NISTIR 5195

Electronics and Electrical Engineering Laboratory

Technical Publication Announcements

Covering Laboratory Programs,
October to December, 1992
with 1992/1993 EEEL Events Calendar

J. M. Rohrbaugh
Compiler

May 1993

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U.S. DEPARTMENT OF COMMERCE
Technology Administration
National Institute of Standards
and Technology
Electronics and Electrical
Engineering Laboratory
Semiconductor Electronics Division
Gaithersburg, MD 20899

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

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
Raymond Kammer, Acting Director

INTRODUCTION TO THE EEEL TECHNICAL PUBLICATION ANNOUNCEMENTS

This is the thirty-fifth 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 Publication Announcements covers the fourth quarter of calendar year 1992.

Organization of Bulletin: This issue contains citations and abstracts for Laboratory publications published in the quarter. Entries are arranged by technical topic as identified in the Table of Contents and alphabetically by first author within each topic. Following each abstract is the name and telephone number of the individual to contact for more information on the topic (usually the first author). This issue also includes a calendar of 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, 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 inside 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 10.

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 6.

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 are necessarily the best available for the purpose.

TABLE OF CONTENTS

SEMICONDUCTOR MICROELECTRONICS

Device Physics and Modeling

Bennett, H.S., and Lowney, J.R., **Majority and Minority Mobilities in Heavily Doped Silicon for Device Simulations**, Proceedings of the Workshop on Numerical Modeling of Processes and Devices for Integrated Circuits, NUPAD IV, Seattle, Washington, May 31-June 1, 1992, pp. 123-128 (1992).

As silicon devices approach 0.2 µm in size, it will be essential to have accurate values for the majority and minority of electrons and holes. These mobilities have been calculated in silicon for donor and acceptor densities between 10^{17} cm^{-3} and 10^{20} cm^{-3}. All the important scattering mechanisms have been included. The ionized impurity scattering has been treated with a quantum-mechanical phase-shift analysis. The results are in good agreement with experiment. In addition, the ionized impurity scattering rates calculated from the quantum-mechanical phase shifts and those rates calculated from the Born approximation are shown to differ by more than factors of three. The commonly used Born approximation is not valid for low energy carriers near band extrema.
[Contact: Jeremiah R. Lowney, (301) 975-2048]

Dimensional Metrology

Vezzetti, C. F., Varner, R. N., and Potzick, J. E., **Standard Reference Materials: Antireflecting-Chromium Linewidth Standard, SRM 473, for Calibration of Optical Microscope Linewidth Measuring Systems**, NIST Special Publication 260-119 (September 1992).

The precise and accurate measurement of feature dimensions on photomasks, such as those used in the production of integrated circuits, becomes increasingly difficult as the dimensions approach the wavelength of the light used to make the measurement. The undesirable effects of optical diffraction obscure the location of the feature edges. Raggedness and nonvertical walls along the edges add to the uncertainty of the measurement.

Standard Reference Material SRM 473 was developed for use in calibrating optical microscopes for measuring linewidths in the range of 0.5 to 30 µm on antireflecting-chromium photomasks. The SRM is described, and instructions on its use and precautions its care and handling are given.

The NIST linewidth measuring system and the procedures used to calibrate the SRM are discussed. The algorithm used for determining the line edge location incorporates a threshold criterion derived from analysis of microscopy image profiles. The profiles are predicted by computer modeling based on the theory of partial coherence. The performance of this system is monitored by measuring line features on a control photomask before and after calibrating each SRM.
[Contact: Carol F. Vezzetti, (301) 975-2098]

Plasma Processing

Olthoff, J.K., Van Brunt, R.J., and Radovanov, S., **Ion Kinetic-Energy Distributions in Argon rf Glow Discharges**, Journal of Applied Physics, Vol. 72, No. 10, pp. 4566-4574 (15 November 1992).

Kinetic-energy distributions have been measured for different mass-selected ions sampled from 13.56-MHz rf glow discharges in argon inside a "GEC reference cell." Kinetic-energy distributions for Ar^+, Ar^+, Ar^{++}, and ArH^+ are present as functions of applied rf voltage, gas pressure, and distance of the mass spectrometer entrance aperture from the edge of the electrodes. The distributions obtained for the sampling orifice placed close to the electrodes exhibit features similar to those expected when sampling ions through the grounded electrode of a parallel plate reactor. This is expected if a "sheath" develops in front of the metal surface in which the aperture is placed. The Ar^+ and Ar^{++} distributions exhibit structure resulting from ion formation in the sheath region by charge-exchange and high-energy electron collisions, respectively. Kinetic-energy distributions for Ar^+ and ArH^+ exhibit no structure and are peaked at high energies that are indicative of the sheath potential, thus, indicating minimal collisions in the sheath.
[Contact: James K. Olthoff, (301) 975-2431]

SIGNAL ACQUISITION, PROCESSING, AND TRANSMISSION

Cryoelectronic Metrology

Harvey, T., Moreland, J., Jeanneret, B., Ono, R.H., and Rudman, D.A., **$YBa_2CU_3O_{7-x}$ to Si Interconnection for Hybrid Superconductor/Semiconductor Integration**, Applied Physics Letters, Vol. 61, No. 18, pp. 2225-2227 (November 2, 1992).

We have successfully made low resistance contacts between high-quality films of $YBa_2Cu_3O_{7-x}$ (YBCO) and single-crystal Si substrates through Ag-Au interconnections. The YBCO films were deposited by laser ablation on an epitaxial yttria-stabilized zirconia buffer layer on Si and had zero-resistance critical temperatures of 83 to 85 K after patterning into lines. Specific contact resistivities (resistance-area products) of the YBCO to Si interconnection, limited by the Au to Si interface, of 10^{-6} Ω cm^2 were achieved on heavily doped Si after deposition and patterning of the YBCO film. This demonstrates the use of high-temperature superconductors as a wiring layer compatible with conventional Si metal-oxide-semiconductor processing.
[Contact: Todd E. Harvey, (303) 497-3340]

Optical Fiber/Waveguide Sensors

Day, G.W., Deeter, M.N., and Rose, A.H., **Faraday Effect Sensors: A Review of Recent Progress**, Proceedings of the International Conference on Optical Fiber Sensors, Wuham, China, October 9-11, 1991, pp. 11-26 (1992).

The last few years have seen dramatic progress in the development of Faraday effect sensors for measuring both magnetic fields and electric current. In the case of magnetic field sensors, the most significant advances have resulted from an investigation of new materials, especially the ferrimagnetic iron garnets. Minimum detectable magnetic fields have been reduced by several orders of magnitude to about 100 $pT/\sqrt{Hz}$ at 500 Hz, and bandwidths of hundreds of megahertz have been obtained. In the case of electric current sensors, new methods of avoiding the effects of linear birefringence in optical fiber have resulted in much smaller and more stable sensors. One of those approaches, annealing of the fiber to reduce birefringence, has yielded sensors with temperature stabilities near that of the material limit, $<10^{-4}/K$. These topics and other developments that have occurred since a previous summary [Proc. SPIE 985 138-150 (1988)] are discussed in this review.
[Contact: Gordon W. Day, (303) 497-5204]

Patterson, R.L., Rose, A.H., Tang, D., and Day, G.W., **Fiber-Optic Sensors for Aerospace Electrical Measurements: An Update**, Proceedings of the 26th Intersociety Energy Conversion Engineering Conference, IECEC-91, Boston, Massachusetts, August 4-9, 1991, pp. 180-183. [Also published as a NASA Technical Memorandum, 104454, pp. 180-183 (July l991)].

Fiber-optic sensors are being developed for electrical current, voltage, and power measurements in aerospace applications. These sensors are presently designed to cover ac frequencies from 60 Hz to 20 kHz. The current sensor, based on the Faraday effect in optical fiber, is in advanced development after some initial testing. Concentration is on packaging methods and ways to maintain consistent sensitivity with changes in temperature. The voltage sensor, utilizing the Pockels effect in a crystal, has excelled in temperature tests. This paper reports on the development of these sensors. It also relates the technology used in the sensors, the results of evaluation, improvements now in progress, and the future direction of the work.
[Contact: Allen H. Rose, (303) 497-5599]

Electro-Optic Metrology

Christensen, D.H., Crochiere, S.M., Parsons, C.A., Pellegrino, J.G., Hickernell, R.K., and Rai, R.S., **Characterization of Vertical-Cavity Semiconductor Structures**, Journal of Applied Physics, Vol. 72, No. 12, pp. 5982-5989, December 15, 1992.

We apply several analytical tools to characterize vertical-cavity surface-emitting laser structures grown on GaAs wafers. These epitaxial structures are amenable to X-ray, electron beam, and optical metrologies. Cross-sectional scanning electron microscopy and transmission electron microscopy were used to measure layer thickness and uniformity. Photoluminescence wafer mapping was used to determine alloy composition uniformity across the wafer. Photoreflectance was also used to determine alloy composition. Cross-sectional micro-photoluminescence was used to measure average alloy compositions in the top and bottom mirrors. Reflectance spectroscopy was used to characterize the cavity resonances and mirrors layers. Double-

crystal X-ray diffractometry (DCXRD) was used to characterize mirror layer dimensions, uniformity, and average alloy composition. We find excellent agreement between these measurement techniques. We also find excellent agreement between simulations and measurements. The results demonstrate the accuracy of the device simulation tools and the applicability of DCXRD in analyzing these structures.
[Contact: David H. Christensen, (303) 497-3354]

Gallawa, R.L., Goyal, I.C., and Ghatak, A.K., **Modal Properties of Circular and Noncircular Optical Waveguides,** Fiber and Integrated Optics, Vol. 11, pp. 25-50 (1992).

We give a review and a comparison of recent methods of analyzing circular and noncircular optical waveguides. Comparison among competing methodologies is made as follows: Galerkin's method is used with Laguerre-Gauss basis functions in circular geometry to examine the modal solution in a step index fiber, and comparison is made with the exact solution. After the veracity of the method has been established, a W-fiber, which has no exact solution, is examined. Rectangular geometry is then considered, and discussion centers on the use of Galerkin's method using 1) trigonometric basis functions and 2) Hermite-Gauss basis functions. A fundamental difficulty in using trigonometric basis functions is illustrated. Finally, a step index square waveguide is used to illustrate a comparison between 1) a variational method that uses the Gaussian approximation as the starting point and 2) Galerkin's method using Hermite-Gauss basis functions. We conclude that the variational method does well in predicting the propagation constant, β, but does not do well in predicting the modal field.
[Contact: Robert L. Gallawa, (303) 497-3761]

Sanford, N.A., Aust, J. A., Larson, D.R., and K.J. Malone, **Rare-Earth-Doped Waveguide Devices: The Potential for Compact Blue-Green Lasers**, Proceedings of the 1992 Technical Digest Series, Vol. 6, pp. ThB4-1 to ThB4-4, Santa Fe, New Mexico, February 20-21, 1992.

Rare-earth-doped waveguide devices have been demonstrated to lase in the infrared. The potential for upconversion lasing in the visible is being explored.
[Contact: Norman A. Sanford, (303) 497-5239]

Sanford, N.A., Aust, J.A., Malone, K.J., Larson, D.R., and Roshko, A., **Nd:$LiTaO_3$ Waveguide Laser**, Optical Society of America, Vol. 17, No. 22, pp. 1578-1580 (November 1992).

Integrated optic waveguide lasers operating at a wavelength of 1092.3 nm were fabricated in Z-cut Nd-doped $LiTaO_3$. The Nd was incorporated by thermal diffusion of 7-nm-thick electron-beam-deposited films. The Nd diffusion was performed at 1400 °C for 120 hours in ambient air. Ti-diffused channel waveguides were subsequently formed from 130-nm-thick Ti stripes, ranging in width from 8 μm to 15 μm, by diffusion in ambient air at 1500 °C for 4 hours. Finished devices were 2 cm in length. The waveguides were end-fire pumped with a cw Ti:sapphire laser operating at 750 nm. Using an output coupler with a 0.4% transmittance, the threshold occurred at an absorbed pump power of 330 mW.
[Contact: Norman A. Sanford, (303) 497-5239]

Schlager, J.B., Takara, H., Kawanishi, S., and Saruwatari, M., **Multi-Wavelength Birefringent-Cavity Mode-Locked Fiber Laser**, Conference on Lasers and Electro-Optics, Anaheim, Cailfornia, May 10-15, 1992, pp. 250-251.

Synchronous optical pulses with different wavelengths are promising for uses such as multi-wavelength transmission and measurement of optical fiber dispersion. Here, we report the successful simultaneous generation of four wavelength optical pulses, we believe for the first time using a mode-locked Er^{3+}-doped fiber ring laser with 45° concatenated birefringent fibers.
[Contact: John B. Schlager, (303) 497-3542]

ELECTRICAL SYSTEMS

Power Systems Metrology

Fenimore, C., and Martzloff, F.D., **Validating Surge Test Standards by Field Experience: High-Energy Tests and Varistor Performance**, IEEE Transactions on Industry Applications, Vol. 28, No. 6, pp. 1234-1241 (November/December 1992). [Also published in the Conference Record of the 1990 IEEE Industry Applications Society Annual Meeting, Seattle, Washington, October 7-12, 1990, pp. 1968-1974.]

New, high-energy surge tests are emerging in IEEE and IEC standards. Field experience offers a valuable criterion for validating or invalidating proposed standards. A proposal under consideration by the IEC involves so much energy that a varistor of the voltage rating commonly used in protecting load equipment, if subjected to this test, would almost certainly fail. Yet, reported varistor failure rates do not reflect such a situation. Thus, a re-examination of the premises that led to the proposed test specifications appears necessary. Proposals for high-energy tests as additional waveforms in the new version of IEEE C62.41, on the other hand, lead to current and energy levels that do not place typical varistors in immediate jeopardy. Thus, they appear more consistent with field experience.
[Contact: Charles Fenimore, (301) 975-2428]

Martzloff, F.D., and Lai, J.S., **Coordinating Cascaded Surge-Protective Devices: An Elusive Goal**, Electrical Business, pp. 1-4 (September 1992).

Cascading two or more surge-protective devices located at the entrance of a building and near sensitive load equipment is done to ensure that each device shares the surge stress in a manner commensurate with its rating. The final purpose is to achieve reliable protection of equipment against surges impinging for the utility supply, as well as internally generated surges. Coordination may or may not be effective, depending upon the relative clamping voltages of the two devices, their separation distance, and the waveform of the impinging surge. The article presents the results of computations, confirmed by measurements of the energy deposited in the devices for combinations of these three parameters. From these results, a suggestion is made on a possible approach to a coordination scheme. However, without consensus among interested parties, some questions remain on the likelihood of ensuring coordination for all possible circumstances.
[Contact: Francois D. Martzloff, (301) 975-2409]

Stricklett, K.L., Weidenheimer, D.M., Pereira, N.R., and Judy, D.C., **Electric Breakdown in Transformer Oil in Large Gaps**, IEEE 1992 Annual Report of the Conference on Electrical Insulation and Dielectric Phenomena, Vancouver, B.C., October 18-21, 1992, pp. 248-254.

The Aurora accelerator uses four Blumlein pulse-forming lines to provide an intense flash X-ray pulse. Timing of the pulses generated by each Blumlein influences the peak radiation intensity. The pulse on each Blumlein and the synchronization between the Blumleins are affected by the closure of high-voltage triggered oil switches in each line. The triggered oil switch utilizes a uniform field geometry with a gap spacing between 40 and 50 cm, a unique environment for observation of arc development in transformer oil. High-speed photography of switch closure shows timing to be influenced by the initiation and spatial development of prebreakdown streamers.
[Contact: Kenneth L. Stricklett, (301) 975-3955]

Van Brunt, R. J., and Cernyar, E. W., **System for Measuring Conditional Amplitude, Phase, or Time Distributions of Pulsating Phenomena**, Journal of Research of the National Institute of Standards and Technology, Vol. 97, No. 6, pp. 635-672 (November-December 1992).

A detailed description is given of an electronic stochastic analyzer for use with direct "real-time" measurements of the conditional distributions needed for a complete stochastic characterization of pulsating phenomena that can be represented as random point processes. The measurement system described here is designed to reveal and quantify effects of pulse-to-pulse or phase-to-phase memory propagation. The unraveling of memory effects is required so that the physical basis for observed statistical properties of pulsating phenomena can be understood. The individual unique circuit components that comprise the system and the combinations of these components for various measurements are thoroughly documented. The system has been applied to the measurement of pulsating partial discharges generated by applying alternating or constant voltage to a discharge gap. Examples are shown of data obtained for conditional and unconditional amplitude, time interval, and phase-of-occurrence distributions of partial-discharge pulses. The results unequivocally show the existence of significant memory effects as indicated, for example, by the observations that the most probable amplitudes and phases-of-occurrence of discharge pulses depend on the amplitudes and/or phases of the preceding pulses. Sources of error and fundamental limitations of the present measurement

approach are analyzed. Possible extensions of the method are also discussed.
[Contact: Richard J. Van Brunt, (301) 975-2425]

Magnetic Materials and Measurements

Day, G.W., Deeter, M.N., and Rose, A.H., **Faraday Effect Sensors: A Review of Recent Progress**, Proceedings of the International Conference on Optical Fiber Sensors, Wuham, China, October 9-11, 1991, pp. 11-26 (1992).

Superconductors

Ekin, J.W., **Critical Magnetic-Field Angle For High-Field Current Transport In $YBa_2Cu_3O_7$ at 76 K**, Cryogenics, Vol. 32, No. 11, pp. 1089-1092 (1992).

High-magnetic-field (0.5 T to 9 T) measurements of the in-plane transport critical current density J_c of $YBa_2Cu_3O_7$ at liquid nitrogen temperature are reported as a function of the orientation of magnetic field B with respect to the a,b-plane. In contrast to earlier results at lower fields (<3 T), the measurements reported here at high fields reveal a J_c-versus-angle curve with a head-and-shoulders shape with two angular regions having distinctly different behaviors. For magnetic field oriented close to the ab-plane, a sharp peak in J_c about B ⊥ c-axis is observed, with a narrow width; on either side of the peak, J_c is still relatively high ($>10^4$ A/cm^2) and nearly independent of magnetic field magnitude and angle. However, beyond a critical angle θ_c, the J_c vs. θ dependence crosses over to a markedly different behavior, characterized by a decrease in the sharpness of the voltage-current characteristic and a rapid decrease in J_c. The critical angle θ_c where this change occurs is determined experimentally from the sharp break in the J_c vs. θ curve at the edge of the shoulders, defined by the angle where the minima in $dJ_c^2/d\theta^2$ occurs. Characteristic values of θ_c (where $\theta \equiv 0$ for B in the a,b-plane) for oriented-grained $YBa_2Cu_3O_7$ at 76 K are ±39°, ±24°, and ±17° at 5 T, 7 T, and 9 T, respectively. To take advantage of the high, nearly field-independent J_c on either side of the intrinsic peak, magnet design will need to allow an adequate angular margin to avoid the pinning transition at θ_c.
[Contact: John W. Ekin, (303) 497-5448]

Ishida, T., Goldfarb, R.B., Kos, A.B., and Cross, R.W., **Offset Susceptibility of Superconductors**, Physical Review, Vol. 46, No. 18, pp. 12 080-12 083 (1 November 1992).

A novel concept of offset susceptibility χ_0 is presented for superconductors in applied field $H_{dc} + H_{ac} \sin\omega t$. χ_0 represents the dc component in time-dependent magnetization M(t). For sintered $YBa_2Cu_3O_7$, χ_0 was measured as a function of H_{ac}, H_{dc}, and temperature using a Hall probe magnetometer and Fourier analysis. For intragranular diamagnetism, χ_0 behaves as the real part of complex fundamental susceptibility χ_1, confirming a London-like field penetration. However, χ_0 arising from intergranular coupling is positive at temperatures just below the onset of the coupling transition, in good agreement with theoretical predictions of a simplified Kim critical-state model of magnetization.
[Contact: Ronald B. Goldfarb, (303) 497-3650]

ELECTROMAGNETIC INTERFERENCE

Conducted

Fenimore, C., and Martzloff, F.D., **Validating Surge Test Standards by Field Experience: High-Energy Tests and Varistor Performance**, IEEE Transactions on Industry Applications, Vol. 28, No. 6, pp. 1234-1241 (November/December 1992). [Also published in the Conference Record of the 1990 IEEE Industry Applications Society Annual Meeting, Seattle, Washington, October 7-12, 1990, pp. 1968-1974.]

ADDITIONAL INFORMATION

Lists of Publications

DeWeese, M.E., **Metrology for Electromagnetic Technology: A Bibliography of NIST Publications**, NISTIR 3972 (August 1991).

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) and **Semiconductor Measurement Technology, 1962-1989, NIST List of Publications 72** (March 1990).

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]

<u>Continuing Production-Expanded Capability Standard Reference Materials</u>

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]

<u>Standard Reference Materials Issued Within Past Year</u>

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.

Transfer of Pulse Waveform Measurements Services to NIST, Gaithersburg, MD

The responsibility for the Special Test Services Provided by NIST for pulse waveform measurements has now been officially transferred to the Electricity Division, Electronic Instrumentation and Metrology Group (811.02) in Gaithersburg, MD. 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

Service for test number 65400S is already available; it is anticipated that the equipment and software necessary for bringing the other waveform measurement services on line will also become available by June 30, 1992. 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
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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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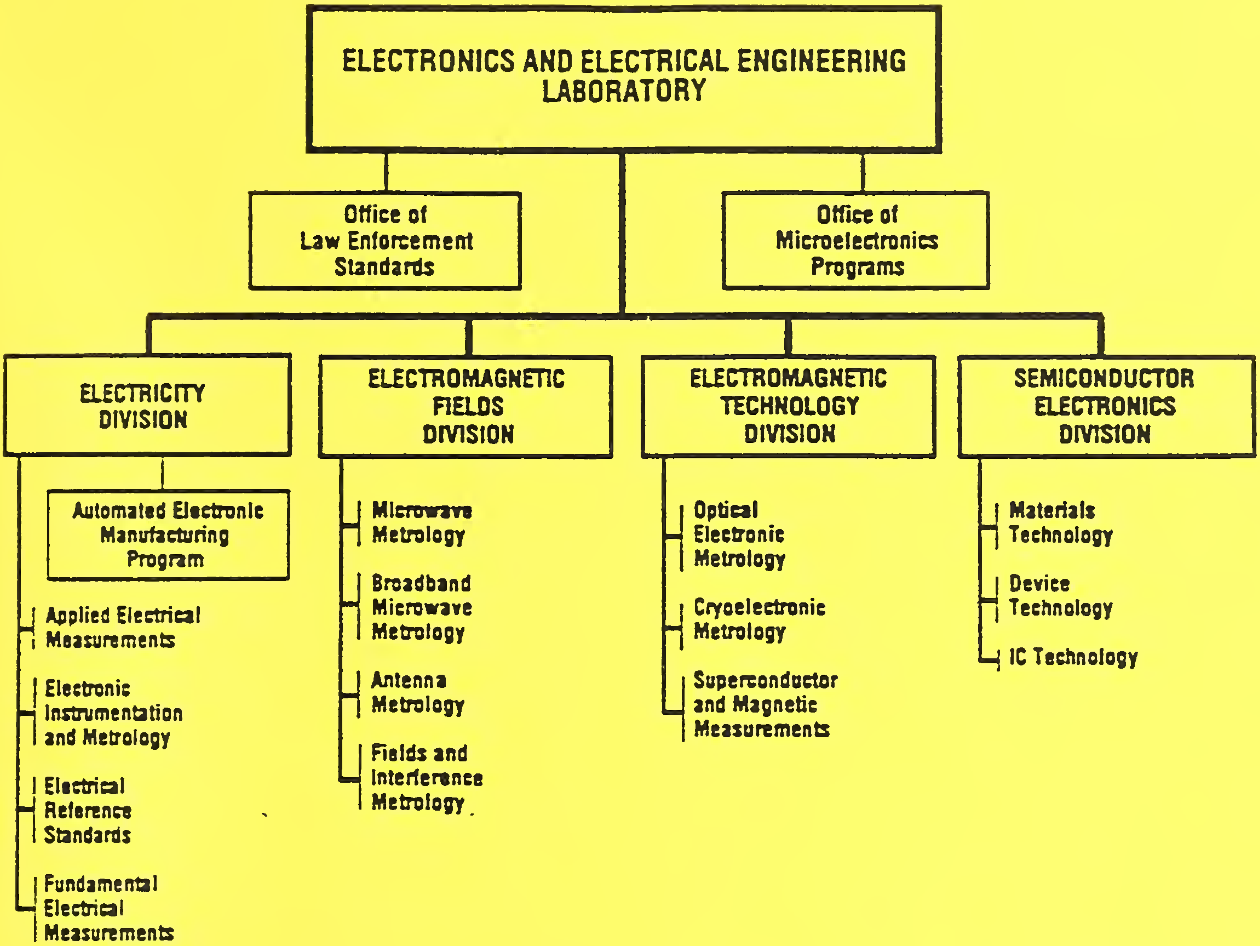

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