R 85-3183

NDE Publications: 1982

Leonard Mordfin, Editor

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Materials Science
Office of Nondestructive Evaluation
Gaithersburg, MD 20899

May 1985

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NBSIR 85-3183

NDE PUBLICATIONS: 1982

Leonard Mordfin, Editor

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Materials Science
Office of Nondestructive Evaluation
Gaithersburg, MD 20899

May 1985

U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

Table of Contents

		Page
1.	Introduction	1
2.	Bibliography and Abstracts	3
3.	Subject Index	27
4.	How to Obtain Copies	32

NDE PUBLICATIONS: 1982

Leonard Mordfin

Office of Nondestructive Evaluation
Center for Materials Science
National Bureau of Standards
Gaithersburg, MD 20899

1. Introduction

This is the sixth 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",
NBSIR 80-2080, "NDE Publications: 1978",
NBSIR 81-2351, "NDE Publications: 1979",
NBSIR 81-2364, "NDE Publications: 1980", and
NBSIR 83-2741, "NDE Publications: 1981".

This report provides bibliographic citations for publications that appeared in the open literature during the calendar year 1982. 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 resistivity measurement and scattering theory, 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 124 entries of 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

1. Alperin, H. A.; Singhal, S. P. **Relaxation behavior of SiC fibers in SiC/Al composite material under stress,** NBS Reactor: Summary of Activities July 1980 through June 1981. NBS TN 1160. 1982 June. 96-97.

   A sample was placed on the neutron diffractometer in a special fixture and subjected to compressive loads while changes in the Bragg peak positions were observed separately for the SiC and the Al reflections.

2. Anderson, W. E.; Ramboz, J. D.; Ondrejka, A. R. **The detection of incipient faults in transmission cables using time domain reflectometry techniques: Technical challenges,** IEEE Trans. Power Appar. Syst. PAS-101, No. 7, 1928-1934 (July 1982).

   The location of faults in underground transmission lines is difficult and time-consuming. DOE has sponsored research in the development of instrumentation to detect and locate incipient fault sites. Some of these methods rely on reflectometry techniques in either the time or frequency domain. NBS has investigated the feasibility of using such methods in extruded polyethylene cables.

3. Anon., **Publications in 1980 and 1981 of the Mechanical Production Metrology Division,** 12 p. (Feb. 4, 1982).

   This bibliography reflects the mission of the Division, which is to develop and maintain competence as an applied resource in mechanical measurements for NBS. These competences include generalized wave scattering and inverse scattering, vibration analysis, acoustics research, and calibrations of acceleration, surface texture, acoustics and optics. These competences are applied to problems in inspection technology to improve productivity and quality.

4. Anon., **Program and abstracts, seventh international symposium on ultrasonic imaging and tissue characterization, June 6-9, 1982, National Bureau of Standards, Gaithersburg, Maryland,** Ultrasonic Imaging 4, No. 2, 171-199 (April 1982).

5. Barnes, J. D. **A computer-controlled apparatus for gas transmission measurements,** Proc. 40th Annu. Tech. Conf. of the Society of Plastics Engineers, San Francisco, CA, May 10-13, 1982, pp. 19-21, (SPE, Brookfield Center, CT, 1982).

   This paper describes a state-of-the-art facility for measuring the gas transmission characteristics of polymer films. Sensitive electronic manometers are used to monitor the rate at which gas passes through a film into an initially evacuated receiving volume. The recent recertification of SRM 1470 for permeances and time-lags of He, CO2, O2, and N2 is described to illustrate the capabilities of the apparatus.

6. **Bechtoldt, C. J.; Placious, R. C.; Boettinger, W. J.; Kuriyama, M. X-ray residual stress mapping in industrial materials by energy dispersive diffractometry, Adv. X-Ray Anal. 25, 329-338 (1982).**

An application of energy dispersive diffractometry to the measurement of residual strains (stresses) in the interior of industrial materials is described with particular emphasis on the use of high energy (up to 250 keV) x-ray photons. The use of high energy photons permits better penetration into materials. Hence diffraction data for evaluating bulk residual strains can be obtained in the transmission geometry in contrast with the conventional angular dispersive diffractometry, which uses Bragg reflections from the surface of materials. The reliability and sensitivity of the method are demonstrated through its application to mapping of residual stress distributions across weld zones in Alaskan pipe line segments.

7. **Berger, H.; Birnbaum, G.; Eitzen, D. G. NDT measurements traceable to NBS, Proc. Tenth World Conf. Non-Destructive Testing, Moscow, USSR, Aug. 23-28, 1982, pp. 58-65 (1982).**

8. **Berger, H.; Mordfin, L. What is NBS doing in NDE? 36th Annu. Quality Congr. Transactions, pp. 929-933 (American Society for Quality Control, Milwaukee, WI, 1982).**

NBS has had an active program in NDE for several years, directed toward the development of NDE standards and improved NDE measurement capabilities.

9. **Blessing, G. V. Ultrasonic measurements of titanium 6211 weld and plate. NBSIR 82-2500. 1982 May. 15 p. Available from: NTIS; PB 82-221672.**

Ultrasonic shear and longitudinal waves are used to evaluate the elasticity and attenuation of titanium weld and plate alloy. Wave speeds are used to measure the materials' elasticity and anisotropy, and the wave amplitude is used to measure relative levels of scattering in the weld and plate regions. Results obtained on a representative weld are compared with results obtained on oxygen contaminated specimens.

10. **Blessing, G. V.; Eitzen, D. G. Ultrasonic standard reference blocks--what future? 1982 Paper Summaries, ASNT National Conferences, 9-12 (ASNT, Columbus, OH, 1982).**

ASTM-type aluminum ultrasonic reference blocks have served as useful standards in materials evaluations for over 20 years. While much effort has been expended to improve this practice, in fact the block variability tolerances have increased substantially over the years. The many system variables which have caused this to happen will be outlined and discussed quantitatively. Specific results on an anomalous block set will be presented.

11. **Blessing, G. V.; Eitzen, D. G. Variables affecting ultrasonic reference block calibration, 1982 Paper Summaries, ASNT National Conferences, 287-291 (ASNT, Columbus, OH, 1982).**

The variables affecting ultrasonic reference block calibrations are many. Of these, the transducer has received the most attention. Sophisticated approaches toward parameterizing its behavior, however, have met with limited success. We present a relatively simple empirical approach whereby the peak amplitude of the transducer's far-field center lobe is normalized and correction factors applied. An example follows, together with a discussion of the other principal system variables.

12. **Boettinger, W. J.; Dobbyn, R. C.; Burdette, H. E.; Kuriyama, M. Real time topography with x-ray image magnification, Nucl. Instrum. Methods 195, 355-361 (1982).**

An X-ray optical configuration for real time synchrotron radiation topography is described. Video images of moving magnetic domain walls under a varying magnetic field were obtained from Ni single crystals in the anomalous transmission geometry.

13. **Bracher, D. A.; Garrett, D. A.; Heller, C. O. Theory and design of instrumentation for bridge investigation, Failure Prevention in Ground Transportation Systems. NBS SP 621. 1982 October. 143-150.**

Theoretical calculations have indicated that hybrid instrumentation using both radiation and electromagnetic interrogation for measurement of the integrity of bridge footings is feasible.

14. **Breckenridge, F. R. Acoustic emission transducer calibration by means of the seismic surface pulse, J. Acoustic Emission 1, No. 2, 87-94 (April 1982).**

A system for calibrating transducers as receivers of elastic waves at the surface of a solid medium has been developed and is now in use at NBS. The method provides the voltage output of the transducer when mounted on a surface whose motion is known. An error analysis is given.

15. **Brown, D. W.; Lowry, R. E.; Smith, L. E. Prediction of the long term stability of polyester-based recording media. NBSIR 82-2530. 1982 June. 44 p. Available from: NTIS; PB 83-172668.**

The stability of poly(ethylene terephthalate) is being studied in order to predict its long term behavior as the base of the film and tape used to record archival information.

16. **Bullis, W. M.; Nyyssonen, D. Optical linewidth measurements on photomasks and wafers, VLSI Electron.: Microstruct. Sci. 3, 301-346 (Jan. 1982).**

This chapter discusses the origins of systematic errors in optical linewidth measurement systems, outlines advances in modeling the linewidth measurement process including imaging in the optical

microscope, describes a primary linewidth measurement system in use at NBS and discusses the use of primary measurements to calibrate less accurate systems conventionally used for linewidth measurements.

17. **Bur, A. J.; Tsao, A. K. Fabrication of ultra-drawn thick PVDF transducers. NBSIR 81-2418. 1981 December. 24 p. Available from: NTIS; PB 83-215715.**

Ultra-drawn polyvinylidene fluoride transducers have been fabricated from pellet resin material. The samples were mechanically ultra-drawn beyond their natural 4:1 draw ratio in order to enhance the molecular orientation and thereby optimize the piezoelectric activity.

18. **Chandler-Horowitz, D. Ellipsometric accuracy and the principal angle of incidence, Proc. Int. Soc. Photo-Opt. Instrum. Eng., Integrated Circuit Metrology 342, 121-130 (SPIE, Bellingham, WA, 1982).**

The effects of the angle of incidence on the ellipsometric determination of thickness and refractive index of oxide and nitride films on a silicon substrate are analyzed. It is found that the accuracy of a determination of a film's parameters depends as much on the accuracy of the angle of incidence as on the accuracy of the ellipsometric angles.

19. **Chandler-Horowitz, D.; Candela, G. A. Principal angle spectroscopic ellipsometry utilizing a rotating analyzer, Appl. Opt. 21, No. 16, 2972-2977 (Aug. 15, 1982).**

The variations of the intensity of the reflected light near null are compared for three ellipsometric techniques. The highest accuracy of the film thickness measurement is obtained when the angle of incidence is equal to the principal angle.

20. **Chang, J. C.; Nadeau, F.; Rosen, M.; Mehrabian, R. Crystallization kinetics study of $Zr_{50}Cu_{50}$ by ultrasonic and microhardness measurements, Scripta Metallurgica 16, 1073-1078 (1982).**

21. **Chang, Y. M. L.; Grot, R. A. Quality of inspections utilizing infrared technology on weatherization retrofit installations. NBSIR 82-2510. 1982 November. 109 p. Available from: NTIS; PB 83-146936.**

A comparative evaluation of various portable infrared sensing systems used for detecting heat loss anomalies within building envelopes was performed. The results of infrared surveys carried out by thermographic surveying firms and those by the National Bureau of Standards were analyzed and compared. Through the comparison, the degree of completeness of inspecting the residences thoroughly was evaluated to be the most important factor for defect identification.

22. Cheng, Y. T.; Garrett, D. A. **Resonance neutron tomography,** NBS Reactor: Summary of Activities July 1980 through June 1981. NBS TN 1160. 1982 June. 101-105.

The effort on this project included the initial tomographic reconstruction of a nuclear waste container.

23. Cheng, Y. T.; Garrett, D. A. **Design study of a facility for neutron-activation autoradiography of paintings at the National Bureau of Standards reactor,** NBS Reactor: Summary of Activities July 1980 through June 1981. NBS TN 1160. 1982 June. 106-111.

Neutron-activation autoradiography extends the range of information that can be obtained with x-rays by being able to measure the distribution of several pigments other than lead and at the same time identify the elementary composition of the painting. The NBS reactor thermal column with modifications can provide a thermal neutron field suitable for studies of paintings while minimizing the radiation dose.

24. Chew, H. **Electromagnetic modeling of oil shale retorts for remote sensing purposes,** IEEE Trans. Geoscience and Remote Sensing GE-20, No. 4, 510-517 (Oct. 1982).

We report here on the modeling of oil shale retorts to obtain useful information about the contents of the retort (e.g., rubble size, void ratio, etc.) by means of electromagnetic probes. The results indicate feasibility of determining the void ratio by remote electromagnetic measurements.

25. Clifton, J. R. **Nondestructive evaluation methods for quality acceptance of building materials,** Proc. 31st Defense Conf. on NDT, Nov. 2-4, 1982, 95-109 (Supervisor of Shipbuilding, Conversion and Repair, Seattle, WA).

See abstract for No. 26.

26. Clifton, J. R.; Carino, N. J.; Howdyshell, P. **In-place nondestructive evaluation methods for quality assurance of building materials.** Report CERL-TR-M-305. 1982 March. 85 p. [Construction Engineering Research Lab (Army), Champaign, IL].

The objectives of this report are: (1) to identify NDE methods which can help building inspectors determine the quality and uniformity of in-place materials; and (2) to develop guidelines to assist inspectors in selecting appropriate NDE methods.

27. Clifton, J. R.; Carino, N. J. **Nondestructive evaluation methods for quality acceptance of installed building materials.** J. Res. Natl. Bur. Stand. 87, No. 5, 407-438; 1982 September-October.

A review of methods developed for the nondestructive evaluation of building materials is presented. The generic features of NDE methods are discussed. This is followed by descriptions of specific methods. The principles underlying the operation of the methods are

described, along with their typical applications, advantages, and limitations. A table is included summarizing the characteristics of various NDE methods.

28. **Clough, R. B.; Wadley, H. N. G. Indentation loading studies of acoustic emission from temper and hydrogen embrittled A533B steel, Metall. Trans. 13A, 1965-1975 (Nov. 1982).**

Isothermal tempering induced acoustic emission activity in A533B steel during indentation loading. Hydrogen charging prior to testing greatly enhanced the acoustic emission activity. This process can continue after unloading the indenter due to hydrogen diffusion to the residual stress field.

29. **Cohen, E. C.; Ruthberg, S., eds. Semiconductor Measurement Technology: NBS/RADC Workshop, Moisture Measurement Technology for Hermetic Semiconductor Devices, II. NBS SP 400-72. 1982 April. 294 p. Available from Superintendent of Documents.**

Manuscripts are provided of 36 presentations which detail progress in mass spectrometer measurements and calibration of internal package moisture and in increased assurance with moisture sensors.

30. **Croarkin, C.; Varner, R. N. Measurement assurance for dimensional measurements on integrated-circuit photomasks. NBS TN 1164. 1982 August. 50 p. SN003-003-02420-1.**

Optical Microscope Linewidth-Measurement Standards, SRM-474 and SRM-475, have been developed by NBS for optical imaging systems capable of making line-spacing and linewidth measurements on IC photomasks. Each artifact affords a means of reducing systematic errors and keeping the optical system in statistical control. Procedures are given for accomplishing these goals along with a discussion of the uncertainty of the calibrated values.

31. **Cronin, D. J.; Blackburn, D. H.; Haller, W. K. Unusual luminescence behavior of terbium phosphate glasses, Nature 295, No. 5851, 680-682 (Feb. 25, 1982).**

32. **Datta, S. K.; Fortunko, C. M.; King, R. B. Sizing of surface cracks in a plate using SH waves, Review of Progress in Quantitative Nondestructive Evaluation 1, 227-231 (Plenum Press, New York, NY, 1982).**

The diffraction of SH waves by surface cracks in plates is studied in two different ways. First, a variational integral expression is used to calculate the reflection coefficients of the propagating modes. The scattered fields away from the crack are then obtained using modal superposition. Second, a finite element-analytical technique is used to calculate the scattered fields. The results of the two calculations are compared for the case of shallow cracks in the long wavelength limit. The theoretical results are also compared with experimental data. It is shown that SH waves may be

particularly appropriate for detecting and sizing elongated planar defects in butt welds.

33. **Datta, S. K.; Shah, A. H.; Fortunko, C. M. Diffraction of medium and long wavelength horizontally polarized shear waves by edge cracks, J. Appl. Phys. 53, No. 4, 2895-2902 (Apr. 1982).**

Scattering of horizontally polarized shear (SH) waves by edge cracks of different orientations relative to the free surface of the half-space is studied. A technique is presented that is suitable for analyzing scattering by cracks or inhomogeneities in a semi-infinite elastic medium. Numerical results are presented for crack opening displacements and scattered fields on the surface. The experimental results are obtained using electromagnetic-acoustic transducers that can efficiently generate and detect low-frequency SH waves in metals. The results are applicable to sizing and characterization of weld defects. Recent experimental evidence suggests that this can be accomplished when the wavelength is of the order of twice the crack length or longer.

34. **Edelman, S.; Payne, B. F. Polymer film accelerometer. U.S. Patent 4,315,433. 16 February 1982. 4 p.**

An accelerometer is provided which utilizes at least one sheet of piezoelectric polymer film, supported under tension in a frame, for sensing the acceleration-responsive movements of an associated inertial mass and providing an electrical output in accordance therewith.

35. **Eitzen, D. G. Electric Power Research Institute/National Bureau of Standards joint program on acoustic emission, Nondestructive Evaluation Program: Progress in 1981, Report NP-2088-SR, Section 35, 18 p. (EPRI, Palo Alto, CA, January 1982).**

The work focuses on calibration and sensor activities, characterization of AE sources and determination of source significance. The problem of repeatability of calibrations of certain sensors has been solved. Preliminary results from a second sensor calibration method are promising, showing good agreement in details with the current method. The NBS conical transducer is under development. It faithfully measures dynamic displacement; present sensors only detect a disturbance. A repetitive simulated source for source deconvolution in complex structures is well along in development. A method for repetitively reproducing AE in steel plates has been developed.

36. **Eitzen, D. G.; Breckenridge, F.; Clough, R,; Hsu, N.; Proctor, T.; Simmons, J. NBS developments in quantitative acoustic emission measurements, Review of Progress in Quantitative Nondestructive Evaluation 1, 433-442 (Plenum Press, New York, NY, 1982).**

The NBS AE transducer calibration service and its relation to other methods are presented. A new piezoelectric AE transducer measures normal surface displacement nearly as faithfully as the NBS standard capacitive transducer but with much greater sensitivity. It holds

promise as a secondary calibration device and for application relying on causal signal processing. A multichannel AE system for characterizing reproducible AE events produced by indentation cracking is being developed.

37. **Evans, A. G. Technical and scientific assessment of the reliability of advanced ceramics, 55 p. (July 1982).**

In this report prepared for the Materials Chemistry Division and the Fracture and Deformation Division of the NBS Center for Materials Science, Professor Evans makes the point that nondestructive methods for probing the structure of green compacts and other pre-sintered forms (e.g., acoustic waves, x-ray and neutron methods) can be an invaluable adjunct to ceramic processing technology.

38. **Feldman, A.; Vorburger, T. Comparison of optical and mechanical methods of thickness measurement, Proc. Int. Soc. Photo-Opt. Instrum. Eng., Integrated Circuit Metrology, 342, 92-99 (SPIE, Bellingham, WA, 1982).**

A variety of techniques is used for the measurement of thin film thicknesses of the order of one micrometer. These techniques include stylus profilometry, multiple beam interferometry, dual beam interferometry, guided waves, channel spectra and ellipsometry. The principles underlying the techniques are discussed and comparisons are presented.

39. **Fickett, F. R. Electrical properties of materials and their measurement at low temperatures. NBS TN 1053. 1982 March. 76 p. SN003-003-02390-6.**

A review is given of the electrical resistance of materials at cryogenic temperatures. Measurement techniques, the data base, and uses of the data are presented.

40. **Fong, J. T. What is fatigue damage? Damage in Composite Materials, ASTM STP 775, 243-266 (1982).**

A conceptual definition of fatigue damage is proposed to assist in the selection of measurement techniques and parameters for correlating damage with fatigue life. A survey of some new techniques for damage monitoring, including the small angle neutron scattering method, is presented and discussed.

41. **Fortunko, C. M.; King, R. B.; Tan, M. Nondestructive evaluation of planar defects in plates using low-frequency shear horizontal waves, J. Appl. Phys. 53, No. 5, 3450-3458 (May 1982).**

An ultrasonic technique is described that allows the determination of the through-thickness dimension and limited localization of planar defects in an isotropic metal plate. The scattering of horizontally polarized shear (SH) plate waves by edge and buried planar defects is investigated using a variational integral expression. It is shown that SH waves are particularly useful for detecting and

sizing of crack-like defects. In addition, it is possible to determine the relative position of a defect from interference phenomena. The results are confirmed experimentally using an electromagnetic-acoustic transducer system to generate and detect wave signals along the normal to the circumference of a steel pipe.

42. **Fortunko, C. M.; Moulder, J. C. Ultrasonic inspection of stainless steel butt welds using horizontally polarized shear waves, Ultrasonics 20, No. 3, 113-117 (May 1982).**

Inspection of austenitic stainless steel weldments by conventional ultrasonic means is fundamentally limited by the textured, columnar grain structure of the weld metal. It is shown that, for selected angles of incidence, shear waves normally polarized with respect to the columnar grains can pass through the weld metal-base metal interface without partial reflection. As a consequence, the inspectability of stainless steel weldments can be improved.

43. **Fortunko, C. M.; Schramm, R. E. Nondestructive evaluation of large diameter girth welds using electromagnetic-acoustic transducers, Proc. Fitness for Purpose Validation of Welded Constructions, London, England, Nov. 17-19, 1981, pp. P20-1-P20-8 (The Welding Institute, Cambridge, England, 1982).**

A new ultrasonic inspection technique is described to detect elongated defects in butt welds. The technique uses noncoupling, electromagnetic-acoustic transducers which can operate on most unprepared surfaces and under adverse environmental conditions. The technique is demonstrated in the context of the detection and sizing of defects in girth welds of cross-country pipeline. The inspection is carried out using shear wave signals polarized in the plane of the weld (SH waves). The advantage of inspections at low frequencies is that the reflected amplitude is relatively insensitive to defect orientation and surface roughness. Since SH waves can propagate at near-grazing angles, the sensitivity to through-wall two-dimensional defects can be maximized.

44. **Fortunko, C. M.; Schramm, R. E. Ultrasonic nondestructive evaluations of butt welds using electromagnetic-acoustic transducers. Weld. J. 61, No. 2, 39-46 (Feb. 1982).**

See abstract for No. 43.

45. **Fortunko, C. M.; Schramm, R. E. Evaluation of pipeline girth welds using low-frequency horizontally polarized waves, J. Nondestructive Evaluation 3, No. 3, 155-173 (Sept. 1982).**

A new ultrasonic inspection method is described that permits complete volumetric inspection of girth welds. The system uses noncontacting electromagnetic-acoustic transducers that operate at low ultrasonic frequencies (454 kHz). Theoretical models of the measurements are developed and verified experimentally. In addition, practical performance limits of the new system are established in terms of minimum flaw sizes that can be detected. The results

are related to accept-reject curves based on a model of the failure processes. An inspection protocol for field applications is also described.

46. **Free, G.; Birnbaum, G.; Berger, H.; Kljuev, V.; Fedosenko, Y. Standards for eddy current nondestructive testing, Proc. Tenth World Conf. Non-Destructive Testing, Moscow, USSR, Aug. 26, 1982, pp. 261-266 (Aug. 1982).**

In order to provide a basis for intercomparison of procedural standards in the field of eddy-current testing, several standards of ASTM and of GOST are identified. A brief description is provided of the contents of each.

47. **Greenspan, M.; Eitzen, D. G. Ultrasonic research--Summary report and literature guide to the National Bureau of Standards/ Office of Naval Research Program. NBSIR 82-2529. 1982 June. 11 p. Available from: NTIS; PB 82-229345.**

This brief report summarizes research efforts in physical acoustics at NBS which were partially supported by the Office of Naval Research. It summarizes many of the major accomplishments at NBS in the area of physical acoustics from 1948 to 1981. The published literature documenting these successes is listed.

48. **Grot, R. A. Implications of thermographic standards on the inspection of buildings, Proc. SPIE 371: Thermal Infrared Sensing Diagnostics (Thermosense V), 118-122 (1982).**

This article reviews recent developments in thermographic standards for inspection of the building envelope. The purpose of the standards is explained, their general content outlined and how they are to be used is discussed. The results of a field evaluation of the accuracy of thermographic inspectors in locating insulation voids in cavity walls are summarized. The reasons for observed inconsistencies in inspections of the same building by different thermographic inspectors are given. It must be concluded that improvements in inspection techniques are needed before thermographic inspections can be considered accurate.

49. **Grot, R. A.; Burch, D. M.; Silberstein, S. Measurement methods for diagnostic procedures in evaluation of thermal integrity of building envelopes. NBSIR 82-2605. 1982 November. 140 p. Available from: NTIS; PB 83-180174.**

This report presents reviews of various measurement and inspection techniques appropriate for assessing the thermal performance of the exterior envelopes of federal buildings. The inspection techniques include ground-based infrared thermographic surveys, aerial infrared surveys, tracer gas air infiltration measurement, pressurization tests for measuring the tightness of the building envelope, and spot radiometer surveys for detecting gross defects. For each technique recommended procedures are provided; they include equipment requirements, conditions under which the techniques can be carried out, calibration, accuracy, and limitations.

50. Harman, G. G. **Semiconductor measurement technology: The use of acoustic emission to determine the integrity of large Kovar glass-sealed microelectronic packages. NBS SP 400-70. 1982 May. 80 p. Available from NTIS; PB 82-234485.**

The objective was to develop tests to determine the integrity of large hybrid packages under various thermal and mechanical stresses that may be encountered during assembly, during installation in systems, or in operation. Emphasis was placed on acoustic-emission test procedures. The accomplishments were: (1) The effects of vibration on the seals of hybrid packages mounted on printed-circuit boards were determined. (2) A small acoustic-emission detector was developed that is sensitive to surface waves, but relatively insensitive to vibration induced cable noise. (3) A high-temperature open-package helium leak test method was successfully developed to observe marginal seal damage. (4) An acoustic-emission test for inspection of hybrid packages during thermal shock was developed. (5) A study of damage to seals during thermocompression and thermosonic bonding during assembly operations was carried out. There is little correlation between visual inspection failures of glass seals and their hermeticity.

51. Harman, G. G. **Acoustic-emission-monitored tests for TAB inner lead bond quality;** IEEE Trans. Components, Hybrids, and Mfg. Technology CHMT-5, 445-453 (Dec. 1982).

This paper gives a brief introduction to acoustic-emission (AE) based tests applied to quality control in the electronics industry and describes some recent research on this testing technique. Equipment and circuits are described that may be used to implement such AE-monitored testing. Acoustic-emission-monitored test systems to determine the inner lead bond quality for Tape Automated Bonding (TAB) have been developed. These include a pull tester and a microfatigue tester for off-line evaluation of bond quality and metallurgical system reliability as well as an automatic on-line production bond quality tester.

52. Harman, G. G.; Harmison, K. A. **The assessment of hybrid package glass-metal seal reliability using acoustic emission measurement techniques,** Intl. J. Hybrid Microelectronics 5, 248-259 (Nov. 1982).

An acoustic-emission monitored hot-stage shock test was developed that detects weak package seals. There is little correlation between visual inspection failures of glass seals and their hermeticity.

53. Hicho, G. E.; Eaton, E. E. **Standard reference materials: A standard reference material containing nominally five percent austenite (SRM 485a). NBS SP 260-76. 1982 August. 25 p. SN003-003-092433-3.**

This Standard Reference Material is a renewal of SRM 485, and is intended for the calibration of x-ray diffraction equipment used in determining the amount of retained austenite in hardened steels.

54. **Hicho, G. E.; Eaton, E. E. Standard reference materials: A standard reference material containing nominally thirty percent austenite (SRM 487). NBS SP 260-78. 1982 September. 25 p. SN003-003-02435-0.**

This Standard Reference Material is intended for the calibration of x-ray diffraction equipment used in determining the amount of retained austenite in hardened steels.

55. **Hsu, N. N.; Eitzen, D. G. The inverse problem of acoustic emission--explicit determination of acoustic emission source time-functions, Review of Progress in Quantitative Nondestructive Evaluation 1, 405-412 (Plenum Press, New York, NY, 1982).**

This paper addresses the problem of determining the AE source time-function from the detected AE signal with a sensor located a short distance away. The solution is in the form of an inverse filter. In other words, by removing the effects of the reverberations of the structure and the particular characteristics of the sensor, the filter recovers the AE source signature which characterizes the source mechanism alone.

56. **Hsu, N. N.; Proctor, T. M., Jr.; Blessing, G. V. An analytical approach to reference samples for ultrasonic residual stress measurement, J. Test. Eval. 10, No. 5, 230-234 (Sept. 1982).**

This paper specifically addresses the question of how to produce a known stress-state reference sample, and ultrasonically determine its zero stress state. A shrink-fit ring-plug assembly was fabricated from carefully screened aluminum bar stock, forming a disk suitable for both longitudinal and shear wave calibration.

57. **Jenkins, D. R.; Knab, L. I.; Mathey, R. G. Laboratory studies of infrared thermography in roofing moisture detection, ASTM Spec. Tech. Publ. 779, pp. 207-220 (1982).**

A laboratory evaluation of infrared thermography for detecting moisture in roofing specimens is presented. For steady state heat flow, and in a few cases, transient heat flow, the effects of moisture on the surface temperature of the specimens were determined by thermography.

58. **Jerke, J. M.; Croarkin, M. C.; Varner, R. N. Semiconductor measurement technology: Interlaboratory study on linewidth measurements for antireflective chromium photomasks. NBS SP 400-74. 1982 November. 191 p. SN003-003-02458-9.**

Optical microscopes fitted with a micrometer attachment are commonly used to measure small linewidths and other critical dimensions on integrated-circuit photomasks. In the absence of calibrated linewidth standards, users have experienced systematic measurement errors much larger than required manufacturing tolerances. This report discusses the results of an interlaboratory study to evaluate a

prototype calibration standard for linewidth measurements and procedures for adjusting and calibrating optical-microscope systems. A linewidth calibration significantly reduced systematic errors for most systems. This study led to the issuance of NBS Standard Reference Material 474 (Optical Microscope Linewidth-Measurement Standard).

59. **Jerke, J. M.; Wendell, C. E. Use of the National Bureau of Standards (NBS) antireflective (AR)-chromium optical linewidth standard for measurements on other types of chromium photomasks, Proc. Int. Soc. Photo-Opt. Instrum. Eng., Integrated Circuit Metrology, 342, 15-26 (SPIE, Bellingham, WA, 1982).**

60. **Kahn, A. H. Impedance changes produced by a crack in a plane surface, Review of Progress in Quantitative Nondestructive Evaluation 1, 369-373 (Plenum Press, New York, NY, 1982).**

A report will be presented of calculations of eddy currents in the vicinity of a crack in a plane slab of conducting material. The problem was solved by a boundary integral equation method. The induced currents at the surface and on the crack will be shown for all ranges of the ratio of crack depth to the electromagnetic skin depth and for selected angles of crack inclination.

61. **Kent, E. W. A hierarchical, model-driven, vision system for sensory-interactive robotics, Proc. COMPSAC '82, Sixth Int. Conf., Chicago, IL, Nov. 8-12, 1982, pp. 400-409 (IEEE Computer Society, Los Angeles, CA, 1982).**

A robot sensory system for industrial robotics, employing structured light vision techniques, is described.

62. **Kilmer, R. D. Safety sensor systems for industrial robots, Proc. Conf. Robotics VI, Detroit, MI, Mar. 2-4, 1982, pp. 479-491 (Robotics International of SME, Dearborn, MI, 1982).**

63. **King, R. B.; Fortunko, C. M. Extended variational solution for scattering from flaws in plates, J. Appl. Phys. 53, No. 5, 3459-3460 (May 1982).**

A variational solution is obtained for scattering of horizontally polarized shear waves from cracks in plates. Numerical results are presented for edge cracks.

64. **Knab, L. I.; Clifton, J. R. Cumulative damage of reinforced concrete subjected to repeated impact, Cem. Concr. Res. 12, 359-370 (1982).**

This study was performed to develop methods of measuring the cumulative damage of steel reinforced concrete slabs subjected to repeated impact. Cumulative damage was monitored by measuring the crater depth and the reduction in ultrasonic pulse velocity across the impact region. The reduction in velocity generally increased with number of impacts up to about 40 percent or more of the total

number of impacts to failure. Beyond that, interpretation of the ultrasonic results with respect to the failure mechanism appears necessary.

65. Knab, L. I.; Jenkins, D. R.; Mathey, R. G. The effect of moisture on the thermal conductance of roofing systems, Proc. ASHRAE/DoE Conf. on Thermal Performance of the Exterior Envelopes of Buildings, Kissimmee, FL, Dec. 3-5, 1979, pp. 816-835 (ASHRAE, New York, NY, 1981).

A procedure was developed, using a heat-flow meter apparatus (ASTM C 518 type), to carry out thermal conductance tests on roofing specimens containing moisture. Relationships between the thermal conductance and moisture content are presented.

66. Kriz, R. D. Monitoring elastic stiffness degradation in graphite/epoxy composites, 1982 Paper Summaries, ASNT National Conferences, 160-164 (ASNT, Columbus, OH, 1982).

This paper describes a nondestructive technique that can be used to measure the degree of degradation of the fiber or matrix stiffnesses. This is accomplished by monitoring the direction of propagation of an acoustic beam as a function of the degree of elastic anisotropy of the composite.

67. Kuriyama, M.; Boettinger, W. J.; Cohen, G. G. Synchrotron radiation topography, Annu. Rev. Mater. Sci. 12, 23-50 (1982).

68. Kuriyama, M.; Cohen, G. G. X-ray extinction theory in the Bragg geometry, Z. Naturforsch. 37a, 465-473 (1982).

69. Ledbetter, H. M. Single-crystal elastic constants in nondestructive evaluation of welds, Review of Progress in Quantitative Nondestructive Evaluation 1, 619-624 (Plenum Press, New York, NY, 1982).

For studying welds nondestructively using elastic waves, we describe the importance of knowing the material's single-crystal elastic constants. Where these are not known, we give guidelines for estimating them from polycrystalline elastic constants such as Young's modulus and the shear modulus.

70. Lieberman, A. G. An electromagnetic formulation for treating optical reflections from graded-material surfaces. NBS TN 1171. 1982 December. 36 p. SN003-003-02467-8.

The reflection of a monochromatic plane wave falling obliquely upon the surface of an arbitrary, flat, depth-dependent material is investigated theoretically. The reflection coefficients can be obtained directly without having to solve Maxwell's equations for the internal field configurations.

71. Linzer, M., ed. Ultrasonic Imaging 4, Nos. 1, 2, 3, 4 (Academic Press, New York, NY, Jan., April, July, Oct. 1982).

This journal provides 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.

72. **Linzer, M.; Norton, S. J. Ultrasonic tissue characterization,** Ann. Rev. Biophys. Bioeng. 11, 303-329 (1982).

We present a critical summary of the methods that have been developed to measure the various ultrasonic parameters. The three major interactions amenable to measurement--velocity, attenuation/absorption, and scattering--are discussed, followed by a brief mention of pattern recognition approaches.

73. **Linzer, M.; Norton, S. J. Tissue characterization,** Diagnostic Imaging 4, 26-29 (1982).

See abstract for No. 72.

74. **Marx, E. Single integral equation for wave scattering,** J. Math. Phys. 23, **No. 6, 1057-1065 (June 1982).**

When a wave interacts with an obstacle, the scattered and transmitted fields can be found by solving a system of integral equations for two unknown fields defined on the surface of the body. By choosing a more appropriate unknown function, the system of equations is reduced to a single singular integral equation of the first kind.

75. **Marx, E.; Maystre, D. Dyadic Green functions for the time-dependent wave equation,** J. Math. Phys. 23, **No. 6, 1047-1056 (June 1982).**

The theory of dyadic Green functions for a transient electromagnetic field is presented within the framework of the theory of distributions. First, the elementary solution of the scalar wave equation is derived, and then it is used to find the general solution of that equation. After establishing the equivalence between Maxwell's equations and the time-dependent vector wave equation, the dyadic elementary solution is derived and applied to solve the equation. The paper includes a collection of formulas from the theory of distributions intended to help readers who are not familiar with the subject.

76. **McCullough, R. E.; Ruthberg, S.; Schafft, H. A.; et al. Techniques of leak testing of hermetic seals and electronic devices, Section 12 of** Nondestructive Testing Handbook, Vol. 1, Leak Testing, **2nd edit., R. C. McMaster, ed., pp. 687-730 (American Society for Metals, 1982).**

This section describes the nature and functions of hermetic seals, and methods for both "gross" and "fine" leak testing of hermetically sealed devices such as electronic components and integrated circuit packages.

77. **Mehrabian, R.; Whitely, R. L.; Van Reuth, E. C.; Wadley, H. N. G. (editors) Process control sensors for the steel industry; report of workshop. NBSIR 82-2618. 1982. 45 p.**

A Briefing/Workshop on Process Control Sensors for the Steel Industry was convened and attended by 160 people on July 27-28, 1982, at NBS in Gaithersburg, Maryland. It was sponsored by the American Iron and Steel Institute, the Defense Advanced Research Projects Agency, and NBS. The aim of the Briefing/Workshop was to provide scientists and engineers in industry, universities, and government with specific process control sensor needs of the steel industry and to seek immediate input and future research and development involvement from a broad spectrum of disciplines to facilitate development of sensors. This report is the proceedings of the deliberations from the Workshop portion of the meeting.

78. **Mordfin, L. Toward the nondestructive characterization of fatigue damage in composite materials, Damage in Composite Materials, ASTM Spec. Tech. Publ. 775, 7-15 (1982).**

The cooperation between specialists in fatigue and in nondestructive testing is marked as a noteworthy milestone in an era in which closer cooperation between these two groups will be needed in order to achieve enhanced quality in materials and manufactured products. Experiences with an unusual form of damage in pultruded guys for antenna support systems are described to show that the development of meaningful test methods for composites may benefit from unconventional approaches.

79. **Mordfin, L. Standards for residual stress measurement, Residual Stress Effects in Fatigue, ASTM Spec. Tech. Publ. 776, 6-12 (1982).**

This paper is a status report on the growing national effort to develop voluntary consensus standards to enhance the reproducibility of residual stress measurements. This effort has achieved noteworthy progress in only a few years, but it has also become evident that further progress will be increasingly more difficult because our understanding of some residual stress phenomena is limited. There is need for a national research effort to parallel and to support the standardization effort.

80. **Mordfin, L. Advanced diffraction techniques for the nondestructive evaluation of internal residual stresses, Proc. Seventh Int. Conf. on Experimental Stress Analysis, pp. 602-603 (The Technion, Israel Institute of Technology, Haifa, Israel, 1982).**

These techniques, which are based upon Bragg diffraction, use thermal neutrons and high-energy x-rays to achieve depths of penetration not attainable by conventional x-ray diffraction techniques.

81. Motz, J. W.; Danos, M. **Quantum noise-limited images in screen film systems,** SPIE 347, 62-66 **(Society of Photo-Optical Instrumentation Engineers, Bellingham, WA, 1982).**

The limits imposed on the spatial resolution obtained with screen-film systems for low contrast images are determined primarily by x-ray quantum noise rather than by the spatial response (MTF curve) of the system.

82. Mountain, R. D.; Birnbaum, G. **Inhomogeneity size and shape determination from scattering of low-frequency sound waves,** J. Appl. Phys. 53, No. 5, 3581-3584 **(May 1982).**

The scattering of sound waves by isolated inhomogeneities in a solid is examined using the Born approximation. A procedure is developed to extract information about the effective volume and shape of the scatterer. A scheme is described which permits the characterization of the scatterer in terms of an equivalent ellipsoid.

83. Norton, S. J. **Acoustical holography with an annular aperture,** J. Acoust. Soc. Amer. 71, 1169-1178 **(1982).**

84. Norton, S. J.; Linzer, M. **Correcting for ray refraction in velocity and attenuation tomography: A perturbation approach,** Ultrasonic Imaging 4, No. 3, 201-233 **(July 1982).**

Assuming that the index of refraction deviates from its mean on the order of the small quantity epsilon, we derive expressions for the refracted ray path whose departure from a straight line is first order in epsilon. We obtain a time-delay correction of order epsilon squared arising from the deviation of the refracted ray from a straight line. The expression is also used to obtain explicit corrections for phase-cancellation and beam-displacement errors that affect attenuation measurements when transducers of finite extent are employed. Because of refraction, large aperture transducers are susceptible to an arrival-time uncertainty in a time-of-flight measurement; a first-order expression for the maximum value of this uncertainty is derived. In both two and three dimensions, the perturbation approach is much simpler computationally than numerical ray tracing methods.

85. Nyyssonen, D. **Design of an optical linewidth standard reference material for wafers,** SPIE 343, 27-34 **(1982).**

86. Nyyssonen, D. **Calibration of optical systems for linewidth measurements on wafers,** Opt. Eng. 21, No. 5, 882-887 **(Sept./Oct. 1982).**

87. Nyyssonen, D. **Theory of optical edge detection and imaging of thick layers,** J. Optical Soc. Am. 72, 1425-1436 **(Oct. 1982).**

Coherent edge detection methods have been developed for the measurement of line objects on integrated-circuit photomasks and wafers. This paper presents a generalization of the coherent threshold

equation which allows the extension to any state of partial coherence of the illumination as well as extension to the measurement of nonplanar objects.

88. Oehl, C. L.; Swartzendruber, L. J. On the optimum applied field for magnetic particle inspection using direct current, J. Nondestructive Evaluation 3, No. 3, 125-136 (Sept. 1982).

Measurements of leakage fields from cylindrical defects were obtained in a geometry which permitted simultaneous measurement of the magnetic induction of the material. The results are compared with calculations using a nonlinear finite difference method. Both the experiments and the calculations indicate that the leakage field continues to grow nearly in proportion with the applied field well into the saturation region of the magnetic material. The implications for magnetic particle inspection are discussed.

89. Parker, R. L. Ultrasonic measurement of solid/liquid interface position during solidification and melting of metals, Physics in the Steel Industry, AIP Conf. Proc. No. 84, 254-271 (American Institute of Physics, New York, NY, June 1982).

The use of ultrasonic flaw detectors to detect the presence and location of discontinuities is well known. The solid-liquid interface in a melting or freezing metal can also be considered a discontinuity, in that there is a measurable difference in both sound velocity and density across the interface. For normal incidence of longitudinal waves in a typical case, about 10 percent of the pressure amplitude of the incident wave would be expected to be reflected. Thus such a technique, if it worked, could be considered as a method for measurement, feedback, and closed-loop process control in such applications as continuous casting of metals. To examine the feasibility of this technique, the melting and freezing of 99.9 Sn has been studied at NBS using pulse-echo equipment. NBS work is focused on the study of the measurement factors inherent in possible use of the method for process control, as well as possible use for interface characterization.

90. Placious, R. C. Radiographic variables and weld flaw analysis, Failure Prevention in Ground Transportation Systems. NBS SP 621. 1982 October. 165-173.

The limits on accuracy of flaw depth analysis, due to radiographic variables, are analyzed in this paper.

91. Proctor, T. M., Jr. An improved piezoelectric acoustic emission transducer, J. Acoust. Soc. Am. 71, No. 5, 1163-1168 (May 1982).

A piezoelectric transducer has been designed and developed that has promise of being a high fidelity acoustic emission transducer. Small transducer contact area, elimination of acoustical interference effects associated with certain geometries, and redistribution of the arrival times of reflected signals originating from various elements of the transducer were the guiding criteria in the design. This transducer consists of a conical active element and an extended

backing. The transducer's performance indicates an amplitude response which is flat within ±3 dB for the range of 50 kHz to 1 MHz. Factors that influence frequency response, such as backing geometry and aperture size, have been experimentally investigated.

92. **Proctor, T. M., Jr. Some details on the NBS conical transducer, J. Acoust. Emiss. 1, No. 3, 173-178 (July 1982).**

We have developed a piezoelectric transducer that responds with a high degree of accuracy to normal surface displacement over the frequency range of 50 kHz to 1 MHz. We have found it extremely useful for investigating transfer functions in AE work. Its faithful time wave response opens many new avenues for investigation.

93. **Proctor, T. M., Jr. Introduction to papers presented at the Symposium on Ultrasonic Measurements of Stress, J. Test. Eval. 10, No. 5, 199-201 (Sept. 1982).**

94. **Rawie, C. C. Benefits and costs of improved measurements: The case of integrated-circuit photomask linewidths. NBSIR 82-2458. 1982 May. 81 p. Available from: NTIS; PB 82-217183.**

Accurate dimensional measurements are vital to quality control in the semiconductor industry. This paper presents a method for estimating the dollar cost-savings from improving integrated-circuit photomask linewidth measurements. The method is illustrated with a case study of a hypothetical semiconductor device manufacturer who uses a Standard Reference Material developed at NBS for optical microscope calibration.

95. **Roberts, J. A.; Ruthberg, S.; et al. Techniques of leak testing with halogen tracer gases, Section 10 of Nondestructive Testing Handbook, Vol. 1, Leak Testing, 2nd edit., R. C. McMaster, ed., pp. 549-623 (American Society for Metals, 1982).**

This section describes techniques of leak testing with halogen compound tracer gases, including common refrigerant gases. The first two parts of this section are introductory in nature. The later parts provide standard recommended practices and techniques for leak testing with halogen tracer gases.

96. **Roe, K. C.; Wittmann, R. C. Improved coal interface detector. NBSIR 82-1663. 1982 May. 44 p. Available from NTIS.**

This report describes the theory, design, construction, and testing of an electromagnetic coal interface detector. The purpose of this type detector is measuring the thickness of roof coal left during underground mining operations.

97. **Roehrs, R. J.; Ruthberg, S.; et al. Introduction to leak testing technology, Section 1 of Nondestructive Testing Handbook, Vol. 1, Leak Testing, 2nd edit., R. C. McMaster, ed., pp. 1-55 (American Society for Metals, 1982).**

This section presents an introduction to the art and science of leak testing, a basic form of nondestructive testing and materials evaluation. Basic principles of leak testing and test methods, equipment and techniques, and hazards to be controlled during leak testing are summarized.

98. **Roehrs, R. J.; Ruthberg, S.; et al. Technology and characteristics of gaseous tracers used in leak testing, Section 2 of Nondestructive Testing Handbook, Vol. 1, Leak Testing, 2nd edit., R. C. McMaster, ed., pp. 57-100 (American Society for Metals, 1982).**

This section presents an introduction to the nature of leakage flow of gases and the factors that control leakage and influence measurements of leakage. This discussion is basic to all leak testing since tracer gases provide higher test sensitivity than do liquid tracers in detection of very small leaks.

99. **Roehrs, R. J.; Ruthberg, S.; et al. Reference standard gaseous leaks, Section 3 of Nondestructive Testing Handbook, Vol. 1, Leak Testing, 2nd edit., R. C. McMaster, ed., pp. 101-138 (American Society for Metals, 1982).**

This section describes reference leaks fabricated for purposes of evaluating the sensitivity of leak testing systems and leak detection instruments. These reference leaks are used to provide known rates of leakage which can be used to adjust leak detector sensitivity, ensure that specified maximum rates of allowable leakage can be detected reliably, and provide standardization of leak testing operations in various locations. In many cases, leakage from the artificial leak is used to calibrate scales on leak detector instruments and, in combination with unknown leakage from test objects or systems, permits quantitative measurement of leakage rates.

100. **Rosen, M.; Fick, S.; Horowitz, E.; Mehrabian, R. An ultrasonic investigation of precipitation hardening phenomena in 2219 aluminum alloy, Review of Progress in Quantitative Nondestructive Evaluation 1, 625-628 (Plenum Press, New York, NY, 1982).**

The present investigation has demonstrated the feasibility of a dynamic ultrasonic NDE method for monitoring the precipitation hardening process, over a wide temperature interval, in aluminum alloys during its progress.

101. **Rosen, M.; Fick, S.; Reno, R.; Horowitz, E.; Mehrabian, R. An investigation of the precipitation-hardening process in aluminum alloy 2219 by means of sound wave velocity and ultrasonic attenuation, Mater. Sci. and Engrg. 53, 163-177 (1982).**

102. **Rosen, M.; Horowitz, E. Ultrasonic nondestructive characterization (NDC) of metallurgical microstructures and transformations, Report CMR-NDE-7 (Johns Hopkins Univ., Baltimore, Sept. 1982).**

103. Rosen, M.; Smith, J. J.; Horowitz, E. Determination of phase stability criteria of extended solid solutions by means of nondestructive characterization, Report CMR-NDE-8 (Johns Hopkins Univ., Baltimore, Nov. 1982).

104. Rosen, M.; Swartzendruber, L.; Horowitz, E.; Mehrabian, R. The aging process in aluminum alloy 2024 studied by means of eddy currents, Mater. Sci. and Engrg. 53, 191-198 (1982).

105. Rosen, M.; Wadley, H. N. G.; Mehrabian, R. Crystallization kinetics study of amorphous Pd-Cu-Si by ultrasonic measurements, Scripta Metallurgica 15, 1231-1236 (1981).

Crystallization kinetics in amorphous metallic ribbons was studied by means of laser-generated and piezoelectrically detected ultrasonic waves whereby the extensional wave velocities, and consequently the Young's moduli, could be determined accurately. Corroboration was obtained with optical metallography.

106. Rowe, J. M.; Glinka, C. J.; Berk, N.; LaRock, J.; Williams, R. H.; Fravel, D. Advanced neutron methods, NBS Reactor: Summary of Activities July 1980 through June 1981. NBS TN 1160. 1982 June. 78-83.

The first part of this report deals with small-angle neutron scattering and describes the small-angle scattering spectrometer and the associated data display and analysis. The second part addresses the neutron time-of-flight facility.

107. Ruthberg, S. Semiconductor measurement technology: Graphical solution for the helium leak detector and radioisotope methods of hermetic test. Master graphs and instruction. NBS SP 400-73. 1982 November. 34 p. SN003-003-02453-8.

A graphic procedure for solution of the molecular flow approximation for the back pressurization method of hermetic test makes use of a set of characteristic curves and a test line. One set of characteristics is provided specifically for the helium leak detector mode as expressed directly in terms of air leak rate; a second set is provided specifically for the krypton-85 radioisotope mode also in terms of air leak rate; and a third set is retained in the original form for use with any tracer gas.

108. Ruthberg, S. Hermetic testing of large hybrid packages, Intl. J. Hybrid Microelectronics 5, 215-232 (Nov. 1982).

Range, efficiency, and usefulness are examined for such popular test procedures as the helium leak detector, radioisotope, weight gain, and bubble methods as well as for others such as the tracer probe, differential pressure, and rapid cycle methods that are more appropriate for the larger package.

109. Ruthberg, S. Leak testing of hermetically sealed electronic components, 1982 Paper Summaries, ASNT National Conferences, 431-436 (ASNT, Columbus, OH, 1982).

Many semiconductor devices are encapsulated in plastic as an inexpensive means of protection, but high reliability devices are typically incorporated into hermetic enclosures. The hermeticity must then be assured. The procedures used for semiconductor devices are considered here, and these are also applicable to other hermetically packaged items.

110. Serbyn, M. R. **Absolute measurement of angular vibration,** Proc. Eleventh Transducer Workshop, Seattle, WA, June 2-4, 1981, L. Bates and K. D. Cox, eds., pp. 260-270 (Range Commanders Council, White Sands Missile Range, NM, May 1982).

With new developments in instrumentation for angular-vibration measurements, the demand for calibration services is expected to grow. This paper investigates the feasibility of measuring the magnitude of vibratory displacement absolutely. In general, a reciprocity calibration is better suited to angular displacements of low frequency and large amplitude, whereas an interferometric calibration has no practical frequency constraints, but requires that the amplitude of vibration be limited.

111. Serbyn, M. R. **Interferometric phase calibration of vibration pickups,** ISA Trans., pp. 223-229 (Instrument Society of America, 1982).

An absolute method for measuring the phase component of pickup sensitivity is described. The phase calibration is in terms of the time interval between zero crossings and can be performed along with magnitude calibration on an automated Michelson interferometer.

112. Serbyn, M. R.; Penzes, W. B. **A real-time vibration controller,** ISA Trans. 21, No. 3, 55-59 (1982).

113. Shives, T. R.; Willard, W. A., eds. Failure prevention in ground transportation systems. NBS SP 621. 1982 October. 223 p. SN003-003-02428-7.

These proceedings consist of 18 submitted entries from the 31st meeting of the Mechanical Failures Prevention Group. The theme of the symposium was failure prevention in ground transportation systems. Areas of interest included rail vehicles and structures, highway and road bridges, pipeline transportation systems, and motor carriers.

114. Shives, T. R.; Willard, W. A., eds. Innovation for maintenance technology improvement. NBS SP 640. 1982 October. 518 p. SN003-003-02425-2.

These proceedings consist of 34 submitted entries from the 33rd meeting of the Mechanical Failures Prevention Group. The subject of the symposium was maintenance technology improvement through innovation. Areas of special emphasis included maintenance diagnostics and maintenance indicators.

115. Shorten, F. J., ed. **NBS Reactor: Summary of activities July 1980 through June 1981.** NBS TN 1160. 1982 June. 204 p. Available from: NTIS; PB 82-240698.

This report summarizes all those programs which depend on the NBS reactor. It covers the period from July 1980 through June 1981. The programs include neutron radiography and nondestructive evaluation.

116. Teague, E. C.; Vorburger, T. V.; Scire, F. E.; Baker, S. M.; Jensen, S. W.; Trahan, C.; Gloss, B. B. **Evaluation of methods for characterizing surface topography of models for high Reynolds number wind-tunnels,** Paper AIAA-82-0603-CP, Proc. AIAA 12th Aerodynamic Testing Conf., CP-822, pp. 246-251 (Amer. Inst. Aeronautics and Astronautics, New York, NY, 1982).

NASA is re-examining aerodynamic effects related to model surface topography definition. This paper describes current work at NBS to evaluate the performance of stylus instruments for this application and to develop a light scattering instrument which will yield accurate characterizations of the surface microtopography and overcome the problems associated with stylus profilometry.

117. Tilford, C. R. **Sensitivity of commercial ion gage tubes,** Proc. 9th Symp. Engineering Problems of Fusion Research, Chicago, IL, Oct. 26-29, 1981, pp. 1924-1927 (Institute of Electrical and Electronics Engineers, New York, NY, 1981).

Fusion science and engineering requires accurate vacuum measurements. In order to determine what performance can be expected from different ion gages, a gage characterization program has been initiated. This program determines the uniformity, accuracy, and linearity for different gage tubes, and for the more promising candidates further characterizes the sensitivity for different gases and the effects of changing bias voltages and emission currents.

118. Wadley, H. N. G.; Stockton, C. K.; Simmons, J. A.; Rosen, M.; Ridder, S. D.; Mehrabian, R. **Quantitative acoustic emission studies for materials processing,** Review of Progress in Quantitative Nondestructive Evaluation 1, 421-431 (Plenum Press, New York, NY, 1982).

This paper first describes a Q-switched laser for the generation of predictable acoustic emission signals which are used to evaluate multichannel source characterization methods. Second, the laser generation of elastic waves is used to measure the speed of extensional wave propagation in metallic glass ribbons.

119. Wilson, R. G.; Weglein, R. D. **Reflection acoustic microscopy.** NBS-GCR-82-401. 1982 October. 186 p. Available from: NTIS; PB 83-139832.

A developmental model of a pulsed reflection acoustic microscope was built, and techniques of nondestructive evaluation of surfaces and thin layered structures were studied. The image signal was enhanced

by the application of a quarter-wave acoustic antireflection coating to the surface of the lens. Many integrated circuits and device structures were studied in the scanning mode, leading to acoustic micrographs. Comparisons were made with optical and scanning electron micrographs.

120. **Wood, J. T.; Grot, R. A. Description of a facility for evaluating infrared imaging systems for building applications, Proc. SPIE 371: Thermal Infrared Sensing Diagnostics (Thermosense V), 246-249 (1982).**

A description is given of a facility for evaluating infrared imaging systems for building applications being constructed at NBS.

121. **Yee, K. W. A guide for the construction and operation of Drill-Up. NBSIR 82-2590. 1982 October. 26 p. Available from: NTIS; PB 83-140186.**

This guide provides detailed information for the construction of a single-speed version of Drill-Up and instructions for its installation and operation. Drill-Up is an instrument designed to prevent breakage of small-diameter drills used on automatic-feed drilling machines with a spindle retract ability.

122. **Yee, K. W.; Blomquist, D. S. An on-line method of determining tool wear by time-domain analysis, Soc. Manuf. Eng. Tech. Pap. MR82-901, 6 pages (1982).**

A method for determining drill wear and predicting drill breakage has been implemented by applying time-domain analysis on a signal from an accelerometer mounted on the workpiece. In 49 of 50 cases the system predicted the drill would fail 2 to 20 holes before actual failure.

123. **Yee, K. W.; Blomquist, D. S. Checking toolwear by time domain analysis, Manufacturing Engineering 88, No. 5, 74-76 (May 1982).**

124. **Yolken, H. T. Technical activities, 1982, Office of Nondestructive Evaluation. NBSIR 82-2617. 1982 December. 185 p. Available from: NTIS; PB 83-155531.**

A review of nondestructive evaluation programs at NBS for FY 1982 is presented in this annual report.

3. Subject Index

Accelerometers (see Transducers).
Acoustic emission, 3, 7, 8, 14, 28, 35, 36, 50-52, 55, 91, 92, 118, 124.
  transducers (see Transducers).
Acoustic velocity, 4, 20, 64, 69, 72, 73, 84, 100, 101, 105.
Aerodynamics, 116.
Aging (see Precipitation hardening).
Aluminum and aluminum alloys, 1, 10, 100, 101, 104.
Amorphous metal, 20, 105.
Anisotropy, 9, 66.
Art objects, 23.
Austenite, 53, 54.
Automated manufacturing, 3, 121-123.
Autoradiography, 23.

Bibliography, 3, 47.
Bonds and bonding (electronic), 51.
Bridges, 13, 113.
Building materials (also see Concrete), 25-27.
Building technology (also see Housing, Roofs, etc.), 13, 25-27, 48, 57, 65, 120.

Cables, 2.
Calibration, 7, 11, 14, 30, 35, 36, 56, 58, 86, 92, 94, 99, 110, 111.
Casting, 89.
Ceramics, 37.
Coal, 96.
Composite materials, 1, 40, 66, 78.
Concrete, 13, 27, 64.
Condition monitoring, 114, 121-123.
Conductivity, electrical, 39.
Conductivity, thermal, 65.
Copper and copper alloys, 20.
Cracks, 32, 33, 41, 60, 63.
Cryogenics, 39.
Crystallization, 105.

Diagnostic systems, 113.
Drills and drilling, 79, 121-123.

Economics, 94.
Eddy currents, 7, 46, 60, 104, 105, 124.
Edge detection, 87.
Elasticity and elastic constants, 9, 20, 66, 69, 93, 100.
Electromagnetic measurements (also see Microwaves), 24, 74, 75.
Electronic applications, 16, 18, 19, 29, 30, 50-52, 58, 59, 76, 85-87, 94, 107-109, 119.
Ellipsometry, 18, 19, 38.
Energy conservation, 21, 24, 48, 96, 120.
Energy dispersive diffractometry, 6, 80.

Fatigue, 40, 51, 78.
Film (see also Polymer films), 15, 18, 19, 38, 81.
Finite difference method, 88.
Finite element analysis, 32.
"Fitness for purpose," 33, 41, 43, 44, 90.
Fluorescent dye, 97.
Fracture and fracture mechanics, 33, 41, 90, 113.

Gamma radiography, 13.
Glass, 31.
Green's functions, 74, 75.
Guys, 78.

Hardness and hardness testing, 20.
Health, 4, 72, 73.
Heat treatment, 100.
Hermeticity, 29, 50, 52, 76, 107-109.
Holography, 40, 83.
Housing, 21, 49.
Hydrogen embrittlement, 28.

Illumination, 87.
Imaging (also see Neutron, Thermography, Ultrasonic, X-ray, etc.), 30, 86, 124.
Impact, 64.
Indentation loading (also see Hardness testing), 28.
Infrared detection, 49, 57.
Infrared imaging (see Thermography).
Integrated circuits (see Electronic applications).
Interfaces, solid-liquid, 89.
Interferometry, 38, 110-112.

Lasers, 55, 105, 118.
Leak testing (also see Hermeticity, Vacuum measurements), 5, 7, 29, 49, 50, 76, 95, 97-99, 107-109, 124.
Light scattering, 116.
Linewidth measurements, 16, 30, 58, 59, 85, 86, 94.
Luminescence, 31.

Magnetic particle inspection, 7, 88, 124.
Magnetism, 12, 88.
Maintenance, 114.
Maxwell's equations, 70, 74, 75.
Medical applications (also see Health), 4, 72, 73.
Metallography, 20, 105.
Microscopy, acoustic, 71, 119.
Microscopy, optical, 16, 30, 53, 54, 58, 59, 85-87.
Microstructure, 102.
Microwave testing, 96.
Moisture measurements, 29, 57, 65.

Neutron
  activation autoradiography, 23.
  diffraction, 1, 80, 115.

radiography, 7, 23, 37, 115.
scattering (see Small-angle neutron scattering).
tomography, 22.
Nickel and nickel alloys, 12.
Nuclear reactors, 35, 106, 115.
Nuclear waste, 22.

Oil shale, 24.
On-line monitoring (see Condition monitoring).
Optics and optical measurement (also see Holography, Interferometry, Microscopy), 15, 18, 38, 70, 86, 94, 124.

Paint and paintings, 23.
Palladium alloy, 105.
Pattern recognition, 4, 71-73, 118.
Penetrant testing, 7, 8, 124.
Permeation, 5.
Photoelasticity, 79.
Photomasks (see Linewidth measurements).
Piezoelectric polymer, 17, 34.
Pipe and pipelines, 6, 41, 43-45, 90, 113.
Plates, 9, 32, 36, 41, 55, 63.
Polyethylene terephthalate, 15.
Polymer films, 5, 34.
Polyvinylidene fluoride (see Piezoelectric polymer).
Positron annihilation, 40.
Powder metallurgy, 53, 54.
Precipitation hardening, 101, 104.
Process controls, 37, 61, 77, 89, 100, 112.
Productivity, 3, 51, 77, 96.

Quality and quality control, 3, 8, 25-27, 29, 37, 51, 77, 78, 94.

Radiography (see Film, Gamma, Neutron, X-ray).
Reflectometry, 2.
Reliability, 37, 48.
Residual stress, 6, 56, 79, 80, 93.
Resistivity (see Conductivity).
Robotics, 61, 62.
Roofs and roofing, 57, 65.

Safety, 62.
Scattering (see Light, Neutron, Ultrasonic, etc.).
Screens, 81.
Seals, 50, 52, 76.
Semiconductors (see Electronic applications).
Sensors, 55, 61, 62, 77.
Signal analysis, 55.
Signal processing, 4, 36, 71, 89.
Sizing, 32, 33, 43-45, 60, 82, 90.
Small-angle neutron scattering (SANS), 40, 106.
Solid solution, 103.
Solidification, 118.
Stability, metallurgical, 103.
Standard reference materials (SRMs), 5, 7, 8, 30, 53, 54, 58, 59, 94.

Standards, 7, 8, 10, 46, 48, 58, 59, 78, 79, 85, 86, 92, 95, 99, 120.
Steel, 6, 35, 36, 53, 54, 77, 89.
Steel, stainless, 42, 69.
Stress (also see Residual stress), 1.
Surfaces, 3, 12, 67, 68, 70, 116.
Synchrotron, 12, 67.

Tape, magnetic, 15.
Terbium, 31.
Terminology, 79.
Texture, 4, 42.
Thermal testing, 65.
Thermography, 21, 48, 49, 57, 120.
Thickness measurements, 18, 19, 38, 96.
Time-domain analysis, 2, 121-123.
Tin and tin alloys, 89.
Titanium and titanium alloys, 9.
Tomography (see X-ray, Neutron, etc.).
Transducers (also see Sensors),
  acceleration, 34, 110.
  acoustic emission, 8, 14, 35, 36, 91, 92.
  electromagnetic acoustic (EMAT), 32, 33, 43-45, 89.
  polymer, 17.
  ultrasonic, 8, 11, 33.
  vibration, 111.
Transformation, metallurgical, 102.
Transmission lines, 2.
Transportation, 113.

Ultrasonic
  attenuation, 9, 72, 73, 84, 100, 101.
  diffraction, 32, 33.
  imaging, 4, 71, 84.
  measurements and testing, 8-10, 20, 32, 37, 41-4, 56, 63, 64, 66, 72, 73, 79, 84, 89, 93, 97, 100-102, 105.
  reference blocks, 8, 10, 11.
  scattering, 4, 32, 45, 63, 72, 73, 82.
  transducers (see Transducers).
  tomography, 4, 71, 84.
  velocity (see Acoustic velocity).
Ultrasonics, 3, 47, 62, 124.

Vacuum and vacuum measurements, 97, 117.
Vibration
  measurements, 3, 34, 50, 110, 112, 121.
  pickups (see Transducers).
  signatures, 122, 123.
Visual acuity, 7.
Visual inspection, 50, 52.
Vision, 61.

Welds and welding, 6, 9, 32, 33, 41-45, 69, 90.

X-ray
  diffraction, 6, 12, 40, 53, 54, 79, 80.
  fluorescence, 53, 54.
  imaging, 8,12, 81.
  magnification, 8, 12.
  radiography, 7, 37, 90, 124.
  topography, 12, 67, 68.
X-rays, 17, 81.

Zirconium and zirconium alloys, 20.

4. How to Obtain Copies

To purchase NBS publications--whether from the Superintendent of Documents or from the National Technical Information Service (NTIS)--you must have the order number for each publication. To get the order number and price, call the NBS Inquiry Service on (301) 921-2318, or write to E07, Admin., National Bureau of Standards, Gaithersburg, Maryland 20899. It will help if you can give the NBS series number (e.g., Technical Note 916; Special Publication 703), plus title and author.

Once you have the order number, you can purchase printed copies of NBS publications from the Superintendent of Documents. Check, money order, VISA, or Master Card are acceptable, or you can establish a deposit account. Orders should be sent to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. For more information, call (202) 783-3238.

When the Government Printing Office sells out, NTIS has a few printed copies for sale, or it can supply microfiche, or paper copy from microfiche, at any time. NBS Interagency Reports and Grant/Contract Reports are available only from NTIS. Orders should be sent to NTIS, Springfield, VA 22161. NTIS will accept American Express in addition to the payment methods specified above. For more information, call (703) 487-4560.

Photoduplicated copies of many NBS publications can be purchased from the Library of Congress. Write to the Photoduplication Service, Library of Congress, Washington, DC 20540, or call (202) 287-5640.

Some NBS publications may be available at a depository library for government publications. Your local library should be able to identify the nearest depository library.

Papers published in the Journal of Research or in non-NBS media are often available from the author, from the publishers, or from a technical library in your area. For further information write to the Office of Nondestructive Evaluation, National Bureau of Standards, Gaithersburg, MD 20899.

NBS-114A (REV. 2-80)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See Instructions)	1. PUBLICATION OR REPORT NO. NBSIR-85/3183	2. Performing Organ. Report No.	3. Publication Date June 1985

4. TITLE AND SUBTITLE

NDE Publications: 1982

5. AUTHOR(S)

Leonard Mordfin, editor

6. PERFORMING ORGANIZATION (If joint or other than NBS, see instructions)

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

7. Contract/Grant No.

8. Type of Report & Period Covered

Bibliography, CY 1982

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP)

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

This is the sixth in a series of bibliographies of NBS publications on nondestructive evaluation (NDE). It provides bibliographic citations, with selected abstracts, for 124 publications that appeared in the open literature, primarily during calendar year 1982. A detailed subject index is included as well as information on how copies of many of the publications may be obtained.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

abstracts; acoustic emission; bibliography, eddy currents; index; leak testing; magnetic testing; National Bureau of Standards; nondestructive evaluation; publications; radiography; ultrasonics

13. AVAILABILITY

☒ Unlimited

☐ For Official Distribution. Do Not Release to NTIS

☐ Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

☒ Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES

36

15. Price

$8.50