NBS
PUBLICATIONS

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Center for Electronics and Electrical Engineering

Technical Publication Announcements

Covering Center Programs, April - June 1984 with 1984 CEEE Events Calendar

August 1984

U.S. Department of Commerce
National Bureau of Standards
National Engineering Laboratory
Gaithersburg, Maryland 20899

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INTRODUCING CEEE TECHNICAL PUBLICATION ANNOUNCEMENTS

This is the first edition of a quarterly abstract journal covering the work of the National Bureau of Standards Center for Electronics and Electrical Engineering. This issue of the CEEE Technical Publication Announcements covers the second quarter of calendar year 1984.

Organization of Announcements: This issue contains citations and abstracts for Center papers published in the quarter. Entries are arranged by technical topic as identified in the table of contents and alphabetically by first author under each subheading within each topic. Following each abstract is the telephone number of the individual to contact for more information on the topic; unless otherwise noted, this person is the first author. This issue also includes a calendar of Center conferences and workshops for the remainder of calendar year 1984, an announcement of newly released standard reference materials, and a list of sponsors of the work.

Center for Electronics and Electrical Engineering: Center programs provide national reference standards, measurement methods, supporting theory and data, and traceability to national standards.

The metrological products of these programs aid economic growth by promoting equity and efficiency in the marketplace, by removing metrological barriers to improved productivity and innovation, by increasing U. S. competitiveness in international markets through facilitation of compliance with international agreements, and by providing technical bases for the development of voluntary standards for domestic and international trade. These metrological products also aid in the development of rational regulatory policy and promote efficient functioning of technical programs of the Government.

The work of the Center is divided into two major programs: the Semiconductor Technology Program, carried out by the Semiconductor Materials and Processes and Semiconductor Devices and Circuits Divisions in Gaithersburg, MD, and the Signals and Systems Metrology Program, carried out by the Electrosystems Division in Gaithersburg and the Electromagnetic Fields and Electromagnetic Technology Divisions in Boulder, CO. Key contacts in the Center are given on the back cover; readers are encouraged to contact any of these individuals for further information.

Center sponsors: The Center Programs are sponsored by the National Bureau of Standards and a number of other organizations, in both the Federal and private sectors; these are identified on pages 11 and 12.

Note on Publication Lists: Guides to earlier as well as recent work are the publication lists covering the work of each division. These lists are revised and reissued on an approximately annual basis and are available from the originating division [publications from the Semiconductor Technology Program are covered in a single list, available from either Semiconductor Division].

NBS
RESEARCH
INFORMATION
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TABLE OF CONTENTS

SEMICONDUCTOR TECHNOLOGY PROGRAM

Silicon Materials

Lowney, J.R. and Geist, J.C., **Comparison of Models of the Built-In Electric Field in Silicon at High Donor Densities**, J. Applied Physics, 55 (10), pp. 3624-3627 (15 May 1984).

The built-in-electric field for holes due to donor-density gradients in n-type silicon is calculated at 300 K for donor densities between 1 x 10^{18} and 1 x 10^{20} cm^{-3}. The calculation is based upon a recent model of band-gap narrowing that includes the effects of ionized impurities, many-body interactions, and an estimate of spatial fluctuations of the band-gap edge caused by the random distribution of donor atoms in the silicon crystal. This model of band-gap narrowing differs significantly from a number of other band-gap narrowing models currently in use in that it agrees with the band-gap narrowing measured optically at 35 and 300 K rather than that inferred from electrical measurements. The built-in-electric field based on this model, which also differs significantly from the results of most previous models, decreases significantly above a donor density of 1 x 10^{19} cm^{-3} with a reversal of the field above 7 x 10^{19} cm^{-3}. The implications of this work for photodiodes are discussed.
[(301) 921-3786]

Thurber, W.R., Lowney, J.R., and Phillips, W.E., **Measurement Techniques for High Power Semiconductor Materials and Devices: Annual Report, January 1, 1982 to March 31, 1983**, NBSIR 84-2838 (April 1984).

This annual report is the final one in a series which describes NBS research to develop procedures for the effective utilization of deep-level measurements to detect and characterize defects which reduce lifetime or contribute to leakage current in power-device-grade silicon. During this reporting period, the previously written computer program for predicting excess-carrier lifetime was revised to calculate more accurately lifetimes for high or low injection conditions and in space-charge regions. Comparisons were made between lifetime measurements on platinum-doped silicon diodes and the predictions of the computer model. As part of the effort to extend the procedures to analyze data from nonexponential transient capacitance measurements, the time dependence of the capacitance-voltage relationship of a heavily platinum-doped silicon diode was measured as a function of bias voltage. Included as appendices are three recent publications resulting from the work. A listing of the lifetime-predicting computer program is also an appendix.
[(301) 921-3625]

Analysis Techniques

Chang, T-T., **The Calibration Methods and the Reference Materials in ESR Spectroscopy**, Magnetic Resonance Review, 9 (1-3), pp. 65-124 (May 1984).

This paper reviews the calibration methods and reference materials that have been recommended or have been in use in ESR [electron spin resonance] spectroscopy. Methods for the measurement of microwave frequencies and magnetic fields are briefly mentioned. Methods to measure the Q-factor of a microwave cavity are described. The calculation and measurement of the microwave magnetic field in an ESR resonance cavity are described in detail. Methods for the determination of the concentration of the paramagnetic centers in a sample are described after a discussion of the theoretical background. Precautions and factors that affect the accuracy of this determination are discussed. Reference materials, in 16 groups, are listed. Recipes for preparation of some of these standard samples are also given.
[Contact: Larrabee, (301) 921-3786]

Dimensional Metrology

Nyyssonen, D., **National Bureau of Standards, A Review of NBS's Activities in the Area of Linewidth Measurement,** Proc. Scientific Apparatus Makers Association Conf., The Future of Optical Technologies in the Semiconductor Industry, pp. 1-7 (March 1984) [Conference, Sunnyvale, CA May 23, 1983].

This manuscript is a summary of a talk covering current NBS activities in linewidth measurement including research, calibration of standard reference materials (SRMs), development of calibration procedures and test methods, and technology transfer. The current status of photomask linewidth SRMs is discussed (anti-reflective "gold" chromium SRMs 474 and 475, bright chromium SRM 476, and the 3X reticle SRM 1830). Wafer linewidth measurements are divided into two categories, thin layers (less than approximately 200 nm) and thick layers. The design of the linewidth standard for thin layers is described. Research problems remaining for thick layers are described along with current NBS waveguide modeling. Instrumentation used for both photomask and wafer calibrations is also described. NBS plans for development of SEM/e-beam instrumentation and SRMs are also included.
[(301) 921-3786]

Integrated Circuit Test Structures

Roenker, K.P. and Linholm, L.W., **An NMOS Test Chip for a Course in Semiconductor Parameter Measurements,** NBSIR 84-2822 (April 1984).

This report describes an NMOS test chip, NBS-40, which was developed to be used in graduate level electronics engineering courses involving semiconductor parameter measurements associated with the fabrication of integrated circuits. The 35 test structures included in the test chip and their use in materials, device, and process parameter measurements are described. Details of the silicon gate NMOS process used in the chip fabrication are also provided.
[Contact: Linholm, (301) 921-3541]

Process and Device Modeling

Albers, J., **Semiconductor Measurement Technology: TXYZ: A Program for Semiconductor IC Thermal Analysis,** NBS Special Publication 400-76 (April 1984).

A computer program, TXYZ, for the thermal analysis of semiconductor integrated circuits is presented and its applications are discussed. The program makes use of the closed form, analytic solution of the steady-state heat flow problem for a rectangular three-layer structure with multiple heat sources on the top layer. The temperature may be obtained for any point or set of points in the structure and is useful in the determination of the steady-state thermal response of IC chips and packages.
[(301) 921-3621]

Bennett, H.S. and Wilson, C.L., **Analysis of the Statistical Comparisons of Data on Band-gap Narrowing in Heavily Doped Silicon: Electrical and Optical Measurements,** J. Applied Physics, 55, 3582-3587 (May 15, 1984).

A system of subroutines for iteratively reweighted least squares (IRLS) computations has been applied to the published measured and theoretical data on band-gap narrowing in heavily doped silicon. The data include electrical and optical measurements at room temperature, photoluminescence and optical measurements for temperatures below 35 K, and theoretical calculations at 300 K and 0 K. This procedure, IRLS, allows an unambiguous comparison of the various experimental and theoretical data in band-gap narrowing to be made. The results are (1) that the optical absorption data and theory are consistent at both 300 K and at temperatures below 35 K; (2) that the electrical and optical measurements are not consistent; and (3) that when compared with the low-temperature optical absorption data, the

Process & Device Modeling, cont'd.

photoluminescence data have low statistical significance. [(301) 921-3541]

Blue, J.L. and Wilson, C.L., **Numerical Methods for Solving Coupled Semiconductor Equations on a Minicomputer**, Proc. Elliptic Problem Solvers II, Academic Press, pp. 521-530 (April 1984).

A general mathematical model for analyzing currents and fields in semiconductor devices requires three coupled nonlinear elliptic partial differential equations in two dimensions. A general-purpose solver for systems of coupled nonlinear elliptic partial differential equations is used. The numerical framework is linear elements on triangles, with nonuniform triangulations. The nonlinear finite element equations are solved by approximate Newton methods; the linearized equations are solved by sparse Gaussian elimination and by multi-level iteration. For accurate solutions, triangle refinements are generated adaptively.
[Contact: Wilson, (301) 921-3541]

Roitman, P., Albers, J., and Myers, D.R., **An Investigation of the Two-Dimensional Shape of Ion-Implanted Regions**, J. Applied Physics, 55 (12), pp. 4436-4443 (June 15, 1984).

The two-dimensional shape of arsenic ion-implanted regions in single-crystal silicon was investigated both experimentally and theoretically. Experimentally, two techniques were shown to have the necessary submicron resolution: a junction etch process and an SEM-induced current collection method. A comparison of junction depths determined by the etch technique and the EBIC techniques with the depths calculated using several amorphous target codes was made. For the case of low temperature (600°C) anneals, the etch technique agrees very well with the junction depths predicted by the amorphous target code due to Winterbon. The lateral junction locations obtained from the etch technique are in good agreement with the predictions of a two-dimensional Monte Carlo code (TRIM) which indicates that the arsenic does not show any significant lateral scattering under mask edges. For the high temperature (1000°C) anneals, the etch and EBIC techniques agree with each other. Comparison with arsenic-diffusion models shows that concentration-dependent effects are important.
[(301) 921-3621]

Packaging

Harman, G.G., **The Microelectronic Ball-Bond Shear Test - A Critical Review and Comprehensive Guide to Its Use**, Solid State Technology, 27 (5), pp. 186-197 (May 1984).

The microelectronic ball-bond shear test was first developed in 1967. Since then, it has been used to study the effects of contamination on bondability, to characterize the reliability of gold-aluminum intermetallic formation, to control bonding machine parameters for device production, and to troubleshoot such production problems as poor metallization adherence and contamination.

This paper critically reviews all of these uses and identifies ways that the shear test can be implemented to improve bond yield and assure long term bond reliability. A manual shear probe is described that can be quickly made from the blade of a jeweler's screwdriver. This probe was instrumented with a strain gage and the shear test results compared within 10% of those obtained from a machine. The paper also presents data obtained from shearing both aluminum-ball and -wedge bonds and determines how the shear testing machine requirements for these differ from those required to test gold ball bonds.

The shear strengths of both annealed gold and aluminum were measured and compiled in a plot of shear force versus diameter of the bonded area in order to

Packaging, cont'd.

determine the maximum force obtainable when shearing both gold and aluminum bonds having differing ball size. Interferences that may produce erroneous shear test results, such as friction rewelding of gold balls on gold metallization, are described along with ways of avoiding such problems. Finally, the implications of pending ASTM and military standards on the widespread use of the shear test is discussed. This paper is intended to present all information necessary to both understand and implement the shear test for research purposes or for production control.
[(301) 921-3621]

Other Semiconductor Metrology

Dodge, M.J., **Refractive Properties of Magnesium Fluoride**, Applied Optics, 23 (12), 1980-1985 (June 15, 1984).

The refractive indexes of a commercially available specimen of single-crystal MgF2 were determined for both the ordinary and extraordinary rays at selected wavelengths from 0.2026 to 7.04 μm. Measurements were made by means of the minimum-deviation method on a precision spectrometer near 19°C. The experimentally determined index values for each polarization were fitted to a three-term Sellmeier-type dispersion equation of the form:

$$n^2 - 1 = \sum A_j \lambda^2 / (\lambda^2 - \lambda_j^2),$$

relating the refractive index n to the wavelength of interest λ, the wavelength Aj. The birefringence was computed as a function of wavelength from the calculated index values obtained for the two polarizations. The dispersion coefficients were also determined for the O-ray and for the birefringence. The results of this study are compared with previously reported work on the refractive properties of MgF2.
[(301) 921-3625].

Kowalski, P., Lankford, W.F., and Schafft, H.A., **Nondestructive Measurement of Solar Cell Sheet Resistance Using a Laser Scanner**, IEEE Trans. Electron Devices, ED-31, pp. 566-570 (May 1984).

Experimental data have shown that a laser scanner can be used as a probe to make nondestructive measurements of solar cell sheet resistance with an accuracy of several percent. The photovoltaic response from cells with controlled sheet resistance was measured using the scanner and compared with the theoretical predictions made by other workers. Several limitations in this technique are identified and a measurement methodology is suggested.
[Contact: Schafft, (301) 921-3621]

FAST SIGNAL ACQUISITION, PROCESSING, AND TRANSMISSION

Antenna Metrology

Fitzgerrell, R.G., **A Source of E and H Fields for Antenna-Factor Calibration**, IEEE Trans. Electromagnetic Compatibility, EMC-26, No. 2, pp. 58-65 (May 1984).

The loop cell used for calibration is fabricated using two intersecting metal sheets joined at the intersection and forming a 36° angle. A section of a loop is mounted between two coaxial panel jacks, one on each sheet located at a distance equal to the loop radius from the intersection. A known current through this section of electrically small loop produces calculable E and H fields between the sheets in the plane of the loop. These known fields may be used to determine the antenna factor of small E and H antennas placed in the field if the mutual impedance due to the antenna images in the sheets is negligible and the antenna is not close to the open edges of the cell. Measured and calculated antenna factors agree within ± 2 dB between 0.25 and 1000 MHz.
[(303) 497-3737]

Microwave and Millimeter-Wave Metrology

Juroshek, J.R. and Hoer, C.A., **A Dual Six-Port Network Analyzer Using Diode Detectors,** IEEE Trans. Microwave Theory and Techniques, MTT-32, No. 1, pp. 78-82 (January 1984).

The performance of a dual six-port network analyzer using diode detectors is described. The network analyzer operates over the 2-18 GHz band using commercially available, low-barrier, Schottky diodes. The paper describes the process for calibrating the diodes for deviation from square-law. Measurement results are presented showing the accuracy and precision of the six-port network analyzer when measuring 1-port and 2-port devices.
[(303) 497-5362 or -3196]

ELECTRICAL SYSTEMS

Power Systems Metrology

Hebner, R.E., **Development of Power System Measurements -- Quarterly Report October 1, 1983 to December 31, 1983,** NBSIR 84-2861 (DoE) (May 1984).

This report documents the progress of three technical investigations sponsored by the Department of Energy and performed by or under a grant from the Electrosystems Division, the National Bureau of Standards. The work described covers the period October 1, 1983 to December 31, 1983. This report emphasizes the errors associated with measurements of electric and magnetic fields, the properties of corona in compressed SF_6 gas, and the measurement of interfacial phenomena in transformer oil.
[(301) 921-3121]

Hillhouse, D.L., Petersons, O., and Sze, W.C., **A Simplified System for Calibration of Coupling Capacitor Voltage Transformers,** IEEE Trans. Power Apparatus and Systems, PAS-103, No. 5, pp. 1092-1098 (May 1984).

Metering accuracy coupling capacitor voltage transformers (CCVTs) are installed permanently in 230-500 kV substations and must be calibrated in place. Several years ago, the National Bureau of Standards (NBS) developed a field calibration system, with uncertainties of ±0.1% and ±0.3 milliradian.

This paper describes a simpler system, consisting of a 15 kV standard transformer and its power supply, a capacitive transfer standard divider, and a voltage comparator. In field tests, this system agreed with the prototype to within ±0.03% and ±0.1 milliradian. The new system can be transported in a non-dedicated truck, and operated from the substation control house or a van.
[(301) 921-3121]

Kelley, E.F. and Hebner, R.E., **Electro-Optic Electric-Field Measurements Near Oil-Pressboard Interfaces,** Conference Record 1984 IEEE International Symposium on Electrical Insulation, Montreal, Canada, pp. 311-314 (June 11-13, 1984).

Electro-optical Kerr-effect measurements are made to characterize the electric field in the vicinity of pressboard interfaces in transformer oil. The interfaces are placed between parallel plate electrodes and are oriented parallel to the field direction and in contact with both electrodes. The electric field enhancement in the liquid alone (due to space charge) is compared with the enhancement with interfaces installed. These results serve to better define the roles of space charge and interfacial surface charging in pressboard/transformer-oil high-voltage systems.
[(301) 921-3121]

Kelley, E.F., Hebner, R.E., FitzPatrick, G.J., and Forster, E.O., **The Effect of Aromatic Impurities on the Positive Streamer Growth in Marcol 70,** Conference Record 1984 IEEE International

Power Systems Metrology, cont'd.

Symposium on Electrical Insulation, Montreal, Canada, pp. 284-287 (June 11-13, 1984).

The growth of positive streamers has been photographed in Marcol 70 in the presence and the absence of dimethylaniline (DMA). Marcol 70 is a fluid which is chemically similar to transformer oil but with the aromatic components removed. This combination has been studied previously by other authors, and was chosen for this work, because it should provide useful information on the contribution of aromatic components to the electrical properties of transformer oil. As in earlier studies, it was noted that the positive streamers initially propagate at or near sonic speed. After the streamer has propagated some distance across the inter-electrode gap, a supersonic secondary streamer develops that leads to breakdown. The initiation of this second event is significantly delayed by DMA. As in earlier studies in n-hexane, the reason for this ehavior is assumed to be structural changes in the streamers because of the low ionization potential of DMA. These structural changes, in turn, lead to a modification of the electric field distribution between the positive streamer tips and the plane cathode.

Information derived from the photographs suggests that the field distribution changes from a very nonuniform to a more uniform one, which would lead to the observed higher breakdown voltages. The data presented are not in complete agreement with those reported in the literature. This disagreement is believed to be attributable to experimental differences.
[(301) 921-3121]

Ramboz, J.D. and Flach, D.R., **High-Current Measurement Techniques**, NBSIR 84-2881 (May 1984).

The measurement of very high ac currents presents special problems in the selection of current sensors, instrumentation, and techniques. This report discusses initial test results for Rogowski coils and high-capacity current shunts often used to measure large ac currents. Eight Rogowski coils of three sizes and ratings were tested at a nominal current of 1000 A. The coils were compared against an NBS precision air-core mutual inductor to obtain a measure of complex sensitivity, positional sensitivity, gap-separation sensitivity (for the split-coil types), and proximity effects of the return conductor and of ferromagnetic material. The shunt was tested to assess the proximity effects of the return conductor and of ferromagnetic material. It was concluded that the particular Rogowski coils tested would not have measurement uncertainties of less than a few percent unless extreme care was taken in their calibration and subsequent use. The measurements for the shunt suggest somewhat less proximity effect than those for the coils. A digital oscilloscope was evaluated for possible use as a transient recorder. The effective number of bits, the differential linearity, and the response to a step function were determined.
[(301) 921-3121]

Van Brunt, R.J. and Anderson, W.E., **Bibliography of Data on Electrical Breakdown in Gases**, NBS Technical Note 1185 (April 1984).

This report consists of a bibliography of currently published data on electrical breakdown in gases. The bibliography contains a list of archival papers and books published since 1950, an index indicating the references that give particular types of data for each gas, an author index, and a list of relevant, regular technical conferences. The citations given in the bibliography contain experimental or theoretical data on breakdown which include:

(1) sparking potentials; (2) breakdown voltages; (3) critical fields, or field-to-gas density ratios; (4) corona

Power Systems Metrology, cont'd.

inception voltages; (5) voltage-time characteristics; (6) relative and absolute dielectric strengths; and (7) breakdown probabilities.

Types of data considered include those which apply to uniform and nonuniform fields; ac, dc, and impulse voltages; and possible effects of particles, surfaces, interfaces, and corona. This bibliography is intended to serve as a guide in locating data on breakdown which are most relevant to particular applications.
[(301) 921-3121]

Magnetic Materials and Measurements

Goldfarb, R.B. and Minervini, J.V., **Calibration of AC Susceptometer for Cylindrical Specimens**, Review of Scientific Instruments, 55 (5), pp. 761-764 (May 1984).

The absolute magnetic susceptibility of cylindrical specimens is obtained with an ac susceptometer whose calibration is based on a calculation of mutual inductance. An axially magnetized cylinder is modeled as a solenoid of the same size. The mutual inductance between such a solenoid and a pickup coil of arbitrary dimensions is computed. The susceptibility is then a function of the mutual inductance, the cylinder length, the magnitude and frequency of the ac magnetizing field, and the voltage induced on the pickup coil. Demagnetization factor and eddy-current effects are considered, an example is given, and pickup coil compensation is discussed.
[(303) 497-3650]

Misakian, M., **Electrical Parameters in 60-Hz Biological Exposure Systems and Their Measurement: A Primer**, NBS Technical Note 1191 (April 1984).

This report presents material intended to facilitate the measurement of a number of electrical parameters that are of importance during bioeffects research involving 60-Hz electric and magnetic fields. The parameters that are considered are the electric field strength E, the magnetic induction or flux density B, field uniformity, harmonic content, phase relations between field components, and corona. Descriptions of the fields and methods for their laboratory generation are surveyed. The text is purposely elementary with references provided to aid the interested reader in obtaining a fuller understanding of many of the topics. It is shown that it is possible to characterize reasonably well the electric and magnetic fields used in animal exposure studies with relatively simple instrumentation.
[(301) 921-3121]

Other Electrical Systems Topics

Anderson, W.E., **Microcomputer-Based Software for Management of Calibration Service**, NBSIR 84-2863 (April 1984).

The majority of the calibration customers' concerns are directed not to the technical details of the calibration service but to the timely delivery of that service. It is therefore proper that the calibration services be closely managed. For a Group or Division with a large calibration load, this can be a difficult task. The Applied Electrical

Measurements Group of the Electrosystems Division has developed microcomputer-based software to provide considerable assistance to the calibration manager. With this database software, complete information on the status of all the calibration jobs is instantly available.
[(301) 921-3121]

Palla, J.C. and Oravec, B.A., Compilers; Sorrells, J.R., Editor, **Electrical and Electronic Metrology: A Bibliography of NBS Electrosystems Division's Publications**, NBS List of Publications 94 (March 1984).

This bibliography lists the publications

Other Electrical Systems Topics, cont'd.

of the Electrosystems Division, Center for Electronics and Electrical Engineering, NBS, and of its predecessor sections, for the period January 1968 to March 1984. A brief description of the Division's technical program is given in the introduction.
[Contact: Sorrells, (301) 921-2727]

ELECTROMAGNETIC INTERFERENCE

Crawford, M.L. and Koepke, G.H., **Operational Considerations of a Reverberation Chamber for EMC Immunity Measurements - Some Experimental Results**, Proc. 1984 IEEE National Symposium on Electromagnetic Compatibility, pp. 47-54 [paper given at Symposium, San Antonio, Texas, April 24-26, 1984].

This paper describes measurement procedures and results obtained from evaluation of a 2.74 m x 3.05 m x 4.57 m shielded chamber modified into a mode tuned reverberation chamber. A brief description of the measurement setup is given. The measurements described include an evaluation of the chamber's: (1) excitation and receiving antennas' voltage standing wave ratio and efficiency, (2) mode tuner effectiveness, (3) loss, and (4) electromagnetic test field statistical characteristics. In addition, the measurement results of two techniques to determine the field strength in the reverberation chamber are compared. Results shown cover the frequency range 200 MHz to 18 GHz.
[(303) 497-5497]

Driver, L.D. and Reeve, G.R., **Application of a Systematic Approach to an Investigation of HF Interference to a Shipboard Radar Set**, Proc. 1984 IEEE National Symposium on Electromagnetic Compatibility, pp. 221-228 [paper given at Symposium, San Antonio, Texas, April 24-26, 1984].

This paper describes an investigation of electromagnetic interference to a shipboard radar caused by a co-located HF, one kilowatt transmitter. The test procedures and analysis used to determine the points of EM field entry, the corrective measures taken, and the results achieved are described.
[(303) 497-3911]

Ondrejka, A.R. and Adams, J.W., **Shielding Effectiveness (SE) Measurement Techniques**, Proc. 1984 IEEE National Symposium on Electromagnetic Compatibility, pp. 249-256 [paper given at Symposium, San Antonio, Texas, April 24-26, 1984].

Five methods of measuring shielding effectiveness of a lossy material are compared. Comparative measurement data is shown, and insights are offered as to why the results do or do not agree. This is a preliminary analysis, not a definitive work.
[(303) 497-3309]

Wilson, P.F. and Ma, M.T., **Small Aperture Analysis of the Dual TEM Cell**, Proc. 1984 IEEE National Symposium on Electromagnetic Compatibility, pp. 365-369 [paper given at Symposium, San Antonio, Texas, April 24-26, 1984].

This paper decribes an analysis of dual TEM cell coupling based on Bethe's small aperture theory. This approach allows one to model a variety of possible aperture shapes (circular, elliptical, square, etc.), including material loaded apertures of finite thickness. Measurements demonstrate that the theory accurately predicts coupling for an unloaded aperture.
[(303) 497-3842]

1984 CEEE CALENDAR

September 10-11 (Santa Clara, CA)

VLSI Packaging Workshop. Sponsored by

CEEE Calendar, cont'd.

NBS and the IEEE Components, Hybrids, and Manufacturing Technology Society. The VLSI Chip Packaging Workshop has become the premier forum for technical professionals in the field of package development and analysis for VLSI integrated circuits. The Workshop addresses large chips, high-lead-count packages, conventional and pin-grid-array chip-carriers, TAB and wire bonding, and electrical and thermal performance of packages. All attendees are expected to be specialists working in the field, and to participate in the discussions. The Workshop is conducted as a single plenary session, with each of the four sessions containing a number of half-hour papers in addition to several shorter technical updates on current work. [Contact: G.G. Harman (301) 921-3621]

October 2-3 (Boulder, CO)

Symposium on Optical Fiber Measurements. This symposium, the third in the series of biennial meetings, is co-sponsored by the National Bureau of Standards, the Optical Society of America, and the Optical Waveguide Communications Committee of the Institute of Electrical and Electronics Engineers. Papers have been solicited "for any experimental or analytical aspect of the characterization of optical fibers and fiber optics systems, including attenuation, bandwidth/distortion, dispersion, index profile, cut-off wavelength, mode diameter/core geometry, fiber-device (e.g., joint, coupler. multiplexer) evaluation, physical measurements, link parameters (e.g., concatenation), polarization characteristics, system performance, field measurements, and standards."
[Contact: Douglas L. Franzen (303) 497-3346]

October 15-17 (Boulder, CO)

Symposium on Optical Materials for High Power Lasers. The Symposium is the principal forum for the exchange of information on the physics and technology of materials for high-power lasers. Topics to be discussed include new materials, bulk damage phenomena, surface and thin film damage, design considerations for high-power systems, and fundamental mechanisms of laser-induced damage. The series of conference proceedings resulting from these annual symposia has collectively become the principal repository of information on optics for all aspects of high-power/high-energy lasers, including, in addition to the subjects given above, environmental degradation, durability, fabrication, material growth and deposition processes, and testing. [Contact: Aaron A. Sanders (303) 497-5341]

November 6-8 (Las Vegas, NV)

1984 Government Microcircuit Applications Conference (GOMAC). This Conference, for which NBS serves as one of a number of Government sponsors, includes sessions covering applications of silicon and gallium arsenide microelectronic circuits, circuit design and packaging considerations, reliability considerations, radiation hardness, signal processing applications, and other systems applications. With respect to circuits, specific sessions are concerned with memory technology, analog-to-digital and digital-to-analog data converters, gallium arsenide digital devices, and gallium arsenide analog monolithic integrated circuits. Conference attendance is restricted to U.S. citizens and immigrant aliens. [Contact: Jay Morreale (212) 620-3371]

NEW STANDARD REFERENCE MATERIALS

Two new Standard Reference Materials (SRMs) for calibrating equipment used to make spreading resistance measurements have been released by the Semiconductor Materials and Processes Division to the NBS Office of Standard Reference Materials for sale to the public. SRM 2526 applies to (111)-oriented p-type silicon surfaces and SRM 2527 to $\overline{(111)}$-oriented n-type silicon surfaces. Each SRM consists of a set of 16 specimens of silicon, approximately 6 x 12 mm in area and mounted on beveled metal blocks for convenient use in calibrating commercial spreading resistance equipment. These silicon chips have resistivities ranging from about 0.001 to 200 Ω•cm. The uncertainties in resistivity range typically from 2 to 5 percent for p-type specimens and from 4 to 10 percent for n-type. Two companion SRMs for (100) silicon surfaces are about to be released (2528, p-type and 2529, n-type).

CEEE SPONSORS

National Bureau of Standards
Department of Defense
    Defense Advanced Research Project Agency; Calibration Coordination Group; Defense Nuclear Agency; National Security Agency
  U.S. Air Force
    Air Force Office of Scientific Research; Air Force Satellite Control Facility, Camp Parks; Bolling Air Force Base; Hanscom Field; Newark Air Force Station; Rome Air Development Center; Space Division; Wright-Patterson AFB
  U.S. Army
    Aberdeen Proving Ground; Aviation Systems Command; Ballistic Missile Defense Systems Command; Fort Huachuca; Fort Monmouth; Harry Diamond Laboratories; Materials & Mechanics Research Center
  U.S. Navy
    Aviation Logistics Center (Patuxent River); Metrology Engineering Center (Seal Beach); Naval Air Systems Command; Naval Air Test Center; Naval Sea Systems Command; Naval Ship Research & Development Center; Naval Ship Systems Engineering Station; Naval Surface Weapons Center; Naval Weapons Support Center (Crane); Office of Naval Research
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4. TITLE AND SUBTITLE

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All technical information included in this document has been approved for publication previously

☐ 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)

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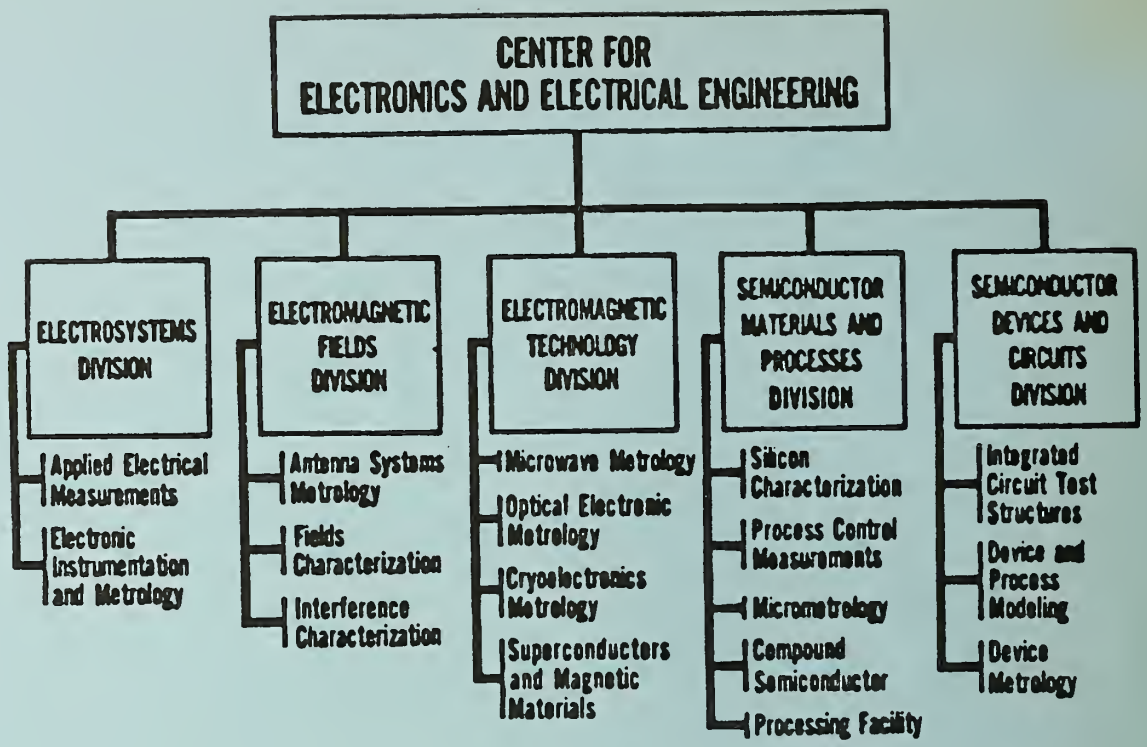

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