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News Briefs

General Developments

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

NEW METHOD PUTS "TRACE" ON THE HARD-TO-MEASURE

Trace elements, as their name implies, make up just a scant part of material or tissue. But their presence in living cells and high-technology materials often determines if both function properly. Biologists and advanced materials researchers are therefore very interested in knowing precise quantities of trace elements in their subjects. Now a new measurement technique will help researchers answer another question: How are trace elements distributed through a material or a living cell? Scientists at NIST and the National Institutes of Health have built upon a series of improvements in electron energy loss spectroscopy, or EELS, to analyze certain trace elements with very high spatial resolution. EELS is capable of near single-atom detection in specimens as small as 10 nm in diameter. The new method marks the first time that the spatial distribution of trace elements can be measured at such high resolution. The method is particularly good for identifying the rare earth elements and transition elements. NIST will use EELS to study materials, and NIH plans to use it to study biological samples.

CRADA TO IMPROVE SEMICONDUCTOR MEASUREMENTS

NIST and a private company, are working together to develop better measures of the progressively smaller features of integrated circuits. The new approach involves scanning capacitance microscopy, utilizing the ultrasharp tip of an atomic force microscope to produce images of a sample's electrical character (such as that of silicon). The partners, working under a cooperative research and development agreement, are improving the design of a highly sensitive microscope and developing practical techniques for using it to profile key internal structures of semiconductors called junctions. The Semiconductor Industry Association's Technology Roadmap identifies nanoscale junction profiling as essential metrology for the development of future generations of integrated circuits. For the first time, theoretical SCM modeling research is being coupled with the practical measurement and calibration techniques possible with a commercial atomic force microscope. Work on this precompetitive technology is expected to impact the semiconductor electronics industry by giving developers a critical tool for improving integrated circuits. SEMATECH provided specimen junctions in silicon for this research. For technical information, contact Joseph J. Kopanski, A305 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2089.

MORE ACCURATE CAPACITANCE STANDARD IN DEVELOPMENT

Electronic devices operating near absolute zero have produced very accurate electrical standards for voltage and resistance. Now, NIST scientists have passed an important benchmark in the development of a new standard of capacitance based on counting electrons as they charge the capacitor. Previous experiments have tested two electron-counting devices, the electron pump and the electron turnstile, that have transferred electrons with an accuracy of 1000 parts per million. However, metrological applications require errors lower than

1 part per million. NIST researchers have demonstrated an electron pump that operates with errors even slightly lower than this. The device is microfabricated from a linear array of five ultra-small tunnel junctions, each with dimensions of approximately 40 nm. The NIST team believes that even greater accuracy should be possible because the measured error was higher than predicted. This difference was probably due to photon noise from the leads of the device causing unwanted tunneling of electrons, making the electron count less accurate. For a copy of a paper discussing the experiment, contact Sarabeth Moynihan, Div. 104, NIST, Boulder, CO 80303-3328, (303) 497-7765. Ask for paper no. 43-93.

1994 DATES FOR OSE WORKSHOPS SCHEDULED

NIST and the IEEE Computer Society will cosponsor four workshop sessions devoted to advancing the use of open computer systems in 1994. Each workshop is an open public forum composed of participants from information technology industry vendors, major private-sector users, and federal and state government agencies who meet to develop technical implementation agreements needed for interoperable open system products. Current projects focus on communications-related services, electronic commerce, health-care information delivery, library applications and multimedia. The workshop meets quarterly in the Washington, DC, area. The 1994 OSE Implementors' Workshops will convene at NIST in Gaithersburg, MD, on March 14–18, June 13–17, Sept. 12–16, and Dec. 12–16. For technical information, contact Albert T. Landberg, (301) 975-2245. To register for the workshops, contact Brenda Gray, OSE Implementors' Secretariat, B266 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-3664, fax: (301) 926-3696.

NIST HELPS PRIVATE INDUSTRY IN DEVELOPMENT OF FILTERS FOR AUTOMOBILE WIRING HARNESSES

NIST recently has completed a 3 year collaborative project with private companies to develop a material suitable for use in feed-through filters for automobile wiring harnesses. One engineer estimated that use of advanced materials could result in cost savings of up to $20 per car, with costs for shielded feed-throughs reduced by a factor of five. NIST's contribution to the work, carried out under a cooperative research and development agreement with the private company, involved the development of techniques to permit the electromagnetic characterization of very-high-permittivity specimens (ε' approaching 1500) over a frequency range of 1 MHz to 2000 MHz. In coaxial transmission-line measurement methods, in which the specimen becomes the dielectric for the line, there are inevitably small gaps or spaces between the specimen and portions of the apparatus that ideally would be in nondeforming full contact.

In lower-permittivity specimens, the effect of the air gap is proportionally much lower than in high-permittivity specimens of the same physical size. As a result, key measurement challenges for high-permittivity specimens are to reduce the air gap to the greatest extent possible and, at the same time, to devise effective techniques based on modeling for compensating for any remaining gap. The small amounts of experimental material available from the private company and issues relating to the homogeneity of larger specimens precluded the use of methods developed by NIST previously that use large-diameter line to reduce the relative effect of air gaps.

Using a method based on a 14 mm diameter coaxial line, NIST was able to characterize nine different specimens, including specimens made of the same components, but mixed in different proportions. As part of this study, NIST and the private company have examined the fit of the measured data to a theoretical modified Maxwell-Garnet model that predicts the electromagnetic properties of a mixture of two constituent media and found reasonably good agreement. Discussions are continuing regarding further collaborative efforts.

NIST JOINS WITH INDUSTRY TO SPUR DEVELOPMENT OF NANOSCALE PROFILING

In response to high demands from industry for fine-scale semiconductor junction profiling, NIST and a private company, have entered into a cooperative research and development agreement to speed the development of scanning capacitance microscopy (SCM). This new measurement tool combines atomic force microscopy with extremely sensitive capacitance measurements to provide a probe sensitive to a wide range of semiconductor properties. SCM offers the potential for spatial resolution finer than state-of-the-art device dimensions, for example, enabling p-n junction profiling with 20 nm resolution. In its technology road map of what industry needs to do in order to develop advanced integrated circuits, the Semiconductor

Industry Association has identified nanoscale junction profiling as essential metrology and an unmet need. In addition to instrument development, a key aspect of the collaboration is the development of a model of the physics of the SCM measurement; a substantial effort is being made to solve the three-dimensional Poisson's equation for the SCM geometry.

Another major goal is to develop a capability to calibrate SCM measurements of a semiconductor junction. To further this work, the SEMATECH consortium has provided a variety of specimen junctions in silicon, together with corresponding state-of-the-art TCAD (technology computer-aided design) solutions. Additional collaborators with real, state-of-the-art, junction-profiling problems are being sought.

WORKSHOP ON FLAT-PANEL DISPLAY MEASUREMENTS IDENTIFIES POTENTIAL NIST ROLES

A majority of the 56 attendees at the recent NIST Flat-Panel Display Measurements Workshop expressed concern over the status of current standard activities in the field and called for NIST to help with specific suggestions, including the organization of a second workshop within a year. Explosive development of the flat-panel display (FPD) industry has led to new concerns for display video quality metrics and measurement standards. Responding to these concerns, a NIST scientist organized and hosted the workshop, which incorporated a morning session of invited talks from recognized experts in industry and an afternoon open forum for discussion of subjects of greatest interest.

In both sessions, the main topic was the directions in which standards appear to be heading. Reportedly, groups are writing standards that overlap or should relate, but are not talking with each other. It was proposed that NIST could serve as an information hub for worldwide FPD standards and provide through workshops a forum for airing and discussing issues and possibly resolving differences. Specifically, it was suggested that NIST identify all standards connected with FPDs and the status of such standards and provide this information, updated, through some form of electronic dissemination means, broadly accessible to outside queries. It was also recommended that NIST hold a second FPD measurements workshop within a year (some wanted it within 6 months) and (1) arrange to provide tutorials on all current FPD standards and (2) to encourage representatives of all bodies writing FPD standards to attend and to participate in discussion. Proposals were also made that third and fourth NIST workshops should be concerned with procedures for laboratory evaluation of FPD standards.

NIST CONTRIBUTES CHAPTER ON OPTICAL PROPERTIES OF SEMICONDUCTORS TO HANDBOOK OF OPTICS

NIST scientists have prepared a chapter "Optical Properties of Semiconductors" for the Handbook of Optics, Second Edition, to be published by the Optical Society of America and McGraw-Hill. The handbook is intended to provide information needed by the large community of optical and opto-electronic practitioners; anticipated sales are 25 000 copies.

In their chapter, the NIST scientists provide an overview of all the major properties of a wide variety of semiconductor materials, including silicon, gallium arsenide, II-VI semiconductors, and alloy materials. They discuss the physics underlying optical properties and measurements, together with mathematical treatment; references to relevant prior reviews; representative examples from the literature; tables of values of various optical parameters; and identification and discussion of important developments. The chapter also incorporates a comprehensive review of important methods for determining optical properties of semiconductors, including information on accuracies and limitations.

NIST PROVIDES BIOEFFECTS COMMUNITY WITH PRIMER FOR THE CONDUCT OF IN-VITRO STUDIES WITH POWER-LINE FREQUENCY ELECTRIC AND MAGNETIC FIELDS

The journal Bioelectromagnetics recently has published in a special supplement "Biological, Physical, and Electrical Parameters for In Vitro Studies with ELF Magnetic and Electric Fields: A Primer," which incorporates guidance developed under the leadership of a NIST scientist for establishing and characterizing exposure conditions. Misakian's collaborators included both biologists and biophysicists. This work complements an earlier primer developed by Misakian for investigators of the effects on small animals of extremely low-frequency (ELF) electric and magnetic fields. Both primers address the needs of individuals who have expertise in other fields but are relative neophytes with respect to the measurement and control of critical electric and magnetic parameters. In-vitro research, especially with respect to the effects of

power-frequency magnetic fields, has received new impetus as societal concerns grow for possible effects on humans and as definitive experiments are sought to demonstrate the mechanism underlying any such effects. The primer identifies electrical and biological parameters that may be encountered in the course of in-vitro studies with ELF electric and magnetic fields and describes how the fields can be produced for exposure purposes, how the fields can be measured, and how the fields can be calculated for some situations. In particular, the text addresses the influence of the geometry of the culture medium-magnetic field combination on the exposure conditions for cells during in-vitro studies with magnetic fields. The primer also discusses and identifies the many biological and physical (other than electrical) parameters that introduce experimental constraints and that must be recognized when an exposure system is designed and operated. For example, a biological factor that needs to be considered is cell type, which affects a number of culture conditions, including method of culture, choice of substratum for growth, medium constituents, pH, and CO_2/O_2 tension.

NIST SIGNS CRADA WITH PRIVATE COMPANY TO IMPROVE THE ACCURACY OF PRESSURE MEASUREMENTS

The most accurate primary pressure standards in the atmospheric pressure region historically have been mercury manometers, with stated uncertainties in the few parts-per-million range. Recently, advances in large-diameter piston and cylinder manufacturing technology and dimensional measurement capabilities allow the possibility of deadweight piston gauges to be used as primary pressure standards that are truly competitive with manometry. NIST has entered into a cooperative research and development agreement with, a piston gauge manufacturer, to build and characterize a new class of piston gauges having pistons and cylinders of 50 mm diameter and made of a ceramic material. Initial measurements have been made by the dimensional metrology group of the diameter of the parts with an uncertainty of 0.050 μm, which results in an overall uncertainty in the dimensional effective area of the gauges of 2 parts per million (2σ level). Measurements to investigate gas species and mode-of-operation effects in these gauges is continuing.

GEOMETRIC-THERMAL MACHINE TOOL ERRORS PREDICTED BY NEURAL NETWORKS

In machining operations, the accuracy of the workpiece dimensions depends on the accuracy of the relative position of the cutting tool and the workpiece. Among the key factors that affect the accuracy of this relative position are the geometric errors of the machine tool and the thermal effects on those geometric errors. Rigid body kinematic models can be used to relate work volume errors to individual axis-related geometric-thermal error components. Individual error components are often modeled as polynomial functions of slide position and temperature state of the machine, which typically is measured by thermal sensors located on the machine tool. An alternative method of modeling the individual error components has been developed by NIST. Instead of polynomial functions of axis position and selected temperature measurements, neural networks have been used as a technique of developing mappings between patterns of recorded position and machine thermal states and measured component errors. Results show that neural networks, using conjugate gradient descent methods for training, will develop highly accurate mappings. The final computed residuals between the predicted component errors and the measured component errors consistently have a near zero mean and a standard deviation, which is within the resolution of the corrections available for the machine tool. As a consequence of this work, the use of neural networks potentially has shown itself to be a simple and accurate technique for machine tool error characterization.

U.S. PATENT AWARDED TO NOVEL X-RAY PHOTOEMISSION SPECTROSCOPY SYSTEM INVENTED AT NIST

The U.S. Patent Office has awarded a patent for an "X-Ray Photoelectron Emission Spectrometry System," which was developed at NIST. The device was invented by a NIST scientist in collaboration with a visiting scientist from Murdoch University in Perth, Australia.

The system consists of a movable x-ray source, which produces a beam of parallel x rays; a detector to measure the reflected intensity of the x rays from the sample; and an electron spectrometer to measure the energy distribution of photoelectrons

emitted from the sample. By illuminating the sample with x rays at different grazing angles, the penetration depth of the radiation can be varied, down to a limit of less than 2 nm. The reflected intensity of the x rays provides a sensitive measure of the sampling depth, the presence of layers, and the smoothness of the sample surface.

The grazing incidence x-ray photoemission system has proven to be very useful for analyzing different chemical components in the oxides of semiconductors. These oxides are used as insulation in transistors on integrated circuits. The formation of multiple oxides on certain compound semiconductors such as gallium arsenide has hindered their use as materials for faster transistors. The invention improves on existing x-ray photoemission spectroscopy by not only measuring the presence of various chemical species, but obtaining the depth distribution of these species in the important 1 nm to 5 nm depth range as well.

ISO GUIDE TO THE EXPRESSION OF UNCERTAINTY IN MEASUREMENT

The 100 page Guide to the Expression of Uncertainty in Measurement, the culmination of a 16 year effort to reach an international consensus on expressing measurement uncertainty, has now been published by the International Organization for Standardization (ISO). In the name of seven organizations that supported its development: the International Bureau of Weights and Measures (BIPM), the International Electrotechnical Commission (IEC), the International Federation of Clinical Chemistry, ISO, the International Union of Pure and Applied Chemistry, the International Union of Pure and Applied Physics, and the International Organization of Legal Metrology (OIML).

The guide represents the current international view of how to express measurement uncertainty based on the approach recommended by the International Committee for Weights and Measures (CIPM) in 1981. The CIPM approach already has been adopted by many organizations, including NIST, the Western European Calibration Cooperation, EUROMET (an organization that coordinates the work of European national standards laboratories), the National Conference of Standards Laboratories, and several large U.S. companies. Publication of the guide is expected to give further impetus to the worldwide adoption of that approach.

The guide was prepared by a joint working group consisting of experts nominated by the BIPM, IEC, ISO, and OIML. Two NIST scientists played a major role in the preparation of the guide. They are also the authors of NIST Technical Note 1297, Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results. Technical Note 1297 succinctly summarizes the most important aspects of the ISO guide and was prepared to help the NIST staff put into practice the new NIST policy on statements of uncertainty associated with measurement results. This policy, reprinted as Appendix C of TN 1297, was adopted by NIST in October 1992.

LASER-FOCUSED ATOMS CREATE NANOSTRUCTURES

Researchers at NIST have demonstrated successfully a new process using lasers to fabricate nanometer-sized metallic structures on a surface. Reporting their work in the November 5, 1993 issue of *Science*, they describe experiments in which a chromium atomic beam is collimated using laser cooling, and then focused in a laser standing wave which grazes across the surface of a silicon wafer. The nodes of the standing wave act as an array of "atom lenses," focusing the chromium atoms into a series of lines as they deposit onto the surface. Examination of the surface with an atomic force microscope after removal from the vacuum system has revealed an array of chromium lines 34 nm high and 65 nm wide. The lines are spaced by 213 nm, or exactly half the wavelength of the laser light, and uniformly cover an area of almost a square millimeter.

The research is the first step in the development of a wide range of extensions and applications of nanostructure fabrication by laser focusing of atoms. A major advantage that this technique has over other methods, such as electron beam lithography, is the fast, parallel nature of the fabrication—an entire square millimeter can be patterned in about 10 min. In addition, theoretical calculations show that the ultimate feature size could be as small as 10 nm or less. Large arrays of structures could also be fabricated by using a two-dimensional standing wave to make an array of dots and by scanning the substrate. Eventual applications may include the fast, accurate fabrication of nanostructured materials or devices for microelectronics or micromagnetics, and the fabrication of length standards on a microscopic scale.

NIST AND STATE GOVERNMENTS SPONSOR WORKSHOP ON RADIOACTIVITY MEASUREMENT NEEDS

Analytical methods and procedures driven by regulatory requirements tend to be prescribed and inflexible. However, regulators involved with environmental restoration and decontamination and decommissioning of operations and buildings are still grappling with approaches to radioactivity analyses. The lack of regulatory policies creates an opportunity for the measurement community to have major impact on future formulation of approaches to needed radioactivity measurements. NIST co-sponsored a workshop Oct. 28–31 in Montgomery, AL, on Procedures for the Sampling and Radioassay of Materials with a major stakeholder in radioactivity measurements—the state governments—as represented by the Conference of Radiation Control Program Directors. Attending along with NIST and state representatives were commercial contractors and participants from government agencies. The outcome of the workshop will be a first draft of selected procedures for sampling and radioassay that will be recommended to the radiation control directors for the 50 states.

CIRMS MEETS AT NIST

The Council on Ionizing Radiation Measurements and Standards (CIRMS) held its first anniversary meeting at NIST Nov. 8–10, 1993. The organization represents thousands of users of ionizing radiation, radioactive sources, and tracers engaged in industrial radiation processing and sterilization, medical radiation therapy and diagnostics, nuclear power, and radiation worker protection programs. CIRMS provides a forum for discussing ionizing radiation measurements and standards issues, defining and prioritizing needed work, disseminating information on standards, and organizing workshops and meetings to advance ionizing radiation technology. About 90 participants attended the meeting, which highlighted the medical applications of ionizing radiation. Topics included radiation therapy and diagnosis, and the latest developments in radiation sterilization of medical supplies and blood, electron beam processing of plastics, and irradiation of foods.

RADIATION-THERAPY DOSE MAPPING WITH A NEW X-RAY IMAGING CAMERA

Under a cooperative research and development aggreement with NIST, a private companyhas developed an x-ray imaging camera with the potential of simultaneously measuring in real time the profiles of tissue density and of radiation dose in a patient undergoing radiation therapy. The efficacy of cancer treatment by beams of ionizing radiation is greatly dependent on the precision with which a large radiation dose can be delivered to the tumor site, while holding to sufficiently low-dose levels elsewhere in order to spare nearby healthy structures. Optimizing the dose distribution is the goal of much current work on focusing radiation using either scanned pencil beams or shaped beams from multiple directions. Delivered doses are predicted using elaborate treatment planning algorithms based on phantom measurements done in rather simple geometry. Nothing is presently available with which an on-line, real-time, noninvasive measurement of the actual dose delivered can be made (and possibly used to control the dose delivery).

The new camera consists of an array of 100 thin x-ray detectors positioned near the patient. The digital signals from x rays in the radiation beam are processed to perform one-sided computed tomography. Proof of principle has been demonstrated using simple phantoms. Calibrations with a variety of phantom structures and with various beam modalities and energies are crucial to accurate performance. These will be carried out at NIST facilities in collaborative studies with medical physicists from Johns Hopkins Medical Institute.

STANDARDS FOR INTERNATIONAL TIME COMPARISON

NIST played a key role in the development of a new standard for international time comparisons. The objective of the new standard is to improve satellite time comparisons between international standards laboratories to the 1 ns level. The standard, issued by a subcommittee operating under the Consultative Committee for the Definition of the Second, refines the data processing methods and data format for GPS common-view time transfer. This

time-transfer concept was developed by NIST and proved to be so precise and convenient that it has become the method of choice for international time coordination. Aside from the initial development of the concept, staff from NIST have contributed substantially to this recent refinement. Four NIST scientists participated in the work of the subcommittee and one of them rewrote the software that controls the data acquisition and processing in the GPS timing receivers used by most participants. This software involves more than 15 000 lines of assembly-language code that reside in read-only memory in the receivers. The software is to be made available to commercial manufacturers of the receivers for distribution to users.

SPECTRAL PURITY MEASUREMENTS

Techniques originally developed for measuring phase-modulation (PM) noise in oscillators and other electronic components have been extended to include amplitude-modulation (AM) noise. The ability to characterize both AM and PM noise means that NIST can now handle complete specification of spectral purity.

The NIST systems can measure spectral purity for carrier frequencies ranging from 5 MHz to 75 GHz at Fourier frequencies extending out to 10 percent away from the carrier or 1 GHz (whichever is smaller). A major consequence of the work is that the ratio of AM-to-PM noise found in many different electronic components can now be measured precisely. It has long been thought that non-linearities in active devices such as transistors generate PM noise preferentially. In fact, the NIST work demonstrates that most simple active devices generate almost equal amounts of AM and PM noise power. This suggests that the much simpler AM measurements can be used to set a bound on the PM noise found in particular components. This should prove very useful to circuit designers. The work also raises new questions about the nonlinear processes that generate PM and AM noise in such devices.

PRECISION FREQUENCY MEASUREMENTS USED TO IDENTIFY INTERSTELLAR IONS

A NIST scientist has made highly accurate (0.1 part per million) measurements of the fine-structure frequencies of singly ionized atomic nitrogen (N^+). This measurement and other high-accuracy spectral measurements by NIST have been supported by NASA's Office of Laboratory Astrophysics. The objective of such accurate spectral measurements is to provide sufficient information on atomic and molecular species to enable searches in the upper atmosphere and the interstellar medium. The N^+ measurements provided solid confirmation of tentative radio astronomy observations of this species which is an important constituent of the interstellar medium. Aside from confirmation of this particular measurement, the laboratory measurements define a second well-defined frequency that can be used in future radio astronomy studies.

EVIDENCE FOR MAGNETIC FIELD ANNIHILATION ON THE SURFACE OF STARS

It has long been suspected that magnetic energy is converted into motions and heat on a grand scale on stellar surfaces. NIST scientists now have discovered a stellar magnetohydrodynamic laboratory for studying this process in detail. Understanding the physical processes that result in efficient energy conversion is critical for developing controlled fusion as a commercial energy source. NIST scientists are developing some of the atomic physics tools needed to infer plasma properties from the emitted radiation. In this case they have analyzed the ultraviolet emission lines of three-times ionized carbon and silicon from the star AU Microscopii observed by the Hubble Space Telescope. They find that these emission lines, formed in gas at about 100 000 K, are very broad with wings extending to 200 km/s from line center. Line profiles this broad are seen over small portions of the solar surface where new magnetic flux is emerging from the interior, producing interactions with the pre-existing field that convert magnetic energy into high-speed motions and heat. It is believed that the new Hubble data provide the first clear evidence for magnetic field emergence and annihilation on a star, but in the case of this very active star, the phenomenon occurs on a far grander scale than in the Sun.

WORKSHOP ON COMPOSITE MATERIALS FOR OFFSHORE OPERATIONS

On Oct. 26–28, 1993 NIST and the Department of Interior sponsored an international workshop on Composite Materials for Offshore Operations at the University of Houston. Over 200 representatives from the oil industry, material suppliers, and regulatory agencies participated in eight working groups to identify and prioritize research and

technology needs to allow the safe and economical use of composite materials for offshore exploration and production. Fiberglass composites currently are used in nonstructural applications to reduce topside weight and to avoid corrosion problems. The long-term goal is to use advanced composites to enable drilling operations in deep water. Design innovations using composites for risers, drill tubes, and tethers are essential to economically exploit oil and gas resources in water depths over 2000 m. The industry representatives developed plans to form a consortium to meet the research and technology needs that were identified.

NEW JOINT VENTURES WITH INDUSTRY AT THE CNRF

Two private companies have established agreements with NIST to join in the development and utilization of a new world-class spin echo spectrometer, and in improved small-angle scattering capabilities at the NIST Cold Neutron Research Facility (CNRF). The spin echo spectrometer, which allows unique measurements of the details of dynamic processes in the 10^{-7} s to 10^{-10} s time regime in polymers, colloids, biological molecules, and magnetic systems, will be the only such instrument in the United States for the next decade. One of the companies will pursue fundamental and applied research on polymers, organic mixtures, the behavior of complex fluids in porous media, and other materials of interest using the improved small-angle neutron scattering spectrometer in the guide hall.

SCANNING ACOUSTIC IMAGING OF STRESS (SAIS)

An acoustic microscopy technology has been developed at NIST that permits the imaging of stresses in bulk materials. Stresses that develop during processing or thermal cycling during service are important in many technological applications because they can degrade performance and lead to premature failure. For example, multilayered semiconductor devices, welds, and fiber optic components are sensitive to such stresses. In this new technique, differences in the acoustic polarized wave amplitude in stressed and stress-free volumes are used to image the stress field. Theoretical models of thermally induced stress distributions have been verified using this technique in layered abrasive discs and electronic components.

CREEP STUDIES ON CERAMICS FOR ADVANCED ENGINE APPLICATIONS

Ceramics are expected to play a major role in future engines for power generation and transportation. As these applications call for extended service (thousands of hours) at high temperatures (>1400 °C), load bearing components must exhibit excellent creep properties, i.e., a high resistance to time-dependent deformation and rupture.

NIST scientists have been engaged in a comprehensive study of the high-temperature creep of structural ceramics. This effort currently is focused on silicon nitride and is being conducted in conjunction with various U.S. producers of this material. This study involves detailed microstructural analysis and defect characterization. Having established that creep deformation results in the formation of cavities (or pores), which ultimately are responsible for failure, a unique three-stage characterization procedure has been adopted to obtain a quantitative description of accumulated cavity damage. This approach first involves high accuracy density measurements to determine the total volume fraction of cavities, followed by small-angle x-ray scattering analysis to obtain the macroscopic distribution of cavity sizes in terms of their volume fraction or number density, and finally, examination by analytical transmission electron microscopy to obtain a detailed description of the cavities and their relationship to the material's microstructure. These studies are expected to provide the basis for models that relate creep lifetime to imposed service conditions and microstructure, which will guide the development of improved ceramics for advanced engine uses.

NIST COMPLETES PHASE 1 OF COOPERATIVE RESEARCH WITH PRIVATE COMPANY

Researchers from NIST and a private company have just completed the joint development of a building emulator for heating, ventilating, and air conditioning systems. The emulator was built on a PC platform; emulates a typical variable air-volume air-handling system with electric actuators, valves, and dampers; and has an interface panel to connect the simulation program to an energy management system. The emulator is now being refined and tested at the private companies laboratories. The company's researchers plan to use the emulator to verify that new control algorithms have been implemented correctly in prototype products, to emulate the performance of final products, and for training company engineers to design and test control

systems. NIST and the company plan to document and publish information on the benefits to the controls industry of using emulators in this manner.

NIST RELEASES COMPUTER PROGRAM MOIST

NIST has just released version 2.0 of MOIST, a computer program that predicts heat and moisture transfer in building walls, cathedral ceilings, and low-slope roofs. The MOIST user is able to investigate the effect of various parameters on moisture movement and accumulation within the building envelope. These parameters include climate, building materials, the use and placement of vapor retarders, and the relative placement of building materials. The capability of MOIST to predict the moisture accumulation within each building material as a function of time allows the user to select the most appropriate building materials and construction for a given climate.

MOIST was developed as a joint effort between NIST and the Virginia Polytechnic Institute and State University. Currently, over 130 researchers, consultants, and practicing engineers across the United States use MOIST for general building design. NIST scientists also use MOIST to recommend moisture control guidelines for use by the Department of Energy and the Department of Housing and Urban Development.

NIST ESTABLISHES PANEL ON FEDERAL INTERNETWORKING REQUIREMENTS

NIST has established a new interagency panel to reassess federal requirements for open systems networks. The Panel on Federal Internetworking Requirements, composed of representatives from eight federal agencies, also will recommend policy on the government's use of networking standards. The panel was created at the request of the Office of Management and Budget in collaboration with the Federal Networking Council and the Federal Information Resources Management Policy Council.

Specifically, the panel will address concerns about the incompatibility of the Internet Protocol Suite (IPS) and Open Systems Interconnection (OSI) specifications as well as other proprietary network protocols. The federal government has participated in the development of the IPS and OSI specifications. Other issues the panel will consider include federal requirements for network features such as global connectivity, the maintenance of standards, and security concerns. Agency costs and the use of protocols not included in IPS or OSI specifications also will be reviewed. The panel will forward recommendations to NIST which develops and maintains Federal Information Processing Standards (FIPS) for federal government use in computer and related telecommunications systems.

FIPS FOR THE USER INTERFACE COMPONENT OF THE APPLICATION PORTABILITY PROFILE (APP) REVISED

The Secretary of Commerce approved a revision to FIPS 158, "The User Interface Component of the Application Portability Profile." To be published as FIPS 158-1, the revised standard adopts updated X Window system specifications developed by a broad-based industry consortium for a consistent user interface to network-based applications. An important component of the APP, which NIST developed to meet federal agency requirements for an open systems architecture based on standards, FIPS 158-1 will enable users to develop applications independent of the display hardware or computer system on which the applications run. The revised standard is effective May 2, 1994.

NEW PUBLICATION DESCRIBES REFERENCE MODEL FOR SOFTWARE ENGINEERING ENVIRONMENTS

A software engineering environment (SEE) deals with information about the software under development, project resources, and organization policy, standards, and guidelines on the production of software. NIST Special Publication 500-211, Reference Model for Frameworks of Software Engineering Environments, provides a reference model for SEE frameworks and describes the role of the framework within the context of the environment. Superseding two previous versions, this third edition of the technical report includes major changes such as the addition of operating system services, enhanced user interface services, a rewritten policy enforcement clause, and replacement of the graphic describing the model. The document was prepared jointly by NIST and the European Computer Manufacturers Association.

USERS' FORUM ON THE APPLICATION PORTABILITY PROFILE (APP) AND OPEN SYSTEMS ENVIRONMENT (OSE) ATTRACTS LARGE TURNOUT

The APP/OSE Users' Forum met Nov. 16–17 to share information and give users an opportunity to respond to NIST proposals on the evaluation and adoption of an integrated set of standards to support the APP and OSE. About 160 users and providers from government and industry attended the workshop.

The forum focused on two major topics of significant interest to the federal community: the Federal Electronic Commerce Initiative and the OSE Procurement Update.

The program included a tutorial on basic concepts of the OSE Reference Model, a status report on OSE standards, current reviews of network protocol standards, multimedia issues, distributed platform profile, and the issue of distributed system management. The next workshop is scheduled for May 1994.

USER'S GUIDE FOR 1978 FORTRAN COMPILER VALIDATION SYSTEM ISSUED

NIST has published a new user's guide that describes the Fortran Compiler Validation System (FCVS78), which evaluates compilers for conformance to FIPS 69-1, Fortran. NISTIR 5287, 1978 Fortran Compiler Validation System User's Guide, Version 2.1, presents the procedures required to use the validation system. NIST offers the validation service to vendors wishing to have a compiler validated for their own purposes; vendors wishing to have a compiler validated in response to a government request for proposal; government agencies involved in a procurement; government agencies wishing to validate a compiler already in use; or other organizations, where the validation of a compiler benefits the federal government.

CRADA SEEKS HIGH-ACCURACY RADIATION DOSIMETERS

A new government/industry collaboration plans to improve radiation exposure measurements in areas such as medical therapy and industrial processing. A private company recently signed a cooperative research and development agreement with NIST to develop dosimeters based on the amino acid alanine. When alanine crystals absorb ionizing radiation, alanine radicals are formed. Scientists can measure these radicals using a technique called electron paramagnetic resonance spectrometry and then relate their quantity to an accurate absorbed radiation dose. When mixed with a polymer binder, alanine dosimeters can be made in the shape of pellets, films, cylinders and cables. Because they are very stable, they can be archived as a permanent record of radiation exposure. NIST and the private company intend to develop alanine dosimeters for the lower radiation levels used in radiotherapy as well as the higher levels in product sterilization, pest control, food preservation and polymer curing. The collaborators hope this effort will lead to inexpensive, mass-produced alanine dosimeters for medical and industrial users of radiation in the United States and abroad.

ENCRYPTION ALGORITHM REAFFIRMED UNTIL 1998

The Data Encryption Algorithm, developed for federal use and employed widely by industrial, financial and other institutions to protect computer data, has completed the third review in its 16-year history and been reaffirmed for 5 years. Comments from interested parties were evaluated and used to make revisions in the Data Encryption Standard that will be specified by Federal Information Processing Standard 46-2, effective June 30, 1994. The primary modification of the standard allows the implementation of the Data Encryption Algorithm to include software, firmware, hardware or any combination thereof. During the 5-year affirmation period, NIST will consider security alternatives to the DEA as it will be over 20 years old when next reviewed in 1998. For more information, contact Miles Smid, Computer Systems Laboratory, A216 Technology Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2938.

NEW METHOD MEASURES COMPUTER DISKS MAGNETICALLY

As computer disks and tapes become smaller and the amount of data gets more compressed, manufacturers need ever more precise measurements to ensure the accuracy of their products. To meet this need, NIST has developed a new mode of magnetic-force microscope with a nonvibrating sensing tip. This device can measure magnetic signatures as small as 100 nm, or about one-thousandth the size of a human hair. To do this, the microscope basically plots a magnetic map of the surface of the disk or tape. First, the instru-

ment acts as an atomic-force microscope to map the surface roughness. With these data programmed in, the device makes a second sweep as a magnetic-force microscope. When the roughness data are subtracted, "what you get out is a pure magnetic signature," says the project's group leader. For more technical information, contact Paul Rice, Div. 814.05, NIST, Boulder, CO 80303-3328, (303) 497-3841.

TIME Q&As, STANDARDS FEATURED IN FACT SHEETS

Two topics that are frequently the subject of inquiries to NIST are highlighted in separate news features now available from the institute's Public Affairs Division. The first, "Never a Dull Moment at NIST's Time Division ... or, Just Keep Those Cards and Letters Coming, Folks!," looks at the many questions relating to time, time zones, calendars and the like that are received by NIST. Along with a humorous peek at some unusual queries, the feature includes answers to the most commonly asked time questions. The second fact sheet, "NIST Support to Industry on National and International Standards Activities," details the work of NIST's Office of Standards Services, assisting industry and the federal agencies in their efforts to improve the acceptance of U.S. technology and manufacturing practices and to promote more effective U.S. contributions to international standardization, conformity assessment, quality assurance and testing activities. To obtain a copy of either fact sheet, send a self-addressed mailing label to Public Affairs, A903 Administration Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2762.

ACOUSTIC FIRE DETECTION "SOUNDS" GOOD FOR BUILDINGS

Few sounds are more appealing this time of year than the cracking and popping of wood blazing in the fireplace. But fire also can produce sounds the human ear cannot hear. Researchers at NIST are using acoustic emission transducers to detect a fire hazard in the making. Heat from a small fire inside a wall, ceiling or an overloaded electrical circuit can cause the surrounding materials to expand and emit sound at very high frequencies. NIST researchers found that trapped moisture boiling or plastic bubbles bursting send out a characteristic "acoustic signature" that can be detected before the material bursts into flames. In recent laboratory tests, NIST's fire experts were able to "hear" these sounds up to 3 m from the heat source. Additional real-life fire testing is needed as well as more research to screen out false alarms. For technical information, contact William Grosshandler, B356 Polymer Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2310, e-mail: wgrosshan @enh.nist.gov (via Internet).

NEW NEUTRON DIFFRACTOMETER SPEEDS CRYSTALLOGRAPHY

Scientists at NIST's research reactor are using a new neutron diffractometer to determine atomic structures of superconductors, ceramic powders and other 21st-century materials. The new diffractometer, which has 32 detectors, collects data approximately 10 times faster than the instrument it replaces (which had five detectors) and also gives far better resolution. "Experiments are now being performed that would not have been feasible in the past," explains a NIST scientist. "For example, data can be collected on samples as small as a half a gram or at 10 temperatures in a single day." Scientists use data from the diffractometer to make three-dimensional maps of atomic arrangements in advanced materials. Information from these studies can reveal how certain elements influence the properties of materials. They also help scientists create new materials with specific properties for a desired application.

NIST JOINS EFFORT TO IMPROVE U.S. STEELMAKING

Scientists at NIST are research participants in two of six projects making up the Advanced Process Control Program, a cooperative effort between the American Iron and Steel Institute and the Department of Energy. Development of process control systems for steelmaking could save U.S. producers an estimated $300 million annually. Advanced process controls will enable industry to achieve more efficient production of consistently higher-quality finished products. Current technology does not permit continuous on-line measurements. The two projects involving NIST researchers concern microstructure engineering in hot strip mills, and on-line, nondestructive mechanical properties measurement. For information on NIST participation, contact George Birnbaum, Office of Intelligent Processing of Materials, B344 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-5727, e-mail: birnbaum@micf.nist.gov (via Internet); for the AISI/DoE program, contact Lawrence W. Kavanagh, AISI, 247 Fort Pitt Blvd., Pittsburgh, PA 15222, (412) 566-2322.

ASSISTANCE TO STATE TECHNOLOGY PROGRAMS PLANNED

NIST has announced its intention to seek proposals for three projects to help states plan, coordinate and implement technology extension activities. The projects, corresponding to the State Technology Extension Program, will provide assistance to states (1) wishing to create extension system plans, (2) needing support for the initial implementation of such programs, or (3) wanting to link their programs to those in other regions to enhance effectiveness. A formal notice requesting proposals is expected to be published in the Federal Register in February. For more information, contact Douglas Deveraux, B115 Polymer Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6466, e-mail: douglasd@micf.nist.gov (via Internet).

POWDERS AND SLURRIES CONSORTIUM SIGNS FIRST MEMBERS

Five manufacturers that produce ceramic powders or make components from silicon nitride materials, an instrument company, and a federal laboratory have committed to join an industry/government effort to improve the processing of ceramic powders and slurries. The project is sponsored by NIST and the Oak Ridge National Laboratory is a participating partner. The consortium's goal: to develop nondestructive evaluation tools for industry. New measurement techniques, standards, and data to monitor the critical parameters—microstructures and chemistry—in powders and slurries will help produce quality products at lower costs. For information, contact Subhas G. Malghan, A256 Materials Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-6101, e-mail: malghan@enh.nist.gov (via Internet).

NIST ANNOUNCES AVAILABILITY OF SPECIAL-TEST MEASUREMENTS FOR HIGH-FREQUENCY PHASEMETERS

In response to industry needs, new capabilities have been established by NIST that extend existing services for phase meters and standards. Phase meters can be calibrated at frequencies to 20 MHz (formerly limited to 50 kHz), and measurements of phase standards now can be carried out at any desired phase angle (formerly limited to 0 degrees, 90 degrees, 180 degrees, and 270 degrees).

A major motivation for the first of these improvements has been the discovery by NIST that phase measurements were limiting the accuracy of the laser heterodyne interferometers universally used for measuring displacement in the manufacturing and research sectors (U.S. instruments are world standards). Earlier, NIST demonstrated to U.S. industry a practical fix that can improve the precision of existing interferometer systems by factors of 10 to at least 55, and established methods for conducting the 1 MHz to 20 MHz and microsecond update-rate measurements required. The expanded service depends in part on this development in which a pair of synchronized function generators, together with a time-interval analyzer, is used to determine phase-angle linearity between 50 kHz and 20 MHz. This approach can be used for both static and dynamic tests, and provides uncertainties from ± 0.05 degrees to ± 0.25 degrees.

The service also uses a new precision phasemeter with a dual-channel, 16 bit, one-million-samples-per-second sampling system, which digitizes both sinusoidal input waveforms over a large number of periods. Signals are processed by computer, implementing a three-parameter sine-fit algorithm, to provide good estimates of the amplitude, phase, and dc offset. The complete measurement system is used to determine phase linearity of phase standards (generators) up to 100 kHz at any phase angle to a basic uncertainty of ± 0.003 degrees. Two customers already have requested measurements on commercial phase generators needing these capabilities.

NIST HOSTS WORKSHOP ON ADVANCED COMPONENTS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES

In response to growing nationwide pressures for the early introduction of practical alternatives to conventionally powered vehicles, NIST recently hosted the Workshop on Advanced Components for Electric and Hybrid Electric Vehicles. The principal goals of the workshop were to define the state of the art in the various key technologies required for electric/hybrid electric vehicles to succeed, with emphasis on innovative approaches, and to identify the standards, design, manufacturing, and other challenges to the full exploitation of these technologies. In particular, the workshop focused on vehicle systems and components for energy storage and conversion and for power delivery, control, and management. The major outcome of the workshop will be its proceedings, to be published as a NIST Special Publication early in 1994. It will present in

a single reference source a detailed statement of present status for each of the technology areas, technology area summaries and projections, and general conclusions.

The workshop was organized under the leadership of a NIST scientist working with the Interagency Task Force on Electric and Hybrid Vehicle Technologies, and sponsored by the Technology Administration, U.S. Department of Commerce. In addition to DOC, cooperating member agencies of the Interagency Task Force included the Departments of Defense, Energy, Interior, and Transportation; the National Aeronautics and Space Administration, the Environmental Protection Agency, the National Science Foundation, the Interagency Power Group, and the Office of Science and Technology Policy.

The workshop drew some 180 persons from industrial, academic, and government organizations. The format of the meeting provided both general overviews by invited speakers and parallel sessions for in-depth discussion of key components. The parallel sessions dealt with energy conversion systems (heat engines, fuel cells), energy storage systems (batteries, flywheels, ultracapacitors), electric propulsion systems (electric motors, motor controllers, regenerative braking systems), controls and instrumentation (on-board emission sensors, energy management systems), and ancillary systems (air conditioning, power steering, tires, charging systems).

NIST DEVELOPS CALIBRATION METHODS TO SUPPORT INTRODUCTION OF NEW OPTICAL DEVICES FOR TRANSMISSION GRID MEASUREMENTS

As part of NIST efforts to provide measurements needed by the electric utility industry to meet growing societal concerns for the reliability of electric power transmission and distribution, NIST has begun the development of calibration methods for optical current transducers (OCTs) under a cooperative research and development agreement (CRADA) with a private company. OCTs are under development by several manufacturers for electricity metering and overcurrent protection applications and offer potentially significant advantages in reliability and safety as replacements for existing current transformers on high-voltage lines, where a number of oil-filled units have failed catastrophically, causing significant equipment damage and constituting a serious hazard to maintenance personnel. In production, OCTs should cost much less than conventional transformers. However, OCTs will require NIST calibration traceability if they are to be used for revenue metering.

Calibration techniques used for conventional current transformers are not directly applicable to OCTs because the OCT has a low-power output, rather than the high-power output of the current transformer. The all-dielectric construction of the OCT renders it intrinsically safe for use in high-voltage environments and eliminates the explosion hazard. An additional advantage of the OCT is that its low-power output is directly compatible with the digital electronics now used in electric power systems for monitoring and control. Under the CRADA, a private company recently delivered one of its OCTs to NIST; the device is designed for use on 500 kV lines for measurement of currents in the 200 A to 4000 A range.

WORKING GROUP ON CIRCUIT SIMULATOR MODEL VALIDATION FORMED UNDER NIST LEADERSHIP

A NIST scientist has spearheaded the formation of the NIST Working Group on Model Validation, a NIST-industry activity intended to establish well-defined procedures for the comprehensive evaluation of circuit simulator models. The working group already has attracted some 60 representatives of the electronics industry with expertise in electronic component design and manufacturing, model development, software development, component characterization, and circuit and system design. An organizational meeting of the working group was held in conjunction with the recent IEEE Industry Applications Society annual meeting. The 26 attendees expressed enthusiasm for the concept and indicated that they will support the group; they believe its function is likely to have substantial positive impact both on the collective capability of U.S. industry to design new power electronic systems and to effectively design new component types.

As new semiconductor device types are introduced, new circuit simulator models must be developed to support the efficient, timely design of electronic systems that are to use the new device types. Questions have been raised in industry as to the adequacy of the models. The working group will develop methods to test the models so that circuit designers will be able to use evaluated models with confidence. In developing test methods, the working group will determine the complete range of

dynamic conditions that must be described for each device type and define test circuits that mimic application conditions.

DIN STANDARDS PUBLISHED IN ENGLISH

As a result of an agreement negotiated by a NIST scientist, 35 German test method standards for evaluating semiconductor materials and high-purity chemicals and gases for semiconductor manufacturing use have been published in English translation by ASTM (American Society for Testing and Materials). The standards were originally developed by Deutsches Institut für Normung (DIN, the German Standards Institute) Committee NMP-221 on Testing of Materials for Semiconductor Technology.

Of the 35 standards, more than half are for measurements not standardized by ASTM, so publication by ASTM provides a substantial addition to the body of test methods for semiconductor technology available in English. In addition, of those closely related to existing ASTM methods, several employ differing but complementary technical approaches that also have value. All told, the ASTM and DIN test methods total over 95 percent of all test methods for semiconductor manufacturing technology available in any language.

As specific examples of the impact of these DIN standards, five test methods provide sensitive analysis techniques for impurities in process chemicals that are cited in industry specifications developed by Semiconductor Equipment and Materials International and used worldwide.

INDUSTRIAL PARTNER COLLABORATES IN DEVELOPMENT OF A NEW STANDARD FOR TURNING CENTERS

As a part of the new effort to develop performance evaluation standards for turning centers, researchers at NIST started to test some of the techniques proposed to be included in the standard. One of these techniques requires a telescoping ball bar to measure contouring accuracy of the machine tool. Originally developed for machining centers, these devices needed some design modifications to be applicable to turning centers. A private company has developed a new version of their telescoping ball bar system for the turning center applications. Recently, a company representative spent a day with NIST researchers to test their ball bar system for the first time on a turning center. As a result of this collaboration, they donated one of their systems to NIST to be tested further in development of the standard.

DEFINITIVE METHOD DEVELOPED FOR SERUM TRIGLYCERIDES

The measurement of triglycerides (TG) in serum is an important clinical measurement because of the correlation between high levels of TG and the risk of heart attack or stroke. Medical researchers have found that the total level of cholesterol in blood is not as important a marker for risk of heart disease as the levels of cholesterol associated with the low-density lipoproteins (LDL) and the high-density lipoproteins (HDL) in blood. The level of HDL-cholesterol may be determined directly, whereas the LDL-cholesterol cannot by routine clinical methods. Instead, the LDL value is calculated from a formula that uses the measured values for total- and HDL-cholesterol and TG. Thus, accurate calculation of this important risk factor depends upon accurate determination of the TG value.

NIST, in cooperation with the College of American Pathologists (CAP), has developed a definitive method for determining triglyceride levels that actually consists of two separate assays: total glycerides consisting of the total tri-, di-, and monoglycerides plus free glycerol; and triglycerides only. This definitive method for organic analytes in serum is based upon isotope dilution/gas chromatography/mass spectrometry because this technique does not depend on sample recovery and it provides high precision.

Bias in the measurements is tested by remeasuring samples using a different gas chromatography column, a different pair of ions, and/or a different method of ionization. If there are no significant differences from the original values, it is strong evidence for there being no significant bias in the measurements. The method has been thoroughly tested on lyophilized and fresh human serum. For example, analysis of a lyophilized serum pool from the CAP found the mean total glycerides to be 166.10 mg/dL, with a relative standard error of the mean of 0.34 percent; and the mean triglycerides only to be 139.10 mg/dL, with a relative standard error of the mean of 0.11 percent. When samples were remeasured as described above by two different approaches, the mean differences from the principal measurements were 0.10 percent and 0.31 percent, evidence that the measurement bias is not significant. The results demonstrate that the method is worthy of consideration as a candidate definitive method.

The definitive method will be used to certify SRMs and to provide value assignment for CAP proficiency testing materials so that the thousands of clinical labs participating in CAP proficiency surveys can evaluate the accuracy of their methods.

THREE-DIMENSIONAL INTERNAL CIRCULATION IN SPINNING DROPLETS

Two researchers at NIST, in collaboration with a researcher from the University of Illinois at Chicago, have made the first experimental and modeling demonstration of three-dimensional fluid motion within rotating spherical droplets. Experimentally, a water droplet was placed at the tip of a syringe and exposed to a steady laminar air stream in a cross-flow configuration which induced rotation of the droplet surface. Internal flow was observed by a novel visualization technique using laser sheet illumination and a fluorescent dye as a tracer. The fluorescent emission was recorded with a high spatial-resolution microscope and a CCD camera/video recording system.

In conjunction with the experiment, a numerical model was formulated to quantify the fluid transport processes within a spherical volume whose surface is subject to a steady rotation about its axis. The model constitutes an important step beyond the classical axisymmetric two-dimensional representation of the structure induced by an irrotational free-stream flow exterior to the droplet (Hill's vortex). The new three-dimensional model predicts a complex, yet ordered, mode of fluid motion in agreement with the experimentally observed fluid trajectories. The fluid elements on the surface of the droplet spiral away from the pole of the axis of rotation, moving toward the equatorial plane. Near this plane of symmetry, the fluid elements spiral inward from the equator toward the droplet center, subsequently turn and then wind about the rotation axis, moving back toward the pole.

The combined experimental and numerical results show that characteristic time scales of diffusion are effectively reduced by a factor of four in comparison to those occurring in irrotational systems. This indicates that droplet spinning may be important in practical situations involving convective transport in droplets, such as spray combustion of liquid fuel mixtures.

NIST PROVIDES INTERNET TIME SERVICE

A new nationally available time service has been established on the Internet. The servers for this service, which went into operation in August 1993, were developed by a NIST scientist. The service responds to a need for modestly accurate time on a wide range of systems connected to the Internet. With virtually no advertising, use of the system has grown to more than 5000 calls per day in a 3 month span.

Time on the server is maintained within 1 ms of Coordinated Universal Time. Users can receive time codes in three commonly used formats. The time codes include advance notice of changes to and from daylight savings time and advance notice of insertion of leap seconds. User software can be downloaded directly from the daytime directory on the server, which has an address of time.nist.gov on the Internet.

A special algorithm has been developed for software which can be used to operate servers at any node on the Internet. The algorithm incorporates the smart-clock concept, a NIST-patented method for improving the performance of a remotely operated clock. Through repeated comparisons with an external standard, the clock in the server is characterized and then regularly corrected. The result is substantially improved clock performance and a gradually diminishing need for comparisons with the external source. This software is available for servers in industrial, government, and academic institutions.

SYNCHRONIZATION OF LORAN-C STATIONS

NIST has entered into a collaboration with the U.S. Coast Guard to improve synchronization of 11 LORAN-C master stations operating in the United States. The objective is to improve the performance of the system. Atomic clocks at each of these master stations control the phase of the 100 kHz navigation signals. The stations have been synchronized through observation of signals received at a network of monitoring stations. Because the propagation delays are variable, it is difficult to use this monitoring technique to achieve the new synchronization specification of 100 ns. The Coast Guard and NIST are planning to use the GPS common-view time transfer technique developed at NIST to meet the new specification. Preliminary experiments using receivers located at the Seneca, NY, master station and Boulder have shown feasibility, and timing receivers for the remaining stations have been ordered.

PROCESS SIMULATION FOR POWDER METALLURGY

During the consolidation of metal powders, it is desirable to control the deformation of the powder body to obtain near-net shape at the end of consol-

idation. To achieve such control, NIST metallurgists have quantified the mechanical behavior of partially densified metal compacts at various temperatures in vacuum. These measurements were used, in collaboration with theoreticians at other institutions, to validate new constitutive relations for porous metal compacts deforming by multiaxial creep. For the first time, the new relations account for the deviatoric stress components introduced by the shielding effects of the metal cans which contain the compacts, as well as the hydrostatic stresses. This work has led to two patents on a material consolidation and modeling system, which, in turn, served as the basis for PROSIM, a commercially available software package. This powerful modeling tool enables expensive preliminary trial-and-error experiments to be minimized for various industrially important powder metallurgy processes, such as hot isostatic pressing, cold compaction, hot vacuum pressing, sintering, and rapid compaction processes.

CERAMIC MATRIX COMPOSITES FROM POLYMER PRECURSORS

NIST is participating in an industry-led consortium that will use a polymer composite processing method known as resin transfer molding (RTM) to fabricate low-cost ceramic matrix composites. The program grew out of a cooperative research and development agreement between NIST and a private company to manufacture polymer composites by RTM and development of a new polymeric material.

Although reinforced ceramics have excellent high-temperature properties, their use is limited by high cost. In the RTM process, the polymer precursor resin will be injected into the reinforcement and polymerized to form a polymer composite. Pyrolysis of this material will produce the reinforced ceramic. Various reinforcement geometries will be used including a three dimensionally braided material. The NIST contribution will be to optimize the RTM process through the application of process simulation models, aid in the installation of in-process sensors, and advise on the operation of on-line process control. The industrial partners will produce a demonstration part which will be tested in an engine by a private company.

FIRE DETECTOR SITING FOR COMPLEX CEILINGS

NIST has released a report on the results of the first year of phase 2 of the International Fire Detection Research Project. The objective of the project is to establish optimum siting requirements for fire sensors located in rooms with complex ceiling geometries and high ventilation rates. This will be accomplished through the use of state-of-the-art computational fluid dynamics modeling of the distribution of temperature, velocities, and particulates in these spaces as a function of compartment geometry and fire size.

In this first year, the computational model was validated against full-scale experimental data and a unique visualization technique was developed to allow the data produced to be analyzed appropriately for optical, ionization, and cloud chamber types of smoke sensors, and for thermally activated sensors including fire sprinklers. The results are being expressed as design guidelines suitable for inclusion directly into codes and engineering specifications.

Some highlights of the first year include:

- The ability to quantify stratification effects in spaces with vertical-temperature gradients that exceed the fire's plume temperature.
- Analysis of the conditions produced by smoldering fires with rates of heat release as small as 100 W.
- Quantification of the impact of beam depth and spacing, ceiling height, and fire growth rate on the rate at which ceiling pockets between beams or joists fill with hot gases and smoke relative to sensor locations within the pockets or on the bottoms of the beams.

This study is being heralded by the alarm industry as providing the first insights into several aspects of fire sensor performance which have been incapable of experimental measurements. Revised installation guidelines based on these results will reduce the costs of providing fire protection in commercial properties where such ceiling arrangements are found.

U.S. PRODUCT DATA ASSOCIATION ADOPTS APPLICATION PROTOCOL TO USE WITH IGES

Work performed by NIST scientists in collaboration with representatives of the U.S. shipbuilding, process plant, and associated CAD/CAM industries has been adopted by the U.S. Product Data Association (US PRO) as the first application protocol delivered to U.S. industry for use with the Initial Graphics Exchange Specification (IGES). IGES is an American National Standard for

product data exchange. The 3D Piping IGES Application Protocol Version 1.1 (NISTIR 4797) was submitted in 1992 as the technical basis for the standardization effort. This NIST document was adopted with minor modifications and issued in September 1993 as US PRO/IPO–110, IGES Application Protocol: 3D Piping Version 1.2. Similar work is now under way for the emerging ISO 10303, known as the Standard for the Exchange of Product Model Data.

NIST ESTABLISHES LABORATORY TO TEST ADVANCED INSULATION SYSTEMS

The building insulation industry is now developing advanced insulation systems such as aerogels, powder-filled panels, and evacuated panels that have the potential for thermal resistance orders of magnitude higher than current glass fiber insulation. NIST's guarded hot plate currently serves as the nation's standard for the measurement of insulation; however, it is only suitable for homogeneous materials with planar surfaces and relatively poor insulating capabilities. NIST has completed a new laboratory equipped with both a specially designed calorimeter and advanced infrared thermography system. In cooperation with a leading manufacturer of evacuated insulation panels, both systems are currently under evaluation. A third system based on the use of thermochromatiac crystals will be tested in the near future. The final result will be national consensus standards for the testing of these new insulation systems.

CCRL COMPLETES RECORD LABORATORY INSPECTION TOUR

The Cement and Concrete Reference Laboratory (CCRL) of NIST recently completed its 27th inspection tour with a record 628 laboratories in the United States, Canada, Mexico, and Puerto Rico participating. This exceeds the largest previous tour by 40 laboratories. The CCRL Laboratory Inspection Program is available on a for-fee basis to laboratories that test cement, concrete, aggregates, pozzolans, and steel reinforcing bars. This program, along with the distribution of proficiency samples to 512 laboratories in 14 countries, gives CCRL a major role in promoting the quality of construction through improved testing of materials.

RASTER GRAPHICS VALIDATION TEST SERVICE ESTABLISHED

NIST established, on a 1 year trial basis, a raster graphics test service for the validation of raster graphics files for conformance to FIPS 150, Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus, and MIL-R-28002B, Requirements for Raster Graphics Representation in Binary Format. NIST will use the trial period to verify the accuracy and completeness of the raster graphics test procedures. The test service trial period will continue through September 1994.

NEW PUBLICATION FOCUSES ON THE FIBER DISTRIBUTED DATA INTERFACE (FDDI)

The FDDI is an emerging fiber optic local area network (LAN) technology based on standards and suitable for backbone and high-performance workstation applications. NIST Special Publication 500-212, Planning for the Fiber Distributed Data Interface (FDDI), describes the FDDI standards and the media that FDDI uses, as well as the wiring and effective configuration of FDDI LANs. It discusses the relationship of FDDI to the Government Open Systems Interconnection Profile and connecting FDDI to other networks.

NIST INITIATES IRDS CONFORMANCE TEST SYSTEM AND VALIDATION TESTING

NIST announced the availability of an automated conformance test system for FIPS 156, Information Resource Dictionary System (IRDS). The test system is specifically designed to be run on an IBM-compatible PC under DOS, but the candidate IRDS itself can be installed, run the test suite, and generate the required output on any platform in any environment.

The test system provides the basis for FIPS 156 validation testing performed by NIST. An organization that has licensed the conformance test system may request NIST validation testing, on a cost-reimbursable basis, of its IRDS Command Language implementations. The validation testing results in a Validated Summary Report for each tested implementation, which is listed in the Validated Products List published quarterly by NIST.

Standard Reference Materials

NEW BOTANICAL STANDARD IS RIPE FOR THE PICKIN'

Juicy tomato slices make mouth-watering sandwiches, but NIST chemists opted instead for another part of the tomato plant for their newest botanical Standard Reference Material. Tomato leaves, ground to a fine powder, can help ensure accuracy in labs that analyze agricultural food products. NIST chemists have certified the chemical composition of leaves from tomato plants by analyzing the concentrations of 21 elements using two independent methods. They also determined approximate values for 20 additional elements. Food producers and others doing laboratory evaluations of agricultural products can use the tomato leaf SRM to verify the accuracy and reliability of their own analytical methods. Standard Reference Material 1573a, Tomato Leaves, is available in 50-gram bottles for $240 from the NIST SRM Program, 204 Engineering Mechanics Building, Gaithersburg, MD 20899-0001, (301) 975-6776, fax: (301) 975-3730.

STANDARD REFERENCE MATERIAL (SRM) 1800—FIFTEEN NON-METHANE ORGANIC COMPOUNDS IN NITROGEN

Mobile-source hydrocarbon emissions are an important environmental concern. Reduction of these emissions is mandated by the Clean Air Act, and accurate measurements of such emissions are critical for regulatory enforcement of the reduction mandate. To meet this national need, the Standard Reference Materials Program provides a number of certified gaseous mixtures.

The Standard Reference Materials Program announces the availability of SRM 1800, 15 non-methane organic compounds in nitrogen, as an addition to the gaseous mixture series of SRMs. All of the certified compounds (ethane, propane, propene, iso-butane, n-butane, iso-butylene, iso-pentane, n-pentane, 1-pentene, n-hexane, benzene, n-octane, toluene, ortho-xylene, and n-decane) are present at a nominal concentration of 5 nmol/mol. The SRM is intended for the calibration of instruments used for separation and speciation of trace hydrocarbons in ambient air. It also is used in other applications, including programs for monitoring mobile-source hydrocarbon emissions and research leading to the development and evaluation of new analytical methods for use in those and similar programs.

STANDARD REFERENCE MATERIAL 2389—AMINO ACIDS IN 0.1 MOL/L HYDROCHLORIC ACID

Accurate measurement of amino acids, the building blocks of proteins, is important in a number of biochemical and nutritional applications. For example, protein quality of foods depends on availability of all essential amino acids in the proper ratio of each to the others. This protein quality can be assessed only using analytical methods that separate the amino acids and then quantify each of them.

The Standard Reference Materials Program announces the availability of SRM 2389, amino acids in 0.1 mol/L hydrochloric acid. This SRM is intended primarily as a calibration standard for chromatographic instrumentation used in the determination of identity and concentration of individual amino acids occurring as a mixture.

Certified concentrations of 17 amino acids (alanine, arginine, aspartic acid, cystine, glutamic acid, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tyrosine, and valine) are provided. These concentrations were determined at NIST by liquid chromatography, and in a round-robin program conducted by the Association of Biomolecular Research Facilities. The SRM is issued as a set of five ampules, each containing approximately 1.2 mL of the amino-acid solution.

Standard Reference Data

REACTION RATES OF LIGANDS AT YOUR FINGERTIPS

NIST Standard Reference Database 46, NIST Critical Stability Constants of Metal Complexes, provides research chemists and chemical engineers with rapid access to important information on the reaction rates of ligands and how they join with ions to form complex chemical compounds. The personal computer database contains data on the interactions in aqueous systems of nearly 4,000 organic and inorganic ligands with protons (hydro-

gen ions) and various metal ions. Users of this information in industry include mining engineers and geologists; scientists investigating the stability of these materials in the environment; chemists developing agricultural fertilizers, pesticides and other products; and manufacturing engineers working on the control of processes such as electroplating. SRD 46 is available for $240 from the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2208, fax: (301) 926-0416, e-mail: srdata@enh.nist.gov (via Internet).

ALTERNATIVE REFRIGERANT DATABASE EXPANDED

NIST chemists have added 12 new, pure-fluid refrigerants to the latest version of the Thermodynamic Properties of Refrigerants and Refrigerant Mixtures Database, or REFPROP. The personal computer database, now containing data on 38 pure refrigerants, is used widely in industry for evaluating the performance of ozone-friendly fluids for refrigeration and air conditioning. Included are fluids of high interest to the refrigeration industry, such as R32 and R125, for which highly accurate data are now available. REFPROP 4.0, also contains 27 new refrigerant mixtures with data on their interaction parameters. REFPROP 4.0, NIST Standard Reference Database 23, is available for $465 from the Standard Reference Data Program, A320 Physics Building, NIST, Gaithersburg, MD 20899-0001, (301) 975-2208, fax: (301) 975-0416, e-mail: srdata@enh.nist.gov (via Internet). Owners of a previous version may upgrade for $100.