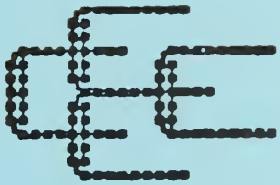
NBSIR 84-2857-1

Center for Electronics and Electrical Engineering



Technical Progress Bulletin

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
National Engineering Laboratory
Center for Electronics and Electrical Engineering
Gaithersburg, Maryland 20899

Covering Center Programs, January - March 1983

March 1984

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U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

INTRODUCTION TO MARCH 1984 ISSUE OF THE CEEE TECHNICAL PROGRESS BULLETIN

This is the second issue 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 Progress Bulletin covers the first quarter of calendar year 1983.

ORGANIZATION: Abstracts and citations are arranged by technical topic as identified in the table of contents and alphabetically by first author under each subheading within each topic. Each abstract ends with a telephone number of the individual to contact for more information on the topic; unless otherwise noted, this individual is the first author. Each citation ends with identification of the issue of the Technical Progress Bulletin in which the associated abstract appeared. 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. SPECIAL NOTE: Because the four issues covering calendar year 1983 are later than intended, the contents of these issues will differ from the original plan of providing abstracts for all papers approved by NBS in a quarter as follows: Each issue will contain (1) abstracts of papers approved for publication by NBS for the appropriate quarter and not subsequently published until calendar year 1984, (2) abstracts of papers approved and published during the quarter, and (3) citations for papers published during the quarter, but for which abstracts have appeared in an earlier issue of the Technical Progress Bulletin. Items in category (1) appear under the subheading "Approved for Publication"; items in categories (2) and (3) appear under the subheading "Recently Published."

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.

Previous special issues: Two special issues of the Technical Progress Bulletin have been published with abstracts for the Signals and Systems Program only, NBSIR 83-2719-1, covering October 1981 through March 1982 and NBSIR 83-2719-2, covering April 1982 through September 1982. NBSIR 82-2636, a special issue of the Semiconductor Technology Program Progress Briefs published in January 1983, listed abstracts of publications from that Program for Federal fiscal year 1982 (October 1981 through September 1982, fifty-third through fifty-seventh quarters of the Program). The new CEEE Technical Progress Bulletin replaces the Progress Briefs series [single copies of 82-2636 are available from the Center, see back cover for address].

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 page 12.

TABLE OF CONTENTS

SEMICONDUCTOR TECHNOLOGY PROGRAM

Gallium Arsenide Materials

Recently Published

Pande, K.P. and Seabaugh, A.C., **Preparation of Device Quality GaAs Using Plasma-Enhanced MO-CVD Technique,** Proc. Symposium III-V Optoelectronics Epitaxy and Device Related Processes, Proc. Vol. 83-13, V.G. Keramidas and S. Mahajan, Eds., pp. 201-209, Electrochemical Society, Pennington, NJ (1983).

Low temperature (≤450°C) deposition of single crystal GaAs using a new plasma-enhanced MO-CVD technique is described. In this technique, plasma is created by a dc potential and the substrate is not directly exposed to the plasma. Deposition of GaAs was achieved at extremely low plasma power (<5 W) using trimethylgallium (TMGa) and arsine (or trimethylarsenic) reactants. The resulting epitaxial films show excellent surface morphology and thickness uniformity over a large area substrate. A linear dependence of growth rate upon TMGa concentration was observed with a typical growth rate of 0.1 μm per minute for a TMGa flow rate of 15 cm^3 per minute. Undoped films were found to be n-type with a room temperature carrier mobility in the range of 5200 $cm^2\ V^{-1}\cdot s^{-1}$. Measurements on Schottky barrier devices fabricated on n/n^+ layers show uniform impurity doping profile and 55-V reverse breakdown voltage. Temperature dependence of the capacitance indicates a density of deep trapping centers as low as $6.2 \times 10^{13}\ cm^{-3}$. Data on photoresponse of these devices are also presented. [Contact: Seabaugh, (301) 921-3625]

Dimensional Metrology

Recently Published

Nyyssonen, D., **Laser Micrometrology for Integrated Circuits,** Proc. First International Congress Applications of Lasers and Electro-Optics, September 20-23, 1982, Boston, MA (1983)

The optical microscope measurement of micrometer and submicrometer linewidths during integrated-circuit fabrication utilizes a wide variety of optical microscope system designs including bright-field, dark-field, and focused laser beam scanning systems. Previous papers have dealt with the problem of accurate edge detection on lines as small as 0.5 μm using partially coherent or effectively coherent imaging. The present paper deals with the "principle of equivalence" in optical system design of both conventional microscope imaging systems and focused-spot scanning systems. It is shown both theoretically and experimentally that, for the case of measurement of lines patterned in thin films like those found on integrated-circuit wafers, the principle of equivalence does not hold because of the angular dependence of the optical parameters that characterize the line object. It is concluded that accurate linewidth measurements require both the angle of incidence and the wavelength to be well defined in a manner analogous to the requirements for accurate ellipsometric measurement of film thickness. [(301) 921-3786]

Process & Device Modeling

Approved for Publication

Albers, J. and Berkowitz, H.L., **The Relation Between Two-Probe and Four-Probe Resistances on Nonuniform Structures,** submitted to J. Electrochemical Society [Extended abstract published in Extended Abstracts of the Electrochemical Society, 83-1, pp. 622-623 (1983)].

A general relation between the two-probe resistance (spreading resistance) and the four-probe resistance on nonuniform structures is derived. In addition, an expression is derived for the derivative of the spreading resistance with respect to the logarithm of the probe spacing,

Process & Device Modeling, cont'd.

and discussed for the evaluation of these equations for nonuniform structures. The relation between the four-probe resistance, Z(x,S), and the incremental sheet resistance, R(x), is shown to arise in the limit as the probe spacing becomes large compared to the distance to an insulating boundary. Specific examples are drawn from calculations on implant-type structures into substrates having insulating boundaries near the end of the implanted region (junction isolation) as well as those where the insulating boundary is far from the implanted region (emulating the back surface of a same conductivity type substrate). Also presented is a method for the self-consistent calibration of spreading resistance profiles utilizing Z(x,S). [(301) 921-3621]

Bennett, H. S., **Improved Device Physics for Calculating the Gain of Bipolar Structures in Silicon,** to be published in Proc. Workshop on Submicron Physics.

A model which is more physically correct than the extension of the empirical procedures of Slotboom and de Graaff for donor densities above 2.5×10^{19} cm^{-3} has been developed for the effective intrinsic carrier concentration n_{ie} in n-type silicon. This new approach, which is based upon quantum mechanics and optical measurements for the band-gap, has been applied to an npn transistor with a 1-μm emitter-base junction depth and with donor densities greater than 10^{20} cm^{-3}. Conventional device physics with even unrealistic carrier lifetimes does not predict the measured dc common emitter gain. The approach described here with carrier lifetimes comparable to those expected in processed silicon (~0.1 μs) does predict the gain correctly. [(301) 921-3541]

Recently Published

Lowney, J.R. and Bennett, H.S., **Effect of Ionized Donors on the Electron and Hole Densities of States in Silicon**, J. Applied Physics 54, pp. 1369-1374 (March 1983).

A self-consistent second Born approximation has been used to calculate the change in the electron and hole densities of states due to ionized donors in silicon. The results are compared with a previous partial-wave technique and found to be in good agreement for a case of common applicability, i.e., a donor density of 10^{20} cm^{-3} at room temperature. [(301) 921-3786]

Other Semiconductor Metrology

Recently Published

French, J.C., Galloway, K.F., and Scace R.I. **The Challenge of Semiconductor Metrology**, Proc. 1983 Measurement Sciences Conf., Palo Alto, CA, January 19-20, 1983, pp. 171-188.

Semiconductor technology has placed challenging demands on the metrologist to provide state-of-the-art capabilities for measurements of dimensional, electrical, thermal, and other physical properties of semiconductor materials, devices, and circuits in a form suitable for meeting the practical needs of science and of industry and its customers. The National Bureau of Standards is responding to these demands by providing generic new measurement methods, physical standards, and services, highlighted by examples given in this paper.
[(301) 921-3357]

Walters, E.J., **Semiconductor Technology Program Progress Briefs**, NBSIR 82-2636 (January 1983).

This report provides abstracts of recent publications of NBS work on measurement technology for semiconductor materials, process control, and devices. Emphasis is placed on silicon and silicon-based devices. Topics include: defects and impurities, IC test structures, micrometrology, packaging, physical analysis,

Other Semiconductor Metrology, cont'd.

power devices, process and device modeling, and radiation effects. In addition, publications in press and conference presentations are listed. Information is also given on recent seminars, workshops, and symposia and those scheduled for the near future.
[(301) 921-3786]

FAST SIGNAL ACQUISITION, PROCESSING, AND TRANSMISSION

Waveform Metrology

Recently Published

Andrews, J., Bell, B., Nahman, N.S., and Baldwin, E.E., **Reference Waveform Flat Pulse Generator**, IEEE Trans. Instrumentation and Measurement, IM-32, No. 1, pp. 27-32 (March 1983) [summary published in Proc. Conf. Precision Electromagnetic Measurements, June 28 - July 1, 1982, Boulder, CO, pp. B10-B12].

The NBS Reference Flat Pulse Generator is used to transfer dc voltage and resistance standards to the nanosecond domain. It provides a step amplitude of 1.000 V (open circuit) from a source impedance of 50.0 ohms. The transition duration is 600 ps and all perturbations are damped out to less than ±10 mV within 5 ns. It can also be used as a time interval transfer standard.
[(303) 497-3529]

Gans, W.L., **The Measurement and Deconvolution of Time Jitter in Equivalent-Time Waveform Samplers**, IEEE Trans. Instrumentation and Measurement, IM-32, No. 1, pp. 126-133 (March 1983) [summary published in Proc. Conf. on Precision Electromagnetic Measurements, June 28 - July 1, 1982, Boulder, CO, p. G6].

The presence of time jitter between the trigger signal and the sampling strobe in an equivalent-time sampling oscilloscope can cause appreciable distortion of the recorded waveform. Under additive signal averaging conditions, a method has been developed to reduce this distortion. The method consists essentially of deconvolving a jitter-related effective impulse response from the recorded waveform data.
[(303) 497-3538 or -3806]

Lentner, K.J. and Flach, D.R., **An Automatic System for AC/DC Calibration**, IEEE Trans. Instrumentation and Measurement, IM-32, pp. 51-56 (March 1983) [abstract appeared on page 2 of May 1983 TPB (NBSIR 83-2719-2)].

Nahman, N. S., **Picosecond Domain Waveform Measurements; Status and Future Directions**, IEEE Trans. Instrumentation and Measurement, IM-32, No.1, pp. 117-124 (March 1983) [paper given at 1982 Conf. Precision Electromagnetic Measurements, Boulder, CO].

A review of the state-of-the-art of picosecond time-domain waveform measurements which includes measurements in both the electrical and optical regions of the electromagnetic spectrum. The review is the latest edition of a series of reviews on high-speed pulse measurements compiled by the author commencing in 1967; specifically, the present review up-dates the 1978 review. The significance to pulse waveform measurements of the IEEE Pulse Standards 194 and 181 or the identical IEC Pulse Standards 469-1 and 2 are discussed briefly. A classification of time-domain measurement methods is described which includes the various real-time and equivalent-time techniques used in electrical and optical transient (pulses, etc.) measurements. The present day capabilities are summarized in an up-dated version of the state-of-the-art charts published in 1978. Also, presented are some opinions as to the future directions of electrical and optical picosecond domain measurements. Approximately 30 references are cited.
[(303) 497-5167 or -3806]

Waveform Metrology, cont'd.

Oldham, N.M., **A 50 PPM AC Reference Standard Which Spans 1 Hz to 50 kHz,** IEEE Trans. Instrumentation and Measurement, IM-32, pp. 176-179 (March 1983) [abstract appeared on page 3 of May 1983 TPB (NBSIR 83-2719-2)].

Schoenwetter, H.K., **High Accuracy Settling Time Measurements,** IEEE Trans. Instrumentation and Measurement, IM-32, pp. 22-27 (March 1983) [abstract appeared on page 3 of May 1983 TPB (NBSIR 83-2719-2)].

Souders, T.M., Flach, D.R., and Wong, T.C., **An Automated Test Set for the Dynamic Characterization of A/D Converters,** IEEE Trans. Instrumentation and Measurement, IM-32, pp. 180-186 (March 1983) [abstract appeared on page 3 of May 1983 TPB (NBSIR 83-2719-2)].

Cryoelectronic Metrology

Recently Published

Peterson, R.L. and McDonald D.G., **Voltage and Current Expressions for a Two-Junction Superconducting Interferometer,** J. Appl. Phys. 54(2), pp. 992-996 (February 1983) [abstract appeared on page 4 of May 1983 TPB (NBSIR 83-2719-2)].

Antenna Metrology

Recently Published

Repjar, A.G., Newell, A.C., and Baird, R.C., **Antenna Gain Measurements by an Extended Version of the NBS Extrapolation Method,** IEEE Trans. Instrumentation and Measurement, IM- 32, No. 1, pp. 88-91 (March 1983) [also published in Proc. Conference on Precision Electromagnetic Measurements, June 28 - July 1, 1982, Boulder, CO, pp. F7-F9; abstract appeared on page 14 of July 1983 TPB (NBSIR 83-2719-3)].

Stubenrauch, C.F., Spiess, W., Galliano, P.G., and Babij, T., **International Intercomparison of Electric Field Strength at 100 MHz,** IEEE Trans. Instrumentation and Measurement, IM-32, No. 1, pp. 235-237 (March 1983) [also published in Proc. Conference on Precision Electromagnetic Measurements, June 28 - July 1, 1982, Boulder, CO, pp. P3-P4; abstract appeared on page 6 of May 1983 TPB (NBSIR 83-2719-2)].

Noise Metrology

Recently Published

Wait, D.F., **Precision Measurement of Antenna System Noise Using Radio Stars,** IEEE Trans. Instrumentation and Measurement, IM-32, No. 1, pp. 110-116, (March 1983) [summary published in Proc. Conference on Precision Electromagnetic Measurements, June 28 - July 1, 1982, Boulder, CO, p. F-17; abstract appeared on page 7 of May 1983 TPB (NBSIR 83-2719-2)].

Wait, D.F., **Earth Terminal Measurement System Operations Manual (Revised),** NBSIR 83-1679 (January 1983) [abstract appeared on page 14 of July 1983 TPB (NBSIR 83-2719-3)].

Wait, D.F. and Daywitt, W.C., **Preliminary Examination of 20 GHz G/T Measurements of Earth Terminals,** NBSIR 83-1686 (March 1983).

Three basic measurement techniques and the associated measuring systems are examined to determine which are most likely to meet the needs for measuring the figure of merit (G/T) of future 20-GHz satellite systems: use of the sun as a known source, use of the sun as an intercomparison source with a calibrated reference terminal, and the use of a satellite signal as an intercomparison source. It is shown that the method of using the sun as a known source is not very accurate (about 1.5 dB uncertainty), but that using the sun as a transfer source is useful (0.3 to 0.5 dB, depending on the measuring system) for Earth terminals with antenna

Noise Metrology, cont'd.

diameters less than 1.8 m (6 ft). For Earth terminals with antenna diameters greater than 1.8 m, the sun cannot be used as a transfer source for geometric reasons, but a satellite signal can be used as such a source. [(303) 497-3610]

Microwave & Millimeter-Wave Metrology

Approved for Publication

Juroshek, J.R. and Hoer, C.A., **A Dual Six-Port Network Analyzer Using Diode Detectors**, submitted to IEEE Trans. Microwave Theory and Techniques.

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]

Recently Published

Hoer, C., **Choosing Line Lengths for Calibrating Network Analyzers**, IEEE Trans. Microwave Theory and Techniques, 31, No. 2, pp. 76-78 (January 1983) [abstract appeared on page 7 of May 1983 TPB (NBSIR 83-2719-2)].

Optical Fiber Metrology

Recently Published

Gallawa, R.L., Editor, **Fiber Optics: Short-Haul and Long-Haul Measurements and Applications.** Proc. set of four sessions at SPIE conf., San Diego, CA, August 24-25, 1982, as Proc. SPIE - The International Society for Optical Engineering, 355, SPIE, P.O. Box 20, Bellingham, WA 98227.

This set of four sessions is intended to concentrate on topics not often covered in fiber conferences. In particular, the organizers included papers on the subjects of short-haul systems and measurements. Attention is also given to the more popular subjects of long-haul systems and applications.

Session 1 represents a potpourri; the papers address some of the more pressing topics of 1982. The work discussed in these papers is generally at the research level, in contrast to the more applications-oriented subjects of the other three sessions.

The second session, on terminal devices, concentrates on those devices that allow full exploitation of the fiber capability. Subjects range from the rather general to the very specialized.

The third session is concerned with test and measurement and includes papers on component testing as well as system evaluation.

The fourth session addresses a number of short-haul fiber system problems, circa 1982. These problems tend to be unusual and frequently difficult, arising in application areas such as military systems (military applications of fibers are frequently over short distances).
[(303) 497-3761]

Other Fast Signal Topics

Approved for Publication

Young, M., **Can You Describe Optical Surface Quality with One or Two Numbers?**, submitted to Proc. Soc. Photo-Optical Instrumentation Engineers.

This talk discusses two optical surface quality standards, total integrated scatter (TIS) and the scratch and dig standard (MIL-O-13830A). I begin by using Fourier optics to show that the well-known expression, $I_t/I(0) = 4\,k^2\sigma^2$, which relates scattered power to rms roughness σ, is truly valid only for

Other Fast Signal Topics, cont'd.

certain classes of surfaces. Vector scattering theory applied to a more general case shows that in fact optics can measure only a bandwidth-limited roughness that can be related to scattered power only if the surface statistics are known. For this reason, the standard should perhaps be regarded as a scattered light standard and not as a surface roughness standard. I conclude by describing our efforts to develop an objective measurement technique to aid in the manufacture of the artifacts used to implement the scratch standard. [(303) 497-3223 or -5342]

Recently Published

Jesch, R.L. and McLaughlin, R.H., **Dielectric Measurements of Oil Shale as Functions of Temperature and Frequency**, NBSIR 83-1683 (January 1983) [also submitted to IEEE Trans. Geoscience and Remote Sensing].

A high-temperature sample holder designed by the National Bureau of Standards was used to determine the dielectric properties of approximately 40 oil shale samples as functions of temperature and frequency. A description of the sample holder characterization is given along with the measurement procedure and the sample preparation. Experimental results are given for different oil shale samples, varying in yield from 0.024 L/kg (6 gal/ton) to 0.338 L/kg (81 gal/ton), that were measured at room temperature (25°C) up to 500°C and within the frequency range of 5-1000 MHz. [(303) 497-3496]

Young, M., **Objective Measurements and Characteristics of Scratch Standards**, Proc. SPIE conf., San Diego, CA, August 24-25, 1982, pp. 86-92 in Proc. SPIE - The International Society for Optical Engineering, 356, SPIE, P.O. Box 20, Bellingham, WA 98227 (1983) [abstract appeared on page 9 of May 1983 TPB (NBSIR 83-2719-2)].

Young, M., **Questions Students Ask**, Physics Teacher, pp. 194-195 (March 1983) [abstract appeared on page 16 of July 1983 TPB (NBSIR 83-2719-3)].

Zimmerman, J.E., **Magnetic Quantities, Units, Materials, and Measurements** and **Crypogenics**, chapters 2 and 3 in book, Biomagnetism: an Interdisciplinary Approach, Samuel J. Williamson, et al., Eds., NATO Advanced Study Institute Publication, Vol. 66, Plenum Press, New York, NY (1983).

ELECTRICAL SYSTEMS

Power Systems Metrology

Approved for Publication

Hillhouse, D.L., Petersons, O., and Sze, W.C., **A Simplified System for Calibration of Coupling Capacitor Voltage Transformers (CCVTs)**, submitted to IEEE Trans. Power Apparatus & Systems.

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]

Recently Published

Hebner, R. E., Kelley, E. F., and Hagler, J.N., **1981 Annual Report -- Optical Measurements for Interfacial Conduction and Breakdown**, NBSIR

Power Systems Metrology, cont'd.

82-1629 (January 1983).

This report presents measurements and calculations contributing to the understanding of space and surface charges in practical insulation systems. Calculations are presented which indicate the size of charge densities necessary to appreciably modify the electric field from what would be calculated from geometrical considerations alone. Experimental data is also presented which locates the breakdown in an electrode system with a paper sample bridging the gap between the electrodes. It is found that with careful handling, the breakdown does not necessarily occur along the interface even if heavily contaminated oil is used.

The effects of space charge in the bulk liquid are electro-optically examined in nitrobenzene and transformer oil. Several levels of contamination in transformer oil are investigated. Whereas much space charge can be observed in nitrobenzene, very little space charge, if any, can be observed in the transformer oil samples even at temperatures near 100°C.
[(301) 921-3121]

Hillhouse, D.L., **Effects of High-Voltage Switching on the EPRI-NBS Coupling Capacitor Voltage Transformer (CCVT) Calibration System Standard Divider**, NBSIR 83-2666 (March 1983).

This report presents the results of tests of the effects of high-voltage switching on the EPRI-NBS CCVT calibration system's capacitive standard divider, completing an investigation stemming from the results of three calibrations at a Gulf States Utilities substation.

Initial tests consisted of full-scale (300 kV) switching operations at EPRI's Waltz Mill test facility, during which the divider exhibited significant ratio offsets (average = $^{+}0.2\%$, maximum = nearly $^{+}0.5\%$). Tests were continued at the National Bureau of Standards (NBS), where it was determined that operation of a grounding switch, installed to protect the divider low side during high-voltage switching, caused ratio offset by trapping charge on the divider's low side capacitor. This resulted in residual dc voltage which changed the value of the divider's low-side capacitance. The addition of a bleeder resistor eliminated the problem in the laboratory. With the bleeder resistor in place, the Waltz Mill tests were repeated. Fifty high-voltage switching operations indicated a negligible shot-to-shot variation (average = -1ppm, σ = 80 ppm).

No obvious correlation was found between the ratio offsets described above and the results of CCVT calibrations performed while the effect may have been present in the divider. Experience indicates that a significant proportion of calibrated CCVTs is outside metering tolerance. Long-term simultaneous monitoring of a sizeable number of CCVTs is suggested.
[(301) 921-3121]

Superconductors

Recently Published

Clark, A.F. and Tachikawa, K., editors, **Proc. International Cryogenic Materials Conference**, Kobe, Japan, May 11-14, 1982, Butterworths, Guildford, England (January 1983).

This Conference, held jointly with the International Cryogenic Engineering Conference, presented 125 papers in 15 sessions. All varieties of materials used at low temperatures, including superconductors, structural steels, nonferrous alloys, nonmetallics and composites, were covered, as was the fabrication, welding, and joining of these materials. [Contact: Clark, (303) 497-3253]

Ekin, J.W., **Four-Dimensional J-B-T-ε**

Superconductors, cont'd.

Critical Surface for Superconductivity, J. Applied Physics 54 (1), pp. 303-306, January 1983.

The concept of a superconducting critical surface in a four-dimensional J-B-T-ε space is introduced and from this a critical strain parameter ε_c is defined in analogy to the usual three superconducting critical parameters: J_c, $B_{c_2}m$, and T_c. Examples of a subset of this surface in a three-dimensional J-B-ε space are presented as a function of temperature for the A15 superconductors, Nb_3Sn and V_3Ga, utilizing the recently discovered strain scaling law. The usefulness of the J-B-T-ε critical surface in characterizing the interaction of strain with the other three critical parameters and in setting strain limits for the mechanical design of superconducting devices is illustrated.
[(303) 497-5448]

Reed, R.P., Arvidson, J.M., Ekin, J.W., and Schoon, R.H., **Magnetic Field Effects on Tensile Behavior of Alloys 304 and 310 at 4K**, pp. 33-36 in Proc. International Cryogenic Materials Conf., Kobe, Japan, May 11-14, 1982, Butterworths, Guildford, England (January 1983).

Experiments were conducted to assess the effects of a steady, transverse 7-T magnetic field on the austenite stress-strain characteristics of types 304 and 310 stainless steels at 4 K. Wire specimens of both a stable Fe-26Dr-20Ni (AISI 310) and metastable FE-18Cr-9Ni (AISI 304) alloy were measured. No change in austenite flow strength of either alloy was observed from the application of a 7-T field. There was no detectable effect of a constant 7-T magnetic field on the yield strength of either alloy. Young's modulus at 4 K was found to decrease linearly with applied strain, but no effect of magnetic field was observed.
[(303) 497-3870]

ELECTROMAGNETIC INTERFERENCE

Approved for Publication

Shafer, J.F., **Field Strength in Vehicles Resulting From On-Board Communications Transmitters** [to be published as an NBS Special Publication in 1984].

The purpose of this report is to measure and report the levels of field strength that are generated by the various types of transmitters in and around an operator in a law-enforcement vehicle equipped with communications equipment. No attempt has been made to assess what levels of field strength may be detrimental to the operator's health or well-being. Typical values of field strength at ten selected locations inside a vehicle with and without the driver's door opened are given in the frequency bands of 30 to 50 MHz, 150 to 174 MHz, 400 to 512 MHz, and 806 to 866 MHz. Levels of output power are given for the data presented along with observations about the operator's physical size and this relationship to the measured data. Levels of field strength are also given for a metallic prisoner shield, a personal transceiver, and a speed measuring radar device as used in a vehicle.
[(303) 497-3724]

Recently Published

Crawford, M.L., **Improving the Repeatability of EM Susceptibility Measurements of Electronic Components When Using TEM Cells**, SAE Technical Paper Series 830607, International Congress and Exposition, Detroit, MI, February 28 - March 4, 1983, pp. 1-8.
[Abstract appeared on page 20 of July 1983 TPB (NBSIR 83-2719-3)].

Crawford, M.L., **Evaluation of Shielded Enclosure for EMI/EMC Measurements Without and With RF Anechoic Material**, Proc. 1983 EMC Symposium and Exhibition, Zurich, Switzerland, March 8-10, 1983, pp. 397-402.

Electromagnetic Interference, cont'd.

This paper gives the results of measurements performed by the National Bureau of Standards to evaluate the potential influence of rf absorbing material installed inside a shielded enclosure on the accuracy of TEMPEST measurements made using the shielded enclosure. The facility evaluated was a 3.76 m wide by 6.2 m long by 2.44 m high shielded enclosure located at Hanscom Air Force Base, Massachusetts. The paper briefly discusses the measurement technique used, describes the test facility and test configurations, and the spherical dipole radiators used for generating the reference standard fields. Tests were performed to evaluate the influence of (1) placement location of both the source and receiving antenna inside the enclosure, (2) separation distance between source and receiving antenna, and (3) height of source above the floor of the enclosure on the measurement results. Measurements made before and after installation of the rf absorbing material indicated a significant improvement in accuracy (error typically less than ±10 dB as compared to >30 dB) at frequencies above 30 MHz where the absorber is effective.
[(303) 497-5497]

Crawford, M.L., **Improving the Repeatability of EM Susceptibility Measurements of Electronic Components When Using TEM Cells**, SAE Technical Paper Series 830607, International Congress and Exposition, Detroit, MI, pp. 1-8, February 28 - March 4, 1983 [abstract appeared on page 20 of July 1983 TPB (NBSIR 83-2719-3)].

Kanda, M., Ries, F.X., Driver, L.D., and Orr, R. D., **An Electric and Magnetic Field Sensor Concept for Simultaneous Near-Field Electromagnetic Field Measurements**, Proc. 1983 EMC Symposium and Exhibition, Zurich, Switzerland, March 8-10, 1983, pp. 263-266 [abstract appeared on page 20 of July 1983 TPB (NBSIR 83-2719-3)].

Koepke, G.H. and Ma, M.T., **A New Method for Determining the Emission Characteristics of an Unknown Interference Source**, Proc. 1983 EMC Symposium and Exhibition, Zurich, Switzerland, March 8-10, 1983, pp. 35-40 [abstract appeared on page 20 of July 1983 TPB (NBSIR 83-2719-3)].

Miller, C.K.S., **The EMI Measurement Challenge**, Proc. Measurement Science Conference, Palo Alto, CA, January 20-21, 1983, pp. 189-197.

With the increasing proliferation of radiating sources to the electromagnetic (EM) environment and the increased use of semiconductor technology in consumer and industrial products, incidents of electromagnetic interference (EMI) to electronic products have increased. Current EMI measurement difficulties are reviewed and a description is given of the National Bureau of Standards' (NBS) measurement research, both planned and in process.
[(303) 497-3131]

CEEE CALENDAR

1984

April 30 - May 4 (Boulder, CO)

NBS Noise Measurement Seminar. The course is intended for practicing noise metrologists and technical managers responsible for systems for which accurate noise measurements are important. The seminar introduces and describes reference noise sources, noise measuring systems, and the problems of characterizing and measuring noise in passive components, amplifiers, and satellite earth terminals. Class examples will specifically address the measurement of noise power; amplifier noise; and antenna system noise, including measures such as noise equivalent flux, the ratio of system gain to system noise temperature G/T, and the ratio of carrier power to noise density C/kT.

CEEE CALENDAR, cont'd.

The course will cover both theory and practice of precision noise measurements; the practical lectures are designed to stand alone and to be understood by those having minimal mathematical background.
[Contact: Sunchana Perera (303) 497-3546]

June 18-21 (Gaithersburg, MD)

Power Electronics Specialists Conference. Co-sponsored by the National Bureau of Standards and the Power Electronics Council of the Institute of Electrical and Electronics Engineers, the Conference is intended to provide a venue where specialists in circuits, systems, electron devices, magnetics, control theory, instrumentation, and power engineering may discuss new ideas, research, development, applications, and the latest advances in power electronics.

The Conference will incorporate six technical sessions (on converter circuits, converter systems, converter control, motor drives, power components, and modeling and analysis techniques), a one-day tutorial on Electromagnetic Compatibility in Power Systems, and three special "rap sessions" (EMI, RFI, and Noise: Fact or Fiction; Emerging Power Semiconductors: Positive and Negative Attributes; and Future Trends in Aircraft Power Electronics and Electrical Actuators).
[Contact: Sandra B. Kelley (301) 921-3541]

August 28-30 (Vail, CO)

Short Course on Optical Fiber Measurements. This course is addressed to scientists and engineers who are involved in fiber characterization. The course will emphasize concepts, techniques, and apparatus used in measuring the engineering parameters of telecommunication-grade fibers. A degree is electrical engineering or physics is assumed. The course will last three days with 18 hours of class time.
[Contact: Robert L. Gallawa (303) 497-3761]

October 2-3 (Boulder, CO)

Symposium on Optical Fiber Measurements. This symposium, the third in the series of biennial meetings, is cosponsored 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 inlcude 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

CEEE CALENDAR, cont'd.

and deposition processes, and testing. [Contact: Aaron A. Sanders (303) 497-5341]

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 $\bar{1}$(111)-oriented n-type silicon surfaces. Each SRM consists of a set of about 15 specimens (number of specimens varies depending on availability of material of appropriate resistivities) of silicon, 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. Slices are measured before dicing; only slices having uniformity of resistivity within predetermined bounds are selected. 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 (110) silicon surfaces are about to be released (2528, p-type and 2529, n-type).

SPONSORS OF WORK REPORTED IN THIS ISSUE

National Bureau of Standards
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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.

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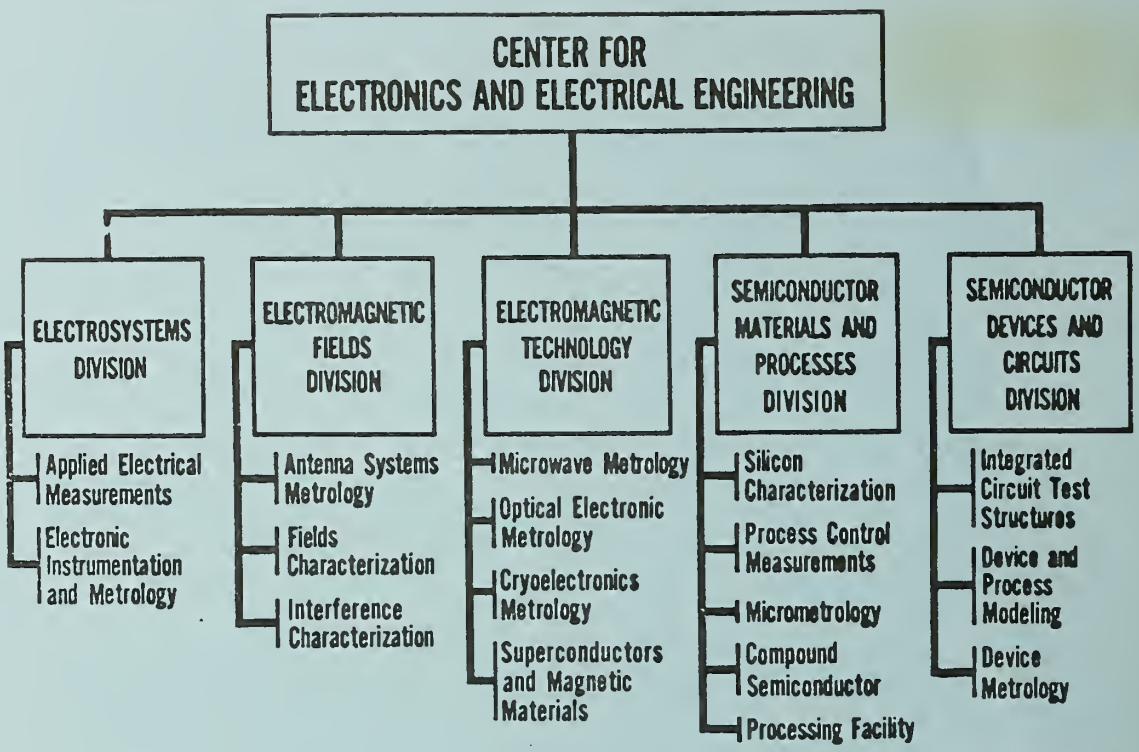

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