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1. Introduction

This is the third in a series of bibliographies of NBS publications on nondestructive evaluation (NDE). Previous reports in this series have been NBSIR 78-1557, "NDE Publications: 1972-1977" and NBSIR 80-2080, "NDE Publications: 1978". This report provides bibliographic citations for publications that appeared in the open literature during calendar year 1979. Also included are citations for several publications that appeared in previous years but were not listed in the earlier compilations.

Almost all of these publications were authored by members of the NBS staff and include papers published in non-NBS media as well as papers and reports from the NBS publications series. A few were written for NBS media by non-NBS authors. Many of the publications cited are based on research that was supported, in whole or in part, by the NBS Office of Nondestructive Evaluation.

These publications address a wide variety of NDE methods, both those that are well established in industry and some that are relatively new. For completeness, several publications dealing with technologies that directly support NDE, such as radiation gauging and piezoelectricity, have been included.

The format of this report is the same as that used previously. Brief, edited abstracts are provided for most of the publications cited. The bibliography and the abstracts comprise Section 2 of the report. The 114 entries in the bibliography are listed in alphabetical order by the surname of the first author.

Section 3 of the report is a subject index for the publications listed. This index is quite comprehensive and, when used together with the abstracts and the alphabetical bibliography, may be expected to enable readers to locate publications of interest without difficulty.

The last section of the report provides some assistance to readers wishing to obtain copies of specific publications listed.
2. Bibliography and Abstracts


   This booklet contains abstracts of all the symposium papers including those presented in the poster session.


   This brochure, prepared by the NBS Office of Nondestructive Evaluation (NDE), describes the NDE Program at NBS.


   This paper describes progress in the development of resonance neutron radiography as a laboratory reference method for measurements for safeguarding nuclear fuel. To demonstrate and test the method a broad energy spectrum of neutrons and a linear position-sensitive proportional counter were used with time-of-flight techniques to determine the distribution of solder between two silver-brazed metal disks and to measure the thickness of the braze.


   This report summarizes the activities of the National Bureau of Standards Nondestructive Evaluation Program. It emphasizes activities over the Fiscal Year 1978. However, since this is the Program's first Annual Report, some material is included to summarize activities since the Program was formally instituted in June 1975.


   Nondestructive testing (NDT) standards provide a practical procedure to bring some measure of reproducibility to NDT measurements. Nevertheless, better standards are needed both to improve reproducibility and to provide quantitative data for performance-related analyses.

This paper describes the work done at NBS for the study of the fluctuations in current and potential of electrochemical systems, commonly referred to as electrochemical noise. Two systems of interest to corrosion science have been investigated, iron and aluminum, both in neutral solution. It is shown that anodic polarization above the pitting potential increases the noise generated by a Fe electrode. In the case of Al, addition of small amounts of chlorides was found to enhance the noise current by two orders of magnitude.


A symposium on nondestructive testing (NDT) standards was held at the National Bureau of Standards May 19-21, 1976. The meeting provided the first general forum encompassing discussions on the processes by which NDT codes, standards, and specifications become accepted, and discussions on the status and needs that exist in all NDT methods. Major themes included standards documents, the status of standards in the major methods used in NDT and future directions.


The purpose of this study is to assess the current status of NDE ultrasonic standards and calibrations and to determine current and future needs in this area. The source material includes surveys of the literature and patents, a study of foreign practice, surveys of NBS and consensus standards, and a Workshop on Ultrasonic NDE Standards: "Current Needs and Future Directions," held October 17-18, 1977 for the purpose of implementing the objectives of this study. Recommendations for improvement in existing standards will impact primarily on conventional pulse-echo systems and on transducers, the electronic system and reference blocks.


Some experimental observations of the switching characteristics and second breakdown susceptibility of high-voltage, fast-switching power transistors are discussed. A unique test circuit is described which permits devices to be taken into reverse-bias second breakdown many times with little or no apparent degradation.

The construction and operation of a unique facility for testing power transistors for reverse-bias second breakdown with minimal device degradation are described. Reverse-bias safe operating limits that have been determined nondestructively are shown.


A method for the magnification of x-ray radiographic images is described and demonstrated. This magnifier employs two successive asymmetric diffractions of an x-ray beam from highly perfect silicon crystals. A device with a magnification of 25x is demonstrated for Cu Kα radiation. This device preserves and sometimes improves the resolution inherent in the radiographic technique. The x-ray magnifier is particularly useful in circumventing the relatively poor spatial resolution of electro-optical imaging systems needed for real-time observation.


This paper reports on a study of electromagnetic surface and subsurface scattering properties of snow using an FM-CW radar system operating in the frequency range 8-12 GHz. The scattering properties are interpreted and compared with the measured physical properties of snow such as density, stratigraphy, hardness, and equivalent moisture content.


Texture measurement as a function of depth with a collimated thermal neutron beam is demonstrated for a 'two-layer' plate geometry sample with preliminary results for a copper cone.

A rationale for the development of well-characterized fatigue cracks for use as standards for advanced ultrasonic flaw evaluation systems is presented. A loading program to generate controlled cracks and to minimize the effects of some of these parameters is described. As determined by these techniques, measured crack lengths are accurate within a few percent. The specimens are being used as test objects in the development of a new technique for flaw evaluation by ultrasonics, radiography, and penetrants.

20. Chwirut, D. J., Recent improvements to the ASTM-type ultrasonic reference block system, NBSIR 79-1742, 54 pages (Apr. 1979). Order from NTIS as PB296044, $7.00.

Recent activities aimed toward improving the ASTM-type ultrasonic reference block system are described. On the aluminum block system (ASTM E 127 and NBS TN 924), efforts were focused on better definition of the measurement equipment (transducer and instrument), the implementation of a Measurement Assurance Program and Loaner Block Service, and modeling of the distance-amplitude relationship. It is shown that a large increase in the precision of reference block readings is easily achievable by implementing simple changes and controls in the measurement procedure. On steel and titanium blocks (e.g. ASTM E-428), efforts were directed toward quantifying the extent of reproducibility possible among blocks fabricated by both conventional drilling and by diffusion bonding.


See abstract for No. 20.


A simple apparatus for recording transmitted or reflected ultrasonic fields, in longitudinal or transverse section, is described. This system has been used at the National Bureau of Standards for ultrasonic transducer characterization, material evaluation, and defect detection.


A nondestructive test method, based on measuring the penetration resistance of adobe, was found to give reliable predictions of the compressive strength and moisture content of adobe specimens.

Apparatus and method for detecting pressure variations by modulating a preset tensile stress in a stretched thin sheet of a piezoelectric polymer. The modulation is provided by the changing stress caused by an impinging acoustic signal or the like. The sheet under preset tension acts effectively as a membrane resulting in a high output combined with a high resonance frequency and a wide operating frequency range.


Some aspects of the fluid mechanics of liquid penetrant testing are considered.


A dynamically-focused annular array system for contact B-scanning has been developed. The design is based on a constant F-number approach, whereby, at short focal lengths, the aperture is increased in proportion to the focal length. This approach allows the use of larger area array elements, thus increasing the sensitivity of the system. Other major advantages include a substantial reduction in the time delays and refocusing rates required for the lens synthesis with a corresponding reduction in the electronic complexity of the system.


Noise spectra have been used frequently to detect faulty bearings. This paper describes how piezoelectric polymer sensors coupled with spectrum analyzers make this technique more useful.


   The role of the National Bureau of Standards as the national reference laboratory for radiation measurements is described.


   This American National Standard applies to the radiation safety aspects of gauging devices, commonly called gauges, which use sealed radioactive sources or x-ray tubes for the determination or control of thickness, density, level, interface location, or qualitative or quantitative chemical composition.


   This brief paper describes measurement services available from NBS including ultrasonic transducer power output vs. frequency, ultrasonic transducer and system power output by calorimetry, aluminum ultrasonic reference block calibration, loaner services for transducers and reference blocks.


   Together with the first volume of this set of books on inservice data for pressure vessels, piping, pumps and valves, we have a total of eighteen
technical papers complete with extensive discussions and closure and two separate chapters on symposium general discussions.


A simple conceptual model to identify the various components of a typical engineering decision-making process is presented. The importance of the documentation of the inservice performance of critical engineering systems or components is discussed within the context of this conceptual model. The critical need for inservice data is illustrated by a case study of a 1976 regulatory decision concerning the integrity of 612 defective girth welds of the Trans-Alaska Oil Pipeline.


Radiography utilizing thermal neutrons as the interrogating probe is employed in the explosives, nuclear, and aerospace industries. The neutron is a nonionizing subatomic particle. It has been this nonionizing property that causes film imaging of spatially-modulated thermal neutron beams to present several problems not encountered in the imaging of other radiation beams such as x- and gamma rays, electrons and protons.


In this work twenty-seven general ultrasonic standards from eleven countries and international organizations were reviewed. Thirty-seven ultrasonic product standards from five countries were studied to evaluate the utilization of the general ultrasonic standards, i.e., to what extent the procedures outlined in the general standards are applied by the product standards.


This paper gives a brief overview of previous work in rapid imaging of x-ray diffraction patterns using conventional x-ray generators, flash x-ray generators, and electro-optical detectors.


Those results of the theory of the baffled, uniform-piston radiator that can be calculated exactly are extended to some other cases, especially the simplest case of a simply supported radiator, the simplest case of a clamped-edge radiator and a Gaussian radiator. It is also shown that from the solution to a problem with boundary conditions framed in terms of velocity, the solution to a corresponding problem, having boundary conditions framed in terms of pressure, can be obtained very easily.


We discuss long-wavelength scattering results for volume flaws and idealized cracks and compare some of the results with those of the Born approximation, which has already been calibrated by comparison to exact calculations and experiment.

47. Harman, G. G., Semiconductor measurement technology: Nondestructive tests used to insure the integrity of semiconductor devices, with emphasis on acoustic emission techniques, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-59, 72 pages (Sept. 1979) SN003-003-02166-4, S3.50.

The discussion is divided into two major sections. The first consists of an introduction to device assembly techniques and problems followed by a review of six important nondestructive tests used during and after device packaging to insure the mechanical integrity of completed electronic devices. The second section begins with an introduction to acoustic emission,
the status of theory as it can be applied to microelectronics. Then the published papers that have applied AE as a nondestructive test in electronics applications will be reviewed. Finally, passive AE techniques are applied to establishing the mechanical bond integrity of beam lead, flip chip, and tape-bonded integrated circuits as well as components in hybrid microcircuits.


See abstract for No. 47.


The measurement systems used at Twin Rivers for determining energy usage are described. These include a weather station, systems for the measurement of temperatures and energy-related events in a house, automated devices to measure the air infiltration rate, and infrared thermography.


The NBS positron annihilation-in-flight facility is described, along with the procedure for the calibration of the positron beam energy. Details are also given of a large NaI(Tl) spectrometer used with the annihilation photon beam.


The work described constitutes an evaluation of the test procedures and apparatus specified in MIL-STD-883, Test Method 2020, Particle Impact Noise Detection Test.


The National Bureau of Standards has prepared over 50 certified Standard Reference Materials for use in the area of thermophysical properties of solids. The properties that have been certified include elasticity, electrical resistivity, emittance, specific heat, thermal
conductivity, thermal expansion, vapor pressure, and fixed points of the International Practical Temperature Scale. The materials include aluminum, copper, gold, iron, tungsten, several high-temperature alloys, alumina, silica, and several glasses.


A large number of isotropic, fine-grained graphite rods in various diameters have been obtained for homogeneity and stability investigations. Electrical resistivity and density measurements have been performed on numerous rods at temperatures from 4 to 300 K. Thermal conductivity measurements have been performed on thirteen specimens at about 20°C. These measurements show that transport property variations both between and within these rods is relatively large. However, a correlation is shown to exist which will allow the calculation of thermal conductivity from simple and inexpensive electrical resistivity and density measurements to within about ± 2%.


Copper was exposed to wear under conditions of abrasive, dry, and lubricated sliding contact in air. An examination of surface morphology and subsurface microstructure was conducted by scanning and transmission electron microscopy methods in order to study the detailed nature of the wear process on a microscopic level. Wear debris fragments were also examined and the results correlated with surface and subsurface observations.


Using appropriate holography, lenses, mirrors, and a two-dimensional array of small holes to sample the electric field of a laser pulse, we demonstrate a technique for beam profile measurements at a preselected observation plane.


Measurement of both the irradiance and phase front (the beam profile) in real time from the output of a laser has interest for control of that beam and for efficient energy and economic design of the source and the
resulting optical systems. The National Bureau of Standards has begun a program to build a unit that can measure, at numerous wavelengths from 1.06 μm to 10.6 μm, a selected spatial sample of the beam profile.

The Hartmann plate method is described briefly so that a comparison between it and the holographic method can be made. The comparison shows why the holographic method is best for a standard for irradiance and phase-front measurements.


Timber pilings are used in bridge structures and for harbor and navigational facilities. The topic for discussion was the inspection and maintenance of these pilings in order to prevent failures such as the collapse of the Coos Bay bridge in Oregon in 1977 due to damage caused by marine borers.


A number of γ-ray energy standards have recently been remeasured with respect to a visible standard wavelength with an accuracy of about 0.5 ppm. These measurements, which were made on a double axis flat crystal spectrometer, established the γ-ray energy scale in the 50 keV to 1 MeV region about 40 times more accurately than it was previously known.


Standard Reference Materials can be used to develop test methods and to calibrate measurement equipment thereby insuring the compatibility of measurements among laboratories and assuring the long-term integrity of quality control in manufacturing processes.


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An initial comparison and analysis is given for several radiographic and ultrasonic standards of the US (ASTM) and the USSR (GOST). Differences between standards are pointed out.


Certain limitations of radiography may be overcome by use of a method developed for magnifying x-ray images.


Elastic properties of three austenitic stainless steels were studied between room temperature and either liquid-nitrogen or liquid-helium temperature. A dynamic (pulse-echo, 10 MHz) method was used to determine longitudinal and transverse sound-wave velocities, which were converted to elastic constants.


Measuring 18 separate ultrasonic velocities in a boron-fiber-reinforced aluminum-matrix composite by a 10-MHz pulse-echo technique provides nine independent elastic-stiffness constants.

This quarterly journal provides rapid publication for original papers concerned with the development and application of ultrasonic techniques with emphasis on medical diagnosis. Papers deal with theoretical and experimental aspects of advanced methods and instrumentation for imaging, computerized tomography, Doppler measurements, signal processing, pattern recognition, microscopy, and measurements of ultrasonic parameters.


The Second International Symposium on Ultrasonic Imaging and Tissue Characterization was held at the National Bureau of Standards on June 13-15, 1977. This volume contains papers based on 43 of the 53 talks presented. Topics covered include techniques for measurement of ultrasonic tissue parameters, Doppler signatures, computerized tomography, signal processing and pattern recognition.


Major elements of the system include: computerized tomography studies; opto-acoustic visualization of ultrasonic fields, studies of propagation through inhomogeneous media, and transducer calibration; electronic focusing, especially annular array imaging; sensitivity enhancement, using digital signal averaging and pulse compression techniques; computer and chirp waveform techniques for compensation of frequency-dependent attenuation; the SonoChromascope, a digital device for real-time acquisition, processing, and display of B-scan images; and computer-based image processing.


In this work, recommended values for the electrical resistivity as a function of temperature from the cryogenic region to well beyond the melting point are given for bulk pure copper, gold, palladium, and silver.

Phased-array echosonographic systems, currently in use in medical diagnosis, employ pulses that are a few wavelengths long at the center frequency. Design of such systems requires that arrays be composed of as few elements as are consistent with acceptable resolution and low side lobes. This paper outlines the development of a model for the field of an idealized phased array. Arrays designed by this method offer advantages over uniform linear arrays because of the smaller number of elements required for given azimuthal resolution and side-lobe level, and because of reduced element interaction.


Four methods for characterizing ultrasonic transducers are reviewed. These methods have been or are being developed for characterizing the performance of ultrasonic devices operating into a water load. The principles upon which these methods are based are electrical measurements related to the equivalent circuit of a quartz transducer, a thermal equivalent calorimetric method, a measurement of total radiation force, and an electroacoustic method involving sampling the acoustic field of a directive device.


The Department of Transportation is sponsoring work at the National Bureau of Standards on the inspection and evaluation of girth welds of the kind used in cross-country pipelines for oil and gas.


An analysis is presented of backprojection methods for reconstructing cross-sectional images of ultrasonic reflectivity from scattering measurements. A circular array of transducer elements is considered, using three basic modes of data acquisition and image reconstruction. The point spread function for each of these cases is derived and is shown to depend on the shape of the acoustic pulse used.

79. Norton, S. J. and Linzer, M., Ultrasonic reflectivity imaging in three dimensions: reconstruction with spherical transducer arrays, **Ultrasonic Imaging** 1, No. 3, 210-231 (July 1979).

Three-dimensional backprojection for reconstructing acoustic reflectivity within a volume is examined. The reflectivity data are acquired by means of a spherical array of point sources-receivers which encloses the object under study. Reconstruction of the image is obtained by backprojecting the recorded pulse echo data over spherical surfaces in image...
space. An analytical expression for the point spread function generated by the backprojection process has been derived. This expression was evaluated for several different choices of the acoustic pulse: a narrowband pulse, wideband pulse, and two analytically derived optimum pulses which provide the best sidelobe response.


An optical scanning microscope system for accurate measurement of linewidth on wafers is described.


Traditional methods of linewidth measurement on integrated circuit photomasks and wafers have employed an optical microscope with some type of measuring eyepiece. In recent years, the push to finer line geometries has revealed systematic measurement differences between instruments as large as 1.0 μm. Modeling of linewidth measurement systems has shown that these differences may be attributed to differences in edge detection criteria. New techniques have been developed at the NBS for accurate optical edge detection and calibration of other optical linewidth measurement systems.


New techniques for accurate edge detection and calibration of optical linewidth measurement systems are discussed.


The theory and instrumentation which have been developed for measurements on both photomasks and wafers are described. Linewidths as small as 0.5 μm can be measured with a sensitivity of 0.01 μm and an estimated uncertainty of 0.05 μm.


The crazes in ductile materials propagate so smoothly that the acoustic signal is not strong enough to be separated from the noise level. It is only in very brittle material that the jumpwise craze propagation yields acoustic bursts strong enough to be recorded easily.


CBT is developing manuals which will include technical data for building components and specific health, safety and general welfare attributes; e.g., strength and stability, accident safety, health and sanitation, and energy conservation. These manuals will cover: (1) test methods for destructive and nondestructive evaluation of existing construction, (2) methods of analyses to predict the performance of existing construction, (3) field inspection and evaluation methodologies, (4) data on the performance of systems no longer used, and (5) data on rehabilitation experiences.


A proposed ANSI standard for classifying radiographic intensifying screens has been under test at the National Bureau of Standards. This standard establishes procedures for characterizing, on an absolute basis, the optical spectral output of fluorescent screens per unit of incident x-ray exposure. The testing procedure has undergone revision since an earlier status report was given. Calcium tungstate screens, however, still form the basis of comparison in this procedure because of the long acceptability and stable output qualities of this screen.


A microcalorimeter has been designed and constructed to measure the self-discharge (or shelf life) of pacemaker batteries under load and to measure the energy dissipation of the completed pacemaker. The design is based on previous work using our earlier biological microcalorimeter which could handle only small camera or watch batteries.


Fracture-mechanics methods were used to provide a basis for assessing the significance of flaws in girth welds in a buried arctic oil pipeline. Methods were assessed for estimating weld-flaw depths and arc-burn depths from field radiographs. Various fracture-mechanics analyses were used to calculate a series of allowable flaw-size curves. Such curves were used to assess the significance of girth-weld flaws and arc burns.


The normal mode vibrational spectrum of a particular object contains a wealth of information about the mechanical integrity of the object. The nondestructive evaluation of objects by observation of such vibrational spectra is facilitated by the combination of recently developed low mass, high compliance piezoelectric polymer transducers, a synchronized method for exciting the sample, and a small minicomputer capable of making digital Fourier transforms.


Positron annihilation linewidth measurements have been used to study defect behaviour in titanium samples which were first cold-worked and then annealed. The line width for a highly deformed high purity sample showed a gradual increase with increasing annealing temperature up to recrystallization temperature, above which there was a rapid increase. In contrast, a commercially pure sample displayed a smooth increase in linewidth over the entire annealing range. Hardness measurements correlate reasonably well with the overall trend of the positron lineshape parameter.

We report here the results of the application of a new instrument, based on back-scattering, that greatly expands the range of applicability of Raman spectroscopy to fluid inclusions.


Activities currently underway to develop and provide reference materials for wear testing, to improve wear measurement procedures and to obtain meaningful wear data will be described.


The paper is a comprehensive review of ultrasonic transducers which are being used for materials testing and flaw detection. Emphasis is placed on the characterization of these transducers.

The scope of this review is four-fold: (1) to consider the ultrasonic transducer coupled to various test media as an element in an ultrasonic system; (2) to survey the various methods of ultrasound transduction; (3) to summarize some of the techniques by which the characteristics of a transducer are modified; and (4) to review the techniques for transducer characterization. The emphasis is on transduction devices of bulk waves propagating in solids including contact, immersion and angle beam transducers.


The workshop, third in a series, served as a forum for pacemaker manufacturers and other interested parties to address technical questions relevant to the enhancement and assurance of cardiac pacemaker reliability. Extended summaries are provided on the following topic areas: microcalorimetric measurements to evaluate nondestructively
batteries used in pacemakers; neutron radiography interrogation of lithium-based batteries; measurement of moisture; automated testing of pacemakers; and conformal coatings for pacemaker applications.


Important components used in the prototype Lixiscope (low-intensity x-ray-imaging scope) are the radioactive x-ray source and the scintillator screen. Calculated data are given pertinent to the spectra and intensity of x-rays emitted by the encapsulated sources used. Detection efficiencies for a rare-earth and a CsI scintillator screen are compared.


These proceedings consist of twenty-five papers from the 28th meeting of the Mechanical Failures Prevention Group. Special emphasis is on aerospace, land based, marine and industrial applications.


This report summarizes all those programs which depend on the NBS reactor. The programs range from the use of neutron beams to study the structure and dynamics of materials through neutron radiography and nondestructive evaluations.


We report calculations for the impedance of a long solenoid which surrounds a cylinder of conducting material containing a radial surface crack of constant depth. The calculation is accomplished by solving for the longitudinal ac magnetic field in the interior of the "cracked" cylinder in terms of an infinite series of cylindrical Bessel functions. The results are tabulated in a form useful for nondestructive testing purposes.

A preliminary study of the relationships between moisture infusion, leak size, and device reliability has been completed. Two sets of experiments were conducted. In one, packages constructed with a controlled leak were placed in a controlled humidity environment and the water vapor content measured as a function of time. The second experiment was a life test in which packages were subjected to an atmosphere with 85-percent relative humidity at 85°C. The results exhibited a great amount of scatter. Nevertheless, it can be safely concluded that present leak rate limits for large packages are not low enough to insure that the maximum permissible moisture level will not be exceeded during a reasonable service life.


The magnetic leakage fields caused by artificial defects have been calculated for the case of a linear isotropic magnetic material, and determined approximately for a non-linear material near saturation. The force fields acting on small magnetic particles have been calculated. Using these results, the magnetic particle surface density which evolves around the artificial defects from a uniform low density cloud of magnetic particles is estimated for the case of dry particles. The calculated fields and powder patterns are compared with those obtained on a typical test ring. The ability of such test rings to accurately gauge system performance is discussed.


Digital image processing and pattern recognition are providing the basis for a growing number of attempts to achieve an automated vision system. This paper begins with a brief historical perspective on image processing and pattern recognition. Next a series of state of the art examples of visual inspection systems, and then robot vision systems is presented. The paper contains a list of other areas in manufacturing for the application of vision systems, and concludes with an assessment of the future of vision systems in manufacturing.


See abstract for No. 107.

In stylus measurements of surface texture the measured results for roughness depends on the stylus radius. Since stylus tips are not perfectly spherical, the local radius of curvature varies significantly over the surface which makes the determination of an effective radius difficult. Comparisons are made between three techniques: sharp-edge traces, optical microscopy and scanning electron microscopy. It is concluded that the radius scale method is accurate, unambiguous and easy to use for routine measurements in the laboratory.


This note describes a low-intensity x-ray imaging device with the acronym Lixiscope. The high sensitivity and large gain of the Lixiscope not only allows safe fluoroscopic examinations, but also enables the use of radioactive sources in lieu of x-ray machines. Furthermore, because the Lixiscope produces a visible-light output image, it can be easily recorded on fast instant-processing films or used in conjunction with any other image recording and processing devices. As will be shown, the small format of the Lixiscope in conjunction with a minute radioactive source provides a truly portable, nearly pocket-size fluoroscopic system.


A prototype low-intensity x-ray imaging system with the acronym LIXIscope was built to demonstrate the feasibility of a modular approach toward x-ray imaging in small-format applications. The prototype, including its own x-ray source, is shown to be fully portable, rugged and pocket-sized. Preliminary results and performance characteristics are presented.


NBS should consider providing measurement services (such as well characterized surfaces) based on a state-of-the-art facility for precision scattering measurements and calibrations.


Thermodynamic properties of nitrogen gas have been calculated from sound velocity measurements using multiproperty fitting techniques.
These new data are intended to improve existing predictive capability of the equation of state in the low density region needed for use with the NASA-Langley National Transonics Facility.


The history of the SQUID is reviewed with emphasis on recent developments.
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