and government to exchange information and strategies for achieving effectiveness, efficiency, and satisfaction in computer-based government systems. New for 1997 is a special focus on measurement and methods.
Topics: Government usability success stories, web usability, expert review vs usability testing, customizing the usability process for your project, developing guidelines, applying standards, usability in legacy systems, evaluating collaborative tools, the bottom line on usability, getting usability into the RFP, usability in Europe, and challenges in measurement and evaluation.
Format: One day with keynote and plenary talks, parallel tracks for novices, experts, and managers.
Audience: Project development managers, chief information officers, government contractors, procurement officials, analysts and engineers, technical staff and researchers, product vendors, consultants, policy makers, and users.
Sponsor: NIST—The Natural Language Processing and Information Retrieval Group and the Visualization and Virtual Reality Group, both of the Information Access and User Interfaces Division within the Information Technology Laboratory.
Contacts: Laura Downey, NIST, Building 225, Room A216, Gaithersburg, MD 20899-0001, phone: 301/975-4659, fax: 301/840-1357, email: laura.downey@nist.gov.
Sharon Laskowski, NIST, Building 225, Room A216, Gaithersburg, MD 20899-0001, phone: 301/975-4535, fax: 301/840-1357, email: sharon.laskowski@nist.gov.

March 3-5, 1997
THE NORTH AMERICAN ISDN USERS' FORUM (NIUF)

Location: Tampa, FL

Purpose: To address high-level concerns over a broad range of Integrated Services Digital Network (ISDN) issues and to reach a consensus on ISDN Implementation Agreements.
Topics: Multimedia applications, messaging and answering, mass marketing, wiring and powering, and simplification of ISDN ordering.
Format: Working (breakout) groups, executive steering committees, and plenaries.
Audience: ISDN users, ISDN implementors, ISDN service providers, and Customer Premise Equipment (CPE) vendors.
Sponsor: NIST.
Contact: NIUF Secretariat, NIST, Building 820, Room 445, Gaithersburg, MD 20899-0001, phone: 301/975-2937, fax: 301/926-9675, email: niuf@nist.gov.

March 4-6, 1997
RCS RANGE CERTIFICATION MEETING

Location: NIST-Boulder
Boulder, CO

Purpose: To inform the RCS Community on RCS Measurement range certification and support planning of the DOD RCS Certification Demonstration Program.
Topics: Measurement Assurance/Improvement Plans (MAP) certifications; philosophy/procedures RCS Certification Demonstration Program.
Format: Presentations and discussion.
Audience: RCS Community.
Sponsors: NIST, Wright Labs, and Wright-Patterson AFB.
Contact: Lorant Muth, NIST, MC-813, 325 Broadway, Boulder, CO 80303, phone: 303/497-3603, fax: 303/497-3122, email: lorant@cassowary.cee.bldrdoc.gov.

May 19–23, 1997

CONFERENCE ON RADIONUCLIDE METROLOGY AND ITS APPLICATIONS ICRM '97

Location: National Institute of Standards and Technology Gaithersburg, MD

Purpose: To provide an opportunity for the exchange of information on techniques and applications of radionuclide metrology, and to encourage international cooperation in this field.
Topics: Alpha-particle spectrometry, gamma-ray and beta-particle spectrometry, life science, low-level measurements, radionuclide metrology techniques (including direct activity measurements), and nuclear decay data (measurements and evaluations).
Format: Oral communications, poster presentations, and business meetings of the ICRM working groups on radionuclide metrology and its applications.
Audience: Radionuclide metrologists.
Sponsors: NIST and the International Committee for Radionuclide Metrology (ICRM).
Contact: J. M. R. Hutchinson, NIST, Building 245, Room C114, Gaithersburg, MD 20899-0001, phone: 301/975-5532, fax: 301/926-7416, email: j.hutchinson @nist.gov.

June 6–8, 1997

1997 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM

Location: Colorado Convention Center Denver, CO

Purpose: The Institute of Electrical and Electronics Engineers (IEEE) and Microwave Theory and Techniques Society (MTT-S) International Microwave Symposium is the foremost and largest conference and exhibition of it's kind in the world. It's purpose is to provide a forum for engineers and scientists to report on recent microwave product development.
Topics: Latest developments in microwave components, power generation, amplification, monolithic technology, millimeter waves, field theory, computer-aided design, measurements, wireless communications and radio-frequency (rf) technology.
Format: Symposium, workshops, exhibition.
Audience: Microwave engineers.
Sponsors: NIST and IEEE Microwave Theory and Techniques Society.
Contacts: Claude Weil, Chair, Electromagnetic Fields Division, NIST, 325 Broadway, Boulder, CO 80303-3328, phone: 303/497-5305, fax: 303/497-6665, email: weil@boulder.nist.gov.
Roger Marks, Vice-Chair, Electromagnetic Fields Division, NIST, 325 Broadway, Boulder, CO 80303-3328, phone: 303/497-3037, fax: 303/497-7828, e-mail: marks@boulder.nist.gov.
Motohisa Kanda, Vice-Chair, Electromagnetic Fields Division, NIST, 325 Broadway, Boulder, CO 80303-3328, phone: 303/497-5320, fax: 303/497-6665, email: mkanada@boulder.nist.gov.

June 9–10, 1997

YEAR 2000 INTERNATIONAL SYMPOSIUM

Location: National Institute of Standards and Technology Gaithersburg, MD

Purpose: To raise international awareness of the problems that could arise from the millennium change from 1999 to 2000. Discuss possible strategies and methods for correcting system date processing.
Topics: Awareness of year 2000 problems, assessment of the extent of the year 2000 problem, renovating systems, validating changes, and implementation of solutions.
Format: General sessions and panel discussions, vendor software and computer exhibitors.
Audience: International computer users and developers.
Sponsors: NIST, Data Administration Management Association National Capitol Region (DAMA-NCR), Interagency Working Group on the Year 2000, U.S. Office of Management and Budget, U.S. Federal Aviation Administration, and U.S. Department of Defense.
Contact: Judith Newton, NIST, Building 820, Room 562, Gaithersburg, MD 20899-0001, phone: 301/975-3256, fax: 301/948-6213, email: judith. newton@nist.gov.

July 14–18, 1997

FOURTH INTERNATIONAL MEETING ON CHEMICAL KINETICS

Location: National Institute of Standards and Technology Gaithersburg, MD

Purpose: To bring together scientists from different disciplines who use chemical kinetics to explore areas of common interest.
Topics: Free radical thermodynamics, reactions of peroxyl radicals, halogen oxides, and others.
Format: Lectures and posters.
Audience: Scientists.
Sponsors: NIST, Environmental Protection Agency (EPA), and National Aeronautics and Space Administration (NASA).
Contact: Robert Huie, NIST, Building 222, Room A261, Gaithersburg, MD 20899-0001, phone: 301/975-2559, fax: 301/975-3672, email: robert.huie @nist.gov.

August 4–6, 1997

ULTRASONIC AND DIELECTRIC CHARACTERIZATION TECHNIQUES FOR SUSPENDED PARTICULATES

Location: National Institute of Standards and Technology Gaithersburg, MD

Purpose: To provide a vehicle for the presentation and discussion of current research and future challenges in fracture science. The focus is on the fundamental aspects of fracture in the disciplines of mechanics, metallurgy, ceramics, polymer science, physics, and chemistry.
Topic: Fracture in materials.
Format: Lecture.
Audience: Scientists.
Sponsors: NIST and the Institute for Mechanics and Materials, (IMMS).
Contact: Robb Thomson, NIST, Building 223, Room A124, Gaithersburg, MD 20899-0001, phone: 301/975-8349, fax: 301/926-5665, email: robb.thomson @nist.gov.

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