NBSIR 88-3854

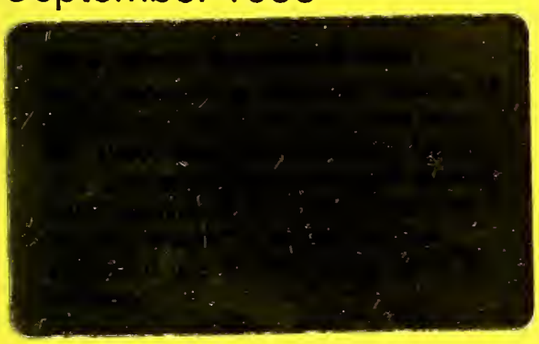
Center for Electronics and Electrical Engineering

Technical Publication Announcements

Covering Center Programs,
January to March 1988,
with 1988 CEEE Events Calendar

16

September 1988



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

INTRODUCTION TO THE CEEE TECHNICAL PUBLICATION ANNOUNCEMENTS

This is the sixteenth issue of a quarterly publication providing information on the technical work of the National Institute of Standards and Technology (formerly the National Bureau of Standards) Center for Electronics and Electrical Engineering. This issue of the CEEE Technical Publication Announcements covers the first quarter of calendar year 1988.

Organization of Bulletin: This issue contains citations and abstracts for Center publications published in the quarter. Entries are arranged by technical topic as identified in the table of contents and alphabetically by first author within each topic. Following each abstract is the name and telephone number of the individual to contact for more information on the topic (usually the first author). This issue also includes a calendar of Center conferences and workshops planned for calendar year 1988 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 Electronics Division 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. See the table of contents on the opposite page for identification of the topics covered by each program, as represented in this issue. 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 Institute of Standards and Technology and a number of other organizations, in both the Federal and private sectors; these are identified on page 13.

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. The current set is identified in the Additional Information section, page 11.

TABLE OF CONTENTS

SEMICONDUCTOR TECHNOLOGY

Silicon Materials

Bennett, H.S., **Indirect Energy Gap of Si: Doping Dependence**, Properties of Crystalline Silicon, Chapter 7.3, EMIS Datareview (Institute of Electrical Engineers, London, February 1988), pp. 174-181.

The doping dependence of the indirect energy gap of silicon is reviewed for the Electronic Materials Information Services (EMIS) of IEE (London). This review is a guide with commentary to assist readers in selecting which values are best for their applications. Our state of knowledge in this area is such that in many cases the intended application for the data on bandgap changes determines the appropriate values to use. Data from interpreting both electrical and optical measurements are given.
[Contact: Herbert S. Bennett, (301) 975-2081]

Analysis Techniques

Jach, T., Novotny, D.B., Carver, G.P., Geist, J., and Spal, R.D., **An X-Ray Monochromator Crystal Which Detects the Bragg Condition**, Nuclear Instrumentation and Methods in Physics Research, Vol. A263 (North-Holland, Amsterdam, 1988), pp. 522-524.

We have fabricated a (111) silicon x-ray monochromator crystal with a diode diffused into its surface. Without suffering any apparent degradation in its rocking-curve width at the Bragg condition, the crystal provides a dc current which changes dramatically at the diffraction of a monochromatic x-ray beam. The current change is directly attributable to extinction at the Bragg angle. It provides a new means to align the two crystals of a double-crystal x-ray monochromator using a feedback circuit.
[Contact: Donald B. Novotny, (301) 975-2699]

Integrated Circuit Test Structures

Kim, J.S., Linholm, L.W., Barley, B.L., Hanes, M.H., and Cresswell, M.W., **A Microelectronic Test Structure for Thickness Determination of Homogeneous Conducting Thin Films in VLSI Processing**, Proceedings of the 1988 IEEE International Conference on Microelectronic Test Structures, Long Beach, California, February 22-23, 1988, pp. 34-38.

This paper describes a new test structure for use in determining the thickness of a uniform conducting film. The structure incorporates the van der Pauw cross method to determine the effective sheet resistance of a vertical, uniformly doped cross section of a polysilicon film and a bridge resistor to determine the thickness of the film. By using a composite structure, which consists of the vertical cross structure and a conventional planar cross-bridge test structure, it is possible to obtain the thickness, linewidth, and resistivity of a conducting line.
[Contact: Jin S. Kim, (301) 975-2238]

Buehler, M.G., Linholm, L.W., Tyree, V.C., Allen, R.A., Blaes, B.R., Hicks, K.A., and Jennings, G.A., **CMOS Process Monitor**, Proceedings of the 1988 IEEE International Conference on Microelectronic Test Structures, Long Beach, California, February 22-23, 1988, pp. 164-168. [Identical publication entitled **Proposed End-of-Fabrication Parametric Test Structures for the CMOS Process Monitor** will appear as Jet Propulsion Laboratory Report #D-4520.]

This document describes a proposed end-of-fabrication CMOS process monitor for VHSIC/VLSI wafer fabrication qualification. The discussion of the CMOS process monitor includes a description of the test structures, test methods, and data analysis techniques needed to acquire 26 key electrical parameters that characterize a CMOS process. This process monitor has been under develop-

IC Test Structures (cont'd.)

ment for a number of years at JPL's VLSI Technology Group and the University of Southern California/Information Sciences Institute MOSIS Project.
[Contact: Loren W. Linholm, (301) 975-2052]

Linholm, L.W., Khera, D., Reeve, C.P., and Cresswell, M.W., **A Developmental Expert System for Test Structure Data Evaluation**, Proceedings of the 1988 IEEE International Conference on Microelectronic Test Structures, Long Beach, California, February 22-23, 1988, pp. 160-163.

This paper describes a developmental expert system, rule generation techniques, a test chip, data handling methods, and statistical data reduction techniques for characterizing the performance of a 1-μm lithography process. Examples of test results and an expert system diagnosis are given.
[Contact: Loren W. Linholm, (301) 975-2052]

Schafft, H.A., and Albers, J., **Thermal Interactions Between Electromigration Test Structures**, Proceedings of the 1988 IEEE International Conference on Microelectronic Test Structures, Long Beach, California, February 22-23, 1988, pp. 132-137.

The thermal interaction between electromigration test structures on a test chip, when subjected to a high current-density stress, must be considered when making median-time-to-failure measurements.
[Contact: Harry A. Schafft, (301) 975-2234]

Suehle, J.S., and Galloway, K.F., **Test Circuit Structures for Characterizing the Effects of Localized Hot-Carrier-Induced Charge in VLSI Switching Circuits**, Proceedings of the 1988 IEEE International Conference on Microelectronic Test Structures, Long Beach, California, February 22-23, 1988, pp. 126-131.

Data are presented that were collected from test circuit structures that were hot-carrier-stressed under conditions existing in actual VLSI switching circuits. It is shown that the localized nature of hot-carrier-induced damage to n-channel MOSFETs must be considered to accurately model these data by computer circuit simulations.
[Contact: John S. Suehle, (301) 975-2247]

Device Physics and Modeling

Wilson, C.L., **Hydrodynamic Carrier Transport in Semiconductors with Multiple Band Minimums**, IEEE Transactions on Electron Devices, Vol. 35, No. 2, pp. 180-187 (February 1988).

Carrier transport equations for analysis of semiconductor devices fabricated in materials with multiple band minimums, such as GaAs, are presented. This revised formulation has several advantages over previous models. Separation of the carrier transport into central and satellite components improves numerical stability in numerical simulations and allows the physical processes associated with each band to be modeled in greater physical detail. This permits processes previously neglected in hydrodynamic models, such as electron injection into insulating substrate material and deep electron traps in GaAs transistors, to be included. A model of a GaAs MESFET, which illustrates the importance of the new physical effects and achieves reasonable agreement with experiment without use of adjustable parameters, is presented as an example.
[Contact: Charles L. Wilson, (301) 975-2080]

FAST SIGNAL ACQUISITION, PROCESSING, AND TRANSMISSION

Waveform Metrology

Leedy, T.F., and Bell, B.A., Concepts

Waveform Metrology (cont'd.)

for ATE Systems Calibration: Transport Standards to Achieve Traceability to National Standards, Proceedings of the 1988 Measurement Science Conference, Long Beach, California, January 23-29, 1988, pp. 307-313.

Technical objectives are presented for a proposed transport standard to establish direct traceability of selected low-frequency electrical quantities between the National Bureau of Standards and automatic test systems including calibration laboratories that support these automatic test systems. The transport standard would consist of precision ac and dc voltage and frequency sources and could also include more specialized measurement modules in future versions. The transport standard would allow the intercomparison of dc voltage, ac (root-mean-square) voltage, total harmonic distortion, phase, and frequency measurements made using automatic test equipment systems. [Contact: Thomas F. Leedy, (301) 975-2410]

Petersons, O., **NBS Initiatives in TMDE/ATE Diagnostics**, Symposium Record, National Security Industrial Association Diagnostics/Prognostics Symposium, Alexandria, Virginia, October 20-21, 1987, pp. 190-193 (1988).

Advances in technology dictate that the National Bureau of Standards consider how to provide metrological support for automatic test equipment (ATE) and the area of complex systems in general. Several decades ago, standard instruments were relatively simple devices such as standard resistors, electrochemical cells for voltage, and relatively simple electromechanical indicating meters. Modern precision instruments, however, such a digital multimeters, calibrators, and waveform analyzers are very complex, computer-controlled systems having a broad spectrum of parameters including wide frequency and dynamic ranges and high speeds of operation. While complete characterization was possible and economical for the older and simpler standard instruments, this may not be true for modern measurement systems. Besides the calibration itself, consideration must be given to such items as judicious selection of a limited number of test points, test coverage, and confidence levels. These considerations relate, at least partly, to the subject of the Conference. In addition, NBS has strong interest in the diagnostics of systems that are required to produce accurate, reliable, and economical measurements. Such systems include state-of-the-art test, measurement, and diagnostic equipment (TMDE) and ATE as used by defense forces.

This presentation outlines several activities along the lines described above that are conducted at NBS, particularly in the Electrosystems Division. First, some basic tools and expertise that are applicable to TMDE and ATE diagnostics are discussed, followed by examples of applications, particularly to DoD systems and TMDE. [Contact: Oskars Petersons, (301) 975-2400]

Turgel, R.S., **Phase Meter Calibration at NBS**, Journal of Research of the National Bureau of Standards, Vol. 93, No. 1, pp. 53-60 (January-February 1988).

To provide a phase meter calibration service, a phase angle calibration standard has been developed at NBS. This standard is a signal generator with two sinusoidal outputs and uses direct digital synthesis to generate the signals. The phase angle between the two sinusoids is determined by the input parameters in the calculation of the sets of digital values from which the analog output is synthesized. An auto-zero compensation mode corrects for residual phase differences in the two output channels. The phase resolution is better than 0.002 deg over a frequency range from 2 Hz to 5 kHz and

Waveform Metrology (cont'd.)

0.005 deg from 5 kHz to 50 kHz.

Phase meter calibration data are fitted to a linear model from which appropriate corrections for the phase meter readings can be derived. Statistical treatment of the data provides an estimate of the uncertainty of the corrected phase meter readings relative to the phase angle calibration standard.
[Contact: Raymond S. Turgel, (301) 975-2420]

Turgel, R.S., Laug, O.B., and Leedy, T.E., **Electrical Performance Tests for True-RMS Voltmeters**, NBSIR 88-3736 (March 1988).

Electrical performance test procedures for a true root-mean-square (rms) voltmeter were developed by the National Bureau of Standards for the U.S. Army Communications-Electronics Command. The report provided detailed, step-by-step test procedures that are based on the specifications supplied by the Army for the purpose of evaluating the bid samples of this type of instrument. Examples are provided of the data sheets and tables for recording of interim data and the final results.

This report discusses the philosophy underlying each of the measurement procedures from a point of view of the basic metrology required to perform the measurements. In addition, the sources of measurement error are discussed.
[Contact: Raymond S. Turgel, (301) 975-2420]

Antenna Metrology

Hill, D.A., and Francis, M.H., **Out-of-Band Response of Antenna Arrays**, IEEE Transactions on Electromagnetic Compatibility, Vol. EMC-29, No. 4, pp. 282-288 (November 1987). [Also appeared in the Proceedings of the 1987 IEEE International Symposium on Electromagnetic Compatibility, Symposium Record, August 25-27, 1987, Atlanta, Georgia, pp. 435-438. An expanded version appeared as NBSIR 86-2037 (June 1986).]

The response of antenna arrays to out-of-band frequencies has been analyzed using the effective aperture approach. An average value of effective aperture can be obtained by averaging the incidence angle and the polarization of the incident field. Far-field patterns have also been calculated by treating the array element excitations as random variables. The randomness in the element excitations causes a decrease in directivity and an increase in sidelobe level.
[Contact: David A. Hill, (303) 497-3472]

Lewis, R.L., **Spherical-Wave Source-Scattering Matric Analysis of Coupled Antennas; A General System Two-Port Solution**, IEEE Transactions on Antennas and Propagation, Vol. AP-35, No. 12, pp. 1375-1380 (December 1987).

Expressions are given for the coupling between two antennas in terms of each antenna's spherical-wave source-scattering matrix. A comparison with the "classical" scattering matrix representation is given in sufficient detail to permit conversion back and forth between the source-scattering matrix and the classical scattering matrix. The paper concludes with expressions for the transmission formulas, showing two different expressions corresponding to reversing the direction of propagation. However, if both antennas are reciprocal with equal characteristic waveguide impedances, then the two-port scattering matrix is a symmetric matrix.
[Contact: Richard L. Lewis, (303) 497-5196]

Lewis, R.L., and Wittmann, R.C., **Improved Spherical and Hemispherical Scanning Algorithms**, IEEE Transactions on Antennas and Propagation, Vol. AP-35, No. 12, pp. 1381-1388 (December 1987).

Antenna Metrology (cont'd.)

A probe-corrected spherical-scanning algorithm has been developed which is applicable when the antenna under test radiates negligibly into its rear hemisphere. Compared to an efficient version of the best previously published full-sphere scanning algorithm, it is found that our hemispherical scanning algorithm is over three and a half times more efficient. Improvements have also been made to full-sphere scanning, with the result that our new spherical scanning algorithm is twice as efficient as the best previous full-sphere algorithm. We also show that our new formulations constitute an exact inversion of the band-limited spherical-coordinate representation of the received signal (i.e., no aliasing errors are introduced).
[Contact: Richard L. Lewis, (303) 497-5196]

Complex Testing

Petersons, O., **NBS Initiatives in TMDE/ATE Diagnostics**, Symposium Record, National Security Industrial Association Diagnostics/Prognostics Symposium, Alexandria, Virginia, October 20-21, 1987, pp. 190-193 (1988).

Advances in technology dictate that the National Bureau of Standards consider how to provide metrological support for automatic test equipment (ATE) and the area of complex systems in general. Several decades ago, standard instruments were relatively simple devices such as standard resistors, electrochemical cells for voltage, and relatively simple electromechanical indicating meters. Modern precision instruments, however, such a digital multimeters, calibrators, and waveform analyzers are very complex, computer-controlled systems having a broad spectrum of parameters including wide frequency and dynamic ranges and high speeds of operation. While complete characterization was possible and economical for the older and simpler standard instruments, this may not be true for modern measurement systems. Besides the calibration itself, consideration must be given to such items as judicious selection of a limited number of test points, test coverage, and confidence levels. These considerations relate, at least partly, to the subject of the Conference. In addition, NBS has strong interest in the diagnostics of systems that are required to produce accurate, reliable, and economical measurements. Such systems include state-of-the-art test, measurement, and diagnostic equipment (TMDE) and ATE as used by defense forces.

This presentation outlines several activities along the lines described above that are conducted at NBS, particularly in the Electrosystems Division. First, some basic tools and expertise that are applicable to TMDE and ATE diagnostics are discussed, followed by examples of applications, particularly to DoD systems and TMDE.
[Contact: Oskars Petersons, (301) 975-2400]

Other Fast Signal Topics

Bell, B.A., Stenbakken, G.N., Flynn, D.R., Evans, D.J., Burnett, E.D., Nedzelnitsky, V., and Eberhardt, K.R., **Evaluation of a Copy Prevention Method for Digital Audio Tape Systems**, NBSIR 88-3725 (February 1988).

The National Bureau of Standards in response to requests from the U.S. Congress tested a system designed to prevent unauthorized copying by digital audio tape (DAT) recorders of suitably encoded audio recordings. The system, designed by CBS Records, filters out a narrow range of frequencies from the spectrum of the original sound in the region of 3840 Hz, thereby encoding the material with a "notch" in the frequency spectrum so that a DAT recorder equipped with the system's decoding circuitry can sense the presence of a prescribed notch in the spectrum and inhibit recording.

Other Fast Signal Topics (cont'd.)

The congressional questions and the NBS conclusions are:

1. Does the copy prevention system achieve its purpose?

NBS Conclusion: The system does not achieve its stated purpose.

2. Does the system diminish the quality of the prerecorded material into which the notch is inserted?

NBS Conclusion: The system's encoder alters the original electrical signal. For some listeners for some selections, this results in a discernible difference between prerecorded notched and unnotched material.

3. Can the system be bypassed and, if so, how easily?

NBS Conclusion: The copy prevention system can be bypassed easily.

[Contact: Barry A. Bell, (301) 975-2402]

Jesch, R.L., **Fixed and Base Station FM Transmitters**, National Institute of Justice, NIJ Standard-0201.01 (September 1987).

This document establishes minimum performance requirements and methods of test for fixed and base station frequency-modulated (FM) transmitters. The standard applies primarily to the law enforcement community, and as such covers the four frequency bands, 25 to 50 MHz, 150 to 174 MHz, 400 to 512 MHz, and 806 to 866 MHz. This standard supersedes NILECJ-STD-0201.00, Fixed and Base Station FM Transmitters.

[Contact: Ramon L. Jesch, (303) 497-3496]

ELECTRICAL SYSTEMS

Power Systems Metrology

Martzloff, F.D., **Power Quality Measurements: Bringing Order Out of Chaos**, Energy Technology XV -- Repowering America (Proceedings of the Energy Technology Conference, Washington, DC, February 17-19, 1988) (Government Institutes, Inc., Maryland), pp. 947-959.

The quality of the power supplied to sensitive electronic equipment is an important issue. Quantifying this quality, however, is difficult under the present state of nonexistent or uncoordinated standards concerning two related questions: (1) what levels of power quality are required for what types of loads, and (2) what measurement techniques are required to determine reliably the level of disturbances that reduce quality. Development of standards by the consensus process and voluntary compliance, although a slow process, is a mechanism for reaching technically sound and cost-effective solutions. Several standards projects are in progress, but need industry-wide support to become the generally accepted basis for valid and useful measurements of power quality.

[Contact: Francois D. Martzloff, (301) 975-2409]

Sieck, L.W., and Van Brunt, R.J., **Rate Constants for F^- Transfer from SF_6 to Fluorinated Gases and SO_2. Temperature Dependence and Implications for Electric Discharge in SF_6**, Journal of Physical Chemistry, Vol. 92, No. 3, pp. 708-713 (1988).

The reactivity of SF_6^- towards SO_2, SOF_2, SO_2F_5, SOF_4, SF_4, and SiF_4 has been investigated using the technique of pulsed-electron-beam, high-pressure mass spectrometry. With the exception of the $SF_6^- + SiF_4$ reaction, all of the pairs exhibited a negative temperature coefficient in that the rate constants for F^- transfer decreased substantially with increasing temperature. The reaction $SF_6^- + SiF_4 \rightarrow SiF_5^- + SF_5$ was found to proceed with a rate constant of $5.6 \pm 0.8 \times 10^{-10}$ cm^3/mol-s throughout the temperature range studied (298 to 510 K), which corresponds to a collision efficiency of unity. The other reactions were found to approach unit collision efficiency only at reduced temperatures (<300 K).

[Contact: Richard J. Van Brunt, (301)

Power Systems Metrology (cont'd.)

975-2425]

Superconductors

Chen, D.-X, Goldfarb, R.B., Nogues, J., and Rao, K.V., **Magnetic Susceptibility of Sintered and Powdered Y-Ba-Cu-O** (Original title: Susceptibility Measurements of a Sintered and Powdered Y-Ba-Cu-O Superconductor), Journal of Applied Physics, Vol. 63, No. 3, pp. 980-983 (1 February 1988).

The real and imaginary parts of magnetic ac susceptibility of a sintered Y-Ba-Cu-O superconductor were measured as functions of temperature. The susceptibility may be separated into two contributions, one sensitive and the other relatively insensitive to the magnitude of the measuring field. The former is partially suppressed upon coarsely crushing the sample. It is completely suppressed after finely powdering, whereupon the susceptibility curves become insensitive to the magnitude of the measuring field. Several models might be consistent with the results.
[Contact: Ronald B. Goldfarb, (303) 497-3650]

Ekin, J.W., **Transverse Stress Effect on Multifilamentary Nb_3Sn Superconductor**, Advances in Cryogenic Engineering Materials, Vol. 34, pp. 547-552 (Plenum Publishing Corporation, 1988).

A large reversible degradation of the critical current of multifilamentary Nb_3Sn superconductors has been observed under application of uniaxial compressive stress at 4 K applied transverse to the conductor axis. In bronze-process multifilamentary Nb_3Sn, the onset of significant degradation occurs at about 50 MPa. The intrinsic effect of transverse stress on the upper critical field is about ten times greater than for axial stress. Although transverse stress on the Nb_3Sn filaments is less than axial stress, it will need to be considered in the internal stress design of large magnets. The effect scales with conductor thickness and consequently will place limits on conductor dimensions and the spacing between distributed reinforcement in large magnets.
[Contact: John W. Ekin, (303) 497-5448]

Goodrich, L.F., Bray, S.L., and Clark, A.F., **Current-Ripple Effect on Superconductive DC Critical Current Measurements**, Advances in Cryogenic Engineering Materials, Vol. 34, pp. 1019-1026 (1988).

The effect of sample current power supply ripple on the measurement of dc critical current is reported. Measurements were made on multifilamentary NbTi superconductors. Ripple in a current supply becomes more significant above 500 A because effective filtering becomes more difficult. The presence of current ripple reduces the measured dc critical current. Ripple can also directly affect the voltmeter used for the measurements, because it has to operate with a noisy input. The quantitative effect of current ripple was studied using a battery current supply instrumented to allow the creation of ripple current with variable frequency and amplitude. Problems common to all large conductor critical current measurements are discussed.
[Contact: Loren F. Goodrich, (303) 497-3143]

Moreland, J.M., Ekin, J.W., Goodrich, L.F., Capobianco, T.E., and Clark, A.F., **Electron Tunneling Measurements in LaSrCuO and YBaCuO**, Proceedings of Symposium S, 1987 Spring Meeting of the Materials Research Society, Anaheim, California, April 23-24, 1987, pp. 273-275 (1988).

The break junction technique whereby vacuum tunneling occurs within the fracture of a bulk sample is used to study the LaSrCuO and YBaCuO perovskite superconductors. Structure in the

Superconductors (cont'd.)

current-versus-voltage characteristics is reminiscent of previous quasiparticle curves obtained for BCS superconducting materials. Some curves have anomalous qualities, including large dips in the junction conductance with increasing voltage just above a well-defined tunneling gap edge, linearly increasing junction conductance with applied bias, along with features occurring near voltage intervals following a 1, 3, 5 pattern.
[Contact: John M. Moreland, (303) 497-3641]

Moreland, J.M., Goodrich, L.F., Ekin, J.W., Capobianco, T.E., and Clark, A.F., **Anomalous Behavior of Tunneling Contacts in Superconducting Perovskite Structures**, Advances in Cryogenic Engineering Materials, Vol. 34, pp. 625-632 (Plenum Publishing Corporation, 1988).

Our break junction results for electron tunneling spectroscopy of the perovskite superconductors La-Sr-Cu-O and Y-Ba-Cu-O are similar to those obtained using thin-film, scanning tunneling microscopy, and point-contact methods. Energy gap structures are sometimes observed in the measured current-voltage characteristics. More often, however, the characteristics are anomalous when compared to previous tunneling studies of BCS superconductors. The anomalies include linearly increasing conductance with voltage, large deviations in junction conductance above the gap edge, and junction diode action. We discuss some possible explanations for these observations.
[Contact: John M. Moreland, (303) 497-3641]

ELECTROMAGNETIC INTERFERENCE

Radiated Electromagnetic Interference

Adams, J.W., Ondrejka, A.R., and Medley, H.W., **Time-Domain System for Identification of the Natural Resonant Frequencies of Aircraft Relevant to Electromagnetic Compatibility Testing**, NBSIR 87-3077 (November 1987).

A method for measuring the natural resonant frequencies of a structure is described. The measurement involves radiating an aircraft with an impulsive electromagnetic field and receiving the echo reflected from this aircraft. Resonances are identified by using a mathematical algorithm based on Prony's method to operate on the digitized reflected signal. The measurement system consists of special transverse electromagnetic horns, pulse generators, a time-domain system, and an implementation of Prony's algorithm. The frequency range covered is 5 to 250 MHz; this range is determined by antenna and circuit characteristics.

The use of this system is shown, and measured data from several different helicopters are presented in different forms. These different forms are needed to determine which of the resonant frequencies are real and which are false. The false frequencies are byproducts of Prony's algorithm.
[Contact: John W. Adams, (303) 497-3328]

Cavcey, K.H., and Friday, D.S., **Aircraft Field Degradation and Electromagnetic Compatibility**, NBSIR 88-3083 (January 1988).

This paper discusses the first tests undertaken to study the problem of field degradation in army aircraft (helicopters and one fixed-wing airplane) due to the deterioration of electronic and electrical systems. The electromagnetic compatibility of such systems was investigated by passive measurement of each aircraft as a collection of radio-frequency sources. Methods for detection of these sources were developed that included sensitivity to both stationary and nonstationary noise that existed.

The collected data were studied to see

Radiated EMI (cont'd.)

if there existed any obvious factors derived from the data that one could use to correct potential problems that might affect flight safety. Emphasis was placed upon making such test methods appropriate, inexpensive, and easily performed by army field personnel. In addition, applications to quality control or acceptance testing, as related to the Environmental Stress Screening program, were examined.
[Contact: Kenneth H. Cavcey, (303) 497-3995]

Crawford, M.L., Koepke, G.H., and Ladbury, J.M., **EMR Test Facilities, Evaluation of Reverberating Chamber Located at RADC, Griffiss AFB, Rome, New York**, NBSIR 87-3080 (December 1987).

This report describes measurement procedures and results obtained from evaluating the reverberating chamber facility located at the Rome Air Development Center (RADC), Griffiss Air Force Base, Rome, New York. The facility was developed by the RADC for use in measuring and analyzing the electromagnetic susceptibility/ vulnerability of weapon systems and the shielding effectiveness of enclosures and shielding materials. A brief description of the facility, including the instrumentation used for performing its evaluation and calibration by the National Bureau of Standards, is given. Measurements described include: (1) evaluation of the chamber's transmitting and receiving antennas' voltage standing-wave ratios; (2) measurement of the chamber's insertion loss or coupling efficiency versus frequency; (3) measurement of the chamber's tuner effectiveness; (4) determination of the electric- (E-) field uniformity in the chamber's test zones versus frequency; (5) determination of the absolute amplitude calibration of the test E-fields in the chamber based upon the reference antenna's received power measurements and calibrated dipole probe antenna measurements; (6) comparison of reference standard equipment under test responses to test fields established inside the RADC reverberating chamber and the NBS anechoic chamber; and (7) evaluation of the performance characteristics of the reverberating chamber excited by pulsed radio frequency (rf) at selected discrete frequencies as a function of pulse width (0.2 to 20 μs) and the chamber's quality factor (Q). Conclusions indicate that the chamber can be used at frequencies down to approximately 150 MHz for continuous-wave (cw) testing, and for rf pulsed immunity testing with pulse widths as short as 0.3 μs by using rf absorber loading. Immunity testing to pulsed rf fields, however, has some inherent limitations that are discussed in the report. Estimates of the cw measurement uncertainties derived empirically from the test results are given.
[Contact: Myron L. Crawford, (303) 497-5497]

Randa, J., Kanda, M., and Melquist, D., **Possible Designs for Electric-Field-Strength Probes for Millimeter Waves**, NBSIR 88-3084 (February 1988).

Various designs are considered for electric-field probes for the frequency range from 26 to 110 GHz. Two particular designs are investigated in some detail. A resistively tapered dipole antenna with a diode detector shows promise for frequencies up to about 40 GHz. The second design is based on a fiber-optically sensed temperature sensor to detect the heating of a resistive strip. If its sensitivity can be increased significantly, this design may be capable of operating to frequencies above 100 GHz.
[Contact: James P. Randa, (303) 497-3150]

Wilson, P.F., Ondrejka, A.R., Ma, M.T., and Ladbury, J.M., **Electromagnetic Fields Radiated From Electrostatic Discharges Theory and Experiment**, NBS Technical Note 1314 (February 1988).

Radiated EMI (cont'd.)

The fields radiated by electrostatic discharges (ESD) are studied both theoretically and experimentally. The ESD spark is modeled theoretically as an electrically short, time-dependent, linear dipole situated above an infinite ground plane. Experimentally, sparks of varying voltages are generated by a commercially available simulator and used to excite a number of targets including: (1) the extended inner conductor of a coaxial cable mounted in a ground plane, (2) direct discharges to a ground plane, (3) indirect radiation from a large metal plate, (4) a metal chair over a ground plane, and (5) a metal trash can. Results show that relatively low-voltage sparks (2 kV to 4 kV) excite the strongest radiated fields. This suggests that the spark fields can pose a significant interference threat to electronic equipment into the gigahertz range.
[Contact: Mark T. Ma, (303) 497-3800]

Conducted Electromagnetic Interference

Martzloff, F.D., **Power Quality Measurements: Bringing Order Out of Chaos**, Energy Technology XV -- Repowering America (Proceedings of the Energy Technology Conference, Washington, DC, February 17-19, 1988) (Government Institutes, Inc., Maryland), pp. 947-959.

The quality of the power supplied to sensitive electronic equipment is an important issue. Quantifying this quality, however, is difficult under the present state of nonexistent or uncoordinated standards concerning two related questions: (1) what levels of power quality are required for what types of loads, and (2) what measurement techniques are required to determine reliably the level of disturbances that reduce quality. Development of standards by the consensus process and voluntary compliance, although a slow process, is a mechanism for reaching technically sound and cost-effective solutions. Several standards projects are in progress, but need industry-wide support to become the generally accepted basis for valid and useful measurements of power quality.
[Contact: Francois D. Martzloff, (301) 975-2409]

ADDITIONAL INFORMATION

Lists of Publications

Gibson, K.A., Page, J.M., and Miller, C.K.S., **A Bibliography of the NBS Electromagnetic Fields Division Publications**, NBSIR 85-3040 (February 1986).

This bibliography lists publications of the National Bureau of Standards' Electromagnetic Fields Division for the period from January 1984 through September 1985, with selected earlier publications from the Division's predecessor organizations.
[Contact: Kathryn A. Gibson, (303) 497-3132]

Kline, K.E., and DeWeese, M.E., **Metrology for Electromagnetic Technology: A Bibliography of NBS Publications**, NBSIR 87-3074 (June 1987).

This bibliography lists the publications of the personnel of the Electromagnetic Technology Division of NBS in the period from January 1970 through December 1986. A few earlier references that are directly related to the present work of the Division are included.
[Contact: Sarabeth Moynihan, (303) 497-3678]

Palla, J.C., and Meiselman, B., **Electrical and Electronic Metrology: A Bibliography of NBS Electrosystems Division Publications, NBS list of Publications 94 (January 1988).**

This bibliography covers publications of the Electrosystems Division, Center for Electronics and Electrical Engineering, NBS, and of its predecessor sections for the period January 1963 to January 1988.

Lists of Publications (cont'd.)

A brief description of the Division's technical program is given in the introduction.
[Contact: Jenny C. Palla, (301) 975-2220]

Walters, E.J., **Semiconductor Measurement Technology, NBS List of Publications 72** [a bibliography of NBS publications concerning semiconductor measurement technology for the years 1962-1987] (March 1988).

This bibliography contains reports of work performed at the National Bureau of Standards in the field of Semiconductor Measurement Technology in the period from 1962 through December 1987. An index by topic area and a list of authors are provided.
[Contact: E. Jane Walters, (301) 975-2050]

RECENTLY ISSUED
STANDARD REFERENCE MATERIALS

The Semiconductor Electronics Division announces the release of a new Standard Reference Material (SRM) for **ellipsometrically derived thickness and refractive index of a silicon dioxide film on silicon.** Available for sale to the public through the NBS Office of Standard Reference Materials [for orders, (301) 975-6776], SRM 2530 is separately available for three oxide thicknesses: 50 nm (2530-1), 100 nm (2530-2), and 200 nm (2530-3).

This SRM was developed to respond to industry needs to evaluate the accuracy of ellipsometers, but may also be used as aid in the calibration of various other optical and mechanical thickness monitoring instruments.

Each SRM consists of a 76-mm (3-in.) diameter silicon wafer on which a uniform silicon dioxide layer was grown, patterned, and partially covered with chromium. The certified values were determined from measurements made using the highly accurate ellipsometer developed in the Division and are the ellipsometric parameters delta, Δ, and psi, ψ, at a wavelength of $\lambda = 632.8$ nm. The SRMs are also certified for the derived values of thickness and refractive index of its silicon dioxide layer determined by using a two-layer model consisting of a silicon dioxide layer on a thin silicon-rich oxide interlayer. [Contact: George A. Candela, (301) 975-2086]

1988 CEEE Calendar

September 12-14, 1988 (San Jose, CA)

VLSI and GaAs Chip Packaging Workshop. This Workshop is co-sponsored by the Components, Hybrids, and Manufacturing Technology Society of IEEE and NBS; attendees are expected to be knowledgeable in the field and to participate in discussions. Topic areas include: VLSI and wafer-scale package design (characterization and implementation, cost and performance-driven solutions); package thermal design (characteristics, results, and issues); package interconnection options (wire bonding, TAB, flip chip, or optical); GaAs IC packaging (high-speed packaging considerations); package electrical issues (reduction of parasitics, improvements in electrical performance, reduction in line resistance); integrating package design (from die to system, including assembly and test issues); VLSI package materials advancements; die-attach solutions for large chips; and new failure mechanisms in VLSI packaging. [Contact: George G. Harman, (301) 975-2097]

September 20-21, 1988 (Boulder, CO)

Symposium on Optical Fiber Measurements. This symposium is intended to provide a forum for the lightwave communications community to discuss and possibly resolve measurement problems related to optical fiber, sources, detectors, switches, couplers, modulators, and other components. The symposium is sponsored by NBS, in cooperation with

CEEE Events (cont'd.)

the Institute of Electrical and Electronics Engineers' Optical Communications Committee, and the Optical Society of America. Eight technical sessions are scheduled, including presentations relating to optical time-domain reflectometry return loss, polarization, losses, transmission modes, cut-off wavelength, geometry, and refractive index. [Contact: Douglas L. Franzen, (303) 497-3346]

October 26-28, 1988 (Boulder, CO)

Twentieth Symposium on Optical Materials for High Power Lasers (Boulder Damage Symposium). In addition to the NBS, this symposium is sponsored by the American Society for Testing and Materials, the Air Force Office of Scientific Research, the Office of Naval Research, the Defense Advanced Research Projects Agency, and the Department of Energy. It serves as 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. [Contact: Aaron A. Sanders, (303) 497-5341]

February 7-9, 1989 (San Diego, CA)

IEEE Semiconductor Thermal and Temperature Measurements Symposium. This fifth annual SEMI-THERM symposium is sponsored by the Components, Hybrids, and Manufacturing Technology Society of IEEE in cooperation with NBS and constitutes an international forum for the presentation of new developments relating to generation and removal of heat within semiconductor devices, measurement of device temperatures, and the simulation of device and system thermal behavior. Major SEMI-THERM topic areas include: thermal measurements; simulation, computation, and software; thermal characterization; and applications.

The program includes keynote speakers, technical presentations, tutorial sessions, workshops, and an exhibit. In addition, the Semiconductor Equipment and Materials Institute (SEMI) and the Joint Electron Devices Engineering Council (JEDEC) have scheduled in conjunction with SEMI-THERM several Standards Committee Task Force meetings, to which attendees are invited. [Contact: Frank F. Oettinger, (301) 975-2054]

September 11-13, 1989 (Munich, FDR)

VLSI and GaAs Chip Packaging Workshop. [Contact: George G. Harman, (301) 975-2097]

December 7-8, 1989 (Gaithersburg, MD)

Power Semiconductor Devices Workshop. [Contact: David L. Blackburn, (301) 975-2068]

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SUPPLEMENTARY NOTES

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

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

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

antennas; electrical engineering; electrical power; electromagnetic interference; electronics; instrumentation; laser; magnetics; microwave; optical fibers; semiconductors; superconductors

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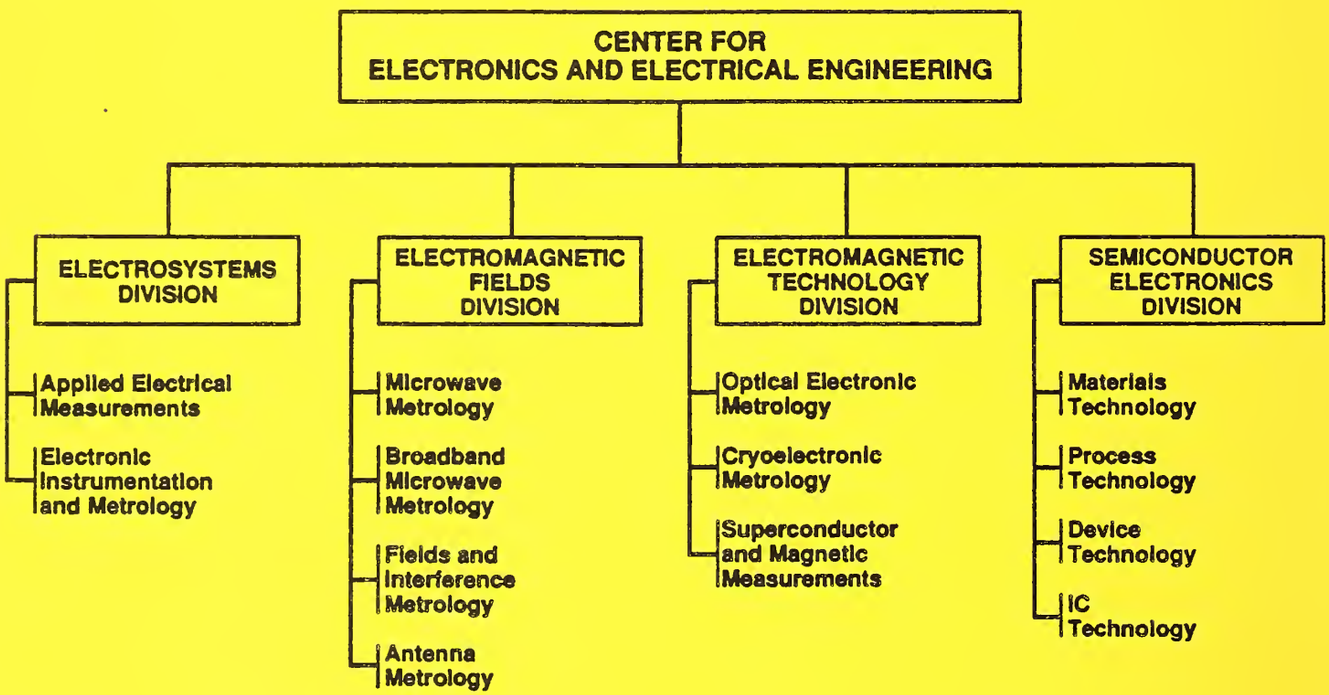

KEY CONTACTS:

Center Headquarters (720)	Director, Mr. Judson C. French (301) 975-2220
	Deputy Director, Mr. Robert I. Scace (301) 975-2220
Electrosystems Division (722)	Chief, Dr. Oskars Petersons (301) 975-2400
Electromagnetic Fields Division (723)	Chief, Dr. Ramon C. Baird (303) 497-3131
Electromagnetic Technology Division (724)	Chief, Dr. Robert A. Kamper (303) 497-3535
Semiconductor Electronics Division (727)	Chief, Mr. Frank F. Oettinger (301) 975-2054

INFORMATION:

For additional information on the Center for Electronics and Electrical Engineering, write or call:

Center for Electronics and Electrical Engineering
National Institute of Standards and Technology
Metrology Building, Room B-358
Gaithersburg, MD 20899
Telephone (301) 975-2220