NISTIR 5114

Electronics and Electrical Engineering Laboratory

Technical Publication Announcements

Covering Laboratory Programs,
July to September, 1992
with 1992/1993 EEEL Events Calendar

J. M. Rohrbaugh
Compiler

January 1993

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U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards and Technology
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Gaithersburg, MD 20899

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U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
John W. Lyons, Director

ELECTRONICS AND ELECTRICAL ENGINEERING LABORATORY TECHNICAL PROGRESS ANNOUNCEMENTS, JANUARY 1993 ISSUE

INTRODUCTION

This is the thirty-fourth issue of a quarterly publication providing information on the technical work of the National Institute of Standards and Technology Electronics and Electrical Engineering Laboratory (EEEL). This issue of the EEEL Technical Progress Announcements covers the third quarter of calendar year 1992.

Organization of Bulletin: This issue contains abstracts for all relevant papers released for publication by NIST in the quarter and citations and abstracts for such 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. Unpublished papers appear under the subheading "Released for Publication." Papers published in the quarter appear under the subheading "Recently Published." 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 Laboratory conferences and workshops planned for calendar year 1992/1993 and a list of sponsors of the work.

Electronics and Electrical Engineering Laboratory: EEEL 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 Laboratory is conducted by four technical research Divisions: the Semiconductor Electronics and the Electricity Divisions in Gaithersburg, Md., and the Electromagnetic Fields and Electromagnetic Technology Divisions in Boulder, Colo. In 1991, the Office of Law Enforcement Standards, formerly the Law Enforcement Standards Laboratory, was transferred to EEEL. This Office conducts research and provides technical services to the U.S. Department of Justice and State and local governments, and other agencies in support of law enforcement activities. In addition, the Office of Microelectronics Programs (OMP) was established in EEEL to coordinate the growing number of semiconductor-related research activities at NIST. Reports of work funded through the OMP are included under the heading "Semiconductor Microelectronics."

Key contacts in the Laboratory are given on the back cover; readers are encouraged to contact any of these individuals for further information. To request a subscription or for more information on the Bulletin, write to EEEL Technical Progress Bulletin, National Institute of Standards and Technology, Metrology Building, Room B-358, Gaithersburg, MD 20899 or call (301) 975-2220.

Laboratory Sponsors: The Laboratory 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 15.

Note on Publication Lists: Publication lists covering the work of each division are guides to earlier as well as recent work. 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.

Certain commercial equipment, instruments, or materials are identified in this paper in order to specify adequately the experimental procedures. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

TABLE OF CONTENTS

FUNDAMENTAL ELECTRICAL MEASUREMENTS

Cage, M.E., **Magnetic Field Dependence of Quantized Hall Effect Breakdown Voltages**, Semiconductor Science Technology, Vol. 7 (IOP Publishing Ltd., U.K., 1992), pp. 1119-1122.

When large currents are passed through a high-quality quantized Hall resistance device, the voltage drop along the device is observed to assume discrete, quantized states when plotted versus the magnetic field. These quantized voltage states are interpreted as occurring when electrons are excited to higher Landau levels and then return to the original Landau level. The quantization is found to be a function of magnetic field, and consequently can be more difficult to verify and determine than previously suspected.
[Contact: Marvin E. Cage, (301) 975-4249]

SEMICONDUCTOR MICROELECTRONICS

Compound Materials

Kopanski, J.J., Lowney, J.R., Novotny, D.B., Seiler, D.G., Simmons, A., and Ramsey, J., **High-Spatial-Resolution Resistivity Mapping Applied to Mercury Cadmium Telluride**, Journal of Vacuum Science Technology B, Vol. 10, No. 4, pp. 1553-1559 (Jul/Aug 1992). [Proceedings of the 1991 U.S. Workshop on the Physics and Chemistry of Mercury Cadmium Telluride and Other II-VI Compounds, Dallas, Texas, October 8-10, 1991.]

The fine-scale resistivity variations of bulk slices of n-type $Hg_{1-x}Cd_xTe$ grown by the solid-state recrystallization (SSR) process and HgCdTe grown by liquid phase epitaxy (LPE) on SSR substrates were mapped at room temperature (297 K). An automatic probe station was used to make four-probe resistance measurements, spaced 80 μm apart, on lithographically defined metal-to-HgCdTe contacts. Most slices of SSR HgCdTe were found to have resistivity that increased from the center to the outside edge, and some SSR material also showed small inclusions with different resistivity than the surrounding material. LPE material was found to have a more random variation in resistivity than SSR HgCdTe. Also, the metal semiconductor contact resistivity of Ni/InPb/In contacts to n-type HgCdTe was measured to be in the range of 0.3 to 20×10^{-5} Ω-cm^2 for HgCdTe resistivities varying from 0.01 to 0.1 Ω-cm.
[Contact: Joseph J. Kopanski, (301) 975-2089]

Analysis Techniques

Dagata, J.A., Tseng, W., Bennett, J., Schneir, J., and Harary, H.H., **Imaging of Passivated III-V Semiconductor Surfaces by a Scanning Tunneling Microscope Operating in Air**, Ultramicroscopy (Elsevier Science Publishers B.V., North-Holland, 1992), pp. 1288-1294.

A procedure is described for preparing stable GaAs and other III-V semiconductor surfaces for scanning tunneling microscope (STM) imaging under ambient conditions. The procedure involves the use of a dilute $P_2S_5/(NH_4)_2S$ passivating solution, which produces a highly uniform, ultra-thin surface oxide. STM imaging with nanometer-scale resolution of a P_2S_5-passivated, $Al_xGa_{1-x}As/GaAs$, $x = 0.1$ to 0.4, compositional superlattice and a variable-period $Al_{0.51}Ga_{0.49}As$/-GaAs superlattice is used to illustrate some of the properties of this passivation method.
[Contact: Wen Tseng, (301) 975-5291]

Device Physics and Modeling

Lowney, J.R., and Mayo, S., **Analysis of Persistent Photoconductivity Due to Potential Barriers**, Journal of Electronic Materials, Vol. 21, No. 7, pp. 731-736 (1992). [Also published in the Proceedings of the Third Workshop on Radiation-Induced and/or Process-Related Electrically Active Defects in Semiconductor-Insulator Systems, Research Triangle Park, North Carolina, September 10-13, 1991, pp. 95-102.]

Persistent photoconductivity has been seen in thin silicon resistors fabricated with SIMOX material at temperatures between 60 and 220 K. This effect has been attributed to the depletion of carriers near the interface between the top silicon layer and the buried oxide, which is due to the large number of surface traps at this interface. The depletion of carriers is accompanied by a built-in field on the order of 10,000 V/cm, which causes a potential barrier that is about a quarter of the energy gap of silicon. The theory of the recombination kinetics of majority carriers with minority carriers trapped at the

interface on the other side of a potential barrier is studied. Both the possibilities of tunneling and thermal activation have been considered. The results show that thermal activation dominates at the temperatures of the NIST measurements in SIMOX material, while at lower temperatures tunneling would dominate.
[Contact: Jeremiah R. Lowney, (301) 975-2048]

Insulators and Interfaces

Kopanski, J.J., and Avila, R.E., **Charge Trapping in Cubic Silicon Carbide MIS Capacitors**, Springer Proceedings in Physics - Amorphous and Crystalline Silicon Carbide III, Vol. 56, pp. 119-124 (1992). [Proceedings of ICACSC '90, Washington, D.C., April 11-13, 1990.]

The charge trapping properties in the insulator and at the insulator-SiC interface of metal-insulator-semiconductor (MIS) capacitors on cubic SiC single crystals have been studied. The interface trap level density, D_{it}, was determined by the high-frequency capacitance-voltage technique and from the conductance-voltage behavior. The number of active interface traps appears to increase sharply in the range from room temperature to 260 °C. SiC MIS capacitors exhibit a slow-trapping instability when subject to a stress voltage. The bulk oxide trap density, N_{ot}, and D_{it} are seen to increase during a voltage stress. The conduction mechanism in thermal oxide layers on SiC is limited by Fowler-Nordheim emission with a barrier height of 1.8 ± 0.1 eV.
[Contact: Joseph J. Kopanski, (301) 975-2089]

IC Test Structures

Cresswell, M.W., Khera, D., Linholm, L.W., and Schuster, C.E., **A Directed-Graph Classifier of Semiconductor Wafer-Test Patterns**, IEEE Transactions on Semiconductor Manufacturing, Vol. 5, No. 3, pp. 255-263 (August 1992).

This paper describes a technique for training an expert system for semiconductor wafer fabrication process diagnosis. The technique partitions an existing set of electrically tested semiconductor wafers into groups so that all wafers within each group have similar spatial distributions of the electrical test data across the selected die sites. The spatial distribution of test data from the selected die sites on each wafer is referred to as the test pattern of that wafer. The supposition is that test patterns reflect the processing histories of the respective wafers. Furthermore, it is presumed that the processing history of each of the existing partitioned set of wafers is at least partially known. A directed graph that is developed by the partitioning algorithm is then able to efficiently classify a new incoming wafer to one of the groups established during partitioning. The directed graph identifies the incoming wafer's processing history on the basis of its test pattern. The processing history thus determined is a first indication of the wafer's process diagnosis. In addition, the way in which similar processing histories agglomerate within particular groups provides a facility for formulating rules for a knowledge-based diagnostic expert system. Intra-level isolation test structure data are used to illustrate the principles of the construction of the directed graph. The technique is appropriate for any available test pattern, whether it is extracted from a test structure or from a functional integrated circuit device or from both.
[Contact: Michael W. Cresswell, (301) 975-2072]

Microfabrication Technology

Dagata, J.A., Tseng, W., Bennett, J., Dobisz, E.A., Schneir, J., and Harary, H.H., **Integration of Scanning Tunneling Microscope Nanolithography and Electronics Device Processing**, Journal of Vacuum Science Technology A, Vol. 10, No. 4, pp. 2105-2113 (Jul/Aug 1992).

The merging field of nanoelectronics demands innovative methods to fabricate nanometer-scale structures. Such structures will play a critical role in the quantum-effect device physics of future highly integrated circuit architectures. An integrated approach to compound semiconductor nanostructure fabrication based on scanning tunneling microscope (STM) nanolithography, molecular-beam epitaxy, and reactive ion etching technique is described. The critical elements of this approach, which have been demonstrated recently, are reviewed. Prospects for the coevolutionary development of nanoelectronics and STM-based fabrication and characterization are considered.
[Contact: Wen Tseng, (301) 975-5291]

Plasma Processing

Olthoff, J.K., Van Brunt, R.J., and Sobolewski, M.A., **Ion Kinetic-Energy Distributions and Electrical Measurements in Ar/O_2 rf Glow Discharges**, Proceedings of the Tenth International Conference on Gas Discharges and Their Applications, Swansea, Wales, U.K., September 13-18, 1992, pp. 440-443.

Ion kinetic-energy distributions and electrical characteristics were measured for a range of argon/oxygen rf plasmas. Correlations between the measurements are investigated. Dramatic changes in all of the measurements are observed when small amounts of oxygen are added to argon discharges, indicating the possible importance of impurities in rf plasma processing.
[Contact: James K. Olthoff, (301) 975-2431]

Roberts, J.R., Olthoff, J.K., Sobolewski, M.A., Van Brunt, R.J., Whetstone, J.R., and Djurovic, S., **Diagnostic Measurements in rf Plasmas for Materials Processing**, AIP Conference Proceedings 257, Atomic Processes in Plasmas, Portland, Maine, August 25-29, 1991, pp. 157-168.

Radio frequency (rf) plasmas are utilized in many applications in materials processing, such as semiconductor fabrication, surface modification, and coating. Plasma processing has replaced older techniques, such as wet chemistry, because the latter could not provide the necessary characteristics as process demands increased. A good example of this is the reduction of the feature size in semiconductors. The present critical dimension for semiconductor processing is 0.8 μm and is anticipated to be ≤0.25 μm by the year 2000. At present, only plasma processing exhibits the potential of producing these linewidths.

An important factor, as the demands on the processing of materials become more critical, is exactly how to determine that the plasma is actually performing the process as designed. One way that is being investigated is to design control diagnosis that necessarily operates in real-time, in situ, without significantly perturbing the process. Many such diagnostic methods have been proposed and are vigorously being investigated. They include probing the plasma with lasers, electric and mass selecting probes, and by observing the emission of radiation coming from the plasma. All of these and others must be investigated if the demands of material processing are to be met. Some of the methods being investigated for process control diagnostics are presented.
[Contact: James K. Olthoff, (301) 975-2431]

Vrhovac, S.B., Jelenkovic, B.M., Olthoff, J.K., and Van Brunt, R.J., **Energy Distribution Functions of Argon Ions in Low Current, Diffuse Discharges at High E/N**, Proceedings of the Tenth International Conference on Gas Discharges and Their Applications, Swansea, Wales, U.K., September 13-18, 1992, pp. 510-512.

Kinetic-energy distributions are measured for ions sampled from diffuse, low-current, dc argon discharges at high E/N. Ion temperatures are calculated from the distributions, and variations from a Maxwellian energy dependence are discussed.
[Contact: James K. Olthoff, (301) 975-2431]

SIGNAL ACQUISITION, PROCESSING, AND TRANSMISSION

DC and Low-Frequency Metrology

Boynton, P.A., **An Automated System for the Measurement of High-Valued Resistors,** Proceedings of the National Conference of Standards Laboratories, Washington, D.C., August 2-6, 1992, pp. 617-621. [Also published in the Conference Record, Conference on Precision Electromagnetic Measurements (CPEM '92), Paris, France, June 9-12, 1992, pp. 278-279.]

An automated method for measuring high-valued resistors is described. It is based on a loss-of-charge method, involving the discharge of a standard capacitor through an unknown resistor. This system is intended to calibrate standards ranging from 10^{10} Ω to 10^{14} Ω.
[Contact: Paul A. Boynton, (301) 975-4241]

Jarrett, D.G., **Automated ac Bridge for Resistance Measurements,** Proceedings of the National Conference of Standards Laboratories, Washington, D.C., August 2-6, 1992, pp. 563-567.

An automated guarded ac Kelvin bridge has been

developed for measuring the frequency dependence of precision resistors from the 1-Ω to the 1-MΩ level over the frequency range 10 Hz to 10 kHz. The main ratio arms consist of two-stage 30-bit binary inductive voltage dividers. A guard inductive voltage divider drives a RC network to provide a known phase compensation to balance the quadrature component of the bridge. A bridge substitution technique is used in which the unknown is compared to a standard of known impedance. The bridge resolution is better than 0.1 parts per million for the in-phase and quadrature components.
[Contact: Dean G. Jarrett, (301) 975-4240]

Kinard, J.R., Knight, R.B.D., Martin, P., Klonz, M., de Vreede, J.P.M., and Dessens, J., **Intercomparison of NIST, NPL, PTB, and VSL Thermal Voltage Converters from 100 kHz to 1 MHz**, Proceedings of the National Conference of Standards Laboratories, Washington, D.C., August 2-6, 1992, pp. 557-561.

Coaxial, thermal voltage converters (TVCs) were hand-carried between NIST, NPL, PTB, and VSL for intercomparison of ac-dc difference from 100 kHz to 1 MHz. This paper briefly describes the methods and underlying principles on which ac-dc difference determinations are based in each laboratory and gives the results of the intercomparisons.
[Contact: Joseph R. Kinard, (301) 975-4250]

Lipe, T.E., **Low-Frequency Errors of Thermal Voltage Converters: A Progress Report,** Proceedings of the National Conference of Standards Laboratories, Washington, D.C., August 2-6, 1992, pp. 543-546.

Characteristics of thermal voltage converters (TVCs) and thermal current converters at low frequencies (below 100 Hz) are discussed. The region of this frequency range where the TVCs begin to cease the thermal averaging of the ac input signal is examined using various devices having different thermal time constants. The data gathered experimentally using these devices are compared to theoretical models of the TVCs at low frequencies and these results are discussed. It is expected that this research will lead to improved accuracies for the NIST ac voltage and current calibration service at low frequencies.
[Contact: Thomas E. Lipe, (301) 975-4251]

Waveform Metrology

Waltrip, B.C., Parker, M.E., Oldham, N.M., and Bell, B.A., **The NIST Sampling System for the Calibration of Phase Angle Generators From 1 Hz to 100 kHz,** Proceedings of the National Conference of Standards Laboratories, Washington, D.C., August 2-6, 1992, pp. 613-616.

A system for calibrating phase angle standard and phase meters from 1 Hz to 100 kHz is described. A commercial dual-channel waveform sampler is used to digitize both waveforms of the generator. The phase relationship between the two signals is resolved to less than 0.001 degrees (17 μrad) using a four-parameter sine fit. The uncertainty in phase linearity is 0.001 to 0.010 degrees over the frequency range.
[Contact: Bryan C. Waltrip, (303) 497-2438]

Antenna Metrology

Francis, M.H., Repjar, A.G., and Kremer, D.P., **A Certification Plan for a Planar Near-Field Range Used for High-Performance Phased-Array Testing**, NISTIR 3991 (July 1992). [A condensed version will be published in the Proceedings of the Antenna Measurement Techniques Association Symposium, Columbus, Ohio, October 19-12, 1992.]

The National Institute of Standards and Technology has written a certification plan to ensure that a proposed planar near-field range is capable of measuring high-performance phased arrays. Generally for a complete plan, one must evaluate many aspects including scanner alignment, near-field probe alignment, alignment of the antenna under test, rf crosstalk, probe position errors, rf path variations, the receiver's dynamic range and linearity, leakage, probe-antenna multiple reflections, truncation effects, aliasing, system drift, room multipath, insertion loss measurements, noise, and software verification. In this paper, we discuss the important aspects of a certification plan specifically written for the measurement of high-performance phased array antennas. Further, we show how the requirements of each aspect depend on the measurement accuracies needed to verify the performance of the array under test.
[Contact: Michael H. Francis, (303) 497-5873]

Optical Fiber Metrology

Drapela, T.J., Franzen, D.L., and Young, M., **Single-Mode Fiber Geometry and Chromatic Dispersion: Results of Interlaboratory Comparisons**, NIST Special Publication 839 (September 1992). [Technical Digest, Symposium on Optical Fiber Measurements 1992, Boulder, Colorado, September 15-17, 1992, pp. 187-190.]

The National Institute of Standards and Technology recently completed two interlaboratory comparisons with members of the Telecommunications Industry Association. Participants included most major fiber and cable manufacturers in North America. We evaluated test procedures for geometry and chromatic dispersion. In both cases, the measurement spread in the industry was due mostly to systematic differences among laboratories. Measurement agreement would be significantly improved through the use of reference fibers.
[Contact: Timothy J. Drapela, (303) 497-5858]

Hale, P.D., and Franzen, D.L., **Fiber Cladding Diameter Measurement by White Light Interference Microscopy**, NIST Special Publication 839 (September 1992). [Technical Digest, Symposium on Optical Fiber Measurements 1992, Boulder, Colorado, September 15-17, 1992, pp. 51-54.]

A white light interference microscope for measuring fiber cladding diameter is described. The microscope uses a Mirau objective and a single surface contact technique. Overall uncertainty is 30 nm. Measurements of eight fiber diameters are compared with measurements made by a scanning confocal microscope and a contact micrometer. The rms difference between the interference microscope and confocal microscope was 26 nm. The rms difference between the interference microscope and the contact micrometer was 16 nm.

[Contact: Paul D. Hale, (303) 497-5367]

Mamileti, L., Wang, C.M., Young, M., and Vecchia, D.F., **Optical Fiber Geometry by Gray Scale Analysis with Robust Regression**, Applied Optics, Vol. 31, No. 21, pp. 4182-4185 (20 July 1992).

We have used least-median-of-squares (LMS) regression to analyze gray-scale images of optical fiber ends. LMS regression is a form of robust regression and ignores outlying data points. We fitted the images of each of two fiber ends to an ellipse by LMS and least-sum-of-squares regression. The two methods yielded nearly identical results on a pristine fiber end, but the LMS method was far superior on a damaged fiber end, even though we made no effort to filter the outlying data points.
[Contact: Matt Young, (303) 497-3223]

Mechels, S., and Young, M., **Scanning Confocal Microscope for Accurate Dimensional Measurement**, Proceedings of SPIE (The International Society for Optical Engineering, P.O. Box 10, Bellingham, Washington 98227-0010), Biomedical Image Processing and Three-Dimensional Microscopy, Vol. 1660, pp. 542-550 (1992).

We have improved and evaluated a scanning confocal microscope for the precise measurement of optical fiber cladding diameter. In particular, we have studied the systematic error that results from a finite detector aperture and concluded that the diameter of that aperture must be less than one-half the radius of the Airy disk in the detector plane. We compared our measurements with a chrome-on-glass Standard Reference Material provided by NIST-Gaithersburg and with optical fibers that were measured with a contact micrometer. We estimate the overall uncertainty of our measurements to be around ±50 nm.
[Contact: Steven Mechels, (303) 497-5409]

Young, M., Mechels, S.E., and Hale, P.D., **Accurate Measurements of Fiber Cladding Diameter,** NIST Special Publication 839 (September 1992). [Technical Digest, Symposium on Optical Fiber Measurements 1992, Boulder, Colorado, September 15-17, 1992, pp. 55-58.]

We have developed three instruments for accurate measurement of optical fiber cladding diameter: a contact micrometer, a scanning confocal microscope, and a white-light interference microscope. Each instrument has an estimated uncertainty (three standard deviations) of about 50 nm, but the confocal microscope may display a 30-nm systematic error as well. The micrometer will be used to generate Standard Reference Materials that will be made commercially available.

[Contact: Matt Young, (303) 497-3223]

Electro-Optic Metrology

Gilbert, S.L., Drapela, T.J., and Franzen, D.L., **Moderate-Accuracy Wavelength Standards for Optical Communications**, NIST Special Publication 839 (September 1992). [Technical Digest, Symposium on Optical Fiber Measurements 1992, Boulder, Colorado, September 15-17, 1992, pp. 191-194.]

We have constructed a simple apparatus for producing a series of reference lines in the 1.5-µm region. We are investigating a similar approach for the 1.3-µm region. These LED/molecular absorber systems provide wavelength references with accuracies of 0.01 nm, which is sufficient for wavelength division multiplexed optical communication systems with channel spacings of about 1 nm.
[Contact: Sarah L. Gilbert, (303) 497-3120]

Hickernell, R.K., Takada, K., Yamada, M., Shimizu, M., and Horiguchi, M., **Chromatic Dispersion of Erbium-Doped Fiber Amplifier Measured by Fourier Transform Spectroscopy** [original title: Chromatic Dispersion Measurement of Erbium-Doped Fiber Amplifier Using Fourier Transform Spectroscopy], NIST Special Publication 839 (September 1992). [Technical Digest, Symposium on Optical Fiber Measurements 1992, Boulder, Colorado, September 15-17, 1992, pp. 201-204.]

We report the measurement of group index and chromatic dispersion in erbium-doped fiber amplifiers by Fourier transformation of low-coherence interferograms. Resonant absorption- and gain-induced changes in dispersion due to erbium ions in a germania co-doped fiber are as large as 25 and -12 ps/km/nm, respectively. The measurements confirm theoretical calculations based on a Kramers-Kronig transformation of measured absorption and emission spectra.
[Contact: Robert K. Hickernell, (303) 497-5342]

Other Signal Topics

Ma, M.T., and Adams, J.W., **System Response to Pulsed Excitations Estimated from Measurement of CW Amplitudes**, Proceedings of the International Symposium on Electromagnetic Compatibility, Beijing, China, May 25-27, 1992, pp. 29-32. [A full paper also published under the title, **Phase Characteristics and Time Responses of Unknown Linear Systems Determined from Measured CW Amplitude Data**, as NIST Technical Note 1349 (November 1991).]

A simple technique for determining the transfer function and the complete time characteristics of an unknown linear system from the measured amplitude response to cw excitations is described. The work is based on modern network theory. The system transfer function so determined may or may not be at minimum phase. The associated time responses can be calculated for all possible cases, thus revealing the worst case.
[Contact: Mark T. Ma, (303) 497-3800]

ELECTRICAL SYSTEMS

Power Systems Metrology

Anderson, W.E., (Editor), **Research for Electric Energy Systems — An Annual Report**, NISTIR 4931 (June 1992).

This report documents the technical progress in the four investigations which make up the project "Support of Research Projects for Electrical Energy Systems," funded by the U.S. Department of Energy and performed by the Electricity Division of the National Institute of Standards and Technology (NIST). The first investigation is concerned with the measurement of magnetic fields in support of epidemiological and in-vitro studies of biological field effects. The second investigation is concerned with two different activities: the production of S_2F_{10} in negative corona in SF_6 and the measurement of electron scattering and dissociative electron attachment cross sections for SF_6 and its electrical-discharge by-products. The third investigation is also concerned with two different activities: several liquids that are currently used or have potential for use as high-voltage dielectrics are studied using conventional impulse breakdown measurement techniques and high-speed photography, and advances in partial discharge measurement techniques are presented. The last investigation is concerned with the evaluation and improvement of methods for measuring fast transients in electrical power systems such as might be associated with an

electromagnetic impulse.
[Contact: William E. Anderson, (301) 975-2432]

Hill, R.C., Key, T.S., and Martzloff, F.D., **Characterization of Transient Voltage Surge Suppressors From a System Compatibility Perspective**, Proceedings of PQA'92 - Second International Conference on Power Quality: End-Use Applications and Perspecitves, Atlanta, Georgia, September 28-30, 1992, pp. C-12:1 to C-12:10.

Transient voltage surge suppressors are characterized from the point of view of electric utilities wishing to offer to their customers a comprehensive surge protection plan. This plan involves a surge arrester installed at the service entrance and one or more plug-in suppressors installed within the premises, at the point of connection of a surge-sensitive appliance. Complementary tests were conducted at two laboratories to assess the compatibility of candidate devices with the needs of the utilities and the end-users. Basic, fundamental tests of protection performance and failure mode were performed for both suppressors and arresters. Mechanical and environmental tests were performed on meter-base arresters. In addition to obtaining data on test specimens, another outcome is the development of test protocols that can be used for systematic and consistent testing of other candidate devices.
[Contact: François D. Martzloff, (301) 975-2409]

Lagergren, E.S., Martzloff, F.D., Parker, M.E., and Schiller, S.B., **The Effect of Repetitive Swells on Metal-Oxide Varistors**, Proceedings of PQA '92 - Second International Conference on Power Quality: End-Use Applications and Perspectives, Atlanta, Georgia, September 28-30, 1992, pp. C-13:1 to C-13:10.

Neither the effects of repetitive swells on metal-oxide varistors nor the natural occurrence of swells have been documented in the literature. The paper briefly describes a laboratory system capable of generating arbitrary swells and applying them to test varistors. A statistical experiment on five lots of varistors has been performed, and preliminary results are reported. Effects of amplitude, duration, and number of swell occurrences are addressed, using as a criterion the change in varistor nominal voltage from before to after the swell sequence.
[Contact: François D. Martzloff, (301) 975-2409]

Martzloff, F.D., and Lai, J.S., **Cascading Surge-Protective Devices: Options for Effective Implementations**, Proceedings of PQA '92 - Second International Conference on Power Quality: End-Use Applications and Perspectives, Atlanta, Georgia, September 28-30, 1992, pp. C-11:1 to C-11:08.

The basic and critical parameters for a successful coordination of cascaded surge-protective devices include the relative voltage clamping of the two devices, their electrical separation through wiring inductance, and the postulated waveform of the impinging surge. The authors examine in detail the implications of the situation resulting from the present uncoordinated application of devices with low clamping voltage at the end of branch circuits and devices with higher clamping voltage at the service entrance. As an alternative, several options are offered for discussion that might result in effective, reliable implementation of the cascaded protection concept.
[Contact: François D. Martzloff, (301) 975-2409]

Martzloff, F.D., Simmon, E., Steiner, J.P., and Van Brunt, R.J., **Detection of Incipient Defects in Cables by Partial Discharge Signal Analysis**, NISTIR 4487 (July 1992).

As one of the objectives of a program aimed at assessing test methods for in-situ detection of incipient defects in cables due to aging, a laboratory test system was implemented to demonstrate that the partial discharge analysis method can be successfully applied to low-voltage cables. Previous investigations generally involved cables rated 5 kV or higher, while the objective of this program focused on the lower voltages associated with the safety systems of nuclear power plants.

The defect detection system implemented for this project was based on commercially available signal analysis hardware and software packages, customized for the specific purposes of the project. The test specimens included several cables of the type found in nuclear power plants, including artificial defects at various points of the cable.

The results indicate that, indeed, partial discharge analysis is capable of detecting incipient defects in

low-voltage cables. There are, however, some limitations of technical and nontechnical nature that need further exploration before this method can be accepted in the industry.
[Contact: François D. Martzloff, (301) 975-2409]

Van Brunt, R.J., Olthoff, J.K., Sauers, I., Morrison, H.D., Robins, J.R., and Chu, F.Y., **Detection of S_2F_{10} Produced by Electrical Discharge in SF_6**, Proceedings of the Tenth International Conference on Gas Discharges and Their Applications, Swansea, Wales, U.K., September 13-18, 1992, pp. 418-421.

Three methods for measuring the concentration of S_2F_{10} in SF_6 are briefly described. These are: 1) a gas chromatograph-mass spectrometer equipped with a thermal conversion tube, 2) a gas chromatograph coupled with an electron-capture detector and a gas enrichment process, and 3) an infrared absorption technique. The above techniques were used to investigate the production of S_2F_{10} from dc-corona discharges and power arcs. The measured yields of S_2F_{10} from corona were found to be quite reproducible, thus suggesting the possibility of using this type of discharge to generate "reference" gas samples that contain known quantities of S_2F_{10} in SF_6. The relative yield of S_2F_{10} from power arcs is found to be very low compared with the yields of other stable by-products such as SOF_2 which was expected from the low thermal stability of S_2F_{10}.
[Contact: Richard J. Van Brunt, (301) 975-2425]

Magnetic Materials & Measurements

Cross, R.W., Kos, A.B., Thompson, C.A., Petersen, T.W., and Brug, J.A., **Local Magnetoresistive Response in Thin-Film Ni-Fe Read Elements: A Sub-Micrometer-Resolution Measurement System**, IEEE Transactions on Magnetics, Vol. 28, No. 5, pp. 3060-3065 (September 1992).

A sub-micrometer-resolution voltage measurement system was developed to measure the bulk and local magneto-resistive responses in Ni-Fe thin-films. Local voltage variations as a function of field magnitude and angle can be measured for responses less than 1 μm in size. The system is used to determine domain formation and motion in magneto-resistive read heads. Longitudinal fields, produced by demagnetizing or external field components, may cause domain formation and subsequent domain-wall motion (and annihilation). This leads to Barkhausen noise, which is detrimental to the performance of the device as a magnetic read head. Experimental results for both the bulk and local responses are found to be in agreement with micromagnetic theory.
[Contact: R. William Cross, (303) 497-5300]

Fickett, F.R., **Low Temperature Magnetic Behavior of "Nonmagnetic" Materials**, Advances in Cryogenic Engineering (Materials), Vol. 38, Part B, F. R. Fickett and R. P. Reed, Eds. (Plenum Press, New York, 1992), pp. 1191-1197. [Proceedings of the Ninth International Cryogenic Materials Conference, Huntsville, Alabama, June 11-14, 1991.]

The magnetically sensitive designs for many superconductor systems, ranging from large magnets to thin film devices, require a knowledge of the magnetic properties of a wide range of materials. Commercial "nonmagnetic" materials may show bizarre magnetic behavior as a function of temperature, changing from paramagnetic to diamagnetic, or vice versa, as the temperature is lowered and sometimes even becoming ferromagnetic. In metallic alloys, whether and when these effects occur is often determined by the exact composition of the alloy, which is frequently correlated with its age. Furthermore, nonmetallic materials may have strong magnetic signatures which arise from magnetic impurities, such as inclusions of magnetite in the glass fibers of fiberglass epoxies. Here we summarize results of magnetic susceptibility measurements on a number of metallic alloys and some nonmetallic materials used in cryogenic applications. The data suggest that care should be taken in the use of many of these common materials, especially in the construction of sensitive magnetometer systems.
[Contact: Fred R. Fickett, (303) 497-3785]

Goldfarb, R.B., **Magnetic Units and Material Specification**, Concise Encyclopedia of Magnets & Superconducting Materials, pp. 253-258 (1992).

A review of magnetic quantities, symbols, and units is presented.
[Contact: Ronald B. Goldfarb, (303) 497-3650]

Katti, R.R., Rice, P., Wu, J.C., and Stadler, H.L.,

Domain Imaging in Magnetic Garnets Using Tunneling-Stabilized Magnetic Force Microscopy, IEEE Transactions on Magnetics, Vol. 28, No. 5, pp. 2913-2915 (September 1992).

Magnetic domains in low-coercivity magnetic garnets have been imaged using tunneling-stabilized magnetic force microscopy (TSMFM). In TSMFM, a triangular, Au-coated, thin-film, Ni-spring tunneling tip flexes in response to the sample's fringing magnetic field as the tip is scanned across the garnet sample. The magnetic garnet is a YGdTmGa/-YSmTmGa garnet, grown epitaxially on a nonmagnetic GdGa-garnet substrate, with a zero-field stripe width of 2.2 μm. The sample garnet is coated with a 150-nm-thick Au conductor to allow a tunneling current from the tunneling tip to flow and be used to maintain constant separation between the tip and sample. The spring constant of the Ni tip is calculated to be 0.1 N/m, so that the Ni tip experiences a relative force of approximately 8.8 nN for peak deflections around 88 nm. The Ni tip does not appear to disturb the garnet's domain structure despite the garnet's low coercivity, nor does the magnetization from the garnet appear to disturb the Ni tip. The shape and period of the contrast observed with TSMFM is consistent with the magnetic domain patterns measured using two types of ferrofluid decoration and the magneto-optic Faraday effect.
[Contact: Paul Rice, (303) 497-3841]

Superconductors

Cross, R.W., **Transport Current Effects on Flux Creep and Magnetization in Nb-Ti Multifilamentary Cable Strands**, Advances in Cryogenic Engineering (Materials), Vol. 38, Part B, F. R. Fickett and R. P. Reed, Eds. (Plenum Press, New York, 1992), pp. 731-736. [Proceedings of the Ninth International Cryogenic Materials Conference, Huntsville, Alabama, June 11-14, 1991.]

We used a Hall-probe magnetometer to measure the effect of transport current on magnetization and flux creep in Nb-Ti multifilamentary cable strands. Large transport currents, up to 70% of the critical current I_c, were applied to the sample. The external field was applied transverse to the current and sample length. When the applied current approached the critical current of the strand, the magnetization decreased and the Lorentz-force interaction between the field and the transport current dominated the creep. Both the short-time and long-time decay of magnetization increased. The increase in the short-time decay was too large to be explained by eddy current decay. The long-time decay was enhanced by a factor of 4 with a transport current of approximately 0.7 I_c.
[Contact: R. William Cross, (303) 497-5300]

Ekin, J.W., Bray, S.L., Miller, T.A., Finnemore, D.K., and Tenbrink, J., **Improved Uniaxial Strain Tolerance of the Critical Current Measured in Ag-Sheathed $Bi_2Sr_2Ca_1O_{8+x}$ Superconductors** [original title: Uniaxial Strain Effect on the Transport Critical Current of Ag-Sheathed $Bi_2Sr_2Ca_1Cu_2O_{8+x}$ Superconductors], Advances in Cryogenic Engineering (Materials), Vol. 38, Part B, F. R. Fickett and R. P. Reed, Eds. (Plenum Press, New York, 1992), pp. 1041-1043. [Proceedings of the Ninth International Cryogenic Materials Conference, Huntsville, Alabama, June 11-14, 1991.]

The first practical electromechanical properties of a high-T_c superconductor have been measured for Ag-sheathed $Bi_2Sr_2Ca_1Cu_2O_{8+x}$ superconductors at high magnetic fields up to 25 T. A melt-processed "powder in tube" $Bi_2Sr_2Ca_1Cu_2O_{8+x}$ conductor had an irreversible strain of 0.2% for the onset of permanent damage and a 50% critical-current-degradation strain of 0.36%. A discontinuous filament melt-processed Ag-sheathed $Bi_2Sr_2Ca_1Cu_2O_{8+x}$ superconductor was measured to have an irreversible strain of 0.6% and a 50% degradation strain of about 1%. These strain damage thresholds are about an order of magnitude higher than for high-T_c superconductors made by the bulk-sinter process and, for the first time, have reached the practical strain range for magnet design.
[Contact: John W. Ekin, (303) 497-5448]

Ekin, J.W., Finnemore, D.K., Li, Q., Tenbrink, J., and Carter, W., **Effect of Axial Strain on The Critical Current of Ag-Sheathed Bi-Based Superconductors in Magnetic Fields Up to 25 T**, Applied Physics Letters, Vol. 61, No. 7, pp. 858-860 (17 August 1992).

The irreversible strain limit ϵ_{irrev} for the onset of permanent damage in Ag-sheathed $Bi_2Sr_2Ca_1Cu_2$-

O_{8+x} and $Bi_2Sr_2Ca_2Cu_3O_{10+x}$ superconductors has been measured to be in the range of 0.2% to 0.35%. This strain damage onset is about an order of magnitude higher than for bulk sintered Y-, Bi-, or Tl-based superconductors and is approaching the range of practical values for magnet design. The value of the damage threshold, ϵ_{irrev}, is independent of the magnetic field, and the critical current does not depend on strain below ϵ_{irrev}, at least up to 25 T at 4.2 K. Both of these factors indicate that the observed strain effect in Ag-sheathed Bi-based superconductors is not intrinsic to the superconductor material. Rather, the effect is an extrinsic one arising from superconductor fracture. Thus, the damage onset is amenable to further enhancement. Indeed, data are presented which suggest that subdividing the superconductor into fine filaments or adding Ag to the superconductor material powder prior to processing significantly enhances the damage threshold to about 0.6%.
[Contact: John W. Ekin, (303) 497-5448]

Moreland, J., Dube, W. P., and Goodrich, L.F., **Dynamic Resistance of Superconducting $YBa_2Cu_3O_x$ Sintered Powder at 81 K: Liquid Versus Vapor Nitrogen Environment**, Advances in Cryogenic Engineering (Materials), Vol. 38, Part B, F. R. Fickett and R. P. Reed, Eds. (Plenum Press, New York, 1992), pp. 965-972. [Proceedings of the Ninth International Cryogenic Materials Conference, Huntsville, Alabama, June 11-14, 1991.]

The dynamic resistance as a function of transport current in a superconducting $YBa_2Cu_3O_x$ sintered powder sample depends on its thermal surroundings. Plots of V versus i, measured with a nanovoltmeter, and dV/dI and d^2V/dI^2 versus I measured with a lock-in amplifier, are markedly different for the sample in nitrogen vapor compared to those measured in liquid nitrogen at 81 K. Assuming the usual power law dependence of $V = V_0 (I/I_0)^n$, then $n = (I \times d^2V/dI^2)/dV/dI + 1$. Therefore, by measuring dV/dI and d^2V/dI^2 at a given current, the n factor can be determined for the V-I curve at that current. Plots of $(I \times d^2V/dI^2)/dV/dI$ as a function of I and dV/dI quantify the curvature of the V-I characteristics of the sample. At 81 K, we find that at the onset of detectable flux flow in the sample, the n factor determined from the dynamic derivatives of the V-I curve is 15 in the vapor versus 5 in the liquid. This phenomenon could be the basis for cryogenic flow meters, bolometers, level detectors, or other types of noninvasive, low-dissipation, thermal sensors.
[Contact: John Moreland, (303) 497-3641]

Other Electrical Systems Topics

Thompson, C.A., and Fickett, F.R., **Electrical Resistivity of Copper Alloys Between 76 K and 300 K**, Advances in Cryogenic Engineering (Materials), Vol. 38, Part B, F. R. Fickett and R. P. Reed, Eds. (Plenum Press, New York, 1992), pp. 1177-1182. [Proceedings of the Ninth International Cryogenic Materials Conference, Huntsville, Alabama, June 11-14, 1991.]

The advent of high-temperature superconductivity and the recent interest in liquid-nitrogen-cooled magnets have increased interest in high-strength, high-conductivity materials in the temperature range 76 K to 300 K. We have measured the electrical resistivity of UNS C10100, C10200, C10700, C11000, C15715, and C17510 alloys at ten equally spaced temperatures over this range. Comparisons between alloys are made using measured resistivity and reported yield strengths. An apparatus which allows for accurate temperature control and simultaneous resistance measurement of eight samples is described.
[Contact: Curtis A. Thompson, (303) 497-5206]

ADDITIONAL INFORMATION

Lists of Publications

DeWeese, M.E., and Moynihan, S., **Metrology for Electromagnetic Technology: A Bibliography of NIST Publications**, NISTIR 3994 (September 1992).

This bibliography lists the publications of the personnel of the Electromagnetic Technology Division of NIST in the period from January 1970 through publication of this report. A few earlier references that are directly related to the present work of the Division are included.
[Contact: Annie Smith, (303) 497-3678]

Lyons, R.M., and Gibson, K.A., **A Bibliography of the NIST Electromagnetic Fields Division Publications**, NISTIR 3973 (August 1991).

This bibliography lists publications by the staff of the National Institute of Standards and Technology's Electromagnetic Fields Division for the period from January 1970 through August 1991. Selected earlier publications from the Division's predecessor organizations are included.
[Contact: Kathryn A. Gibson, (303) 497-3132]

Palla, J.C., and Meiselman, B., **Electrical and Electronic Metrology: A Bibliography of NIST Electricity Division's Publications, NIST List of Publications 94** (January 1992).

This bibliography covers publications of the Electricity Division, Center for Electronics and Electrical Engineering, NIST, and of its predecessor sections for the period January 1968 to December 1991. 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, 1990-1991, NIST List of Publications 103** (April 1992).

The bibliography provides information on technology transfer in the field of microelectronics at NIST for the calendar years 1990 and 1991. Publications from groups specializing in semiconductor electronics are included, along with NIST-wide research now coordinated by the NIST Office of Microelectronics Programs which was established in 1991. Indices by topic area and by author are provided. Earlier reports of work performed during the period from 1962 through December 1989 are provided in NIST List of Publications 72.
[Contact: E. Jane Walters, (301) 975-2050]

Continuing Production-Expanded Capability Standard Reference Materials

The Semiconductor Electronics Division announces the continuing production of three thicknesses and the addition of two new thicknesses for the Standard Reference Material (SRM) for **ellipsometrically derived thickness and refractive index of a silicon dioxide film on silicon.** For sale to the public through the NIST Standard Reference Material Program [(301) 975-6776], the following three individual oxide thicknesses continue to be available: 50 nm (SRM 2531), 100 nm (SRM 2532), and 200 nm (SRM 2533). Recently, two new thicknesses, 25 nm (SRM 2534) and a limited number of 14-nm prototypes (SRM 2535), were added to the availability list.

SRMs 2531, 2532, and 2533, originally released as SRM 2530-1, 2530-2, and 2530-3, were developed in response to the industry's need to evaluate the accuracy of ellipsometers and other thin-film thickness-monitoring instruments. The scope of these SRMs has now expanded with the recent issuance of the 25-nm and 14-nm oxide thicknesses so they have application as thickness standards for use in research as well as in semiconductor fabrication production lines.

Each SRM unit, consisting of a 76-mm (3-in) diameter silicon wafer on which a uniform silicon dioxide layer has been grown, is individually measured and certified over a 5-mm diameter area in the center of the wafer for the ellipsometric parameters delta, Δ, and psi, ψ, at the vacuum wavelength $\lambda = 633.0$ nm using the High-Accuracy Ellipsometer built at NIST. Each SRM is also certified for the derived values for the thicknesses and indices of refraction of both layers of a two-layer optical model of an oxide film on a single-crystal silicon substrate.
[Contact: Barbara J. Belzer, (301) 975-2248]

Standard Reference Materials Issued Within Past Year

The Microelectronics Dimensional Metrology Group of the Precision Engineering Division announces the release of two Standard Reference Materials (SRMs) for calibrating optical microscopes used to measure linewidths on photomasks. Each SRM consists of a 63.5 × 63.5 × 1.5 mm (2.5 × 2.5 × 0.060 in) photomask patterned with chromium lines of widths in the range of 0.9 to 10.8 µm. SRM 475, patterned with antireflecting chromium on a quartz substrate, is being reissued after being out of production for almost four years. SRM 476, a new SRM, is patterned with bright chromium on a borosilicate substrate.

In addition to isolated opaque lines on a clear background and isolated clear lines on an opaque background, these SRMs contain opaque line pairs for calibrating the length scale of optical microscopes, adjacent clear and opaque lines of approximately equal widths for setting the line-to-space ratio (contrast) on video image-scanning instruments, and features with 10 approximately equally spaced opaque lines for checking the linearity of measurement systems (e.g., the magnification as a function of position over the field of view).

The certified linewidth and spacing values were determined from measurements made with the NIST automated linewidth measurement system. The uncertainty of the linewidth measurements is 0.081 μm or less for SRM 475 and 0.064 μm or less for SRM 476. The dominant contribution to this uncertainty is the nonvertical geometry of the line edges, and finding a source of photomasks with better edge geometry would lead to considerable improvement in the calibration uncertainty.
[Contact: James Potzick, (301) 975-3481, or Robert Larrabee, (301) 975-2298]

Emerging Technologies in Electronics ... and Their Measurement Needs, Second Edition

This report assesses the principal measurement needs that must be met to improve U.S. competitiveness in emerging technologies within several fields of electronics: semiconductors, superconductors, magnetics, optical fiber communications, optical fiber sensors, lasers, microwaves, video, and electromagnetic compatibility. The report seeks feedback from industry and Government agencies on the assessment. The feedback will guide the development of NIST programs that provide U.S. industry with new documented measurement methods, new national reference standards to assure the accuracy of those measurement methods, and new reference data for electronic materials. Copies may be obtained by ordering Report No. PB90-188087/AS ($23.00 hard copy, $11.00 microfiche) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4650.

Services for Pulse Waveform Measurements Reestablished in the Electricity Division

The Special-Test Services for measurements of fast electrical pulse waveforms are now operating in the Electronic Instrumentation and Metrology Group (811.02) of the Electricity Division in Gaithersburg, Md., having been transferred from the Electromagnetic Fields Division, Boulder, Colo. These services include:

Test Number	Description of Services
65100S	Impulse Generator Spectrum Amplitude (50 Ohm)
65200S	Fast Repetitive Broadband Pulse Parameters (50 Ohm)
65300S	Network Impulse Response (S_{21}) of Coaxial Networks
65400S	Pulse Time Delay through Coaxial Transmission Lines

Please direct specific technical questions concerning these services to Mr. William L. Gans, (301) 975-2502.

Information Notice to Purchasers of Specified Sets of NIST SRM 1522, Silicon Power Device Level Resistivity Standard

This notice applies only to the use of 180-Ω·cm slices of certain sets of Standard Reference Material 1522, Silicon Power Device Level Resistivity Standard, identified below by set and slice number. These slices were certified for resistivity determined at the center of each slice as stated in the certificate; the certified values are valid.

The introduction of resistivity measuring equipment that measures over a larger area than the center may lead some users to attempt to calibrate these instruments with SRM 1522 slices. A recent review of data for SRM 1522 suggests that possible resistivity variations for some of the slices provided as part of the SRM 1522 sets may provide misleading results when used as a basis for calibrating areal-responding instruments. As a service to industry, NIST is prepared to provide replacement slices for the slices identified below. With each replacement slice, NIST will provide a new certificate and instructions for incorporating the slice into the SRM 1522 set. The slices will be certified for center values of resistivity as before, but the resistivity variations will be reduced to values typical of the production run of SRM 1522 180-Ω·cm slices.

If you have a set assigned one of the following set numbers or a 180-Ω·cm slice assigned one of the following slice numbers, please contact James R. Ehrstein (telephone: (301) 975-2060; fax: (301) 948-4081; mailing address: National Institute of Standards and Technology, Bldg. 225, Rm. A305, Gaithersburg, MD 20899).

SRM 1522

Set #	Slice #
301	341
302	342
303	343
305	371
307	375
314	384
315	386
316	390
317	377
318	403
319	395
320	393
321	394
322	388
325	401
326	389
327	402
328	398
329	404
330	405
331	355
333	345
335	356
336	351
337	347
338	348
339	346
340	358
342	359
R10	373

1992/1993 EEEL Calendar

1st VLSI Packaging Workshop of Japan

November 30 and December 1-2, 1992 (Kyoto, Japan)

The IEEE CHMT Society, the Japan Chapter thereof, and NIST are jointly sponsoring this workshop, which will extend this successful series of meetings to Japan. Topics to be discussed include: packaging for hand-held applications, packaging production processes, package design for high-speed applications, multichip modules, modeling/CAE, reliability physics and chemistry, materials, and thermal management.
[Contact: George G. Harman, (301) 975-2097]

International Laser Safety Conference 1992

December 1-4, 1992 (Cincinnati, Ohio)

The International Laser Safety Conference 1992 is planned as a comprehensive four-day conference for those with interests and responsibilities for laser safety practices and control. Emphasis in this year's conference is centered on the harmonization of laser safety standards. This will highlight activity of the TC-76 Committee of the International Electrotechnical Commission and the TC-172 Committee of the International Standards Organization. The recent revisions proposed in the ANSI Z-136 standards and soon to be proposed changes in the FDA/CDRH standard are also covered. The conference is designed for those with specific laser safety responsibilities including: laser product engineers, biomedical researchers, physicians, laser safety officers, government personnel, nurses, industrial hygienists, safety product manufacturers, entertainment specialists, safety engineers, biomedical technicians, and risk managers.
[Contact: Thomas R. Scott, (303) 497-3651]
Ion Implant Users Group Meeting.

January 28, 1993 (Gaithersburg, Maryland)

The topic for discussion at this tenth meeting of the Ion Implant Users Group will be High-Energy Implantation. Also to be presented is a Summary of the SEMATECH Workshop on Charging.
[Contact: John Albers, (301) 975-2075]

9th Annual IEEE Semiconductor, Thermal Measurement and Management Symposium (SEMI-THERM).

February 2-4, 1993 (Austin, Texas)

Sponsored by IEEE CHMT and NIST, SEMI-THERM is the premier forum for the exchange of information

on thermal management of electronics systems between the academic and industrial communities. The program will address the following topics: analytical and computational modeling; measurement techniques including temperature, fluid flow, and thermal-mechanical properties; and thermal reliability screening and testing.
[Contact: David Blackburn, (301) 975-2053]

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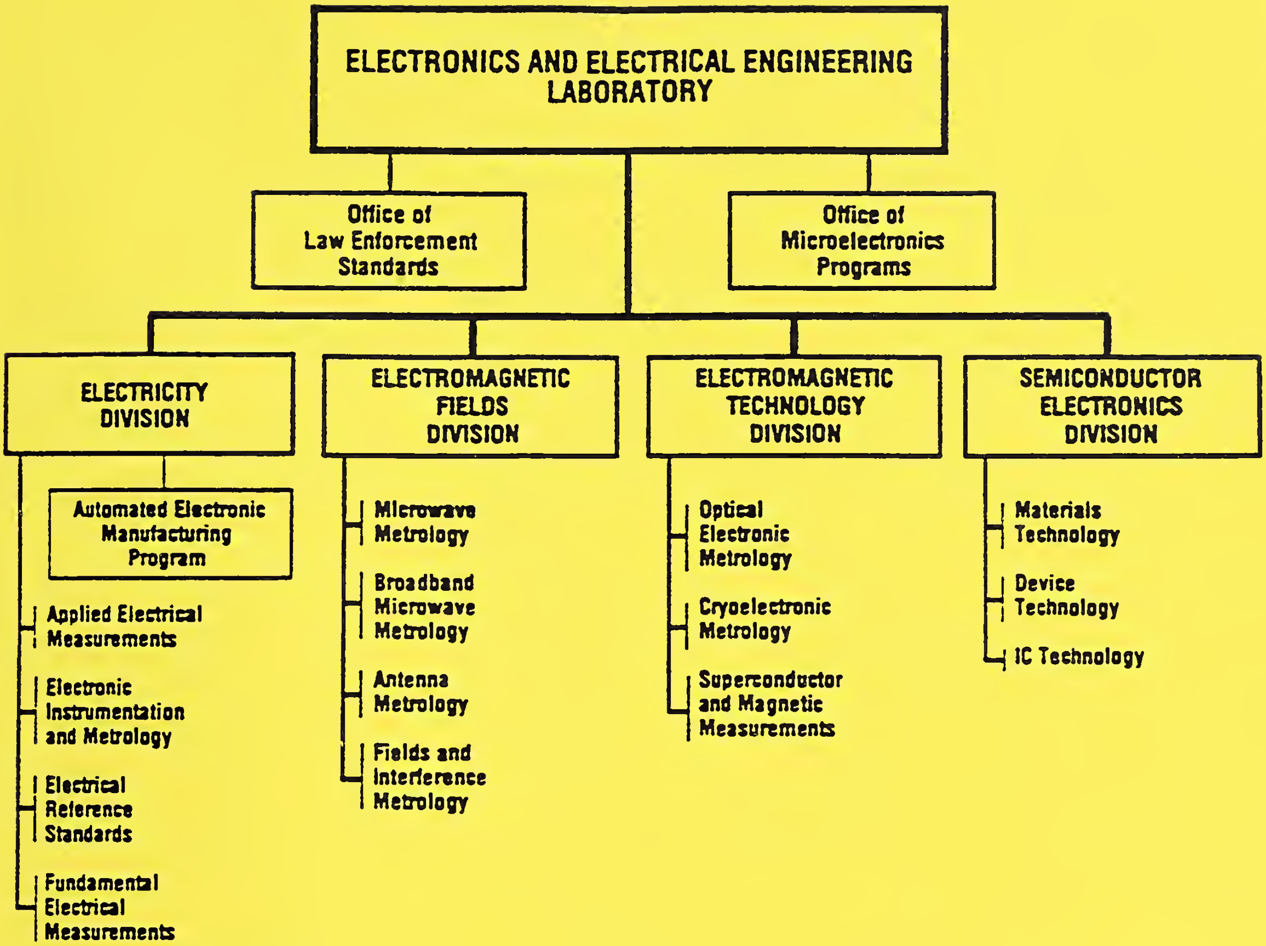

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