

News Briefs

General Developments

NIST SOLVES WELD PROBLEMS IN ATOM SMASHER

NIST investigators have solved problems with weld cracks during construction of a massive steel toroid at the Fermi National Accelerator Laboratory in Batavia, IL. The toroid, a $45 \times 35 \times 35$ ft energy measurement device, was designed to determine the momentum of muons emerging from high-energy collisions produced by the atom smasher. But recurrent cracks in welds in walls of the toroid caused safety and structural concerns, and Fermi Lab asked NIST for help. A NIST team found the cracking was due to overload of the highly constrained steel forging. They made a series of recommendations to improve the welds. The recommendations were adopted, and the toroid was completed with no further cracking. For a copy of a paper describing this investigation, contact Jo Emery, Division 104, NIST, Boulder, CO 80303; telephone: 303/497-3237. Ask for paper no. 6-90.

AGENDA DEFINED FOR INTELLIGENT PROCESSING OF STEEL

A NIST report summarizes the research agenda for the intelligent processing of steel, which was developed at a workshop on "Intelligent Processing of Primary Metals," sponsored by NIST, the Department of Energy, and the American Iron and Steel Institute (AISI). The agenda was developed after officials from industry, universities, and government defined the key elements producers need for the intelligent processing of steel, assessed the status of available technologies, and outlined strategies for implementing their use. Experts at the workshop recommended applying intelligent

processing concepts in three generic areas: production and refining of primary metal (iron, steel, and aluminum), production of near-net shape products, and the finishing and coating of metals to yield final properties. The findings have been reviewed by an AISI advisory committee, which recommended that priorities be determined and a long-term research program be established with an industry consensus. For a copy of the workshop report, Intelligent Processing for Primary Metals (NIST SP 772), send a self-addressed mailing label to James Early, B309 Materials Bldg., NIST, Gaithersburg, MD 20899; telephone: 301/975-6113.

NARROWEST SPECTRAL LINE PRODUCED

Researchers at NIST have made the narrowest known observation of an optical spectral line. To do it, they developed the narrowest line-width laser ever produced. Their work represents a big step towards an optical frequency time standard which would be 10,000-times more accurate than the best current standard (based on a microwave-range frequency of the cesium atom). For a variety of reasons, a time standard in the optical frequency range would be very useful, and the more narrow the observed line, the more accurate the standard. At present, the limiting factor is the inability to build a very narrowly tuned laser as a probe for the spectral line. The NIST researchers isolated a single, laser-cooled mercury ion in an electromagnetic trap and probed it with a newly designed laser with an effective linewidth of about 86 Hz at a wavelength of 563 nm. The frequency observation was more than 10 times narrower than any previous such attempt. A time standard based on such a system could be accurate to a part in 10^{18} , compared with the current standard accurate to a part in 10^{13} . For a copy of the paper describing this work, contact Jo Emery, Div. 104, NIST, Boulder, Colo. 80303; telephone: 303/497-3237. Request paper no. 13-90.

SYMPOSIUM ON OPTICAL FIBER MEASUREMENTS SCHEDULED

NIST, in cooperation with the Institute of Electrical and Electronics Engineers Optical Communications Committee and the Optical Society of America, will sponsor the 6th biennial Symposium on Optical Fiber Measurements on Sept. 11-12, 1990, in Boulder, CO. The symposium will be devoted entirely to measurements on fiber, related components, and systems. Typical topics will include telecommunications fibers, fiber lasers and amplifiers, fibers for sensors, couplers, connectors, multiplexers, integrated optics, sources, detectors, modulators, switches, long haul systems, LANs, subscriber loops, field and laboratory instrumentation, and standards. For more information, contact the General Chairman, Douglas L. Franzen, NIST Div. 724.02, Boulder, CO 80303 or call 303/497-3346.

CANADA AND U.S. WEIGHTS AND MEASURES COORDINATE PLANNING

The NIST Office of Weights and Measures (OWM) and the Canadian Division of Weights and Measures have developed plans to coordinate their programs and to work toward uniformity in the regulation of weights and measures in the two countries.

Senior representatives of the Canadian Weights and Measures Division have been members of the National Conference on Weights and Measures (NCWM) for several years. Recently, OWM has been working with its Canadian counterpart and, through the exchange of letters and visits, has developed an agreement of cooperation. The agreement includes plans for representatives of each country to participate in the technical and policy development activities of the other. OWM staff have attended meetings of the Canadians to: (1) gain understanding of the Canadian program; and (2) contribute technically and administratively to the Canadian program.

PHASE EQUILIBRIA AND CRYSTAL CHEMISTRY IN SYSTEMS CONTAINING HIGH- T_c SUPERCONDUCTIVITY:

THE SYSTEM Sr-Ca-Bi-Cu-O

Phase equilibria studies of the binary and ternary boundary systems for the complex four component system SrO-CaO-Bi₂O₃-CuO have been completed. Phase diagrams have been prepared for publication for the binary systems SrO-CuO, SrO-Bi₂O₃, CaO-CuO, and CaO-Bi₂O₃ and for the ternary systems

SrO-CaO-CuO, SrO-Bi₂O₃-CuO, CaO-Bi₂O₃-CuO, and SrO-CaO-Bi₂O₃. Precise unit cell dimensions and standard x-ray powder diffraction data have been collected and prepared for publication for most of the binary and ternary phases. Whenever possible, small single crystals have been synthesized for each phase and characterized as to symmetry and space group. In collaboration with industry scientists, crystal structure determinations are in progress for most of these crystals prepared at NIST. Thus, precise information has been obtained on the geometric nature of the Bi-coordination. Surprisingly, several of the phases show threefold coordination of oxygen around the bismuth ion. Examination of the structure of such phases as Ca₄Bi₆O₁₃ and Sr₂Bi₂O₅ has afforded an opportunity to study aspects of the Bi-geometry and bonding not possible in the complex superconductors containing the rigid covalent Cu-O network.

ULTRA-HIGH STRENGTH WELDABLE Al-Cu-Li ALLOYS

A weldable aluminum alloy, which has recently been developed by industry, has twice the strength of currently used weldable alloys. At the same time, the density is lower and the elastic modulus is improved. This alloy, containing copper and lithium with minor amounts of silver, magnesium and zirconium, is targeted for use on the Advanced Launch System, the Space Shuttle, and other aerospace vehicles where weldability is required for containment of cryogenic liquid propellant. The use of such a high-strength alloy would allow substantial weight savings and corresponding increases in payload capacity.

The microstructural basis for these alloy properties is presently under study in a collaborative research effort between NIST and industry. Microstructural studies have been conducted using analytical electron microscopy techniques. The ultra-high strength arises from a fine, dense precipitation of at least three types of strengthening phases: θ' (Al₂Cu), S' (Al₂CuMg), and T₁ (Al₂CuLi). Further, there are indications of a fourth, previously unknown precipitate. These phases reside in a matrix of aluminum solid solution and each has a different habit and habit plane. This intricate microstructure leads to high strength by making dislocation motion complex and difficult.

Microstructures resulting from various alloy processing conditions are being correlated with mechanical properties, at cryogenic and room temperature, and with corrosion resistance in critical

environments. With an understanding of the basis for properties, processing conditions and alloy composition can be optimized to improve the performance of the alloy system. The understanding and correlations obtained in this work are expected to have applications to a large number of aluminum alloys.

UNIVERSITY OF MINNESOTA TO PARTICIPATE IN CNRF INSTRUMENT DEVELOPMENT

The University of Minnesota will participate with NIST in the development and use of two high-resolution instruments at the Cold Neutron Research Facility (CNRF).

The instruments are the 30-m cold neutron small-angle scattering spectrometer and the cold neutron reflectometer. The former is further along in construction and, on commissioning later this year, will be the first state-of-the-art high-resolution SANS instrument available in the United States. The reflectometer is in its final design phase and is expected to be installed in early 1991. It, too, will be a state-of-the-art instrument, with expected measurement sensitivity down to $\sim 5 \times 10^{-7}$ in reflectivity.

These instruments are expected to play a major role in the elucidation of the structure and microstructure of polymers and other materials as well as surface and interfacial structure and interactions—areas of considerable interest both to scientists of the University of Minnesota and NIST. Neutron reflectometry measurements at poorer sensitivities already have provided important information on surfaces, interfaces, and thin films for systems as diverse as magnetic films and multilayers, and diblock copolymers. In addition to its powerful role in the study of micro- and macromolecular structures, SANS also has been used to study a wide variety of interfacial problems, including internal surface adsorption in controlled pore glasses and micellar growth and aggregation.

POLYMER FILMS USED IN RADIATION DOSIMETERS ANALYZED

Scientists at NIST have used high sensitivity dielectric loss measurements to evaluate polymer films to be used in the construction of radiation dosimeters. The work is being carried out for the Federal Emergency Management Agency, which maintains large quantities of dosimeters to be used

in the event of a nuclear emergency. It is important that the electrical leakage characteristics of the polymer, typically polystyrene, not be altered after short exposure to high levels of ionizing radiation in any manner which would change the dosimeter's response. The leakage characteristics tend to be dominated by adventitious impurities introduced during polymerization or subsequent processing rather than being an intrinsic property of the polymer. Dielectric loss measurements have enabled selection of materials with the appropriate electrical characteristics before exposure to ionizing radiation. These materials now are being irradiated for further evaluation.

UNITED STATES AND FRANCE AGREE ON EQUIVALENCE OF LUMINOUS INTENSITY STANDARDS

A series of agreements that recognize the equivalence of the practical realizations of a number of SI units by the national standardizing laboratories of the United States and France have been signed.

Typical is the reciprocity agreement on luminous intensity which states that the national standards for the practical realization of the candela in the United States and France are equivalent to each other within an uncertainty of 1 part in 100 (three standard deviation estimate). Within the same limit of uncertainty, the NIST and BNM units are believed to be smaller than the SI unit by 4 and 5 parts in 1,000, respectively.

These estimates are based on data contributed by NIST and BNM to an international intercomparison of photometric base units, which was conducted by the Consultative Committee for Photometry and Radiometry between 1984 and 1986. Overall, the intercomparison showed 0.8 percent agreement (one standard deviation) of independent luminous intensity scale realizations by 15 national laboratories, and 0.6 percent agreement of luminous flux realizations by 11 national laboratories. The NIST candela and lumen agreed with the world mean within quoted uncertainty limits and were shown to be consistent with one another within 0.5 percent.

The U.S./French SI unit equivalency agreements will remain in effect for an unlimited period but may be withdrawn by either party at any time. These agreements will facilitate the sale of products between the United States and France if traceability to national standards of the relevant SI units is required.

ABSOLUTE CRYOGENIC RADIOMETER

An absolute cryogenic radiometer, constructed in the United Kingdom as part of a joint NIST-NPL (National Physical Laboratory) project, has arrived in the United States. The instrument is to be used in a series of collaborative measurements involving the two laboratories. These measurements are being used to compare this radiometer with a similar instrument at NPL and to carry out a collaborative long-term effort to develop transfer standard detectors and working standard detectors. The first intercomparison of the instruments was accomplished before the NIST radiometer was transferred to the United States. The results indicated that the two instruments measured optical power in a consistent manner, within the expected accuracy.

The instrument will be set up at NIST in a specially prepared laboratory that is designed to minimize dust and electrical noise and will provide a stable temperature environment. The instrument will serve as the absolute radiometric base for NIST and will accommodate calibration and research activities being carried out at NIST. The long-term goal of this program is to improve the calibrations provided by NIST and make available more accurate laboratory standards for use in a wide range of radiometric activities. It is expected that the instrument will be in operation this year and start to make an impact on NIST programs immediately after commissioning. The instrument has a demonstrated level of accuracy of at least 0.01 percent in work carried out over the last few years by the NPL staff.

AIR POLLUTION TRACER EXPERIMENT

NIST scientists in collaboration with researchers at the University of Maryland, have developed a new method for air pollution source apportionment. This technique involves tagging the emissions from combustion sources with a small amount of an enriched isotope of a rare earth element. In the case of coal-fired power plants the tracer is injected into the stack as an organic complex dissolved in an organic solvent. For sources that burn oil, the tracer can be directly mixed with the fuel. Air particulate samples are then taken and the isotopic composition measured by thermal ionization mass spectrometry.

This technique is currently being used as part of the Environmental Protection Agency's (EPA) Integrated Air Cancer Project to study the emissions

from residential heating oil furnaces and diesel trucks. For this experiment, extremely small amounts of two isotopes of samarium (Sm) were used. Samarium 149 was added to a supply of home heating oil and ^{150}Sm was added to a supply of diesel fuel. In both cases, the final concentration of tracer in the fuel was a few parts per billion.

Samples from the sources and receptor sites, including filters from air samplers, vegetation, soil, and rain samples, were collected during the winter of 1989. The absolute amounts and isotopic enrichment of the Sm isotopes will be determined by high-precision isotope dilution thermal ionization mass spectrometry. This experiment should provide a quantitative measure of the dispersion of particulates as a function of both their source and size. These data will help EPA to assess the relative impacts of these two emission sources on human health.

CLUSTERS OF ATOMS SHOW METALLIC BEHAVIOR

When metal atoms are brought together to form clusters, transition to the metallic state must occur at some critical cluster size or number of atoms. This transition is noted by the change from isolated electrons (and electronic states) in each metal atom to completely delocalized electrons in the metal cluster. Using scanning tunneling electron microscopy (STM), NIST scientists have observed this transition and determined the critical size for Fe clusters on GaAs surfaces.

Molecular beam epitaxy was used to deposit quantities of Fe on GaAs below the number of atoms needed to form one continuous layer of Fe. The STM shows that this process generates localized clusters of Fe, up to several hundred atoms in size, growing on the GaAs surface. It was found that clusters of fewer than about 13 Fe atoms were nonmetallic or semiconducting in nature, and that clusters of more than 35 Fe atoms clearly exhibited metallic behavior. These measurements also have revealed evanescent electronic states in the GaAs band gap at the metal-semiconductor interface. The electron tunneling characteristics at the edges of the clusters show that the electronic states of the metallic clusters "leak out" into the semiconductor region where there are usually no electronic states within the band gap. These measurements are the first clear experimental observation of metal-induced gap states, shown previously in theoretical modeling of metal-semiconductor interfaces.

HIGH- T_c SUPERCONDUCTIVITY THEORY ELIMINATES LARGE CLASS OF PROPOSED MECHANISMS

The discovery of high-temperature, copper oxide superconductors was not anticipated by existing theories of superconductivity, and no attempt to explain the phenomenon has been fully successful. A number of theories invoke electronic excitations to mediate an attractive interaction between electrons near the Fermi surface. Such mechanisms might account for the high values of T_c , since electronic excitations are characterized by much higher energies than the lattice vibrations responsible for low- T_c superconductivity. However, recent theoretical work in collaboration with researchers from the University of California at Berkeley, has shown that many proposed electronic mechanisms are not appropriate.

The standard BCS theory of superconductivity is not applicable to the high- T_c oxides. The properties of high- T_c compounds must be examined within a generalization of the BCS theory, which involves solving equations derived by Eliashberg. The scientists solved the Eliashberg equations in a model that represents strong electronic interactions in a fairly general way, yet also accounts for specific materials properties by incorporation of experimental data.

Their main finding is that the appropriate constants required to fit experimental data are much too small. Thus, electronic mechanisms of this type are inconsistent with the predictions of the standard strong-coupling theory of superconductivity as applied to known high- T_c compounds. This means that the agent of high-temperature superconductivity still remains un-identified. Some simplifications made to the model, such as the assumption of isotropic interactions, could change their results; but this would indicate a major deficiency in existing simple models. The possibility that the Eliashberg formalism is inapplicable would have far-reaching implications because it would place strong-coupling theories of high- T_c superconductivity outside the realm of tested physical theory.

FEDERAL INFORMATION PROCESSING STANDARD (FIPS) FOR COBOL REVISED

The Secretary of Commerce has approved a revision of FIPS 21-2, COBOL, to be published as FIPS 21-3. To be effective June 29, 1990, the revised standard adopts American National Standard Programming Language COBOL, ANSI X3.23-1985 and X3.23A-1989 for federal agency use.

FIPS 21-3 adds an intrinsic function facility to the COBOL specifications. FIPS COBOL is one of the high-level programming language standards provided for use by all federal agencies. The language is especially suited for applications that emphasize the manipulation of characters, records, files, and input/output (in contrast to those primarily concerned with scientific and numeric computations).

NIST PUBLISHES RESEARCH RESULTS ON DIRECT IMAGE STORAGE TECHNOLOGY

Direct image storage technology promises to provide substantial improvements in the transmission and storage of forms. NISTIR 89-4177, Decoding Bar Codes from Image Data, describes a process of direct decoding of the bar code in a scanned image which simplifies paper handling and systems design. In work done for the Bureau of the Census, researchers developed software to provide portable "C" programs which demonstrate the feasibility of directly decoding bar codes from raster images.

Three distinct decoding algorithms were developed and tested: a scan method which decodes a single scan line without prior image processing; a global histogram averaging method which takes into account information from the entire image maximizing reliability at the expense of processing time; and a hybrid method which samples the original bar code into a collection of representative scan lines. These methods are fully portable and can be incorporated into a wide range of image applications.

REPORT DESCRIBES GRAPHICS APPLICATION PROGRAMMER'S INTERFACE STANDARDS AND CALS

NISTIR 89-4199, Graphics Application Programmer's Interface Standards and CALS, focuses on two graphics application programmer's interface (API) standards of interest to CALS (Computer-Aided Acquisition and Logistic Support): programmer's hierarchical interactive graphics system and programmer's imaging kernel. API standards are tool boxes of graphics functions used by application programmers who develop graphics programs.

The primary purpose of a graphics API standard is to provide portability for an application program across a wide range of computers, operating systems, programming languages, and interactive graphics devices. Other benefits of API standards include reducing software development and lifecycle costs and reducing programmer time and costs

since many of the functions currently performed by the application program can be performed by the API standard.

NIST DEVELOPS FACT SHEET ON THE DATA ENCRYPTION STANDARD (DES)

In response to the many questions received from federal agencies about DES, NIST has developed a fact sheet covering all aspects of the standard and its applicability. Federal Information Processing Standard (FIPS) 46, Data Encryption Standard, was issued in 1977 and has been reaffirmed twice; the current FIPS 46-1 reaffirms the standard until 1993. Subject to agency waivers, the use of DES is mandatory for all federal agencies, including defense agencies, for the protection of sensitive unclassified data communications (except information covered by 10 U.S.C. Section 2315) when the agency determines that cryptographic protection is required.

CD-ROM VERSION OF THE DEFENSE ADVANCED PROJECTS AGENCY'S (DARPA) RESOURCE MANAGEMENT CONTINUOUS SPEECH CORPUS COMPLETED

NIST has completed the preparation and public availability of a CD-ROM version of DARPA's Resource Management Continuous Speech Corpus. This speech database has been in use within the DARPA speech research community since 1987, and a series of benchmark performance assessment tests has been conducted using designated training and test sets in conjunction with scoring software that provides a basis for a uniform reporting standard.

The CD-ROM discs that are now publicly available contain all speaker-dependent and speaker-independent system training and benchmark test material used to date, together with the latest version of the scoring software and other tools. Arrangements have been made with NTIS (National Technical Information Service) for public sale of these CD-ROM releases, both domestically and abroad.

REPORT INTRODUCES CONCEPT OF A HETEROGENEOUS COMPUTING ENVIRONMENT

Computer networks are becoming larger not only in the number of nodes connected but also in the geographic area spanned. Networks are also becoming more diverse in the variety of equipment

from which the network is implemented. NIST Special Publication 500-176, Introduction to Heterogeneous Computing Environments, characterizes heterogeneous computing environments from the point of view of the generic services provided. The report introduces the types of technical standards necessary in a heterogeneous computing environment and illustrates how such standards can be used to provide services.

NIST DEVELOPS NEW RATING PROCEDURE FOR MIXED AIR-SOURCE HEAT PUMPS TO AIR CONDITIONING INDUSTRY

A recently completed NIST rating procedure for mixed air-source heat pumps was presented to a special meeting of the Unitary Equipment Committee of the Air-Conditioning and Refrigeration Institute. Mixed air-source heat pumps are those that are not designed and tested as a single system. An outdoor section of compressor and condenser is used with a separate indoor section of evaporator and fan, typically in a retrofit application. A rating procedure is necessary for utilities' rebate programs where the amount of rebate is governed by the predicted efficiency of the new system. The rating procedure developed by NIST enables the manufacturer and/or designer to calculate the seasonal performance of such units from prior tests on a complete system that included the outdoor unit plus relevant engineering performance data on the indoor refrigerant-to-air heat exchanger and indoor fan. The procedure will be adopted by the U.S. Department of Energy in their mandatory minimum standards program and used extensively throughout the industry.

ROLE OF TURBULENCE CLARIFIED IN FLAME SPREAD

Prof. A. C. Fernandez-Pello (U.C., Berkeley) under a grant from NIST has quantitatively shown for the first time the role of turbulence on flame spread rate over materials. Although this work emphasizes the influence of free stream turbulence on a laminar boundary layer flame, it clearly shows the effect is to decrease flame length and increase flame heat flux. This quantification of the effects allows rate predictions based on the general theory of flame spread. The implications of this work are significant to the interpretation and reproducibility of standardized flame spread tests, and on the need to understand more fully turbulent flame spread in real fires.

UNSTABLE SOIL A CULPRIT IN LOMA PRIETA QUAKE

Unexpectedly severe damage to buildings in the San Francisco Bay area during last October's Loma Prieta earthquake underscores the lesson that structures sited on unstable soil deposits need to be assessed to determine their earthquake safety, according to a recent NIST report. "Lifelines," such as bridges, highways, and water and gas pipelines, also are vulnerable to earthquakes and should be assessed as well. NIST investigated the earthquake at the request of Congress. Not surprisingly, NIST found that older wood-framed dwellings and unreinforced masonry buildings that had not been strengthened sustained substantial damage. Somewhat unexpected, however, was that many structures in the Bay area of San Francisco, 60 to 70 miles away from the earthquake's epicenter, suffered severe damage, including some buildings constructed using modern seismic safety practices. To a large extent, these damages occurred to structures located on unstable soil deposits. Most buildings on firmer ground sustained little or no damage. Since 1971, NIST has participated in nine earthquake investigations.

REPORT SUMMARIZES NIST ELECTRIC ENERGY RESEARCH

A summary of numerous investigations aimed at improving measurement science for the electrical power industry is contained in a report now available. The document, prepared for the U.S. Department of Energy, covers four major research projects. One of these examines the measurement of ions in the vicinity of dc high-voltage transmission lines and in biological exposure facilities that simulate a transmission line environment. Another project is concerned with the behavior of the compressed gas insulators (dielectrics) used in high-voltage power systems. Understanding the breakdown of liquid dielectrics such as the oil used as an insulator in power transformers is the goal of another project. (The summary for this research includes a description of a novel high-speed camera designed at NIST to record the random events that take place in the nanosecond range of breakdown phenomena.) A fourth project aims to improve the measurement of fast transient pulses such as lightning and power surges. The free publication, *Research for Electric Energy Systems—An Annual Report*, is available from the Center for Electronics and Electrical Engineering, B344 Metrology Bldg., NIST, Gaithersburg, MD 20899.

SMALL SHOP AUTOMATION: A HANDS-ON SEMINAR

Shop owners, managers, and foremen examined computer software designed to automate small plant production in the first "Shop of the 90's" seminar held at NIST. Participants used commercially available automation software that is ready to run on personal computers. The hands-on demonstrations covered computer-aided process planning and computer-aided cost estimation, as well as programs devised to speed manufacture such as computer-aided design and computer-aided manufacturing packages. Direct numerical control, the process that transmits machine codes to the computer-driven shop machines, also were discussed. Representatives of state and regional technology transfer centers were on hand to review their automation and technology transfer efforts. Seminar participants left with a good idea of how to build a computer-integrated manufacturing system for their small job shop. For more information contact: Adrian Moll, Rm. 136 Shops Bldg., NIST, Gaithersburg, MD 20899; telephone: 301/975-6504.

NEW VIDEO PROFILES QUALITY AWARD WINNERS

The 1989 winners of the Malcolm Baldrige National Quality Award—Milliken & Company and Xerox Corporation Business Products and Systems—are profiled in a new videotape, "The Malcolm Baldrige National Quality Award—1989." Produced under NIST supervision, the 14 1/2-minute tape in VHS format highlights the award and the management philosophies of the two firms. Also covered are the management approaches that contributed to their choice as recipients of the award for total quality management. The videotape, funded by the Foundation for the Malcolm Baldrige National Quality Award, is available for \$10 through the American Society for Quality Control, Customer Service, 1-800-952-6587.

NIST, INDUSTRIAL COMPANY SIGN OPTICAL FIBER SENSOR RESEARCH AGREEMENT

NIST and an industrial company have begun a cooperative program to develop components for optical fiber current sensors. These electric current sensors have potential applications in the electric power industry, electromagnetic pulse and interference testing, and general electronic instrumenta-

tion. Having no electrical parts, fiber current sensors are especially attractive in applications where current must be measured at high voltage or in the presence of electromagnetic interference. NIST has developed certain technologies in this field, including methods for improving the properties of fiber coils for sensing. A guest scientist from the industrial company will spend a year working with researchers at the NIST Boulder Laboratories. NIST will share its knowledge with the company, and the visiting scientist will participate in further developmental work in fabrication, packaging, and characterization of the coils. The goal of cooperative research programs, which exist in many different fields of research at NIST, is to accelerate the transfer of federally generated technology to commercial enterprise.

SPRINKLERS IN CHEM LABS CAN PROTECT LIVES, PROPERTY

During a fire in a chemical laboratory, lives and property as well as critical scientific experiments are at risk within seconds. Researchers at NIST recently conducted a series of full-scale fire tests in chemical labs to examine the potential of quick response sprinklers to improve life safety and protect property. The tests were part of a project to help the National Institutes of Health develop sprinkler design criteria for its chemical labs. In a test in an unsprinklered laboratory, the NIST researchers found that within 38 s all combustible material in the lab was burning, creating lethal conditions and extensively damaging the laboratory. In contrast, both the standard and quick response sprinklers effectively controlled the fires and reduced temperatures as well as carbon monoxide and carbon dioxide levels. A report, *Quick Response Sprinklers in Chemical Laboratories: Fire Test Results* (NISTIR 89-4200), is available from the National Technical Information Service, Springfield, VA 22161 for \$17 prepaid. Order by PB #90-151721/AS.

NEW APPARATUS FOR STUDYING METALS

Over the past 20 years the steel industry has developed thermomechanically processed (TMP), high-strength, low-alloy steel plates which are strong, tough, and easily welded. Production of TMP

plates, however, requires careful control over each step. To assist the steel industry, NIST scientists have devised a laboratory-scale, hot-deformation-apparatus to simulate the thermal and mechanical treatments metal receives during a rolling or forging operation. The apparatus has advantages of economy, versatility, and reproducibility. It has been used successfully to perform the direct-quenching simulation of the ASTM A710 plate steel and forging simulation of the directly cooled microalloyed AISI 1522 and 1141 steels. More information is contained in *Development of a Computer-Controlled Hot-Deformation Apparatus at NIST* (NISTIR 89-3925). Order from the National Technical Information Service, Springfield, VA 22161. Order by PB #90-149964 for \$23 prepaid or \$8 for microfiche.

NEW PUBLICATIONS DISCUSS ADVANCES

To maintain our lead in biotechnology research and commercialize the results of that research, the United States needs a strong base of generic technology in bioprocess engineering. Two recent publications, co-edited by NIST personnel, make significant contributions to that base. *Frontiers in Bioprocessing*, contains 35 papers originally presented at a NIST-NASA conference. Areas covered include process integration, fermentation control, sensor development, free-fluid bioseparations, chromatography, and emerging technologies. One chapter, written by NIST researchers, discusses the rapidly expanding interest in applying microbial processing for metal dissolution and recovery from ores and wastes. The publication is available from CRC Press Inc., Boca Raton, FL 33431. The second publication, *Downstream Processing and Bioseparation*, discusses the increasingly important role played by downstream processing in the commercialization of biotechnology. Two chapters, written by NIST personnel, discuss aqueous two-phase extraction systems for recovering and purifying proteins, enzymes, and other molecules. The publication is part of the American Chemical Society Symposium Series, Vol. no. 419, and is available from ACS, Distribution Office, Dept. 225, Washington, DC 20036.

MIT TO PARTICIPATE IN NEUTRON DIFFRACTOMETER DEVELOPMENT

The Massachusetts Institute of Technology (MIT) will participate with NIST in the development and use of a new powder neutron diffractometer for materials research at the NIST reactor.

The new 32-detector ultra-high resolution powder diffractometers to be installed at the BT-1 thermal neutron port. It will replace the 5-detector instrument currently in use. The new instrument will be a world-class diffractometer with state-of-the-art capabilities in resolution, versatility, and data collection efficiency.

As is generally well-known now, Rietveld analysis of neutron powder diffraction provides details of atomic arrangements in condensed materials which is not possible with other diffraction methods. With this capability, this experimental station is expected to play a major role in research programs of mutual interest to NIST and MIT. Of particular initial interest in the collaborative program are structural studies of graphite intercalation compounds and fast-ion conductors, and advanced ceramics.

INTERIM U.S. ADOPTION OF HUNGARIAN RADIONUCLIDE STANDARDS

Cooperation between the Hungarian National Office of Measures (OMH) and NIST will allow NIST to adopt radionuclidic standards developed in OMH's respected Radionuclide Metrology Section until direct activity measurement of the radionuclides can be made in this country. This interim adoption will give NIST a means of performing accurate measurement-traceability tests of U.S. commercial calibration-material suppliers and nuclear-power radiochemistry departments much sooner. Because of this cooperation, resources in the NIST radioactivity group can now be focused on the establishment of national standards for new radionuclides being introduced into nuclear medicine. An ampoule of ^{106}Ru — ^{106}Rh has been sent to OMH, together with a test ampoule of ^{144}Ce — ^{144}Pr recently standardized here. Arrangements are being made for the transfer of standardizations of ^{86}Rb , ^{65}Zn , ^{182}Ta , and ^{192}Ir during the year with ^{141}Ce included to compare with a recent NIST value.

MARINE BIOGEOCHEMICAL SULFUR CYCLE AND GLOBAL WARMING

NIST scientists in collaboration with researchers from the University of Washington, helped determine the sulfur isotopic composition in atmo-

spheric samples collected over the Pacific Ocean. The results of these findings may provide additional constraints on global warming models.

Dimethyl sulfide (DMS) and non-sea-salt sulfate samples were collected on a NOAA cruise in the Pacific Ocean. Dimethyl sulfide, produced by oceanic bacteria, is believed to be the major precursor to other sulfur-containing species that are a primary source of cloud condensation nuclei. The biogeochemical sulfur cycle as now defined has been postulated as a temperature-regulating feedback system for the Earth. Global warming will induce the formation of more DMS, followed by more cloud condensation nuclei and more clouds, and hence compensative cooling.

The first determinations of the sulfur isotopic composition of DMS and non-sea-salt sulfate were made in January. These measurements were made using the NIST thermal ionization procedure for sulfur which is based on the formation of the stable AsS^+ molecular ion. Since As is mononuclidic, no corrections to the measured isotopic ratios are necessary. These first measurements of the sulfur isotopic composition of DMS and non-sea-sulfate indicate that the two species are isotopically distinctive from sea-salt sulfate. These results provide an important additional link between DMS and the cloud condensation nuclei.

NIST XUV OPTICS FACILITY USED IN X-RAY LITHOGRAPHY DEMONSTRATION

A novel projection XUV lithography system has been used by industry to form a printed image (on a resist) with $0.1\ \mu\text{m}$ features. NIST characterized the reflective multilayer optics of the system, which forms a 20:1 reduced image on the resist. The work is part of a large industrial effort to develop a short wavelength (13 nm) lithography technique capable of fabricating semiconductor devices with $0.1\ \mu\text{m}$ components, nearly an order of magnitude smaller than presently possible.

A key development in soft x-ray science that has made XUV projection lithography a possibility is the XUV multilayer reflector first demonstrated about a decade ago. XUV optical systems based on multilayer mirrors are now revolutionizing soft x-ray technology.

The NIST Synchrotron Ultraviolet Radiation Facility (SURF II) is ideally suited as a source to support the development of multilayer systems and soft x-ray projection lithography. The spectral region of interest for these technologies, 4-40 nm, is the region of highest spectral output power of SURF II, and the extremely small beam

cross-section of this source allows the establishment of a very high quality test facility for optical components. Scientists at NIST evaluated the quality of the multilayer mirrors—the reflectivity was 38 percent at 13.2 nm, about two orders of magnitude larger than conventional optics.

NIST also has provided measurements to numerous collaborators engaged in developing XUV telescopes, monochromators, and new multilayer combinations.

NIST SCIENTISTS SOLVE FUNDAMENTAL PROBLEM IN GENE CLONING AND EXPRESSION

The ability to express a gene at high levels to produce large quantities of protein in bacteria using recombinant DNA technology is one of the biotechnology industry's core technologies. However, not all genes can be cloned in expression systems for reasons that until now have been unclear. NIST scientists report that current high-expression techniques fail to work with genes that produce protein products lethal to bacterial cells, because of "leaky" vector transcription.

Working with the gene that codes for the enzyme adenylate cyclase, scientists demonstrated that increasing the level of enzyme in the cell from 0.004 percent to 0.20 percent of total protein was lethal to the cell. The lethal problem could be overcome in the case of adenylate cyclase by using a bacterial cell that had a defective receptor protein for cyclic AMP, the product of adenylate cyclase catalysis. To solve this problem in the general case for all lethal gene products, the researchers used DNA technology to engineer a new generation of expression vectors that block "leaky" transcription. Using this system it was demonstrated that adenylate cyclase could be expressed in normal bacterial cells at very high levels (up to 30 percent of total cell protein). This means that the amount of protein previously produced from a 1,000 L fermenter can now be isolated from 1-L of cells. This technology should be useful for other genes that have been demonstrated to be difficult to express in bacterial cells, such as the HIV protease and human cystic fibrosis gene.

NIST INVESTIGATES APPLICATION OF MULTI-ATTRIBUTE DECISION MODEL TO FIRE PROTECTION INVESTMENT ALTERNATIVES

A NIST scientist investigated the use of the analytic hierarchy process (AHP) model for making choices among alternative fire protection strategies

in buildings. The AHP, a multiattribute decision support model, has the advantage that it allows the decision-maker to combine quantitative and qualitative criteria. Quantitative criteria may include system price, future costs, insurance, and property tax savings. Qualitative criteria may include attitudes towards risk and aesthetics, and exposure of the individual building and its occupants to risk of death, injury, and property loss. In the application of the model, the decision-maker weights all relevant criteria and alternatives by comparing them in a pairwise fashion. The pairwise comparisons elicit user-specific information; this is an advantage for fire protection decisions which involve unique combinations of risk exposure and attitude. The AHP model combines the weights resulting from the comparisons and assigns to the investment alternatives a ranking that reflects the decision-maker's particular situation. Two hypothetical case studies apply the method to a choice among smoke detectors, a sprinkler system, and a combination of the two. The NIST report "Risk Exposure and Risk Attitude of Homeowners in Fire Protection Investment Decisions," lays the groundwork for possible development of specialized computer software to apply the AHP model to a wide variety of fire protection measures.

NIST ESTABLISHES NEW MICROWAVE POWER SERVICES

NIST has announced new special-test measurement service for power measurements for 3.5-mm coaxial connectors in the range 2 to 26.5 GHz. The approach used to establish the service was to employ existing coaxial and waveguide power standards as a base and to adapt them to 3.5-mm coaxial connectors with precision adapters. The scattering parameters of these connectors were determined with measurements on division-developed dual six-port automatic network analyzers, using a mixed-connector calibration technique. A number of measurements were carried out to demonstrate consistency, with the result that the efficiency of the adapter when connected to a power standard contributes no more than 1 percent to the overall uncertainty of the measurement of 1.5 to 2 percent. The division also completed work on dual six-port systems covering the waveguide bands WR42/28 (18 to 40 GHz) and WR22 (33 to 50 GHz) and is now providing special-test services for power and scattering parameters over these ranges. These new six-port based services offer improvements in sensitivity and accuracy of up to one order of magnitude over measurements available from tuned-reflectometer manual systems.

NASREM ARCHITECTURE ADOPTED FOR NEXT GENERATION CONTROLLER

The NIST/NASA Standard Reference Model for Telerobotic Control System Architecture (NASREM) developed by NIST for the NASA Space Station Flight Telerobotic Servicer has been adopted for the next generation controller (NGC) for the Air Force Wright R&D Center. The Air Force NGC program is part of a national initiative to revitalize the U.S. machine tool industry. The NGC will be an open-system, real-time computer control system for machine tools, robots, and coordinate measuring machines. NIST will develop a task vocabulary and syntax at each level of the NASREM hierarchical architecture as the basis for a NGC "Neutral Manufacturing Language."

STATE-OF-THE-ART ROBOTIC WORKSTATION TRANSFERRED TO MARE ISLAND NAVAL SHIPYARD

NIST transferred a robotic flexible manufacturing workstation, developed in its Automated Manufacturing Research Facility (AMRF), to the Mare Island Naval Shipyard located north of San Francisco, CA. By applying the research and technology developed in the turning workstation, the state-of-the-art small-batch workstation is designed to produce critical component parts for the U.S. Navy. The development of this advanced workstation, partially supported by Naval Sea System Command, the Navy Manufacturing Technology program, and NIST, launches the Navy into the forefront of advanced flexible manufacturing. This development and further research will yield applications at seven other naval shipyards in the United States.

This robotic workstation is driven totally by process plans and data. It has many capabilities and sophisticated features including hierarchical control architecture, in-process gaging, robotic material handling, robotic assembling of pallets, flexible workholding, and an intelligent robot gripper. With in-process inspection built into the workstation, scrap parts are virtually eliminated. The workstation can improve productivity five-fold over existing technology and practices currently employed by the U.S. Navy. This automated workstation can produce parts continuously, unattended, and on a part-on-demand basis so that no inventory of parts needs to be maintained.

NIST JOINTLY SPONSORS ROUNDTABLE ON INTERNATIONAL CONSTRUCTION STANDARDS AND PRACTICES

Twenty-seven U.S. private- and public-sector design and construction community leaders met for a 1-day roundtable on "International Harmonization of Construction Standards and Practices—Assets or Liabilities for Competitiveness." They identified actions to enhance the effectiveness of U.S. construction:

- A national certification and testing system is essential to provide for mutual recognition for international trade.
- Strengthened U.S. participation in international standardization. The international standard soon will be the basis for acceptance of products and services internationally and domestically. Federal participation is appropriate.
- SI conversion is needed. Most of the world's trade activities are in metric units. The U.S. construction industry must convert to be competitive.
- Effective communication is fundamental to industry and government policy makers on the importance of international harmonization of construction standards and practices.

TENSILE PROPERTIES OF INDIUM DETERMINED

Indium, the softest metal known that is stable in air, and its alloys are used in many high-technology applications because their excellent wetting properties enable reliable joining of glass, ceramics, and metals. Indium is also a superconductor below about 3.4 K. Curiously for an engineering material, there are no data on its mechanical strength in tension. NIST has performed extensive tensile tests on 99.99 wt% pure indium, cast in a nitrogen atmosphere into cylindrical tensile specimens of 13-mm reduced-section diameter. The specimens were tested at 4, 10, 76, and 295 K. Some specimens were studied metallographically before and after testing to determine characteristics such as grain size and precipitate structure, mode of failure, and recrystallization. Data on the yield strength, tensile strength, elongation, and reduction in area are given in "Tensile Strength and Ductility of Indium," published in *Materials Science and Engineering A*, 102 (1988). Copies of the paper, no. 15-90 are available from Jo Emery, Div. 104, NIST, Boulder, CO 80303; telephone: 303/497-3237.

ANTENNA DATA ANALYSIS AND RESEARCH USING PCs

NIST researchers have developed a new software package that allows scientists, engineers, and programmers to make complex antenna computations on personal computers. The package, termed Planar Near Field Codes, has a highly modular structure and can be used to address diverse research problems. A recent publication describes some of the inner workings of the FORTRAN codes, the data management schemes, and the structure of the input/output sections. The structure of the codes is open so that a user can incorporate a new application into the package relatively easily. The publication includes some basic research problems to illustrate the use and effectiveness of the codes. Planar Near-Field Codes for Personal Computers (NISTIR 89-3929) is available from the National Technical Information Service, Springfield, VA 22161. Order by PB #90-155839 for \$17 prepaid. To order the software package, available for \$1500, contact Lorant A. Muth, Div. 723.05, NIST, Boulder, CO 80303; telephone: 303/497-3603.

CALIBRATING THE SPACE TELESCOPE

NIST researchers provided a suite of state-of-the-art radiometric calibrations for the Hubble Space Telescope (HST). Because everything discovered by astronomy depends on analyzing light from distant stars and exotic objects, extremely accurate instrument calibrations are essential to the space telescope mission. Scientists at NIST aided in the design of a special optical simulator to test the HST Faint Object Spectrograph and calibrated the simulator for brightness. They then calibrated the special light sources used to test the overall sensitivity of the telescope's optics and measuring instruments. In addition, the researchers provided special wavelength and brightness calibrations for an on-board standard lamp, part of the HST High-Resolution Spectrograph. The latter will make it possible to identify the particular element associated with individual spectral lines, to estimate the speed of the element to within a km/s and to account for any changes in instrument calibrations while in space. NIST is the only source in the world for radiometric calibrations of short-wavelength vacuum ultraviolet radiation, which are essential for space-based astronomy.

USING THE SPACE TELESCOPE

Two NIST scientists at the Joint Institute for Laboratory Astrophysics (JILA) have obtained observing time on the Hubble Space Telescope. An

astronomer and co-investigator on the Goddard High Resolution Spectrograph instrument, will make high-precision measurements of the deuterium-to-hydrogen ratio for interstellar gas, an important test of some models of the origin of the universe. He will also study six stars of very low mass to learn whether they have atmospheres which resemble the sun's—such stars are too faint to observe from Earth and can be studied only from space. An astrophysicist, will work with colleagues at JILA and the University of Munich to measure the ultraviolet spectrum of hot stars in the Magellanic Clouds, the galaxies nearest to our own. With this data they will be able to study the origin and evolution of these stars which, unlike stars in our own galaxy, appear to contain a much lower abundance of elements heavier than hydrogen. JILA is a joint operation of NIST and the University of Colorado and is located on the university's campus in Boulder, CO.

NIST EXPERT SYSTEM HELPS DIAGNOSE CAUSE OF CRACKS

To help diagnose the causes of cracks in concrete, NIST researchers have developed a prototype expert system known as "CRACKS." An expert system is a computer program that incorporates facts along with experts' opinions and guidelines. In addition, CRACKS includes a database for maintaining information describing a structure and an "image base" for storing digitized photographs and drawings of cracking. CRACKS also can be used to measure the rate of deterioration of a structure by comparing observations over time. While CRACKS is not yet available commercially, it is available for review and comment. Contact Lawrence J. Kaetzel, B348 Building Research Bldg., NIST, Gaithersburg, MD 20899; telephone: 301/975-5912. A report describing CRACKS is available from the National Technical Information Service, Springfield, VA 22161 for \$15. Order Integrating Knowledge for the Identification of Cracks in Concrete Using An Expert System Shell and Extensions (NISTIR 89-4206) by PB #90-151234/AS.

COMMERCE APPROVES REVISION OF POSIX

The Secretary of Commerce has approved a revised version of the Federal Information Processing Standard (FIPS) for POSIX which adopts the final IEEE (Institute of Electrical and Electronics Engineers) standard for portable operating system interface. Issued as FIPS 151-1, this version

replaces an earlier one based on an IEEE draft standard. POSIX defines the interface, or link, between applications and computer operating systems based on UNIX. NIST considers POSIX as the first step toward a more open software environment for federal agencies. FIPS 151-1 will be available from the National Technical Information Service, Springfield, VA 22161; telephone: 703/487-4600.

ASTM APPROVES NIST TEST AS A NEW FIRE STANDARD

A new way to predict flame spread over a material, developed by researchers at NIST, has been approved as a standard from the American Society for Testing and Materials. Flame spread is a key factor in predicting the growth of a fire. Current tests measure flammability—how far and how fast a flame will spread over a particular material—and then rank the material with others. But, these results are arbitrary and, in some cases, differ from one test to another. The NIST method determines the basic physical properties of a material that enable it to ignite and spread the flames. They include ignition temperature, thermal properties (the ease in which a material heats up), and the minimum temperature of the material needed to allow the flame to spread. These properties can be used in mathematical or computer models to predict the behavior of many materials, including a composite or one which has additives, over a wide range of fire conditions.

Calibration Services

LOW-BACKGROUND INFRARED (LBIR) CALIBRATION FACILITY

NIST recently completed the construction of the LBIR facility. The first calibration of a low-background blackbody has been completed, and a second one has been started. The facility uses an absolute cryogenic radiometer as a fundamental radiometric standard with which to calibrate the temperature and radiant output of blackbody sources. The sensitivity of the detector is at the nanowatt level with flat response to approximately 50 μm . The blackbody and the radiometer are contained in a cryogenically cooled vacuum chamber, which is maintained at about 20 K while it is being operated. This allows low power sources to be calibrated.

Development programs are under way to provide more sensitive detectors for these calibration endeavors and to develop spectral capability for the facility. The spectral capability would be used to fully characterize blackbody sources as well as to allow scientists to characterize the spectral response of detectors.

The facility is available for calibration or research activities on a scheduled basis.

Standard Reference Materials

STANDARD REFERENCE MATERIAL 1804—EIGHTEEN TOXIC VOLATILE ORGANIC COMPOUNDS IN NITROGEN

NIST announced the availability of SRM 1804 intended for the calibration of instruments used for the determination of toxic volatile organic compounds (VOCs) in stationary source emissions. SRM 1804 is a mixture of 18 toxic VOCs, collectively designated as EPA Group 5, in a nitrogen matrix. It should be useful for providing quality assurance and accuracy to measurements of VOCs in air monitoring and research programs and for the development and evaluation of methods used for such measurements.

This SRM was developed through joint support of NIST and the Atmospheric Research and Exposure Assessment Laboratory of the U.S. Environmental Protection Agency in Research Triangle Park (EPA/AREAL/RTP), North Carolina.

SRM 1804 is supplied in an aluminum cylinder with a pressure of 12.4 MPa (1800 psi) with a deliverable volume of 3.6 m^3 (127 ft^3) at normal temperature and pressure. The cylinder conforms to DOT specifications and is equipped with a stainless steel CGA-350 packless valve.

NEW BROCHURES FOR SEMICONDUCTOR AND COATING SRMS

Two new NIST brochures offer quick access to special listings of important standard reference materials (SRMs) for the producers of semiconductors and the manufacturers of coated metal materials. Standard Reference Materials for Semiconductor Manufacturing Technology lists a series of SRMs for use in characterizing semiconductor materials and processes. The SRMs include a series of silicon resistivity materials for calibrating four-probe and eddy-current test equipment, sizing materials for

calibrating optical and scanning electron microscopes, SRMs for mechanical testing, optical measurements, x-ray and photographic films, x-ray diffraction, and the chemical analysis of materials. Standard Reference Materials for Coating Thickness Materials contains a listing of SRMs for calibrating various coating thickness gages. There are materials for calibrating non-magnetic coating on magnetic substrate—copper and chromium on steel, magnetic coating on magnetic substrate—nickel on steel, gold coating on glass sealing alloy, gold coating on nickel, and solder coating on copper. Copies of the new SRM brochures are available from the Standard Reference Materials Program, Rm. 204 Bldg. 202, NIST, Gaithersburg, MD 20899; telephone: 301/975-OSRM (6776).

NIST ANNOUNCES NEW RADIOCHROMIC DYE STANDARD

Standard Reference Material (SRM) 4500 is a new calibration standard for the radiation processing industry. Based on research at NIST, radiochromic dyes change color—blue in this case—when irradiated, and the color intensity increases linearly with radiation dose. They can be used for standardizing measurements of absorbed dose in many radiation processing applications, such as sterilizing medical devices, curing polymer and elastomer materials, testing electronics, and for extending the shelf-life of foods. SRM 4500 consists of a set of flame-sealed amber glass ampoules, each containing 5 mL of solution of a radiochromic dye. These standards are for calibrating cobalt-60 and cesium-137 sources of gamma radiation for absorbed dose in the range from 50 Gy to 5 kGy (5–500 krad). SRM 4500 is available for \$698 from the Office of Standard Reference Materials, Rm. 204 Bldg. 202, NIST, Gaithersburg, MD 20899; telephone: 301/975-6776, FAX: 301/948-3730.

1990-91 SRM CATALOG PUBLISHED

The NIST Standard Reference Materials Catalog 1990-91 (SP 260) lists approximately 1,100 standard reference materials (SRMs) available from the institute. Materials certified for their chemical and physical properties include cements, ores, metals, glass, plastics, food, and environmental standards. Also certified are nutrition and clinical health standards to calibrate instruments that measure marijuana and cholesterol in human urine and serum, fat-soluble vitamins and cholesterol in food products, and levels of the enzyme aspartate aminotransferase (AST) to detect heart attacks. New materials listed include polyethylene samples for

evaluating the performance of plastic gas pipe, a reference material for calibrating non-destructive evaluation systems to detect fatigue cracks and flaws, and sets of low-energy and high-energy test blocks for calibrating Charpy V-notch impact machines. The catalog contains an alphabetical index and a complete numerical listing of the latest renewal SRMs and their certificate dates. Prices for the SRMs are published separately in annual supplements. Copies of SP 260 are available from the Office of Standard Reference Materials, Rm. 204 Bldg. 202, NIST, Gaithersburg, MD 20899; telephone: 301/975-6776.

Standard Reference Data

STANDARD REFERENCE DATA DIRECTORY UPDATED

The Standard Reference Data Program, which evaluates data on the physical and chemical properties of substances, is an important part of NIST's measurement services program for science and industry. Standard Reference Data Publications 1987-1989 (SP 708, Supplement 2) updates the 1964-1984 directory of publications and computerized databases prepared through the National Standard Reference Data System (NSRDS), established in 1963. The supplement contains new information on reprints and supplements from the Journal of Physical and Chemical Reference Data, other NSRDS data compilations, critical bibliographies and indexes from other publishers, and databases available in printed form, on magnetic tape, disks, and through on-line computer networks. Author, materials, and property indexes, as well as ordering information and price lists, are included. To obtain a copy of SP 708, Supplement 2, send a self-addressed mailing label to: Standard Reference Data Program, A323 Physics Bldg., NIST, Gaithersburg, MD 20899; telephone: 301/975-2208.

NEW ION THERMOCHEMISTRY DATABASE AVAILABLE FOR PCs

A new computerized database package with thermodynamic information on the positive and negative ions in the gas phase has been developed by NIST. Designed for personal computers (PCs), NIST Standard Reference Database 19A and 19B, Positive and Negative Ion Energetics, provides rapid access to important information on charged atoms and molecules. Evaluated data on the

thermochemistry of positive ions and negative ions are presented separately in the database package, each with its own software and documentation. Database 19A, Positive Ion Energetics, contains approximately 5,000 values for ionization energies of molecules and radicals, along with enthalpies or heats of formation of the corresponding neutral species and ions. Values for proton affinities of about 1,000 molecules also are provided. Database 19B, Negative Ion Energetics, includes data on electron affinities and gas phase acidities of molecules, and enthalpies of the molecules and corresponding ions. Data on about 2,000 species are given. The NIST ion energetics database package is available for \$130 from the Office of Standard Reference Data Programs, A323 Physics Bldg., NIST, Gaithersburg, MD 20899; telephone: 301/975-2208.

NEW PC DATA FILE ON ATOMIC RADIATION ANNOUNCED

Space scientists, astrophysicists, combustion and fusion engineers, designers of laser systems, and plasma scientists and modelers now have a new reference that can be stored on personal computers (PCs) for analyzing the properties of plasmas and the performance of hot gaseous systems. NIST Standard Reference Database 24, Atomic Transition Probabilities Data File, Scandium Through Nickel, contains numerical data on eight iron-group elements—atomic numbers 21 to 28—that were published in Supplements 3 and 4 to Volume 17 (1988) of the Journal of Physical and Chemical Reference Data. The iron-group elements are of particular interest to space scientists who use atomic spectroscopy techniques to determine the temperatures of stars. The database contains two types of files: numerical files, or tables containing atomic transition probabilities and spectral identification data; and files of references pertaining to the numeric tables. The data file is available for \$125 from the Office of Standard Reference Data Programs, A323 Physics Bldg., NIST, Gaithersburg, MD 20899; telephone: 301/975-2208.