Volume 98, Number 5, September–October 1993
Journal of Research of the National Institute of Standards and Technology

News Briefs

General Developments

Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Administration Building, A635, Gaithersburg, MD 20899-0001; telephone: 301/975-3572.

UNITED STATES, RUSSIA DEVELOP OPTICAL IMAGING SYSTEM

NIST and the Institute of Solid State Physics at the Russian Academy of Science have established a cooperative project to study flux distributions in superconducting materials. A magneto-optical measurement system now being operated at NIST (with the assistance of the Russian scientists who developed it) will be used to study the influence of defects in single crystals and in inhomo- geneities in bulk samples of barium-yttrium-copper-oxygen ceramic materials. A laboratory director at NIST says, "The cooperative project between the United States and Russia enables us to take advantage of a new concept and technology that enhances our broad base of expertise. The system will offer us an opportunity to focus on many fundamental issues in magnetic measurements, optical microscopy and single crystal growth." For information on the magneto-optical measurement system, contact Debra L. Kaiser, A329 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6759.

BIOSENSOR CONSORTIUM ANNOUNCES FIRST MEMBERS

Members of the new Consortium on Advanced Biosensors, six companies and one government agency, are helping NIST launch a new research program to improve biosensor technology. The Environmental Protection Agency has joined the new consortium as an interagency partner. The consortium's goal is to solve problems that prevent commercialization of many biosensor technologies in U.S. industry. Located at NIST, the consortium can take direct advantage of the institute's scientific expertise and laboratory facilities. CAB's first project is studying ways to eliminate background interference from biosensor signals. In this initial research, scientists are examining how positively and negatively charged proteins bind to a dozen different chemical surfaces. Consortium members will select future projects and support them through yearly membership fees. For more information, contact Howard Weetall, Biosensor Technology Group, A353 Chemistry Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2628.

STANDARDS WORKING GROUP PLANS MOSCOW MEETING

Industry and government standard officials concerned about the harmonization of standards and conformity assessment measures between the United States and Russia to improve international trade should plan to participate in the third meeting of the Inter-governmental United States/ Russian Business Development Committee's Standards Working Group. The meeting will be hosted by the State Committee of the Russian Federation for Standardization, Metrology and Certification (GOSSTANDART) in Moscow, May 24-25, 1994. The group also has been invited to meet with the State Committee of Ukraine on Standardization, Metrology, and Certification in Kiev, May 26–27, 1994 and the Standardization, Metrology and Certification Committee, Council of Ministers, in Minsk, Republic of Belarus, May 30. The Standards Working Group is co-chaired by Stanley I. Warshaw, director of the NIST Office of Standards Services, and Serguei F. Bezverkhi, president of GOSSTANDART. To participate in the meetings, contact Warshaw, A603 Administration Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4000, fax: (301) 963-2871.

MODELS MEASURE SPEED OF SOUND FOR GAS MIXTURES

Under the sponsorship of the Gas Research Institute, NIST has gathered comprehensive experimental data on the speed of sound of 13 binary and four multicomponent mixtures of natural gas constituents, and has developed mathematical models (equations) from these data. Knowledge of the speed of sound for specific mixtures of gas can be used to calibrate flowmeters used in the sale and transfer of huge quantities of natural gas. Modeling uncertainty averages 0.1 percent over the range of pressure, temperature, and composition encompassing the major region of custody transfer of natural gas. Temperatures ranged from 250 K to 350 K, with pressures running from below 0.5 MPa to over 10 MPa. The gas mixtures were primarily methane with smaller amounts of ethane, nitrogen, carbon dioxide, or propane. NIST Monograph 178, Speed of Sound Data and Related Models for Mixtures of Natural Gas Constituents is available from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650, for $19.50 prepaid. Order by PB 93-200822.

LOCATION EFFECTS IN ORIFICE FLOWMETERS DOCUMENTED

Orifice meters are used extensively to measure the high-volume flow of fluids (such as natural gas) through a pipe. Asymmetric and swirling flows (caused by nearby upstream bends, tees, or constrictions such as a partially closed valve) can make orifice meters inconsistent, so a flow conditioner of one kind or another is generally placed upstream between the meter and the first disturbance. NIST's latest publication on the subject, Flow Conditioner Location Effects in Orifice Flowmeters (NIST Technical Note 1356), describes experimental results for four kinds of conditioners and two sizes of orifice meters, 52 mm and 104 mm (2 in and 4 in), with various sizes of orifice plates and various degrees of roughness, using nitrogen gas. TN 1356 is available from the National Technical Information Service, Springfield, VA 22161, (703) 487-4650 for $19.50 prepaid. Order by PB 93-159457.

KEY ESCROW ENCRYPTION STANDARD PROPOSED

NIST is proposing a voluntary escrowed encryption standard that will help improve the security and privacy of telephone communications while meeting law enforcement needs. The standard specifies use of the SKIPJACK cryptographic algorithm and a method for creating a Law Enforcement Access Field, or LEAF. The LEAF provides a mechanism needed for authorized government agencies to decipher lawfully intercepted encrypted telecommunications. The proposed standard may be used by federal agencies and others in designing and implementing security products and systems to encrypt sensitive, but unclassified data. Specific operations of the algorithm and the LEAF creation method are classified. They are referenced, but not specified, in the standard. The standard is part of a voluntary key escrow encryption program announced by the White House on April 16. The announcement by NIST and information concerning the applicability, implementation and technical aspects of the standard appeared in the July 30 *Federal Register*.

GUIDE HELPS USERS BUILD OPEN SYSTEMS

More and more organizations are realizing that isolated "islands of computing" are not productive. The ideal computing environment is one in which all products interoperate, data can be easily transferred, applications can be used on a variety of systems, and users can interact with all. Many standards and specifications are needed to define an open system environment, and not all have been written. A new NIST catalog can help managers select available specifications that can be used to move toward an open system environment. The guide covers standards for different functions and services that must work together, from the human interface with the computer to applications and interconnections with networks. Known as the Application Portability Profile guide, this version updates the initial one issued in April 1991. The APP, The U.S. Government's Open System Environment Profile, OSE/1 Version 2.0 (NIST SP 500-210) is available for $6.50 prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, (202) 783-3238. Order by stock no. 003-003-03222-1.

RESEARCHERS HELP CIRCUIT LAYERS "GET IN LINE"

A fast, inexpensive method to calibrate alignment systems for photo- and x-ray lithography equipment has been developed by NIST researchers. The measurement procedure allows semiconductor manufacturers to ensure proper "registration" or alignment of successive layers within an integrated circuit with a precision better than 10 nm. This represents a more than fivefold improvement over current alignment calibration methods. Unlike those techniques that require multimillion dollar optical equipment, the NIST procedure relies on a pair of relatively easy-to-make circuit patterns that a manufacturer overlays to "print" a simple, microelectronic test structure. Electrical measurements taken at several points on the structure allow calculation of its length, and in turn, an assessment of proper alignment. A patent application has been filed. For more information, contact Loren Linholm, B360 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2052.

VOLT STANDARD MARKETED WITH NIST COOPERATION

With the recent signing of a cooperative research and development agreement, NIST has formalized a long-standing relationship with a private company to continue development of commercial Josephson voltage standard systems. NIST developed the original intrinsic voltage standard in the early 1970's using a Josephson junction (a weak contact between two super-conductors that can convert an easily measured microwave frequency into voltage). An array of Josephson junctions, developed by NIST, forms the heart of the systems sold by the private company. Under the terms of the CRADA, NIST will assist the company in improving the voltage standard, configuring it to meet customer requirements, and making products developed from it conform to accepted metrological practice. The company will provide feedback to NIST on the performance of these devices in a commercial environment. For more information, contact Clark A. Hamilton, Div. 814.03, NIST, Boulder, CO 80303-3328, (303) 497-3740.

NEW TEST PLANNED FOR PAINT INDUSTRY'S PALETTE

A government-industry consortium for seeking a better way to predict the service life of paint was proposed by NIST and the Federal Highway Administration at an October 1993 workshop at NIST's Gaithersburg, MD, headquarters. The group's goal will be to help the U.S. paint industry get new, highly predictable products more quickly to market. Because of health and environmental concerns, the chemical makeup and manufacturing processing of paints have changed tremendously over the past decade. However, reliable methods of predicting performance have not kept pace. Current methods rely heavily on outdoor exposure tests that are time-consuming and difficult to duplicate. The proposed consortium will develop an assessment protocol based on the fundamental mechanisms that cause paint degradation and will rely more on short-term laboratory tests. The consortium is expected to start in January 1994. For more information, contact Jonathan Martin, B348 Building Research Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6717.

DNA STANDARD MAKES THE "TOP 100" LIST

A standard developed at NIST to ensure accuracy in forensic DNA analysis has been named one of the "100 most technologically significant new products of the year" by R&D Magazine. Two NIST chemists and a NIST physical scientist were honored for developing the DNA Profiling Standard (Standard Reference Material 2390) at a ceremony on Sept. 9, 1993, at the Chicago Museum of Science and Industry. First made available in August 1992, the NIST DNA Profiling Standard is used by forensic and medical labs that examine patterns in genetic material to calibrate their own DNA profiling techniques. Including this year's honor, NIST researchers have won 75 R&D 100 awards since 1973. To order the DNA Profiling Standard, contact the Standard Reference Materials Program, Rm. 204, Building 202, NIST, Gaithersburg, MD 20899-0001, (301) 975-6776, fax: (301) 948-3730.

NOVEL CHEMICAL CONCENTRATOR MAKES DEBUT

A U.S. patent (5,217,904) has been issued to a physical chemist at NIST's Boulder, CO, laboratories, for a new device that concentrates chemicals faster, more efficiently and cheaper than conventional methods. Such concentrates are used in the analysis of laboratory and environmental samples. The apparatus operates by compressed air, emitting hot and cold air streams from a vortex tube to provide a combination of controlled evaporation and thermal concentration of chemicals. Because it does not require electric heat to concentrate, this method has a number of advantages over current

procedures including greater safety, speed, efficiency, and variety of samples that can be processed (including heat-sensitive chemical compounds). It also is very economical; the cost to produce the concentrator is about one-fourth that of the lowest-priced commercial unit now available. The chemist has used his method successfully to concentrate promising cancer drugs beta-carotene and taxol, and isolate pollutant polychlorinated biphenyls from environmental samples. For more information, contact Thomas J. Bruno, Div. 838.02, NIST, Boulder, CO 80303-3328, (303) 497-5158.

CONSORTIUM TO HELP BUILDING SYSTEMS COMMUNICATE

NIST is looking for partners for a cooperative research and development consortium to help test the BACnet standard communication protocol. BACnet—*B*uilding *A*utomation and *C*ontrol *Net*works—will allow building control systems from different manufacturers to communicate and work together. Currently, different systems (such as those for energy management and control, security, fire detection, and telecommunications) use proprietary protocols which make interactions almost impossible. Consortium members will develop prototype control products or software which implement BACnet, or tools for developing and testing the implementations. Tests for the 2 year program will be conducted at NIST. BACnet, developed by NIST and building industry experts, has been published as a draft standard by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. For further information, contact Steven Bushby at (301) 975-5873.

PLAN ANNOUNCED TO HARMONIZE U.S. LABS

In a major effort to improve the acceptance of U.S. products in foreign markets, NIST is proposing to make the National Voluntary Laboratory Accreditation Program fully compatible with international standards, both those used by other accreditation systems in the European Community and worldwide for lab accreditation and quality systems management. NVLAP procedures will be revised and expanded to include calibration labs; to ensure compatibility with conformity assurance and assessment concepts; and to assure accreditation with relevant ISO documents (such as ISO Guide 25, General Requirements for the Technical Competence of Testing Laboratories and the ISO 9000 Standard Series on quality management and assurance). For information on the proposed changes to the federal regulations on NVLAP procedures, contact Albert D. Tholen, NVLAP, A162 TRF Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4016, fax: (301) 926-2884.

NOW HEAR THIS: SOUND USED FOR CLEANER BURNS

Most commercial and industrial burners ignite fuel supplied through pressurized nozzles. The nozzles atomize the fuel stream into tiny droplets for better combustion and less pollution. A new way of atomizing fuel with sound waves could improve efficiency and reduce emissions even more. NIST and a private company recently signed a cooperative research and development agreement to investigate high-power acoustic nozzles. These devices can provide droplets of known size and distribution from a high-quality orifice plate or even from commercial pressurized nozzles. Researchers plan to study whether these nozzles are feasible for combustion systems. Tests at the NIST Spray Combustion Facility will check spray characteristics, flame stability, and emission levels. The research is part of a NIST program to design more fuel-efficient and environmentally acceptable combustion systems for U.S. industry.

MAJOR BARRIER TO ADVANCED MATERIALS IDENTIFIED

More than 250 people from 12 countries met at NIST recently to strengthen communications and technology transfer among researchers and engineers involved in ceramics and composites machining. The high cost associated with machining and finishing was identified as a major barrier to the use of these materials in commercial components. It was concluded that development of new machining technologies for advanced materials requires interdisciplinary research and collaboration between industry, government, and universities. The conference proceedings, Machining of Advanced Materials, Proceedings of the International Conference on Machining of Advanced Materials, July 20-22, 1993 (NIST SP 847), contains 48 papers on machining and finishing techniques, surface quality, cutting tools, precision grinding, and other topics. Copies are available prepaid for $33 from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325, (202)783-3238. Order by stock no. 003-003-03218-2.

GATT STANDARDS ACTIVITIES REPORTED FOR 1992

The annual report, GATT Standards Code Activities of the National Institute of Standards and Technology 1992 (NISTIR 5194), describes the NIST Standards Code and Information Program's role in supporting industry with information on standards and certification information activities that might affect U.S. trade. SCIP operates the U.S. inquiry point for standards and certification information in support of the General Agreement on Tariffs and Trade, or GATT, Standards Code. For 1992, SCIP received and processed 394 notifications of proposed regulations; reported 20 proposed U.S. technical regulations to the GATT Secretariat in Geneva, Switzerland; and responded to more than 8500 inquiries on the existence, source, and availability of standards and related documents. SCIP also operates a GATT hotline on proposed foreign regulations (301) 975-4041, and a European Community hotline with information on draft EC documents (301) 921-4164. To obtain the report, send a self-addressed mailing label to SCIP, A163 TRF Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4037.

NEW SOFTWARE SIMPLIFIES SEMICONDUCTOR MEASUREMENTS

Two-probe (spreading) and four-probe resistance measurements are important for determining a semiconductor's resistivity profile (electrical activity). A new report and corresponding software package known as RESPAC provides users with a simplified means of accomplishing this critical measurement. Consisting of ten FORTRAN77 programs, the RESPAC software may be used to calculate the two-probe resistance from the resistivity profile, the resistivity profile from the two-probe resistance, and the four-probe resistance from the resistivity profile. The report, Semiconductor Measurement Technology: A Collection of Computer Programs for Two-Probe Resistance (Spreading Resistance) and Four-Probe Resistance, RESPAC (NIST SP 400-91), supplies background material enabling the reader to make optimal use of the software package. Single copies of NIST SP 400-91 and the RESPAC programs are available by contacting John Albers, B310 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2075, fax: (301) 948-4081, and email via the Internet system (albers @sed.eeel.nist.gov).

CRYOGENIC ALLOY NOW AVAILABLE FOR LICENSING

Welding seams in magnet cases and other components of superconducting magnets must remain fracture-resistant in the cryogenic temperatures (4 K to 77 K) in which such magnets operate. NIST researchers have developed a new technology which, when incorporated into a consumable welding electrode, produces a strong alloy that achieves the needed durability. The alloy contains nickel, chromium, manganese, molybdenum, copper, nitrogen, and iron. It remains very ductile and provides a yield strength of 900 MPa at cryogenic temperatures. This is two to three times stronger than conventional construction steel at room temperature. For technical information, contact Thomas Siewart, Div. 853.07, NIST, Boulder, CO 80303-3328, (303) 497-3523. For licensing information, contact Mike Blaney, Office of Technology Commercialization, B256 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2870.

NEW FACILITY DESIGNED FOR BETTER ANTENNA ASSESSMENTS

Aerospace and defense-oriented companies will be interested in a new, multipurpose antenna facility recently put into operation at NIST's Boulder, CO, laboratory. It is used to perform extrapolation gain, probe pattern, spherical near-field, cylindrical near-field, and polarization measurements. The frequency range is from 1 GHz to 75 GHz. The facility has 10 m long horizontal rails for gain measurements using the NIST-developed extrapolation technique. At this length, gain calibrations at 1 GHz can be performed on antennas with apertures as large as 1 m. Another setup allows antennas up to 2 m in length to be accommodated for probe pattern measurements and also permits spherical near-field measurements on antennas up to 3.5 m in diameter. A set of 6 m long vertical rails allows cylindrical near-field measurements on antennas up to 3.5 m in diameter. For more detailed information on the new facility, contact Sarabeth Moynihan, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-3237. Ask for paper no. 31-93.

1993 WEIGHTS AND MEASURES LABS DIRECTORY PUBLISHED

State and other labs accredited by the NIST Office of Weights and Measures are listed in State Weights and Measures Laboratories: State Standards Program Description and Directory, 1993 Edition (NIST SP 791). The publication serves as 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. The directory lists a lab's accreditation period; general data such as address, telephone/fax number, and names of staff members; services available; and fees for services. Accreditation requirements currently are being revised to include the adoption of ISO Guide 25. Most accredited labs will 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. Order by stock no. 003-003-03220-4.

ATOMIC-LEVEL DEPOSITS PROMISE SOLID RETURNS

NIST has installed a unique, state-of-the-art chemical beam epitaxy system at its Boulder, CO, laboratory. The CBE is a high-tech, computer-controlled vacuum system that uses thermally vaporized solid elements, metal-organic liquids, and gas chemicals as sources for creating semiconductor materials with specific electronic and optical properties for advanced optoelectronic devices. With the CBE, elements can be deposited, as precise crystalline forms, uniformly over large areas while monitoring the growth of individual atomic layers. The elements of primary interest are aluminum, gallium, indium, arsenic, and phosphorous—all basic ingredients for optoelectronic devices such as semiconductor diode lasers and optical detectors. NIST's role is to provide metrology support for the optoelectronic industry. The CBE machine will be used to: (1) develop metrology to support the actual crystal growth process, (2) make specific structures to evaluate new metrology concepts and (3) make unique devices not otherwise available but required for advanced metrology and measurement standards. For more information, contact Mark McCollum, Div. 814.02, NIST, Boulder, CO 80303-3328, (303) 497-5167.

RESEARCHER WINS TURKEY'S HIGHEST SCIENCE AWARD

A NIST scientist received the Republic of Turkey's highest scientific honor in an award ceremony in Ankara on Sept. 6, 1993. A 12 year veteran of NIST (and its predecessor, the National Bureau of Standards), the scientist has been investigating the chemical mechanisms of DNA damage for more than 2 decades. The Scientific and Technological Research Organization of Turkey recognized the Turkish-born scientist for his research on DNA damage by free radicals, molecules believed responsible for certain cancers and other diseases. He also has developed a method for identifying and assessing molecular-level damage to DNA in cells and organs. "If you're able to understand the mechanisms of DNA damage and repair, you could potentially develop the necessary means to prevent or repair the DNA damage in cells," the scientist explains. A naturalized U.S. citizen, the scientist also received the 1989 Hillebrand Award of the American Chemical Society.

PROPOSALS SOUGHT FOR PRECISION MEASUREMENT GRANTS

NIST is seeking project proposals for its 1995 Precision Measurement Grants. The grants are for $50,000 for 1 year and may be renewed for up to 2 additional years. Prospective candidates must submit summaries of their proposed projects and biographical information to NIST by Feb. 1, 1994, to be considered for the current grants, which will run from October 1994 through September 1995. The Precision Measurement Grants are awarded each year to scientists in U.S. academic institutions for work in determining values for fundamental constants; investigating related physical phenomena; or developing new, fundamental measurement methods. For further information, contact Barry N. Taylor, B160 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-4220.

DATA TABLES ON ETHANE PROPERTIES AVAILABLE

NIST's study of the thermophysical properties of fluid ethane has been documented in several forms: as an equation of state and a limited number of tables based on critical analysis of the best experimental data in the literature [J. Phys. Chem. Ref. Data, **20**(2), 275-347 (1991)]; as a companion publication with more complete tables and extensive graphical comparisons between the data

and correlating equations (the 1990 NIST Technical Note 1346, Tables for the Thermophysical Properties of Ethane); and now, as the complete tabulation of the data considered in the study. This latest publication, Tables of Experimental Data Used for the Correlation of the Thermophysical Properties of Ethane (NISTIR 3953), includes comparisons between the data and the correlations, and the weight assigned to each point during the latter's development. Properties considered include vapor pressures, densities of saturated liquid and vapor, the pressure-vapor-time relationship in the single phase, isochoric and isobaric heat capacities, sound speed, viscosity, and thermal conductivity. The general range of the data is from the triple, point temperature near 90.4 K to about 625 K, and for pressures to 100 MPa. Both NISTIR 3953 and TN 1346 are available from the National Technical Information Service, Springfield, VA 22161, for $44.50 each. Order by PB 93-173417 (NISTIR 3953) and PB 93-160786 (TN 1346).

FIRST PRODUCT SUCCESSFULLY MACHINED USING STEP

An automobile connecting rod doesn't sound like something that would make history, but one designed and built by a major automobile manufacturer and the Department of Energy's AlliedSignal Kansas City Plant recently did. The engine part was the first product created using STEP (Standard for the Exchange of Product model data). The new technology enables companies to express and share a product's design, manufacturing, and support processes via computer in a three-dimensional standard format. STEP, whose U.S. development has been primarily coordinated by NIST, was approved as a draft international standard in February by the International Organization for Standardization. The automobile manufacturer's engineers hope to use STEP to improve processes for powertrain design and manufacture, ultimately reducing current automotive engine design lead time and development costs by an estimated 25 percent. The automobile company, AlliedSignal, the Commerce Department, and the Department of Energy are members of the National Initiative for Product Data Exchange, an industry-led organization established to accelerate digital product data exchange development and use. NIPDE is hosted by NIST.

NIST MEASUREMENT TECHNOLOGY GOES TO MARKET

Prototypes of a NIST-developed measurement technology played well in Peoria—at a private company's Technical Center there—and now an equipment manufacturer says the technology is ready for market. The equipment manufacturer recently announced it is commercializing NIST's novel interim testing standard device for assessing the performance of coordinate measuring machines, which firms use to check the dimensions of manufactured parts and assembled products. Typically, companies calibrate their CMM's about once a year, but without periodic checks between calibrations, they cannot be certain that their machines are continuing to measure accurately. If not, firms may reject parts that are within tolerance limits or let unacceptable parts slip through. The NIST invention consists of inexpensive, calibrated ball bars (two steel spheres connected by a steel bar) kinematically mounted on an arm that can be rapidly rotated throughout most of a CMM's three-dimensional work zone. A complete system check-out can be completed within 15 min. Under a cooperative research and development agreement, a private company tested several prototypes of the interim standard, providing the NIST inventors with feedback that led to improvements in subsequent versions. The NIST work was supported by the U.S. Air Force, the U.S. Navy, a private company, and an equipment manufacturer.

CRADA SETS PLANS FOR ATOMIC MICROCLOCK IN MOTION

Imagine a clock with atomic accuracy, roughly the size of a cube 10 cm on each side and running on only half a watt of power. The development of such a device is under way, thanks to a cooperative research and development agreement between NIST and a private company. The company's Science and Technology Center in Pittsburgh has already built and tested a prototype miniature atomic clock that runs on electricity. However, the stability is poorer than predicted. Under the CRADA, NIST, which pioneered the development of atomic clocks, will work with the private company on resolving the stability issue. NIST also will assist the company with measurements to ensure that the company's specifications are met. As a result of their efforts, the partners hope to

better understand the physics and electronics associated with producing a tightly packaged clock. NIST expects to learn generic fabrication and processing methods that will be helpful in developing future primary frequency standards. The company has identified many commercial and military systems that would benefit from a miniature atomic clock. For technical information, contact Bob Drullinger at NIST at (303) 497-3183 or Irving Liberman at Westinghouse at (412) 256-1571. For marketing information, contact David Leksell at (412) 256-1467.

NCWM TO WORK ON PRICE ACCURACY IN RETAIL STORES

In response to nationwide concern about price accuracy in retail stores, the National Conference on Weights and Measures has established a Working Group on Price Verification. The aim will be to develop a field handbook for officials to use in verifying the accuracy of advertised prices. Recent national news stories have accused both retailers, and state and local weights and measures officials of failing to ensure that posted prices match advertised and "scanned" prices, and have called for tougher inspection standards. To address this important issue, NCWM invited state and local weights and measures officials as well as business representatives to participate in an effort to develop uniform price accuracy test procedures. Plans call for a final report to be ready for adoption by NCWM at its 79th Annual Meeting, San Diego, CA, in July 1994. For information, contact Ken Butcher, Office of Weights and Measures, A617 Administration Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3991, fax: (301) 926-0647.

PARTNERS TO DEVELOP POWERFUL TUNABLE LASER

NIST and a private company have signed a cooperative research and development agreement to develop frequency-tunable diode lasers for a variety of commercial applications, including pollution monitoring and isotope detection. The company is a world leader in high-power laser diode technology, and NIST is a leader in using diode lasers for scientific applications. NIST has developed several low-power, tunable laser diode prototypes; however, their performance has been limited by designs not optimized for frequency-tuning applications. The goal of the collaboration is to custom-fabricate a broadly tunable (over 10 nm) external cavity semiconductor laser with narrow linewidths (less than 500 kHz) and high power (20 mW). The program has three aspects: development of high-power laser diodes suitable for implementation into the external cavity; development of optomechanical designs that are compact, stable, and efficient; and optical characterization of the external cavity laser. For more information, contact Leo Hollberg of NIST at (303) 497-5770 or David Welch of SDL at (408) 943-9411.

NEW DEVICE PRECISELY MEASURES HYDROGEN IN METALS

Failed turbine blades, fouled silicon chips, faltering superconductors. Blame them on hydrogen, an element that can embrittle metals in high concentrations. Chemists at NIST's Cold Neutron Research Facility have developed an instrument for nondestructive measurement of hydrogen and other elements. Their method, called cold neutron prompt gamma activation analysis, determines the trace hydrogen content of a sample without the disadvantages of other measurement techniques. The U.S. Air Force recently asked NIST to determine the levels of hydrogen in titanium-alloy turbine blades that had broken. Cold neutron prompt gamma activation analysis revealed that one turbine blade contained two to three times as much hydrogen as another blade from the same engine. In other tests of the new method, NIST chemists have measured hydrogen in advanced materials such as fullerenes, quartz crystals, and silicon wafers. Many of these measurements were made on request for U.S. companies. For technical information, contact Rick Paul, B125 Reactor Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6287.

ANTENNA SOFTWARE MEASURES "NEAR AND FAR"

NIST researchers have developed a new software package that allows scientists, engineers, and programmers to make complex antenna computations on any IBM RISC (Reduced Instruction Set Codes) machine. The package, named "Planar Near-Field Codes," provides analysis of near-field antenna data to obtain the far-field data; it also corrects near-field data for probe position errors. The software was transferred to the RISC systems under a developer's contract. This package is an adaptation of an earlier one designed for personal computers. To order either package, contact Lorant A. Muth, Div. 813.08, NIST, Boulder, CO 80303-3328, (303) 497-3603.

NIST LEADS INDUSTRY TO RESOLVE PROBLEMS IN DETERMINING LASER BEAM SPATIAL PARAMETERS

NIST scientists have conducted and analyzed the results of an interlaboratory comparison to test the current International Standards Organization (ISO) procedure for determining laser beam spatial parameters, which characterize the propagation of the beam. In the round-robin experiment, six manufacturers of laser beam profilers measured the same laser, each using its own measurement method for, and definition of, beam diameter, and then applied the ISO procedure to the resulting data. NIST presented the results as an invited paper at the recent SPIE OE/Technology conference in Boston, including the surprising result that values for the calculated spatial parameters disagreed by as much as 380 percent (relative standard deviation). By contrast, the beam diameter measurements agreed to within a few percent.

These results catalyzed the ISO committee to revise its procedure and to redefine laser beam diameter, and in a subsequent meeting, the committee decided that NIST should conduct a second round robin to test the revised procedure and that this intercomparison should be international in scope. At that meeting NIST presented preliminary results of a propagation-of-errors analysis of the original ISO procedure, showing that the uncertainties resulting from its application could be halved by using an alternative calculational procedure. This work has been completed and can be applied in the revised procedure. A paper has been accepted for publication in the journal Optical and Quantum Electronics.

NIST, SANDIA COLLABORATE TO DEVELOP TOOLS FOR EVALUATING THERMAL PERFORMANCE OF SEMICONDUCTOR DEVICE PACKAGING

NIST scientists are collaborating with their counterparts in Sandia National Laboratories in the development of new tools for evaluating the thermal performance of the packaging of semiconductor microelectronic chips. This is one of the first projects undertaken in the context of the technical agreement signed by the two organizations earlier this year. In the collaboration, NIST and Sandia will separately and jointly design test chips, Sandia will fabricate them from the design information, and NIST will develop test methods for applying them. Both laboratories will participate in test-chip evaluation. Thermal performance considerations are vital to advanced semiconductor device design: no matter how excellent the chip, if the heat generated by its operation is not removed by the packaging, it will fail. The first stage of the collaboration is concerned with a special test chip—one of a class of "assembly test chips"—developed by Sandia and applied to the characterization of the thermal properties of various die-attach materials. Sandia has encountered some difficulty in interpreting the results and sought the benefit of NIST expertise in test structure methodology. As a result, NIST scientists have developed measurement methods and techniques, including a special constant-power circuit, for using this chip and evaluating its performance. The data from the NIST measurements show that the chip can be significantly improved through redesign to reduce parasitic resistances. Sandia is beginning the redesign and is replicating the constant-power circuit. A NIST goal of the overall effort is to supply to industry evaluated test chips for packaging characterization for sale in the Standard Reference Material mode.

NIST MEASUREMENTS OF ION KINETIC ENERGIES FROM RF PLASMAS PROVIDE BASELINE DATA FOR SEMICONDUCTOR PROCESSING

In support of advanced plasma processing steps coming into use in the semiconductor industry, NIST researchers have completed an extensive set of measurements of the kinetic energy of ions sampled from radiofrequency glow discharges. These energies represent a key parameter determining etching rates, and industry is developing instruments to monitor ion energies in real time as part of the plasma diagnostics needed for manufacturing control. The NIST project supports these developments by characterizing and calibrating the performance of the resulting diagnostic tools and by correlating electrical parameters measured by other methods in order to obtain a better understanding of the physical processes involved.

The researchers determined kinetic energies of ions from radiofrequency discharges generated in argon, helium, and hydrogen and in mixtures of argon-helium, argon-oxygen, helium-nitrogen, and argon-hydrogen in a reference parallel-plate discharge cell having well-characterized electrical parameters. These gases and gas mixtures were chosen because they are representative of gases used in plasma processing and because the cross sections and rates describing the kinetic processes occurring in the plasmas are well enough known

that observed changes in ion energy distributions can be related to changes in plasma conditions. Developing effective control for processes such as etching requires predictive models; the team's data provide means for testing the validity of various models proposed. Of particular interest to practical applications, the team made an unexpected discovery: ion energy distributions measured through an electrode agree well with those measured from the side of the plasma. This finding suggests that the methods used may be applicable to many different types of plasma reactors. The team has reported on its results to industry at five conferences and through three archival publications.

NIST CONTRIBUTES TO DEVELOPMENT OF PROTOTYPE SOFTWARE SUPPORTING COMPUTER DESIGN OF HIGH-POWER MICROWAVE TUBES

NIST scientists have been asked by the Microwave and Millimeter-Wave Advanced Computational Environment program (MMACE) to participate in the development of software protocols and interfaces in support of the design of high-power microwave products. A Tri-Service/Advanced Research Projects Agency program, MMACE goals include maximizing the effectiveness of the design process, improving the quality of products, and generally reducing the cost of doing business, especially as applied to a niche market. In Phase One, four contractor teams have written software to serve as a framework of information exchange standards to support the design and modeling of high-power microwave vacuum tubes by means of various application programs. Phase Two will result in an integrated software product that has been evaluated at a number of sites. NIST has provided the teams and the project technical director guidance and consultation based on expertise in software standards development and knowledge of the state of relevant standards in place or under development.

For example, a NIST scientist has analyzed software development plans, identified potential problems with proprietary and acceptance issues, and steered work in directions more likely to lead to general use. The problem addressed by the MMACE project is that individual application programs have been developed as independent entities with program-specific requirements for data format and entry. Thus separate packages model magnetic circuits (magnetostatic and magnetoinductive codes), electron optics (electrostatic and electromagnetic codes), electron beam interaction with radiofrequency fields (helix traveling-wave tube and electro-magnetic particle-in-a-cell codes), thermal energy transfers and states (finite-element codes), and mechanical characteristics (also finite-element codes). An agreed-upon standardized framework will provide a basis for specifying interfaces and protocols that individual software programs will have to meet. Data formats resulting from device design processes then will be compatible with each other, with data formats supporting device manufacturing, and with data formats needed by the designers of equipment incorporating the device.

AFM MAPS OBSERVE NEW DEPOSITION PROCESS

News of a new high-resolution deposition process was highlighted in a news article in the June 1993 issue of Laser Focus World. The process was observed using an atomic force microscope (AFM). One of the AFM images is shown in that article.

The process involves laser-assisted metallic-vapor deposition and was developed by NIST scientists. They produced a fine grating-like structure with 212 nm periodicity and linewidths approximately 50 nm across.

The AFM measures surface topography at higher lateral resolution than traditional stylus or optical instruments. With a tip size in the range of 10 nm and a contact force in the range of 10 nN, the AFM generated a topographic image of the grating, and features to the 10 nm scale were visible. In addition to viewing the image, the AFM provides dimensional measurement in three directions. The measured area can be up to 80 μm by 80 μm in size. The dimension of the sample is not constrained, and the probe on this AFM can position on any part of a flat sample. In addition, it does not require a vacuum system, so turnaround time is fast. The AFM can also measure insulators unlike the counterpart scanning tunneling microscope, which is limited to measuring conducting surfaces only. Therefore, NIST's AFM has been an ideal tool for testing the results of the experimental deposition process, so that it could be optimized.

SEA-VIEWING RADIOMETER DEVELOPED

A high-accuracy portable transfer radiometer (SXR) for the SeaWiFS (Sea viewing Wide Field Spectrometer) project was designed and characterized at NIST. The SeaWiFS project is an ocean color remote-sensing project to study ocean biology in the first 10 m of water. The project includes a satellite instrument to be flown in 1994 and a large network of ocean-based spectroradiometers to measure down-welling and up-welling irradiance below the ocean surface in field studies. Some of the radiative transfer measurements derived through the network include aerosol samples, temperature and saline profiles, phytoplankton pigments, total suspended material concentration, and airborne fluorescence and radiances.

The development of the SXR was sponsored by NASA Goddard Space Flight Center and was used in June 1993 in an intercomparison of laboratory calibration sources at the Center for Hydro-Optics and Remote Sensing at San Diego State University. Participants included NASA, NIST, two universities, and two private companies. Through round-robin intercomparisons the SXR will verify the radiometric output of sources used to calibrate the satellite and ground-based instruments used throughout the SeaWiFS project. This will serve to improve the accuracy and long-term consistency of data produced by the SeaWiFS project over the mission lifetime of 5 years. NIST has also been asked to develop a rugged calibration source for shipboard calibration and verification of submersible spectrometers during field studies.

NEW IONIZATION SOURCE DEVELOPED FOR MASS SPECTROSCOPY

At NIST, a glow discharge cell has been coupled to a resonance ionization mass spectrometer system (RIMS) and the production of ions and atoms demonstrated. This source allows the direct analysis of solid materials and represents a first step in our goal to achieve direct compositional analysis of environmental materials without chemical processing. Potential advantages of the glow discharge source over other atomization sources are its simplicity, its applicability to direct analysis of conductors with wide coverage of the periodic table, and its sensitivity.

The glow discharge source consists of a cylindrical stainless steel cavity held at approximately 67 Pa of argon with a rod of sample material inserted from one end. A plasma is developed at the inside end of the rod by impressing a 1000 V potential drop between the cavity wall and the rod. Neutral atoms are sputtered from the sample by bombardment of ions within an argon ion plasma, after which they are selectively ionized by means of carefully tuned lasers, and then mass analyzed in a double-focusing mass spectrometer.

A sample containing 95 percent aluminum and 5 percent iron has been examined. The ion source was operated in two modes: using glow discharge ions and using RIMS ions. The glow discharge ions gave a clean spectrum but with an enhanced peak at mass 54 corresponding to aluminum interference. The interference was completely removed in the RIMS spectrum because of the selectivity of the laser.

Work is continuing toward improvement of the selectivity and sensitivity by dramatically increasing the duty cycle with high-frequency and cw lasers.

MISSING LINK IN FISSION SYSTEMATICS FOUND

A long-standing problem in understanding the systematics of nuclear fission has been resolved by measurements carried out by a NIST scientist in collaboration with scientists from the Los Alamos and Oak Ridge National Laboratories. Missing in all earlier measurements of the neutron-induced fission of ^{236}U was a subthreshold structure in the fission probability predicted by the double-humped barrier of fission theory. This breakdown of fission formalism was difficult to understand since the expected structure is observed for fissionable nuclides of similar neutron-proton pairing.

The new measurements, using targets of very high isotopic purity and using highly selective fission fragment detection, found the expected intermediate structure in the difficult subthreshold regime of small fission probability. The new data place the anomalous ^{236}U nucleus where it belongs in fission systematics based on the well-established, two-potential-well theory of nuclear fission. The fission detectors in the experiment, a NIST specialty, were the key. They provided the needed level of discrimination against interfering radiation now believed to be the major cause of the erroneous results in earlier work. These specific experiments are part of a larger effort to establish reference and standard neutron interaction data for the design and safe operation of electric power generation systems and for medical therapy applications.

LASER IONIZATION MONITORING PROMISES NEW DIAGNOSTIC OF SEMICONDUCTOR GROWTH

Precise control of the purity and concentration of materials deposited under high vacuum during semiconductor growth is a significant factor in the "art" of fabrication processes. Lack of control of fluxes in the deposition processes can result in high failure rates and defects, and in poor junctions. At NIST an important recent technological advance was the successful incorporation of 118 nm laser ionization detection (10.5 eV per photon) into a molecular beam epitaxy (MBE) reactor. A patent has been filed on the application of this technique to commercial MBE reactors. The laser source is used to produce selective, single photon ionization of gaseous fluxes of Ga, In, As_4, As_2, and As species; the ions are detected by a time-of-flight mass spectrometer. This new laser technique affords a major new non-intrusive optical tool for the study and control of epitaxial growth. The ability to continuously and individually monitor the gas phase species involved in growth of III-V and II-VI semiconductor materials is particularly important for process control. The incorporation of non-invasive probes into advanced generations of MBE machines would make it possible to carry out in situ diagnostics to quantify and characterize the growth process, to provide optical feedback for adjustment of species concentrations, and to determine the purities of materials used during semiconductor fabrication.

NIST RESEARCH ASSOCIATES LICENSE BONE REPAIR/REPLACEMENT MATERIAL

The American Dental Association Health Foundation has licensed a hydroxyapatite bone repair and replacement material developed by research associates at NIST. The material is currently completing FDA evaluation for neurosurgical and maxillofacial applications and is expected to be marketed within the next 2 years. The cement greatly simplifies surgical procedures by repairing bone defects with a biocompatible material very similar in chemistry to natural bone. Once in place, the cement becomes a template for new bone development as it is resorbed and replaced by new bone. Its use would eliminate the need for additional surgery to harvest graft material elsewhere from the patient or the use of less satisfactory alloplastic materials. This surgical bone repair material was developed under an ongoing Cooperative Research and Development Agreement between NIST and the American Dental Association Health Foundation.

CLASSIFICATION SYSTEM FOR ADVANCED CERAMICS DEVELOPED BY INTERNATIONAL COLLABORATION

An international effort chaired by a NIST scientist, and conducted under the auspices of the Versailles Project on Advanced Materials and Standards (VAMAS), produced a classification system for advanced ceramics that meets the prescription set by the worldwide ceramics industry. VAMAS, operating under a memorandum of understanding between Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the Commission of the European Communities, supports precursor technical projects leading to advanced materials standards. The classification system as developed is built upon a non-hierarchical, matrix-type scheme accessible by a number of entry routes to build relational databases. The system identifies 500 different advanced ceramic product classes, sortable by a machine-readable coding system comprised of four independent descriptor fields: A—application, C—chemical/form character, P—processing, and D—property data. The system's design makes it multifunctional to meet the classification needs of individuals, companies, industries, and governments alike.

PHASE TRANSITION PUZZLE CLARIFIED

A collaborative study involving scientists from NIST and Brookhaven National Laboratory has provided the answer to a fundamental question concerning phase transitions in crystals. When a crystal is brought close to its transition temperature T_c, small regions of the crystal undergo thermally induced fluctuations into and out of the low-temperature ordered phase. A central feature of the theory of second-order phase transitions is that the average size of these regions can be characterized by a single correlation length which diverges at T_c. In 1986, high-resolution x-ray scattering experiments found that the cubic to tetragonal structural phase transition in $SrTiO_3$ exhibited two correlation lengths instead of one. This startling result motivated an intense study of this and various other systems possessing both structural and magnetic phase transitions, the results of which suggested that two correlation lengths may be a feature common to all phase transitions in condensed matter systems. Available experimental techniques could

not provide further clarification: x rays, which probe crystal surfaces to a depth of order 1 μm, could not show if it is absent in the crystal bulk; neutrons, which do probe the bulk, were not able to separate surface and bulk contributions.

The recent experiments at NIST utilized high-resolution neutron scattering at the reactor's BT7 reflectometer to study a cube-shaped single crystal of Tb, which exhibits a transition to a magnetically ordered spiral phase. By using a 300 μm wide beam, very thin slices of the Tb crystal could be isolated and studied by translating the sample through the beam. The results show that the origin of the second correlation length lies in the near-surface volume or "skin" of the Tb sample, and not in the bulk. In this context the meaning of skin is distinct from that of surface since the second correlation length is spread over several hundred μm and not just one or two.

As yet, a satisfactory microscopic explanation for this phenomenon has not been formulated. One model suggests that extended crystal defects such as dislocations might produce a second correlation length. Another possibility is that the phenomenon results from the boundary condition imposed by the crystal surface on the interaction driving the transition. The unique facilities available at the reactor will be used in future experiments in an effort to further resolve this important and fundamental question.

SIMULTANEOUS MEASUREMENT OF SOOT VOLUME FRACTION AND TEMPERATURE IN FLAMES

Radiative heat transfer governs burning and flame-spread rates in fires and, therefore is a key factor in assessing potential fire hazards. The radiative heat feedback from a flame to the fuel surface is controlled by the temperature and soot concentration distribution inside the flame. NIST scientists have evaluated the performance of a new *in situ* technique for measuring soot volume fraction and temperature developed by colleagues at the University of Maryland under grant from BFRL. The method involves determination of the temperature and soot volume fraction from two-line (900 nm and 1000 nm) emission measurements and an independent determination of the latter from a third-line (632.8 nm) laser extinction measurement. For a premixed, fuel-rich ethylene/air flame of varying equivalence ratio, good agreement was obtained with previously published data. However, the soot volume fractions measured by the two methods differed. Further experiments demonstrated that this was not due to scattering by the soot or to light absorption by large molecules. The agreement between the two values improved when extinction measurements were performed with longer wavelength light sources. This observation, combined with a strong sensitivity to the refractive index at shorter wavelengths, leads to a recommendation that future soot volume fraction measurements be made with a light source such as a 1523 nm He-Ne laser. A paper has been submitted to Combustion and Flame.

APPLICATION PORTABILITY PROFILE (APP) GUIDE REVISED

Computer system users need open systems that provide interoperability of products and portability of people, data, and applications throughout heterogenous computing environments. NIST Special Publication 500-210, APP, The U.S. Government's Open System Environment Profile OSE/1 Version 2.0 (known as the APP Guide), provides recommendations on a variety of specifications that fit the requirements of U.S. government systems. The APP integrates industry, federal, national, international, and other specifications into a federal application profile to provide the functionality necessary to accommodate a broad range of federal information technology requirements.

The revised document assists federal agencies in making informed choices regarding the selection and use of Open System Environment specifications and in developing more selective application profiles based on the APP. The report targets managers and project leaders who acquire, develop, and maintain information systems supported by heterogeneous computing environments.

NIST SUPPORTS THE DEPARTMENT OF DEFENSE COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS) INITIATIVE IN COMPUTER GRAPHICS

To meet CALS conformance test requirements, NIST developed validation test services for testing metafiles and generators for conformance to Federal Information Processing Standards (FIPS) 128-1, CGM, and the CALS CGM application profile, MIL-D-28003. NISTIR 5191, Computer Graphics Metafile (CGM) Test Requirements Document, updates the initial test requirements document to include new functionality and additional require-

ments resulting from revisions to the standard and the CALS CGM profile. The updated conformance test suite and tools ensure that a CGM product correctly implements FIPS 128-1 and its associated application profile. NIST is also developing a test service for interpreters in support of CALS.

FIPS FOR MASSACHUSETTS GENERAL HOSPITAL UTILITY MULTI-PROGRAMMING SYSTEM (MUMPS) PROGRAMMING LANGUAGE REVISED

The Secretary of Commerce recently approved a revision to FIPS 125, MUMPS, which will be published as FIPS 125-1. Now known as M Technology, the MUMPS language was developed at Massachusetts General Hospital in 1969 and has been adopted for use in government health care systems. The standard promotes the portability of MUMPS programs for use on a variety of computer systems. FIPS 125-1 adopts American National Standard for MUMPS, ANSI/MDC X11.1-1990, which was developed by industry and users. NIST is developing a validation suite to test MUMPS language processors for conformance to the standard.

NIST/ASA/NSF FELLOW DEVELOPS NEW STATISTICAL METHODS FOR MANUFACTURING PROCESS QUALITY ASSURANCE

A NIST visiting research fellow, and a NIST scientist have developed new statistical methods for manufacturing process quality assurance. In particular, they proposed a new statistical model for measurements collected on the circumference of circular features using a coordinate measuring machine. The statistical model is motivated by hole location problems of the automobile gear carrier manufacturing process. The model takes into consideration the variability of center locations in a series of machined parts. Statistical procedures were developed to assess the performance of the manufacturing process in producing parts that conform to design specifications, and to keep track of the trend of the manufacturing process over time.

In related work, the researchers developed new statistical procedures for estimating the proportion of conformance of a manufacturing process. Proportion of conformance is defined as the proportion of products with quality characteristics inside the specification limits and is, therefore, a measure of the capability of the process in meeting design specifications. Proportion of conformance, in many ways, is preferable to the widely used process capability indices for assessing the performance of manufacturing processes. The new methodology has been implemented in a computer program that produces both point and interval estimators for the proportion of conformance. The work described above was performed at NIST under the NIST/ASA/NSF Fellowship Program, administered by the American Statistical Association.