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News Briefs

General Developments

Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Building 416, Room 119, Gaithersburg, MD 20899-0001; telephone: 301/975-3572.

NIST TRANSFERS FABRICATION TECHNOLOGY FOR JOSEPHSON-JUNCTION VOLTAGE ARRAY STANDARDS TO A PRIVATE U.S. COMPANY

NIST has successfully transferred the technology for fabricating Josephson-junction voltage standard array chips to a private U.S. company. NIST had been seeking to develop a U.S. commercial supplier for chips to relieve its position as the only source in the world of metrologic-quality devices. Following NIST assistance, the company was able to fabricate a quantity of operating 1 V chips in a design having 3600 junctions about a year ago. NIST tested these devices to confirm their operation and subsequently certified them for delivery to other organizations; ten have been shipped for use in calibrations.

The reliability of the private company devices has been demonstrated to date in that there have been no failures during the time approaching 1 year that the devices have been in commercial service. More recently, the company has been successful in fabricating 10 V chips, in a design having 20208 junctions, that also have been certified by NIST. The division expects that future orders to NIST for 10 V Josephson standards will be satisfied with the private company or other commercial devices. Josephson voltage standard systems play a critical role for a number of U.S. companies. The Josephson measurement systems of three companies provide the only means they have to confirm the performance of their high-accuracy voltage measurement and reference instruments. Two aerospace companies use Josephson systems to meet the calibration requirements for large DOD procurements. Systems at six U.S. national and military standards labs provide the foundation of voltage metrology for the country.

NIST DEMONSTRATES INTEGRATED OPTICAL POLARIZATION DIVERSITY RECEIVER

NIST scientists have successfully demonstrated a fully integrated optical polarization diversity receiver. The receiver exhibits the advantages typical of integrated optical devices: it is small (2 mm × 20 mm), rugged, and easy to fabricate. Polarization diversity receivers provide a means for separating components of an incoming signal of mixed polarizations and, as such, find uses in sensing and communications applications, including polarimetric optical sensors, machine tool positioning sensors, magnetic read head positioning systems, optical read heads for compact disk drives, and coherent communication systems.

A CRADA partner is interested in using the receiver in vehicle sensor applications. The device consists of a Y-branch waveguide splitter, with a one-degree splitting angle, formed by potassium-sodium ion exchange in silicate glass. A hydrogenated-amorphous-silicon cladding is deposited on each branch of the splitter to act as a polarizer. One output cladding is individually trimmed to a thickness which attenuates the component of guided light having a transverse electric field, while the other cladding is trimmed to attenuate light having a transverse magnetic field. The device is trimmed by a NIST-patented process of localized plasma etching which allows *in situ* extinction optimization by monitoring transmitted light. Extinction ratios of 27 dB have been demonstrated for the polarizers using claddings 1.2 mm in length. The device is completed with the deposition of

metal-semiconductor-metal photodetectors on each of the output waveguide branehes following the polarizers. Amorphous silicon claddings are contacted with chrome-gold interdigitated finger Schottky contacts to form the deteetors. The detectors have exhibited very high bandwidths, on the order of 5 GHz.

RECORD RESULT ACHIEVED FOR MIXING IN SUPERCONDUCTORS DEMONSTRATES POTENTIAL FOR PRACTICAL IR-FREQUENCY SYNTHESIS

NIST seientists have used a superconducting detector to mix two signals from CO_2 lasers each operating at a wavelength of 10 μm, corresponding to a frequency of 30 THz. The beat frequency observed—6.9 GHz—is the highest ever observed by mixing in superconductors. The mixer was a Josephson junction formed from the high-temperature superconductor YBCO. The experiment provides an important connection between length standards and time and frequency standards.

The NIST team first tuned the lasers to the same line, yielding beat-note frequencies from a few MHz up to the free spectral range of the lasers (~80 MHz). One of the lasers was then tuned to a higher-energy line separated from the first line by 6.9 GHz, and the beat note was observed. This is a high enough beat frequeney to exclude thermal mixing, leaving only Josephson or (more likely) hot-electron mixing as the physical meehanism responsible. This experiment is a modern version of experiments performed at NIST some years ago as part of the infrared frequency synthesis effort that precisely measured the speed of light. Those experiments used mixers made from niobium (a low-temperature superconduetor) point-contact Josephson junctions or room-temperature metal-insulator-metal point contacts. The recent success with a YBCO Josephson junction suggests that the highly unstable and irreproducible point-contaet mixers can be replaced with a completely monolithic device. These results open the possibility of much more compact, reliable, and practical IR frequency synthesis systems.

NIST TRANSFERS NEAR-FIELD ANTENNA MEASUREMENT TECIINOLOGY THROUGH SHORT COURSE

NIST scientists recently organized and presented the 4 day course, "Antenna Parameter Measurement by Near-Field Techniques." The course was tailored to the needs of engineering and scientific personnel who find it important for them to become familiar with the theory and practice of near-field antenna measurements, especially for antennas of advanced design. Near-field techniques have become the method of choice for precision measurement of high-performance antennas and are now in common use in industry. In these techniques, antenna performance parameters are measured at many points over a defined scanning surface by means of a probe located physically close to the antenna; the resulting measurement data are then transformed to the desired antenna far-field pattern through calculation.

Near-field techniques provide the only means for accurate characterization of complex multi-element antenna structures, such as phased arrays used in communications and radar. Consisting of 21 lectures, the course included material on scattering matrix theory; planar, cylindrical, and spherical near-field techniques; calibration of gain standards and probes; antenna diagnostics, error correction, range certification, and measurements at millimeter-wave frequencies. The 22 attendees included eight from industry, 12 from government/military organizations, and one each from Canada and Israel.

NIST/SEMATECH COLLABORATION

Under the NIST/SEMATECH Cooperative Research and Development Agreement (CRADA), members of several technical groups at NIST eooperated under Phase I of a consulting eontraet with SEMATECH. This work was for a study of the lithometrology needs and capabilities of the microelectronics industry in the United States. At the culmination of Phase I, NIST proposed several projects that (with partial SEMATECH funding under Phase II of the contract) could be undertaken to bridge some of the gaps between these identified needs and the current capabilities. This work involves three key technical areas: Seanning Electron Microscope (SEM) metrology, optical metrology, and scanned probe metrology. Phase II of the contract was recently signed and projects in these three areas have been started. The contract is being managed by three NIST scientists.

NIST TEMPERATURE CONTROL EFFORT

NIST has placed in service a new precision environmental enclosure housing the dimensional metrology group's Moore M48 coordinate measuring machine. The enclosure is designed such that, with very low air velocities, the temperature of any

point within the approximately 6.5 m × 4 m × 3.5 m volume is stable to ±0.15 °C from setpoint with a permitted gradient of 0.2 °C between any two points within the volume. Further, the enclosure is designed such that the temperature of any point within the 2 m × 1 m × 1.5 m measurement volume of the M48 itself is stable to ±0.05 °C from setpoint with a permitted gradient of 0.05 °C between any two points within the measurement volume. Future plans include the construction of a second similar enclosure as part of NIST's gear metrology effort.

CRADA BEGUN ON SILICON MICROMACHINED ACOUSTIC SENSOR TECHNOLOGY

The objective of a new joint project between NIST and a private company is to enable applications of micromachined silicon-based capacitive microphones and hydrophones. Potential applications include locating and tracking vehicles and other noise sources (e.g., gunshots) acoustic and ultrasonic imaging, airport monitoring, and monitoring of stored grain for pests. These new acoustic sensors and sensor arrays have the potential sensitivity, noise floor, and perhaps, stability, of expensive instrumentation grade microphones but can be inexpensively mass produced as single element or multi-element arrays. Research is required to develop measurement techniques to evaluate element-to-element response characteristics. Results from systematic measurements on prototype sensors will be used to develop improved sensors.

The major research activities at NIST will use the NIST anechoic chamber and Fast Fourier Transform (FFT)/dynamic signal analysis systems. These and closed acoustical couplers can be used to determine: free field response versus frequency, self-noise voltage spectra, relative phase response and linearity, distortion, and tradeoffs and improvements for potential applications.

NEW REFRIGERATOR FOR LIQUEFYING NATURAL GAS

NIST has signed a cooperative research and development agreement with a private company to help design two thermo-acoustically driven orifice pulse-tube refrigerators for liquefying natural gas. A NIST scientist and a scientist from Los Alamos National Laboratory (LANL) are the co-inventors of the TADOPTR—a super-cold refrigerator without any moving parts. The private company has obtained the development license as well as the exclusive license to the patents on TADOPTRs through LANL. The scientists will help the company design two commercial versions of their TADOPTR which the company will manufacture, test, and market.

The first commercial unit, to be designed in 3 to 5 months, will be capable of producing about 2000 L per day of liquefied natural gas; the second unit, capable of liquefying about 40 000 L per day, will be designed in 5 to 7 months. TADOPTRs will be useful in areas remote from natural gas pipelines and where wells don't produce sufficient volume to warrant extensions of existing pipelines. TADOPTRs will also be utilized in the production of LNG and compressed natural gas to fuel motor vehicles that will meet all environmental standards required by the Clean Air Act. The liquefaction plants will be very economical and liquefaction will take place on-site, where needed, thereby eliminating transportation costs.

STATISTICAL PROPERTIES OF ISLANDS DURING THIN-FILM FABRICATION

Ultra-thin metal films have become increasingly important in today's smaller devices. To improve performance of thin films, scientists at NIST have studied the process of film growth from the earliest stages, when single atoms come together to form islands, to the later stages of complete film growth. The diffusion of the deposited atoms depends on temperature. The diffusion rate can vary orders of magnitude with a change in temperature of only 100 °C. The number and size of the islands that form during growth therefore also depends strongly on growth temperature. NIST scientists reported in a recent issue of Physical Review B Rapid Communications that in the early stages of film growth the island size distributions show self-similar properties as the atom diffusion rate is increased over four orders of magnitude, by changing the growth temperature by 250 °C. This property is similar to the scaling of coastlines and other fractal objects which show similar shapes and outlines independent of the magnification. These measurements are the first to confirm theoretical predictions of scaling in this growth regime. This work allows a test of the statistical growth theories which promise a more general and powerful description of thin-film fabrication.

INTERNATIONAL WORKSHOP ON MEASUREMENT STANDARDS FOR STUDIES OF RADIONUCLIDES IN OCEANS

International concerns about the potential of global oceanic radioactivity contamination from releases by dumped nuclear waste have increased significantly in recent years. The credibility of monitoring activities around ocean dump sites has become a major measurement issue. Twenty-two metrology, oceanography, and regulatory representatives from Canada, Japan, Korea, Poland, Russia, and the United States shared their expertise at the international "Workshop on Measurement Standards for Studies of Radionuclides in Oceans," held at NIST, June 1–2, 1994. The workshop established a consensus-sampling strategy and plan of action, assigned responsibilities, set time lines for milestones, and defined a management infrastructure to develop ocean-based natural-matrix Standard Reference Materials. These SRMs will be crucial for international comparability and credibility of data collected from monitoring around nuclear-waste dump sites in the world oceans.

Recommendations from the workshop included:

- development of biota (shellfish, fish flesh, and seaweed), sediments (high-calcium, high-organic, and high-clay), and seawater media for strontium-90, cesium-137, lead-210, plutonium-(239 and 240), and other radionuclides at concentrations of 0.03–10 disintegrations-per-second per kilogram;
- certification of the reference materials through laboratory comparisons by a network of high-quality international reference laboratories;
- coordination of standards production with the International Atomic Energy Agency programs; and
- establishment of an advisory panel for oceanographic consultative services.

ACCURATE CESIUM LIFETIME EVALUATED FOR PARITY NONCONSERVATION TESTS

Recent parity nonconservation experiments in atomic cesium require accurate interpretations by *ab initio* theory. Errors can be introduced by the theoretical contribution in the extraction of the fundamental quality, Q_w, the weak charge. Thus it is important to verify the accuracy of these many body perturbation theory calculations for heavy atoms. One such test of the calculations is an accurate comparison of the measured and calculated dipole matrix element for the Cs ($6s$–$6p$) transition. A group composed of a NIST scientist, JILA Visiting Fellows, and University of Colorado scientists, recently collaborated to make highly accurate lifetime determinations (0.2 % to 0.3 % uncertainties) for the Cs ($6p$–$6s$) transitions in emission. The $6p\ ^2P_{1/2}$ state lifetime is (34.75 ±0.10) ns and the $6p\ ^2P_{3/2}$ level is (30.41 ± 0.10) ns. These lifetimes are only 0.7 % to 0.9 % longer than predicted by *ab initio* theory, following a similar trend observed for the lighter alkali atoms. The experiments used a high-repetition-rate, mode-locked Ti:sapphire laser source and single-photon, time-correlated counting. An extensive analysis of the uncertainties associated with this method was also completed, with the goal of eventually achieving 0.1 % uncertainty. This effort represents a highly successful collaboration of NIST and its University of Colorado partnership.

JOINT NEUTRON RESEARCH WITH PRIVATE COMPANY ON ADSORBENT-GAS INTERACTIONS IN MOLECULAR SIEVES

Key to the success of a private company and other major worldwide producers of industrial gases, has been the application of state-of-the-art materials and procedures for gas separation. However, despite the widespread use of molecular sieves in absorption-based processes for industrial gas separation, little is understood of the mechanisms that differentiate the relative performance of different adsorbents for different gas mixtures. Of increasing importance for the development of improved materials and gas separation efficiency is an accurate determination of the detailed crystal structures of adsorbents to identify absorption sites.

A collaborative research effort has been initiated between scientists at NIST and a private company to use the new high-resolution powder diffraction at the NIST reactor and other neutron probes to perform in-situ measurements of adsorbent and absorbate molecular arrangements at relevant temperature and pressure. The high intensity and resolution of the new 32-detector diffractometer provides the means to perform detailed studies of nonframework species and lighter elements that define cation sites, crucial information for advancing absorbent development efforts. These studies combined with other physical methods could lead to a much better understanding of gas-adsorbent interactions and help towards the design of new adsorbent materials that will lower the costs of commercial gas production for the private company and other U.S. industries.

PRIVATE COMPANY AND NIST COOPERATE TO IMPROVE PROCESS CONTROL IN CERAMIC THIN-FILM DEPOSITION

A cooperative research and development agreement with a priate company has been signed to transfer measurement technology under development at NIST to industry. Under the auspices of NIST's Advanced Technology Program, the private company has developed a laboratory-scale process for depositing Tl-containing high Tc oxide thin films. The company is planning to commercialize this process in the near future. Because the process fundamentals are not well understood, and because many chemical entities with different volatilities and deposition efficiencies are involved, an efficient optimized process scale-up will require improved process understanding and real-time control. NIST researchers have developed in-situ, real-time optical and mass spectroscopic measurement methods that should be applicable to both the laboratory and plant-scale process. As part of the CRADA, the private company will provide access to its deposition facilities, target materials, and empirical process experience on film deposition using magnetron sputtering and, secondarily, pulsed laser energy sources.

NIST STUDIES VENTILATION RATES AND CARBON DIOXIDE CONCENTRATIONS IN AN OFFICE BUILDING

NIST scientists performed a 2 year study of outdoor air ventilation rates and indoor carbon-dioxide concentrations in a mechanically ventilated office building in Overland, MO. The measurements were made to assess the operation and performance of the ventilation system in the building and to investigate the relationship between ventilation rates and indoor carbon dioxide levels. Ventilation rates were measured with the tracer gas decay technique using an automated measuring system. The ventilation rates exhibited a dependence on outdoor temperature that was expected based on the heating, ventilating, and air-conditioning system's controls. The air-change rates under conditions of minimum outdoor air intake were about 0.5 air changes per hour, which is lower than both the air-change rate corresponding to the building design for minimum outdoor air intake and the rate corresponding to the recommendations in ASHRAE Standard 62-1989. The indoor relative carbon dioxide concentrations were generally lower than the 1000×10^{-6} guideline in Standard 62-1989. The relationship between the indoor carbon dioxide levels and the building air change rates was similar to that seen in other office buildings. This relationship is analyzed as part of a discussion on the use of equilibrium analysis of carbon dioxide concentrations to determine building air change rates. The results of this analysis raise questions regarding the use of equilibrium analysis of carbon dioxide concentrations in office buildings.

NEW PUBLICATION REPORTS ON SECOND CENSUS OPTICAL CHARACTER RECOGNITION SYSTEMS CONFERENCE

NISTIR 5452, The Second Census Optical Character Recognition Systems Conference, presents the results of the second in an series of conferences which focus on the cooperative efforts of NIST and the Bureau of the Census in advancing the use of OCR in the national census. Held in February 1994, the conference consisted of 10 invited groups who had responded to a call to participate, received the training material, and conducted the OCR task which involved a handwriting sample from a large number of different writers. Participants concluded that the accuracy for OCR systems has improved dramatically over the last few years and suggested directions for future OCR research and development.

NORTH AMERICAN INTEGRATED SERVICES DIGITAL NETWORK USERS' FORUM MEETS

On June 21–24, 1994 NIST sponsored the 21st meeting of the NIUF which attracted about 175 users, implementors, and suppliers of ISDN technology. The forum advances the development of interoperable ISDN broadband and narrowband products and services. A special 1-day National Information Infrastructure Seminar focused on "Clarifying the Vision of the Information Highway". The new National Information Infrastructure Working Group gained approval of its charter which stresses the value of ISDN to the information highway and the requirements of efficient access to the information infrastructure, use of standards, interoperability, and the development of suitable ISDN technologies to support the NII.

Other highlights included a presentation on the content and schedule for National ISDN-3 specifications and a demonstration by networking equipment makers on using ISDN to link products and applications. The second edition of the Catalog of National ISDN Solutions for Selected NIUF Applications is now available from the National Technical Information Service.

FEDERAL INFORMATION PROCESSING STANDARD FOR THE SPATIAL DATA TRANSFER STANDARD REVISED

The Secretary of Commerce recently approved a revision of FIPS 173, "SDTS," to be published as FIPS 173-1. The standard provides specifications for the organization and structure of digital spatial data transfer, definition of spatial features and attributes, and data transfer encoding. The revision adds Topological Vector Profile to the specifications adopted by the standard. To be effective Dec. 30, 1994, FIPS 173-1 will facilitate the transfer of digital spatial data between dissimilar computer systems.

NIST ASSISTS GSA IN RATING HISTORIC BUILDINGS

NIST is developing and automating a system for rating GSA-owned buildings by their historic significance. Sixty percent (or 953) of the buildings GSA owns are technically classified as historic structures based solely on their age. Some of these buildings are truly historic, while others have little historic significance. In order to manage them effectively, GSA needs to evaluate their relative historic importance. NIST has developed a multicriteria rating method which yields a single numeric score for each building. The method is based on the operations research technique called the Analytic Hierarchy Process and takes into account GSA's quantitative and qualitative criteria including the architectural details and the building as a whole. NIST is incorporating the method into a software program called HIST (Historic Importance Software Tool). GSA plans to use the ratings derived from HIST to allocate rehabilitation funds across all buildings in their inventory.

NEW OFFICE CHAMPIONS SUPPORT FOR NII APPLICATIONS

NIST recently created the Office of Enterprise Integration to coordinate NIST's laboratory efforts to provide the technical underpinnings for applications of information technology in areas such as manufacturing, construction, health care and government services. "We want to help NIST's customers in industry to make better use of the NII," says NIST Director Arati Prabhakar. To streamline service, NIST provides an initial point of contact for policy makers and researchers in industry, academia and government interested in learning more about NIST activities related to information infrastructure development, enterprise integration and electronic commerce. The new office also supports NIST's participation in the Clinton Administration's effort to develop the National Information Infrastructure. Contact the Office of Enterprise Integration at Rm. 102, Building 415, NIST, Gaithersburg, MD 20899-0001, (301) 975-4529, fax: (301) 948-7242, e-mail: jbrooks@nist.gov (via Internet).

GREEN BUILDING CONFERENCE PROCEEDINGS AVAILABLE

Chances are, most buildings of the future will be "green." Not in color, but in the way they are designed, constructed, operated and even demolished so that there is minimal impact on both the indoor and outdoor environments. NIST and the U.S. Green Building Council co-sponsored a February 1994 conference to discuss current and future green building technology. The proceedings from that conference are now available. Among the presentations documented: a description by the president of the National Association of Home Builders Research Center of a house built to test and demonstrate prototype resource-conserving products and systems; and a talk by an official with Canada's Advanced House Program about field trials of new technologies designed to reduce energy consumption by 50%, improve indoor air quality and reduce environmental impact. Other topics include the NIST green building program, "greening" the White House and life-cycle assessment. Single copies of the conference proceedings are available free of charge by mailing or faxing a request to Kim Whitter, B320 Building Research Building, NIST, Gaithersburg, MD 20899-0001, fax: (301) 990-4192.

REPORT MAPS METRIC PATH TO MARKETS AND JOBS

"The logic for use of the metric system in the United States is strongest when metric use is viewed as an element of our national economic infrastructure, as an investment in efficiency, and as a necessity for international competitiveness," says a NIST scientist in the latest report from the NIST Metric Program, The Metric Path to Global Markets and New Jobs: A Question-and-Answer and Thematic Discussion (NISTIR 5463). The report covers such important questions as: "Why use the metric system?," "What are the advantages of metric use for U.S. industry?," "Why do U.S. exports have to be metric?," and "Why is the Federal government involved?" Themes in the report include the

isolated position of the United States as the sole nonmetric nation; demand of foreign customers for metric products; ease of computation in the metric system as an aid to the training of U.S. workers for new business opportunities; and standards, the path to global markets. Copies of NISTIR 5463 are available from the Metric Program, A146 TRF Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3690, fax: 93010 946-1416.

PAPER DETAILS EMF SHIELDING THEORY

In work supported by the Federal Aviation Administration, NIST researchers have developed a mathematical model and theory for predicting the electromagnetic field shielding effectiveness of large metal enclosures with apertures and interior loading. The model also should allow for estimations of the average field strength inside enclosures such as electronic equipment cases and aircraft bodies. It can be used for any enclosure regardless of size, shape, type of material and number of apertures, as well as for any frequency above a lower limit related to the dimensions of the enclosure. The model was experimentally evaluated using a rectangular aluminum cavity of about 0.57 m^3 with one aperture, and for a microwave frequency range from 1 GHz to 18 GHz. The agreement between model and actual measurement was within 20% after a number of additional sources of loss were incorporated into the original model. A report, Aperture Excitation of Electrically Large, Lossy Cavities (NIST Technical Note 1361), is available from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650, for $19.50 prepaid. Order by PB 94-145711.

NIST RESEARCHERS ACHIEVE COLDEST TEMPERATURE EVER

If it's too hot outside, then a visit to NIST might provide some relief. Physicists here recently cooled atoms to 700 nK, the coldest temperature ever recorded for matter. NIST scientists chilled a cloud of cesium atoms very close to absolute zero using lasers to catch the atoms in an optical lattice. The atoms reached 700 nK, or 700 billionths of a kelvin. Zero K (minus 273 °C), or absolute zero, is the temperature at which atomic thermal motion would cease. Since the late 1970s, physicists have sought to use lasers to cool atoms to as close to absolute zero as possible, primarily for improving atomic timekeeping. Since laser cooling was first demonstrated in the NIST laboratories in Boulder, CO, in 1978, scientists around the world have been steadily pushing to lower temperatures. The new record low temperature at NIST was achieved with a technique borrowed from the Ecole Normale Superieure in Paris: an arrangement of four laser beams interfering to produce a regular array, or "optical lattice" of microscopic hills and valleys for the atoms.

PROPOSALS SOUGHT FOR PRECISION MEASUREMENT GRANTS

NIST is requesting project proposals for two research grants for fiscal year 1996 in the field of precision measurement and fundamental constants. Each one-year Precision Measurement Grant of $50,000 may be renewed by NIST for up to two additional years and a total of $150,000. Prospective candidates must submit summaries of their proposed projects and biographical information to NIST by Feb. 1, 1995. NIST Precision Measurement Grants are awarded each year to scientists in academic institutions for work in determining values for fundamental constants, investigating related physical phenomena, or developing new, fundamental measurement methods. By the Feb. 1 deadline, applicants should deliver a pre-proposal summary of not more than five double-spaced pages outlining the objective, motivation and technical approach of the research, and the amount and source of current funding for the research, together with a concise biographical sketch of the applicant and a list of the applicant's most important publications. Submit three copies to Barry N. Taylor, NIST Precision Measurement Grants Committee, C229 Radiation Physics Building, NIST, Gaithersburg, MD 20899-0001. For further information, contact Taylor at the above address or call (301) 975-4220.

NEW CENTER NOW SERVING CHICAGO MANUFACTURERS

U.S. Commerce Secretary Ronald H. Brown announced a cooperative agreement with the city of Chicago on July 22, 1994, that officially launched the Chicago Manufacturing Technology Extension Center. Operated by the private, non-profit Chicago Manufacturing Center, the CMTEC is affiliated with the Manufacturing Extension Partnership, a national network of manufacturing extension centers designed to assist small and medium-sized companies. The new center serves a six-county metropolitan area that is home to some 15 000 manufacturing firms employing 400 000 workers. The CMTEC is partially funded through the Technology

Reinvestment Project, the Federal government's program to provide funds for dual-use (military and civilian) technology development, deployment and utilization. Additional support for the CMTEC comes from the city of Chicago, the state of Illinois and private- sector contributors. The current number of centers in the MEP is 35, with plans calling for a total of 100 by 1997. For more information on the CMTEC, contact Helen Squires, CMC, 3333 W. Arthington, Chicago, IL 60624, (312) 265-2031.

CHIP MAKERS PROVE AFM WORK IS "NO SMALL MATTER"

Eyed for key process-control applications in semiconductor manufacturing and other high-precision operations, atomic force microscopes produce three-dimensional, atomic-scale images of surface features. However, AFM uses are currently confined mostly to surface-characterization studies in the laboratory. Measurement capabilities are limited by the lack of reference standards needed to establish accuracy levels and make comparisons with measurements from different AFMs. In two separate, but complimentary cooperative research efforts, NIST and industry collaborators are developing a calibrated atomic force microscope, or C-AFM. NIST's C-AFM is assembled mostly from commercial components and will calibrate reference artifacts to certified levels of uncertainty in all three dimensions. These artifacts will enable semiconductor makers to ensure the accuracy of their "critical dimensions" measurements on wafers and lithography masks. Two California firms are working with NIST. One project with the maker of the C-AFM's control system, focuses on extending AFM applications to achieve high-quality measurements of features on semiconductor wafers. The collaboration with the second company focuses on surface topography standards (pitch and step height) to support the manufacture of current and future generations of integrated circuits. Goals of the NIST C-AFM project were developed in consultation with U.S. AFM makers and member companies of SEMATECH, which is providing partial support. For more information, contact Jason Schneir, A107 Metrology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3486.

RECIPE FOR INEXPENSIVE ATOM TRAP PUBLISHED

Want to build your own atom trap for less than $3000? Researchers at NIST and the University of Colorado have come up with a "cookbook" that gives directions for constructing and operating a low-cost trapping apparatus for atomic rubidium. It is aimed primarily for use by undergraduate laboratory classes. Laser cooling and trapping of neutral atoms is a rapidly expanding area of research. In the past decade, scientists have cooled atoms down to 700 nK and held samples of a gas isolated in the middle of a vacuum system for many seconds. But the apparatus for these projects is quite expensive. "Our principal goal was to develop an apparatus which could be built and operated reliably with minimum expense and technical support," the researchers state in an article submitted to the American Journal of Physics. In fact, they say, "this trap's performance is equal or superior to what is achieved with the 'traditional' designs used in many research programs and some innovations have advantages over these designs." The $3000 price tag does not include the cost of required diode lasers. For a copy of paper 35-94, contact Sarabeth Moynihan, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-7765, e-mail: moynihan@bldrdoc.gov (via Internet).

COLD PROBE MAY HELP RESTORE A WARM HEART

NIST has signed a cooperative research and development agreement with a private company, to assist the company's effort to develop a super-cold catheter that can be used to freeze abnormal heart tissue and prevent irregular heartbeats. Arrhythmias (irregular beating) can be present at birth or can arise from damaged tissue after a heart attack. The two current methods of treatment, medication and electrical burning, both have drawbacks, says physicians. Medication is not always effective and can have side effects; electrical burning cannot safely treat enough tissue to cure all types of arrhythmias. Another way to treat arrhythmic heart tissue is to freeze it. Ideally, this would be performed by inserting a catheter with a cold tip into a vein and running it to the damaged area. However, attempts to develop such a catheter have been hindered by existing instrumentation that cannot attain sufficiently low temperatures (below the currently achievable minus 60 °C) at the tip. NIST will work with the company to develop heat exchange and fluid technology that will help the company create a super-cold catheter that can reach temperatures between minus 150 °C and minus 190 °C. Of particular note: the use of a miniature heat exchanger that fits into a catheter sheath less than 3 mm in diameter. For more information,

contact Ray Radebaugh, Div. 836.06, NIST, Boulder, CO 80303-3328, (303) 497-3710, or John Dobak, M.D., Aegis Medical Technologies, 10237 Flanders Ct., San Diego, CA 92121, (619) 587-6771, ext. 125.

REPLACEMENTS FOR BANNED HALON 1301 RECOMMENDED

NIST researchers have recommended three chemicals—HCFC-124, HFC-125 and FC-218—as primary candidates to replace halon 1301, a fire-fighting agent used aboard aircraft. Halon 1301 has been used as a fire suppressant for almost 40 years because it is harmless to humans, is effective against all types of fires, and is gentle to expensive and sensitive equipment. But halon 1301 contains bromine, which causes an ozone-destroying reaction, and by international agreement is no longer being produced. The project to find replacements is being sponsored by the U.S. Air Force, the U.S. Navy, the U.S. Army and the Federal Aviation Administration. The Air Force now is testing possible replacements, and wants to begin installing new firefighting agents in its fleet beginning in 1996. Nearly 40 researchers in three NIST laboratories ran hundreds of tests to rate a group of 12 possible replacements. Also involved were researchers from universities, aircraft and equipment manufacturers, and chemical suppliers. Related work currently going on at NIST includes determining the long-term compatibility of the recommended replacements with metals and polymers, and developing a mathematical model to predict chemical byproducts from the new chemicals.

ULTRASOUND MAY SOON RELIEVE "FATIGUED" BRIDGES

NIST and the Constructed Facilities Center of West Virginia University have begun a project to develop an ultrasonic strain gage system for measuring fatigue loading of bridges. Based on laboratory stress tests of aluminum and steel plates, and steel I-beams, NIST and WVU researchers have concluded that a properly designed ultrasonic system should be capable of achieving the desired stress resolution for field applications. Currently, conventional strain gages are used to measure fatigue loading on bridges. But they are time consuming to install and may require paint removal as part of the surface preparation (not a trivial matter when lead paint is involved). While ultrasonic measurement of stress has been known for decades, conventional ultrasonic devices are not much better than strain gages that require direct contact with the bridge surface. NIST and WVU are proposing the use of noncontact electromagnetic acoustic transducers (or EMATs), which can work on rough, pitted and rusted surfaces. EMATs also have drawbacks; they are less efficient than piezoelectric transducers and more attention has to be paid to signal-to-noise issues. EMATs will operate only on conductive materials such as steel and aluminum. The next steps in the NIST/WVU project are to develop an instrument suitable for use on bridges and then conduct large-scale verification tests. These will be done at the Constructed Facilities Center with technical assistance from NIST. A paper, no. 31-94, detailing the use of EMATs and the results of laboratory testing is available from Sarabeth Moynihan, Div. 104, NIST, Boulder, Colo. 80303-3328, (303) 497-7765, e-mail: moynihan@bldrdoc.gov (via Internet).

NEW FACILITY FOCUSES ON IMPROVED RADIATION STANDARDS

A new facility at NIST is now available to ensure accurate radiation measurements in medicine and as a new technology testbed for industry. The NIST Medical-Industrial Radiation Facility, or MIRF, is a national user facility for the medical and industrial radiation communities. The MIRF contains a high-energy electron beam linear accelerator donated by the Radiation Therapy Center of Yale University-New Haven Hospital. The range of electron energies available from the accelerator makes the MIRF a unique facility, ideally suited for medical radiation calibration research and industrial radiation technology development. The MIRF's primary medical application will be direct calibration standards for accelerator electron beams used in ionizing radiation treatments for cancer patients. NIST scientists also are planning research projects that could improve industrial processes such as polymer curing and wastewater treatment.

NIST PUBLISHES WEIGHTS AND MEASURES LAB DIRECTORY

The 1994 edition of State Weights and Measures Laboratories: State Standards Program Description and Directory (Special Publication 791), lists state and other labs accredited by the NIST Office of Weights and Measures. It is a guide for locating and obtaining measurement services required by contract or law. Accreditation by NIST indicates the lab is capable of providing a measurement

service, but each state is responsible for verifying its measurement traceability. For each state or accredited lab, the directory lists the accreditation period; staff members, addresses and telephone/fax numbers; services available; and fees for services. Of note: new requirements include a revision of current quality manuals to meet ISO Guide 25 criteria. Lab accreditations under the new criteria will fully meet ISO 9000 customer requirements. Copies of SP 791 are available for $8.50 prepaid from the U.S. Government Printing Office, Washington, DC 20402, (202) 783-3238, fax: (202) 512-2250. Order by stock no. 003-003-03272-7.

NIST/ANSI TO CREATE ELECTRONIC STANDARDS NETWORK

NIST and the American National Standards Institute have signed a cooperative agreement to jointly lead the effort to develop the National Standards Systems Network. The NSSN eventually will link the databases of hundreds of U.S. organizations involved in the development, production, distribution and use of technical standards. When operational in 5 years, the NSSN will provide cataloging, indexing, searching and routing capabilities to end users—allowing access to the entire range of regional, national and international standards. The NSSN is expected to reduce significantly standards development time and costs; minimize duplication between government and private-sector standards; increase dissemination of standards data to small businesses and increase involvement in national and international standards activities. For more information, contact David Cranmer, B115 Polymer Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5753, e-mail: cranmerd@micf.nist.gov (via Internet), or Dianne E. Kelley, ANSI, 11 W. 42nd St., New York, NY 10036, (212) 642-4911, e-mail: dianne.kelley@tlbbs.org (via Internet).

REPORT ISSUED ON USE OF INTERNATIONAL GUIDELINES

Staff of the Standards Code and Information Program of the Office of Standards Services have completed an analysis of worldwide use of international guidelines for determining the competency of testing laboratories. Based on 37 responses to a survey of laboratory accreditors who participate in the International Laboratory Accreditation Conference, the NIST report concludes that there is widespread use of the international guidelines with all respondents reporting use of the guidelines. However, 27 of the 37 respondents indicated reliance on interpretative documentation, thus suggesting the possibility of nonuniform application of the guidelines. While many topics were cited as needing amplifying interpretation, the three most often cited were quality system audits, measurement traceability, and calibration and test reports. Scheduled revision of the guidelines issued by the International Organization for Standardization and the International Electrotechnical Commission is expected to focus on the topics identified as most susceptible to divergent interpretation. Uniformity of application and interpretation is fundamental to the mutual recognition of the findings of competence issued by accreditors on behalf of testing laboratories in their respective countries.

NIST INVENTS NEW METHOD FOR SEMICONDUCTOR OVERLAY METROLOGY

NIST scientists have invented a new, nonoptical, method for overlay metrology for semiconductor fabrication. NIST is applying for a patent, and is prepared to provide preliminary information on the method to parties signing a formal nondisclosure agreement. Continued advances in the semiconductor microcircuits that form the building blocks for electronics require increasingly accurate alignment of individual features formed on multiple levels. A misalignment of only a few nanometers can ruin the circuit being fabricated. For optical lithography, in which shapes carried by masks are in effect "printed" in a series of photographic-like processes onto different levels, alignment errors, or *overlays*, conventionally have been measured by optical instruments. Systematic errors affect the readings of these optical overlay-metrology instruments. These errors, known as *shifts*, result from the lithography tool itself (tool-induced shifts) and from deviations in symmetry of the cross sections of replicated target features (wafer-induced shifts). Tool-induced shift can be estimated by comparing measurements taken with the target pattern in one orientation with those taken with the pattern rotated by 180°, but wafer-induced shifts can be more than 50 nm and are highly variable. Furthermore, there is no good way to estimate their magnitude. The new NIST method provides a means for estimating wafer-induced shift and, in fact, appears to be substantially free from both shift errors, although it uses the same targets as the existing optical methods.

CALCULATIONS IMPROVE MEASUREMENTS OF POWER-FREQUENCY MAGNETIC FIELDS

NIST scientists have carried out computations to improve measurements of power- frequency magnetic fields from localized sources such as home appliances, office equipment, machine tools, and electrical and electronic systems in transport vehicles. This NIST work responds to the increasing concern for possible health effects resulting from exposure to such sources. Since the sources behave more nearly as point sources than as extended sources such as electrical transmission lines and since there are frequently a number of sources to be considered in a given environment, the magnetic fields experienced can be highly nonuniform, particularly near electrical equipment such as motors, transformers, and heating elements. This situation complicates the measurement of magnetic fields, since there can be a significant difference between the field at one point and at another point only a few centimeters away. The probes that sense fields are typically in the form of circular coils, and the measured flux density is averaged over the cross-sectional area of the coil. Additional measurement uncertainties arise because this value is not necessarily the same as the value of the flux density at the presumed measurement location at the center of the coil.

The NIST team calculated the resulting additional uncertainties for a number of coil diameters with the assumption that the magnetic field was produced by a small loop of alternating current, i.e., a magnetic dipole. The magnetic dipole field was chosen because its geometry approximates the field geometry of many electrical appliances. The team calculated additional uncertainties first for single-coil probes and more recently for probes having three mutually perpendicular coils. The results of the calculations are being incorporated into the draft of an Institute of Electrical and Electronics Engineers standard on instrumentation used for measuring extremely low-frequency magnetic and electric fields, under development at NIST in collaboration with committees in the IEEE Power Engineering Society. Details of the calculation and tabulations of the measurement uncertainties as a function of probe radius and distance from the field source have appearcd in two papers appearing in the NIST Journal of Rcsearch.

NIST EXPERTISE CONTRIBUTES TO GOALS OF INTER-SERVICE ANTENNA GROUP MEETING

NIST recently hosted the 57th Inter-Service Antenna Group (ISAG) meeting, using the opportunity to transfer some of the expertise of its antenna and materials metrology and fields and interference metrology groups to participating government agencies. This transfer took the form of real-time consultation on antenna measurement issues raised in the meeting in addition to formal papers describing recent group work and a tour of NIST's antenna laboratories. Established by direction of the Secretary of Defense, ISAG is restricted to government personnel only and provides a forum for presenting project updates and for open discussion of current research among those having the responsibility for evaluating antenna performance and design. Free discussion of technical problems, challenges, and opportunities is encouraged as is mutual problem solving based on sharing the results of experience. The 3 day meeting drew 25 participants representing 13 government agencies from the U.S. Air Force, Army, and Navy, in addition to NIST.

CALS TECHNOLOGIES APPLIED TO THE FIBER/TEXTILE/APPAREL (FTA) INDUSTRY

An article describing the advances being made in the fiber, textile, and apparel industry with Electronic Data Interchange (EDI) and the Standard for the Exchange of Product Model Data (STEP) has been published in the summer 1994 edition of the CALS/Enterprise Integration Journal (formerly CALS Journal). This article was written by two NIST scientists.

The FTA industry is one of America's largest manufacturing industries, shipping $128 billion of apparel and textile products in 1990 and providing over 10% of all manufacturing jobs. The industry is facing fierce competition from imported products and is looking to EDI and STEP to improve efficiency through electronic commerce and life-cycle integration.

A number of nationwide R&D programs have been established to benefit the industry. One example is the Defense Logistics Agency's Customer-Driven Uniform Manufacturing Program – a program to improve apparel manufacturing tech-

nology for better fit, higher product quality, more economical unit-production methods, and quicker response. The Apparel Product Data Exchange Standard project, performed at NIST, is part of the program sponsored by DLA. The objective of the APDES project is to extend STEP to include the apparel industry. Other organizations, such as the Textile/Clothing Technology Corporation, the American Textile Partnership, the National Initiative for Product Data Exchange, etc., are forming linkages to support the FTA industry. NIST recently proposed a new program, the Apparel Technology Program, to bring together advanced technology, systems integration, product data exchange standards, and electronic commerce.

NEW RECORD STORED ELECTRON CURRENT AT SURF II

Synchrotron radiation from a stored high-energy electron beam provides a continuous source of radiation from the microwave through the x-ray regions of the electromagnetic spectrum, which has proven to be invaluable in numerous scientific applications. Originally built in 1974, SURF II has seen substantial improvements in performance over the years. In July, a new record electron beam current of 390 mA was achieved by NIST's SURF II operations staff. This was the first record high current obtained in 2 years, and it represents a 15% improvement over the previous best of 339 mA; the original design of the machine envisaged a maximum current of 10 mA. The radiative output is directly proportional to the stored beam current, so all users benefit directly from higher operating currents. SURF II provides the central national basis for absolute radiometry in the far ultraviolet spectral region and supports research programs in surface science, aeronomy, and soft x-ray optics.

THIN-FILM GROWTH PROPERTIES STRONGLY AFFECT MAGNETIC COUPLING

The performance of next-generation, giant magnetoresistance "read heads" for high-density information magnetic storage will be determined by the nature of the magnetic coupling of two ferromagnetic thin films separated by a thin nonmagnetic spacer layer. The electrical resistance of such a structure decreases dramatically if the magnetization of one layer is initially opposite to the other (antiferromagnetic coupling) and then aligns in the same direction (ferromagnetic coupling) when a magnetic field is sensed. Using scanning electron microscopy with polarization analysis (SEMPA), researchers at NIST found that the coupling of Fe layers separated by a Cr spacer layer in the absence of a magnetic field oscillated from ferromagnetic to antiferromagnetic, as the Cr increased in thickness, with a period that depended critically on the Cr growth temperature.

To determine how the properties of the Cr thin film are affected by the substrate temperature during growth, the scanning tunneling microscopy capabilities at NIST were applied to make atomic-scale-resolution measurements of the Cr topography. By taking into account the thickness fluctuations in the Cr spacer layer determined by the STM for each growth temperature, the periodicity of the magnetic coupling measured by SEMPA could be consistently explained. This work, reported in the May 15, 1994 issue of the Physical Review B, shows how strongly the physical microstructure, in this case an average roughness of less than one atomic layer, influences the observed magnetic coupling. The ability to control the magnetic coupling of such layered structures will allow their optimization for maximum sensitivity in magnetic sensor applications such as read heads for high-density disk storage.

NIST HOSTS ANNUAL MEETING OF THE ICRU

NIST served as host to the annual meeting of the International Commission on Radiation Units and Measurements at NIST on July 25–30. ICRU is a 13-member commission sponsored by the International Society of Radiology, and is a sister commission to the International Commission on Radiological Protection. ICRU writes consensus reports on the measurement of radiation and on quantities and units, while ICRP makes recommendations on protection of persons from ionizing radiation. ICRU interests include measurement methods for all uses of radiation, fundamental data, environmental measurements, radiation protection, medical imaging, radiation therapy, space radiation, and others. NIST has been a long-time active participant in ICRU.

At this meeting ICRU reviewed three draft reports: "Dose-Related Quantities for Radiological Protection Against External Radiation," written by an ICRU-ICRP task group, which should be approved next year; "Beta-Ray Dosimetry for Radiation Protection," approved for publication; and "Secondary Electron Spectra Resulting from Charged Particle Interactions," approved for publication.

REVISED FREQUENCY STANDARDS FOR THE INFRARED BASED ON THE CO_2 LASER

In a recent paper in the Journal of Molecular Spectroscopy, NIST researchers report substantially improved frequencies for the CO_2 laser. This revision of the frequencies of 780 lines of this laser will serve as an important standard for frequency measurements in the infrared region of the spectrum. A number of the measurements upon which this revision is based were made at NIST. A NIST scientist performed the new least-squares fit of the data. Aside from the many measurements on the CO_2 frequencies made at NIST, this revision relies critically on a highly accurate measurement, made in France, of the frequency of one of the CO_2 lines.

The CO_2 laser now stands as the most used secondary frequency standard in the far infrared. This standard supports accurate spectroscopic measurements useful for identification of molecular species in space, in the upper atmosphere, and in industrial processes. These results, combined with the development at NIST of a substantially improved CO_2 laser, put NIST in an excellent position to support scientific and industrial measurements in this important spectral region. The new NIST laser operates in a continuous-wave mode on more laser lines than any other CO_2 laser ever built.

MAGNETIC MATERIALS FOR HIGH-DENSITY RECORDING HEADS

Assisting the National Storage Industry Consortium effort to develop 10 Gb/in^2 recording heads, NIST has been cooperating with a number of NSIC members in evaluation of multilayer read-head sensor films by ferromagnetic resonance (FMR) and in modeling of write heads and Barkhausen noise. The NSIC-heads consortium, which includes 11 companies and seven universities, won an ATP grant in 1992 to develop 10 Gb/in^2 recording heads. Films from two NSIC members, and films prepared for NSIC by a NIST scientist have been measured to determine film homogeneity and the performance of pinning layers. FMR is unique in its ability to separately determine properties such as anisotropy of the individual layers in the sensor films.

Theoretical work in cooperation with George Washington University is under way to model the micromagnetic behavior of write heads. The NIST contribution to this effort so far has included improvement of algorithms used to calculate the minimum energy configuration of the magnetization. In separate calculations, the statistical properties of magnetic domain wall jumps known as Barkhausen jumps were modeled in conjunction with another NIST scientist.

ORIGIN OF THE ANOMALOUS LOW-FIELD GIANT MAGNETORESISTIVE EFFECT (GMR) IN $Ni_{80}Fe_{20}$/AG MULTILAYERS

Using x-ray diffraction and polarized-neutron reflectivity techniques, NIST scientists are studying a series of $Ni_{80}Fe_{20}$/Ag multilayers in collaboration with a private company. These methods provide structural and magnetic information about the exact nature of the $Ni_{80}Fe_{20}$/Ag interfaces and the magnetic domain size and will complement the company's magnetization and TEM characterizations. These multilayers are remarkable in that the field dependence of the resistivity is profoundly affected by post-growth annealing. Samples prepared by sputtering and then annealed at high temperatures show giant magnetoresistive effects at anomalously low magnetic fields, an effect not previously observed in related materials. Thus these materials represent a major advance toward the use of magnetic multilayers as highly sensitive recording heads.

Preliminary neutron measurements have provided detailed information about the nature of the magnetic coupling of the $Ni_{80}Fe_{20}$ layers across nonmagnetic Ag inter-layers. Though GMR in related materials is associated with a coherent antiferromagnetic (anti- parallel) alignment of the ferromagnetic layers across the nonmagnetic spacers, data suggest that the spin structure is more complex. In annealed samples, the $Ni_{80}Fe_{20}$ moments are antiferromagnetically coupled along the growth-axis direction with in-plane magnetic domains limited to ≈ 1 μm to 5 μm in size.

Future experiments will continue to probe the key submicron properties of such materials to enhance the prospect of tailoring the multilayer composition and growth so that the GMR effect can be exploited in a variety of technological applications.

NIST STAFF INVENT NEW COMBUSTION DIAGNOSTIC

The efficiency of combustion is highly dependent on the equivalence ratio, ϕ, the quotient of the fuel vapor and oxygen concentrations relative to the stoichiometric quotient. NIST scientists have devised a fuel-independent instrument that enables the first direct measurement of this quantity. The

device, called the "phi meter," analyzes an extracted sample of the combustion gases. It measures the oxygen consumed during catalytic combustion to carbon dioxide and water (and other final products of atoms other than C, H, and O), along with the volumetric flow in the analyzer. The NIST researchers have derived the equation relating these values to the equivalence ratio. The uncertainty in the determination is under 5%. The results of this research have appeared in Review of Scientific Instruments, No. 1 65 page 2367 (1994). It is anticipated that this tool will find use in characterizing industrial burners and incinerators, as well as in fire research.

NIST SOFTWARE ASSESSES FLAMMABILITY OF REPLACEMENT REFRIGERANTS

R-22 is the predominant refrigerant used in all residential air conditioners and heat pumps. All proposed alternatives to this refrigerant are mixtures of refrigerants that contain at least one flammable component. This gives potential to serious safety problems. For example, consider the case of a home heat pump unit that develops a slow leak and the repair technician erroneously replaces the missing portion of the original charge from the vapor portion of the refrigerant canister. Would a subsequent leak, under winter conditions, expel a composition that will have sufficient quantity of the flammable component(s) of that mixture be flammable? NIST has developed a new computer program for predicting the shift in composition of zeotropic refrigerant mixtures during an isothermal (slow) or adiabatic (fast) expansion process (leak). This model, named LEAK, uses the NIST thermodynamic properties program REFPROP as its core source of data and queries it in a sequential manner to establish the equilibrium path and final thermodynamic states of the escaping vapor and vapor and liquid remaining with the source container. The model already has been used by several major manufacturers. Also, NIST has completed a careful experimental verification utilizing several mixtures.

FRAMEWORK FOR NATIONAL INFORMATION INFRASTRUCTURE SERVICES DEVELOPED

NISTIR 5478, Framework for National Information Infrastructure Services, presents the NII Services Framework, which will serve as a point of departure for discussing the definition, scope, and alignment of NII services. Industry, academe, government, and other elements of the private sector can use the document to refine their requirements for the implementation of services, issues requiring legal resolution or governmental policy, the scope and responsibilities of service providers, and the refinement of NII goals and objectives regarding the smooth interworking of the information infrastructure.

The services framework document is one of a series of reports that together will provide a comprehensive overview of NII issues from the different perspectives of the three-layer model defined by the Information Infrastructure Task Force.

INDUSTRY/GOVERNMENT OPEN SYSTEMS SPECIFICATION PUBLISHED

NIST published Special Publication 500-217, IGOSS-Industry/Government Open Systems Specification, as a reference for organizations to use when acquiring and operating computer and communications systems or services based on Open Systems Interconnection (OSI) protocols. The document is jointly authored by the U.S. government, the Canadian government, the Manufacturing Automation Protocol User Group, the Technical and Office Protocol User Group, and the electric power industry. Each of these major user organizations previously had issued their own OSI procurement profiles. The IGOSS affords a broad scope of user services provided by OSI applications and gives users access to standardized applications that can operate over diverse, reliably interconnected computer systems.

FACE RECOGNITION TECHNOLOGY ADVANCES

NISTIR 5465, Face Recognition Technology for Law Enforcement Applications, describes the extensive face recognition technology available in the literature to law-enforcement applications. Applications of FRT range from static matching of controlled format photographs in mugshot matching to real-time matching of surveillance video images. These applications pose a wide range of different technical challenges and require an equally wide range of techniques from image processing, analysis, understanding, and pattern recognition. The document concludes that face recognition, in addition to fingerprint recognition, remains a critical high-technology strategic research area with significant potential impact on reducing crime. Researchers from NIST and the University of Maryland collaborated in preparing the survey of FRT applications.

NIST COLLABORATES WITH DEPARTMENT OF DEFENSE ON REUSABLE SOFTWARE

Organizations that want to reuse existing software must consider many variables, including software quality, to determine if the software is fit for reuse. NISTIR 5459, Quality Characteristics and Metrics for Reusable Software, identifies quality characteristics common to all software products that are most commonly refereneed in technical literature and standards.

The report was prepared by NIST for the Ballistic Missile Defense Organization, Department of Defense.

NIST RESEARCHERS IN HOT WATER OVER SOLAR DEVICE

A novel solar water heating system—believed to be the first to use photovoltaic cells in combination with computer technology to capture the sun's energy—has been developed at NIST. PV cells are semiconduetor devices that convert the energy in sunlight into electrical energy. A big advantage of the reeently patented NIST system is that it directly heats the water in the tank. Other types of solar water heaters generally have a complicated array of pipes to pump water up to a rooftop solar collector where it is heated and then returned to a storage tank. These systems have had numerous problems, including freezing or leaking fluid. One disadvantage of the NIST system is the current cost of PV cells. However, with the introduction of new, more effieient PV technologies and an increased worldwide demand, PV prices are expected to deeline to $1.50 per peak watt within the next decade. At this cost, a PV water heater could be installed for approximately $4000, about the same eost as a solar thermal heater. NIST researchers are building a full-scale PV system and will monitor its performanee for a year. Industry partners on this project are welcomed. Contaet Hunter Fanney, B322 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5864, e-mail: hunter@micf.nist.gov (via Internet).

REPORT EXPLORES NII QUALITY-OF-LIFE ISSUES

Commerce Secretary Ronald H. Brown, chairman of the Clinton Administration's Information Infrastrueture Task Foree, recently releasd a new report on how the National Information Infrastructure can be used to enhance quality of life. The report, The Information Infrastructure: Reaching Society's Goals, is published as a draft for public comment. The report describes the benefits and barriers of using the NII for eight areas: people with disabilities, electric power, transportation, telecommuting, emergeney management, public empowerment with environmental information, arts and humanities, and public safety. To get a copy of the report, order NIST Special Publication 868 from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650, or from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, (202) 783-3238. The document also is available electronically by gopher, telnet (login = gopher) or anonymous ftp to iitf.doc.gov (via Internet). The document can be found in the "documents/papers" subcategory of the "speeches/testimony/documents" category.

UNITED STATES, KOREA AGREE TO COOPERATE ON TECHNICAL ISSUES

A memorandum of understanding on technical cooperation has been signed by NIST and the Korea Research Institute of Standards and Science to help remove non-tariff trade barriers between the United States and Korea. The MOU in the fields of chemistry, physics, and engineering measurement sciences provides a framework for the exchange of scientific and technical knowledge services, and the augmentation of scientific and technical capabilities of the parties with respect to agreed-upon scientific fields. The MOU renews a previous agreement between NIST and the former Korea Standards Research Institute. The MOU with KRISS is similar to other agreements in measurement science that NIST has with Mexico, Argentina, Ecuador and Venezuela to improve international trade. For information on the MOU, contact the Office of International and Academic Affairs, A505 Administration Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3089, fax: (301) 975-3530, e-mail: OIAA@micf.nist.gov (via Internet).

FORECAST FOR SUNSHINE? NIST HELPS TRACK THE UV INDEX

Weather forecasters around the country recently have added a new number to their nightly broadcasts: the ultraviolet (or UV) index. A number from 0 to 10 in most areas, the index indicates when it's necessary to protect against damaging solar rays. This scale measures the intensity of UV light at ground level where it can damage exposed skin, crops, fisheries and materials. But how can the

public be sure the readings are accurate, or that measurements made around the country can be compared with each other? NIST physicists are helping two U.S. agencies ensure this accuracy. They recently installed a new instrument, a spectroradiometer, on the roof of the NIST Physics Building in Gaithersburg, MD, to continually monitor UV light. The device supplies UV measurements representative of the Washington, DC, area to the U.S. UV monitoring network. This network, coordinated for the Environmental Protection Agency by the University of Georgia, collects data from an expanding number of sites nationwide. The U.S. Department of Agriculture also is establishing a UV monitoring network; before new USDA instruments are deployed to sites, they are assessed by NIST's Solar Radiometry Program. Data from these stations will reveal fluctuations or increases in the amount of UV light at ground level, as have been projected due to ozone depletion and the greenhouse effect.

PAPERS HIGHLIGHT WAVEGUIDE LASERS FOR OPTICAL FIBERS

Integrated-optical devices using rare-earth-doped glasses have emerged as an attractive new technology on the verge of wide-scale manufacturing and commercialization. These devices are glass waveguides doped with one or more rare-earth ions such as neodymium or erbium. Also known as waveguide lasers, they can be used as laser oscillators and optical amplifiers. They are formed by a number of methods, including ion exchange and thin-film deposition. These integrated-optical devices are expected to be important elements in future optical fiber networks because they provide nearly perfect amplification of signals transmitted by the fibers. Two new technical papers from NIST discuss the devices in detail, including a chronological review of research in this area, a description of fabrication methods and a listing of ways to improve device performance. For a copy of the papers (designated no. 38-94), contact Sarabeth Moynihan, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-7765, e-mail:moynihan @bldrdoc.gov (via Internet).

NEW SYSTEM HELPS SEMS PUT FORTH A BETTER IMAGE

NIST and two industrial partners have developed a new high-resolution image acquisition and analysis system that may be retrofitted to most scanning electron microscopes to substantially improve the quality and detail of SEM images. The system, named ISAAC, digitizes the collected SEM signal with a resolution up to 4096 by 4096 pixels (compared with many commercial SEMs whose images are resolved at only 512 or 1024 pixels across). Another feature of ISAAC—a 16 bit image processing system rather than the 8 bit commonly found in SEMs—produces more than 65 000 intensity levels in the final image compared to the 256 levels usually available. ISAAC also provides researchers with greater flexibility for data analysis, storage, and retrieval. It can produce "movies" of dynamic processes, make dimensional measurements, count and analyze particles, and automate micrograph analysis. For more information, contact Michael Postek, A347 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2299, e-mail: postek@sed.eeel.nist.gov (via Internet).

FOR STEP, IT'S OFF TO THE PUBLISHER

The Standard for the Exchange of Product Model Data, better known as STEP, has been submitted for publication as an international standard. Twelve documents comprising the initial release of STEP—essentially a common language for exchanging a wealth of product-related information between computers—recently were sent from NIST to the International Organization for Standardization in Geneva, Switzerland. Officially designated as ISO 10303, STEP will be published by year's end and culminate an effort involving 450 people in 26 nations. That effort, including resolution of nearly 2000 comments on the draft standard approved in ISO balloting, was coordinated by an international committee (TC184/SC4) chaired by 2 NIST scientists and administered by its NIST-headquartered secretariat. Major automotive and aerospace companies already have pledged to use STEP, viewing it as critical to shortening lead time for new products. In response a growing number of software companies are developing products that facilitate implementation of the modular, evolving standard. The initial release enables direct, computer-to-computer exchanges of data necessary for certain design, engineering and manufacturing tasks. More than a dozen new elements of the standard are already in development and early committee review. These will add new applications, specify shared database methods and provide more explicit techniques for conformance testing. For more information, contact Brad Smith, A127 Metrology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3558, fax: (301) 258-9749, e-mail: smithb@cme.nist.gov (via Internet).

PLASTIC VS. METAL? NIST KNOWS FOR SPRINKLER PIPING

Fire sprinklers have come a long way since the first system was installed in the United States in 1852. Originally made of iron, they were heavy, cumbersome, expensive and used primarily in buildings such as warehouses. But in the mid-1980s, easier-to-install and less costly piping material was introduced. As a result, sprinkler systems increasingly are being incorporated into multi-occupancy structures such as hotels, office buildings and hospitals, as well as private residences. Researchers at NIST recently compared the advantages and disadvantages of using lightweight steel, copper, chlorinated polyvinyl chloride and polybutylene pipe materials. This information can help architects, builders and building owners select the type of piping that best suits their needs. For example, the NIST researchers report that while steel and copper piping are stronger and less likely to be damaged during installation, the CPVC and PB materials are lighter and easier to route around objects such as columns. A single copy of the report is available at no charge by sending a self-addressed mailing label to the Fire Research Information Service, A252 Polymer Building, NIST, Gaithersburg, MD 20899-0001. Please request NISTIR 5339.

REPORT SAYS NAVY NEEDS MORE OPTICAL FIBER SENSORS

A new report from NIST recommends that the U.S. Navy work closely with industry to adapt off-the-shelf or dual-use technology for shipboard optical fiber sensors. Although the Navy has been exploring optical fiber sensors for over a decade, very few systems have been installed on ships. The report finds that few companies want to contract with the Navy unless the systems they develop have broader commercial applications. In the Navy, the sensors are used for monitoring and controlling shipboard machinery, maintenance and damage assessment. Optical fiber sensors are preferred over conventional electric sensors particularly because they are immune to electrical disturbances. "Optical fiber sensors have very valuable potential advantages, but those that the Navy can use may remain too expensive to be deployed if the Navy uses traditional methods of writing specifications and soliciting development and procurement bids. For this reason, the study focuses on cooperation with industry and promoting commercial off-the-shelf and dual-use technology," the report reads. For a copy of Optical Fiber Sensors: Accelerating Applications in Navy Ships (NISTIR 5018), contact the National Technical Information Service, Springfield, VA 22161, (703) 487-4650. The prepaid cost is $27; order by PB 94-186848.

SURF'S UP IN NIST PHYSICS LAB!

Undergraduates and graduating college seniors in science and engineering are invited to apply for the 1995 SURF, or Summer Undergraduate Research Fellowships, program in physics at NIST. Fellowships are awarded to about 20 students each summer for 10 to 12 weeks of research within the agency's Physics Laboratory. SURF students are paired with NIST scientists based on the student's background and interests. Each SURF fellowship includes a $3600 stipend as well as housing and transportation. The program, supported in part by the Physics Division of the National Science Foundation through its Research Experiences for Undergraduates Program, encourages participation of minorities and women, but is open to all undergraduate U.S. citizens interested in a career in physics. Students receive SURF awards through nominations from their college or university. Each school may nominate two candidates plus one alternate. Applicants must submit one signed original and two copies of their proposal along with the federal Grant Application Standard Form 424. Applications should be submitted to David King, B266 Physics Building, Gaithersburg, MD 20899-0001, by Feb. 1, 1995. For more information on the SURF program, contact King at (301) 975-2369, fax: (301) 975-3038, or e-mail: king@enh.nist.gov (via Internet).

NIST LEADS VAMAS "PRESTANDARDS" RESEARCH

NIST is playing a leading role in the Versailles Project on Advanced Materials and Standards, known as VAMAS. "Prestandards" research is the research that forms the basis for satisfactory measurement agreement so that materials developed in one location may be produced in a second, incorporated into products in a third, and then used throughout the world. The international collaboration in prestandards research is one of 18 cooperative technical projects in technology, growth and employment established at the Economic Summit of Heads of State at Versailles in 1982. VAMAS is led jointly by the United States and the United Kingdom on a rotating 3 year basis. NIST is the lead U.S. representative. VAMAS became self-sustaining on April 2, 1987, in a memorandum of

understanding signed by Canada, France, Germany, Italy, Japan, the United Kingdom, the United States and the European Union. For more information, contact VAMAS Secretary, James G. Early, B309 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6113, fax: (301) 926-8349.

TESTING TOOL FOCUS OF CRADA WITH NIST

Inspection and process control improvements achievable with a NIST-developed testing tool have prompted an aircraft manufacturer to enter into its first-ever cooperative research and development agreement with a federal laboratory. NIST and the Seattle-based maker of passenger jets will focus initially on NIST's easy-to-use system for regularly checking the performance of coordinate measuring machines. Potentially, the technology could be applied to all of the company's 130 CMMs. The modular, lightweight system, known as the NIST interim testing artifact, consists of a pair of inexpensive, calibrated ball bars that are kinematically mounted on rotatable aluminum arms. The base is screwed into inserts on a CMM table, and the baton-like ball bars are rotated from one indexed position to another. At each position, the CMM takes a series of pre-programmed measurements, and the results are compared with known values. A thorough system check-up can be accomplished in less than half an hour, making weekly CMM performance evaluations practical. The company also is exploring applications of the testing artifact in manufacturing process control, using it to assess the performance of measurement probes incorporated into machine tools for in-process inspection of part dimensions. For more information, contact Steve Phillips, B113 Metrology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3565.

FUTURE SEMICONDUCTORS MAY USE ELECTROSTATIC "GLUE"

When it comes to socks and dryers, electrostatic charges are a nuisance. When it comes to semiconductor processing, NIST ceramists soon may put them to work. Researchers at NIST have patented a process that makes these charges a useful adhesive. For example, naturally acidic surfaces like silicon oxide and some forms of gallium arsenide readily give up positively charged protons. To get these two surfaces to stick together, the process would involve bonding a single molecular layer of a basic chemical (that wants to take on extra protons) to the silicon oxide. When the newly processed silicon oxide and the gallium arsenide come together, the proton exchange creates two oppositely charged surfaces and an electrostatic pull between them. The process works best with thin, smooth layers. The top layer may be peeled up and repositioned—like a sticky yellow office note—without damaging the adhesive. For more information, contact Douglas Smith, A329 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5768, e-mail: dougs@enh.nist.gov (via Internet).

NEW CONVERTER WINS R&D 100 FOR CRADA PARTNERS

A multilayer, thin-film multijunction thermal converter, or MJTC, developed jointly by NIST and a private company has been named one of "100 most technologically significant new products of 1994" by Research and Development magazine. The result of a cooperative research and development agreement between the two organizations, this approach to the fabrication of thermal converters permits mass production of a previously difficult-to-make, hand-made device, with a subsequent reduction in price. Thermal converters, which are the most accurate calibration standards for ac voltage and current, also produce the most precise measurement method for both. Unlike conventional wire MJTCs, the thin-film devices permit operation at cryogenic temperatures where thermoelectric errors are lower; therefore, they can provide more accurate ac voltage and current measurements. For more information, contact Joseph Kinard at B146 Metrology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4250, e-mail: kinard@eeel.nist.gov (via Internet).

DIGEST HIGHLIGHTS RECENT OPTICAL FIBER RESEARCH

Fifty papers presented at the Eighth Symposium on Optical Fiber Measurements, Sept. 13–15, 1994, at NIST in Boulder, CO, are now available in a published digest. More than 20 % of the papers are concerned with polarization measurements, including polarization mode dispersion, polarization dependent loss and characterization of fibers and components with special polarization properties. Other papers discuss optical time-domain reflectometry measurements, the characterization of optical fiber amplifiers and non-linear processes in fiber. The symposium was sponsored by NIST, the Lasers and Electro-Optics Society of the Institute of Electronics and Electrical Engineers, and the Optical Society of America. Copies of Technical

Digest Symposium on Optical Fiber Measurements, 1994 (NIST Special Publication 864) may be purchased for $14 prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, (202) 512-1800. Order by stock number 003-003-03277-8.

PROGRAM HIGHLIGHTS A GIANT "STEP" FOR U.S. INDUSTRY

STEP—or Standard for the Exchange of Product Model Data—is a technology that enables companies and suppliers to digitally express and share a product's design, manufacturing and support processes via computer in a standard format. A new video, "STEP—A Futurevision . . . Today," depicts how the new international STEP standard (ISO 10303) works, what it can do to improve efficiency, cost and time to market for new products, and what it means to the worldwide marketing of U.S. manufactured goods. Examples featured include work in progress at the nation's leading automotive, aerospace and electronic firms. STEP is shown as useful to giant corporations and small suppliers alike. The program was sponsored by PDES Inc., the Automotive Industry Action Group, the National Center for Manufacturing Sciences and the National Initiative for Product Data Exchange hosted by NIST. For a free copy of the 10 minute VHS video, contact John Blair, NIDPE/NIST, B102 Radiation Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4261, e-mail: blair@micf.nist.gov (via Internet). A Betacam version is available for television media.

SPECIAL STANDARDS TRAINING PROGRAM FOR RUSSIA/NEWLY INDEPENDENT STATE EXPERTS

NIST is cooperating with Commerce's Special American Business Internship Program and the American National Standards Institute to develop a comprehensive standards-related training program in 1995 for qualified engineers, administrators, and technical and regulatory experts from Russia and the Newly Independent States. A total of $1.5 million has been allocated to train 100 interns. Invitations to potential applicants will be extended through the central standards organizations in Russia and the NIS. Applicants must be in positions of significant responsibility in their employing organizations and have had 5 years of engineering, technical, administrative, and/or regulatory experience to be considered for an internship. The program will familiarize participants with U.S. government and private-sector processes and procedures for standards development, conformity assessment, and quality management. It will include a 2 week orientation in Washington, DC, followed by 6 weeks of localized training with private-sector hosts, focusing on standards-related issues.

NIST DEVELOPS METHOD FOR MEASURING RESISTIVITY OF SHORT, FINE CONDUCTING FIBERS

In response to a request from the U.S. Army, NIST has developed a method for determining the resistivity of short (0.5 mm to 50 mm), fine (1.5 mm to 14.7 mm) conducting fibers. These fibers are used as chaff for confusing enemy radar in defense applications and may be made by a variety of fabrication technologies, such as catalytic chemical vapor deposition, with a resulting considerable variation in diameter. The fibers exhibit a wide variation in resistivity depending on fiber material, fabrication means, and additional processing, including surface treatment. The measurement challenge lies in the very small fiber size.

The NIST method measures the resistance per length of individual fibers and calculates the resistivity based on SEM (scanning electron microscope) determinations of fiber diameters. By switching between three different types of measurement boards, this system can accurately measure very-high-resistance samples (uncoated carbon fibers), low-resistance samples (metal-coated fibers), and samples too short to mount conventionally. For fibers less than 1 mm in length, a special photolithographed sample board with 5 μm wide voltage taps was developed. The design of the system used to implement the method accounts for errors due to current heating, eliminates thermal voltages, and evaluates voltage drift. Measurement uncertainties are within 4 %.

A second system based on the NIST method was constructed and has been delivered to the Army, together with associated software. In its first use of the system, the Army will measure fiber resistivities and then compare results with those obtained previously at NIST.

MODELS TO PREDICT SEMICONDUCTOR DEVICE PERFORMANCE FEATURED IN VOLUME OF SPRINGER-VERLAG SERIES ON MATHEMATICS

Work done by two NIST scientists on modeling the physical parameters that control semiconductor device performance is the subject of a chapter in Semiconductors, Part II, titled "Physics for Device Simulation and its Verification by Measurement." The scientists' models, which are based on quantum-mechanical concepts and first principles, calculate the effective intrinsic carrier density, carrier lifetimes, and carrier mobilities.

The models were verified by comparisons with experimental data taken on GaAs devices prepared at NTT in Atsugi, Japan. The experimental measurements compared very well with the NIST predictions, while conventional models predicted much lower transistor gains (by about a factor of 3) as a function of collector current. The book describing this work is being published by Springer-Verlag as Volume 59 of a series on mathematics and its applications.

NIST, INDUSTRY COLLABORATION TAKES STEP TOWARD HIGH-TEMPERATURE SUPERCONDUCTOR JOSEPHSON ARRAY VOLTAGE STANDARD

Working together, NIST researchers and researchers from a private company have succeeded in measuring the critical current uniformity (J_c) and rf response of stacked Josephson junctions made from the layered high-temperature superconductor, $Bi_2SrCa_2Cu_2O_x$, (BSCCO (2212)). J_c uniformity and rf phase-locking are necessary ingredients for the development of a high-temperature Josephson voltage standard, a development that would permit industry much simpler access to what is, effectively, the nation's primary voltage standard.

Each junction stack was composed of three levels of BSCCO (2212) separated by two levels of Dy-doped BSCCO (2212). The materials were grown in an atomic-layer-by-layer MBE system at the company. The resulting stack of alternating superconductor and normal conductor layers formed two series SNS Josephson junctions. Each junction stack responded to an external 75 GHz source by showing Shapiro steps at twice the voltage expected for one junction, thus confirming the desired phase-locking capability. More importantly, the junction stacks exhibited excellent critical current uniformity, far better than most other HTS junctions reported to date. Five out of six junction pairs had critical densities within a total spread of 12%.

NIST M^3 PERFORMS FIRST MEASUREMENTS, ACHIEVING SUB-NANOMETER ACCURACY

The NIST Molecular Measuring Machine, conceived and designed to extend the state of the art of the world's dimensional measurement capabilities to meet the most advanced needs of the U.S. microelectronics industry in the late 1990s, has demonstrated its design function by measuring to nanometer-level accuracy millimeter-scale distances on a pattern of two-dimensional features. In particular, M^3 measured with an estimated standard uncertainty of 0.02 nm the spacings of an array of chromium lines formed with half-wavelength spacing by another recent NIST innovation, laser-focused deposition of neutral atoms.

In its first measurements, the M^3 interferometrically scanned its tunneling microscope probe across 4700 lines over a distance of about 1 mm, yielding an average spacing of 212.83 nm, this measured value corresponds with the theoretically predicted but previously experimentally unconfirmed value of 212.78 nm within 0.05 nm, which is about one-fifth that of the distance of typical interatomic spacings.

Development of M^3 was started in 1988 to provide a NIST capability 20 times better than the 20 nm accuracy then, and still, projected to be needed by U.S. industry in measurements of x,y-coordinate positions on, for example, electron-beam lithography integrated circuit masks. The M^3 presently incorporates multiple innovations in precision metrology, including an ultrastable spherical machine frame, a separate ultrastable optically contacted metrology frame, advanced optical heterodyne interferometers, and a picometer-resolution z-axis STM probe. Immediately ahead for the M^3 are test measurements on other industrially important artifacts with the necessary nanometer-scale features spaced up to the 50 mm range of the machine, which can help advance its further development and ultimate introduction into formal measurement service.

NIST INITIATES ASME-ADMINISTERED PANEL ON THREAD-GAGING ISSUE

NIST is initiating an independent-panel study administered by the American Society of Mechanical Engineers to look at the controversial issue of the efficacy of certain types of gaging systems for assessing threaded products used in aircraft, nuclear power reactors, and a variety of other

applications. The issue is the degree to which each of three gaging systems, defined in ASME standards as Systems 21, 22, and 23, can assure conformance of threaded products to dimensional specifications. Central to the issue is the fact that System 21, which apparently is widely used for acceptance testing of threaded products, is a go/no-go test of the ability of mating threads to be assembled and does not assure conformance of those threads to dimensional specifications.

Beginning more than a decade ago, the issue of the limitation of System 21 has successively embroiled in yet-unresolved controversy the U.S. Air Force and manufacturers of military aircraft, the Federal Aviation Agency and manufacturers of civilian aircraft, the Nuclear Regulatory Commission and operators of nuclear power reactors, and a variety of manufacturers of threaded products and producers of thread gaging instruments. To contribute to an effective resolution of the controversy, NIST is initiating an 18-month two-phase panel study as a neutral forum, administered by a non-standards arm of ASME, in which the various entities involved in the controversy can: (1) articulate the issues as they see them; and (2) identify potential courses of action regarding gaging of threaded products, such as modification of existing documentary standards, issue of guidelines for application of such standards, changes in accepted practices, and creation of bibliographies and databases of engineering data relating the degree of conformance of threads to dimensional specifications to their performance in use.

MONOLAYER TECHNOLOGY USED TO PATTERN IMMOBILIZED AVIDIN PROTEIN AND TO INCREASE ITS BIOLOGICAL ACTIVITY

The protein avidin is used widely in biomedical diagnostic assays and biosensors because it functions as a generic binding agent for immobilizing biomolecules. There is interest in utilizing this protein in next- generation sensing devices that use patterned arrays of biomolecules to perform multi-analyte bioassays. Four NIST scientists used self-assembled monolayer (SAM) technology to create patterned arrays of avidin and have found as an added benefit that the use of SAMs increases the biological activity of this important protein.

Avidin is known to adsorb on bare gold, negatively charged or hydrophobic surfaces. In work using SAM-coated gold surfaces the researchers found avidin adsorption to be influenced strongly by the salt concentration of the protein solution, in contrast to avidin adsorption on bare gold, which is insensitive to salt concentration. This observation was the basis of the approach developed to produce patterned adsorption of avidin on SAM-coated gold surfaces. Building on previous work, the researchers used an ultraviolet photo-lithographic technique to create patterned hydrophobic and negatively charged monolayer surfaces. These surfaces were then exposed to avidin solutions having salt concentrations that promoted avidin adsorption on negatively charged regions while simultaneously retarding adsorption on hydrophobic regions. Secondary ion mass spectrometry images confirmed that avidin adsorbed preferentially on the negatively charged regions of the monolayer. These results demonstrate that SAM technology will be useful for creating patterned biomolecular array devices that take advantage of generic avidin biomolecule immobilization chemistry.

SAMs also protected adsorbed avidin from deactivation by the underlying gold. Following adsorption, avidin on SAM-coated gold showed two to five times greater biological activity when compared to avidin on bare gold, even though the same amount of protein was adsorbed on both surfaces. By preserving more of avidin's biological activity, the use of SAMs will dramatically increase the sensitivity and/or reduce the cost of bioassays and biosensors based on avidin immobilized on gold surfaces. Cost reductions can be substantial since avidin protein is approximately 30 times more expensive than gold at the present time.

Because SAMs can be used to control biomolecule immobilization, patterning, and biological activity, SAM technology will make design and fabrication of bioassays and biosensors simpler, more reliable, and less costly.

NIST PRECISION MEASUREMENT GRANTS AWARDED FOR FY 1995

Two new $50,000 NIST Precision Measurement Grants have been awarded for fiscal year 1995. The recipients, Kurt Gibble of Yale University and Luis Orozco of the State University of New York at Stony Brook, were selected from an initial group of 50 candidates. NIST sponsors these grants to promote fundamental research in measurement science in U.S. colleges and universities and to foster contacts between NIST scientists and researchers in the academic community actively engaged in such work.

The aim of Gibble's project, "Laser-Cooled Atomic Clocks 'without' Cold Collisions," is to first eliminate the frequency shifts due to collisions between laser-cooled atoms in an atomic fountain clock. To this end, ^{133}Cs, ^{135}Cs, ^{137}Cs, and ^{87}Rb fountains will be investigated. Work then will focus on using the optimal candidate to achieve the 10^{-16} stability potential (for averaging times of less than 10^4 s) of a laser-cooled clock operating as a semi-continuous atomic fountain.

The aim of Orozco's project, "Spectroscopy of Francium: Towards a Precise Parity Nonconservation Measurement in a Laser Trap," is to understand the spectroscopy of magneto-optically trapped radioactive francium atoms well enough to perform a precise test of the standard model of particle physics at low energy. Francium is an ideal atom because the parity nonconserving transition rate is 15 times larger than in the commonly used cesium atom, and the availability of many isotopes can make the interpretation of the results less sensitive to atomic theory calculations.

WORKSHOP ON QUANTUM COMPUTING AND COMMUNICATION CONVENED AT NIST

A workshop on quantum computing and communication, sponsored by a number of organizations and NIST, took place at NIST Aug. 18–19 with about 100 attendees. The evolving field of "quantum information technology" deals with information transmission in quantum mechanical systems and the prospects for developing novel electronic devices. For example, a classical "bit" is always in one of two states (0 or 1), whereas a quantum mechanical bit, or "qubit," is generally in a coherent superposition of those two states. If this coherence could be maintained during a sequence of operations, a quantum computer could perform certain types of calculation—such as the prime factorization of large integers—much faster than is possible on a classical computer. Practical realization of a quantum computer was one of the main topics of the workshop. Another was the use of quantum-correlated photon pairs for secure communication; several plans for carrying out such communication over distances of about 10 km were reviewed at the workshop.

CALIBRATION SERVICES BECOMING ISO/IEC GUIDE 25 COMPLIANT

An effort is under way at NIST to document five highly important calibration services. Quality manuals have been written for each of the following services: radiance temperature measurements, spectroradiometric measurements, spectrophotometric measurements, photometric measurements, and photodetector measurements. Based on the ISO/IEC Guide 25 and the ANSI Z540-1, several key sections of the ISO Guide 25 have been incorporated into this quality system. Computer software and calibration methods also have been uniformly documented in the quality system. In addition, uniform test report formats are being used by each calibration laboratory, and NIST has adopted a standard procedure for handling complaints. The ISO compliance and the effort to document the quality system benefit the services offered by NIST. First, the importance of the customer and the end product are brought to light, and second, all records and procedures pertaining to calibrations are maintained in a standardized manner.

WORKSHOP ON CRITICAL ISSUES IN AIR ULTRAVIOLET METROLOGY CO-SPONSORED BY NIST

Several national programs and a variety of industrial applications require the use or monitoring of ultraviolet radiation. The need for high-accuracy radiometry in this region of the electromagnetic spectrum is becoming increasingly urgent. In response to this need, NIST organized a Workshop on Critical Issues in Air Ultraviolet Metrology, held at NIST May 26–27. The workshop was attended by more than 120 representatives from the instrumentation, medical, and research communities in academia, private industry, and federal agencies. The goals of the workshop were to identify standards and instrumentation necessary for absolute measurements of UV irradiance and radiance, to compile a list of specific recommendations to improve the nation's UV measurement capabilities, and to determine NIST's role in supporting these efforts. The workshop was co-sponsored by NIST, EPA's Office of Research and Development, NSF's Office of Polar Programs, the National Renewable Energy Laboratory UV Monitoring and Assessment Program Panel, and USDA's Cooperative State Research Service.

The workshop was organized into four sessions: ultraviolet radiometric standards; radiometric instrumentation, calibration, and measurement uncertainty; measurement requirements of solar ultraviolet monitoring and ozone; and quantitation of ultraviolet biological effects and hazard evaluation. A conference report on the workshop will

appear in a future issue of the NIST Journal of Research.

PRECISE DETERMINATION AND CRITICAL EVALUATION OF RADON HALF-LIFE

Radon and a precise and uniformly accepted value of its half-life, is of interest in a variety of disciplines ranging from studies in global atmospheric modeling and the geophysical sciences to indoor air quality and concern over its potential human health hazards. NIST recently completed two studies on the radon half-life. The first study is a very precise determination of the half-life by 4π-$\alpha\beta$ liquid scintillation measurements that resulted in a value (3.8224 days) having a relative combined standard uncertainty of 0.05 %. The second study consisted of a critical review and evaluation of 17 independent determinations of the half-life made over the past 90 years. A ^{222}Rn half-life value of 3.8232 days was recommended. This value has an estimated relative combined standard uncertainty of 0.01 %. Both studies were prepared for publication and submitted to the journal Radioactivity and Radiochemistry.

NANOSTRUCTURED MATERIALS VIA MECHANICAL ALLOYING

Nanostructured materials have microstructural features that are of the scale of 100 nm or less and can exhibit unusual physical and mechanical properties. Mechanical alloying is a relatively simple technique for producing bulk quantities of "nanomaterials" as well as phases of compositions that are not achievable by any other means.

NIST is developing techniques for improved production of mechanically alloyed nanostructured materials and for measurement of grain size and defect structures in these materials. NIST shaker mill modifications designed to produce more rapid mechanical alloying appear to result in increased energy transfer to the material under study, while at the same time maintaining lower processing temperatures and reduced contamination by oxides and nitrides. X-ray diffraction studies of the resulting samples show that standard methods of grain size determination can be in error by a factor of 5 or more and thus must be corrected. This need for correction arises because of the high density of defects known as stacking faults, which lead to an underestimate of grain size. Correlation of properties of mechanically alloyed materials with true grain sizes (i.e., corrected for stacking fault contributions) should lead to a better understanding of the properties of nanomaterials.

FIRST PRINCIPLES CALCULATION OF PHASE DIAGRAMS

First-principles calculations of phase diagrams combine quantum mechanical calculations of total energies with statistical mechanical models of configurational entropy. Only atomic numbers, formal charges, and crystal structures are used as input, but predicted quantities include formation energies for observed and metastable phases (including newly predicted phases), critical temperatures of ordering transitions, and temperature-composition phase diagrams.

Previously the FP approach has been applied successfully to simpler metallic and semiconductor alloys; recent calculations performed at NIST have extended these methods to the complex relaxor ferroelectric system $Pb(Sc_{0.5}, Ta_{0.5})O_3$-$PbTiO_3$ (PST). Relaxor ferroelectrics are technologically important solid solution materials in which the ferroelectric properties are sensitive functions of the composition and degree of cation order. The latest calculations reproduce the observed ordering in pure PST and predict the presence of three additional (new) ordered phases, plus broad two-phase fields between them. Experiments are being conducted to validate these predictions.

PATENT AWARD FOR OPTICAL SENSOR FOR POLYMER PROCESSING

A patent has been awarded to NIST scientists for the development of an optical sensor that can be used to monitor the solidification of polymer resins during processing by injection molding. The patent, entitled Method for Detecting Thermodynamic Phase Transitions During Polymer Injection Molding, discloses technology to detect the crystallization of a crystallizable polymer or the glass formation of an amorphous polymer. The sensor operation is based on monitoring fluorescence light from a fluorescent dye that has been doped into the resin at very low concentration (parts per million by weight). The sensor hardware consists of an optical fiber that is inserted into the mold and used to transmit the fluorescence light to light detection equipment. The fluorescent dyes are chosen for their sensitivity to temperature and viscosity of the polymer, both of which are defining parameters for a phase transition from liquid to solid. During injection molding, the polymer is heated to the molten state whereupon it is injected into the mold that determines its final dimensions. The polymer cools in the mold and solidifies by crystallization or glass formation. The time of solid-

ification is an important event during the process because it signals the time when the processed part can be ejected from the mold and fresh molten resin can be introduced to make the next part. Using this technology, processors obtain a light intensity versus time profile that characterizes resin cooling and solidification. The information can be used to reduce cycle time, thereby improving productivity.

RESEARCH PRIORITIES IN MATERIALS FOR TOTAL JOINT REPLACEMENTS

A priority list of research needs in materials used in orthopedic implants resulted from a NIST/industry workshop held Sept. 1–2. Representatives from seven companies involved with the manufacture of orthopedic implants joined NIST scientists to discuss key technical concerns affecting total joint replacements and how NIST might assist industry address these issues. Representatives from the Food and Drug Administration and the Mayo Clinic also participated. The compatibility of implant materials with body tissues and effects of wear are leading concerns of the industry. Prior to clinical applications new materials are currently evaluated through expensive and time-consuming *in vitro* joint simulation studies. Replacement of this evaluation method by simplified, inexpensive, and reliable technique(s) is a high priority of the industry. The test procedure(s) would be used to screen materials and could accelerate the gathering of data for identifying materials interactions in wear processes. Other needs discussed included the development of a synthetic synovial fluid to replace bovine serum currently used in wear studies and the potential usefulness of polyethylene particulate standards for studies of the contribution of wear debris toward osteolysis. Osteolysis, the dissolution of bony tissue, leads to loosening of artificial joints in about 5 % to 10 % of patients over a 10 to 15 year period. Follow-up workshops are planned for the development of a NIST-industry program to address these and other issues.

NIST PROVIDES TECHNICAL SUPPORT TO SANTA ANA, CA FIRE DEPARTMENT

The Santa Ana Fire Department in Santa Ana, CA, conducted a series of fire experiments in three vacant single-family dwellings in the City of Santa Ana in July 1994. NIST provided technical support, consisting of measurements of fire phenomena, to the fire department during these experiments. The measurements included floor to ceiling temperature profiles, the velocity and temperature of outflowing gases, smoke detector and sprinkler activation times, the heat flux at floor level, the fuel mass loss rate, glass temperatures, and time to full room fire involvement.

The results of the experiments will be used by the Santa Ana Fire Department to address the effects of overcrowding on the fire safety of single-family homes.

NEW PUBLICATION FOCUSES ON SECURITY IN OPEN SYSTEMS

NIST Special Publication 800-7, Security in Open Systems, assists software developers and service designers use standard, open systems platforms in building security into their software applications. In an open system environment, security may be affected by the need to use both standard and non-standard components, as well as incompatibilities among products that claim to meet the same standard. Although providing technical information for programmers, the report is also of value to product planners, administrators, users, and managers who are interested in understanding the capabilities and limitations of open systems.

CONFERENCE SHOWCASES NATIONAL INFORMATION INFRASTRUCTURE APPLICATIONS

On Sept. 7-8, NIST participated in the conference Breaking the Barriers to the National Information Infrastructure, held in Washington, DC. Sponsored by the Council on Competitiveness and the Information Infrastructure Task Force, the conference featured 25 interactive demonstrations of interesting and useful applications of the planned NII, as well as panel discussions and keynote speakers, including Secretary Ronald Brown and NIST Director Arati Prabhakar.

NIST scientists demonstrated a pilot electronic commerce procurement system jointly developed by NIST and a private company under a recently signed cooperative research and development agreement. The SmartProcurement system is an innovative application of two evolving computer technologies: the World Wide Web and Intelligent Agents. The system enables a purchaser to execute the government's procurement process electronically, obtaining competitive bids from participating vendors in hours vs. days or weeks.

SmartProcurement demonstrates a potential approach for streamlining the federal government's procurement processes, allowing purchases to be made faster and more cost-effectively. Currently in a demonstration phase, the project will focus next on implementing the many details required to make SmartProcurement operational, including the integration of Electronic Data Interchange interfaces to vendors, digital authorization signatures, shipping notices, invoices, payment, etc. The project is expected to lead to a full-fledged pilot deployment on CommerceNet, a nonprofit consortium funded under the U.S. government's Technology Reinvestment Project.

GUIDANCE TO FEDERAL AGENCIES ON VIDEOCONFERENCING PUBLISHED

NISTIR 5485, Videoconferencing Procurement and Usage Guide, provides guidance on the evaluation, selection, purchase, installation, and use of various videoconferencing systems and their options. Following a brief tutorial on videoconferencing systems, the document discusses the current state of applicable standards and their effect on the utility of available systems.

Videoconferencing is a cost-effective means of conducting project meetings, holding training sessions, and providing real-time customer assistance. As new capabilities such as whiteboarding, application sharing, and computer sharing are introduced, videoconferencing will become a progressively more powerful and effective business tool for government and industry. Standards-making organizations are expected to enhance existing standards to include these additional capabilities over the next few years.

NEW FEDERAL INFORMATION PROCESSING STANDARD APPROVED

The Secretary of Commerce recently approved FIPS 187, Administration Standard for the Telecommunication Infrastructure of Federal Buildings, for federal agency use. To be effective Feb. 10, 1995, FIPS 187 adopts ANSI/TIA/EIA-606-1993, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, which establishes guidelines and defines administrative requirements of the telecommunications infrastructure within a new, existing, or renovated office building or campus. The infrastructure includes equipment spaces, cable pathways, grounding, wiring, and termination hardware, which support the distribution of information.

Also approved was FIPS 188, Standard Security Label for Information Transfer. Effective March 1, 1995, the standard defines a security label syntax for information exchanged over data networks and provides label encodings for use at the Application and Network Layers of the Open System Interconnection reference model. Security labels convey information used by protocol entities to determine how to handle data communicated between open systems. FIPS 188 will enhance the security of information systems by controlling access, specifying protective measures, and determining additional handling restrictions required by a communications security policy.

Standard Reference Materials

STANDARD REFERENCE MATERIAL 2582—POWDERED PAINT (LOW-LEAD CONCENTRATION)

The Lead-Based Paint Poisoning Prevention Act demands testing of all painted surfaces in public and Indian housing by 1994. NIST has developed Standard Reference Material 2582, Powdered Paint. Developed in conjunction with the U.S. Department of Housing and Urban Development and the U.S. Environmental Protection Agency, SRM 2582, Powdered Paint, is intended to mimic or resemble the paint on interior surfaces of modern housing. It assists investigators to produce accurate data in fulfillment of legal requirements. Accurate data are needed to disclose lead-based paint hazards so that abatement efforts can be properly directed.

The Standard Reference Materials Program announces the availability of powdered paint (low-lead concentration) SRM 2582. It consists of 20 g of a fine homogeneous powder of latex paint of which 99+% passes a 100 μm (no. 145) sieve. The certified value of (208.8 ± 4.9) mg/kg is based on measurements by isotopic dilution thermal ionization mass spectrometry.

SRMs 2580 and 2581 with targeted concentrations of 5.0% and 0.5 % lead by weight are also being developed to extend the available range of analytical validation points.

The current availability of other SRMs for lead content include SRM 1579a—Lead in Powdered Paint and SRM 2579—Lead Paint Film.

SRM AVAILABLE FOR INTERSTITIAL OXYGEN IN SILICON

NIST has announced the availability of Standard Reference Material 2551, a calibration standard for interstitial oxygen in silicon. In response to requests from the semiconductor industry, this SRM was prepared by the Semiconductor Electronics Division for the qualification and calibration of infrared spectrometers used by the industry to determine oxygen concentration in silicon. NIST intends that the new SRM supports the measurements that will be needed to achieve the improved oxygen control required by the Semiconductor Industry Association Roadmap. Realizing the benefits provided by the exceptionally small uncertainty values certified for the SRM probably will require more stringent measurement procedures for some infrared test systems. The estimated 2 standard deviation uncertainty of certification for the four-piece SRM 2551 ranges from 0.17 % at the low-oxygen level to 0.12 % for the high-oxygen level. This uncertainty is a measure of the equivalence of the oxygen values of each SRM set to those of the Grand Round Robin master set and therefore to those of each other SRM set. (The name *Grand Round Robin* refers to an international intercomparison for which NIST was the pilot laboratory; the uncertainty of absolute oxygen levels as measured in the Grand Round Robin is not incorporated in the SRM certificate.)

Use of the SRM will enable operators of infrared test stations to determine the specific conversion factor between infrared absorption and interstitial oxygen level for each instrument rather than assuming that all instruments operate with the same conversion factor. This information will enable significant improvement in the control of oxygen measurements and the degree of uniformity of measurement station values throughout the semiconductor industry. The SRM is issued as sets of four pieces of silicon, each double-side polished squares 2.5 cm on a side and having a thickness of 2 mm. The four pieces are: a float-zone reference specimen and low-, medium- and high-level oxygen (Czochralski-grown) specimens having oxygen levels on the IOC-88 scale from approximately 16.5×10^{-6} to 26.5×10^{-6} atomic.

CERTIFICATION OF HIGH-PURITY ALUMINUM AS STANDARD REFERENCE MATERIAL 1744—A FREEZING-POINT STANDARD

NIST scientists recently completed the certification of Standard Reference Material 1744 as a freezing-point standard. This new SRM of high-purity aluminum (99.999 96 %) can be used for realizing one of the defining thermometric fixed points (at 660.323 °C) of the International Temperature Scale of 1990 (ITS-90) for the calibration of standard platinum resistance thermometers. The fixed point is realized as the plateau temperature (or liquidus point) of the freezing curve of the high-purity aluminum at 101325 Pa.

The thermal tests used to confirm the purity of the aluminum, and to ascertain that the aluminum is suitable to be used as a freezing-point standard, involved the evaluation of three aluminum freezing-point cells, each containing 356 g of the aluminum. The freezing and melting curves obtained for these cells were compared directly with the NIST laboratory standard. Based on the random samples of the aluminum tested, the plateau temperatures of freezing curves of this aluminum should not differ by more than 0.0005 °C from each other, nor by more than 0.001 °C from the assigned temperature. The range of the melting temperatures of the material should not exceed 0.0015 °C.

The metal is in the form of millimeter-size "shot" and is packaged in units of 200 g in the presence of argon in plastic bottles. The shot form of the aluminum minimizes the need to handle the metal during freezing-point cell construction. This material provides a valuable measurement tool for those industries, ranging from aerospace to chemicals, which require accurate temperature standards to monitor a wide variety of industrial processes.

NIST DEVELOPS SRM FOR COMPOSITE FABRICATION

Resin transfer molding is the most promising method to fabricate rapidly and inexpensively large, complex, structural, composites parts. In this manufacturing method, the fiber reinforcement is placed into a closed mold, often as layers of fabric shaped into the form of the part. A liquid resin is then injected into the mold, and heat is applied to convert the resin to a rigid polymer. Proper filling of the mold is critical if the fabrication is to be successful. The critical parameter that controls mold filling is the permeability of the reinforcement. Permeability is a measure of the resistance that the reinforcement offers to infiltration of the resin. Measuring permeability is a difficult task, and a recent industry workshop held at NIST concluded that there was an urgent need for a Standard Reference Material so industries could test and validate their permeability measurements.

NIST has been in the process of generating just such an SRM, and it is now undergoing round robin testing. There are two samples in the SRM package. One is an isotropic material that is easy to test and lets industry develop their technique. The second is a 3-dimensionally woven material which is stable and provides an excellent test of the company's measurement capabilities. This SRM package will become available in the near future.

STANDARD REFERENCE MATERIAL 2084—CMM PROBE PERFORMANCE STANDARD

Over the past two decades, the coordinate measuring machine has matured as a technology for both shop floor and gage lab three-dimensional coordinate metrology. The ASME National Standard B89.1.12M "Methods for Performance Evaluation of Coordinate Measuring Machines" is the *de facto* agreement between the buyers and sellers of coordinate measuring machines. This standard was revised in 1990 to include probe testing, which created a need for a well-designed probe test artifact.

In response to this need, SRM 2084, CMM Probe Performance Standard, was developed to assess the point-to-point probing performance of a CMM. It consists of a precision 10 mm tungsten carbide sphere, mounted on a tungsten carbide stem; a stainless-steel stand (with provisions for mounting the sphere in either a horizontal, vertical, or 45 degree inclination); mounting hardware; storage case; a copy of the ASME Standard B89.1.12M-1990; and a copy of NIST Special Publication 260-120, A Users' Guide to SRM 2084: CMM Probe Performance Standard. The spheres, which are calibrated for both roundness and diameter, are available in two sizes, the standard 10 mm diameter, tungsten carbide sphere, which is included as part of SRM 2084 and an optional 25 mm diameter stainless steel sphere, designated as SRM 2085. Additional 10 mm tungsten carbide spheres can be purchased separately as SRM 2084R.

NEW BLUBBER SRM IS A WHALE OF A STANDARD!

Eskimos have used whale blubber for centuries in cooking. Now, NIST chemists have found another use—as a frozen, powdered Standard Reference Material, or SRM. Fatty tissue, such as whale blubber, concentrates certain organic pollutants like polychlorinated biphenyls, or PCBs, and other chlorine-containing pesticides. Consequently, researchers analyze fatty tissues of marine mammals and fish to monitor pesticides and other pollutants in the environment. Each 15 g sample of Whale Blubber SRM 1945 comes with a certificate for measurements of 42 different pollutants with concentrations ranging from 10 parts to 500 parts per billion. Researchers can use the known concentrations in the SRM to validate their own analytical methods. Blubber for the SRM came from a whale that was stranded on a Massachusetts beach. To order SRM 1945, contact the NIST Standard Reference Materials Program, 204 Engineering Mechanics Building, Gaithersburg, MD 20899-0001, (301) 975-6776, fax: (301) 948-3730.

SRM SUPPORTS MEASUREMENTS OF THICKNESS OF 10-NANOMETER OXIDES ON SILICON

In response to industry requests, NIST has released a new Standard Reference Material (SRM 2536) consisting of silicon wafers having a silicon dioxide layer with a calibrated nominal thickness of 10 nm. Release of the 10 nm standard followed a NIST-directed interlaboratory study in which nine laboratories, including NIST, participated. The level of agreement established by the study demonstrates that requirements for 10 nm thickness control outlined by the Semiconductor Industry Association Semiconductor Technology Workshop Working Group (SIA Roadmap) can be met.

SRM 2536 is the sixth of a set of standards used for the calibration of ellipsometers and other thin-film thickness measuring instruments used in the microelectronics fabrication industry. This series of standards began with the release of 200 nm, 100 nm, and 50 nm oxide thickness standards in 1988, followed by the addition of 25 nm and 14 nm standards in the early 1990s. The timely development and release of the 10 nm oxide thickness as an SRM underscore the support and leadership NIST continues to provide to the semiconductor industry in critical measurement areas.

Standard Reference Data

CHETAH CHEMICAL THERMODYNAMIC AND ENERGY RELEASE PROGRAM UPGRADED

NIST and the American Society for Testing and Materials (ASTM) have combined to release a new database – Version 7.0 of CHETAH. This database is a unique tool for predicting both thermochemical properties and certain "reactive chemical" hazards associated with chemicals and their reactions. For thermochemical estimations, CHETAH is designed to conveniently and accurately calculate properties such as: heat capacity, enthalpy, entropy, and Gibbs energy of reactions as a function of temperature. The output of the "Energy Release Evaluation" option provides information about the ability of a material to decompose with violence if subjected to severe impact. This upgrade is available from the Standard Reference Data Program.

THREE DATABASES RELEASED FOR SCIENCE/INDUSTRY

For more than 34 years, NIST has been providing carefully evaluated data to researchers in science and industry to improve the design efficiency of chemical processes, identify potential toxic substances in the environment, improve materials durability and calculate the performance of chemical reactors. NIST has recently released three products for personal computers:

- The Chemical Thermodynamic and Energy Release Program, known as CHETAH, Version 7.0, (new from NIST) is an important tool for estimating both thermochemical properties and predicting certain "reactivity" hazards associated with a pure chemical, mixture of chemicals, or a chemical reaction. It can help chemical manufacturers, material suppliers and researchers in predicting the performance of chemicals in their custody, including storage, shipping, and use in the laboratory and in manufacturing. CHETAH, NIST Special Database 16, is available for $350.
- The NDRL/NIST Solution Kinetics Database, Version 2.0, (updated) holds information on the rates of 10 800 free radicals derived from more than 14 000 experimental determinations; searches can be made for 17 000 chemical species which are reactants or products. These data are necessary, for example, in predicting the rates of chemical processes such as those involving free radicals. This information can be used to design chemical processes, to study pollution in the environment and to measure the effects of radiation treatments. The data also can be used to study antioxidants for the development of pharmaceuticals and food preservatives. NIST Standard Reference Database 40, NDRL/NIST Solution Kinetics, is available for $265.
- The GRI/NIST Orifice Meter Discharge Coefficient Database, Version 1.0 (new) will be helpful to the owners and operators of gas and oil pipelines, mechanical and petroleum engineers, industrial designers, researchers and others concerned with flow management. The database contains data for five working fluids: air, gas-oil, nitrogen gas, natural gas and water, in orifice meter line sizes from 50 mm to 600 mm. Other information includes meter tube size, surface roughness and pressure tap orientation. In addition to fluids, there are data on installation conditions such as long upstream straight pipe, elbow, tees and reducers at varying positions. NIST Standard Reference Database, GRI/NIST Orifice Meter Discharge Coefficient Database, is available for $240.

To order NIST Special Database 16, and SRDs 40 and 45, contact the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2208, fax: (301) 926-0416, e-mail: srdata@enh.nist.gov (via Internet).

NIST DATABASE 45 NOW AVAILABLE FROM STANDARD REFERENCE DATA PROGRAM

NIST Database 45 (Gas Research Institute/ National Institute of Standards and Technology (GRI/NIST) Orifice Meter Discharge Coefficient Database, Version 1.0) is now available from the Standard Reference Data Program on floppy disk. Database 45 contains over 23000 data points obtained from orifice meter research performed in eight laboratories, using five fluids in orifice meter line sizes of 50 mm, 100 mm, 150 mm, 200 mm, and 600 mm. Those data from orifice meter research that were available in computer-readable format were considered for inclusion in NIST Database 45, but not all of the data were incorporated. Included are data from GRI-sponsored research at

NIST (Gaithersburg and Boulder), Southwest Research Institute (San Antonio, Texas), and Gasunie (The Netherlands). In addition, data obtained at NIST on various-size orifice meters, through work sponsored by the American Petroleum Industry and the Gas Processors Association, as well as data on 50 mm orifice meters that were available from other organizations, are included.

This database provides a convenient, single source of data from the large amount of orifice flowmeter research conducted in recent years. The purpose of that research was to evaluate, update, and possibly combine U.S. and European industrial standards, such as ANSI 2530 and ISO 5167. Pursuant to that, some of these data were used to develop the equation for orifice meters that was adopted by ANSI in 1992, and some will be used to improve guidelines on orifice meter installation in future versions of industrial standards. With continued support, this database will be updated from research on orifice meters as the data become available.