News Briefs and Reports

Developments

NBS MAKES OPERATIONAL HIGH-TEMPERATURE SUPERCONDUCTING DEVICE

NBS scientists have demonstrated what may be the first superconducting electronic device to operate at 81 kelvins—above the liquid nitrogen temperature of 77 K. The superconducting quantum interference device, or SQUID, is a high-temperature version of the most sensitive existing device for measuring magnetic fields. In the future these high-temperature devices may replace important elements of the common electrocardiograph, and be used for prospecting and in computers.

James E. Zimmerman, a recently retired NBS physicist now working in the Bureau's Boulder laboratories as a guest researcher, designed and constructed the SQUID. Zimmerman is internationally known for his work on superconducting devices and the refrigerators used to cool them.

The yttrium-barium-copper oxide material, which permitted the device to operate up to 81 K, was made at NBS by Ronald Ono and James Beall. Because of the relatively high operating temperature of the SQUID, there was no need to reduce the pressure of the liquid nitrogen, an expensive process sometimes needed to cool the nitrogen below 77 K.

In another development at NBS, John Moreland and Alan Clark observed the ac Josephson effect above 77 K, confirming that electrons in these new materials are paired as they are in conventional superconductors. Devices based on this effect may become future microwave detectors and sources, and voltage standards.

The National Bureau of Standards has conducted research on superconductivity for many decades.

Scientists at NBS have achieved record-setting performance with superconducting electronic devices, applying them in standards and electrical measurements. They also have worked with industry and universities in superconducting device applications in biomagnetism and geophysics, as well as in basic physics.

In addition, Bureau scientists have helped industry to develop superconducting wires and magnets, contributing through standards development and research to understand their operation.

For further information, contact any of the above-named researchers at the National Bureau of Standards, Boulder, CO 80303.

FIRST ENERGY GAP MEASUREMENTS ON SUPERCONDUCTOR MATERIALS

Using a recently developed break junction technique, NBS researchers have made the first electron tunneling measurements of the energy gap in one of the new superconductor materials with relatively high critical temperatures (T_c). The material was lanthanum-strontium-copper oxide, which becomes superconducting at 36 K, and is similar to other materials recently discovered with T_c's as high as 98 K. The energy gap in La-Sr-Cu-O_4 was found to be 7.0 ± 0.1 meV. This measurement provided the first glimpse at the microscopic quantum nature of the superconductivity in these new high-T_c materials. Until recently superconductivity was a phenomenon observed only at temperatures below about 20 K, where refrigeration costs are very high. Several materials have now been discovered with T_c's up to five times as high, allowing the substitution of liquid nitrogen (at 77 K) for helium as a refrigerant, lowering costs by a huge factor.

For further information, contact J. M. Moreland or A. F. Clark, National Bureau of Standards, Boulder, CO 80303.

NBS REPORT TO CONGRESS ON U.S. EMBASSY BUILDING IN MOSCOW: STRUCTURAL DEFICIENCIES EXIST BUT CAN BE CORRECTED

The new U. S. Embassy Office Building under construction in Moscow has important structural deficiencies, but the costs to remedy these deficiencies would be modest in comparison to the total construction project. This was the conclusion reached by NBS researchers in a report to Congress.

Last spring, NBS was directed by Congress to assess and report on the current structure and to provide recommendations and cost estimates for correcting structural flaws and defects.

The NBS report to Congress states that remedial measures required to assure the safety of occupants do not involve major reconstruction. It concludes that if similar repairs were done in Washington, DC, the corrective measures could be completed in less than a year and would cost an estimated $1.83 million. Actual costs of the recommended measures would depend greatly upon working conditions in Moscow and the way in which the work was performed, according to the report.

As directed by Congress, NBS investigated only the structural integrity of the building and did not consider security aspects.

NBS concluded that "important deficiencies exist in the structure that must be corrected for adequate safety before the building is occupied."

These deficiencies include joints in reinforced concrete columns and in walls which are not completely filled with the grout and concrete needed to give them full strength. They also include cracking in the roof-top parapet walls. In addition, the NBS research team recommended measures to protect against progressive collapse, which occurs when the failure of a single structural component leads to wider failures within the structure.

NBS assessed the embassy building using criteria consistent with good practice for construction of U.S. office buildings as set out in widely used U.S. voluntary industry standards. In conducting the study, the NBS team reviewed design and construction documents for the site and building, made two visits to Moscow to investigate structural aspects of the building, and conducted tests both at the site and in NBS laboratories in Gaithersburg, MD.

NBS is not a regulatory agency and does not promulgate building standards or codes. The Bureau does develop the tools and technology to test and improve the performance of structures. Results of its research are provided to voluntary standards organizations, state and local governments, and other federal agencies.

NBS has a long history of investigating structures and has studied several well-publicized building failures. Investigations focus on the technical causes of a structural failure or on potential problems which could lead to failure.

For further information on the Moscow report, write Samuel Kramer, National Bureau of Standards, Gaithersburg, MD 20899, or call 301/975-2302.

DIESEL ENGINE IMPROVEMENTS ARE AIM OF NEW THERMOCOUPLES

More efficient and longer-lasting diesel engines may result from the application of a new type of thermocouple device developed at NBS that monitors critical internal temperatures of these engines. Bureau researchers are experimenting with "thin films" of noble, chemically inactive metals such as platinum and gold. Unlike traditional wire thermocouples, these films are deposited directly onto engine parts and act as sensors to indicate temperature at those points. By having accurate temperature measurements during operation of such diesel engine components as valves, cylinder heads, and piston crowns, it is possible to monitor wear and tear of engine hardware, as well as to provide input for controlling automatic engine functions such as fuel-air mix and timing.

Temperature data also are important in the design phase of modern ceramic-coated diesel engines for decisions such as how thick the engine's insulting ceramic coating should be or what porosity the coating should have. NBS is working with researchers from Purdue University, the Department of Energy, and the National Aeronautics and Space Administration to test the thin-film technology in a ceramic diesel research engine.

For further information, contact Kenneth Kreider, National Bureau of Standards, Gaithersburg, MD 20899.

NDE TECHNIQUE FOR EARLY DETECTION OF PAINTING FLAWS

NBS researchers have developed a sensitive technique to detect and quantify defects in paint on wood or metal surfaces. The technique uses computer image processing in conjunction with either a video or infrared thermography camera. It can be used not only to determine the number, size, and location of defects within a certain area, but also to estimate the total area covered by defects.

Since the information can be stored, a degradation history can be developed which should help in scheduling maintenance and evaluating the performance of the coating system. Concerns which need

to be addressed include how much of a structure should be sampled to accurately estimate its degradation. Another concern is finding the best photographic procedures to detect defects while avoiding shadows and nonuniform lighting which may hide them.

For further information, contact Mary McKnight, National Bureau of Standards, Gaithersburg, MD 20899.

JOINT AGREEMENT WILL EXAMINE IMPROVED CHEMICAL ANALYSES

Dionex Corporation, a major producer of ion chromatographic equipment, has signed a cooperative agreement with NBS that aims to improve methods of separating "transition" elements—metals such as nickel and copper—from chemical samples. These separations are important preludes to chemical tests by traditional analytical methods such as thin film X-ray fluorescence, isotope dilution mass spectrometry, and electrochemistry. A significant benefit of improving ion chromatographic separation techniques is that better quantitation will likely result from follow-up analytical instruments.

Ion chromatography has many applications. Though these include the analysis of botanical and environmental samples, the NBS Dionex research will concentrate on improving tests of biological and biomedical samples—for example, determining reliably if toxic levels of nickel or vanadium are contained in biological tissues exposed to fossil fuel emissions. Dr. Archava Siriraks, a Dionex chemist, will work on the project with Bureau scientists for an anticipated 3 years.

NBS, MARTIN MARIETTA STUDY COMPUTER VISION SYSTEMS

NBS and Martin Marietta Baltimore Aerospace have begun a joint research program to develop a series of advanced computer-vision algorithms using the Parallel Image Processing Engine (PIPE), a specialized image-processing computer invented at NBS. William Hoff of Martin Marietta will work as a Research Associate with NBS on algorithms for stereo analysis, sparse depth maps, 2-D feature extraction—including color and texture as well as geometric features, image flow, and 3-D range information. The algorithms will be applicable to a wide variety of computer vision problems.

NBS-DESIGNED PRECISION VOLTAGE STEP GENERATOR DESCRIBED

A voltage step generator developed at NBS and designed to calibrate transient waveform records and other test instruments is described in a report [1] now available.

Transient waveform recorders measure rapid voltage pulses. They are used for a wide variety of applications including research into the generation of electrical power by particle-beam fusion reactions or simpler operations such as checking automobile engine performance. The NBS step generator will ensure the reliable operation of these instruments.

The 104-page report devotes sections to the step generator's theory of operation, a description of the instrument system, the device's software, operating instructions, and testing.

Reference

[1] NBS TN 1230, A Precision Programmable Step Generator for Use in Automated Test Systems, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 ($5.50 prepaid, order by stock no. 003-003-02786-3).

HISTORY OF NBS RADIO RESEARCH PUBLISHED

A project to compile the definitive history of radio research at NBS has culminated in the publication of the 842-page, hardbound volume [1].

Achievement in Radio is a comprehensive, exhaustive treatment of the accomplishments and people of the Bureau, always set in the context of external events and developments. NBS was only 10 years old, and practical radio only about 25, when NBS made its first official radio measurement in 1911, a calibration of a wavemeter. Achievement in Radio tells the story of NBS's involvement in radio science, from its spark-and-crystal origins to today's integrated circuits, masers, and satellites. The authors write from firsthand knowledge of most of the period covered.

Reference

[1] Achievement in Radio: Seventy Years of Radio Science, Technology, Standards, and Measurement at the National Bureau of Standards, by Wilbert F. Snyder and Charles L. Bragaw, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 ($55 prepaid, order by stock no. 003-003-02762-6).

OMNITAB 80: STATISTICAL ANALYSIS FOR SCIENTISTS

NBS has published a revised user's manual to OMNITAB, the Bureau's statistical software package [1]. OMNITAB 80 was designed for "scientists who are not programmers." It provides a complete, highly integrated programming system that uses a simple, high-level language to perform both simple and complex statistical and numerical analyses—including matrix analyses—of experimental data. OMNITAB 80 includes a large library of tested, reliable routines with extensive capabilities for plotting the results. It was written to be largely

machine independent and can be run in either batch or interactive modes.

Reference

[1] NBS SP 701, OMNITAB 80: An Interpretive System for Statistical and Numerical Data Analysis, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 ($17 prepaid, order by stock no. 003-003-02775-8). Copies of the program OMNITAB 80, furnished on customized magnetic tape, are available for $1,500 through the NBS Office of Standard Reference Data. For further information, contact Shirley Bremer, A337 Administration Building, National Bureau of Standards, Gaithersburg, MD 20899, or telephone 301/975-2845.

GUIDE AVAILABLE FOR MAKING ECONOMIC ENERGY DECISIONS

More than a decade after the first shock from escalating energy prices, many buildings continue to be designed and constructed with little consideration for energy conservation. The resulting cost to building owners and the nation is enormous.

A new guide by NBS researchers will help builders and building designers, owners, and operators find a balance between energy consumption and energy conservation which will result in more cost-effective building [1]. The publication guides the decision maker to ask the right economic questions. It also shows how to structure problems for solution, how to estimate future cash flows, and how to interpret various measures of economic performance. Worksheets, a computer program, and data tables to assist with evaluations are provided in the publication.

Reference

[1] NBS SP 709, Comprehensive Guide for Least-Cost Energy Decisions, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 ($11 prepaid, order by stock no. 003-003 02790-1). In addition, a computer program diskette is available from several vendors for under $20 and will shortly be available from the National Technical Information Service. Diskette ordering information is in the publication.

SEISMIC DESIGN GUIDELINES ISSUED

NBS, as secretariat of the Interagency Committee on Seismic Safety in Construction, has issued guidelines for federal agencies to use in designing and constructing buildings to resist earthquake damage [1]. The report was prepared as part of the National Earthquake Hazards Reduction Program. The guidelines are based on existing voluntary standards, model building codes, and federal regulations. In particular, the technical content is similar to the seismic design requirements of the 1985 Uniform Building Code published by the International Conference of Building Officials. The report includes information on site planning, structural design criteria, structural analysis procedures, and design details as well as design and construction standards for structural materials including steel, concrete, and wood. In addition, it includes nonstructural design requirements, such as protecting against secondary hazards and information on quality control and inspection.

Reference

[1] NBSIR 87-3524, Seismic Design Guidelines for Federal Buildings, available from the National Technical Information Service, Springfield, VA 22161 ($18.95 prepaid, order by PB# 87-161204/AS).

NBS ISSUES REVISED KWIC INDEX OF ENGINEERING STANDARDS

NBS has updated its Key-Word-In-Context (KWIC) Index of U.S. Voluntary Engineering Standards for use by manufacturers, exporters, importers, and others concerned with standards developed by U.S. trade associations and technical and professional societies.

The KWIC index contains more than 28,000 titles of standards developed by approximately 400 U.S. standards organizations. First published in 1971, the revised microfiche index provides the title, date, source, and number of the standard for each entry. Each standard can be found under all significant key words in the title. The date of publication or last revision, the standard number, and an acronym designating the standards-issuing organization appear as a part of each entry.

For information in the KWIC index, contact the National Center for Standards and Certification Information, A629 Administration Building, National Bureau of Standards, Gaithersburg, MD 20899, telephone: 301/975-4040. Microfiche copies of the KWIC index are available for $18 prepaid from the National Technical Information Service, Springfield, VA 22161. Order by PB# 87-133377.

Standard Reference Materials

SECOND COMMERCIAL SPACE-MADE PRODUCT IS NEW MEASUREMENT TOOL FOR CHEMISTS

The second commercial space-made product, Standard Reference Material 1961, 30-Micrometer Polystyrene Spheres, is a new small-particle measurement standard developed for industry by NBS. The reference material is an important quality-control tool for chemists using powders for the manufacture of pharmaceuticals, chemicals, industrial compounds, and other products that require particle sizing near 30 micrometers.

The new SRM is the fourth small-particle material in a series of primary measurement standards NBS is developing in cooperation with ASTM. The Bureau plans to certify other small-particle standards up to 100 micrometers.

SRM 1961 is a 5-milliliter vial with approximately 1 million of the 30-micrometer spheres suspended in water. Like the first commercial space-made product offered by NBS in 1985—SRM 1960, 10-Micrometer Polystyrene Spheres—the new SRM also was made in space by the National Aeronautics and Space Administration (NASA) because a low-gravity environment produces a product that is more uniform in size and shape than earth-bound processes for polystyrene materials of this size.

NASA completed the manufacture of the particles for the new SRM aboard the Space Shuttle Challenger during the STS-11 mission in February 1984 with the same Monodisperse Latex Reactor (MLR) experiment that produced SRM 1960. The MLR experiments use a chemical process developed for NASA by Lehigh University.

The principal investigator for the chemical process was John W. Vanderhoff of Lehigh University's Polymer Emulsion Institutes along with coinvestigators Mohamed S. El-Aasser and Fortunato J. Micale of Lehigh, and Dale M. Kornfeld of the NASA Marshall Space Flight Center.

The 30-micrometer measurement standard was certified by NBS physicists Arie W. Hartman and Theodore T. Doiron, using optical measurement techniques to obtain the average particle diameter. Their certified value was confirmed by Gary G. Hembree using an electron microscope to scan individual particles. Russell C. Obbink, ASTM Research Associate at NBS, coordinated industry participation through the ASTM Coordinating Committee for SRMs for Particle Metrology.

The other small-particle reference standards, available from NBS in 5-milliliter vials, are earth-made spheres measuring 0.3 and 1 micrometers. The 10-micrometer space-made material also is available on a microscope slide (SRM 1965) as an education tool for students and as a standard to calibrate microscopes.

SRM 1961 is available as a 5-milliliter vial with approximately 1 million of the 30-micrometer spheres suspended in water, at a cost of $608.

NEW TEMPERATURE FIXED-POINT SRM: INDIUM

NBS has issued a new Standard Reference Material for temperature based on the freezing/melting point of pure indium. SRM 1971: Indium Freezing-Point Standard supplies a fixed point for temperature calibrations at 156.635 ± 0.002 degrees Celsius on the IPTS-68. The indium point lies near the center of a gap between two other temperature reference points, the freezing points of gallium (30 °C) and tin (232 °C), and so provides an important new point for precision thermometry and temperature control.

SRM 1971 consists of a sealed polytetrafluoroethylene cell containing 100 grams of 99.9999 percent pure indium. The cell has a re-entrant well for temperature measurement. The cost is $655.

IMPROVING CHOLESTEROL, DRUG TESTS IS AIM OF NEW PROGRAM

A "reference laboratory" program, which initially aims to improve clinical measurements of blood serum cholesterol levels and drugs of abuse in urine, has been established by NBS and the 10,450-member College of American Pathologists (CAP).

Both organizations have observed wide variances in clinical test results from laboratories around the country and have worked together for nearly a decade to help improve these often critical measurements. To date, the cooperative research has been devoted to perfecting "definitive" analytical techniques for measuring important blood serum components such as cholesterol, glucose, and uric acid.

The new program expands the joint agreement and places special emphasis on developing affordable reference samples that laboratories can buy and use to check or improve their measurement reliability. The first of these is a kit of freeze-dried human blood serum samples certified for three cholesterol levels. These samples, expected to be available by mid-summer, can be reconstituted as liquids and run through the same tests as patient samples to check equipment operation and methods. NBS and CAP scientists also plan to develop reference samples that would check the accuracy of urinalysis for cocaine abuse.

For further information, contact Harry Hertz, National Bureau of Standards, Gaithersburg, MD 20899.

NBS, VLSI STANDARDS BEGIN JOINT PROGRAM ON LINEWIDTH

NBS and VLSI Standards, Inc. of Mountain View, CA, have begun a joint research program aimed at developing the next generation of linewidth standards for the semiconductor fabrication industry.

Linewidths are an important feature dimension on integrated circuits (ICs). They can be as small as 1 micrometer or below. Proper process control requires the fabricator to be able to measure linewidths accurately, but the problem is compli-

cated because the dimensions of these features are approaching the wavelength of the light used to measure them under a microscope. Determining *exactly* where the edges of the lines are is particularly difficult.

The best current linewidth standards—sold as NBS Standard Reference Materials—are for lines on the photomasks used to make ICs, and depend on light transmitted through the transparent photomask. Equivalent standards are needed for opaque materials such as the silicon IC wafers themselves.

VLSI Standards will develop prototype "artifacts" for NBS consisting of silicon wafers with precisely etched silicon "lines" in relief using a technique to make the walls of the lines as vertical as possible. These artifacts will be used by NBS to correlate physical measurements with optical theory, leading to well-understood techniques for making precise feature measurements on opaque wafers. The samples will also be used in studies to develop similar techniques for scanning electron microscopy.

For further information, contact Robert Larrabee, National Bureau of Standards, Gaithersburg, MD 20899.

NBS Services

SPECIAL TEST SERVICE FOR HELIUM PERMEATION LEAKS

NBS has begun, on a trial basis, a Special Test service for helium permeation leaks. This service offers measurement of leak rates from 10^{-8} to 10^{-11} moles/second (2×10^{-4} to 2×10^{-7} atm cc/s @ 0 °C), and determines the temperature dependence of the leak standard over the range 0 to 50 °C. (The temperature dependence of leak standards is an important—and often unrecognized-factor in their accuracy.)

Initial costs of the service will be assessed on a case-by-case basis, depending on the time involved, and should range from approximately $2000 to $4000. NBS plans to extend the range of the service and offer calibrations for gases other than helium in the future.

Interested parties should write Charles Ehrlich, A55 Metrology Building, National Bureau of Standards, Gaithersburg, MD 20899, or call 301/975-4834.

NBS UPGRADES ac/dc DIFFERENCE CALIBRATIONS

As a result of continuing research and improved instrumentation, NBS has announced major reductions in the uncertainties for its calibration services for ac/dc thermal voltage and current converters. The highest-accuracy measurements of ac voltage and current are made by reference to well-known dc quantities through thermal converters. Accurate comparisons require calibrating the thermal converter for the difference in response between a dc source and an ac source of equal RMS voltage and current. NBS has lowered the uncertainties in its thermal converter calibration service across most of the audible and higher frequency ranges up to one megahertz, and most of the voltage and current ranges by as much as 50 percent in some cases.

ac/dc thermal converters are the ultimate reference for almost all ac measurements made in the aerospace, defense, and electronics industries, and the market for test equipment making ac current or voltage measurements—over $3 billion in this country last year—is intensely competitive. The improved measurement service should be an important aid to U.S. companies seeking foreign markets.

For further information, write Joseph Kinard, National Bureau of Standards, Gaithersburg, MD 20899, or call 301/975-4250.

MEASUREMENT ASSURANCE FOR THE NUCLEAR POWER INDUSTRY

NBS and the Atomic Industrial Forum (AIF) have begun a new Measurement Assurance Program to aid nuclear power facilities in making accurate measurements of radioactivity. The program, conducted by AIF with assistance from NBS, concentrates on operational and environmental radioactivity measurements (not personnel dosimetry), and includes the distribution of blind standard samples for measurement by participants, analysis of the data from the blind tests, calibration services, technical consulting, and direct traceability to NBS standards.

Utilities representing approximately 40 operating power stations and four commercial laboratories which provide radioactivity standards and calibration services for the nuclear industry already participate in the program. The cost of participating in the program is approximately $10,000 for the first year.

For further information or to enroll in the program, call David Harward, Atomic Industrial Forum, 301/654-9260. For technical details about the program, call Daniel Golas, an AIF research associate at NBS, 301/975-5540.