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# **Semiconductor Measurement Technology: A Bibliography of NBS Publications for the Years 1962-1986**

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Edited by: Jane Walters

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

February 1987



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**SEMICONDUCTOR MEASUREMENT  
TECHNOLOGY: A BIBLIOGRAPHY OF  
NBS PUBLICATIONS FOR THE YEARS  
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**U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary***  
**NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director***





# SEMICONDUCTOR MEASUREMENT TECHNOLOGY

Publications for the Years 1962-1986

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# SEMICONDUCTOR MEASUREMENT TECHNOLOGY;

## LIST OF PUBLICATIONS - 1962-1986

### Introduction

This list of publications contains reports of work performed at the National Bureau of Standards (NBS) in the field of Semiconductor Measurement Technology. The publications are grouped by author in a given year, with the current year appearing first in the listing. An index by topic area is provided. Each topic is followed by year and reference number of the appropriate publication. For the reader's convenience, a list by author is also given.

Most of the publications listed herein resulted from work carried out as part of the NBS Semiconductor Technology Program (STP). This Program serves to focus NBS research on improved measurement technology for the use of the semiconductor device community in specifying materials, equipment, and devices in national and international commerce, and in monitoring and controlling device fabrication and assembly. This research leads to carefully evaluated, well-documented measurement methods, data, reference artifacts, models and theory, and associated technology which when applied by the industry are expected to contribute to higher yields, lower cost, and higher reliability of semiconductor devices and to provide a basis for controlled improvements in fabrication processes and device performance. By providing a common basis for the purchase specifications of government agencies, improved measurement technology also leads to greater economy in government procurement. Financial support of the Program is provided by a variety of Federal agencies; sponsorship is acknowledged in each report.

The work of the Semiconductor Technology Program is carried out by the Semiconductor Electronics Division (formerly the Semiconductor Materials & Processes and the Semiconductor Devices & Circuits Divisions). Inquiries regarding the work of the Division should be directed to Frank F. Oettinger, Division Chief, Room B344, Technology Building, National Bureau of Standards, Gaithersburg, MD 20899.

The linewidth metrology work, formerly a part of the Semiconductor Materials & Processes Division, is now part of the Precision Engineering Division of the Center for Manufacturing Engineering, although those publications that pertain to the semiconductor industry still appear in this report. Detailed inquiries may be made to Robert D. Larrabee, Group Leader, Linewidth Metrology, Room A331, Technology Building, National Bureau of Standards, Gaithersburg, MD 20899.

## How to Obtain Listed Publications

In most cases, reprints of articles in technical journals may be obtained on request to the author or to the above address. Copies of most NBS Technical Notes and Special Publications, NBS Interagency Reports (NBSIR Series), NBS Grant-Contract Reports (NBS-GCR Series), and other Government reports may be ordered through the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161; or from the Government Printing Office (GPO), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Current price information may be obtained from the NTIS Order Desk, (703) 487-4650 or from the GPO Order and Inquiry Section, (202) 783-3238.

### Progress Briefs

Progress Briefs have been issued in the NBSIR Series to describe the work in the Semiconductor Technology Program on a periodic basis and also to list new reports as they become available. The Center for Electronics and Electrical Engineering (CEEE) continues to publish such material in a Center-wide publication, CEEE Technical Progress Bulletin. All individuals on the present Progress Briefs mailing list will continue to receive issues in that series. Requests to have names placed on this list should be sent to: Mr. J. F. Mayo-Wells, CEEE, Room B358, Metrology Building, National Bureau of Standards, Gaithersburg, MD 20899, telephone: (301) 975-2220.

### Videotapes

The videotape on Safe Operating Area Limits for Power Transistors, by David L. Blackburn, continues to be available. Address requests to the author, Room B310, Technology Building, for a copy of the tape and NBS Special Publication 400-44 (issued September 1977), the videotape script.

Also available is the videotape on Laser Scanning of Active Semiconductor Devices. Contact David W. Berning, Room B310, Technology Building, concerning a copy of the videotape and NBS Special Publication 400-27 (issued February 1976).



## PROGRESS REPORTS

Comprehensive progress reports covering the period July 1, 1968 through June 30, 1973 were published as NBS Technical Notes with the title, Methods of Measurement for Semiconductor Materials, Process Control, and Devices:

QUARTER ENDING	NBS TECHNICAL NOTE	DATE ISSUED
September 30, 1968	472	Dec 1968
December 31, 1968	475	Feb 1969
March 31, 1969	488	Jul 1969
June 30, 1969	495	Sep 1969
September 30, 1969	520	Mar 1970
December 31, 1969	527	May 1970
March 31, 1970	555	Sep 1970
June 30, 1970	560	Nov 1970
September 30, 1970	571	Apr 1971
December 31, 1970	592	Aug 1971
March 31, 1971	598	Oct 1971
June 30, 1971	702	Nov 1971
September 30, 1971	717	Apr 1972
December 31, 1971	727	Jun 1972
March 31, 1972	733	Sep 1972
June 30, 1972	743	Dec 1972
September 30, 1972	754	Mar 1973
December 31, 1972	773	Jun 1973
March 31, 1973	788	Aug 1973
June 30, 1973	806	Nov 1973

Between July 1, 1973 and September 30, 1977, comprehensive progress reports were issued in the NBS Special Publication 400- subseries with the title, Semiconductor Measurement Technology:

QUARTER ENDING	NBS SPECIAL PUBLICATION	DATE ISSUED
September 30, 1973	400-1	Mar 1974
December 31, 1973	400-4	Nov 1974
March 31, 1974		
June 30, 1974	400-8	Feb 1975
September 30, 1974	400-12	May 1975
December 31, 1974	400-17	Nov 1975
March 31, 1975	400-19	Apr 1976
June 30, 1975		
September 30, 1975	400-25	Oct 1976
December 31, 1975		

QUARTER ENDING	NBS SPECIAL PUBLICATION	DATE ISSUED
March 31, 1976	400-29	Apr 1977
June 30, 1976		
September 30, 1976	400-36	Jul 1978
December 31, 1976	400-38	Nov 1979
March 31, 1977		
June 30, 1977	400-45	Aug 1980
September 30, 1977		

After October 1, 1977, brief progress reports were issued as NBSIRs with the title, Semiconductor Technology Program, Progress Briefs:

QUARTER ENDING	NBSIR	DATE ISSUED
December 31, 1977	78-1444	Mar 1978
March 31, 1978	78-1444-2	Jul 1978
June 30, 1978	78-1444-3	Oct 1978
September 30, 1978	79-1591	Jan 1979
December 31, 1978	79-1591-2	Mar 1979
March 31, 1979	79-1591-3	Jun 1979
June 30, 1979	79-1591-4	Aug 1979
September 30, 1979	79-1591-5	Dec 1979
December 31, 1979	80-2006	Apr 1980
March 31, 1980	80-2006-2	Jun 1980
June 30, 1980	80-2006-3	Oct 1980
September 30, 1980	80-2006-4	Dec 1980
December 31, 1980	81-2230	Mar 1981
March 31, 1981	81-2230-2	Jul 1981
June 30, 1981	81-2230-3	Oct 1981
July 1, 1981	83-2636	Jan 1983
September 30, 1982		

The Center for Electronics and Electrical Engineering Technical Progress Bulletins (TPB), which appeared after October 1, 1982, contain abstracts of recent publications, and of those to be published, covering work of the Semiconductor Technology Program as well as that of the Signals and Systems Metrology Program.

QUARTER ENDING	NBSIR	DATE ISSUED
December 31, 1982	83-2719-3	Jul 1983
March 31, 1983	84-2857-1	Mar 1984
June 30, 1983	84-2857-2	Apr 1984
September 30, 1983	84-2857-3	Apr 1984
December 31, 1983	84-2857-4	Apr 1984
March 31, 1984	84-2877-1	May 1984

QUARTER ENDING	NBSIR	DATE ISSUED
June 30, 1984	84-2877-2	Jul 1984
September 30, 1984	84-2877-3	Dec 1984
December 31, 1984	85-3181	Jun 1985
March 31, 1985	85-3181-2	Aug 1985
June 30, 1985	85-3181-3	Dec 1985
September 30, 1985	86-3344	Mar 1986
December 30, 1985	86-3344-2	Jun 1986
March 31, 1986	86-3449	Sep 1986

## Publications for the Year 1986

1. Baghdadi, A., Measurement of the Oxygen and Carbon Content of Silicon Wafers by Fourier Transform Spectrophotometry, American Chemical Society Symposium Series 295, Inorganic Materials Characterization, L.A. Casper, Ed., pp. 208-229 (1986).
2. Baghdadi, A., Gladden, W. K., and Flach, D. R., Nonlinear Effects of Digitizer Errors in FT-IR Spectroscopy, *Appl. Spectrosc.* 40 (5), 617-628 (1986).
3. Bennett, H. S., Band Structure and Density of States Changes in Heavily Doped Silicon, *J. Appl. Phys.* 59 (8), 2837-2844 (1986).
4. Bennett, H. S., High Dopant and Carrier Concentration Effects in Gallium Arsenide: Band Structure and Effective Intrinsic Carrier Concentrations, *J. Appl. Phys.* 60 (8), 2866-2874 (1986).
5. Bennett, H. S., Device Physics for Modeling GaAs Bipolar Transistors, Proc. SRC Conference on Bipolar Device Technology, Tempe, AZ, Apr. 24-25, 1986, Paper II.17, S.A. Abbas, Ed., (1986).
6. Bennett, H. S., Gaitan, M., Roitman, P., Russell, T. J., and Suehle, J. S., Modeling MOS Capacitors to Extract Si-SiO<sub>2</sub> Interface Trap Densities in the Presence of Arbitrary Silicon Doping Profiles, *IEEE Trans. Electron Devices* ED-33, 759-765 (1986).
7. Berning, D. W., and Blackburn, D. L., Power MOSFET Failure During Turn-Off: The Effect of Forward Biasing the Drain-Source Diode, Conf. Proc. 1986 IEEE Industrial Applications Society Annual Meeting, Denver, CO, Sept. 25-Oct. 3, 1986, pp. 335-339 (1986).
8. Bullis, W. M., Watanabe, M., Baghdadi, A., Yue-zhen, L., Scace, R. I., Series, R. W., and Stallhofer, P., Calibration of Infrared Absorption Measurements of Interstitial Oxygen Concentration in Silicon, Proc. Electrochemical Society Silicon Symposium, Boston, MA, May 4-9, 1986, 86-1, p. 196 (1986).
9. Candela, G. A., Chandler-Horowitz, D., Novotny, D. B., Vorburger, T., and Giauque, G. H., Film Thickness and Refractive Index Standard Reference Material Calibrated by Ellipsometry and Profilometry, *Proc. Soc. Photo-Optical Instrum. Engrs.*, 661, Optical Testing & Metrology, 402-407 (1986).
10. Chandler-Horowitz, D., Semiconductor Measurement Technology: Analytic Analysis of Ellipsometric Errors, NBS Spec. Publ. 400-78 (1986).
11. Cresswell, M. W., Coleman, E. S., Pessall, N., Linholm, L. W., and Radack, D. J., An Expert System Approach to Enhanced VLSI/VHSIC Process Development, 1986 Government Microcircuit Applications Conf. Digest of Papers, San Diego, CA, Nov.



- 11-13, 1986, pp. 391-392 (1986).
12. Cresswell, M. W., Pessall, N., Linholm, L. W., and Radack, D. J., The Use of Artificial Intelligence and Microelectronic Test Structures for Evaluation and Yield Enhancement of Microelectronic Interconnect Systems, Proc. Third Int. IEEE VLSI Multilevel Interconnection Conf., Santa Clara, CA, June 9-11, 1986, pp. 331-340 (1986).
  13. Dodge, M., Refractive Index. CRC Handbook of Laser Science and Technology, Optical Materials, Part 2, Vol. IV, M. J. Weber, Ed., pp. 21-47 (CRC Press, Boca Raton, FL, 1986).
  14. Ellenwood, C. H., and Mattis, R. L., Release Notes for STAT2 Version 2.00A: An Addendum to NBS Special Publication 400-75, NBSIR 85-3292 (1986).
  15. Hefner, A. R., and Blackburn, D. L., Performance Trade-Off for the Insulated Gate Bipolar Transistor: Buffer Layer Versus Base Lifetime Reduction, PESC '86 Record, 17th Annual IEEE Power Electronics Specialists Conf. Vancouver, BC, June 23, 1986, pp. 27-38 (1986).
  16. Hefner, A. R., Blackburn, D. L., and Galloway, K. F., The Effect of Neutrons on the Characteristics of the Insulated Gate Bipolar Transistor (IGBT), IEEE Trans. Nucl. Sci. NS-33, 1428-1434 (1986).
  17. Larrabee, R. D., and Bell, M. I., Nondestructive Evaluation Activities in the Semiconductor Materials and Processes Division, NBSIR 86-3495 (1986).
  18. Lowney, J. R., Impurity Bands and Band Tailing in Moderately Doped Silicon, J. Appl. Phys. 59 (6), 2048-2053 (1986).
  19. Lowney, J. R., Impurity Bands and Band Tailing in n-Type GaAs, J. Appl. Phys. 60 (8), 2854-2859 (1986).
  20. Ma, Y., Stern, E. A., and Bouldin, C. E., The Structural Unit in Icosahedral MnAlSi and MnAl, Phys. Rev. Lett. 57 (13), 1611-1614 (1986).
  21. Mattis, R. L., Release Notes for STAT2 Version 1.7; An Addendum to NBS Special Publication 400-75, NBSIR 86-3333 (1986).
  22. Mazer, J. A., and Ehrstein, J. R., Effect of Sintering on the Sheet Resistance Directly Under an Aluminum/Silicon Ohmic Contact, Proc. Electrochemical Society Silicon Symposium, Boston, MA, May 4-9, 1986, 86-1, pp. 396-397 (1986).
  23. Mountain, D. J., Russell, T. J., and Galloway, K. F., Effect of Post-Oxidation Anneal on Electrical Characterization of Thin Oxides, Proc. Electrochemical Society Silicon Symposium, Boston, MA, May 4-9, 1986, 86-1, pp. 382-383 (1986).
  24. Novotny, D. B., Measurement of the Separation Distance in Contact and Proximity Lithography, J. Electrochem. Soc. 133, 2600-2605 (1986).

25. Nyssonen, D., Procedure for Calibration of Ferrite Gaps in Magnetic Tape Heads Traceable to NBS AR-Chromium Optical Linewidth SRMs, NBSIR 86-3306 (1986).
26. Nyssonen, D., Linewidth Calibration for Bright-Chromium Photomasks, NBSIR 86-3357 (1986).
27. O'Keefe, T. W., Cresswell, M. W., Linholm, L. W., and Radack, D. J., Evaluation and Improvement of E-Beam Exposure Routines by Use of Microelectronic Test Structures, Ext. Abs. Digest of IEEE VLSI Workshop on Test Structures, Long Beach, CA, Feb. 17-18, 1986, pp. 82-94 (1986).
28. Oettinger, F. F., Thermal Characterization of Integrated Circuits - A Tutorial, Proc. Semiconductor Thermal & Temperature Measurement Symp., Scottsdale, AZ, Dec. 9-11, 1986, T2-1 - T2-4 (1986).
29. Postek, M. T., Electron Detection Modes and Their Relation to Linewidth Measurement in the Scanning Electron Microscope, Proc. 44th Annual Meeting, Electron Microscopy Soc. of America, Albuquerque, NM, Aug. 10-15, 1986, pp. 646-649 (1986).
30. Postek, M. T., and Joy, D. C., Microelectronics Dimensional Metrology in the Scanning Electron Microscope, Part I (November issue), Solid State Technology, 145-150 (1986).
31. Postek, M. T., and Joy, D. C., Microelectronics Dimensional Metrology in the Scanning Electron Microscope, Part II (December issue), Solid State Technology, 77-85 (1986).
32. Pugh, R. D., Johnston, A. H., and Galloway, K. F., Characteristics of the Breakdown Voltage of Power MOSFETs After Total Dose Irradiation, IEEE Trans. Nucl. Sci. NS-33, 1460-1464 (1986).
33. Radack, D. J., and Linholm, L. W., The Application of Microelectronic Test Structures for Propagation Delay, Ext. Abs. Digest IEEE VLSI Workshop on Test Structures, Long Beach, CA, Feb. 17-18, 1986, pp. 191-207 (1986).
34. Roitman, P., Suehle, J. S., Russell, T. J., and Gaitan, M., On the Measurement of Capacitance on Wafers, Ext. Abs. Digest IEEE VLSI Workshop on Test Structures, Long Beach, CA, Feb. 17-18, 1986, pp. 96-104 (1986).
35. Russell, T. J., Bennett, H. S., Gaitan, M., Suehle, J. S., and Roitman, P., Correlation Between CMOS Transistor and Capacitor Measurements of Interface Trap Spectra, IEEE Trans. Nucl. Sci. NS-33, 1228-1233 (1986).
36. Schafft, H. A., Grant, T., Mandel, J., and Shott, J., Report on an Interlaboratory Electromigration Experiment, Ext. Abs. Digest IEEE VLSI Workshop on Test Structures, Long Beach, CA, Feb. 17-18, 1986, pp. 306-325 (1986).

37. Schafft, H. A., and Saxena, A. N., Electromigration Test Methodology and Characterization, Proc. Third IBM Symp. on Electromigration, Poughkeepsie, NY, Apr. 1-2, 1985, unpagged (1986).
38. Singh, G., Galloway, K. F., and Russell, T. J., Radiation-Induced Interface Traps in Power MOSFETs, IEEE Trans. Nucl. Sci. NS-33, 1454-1459 (1986).
39. Stern, E. A., Ma, Y., and Bouldin, C. E., Answer to Comment by M. A. Marcus Concerning "Local Structure at Mn Sites in Icosahedral Mn-Al Quasicrystals," Phys. Rev. Lett. 57 (13), 1659 (1986).
40. Wachnik, R. A., The Use of Charge Pumping to Characterize Generation by Interface Traps, IEEE Trans. Electron Devices ED-33, 1054-1061 (1986).
41. Wachnik, R. A., and Lowney, J. R., A Model for the Charge-Pumping Current Based on Small Rectangular Voltage Pulses, Solid-State Electron. 29 (4), 447-460 (1986).
42. Wunder, S. L., Bell, M. I., and Zerbi, G., Band Broadening of CH<sub>2</sub> Vibrations in the Raman Spectra of Polymethylene Chains, J. Chem. Phys. 85 (7), 3827-3839 (1986).



## Publications for the Year 1985

1. Albers, J., Monte Carlo Calculation of One- and Two-Dimensional Particle and Damage Distributions for Ion-Implanted Dopants in Silicon, *IEEE Trans. Computer-Aided Design CAD-4*, 374-383 (1985).
2. Albers, J., Monte Carlo Calculation of One- and Two-Dimensional Particle and Damage Distributions for Ion-Implanted Dopants in Silicon, *IEEE Trans. Electron Devices ED-32*, 1930-1939 (1985).
3. Albers, J., and Berkowitz, H. L., An Alternative Approach to the Calculation of Four-Probe Resistances on Nonuniform Surfaces, *J. Electrochem. Soc.* 132, 2453-2456 (1985).
4. Baghdadi, A., Comments on "Precise Evaluation of Oxygen Measurements on Cz-Silicon Wafers," *J. Electrochem. Soc.* 132, 510 (1985).
5. Baghdadi, A., and Gladden, W. K., ADC Errors in Quantitative FT-IR Spectroscopy, *Proc. Soc. Photo-Optical & Instrum. Engrs., Fourier and Computerized IR Spectroscopy* 553, 207-209 (1985).
6. Bennett, H. S., Modeling GaAs/AlGaAs Devices: A Critical Review, *IEEE Circuits and Devices Magazine* 1, 35-42 (1985).
7. Bennett, H. S., Band Structure and Density of States Changes for Doped Gallium Arsenide, *OM85 Basic Properties of Optical Materials, Summaries of Papers [Conf. May 7-9, Gaithersburg, MD]*, NBS Spec. Publ. 697 (1985).
8. Bennett, H. S., Heavy Doping Effects on Bandgaps, Effective Intrinsic Carrier Concentrations, and Carrier Mobilities and Lifetime, *Solid State Electronics* 28, 193-200 (1985).
9. Bennett, H. S., and Fuoss, D. E., Improved Physics for Simulating Submicron Bipolar Devices, *IEEE Trans. Computer-Aided Design CAD-4*, 513-522 (1985).
10. Bennett, H. S., and Fuoss, D. E., Improved Physics for Simulating Submicron Bipolar Devices, *IEEE Trans. Electron Devices ED-32*, 2069-2078 (1985).
11. Blackburn, D. L., Turn-Off Failure of Power MOSFETs, *Proc. 16th Annual Power Electronics Specialists Conf., Toulouse, France, June 24-28, 1985*, pp. 429-435 (1985).
12. Chandler-Horowitz, D., Ellipsometric Metrology of Ultrathin Films: Dual Angle of Incidence, *Proc. Soc. Photo-Optical & Instrum. Engrs., Micron and Submicron Integrated Circuit Metrology* 565, 93-97 (1985).
13. Ehrstein, J. R., Preparation and Certification of SRMs for Calibration of Spreading Resistance Probes, *NBS Spec. Publ.* 260-93 (1985).

14. Forman, R. A., Bell, M. I., and Mayo, S., Rapid X-Ray Topographic Examination of GaAs Crystals, Proc. Int. Symp. on Defect Recognition & Image Processing in III-V Compounds, Montpellier, France, July 2-4, 1985, pp. 55-62 (1985).
15. Forman, R. A., Bell, M. I., Myers, D. R., and Chandler-Horowitz, D., The Raman Spectrum of Carbon in Silicon, Jap. J. Applied Physics 24, L848-L850 (1985).
16. Forman, R. A., and Mayo, S., In Situ Alignment for X-Ray Topography, J. Appl. Crystallography 18, 106-109 (1985).
17. Galloway, K. F., Wilson, C. L., and Witte, L. C., Charge-Sheet Model Fitting to Extract Radiation-Induced Oxide and Interface Charge, IEEE Trans. Nucl. Sci. NS-32, 4461-4465 (1985).
18. Galloway, K. F., Wilson, C. L., and Witte, L. C., MOSFET Electrical Parameter Extraction from Charge-Sheet Model Fitting, Proc. Sixth Biennial University/Government/Industry Microelectronics Symposium, Auburn, AL, June 11-13, 1985, pp. 77-81 (1985).
19. Imhoff, E. A., Bell, M. I., and Forman, R. A., Hot Photoluminescence in Beryllium-Doped Gallium Arsenide, Solid State Communications 54, 845-848 (1985).
20. Kirk, C. P., and Nyyssonen, D., Modeling the Optical Microscope Images of Thick Layers for the Purpose of Linewidth Measurement, Proc. Soc. Photo-Optical Instrum. Engrs., Optical Microlithography IV 538, 179-187 (1985).
21. Lie, L., Pramanik, D., Saxena, A. N., Mazer, J. A., and Linholm, L. W., Contact Resistance of Al-1%Si-0.5%Cu and Al/TiW/PtSi Metallization, Proc. 1985 IEEE VLSI Multilevel Interconnection Conf., Santa Clara, CA, June 24-26, 1985, pp. 201-210 (1985).
22. Linholm, L. W., Cresswell, M. W., Coleman, E. S., and Partlow, W. D., Design, Fabrication, and Testing of an Interconnect Test Structure for Evaluating VLSI Processes, 1985 Government Microcircuit Applications Conf. Digest of Papers, Orlando, FL, Nov. 5-7, 1985, pp. 359-360 (1985).
23. Linholm, L. W., Mazer, J. A., and Galloway, K. F., Characterizing VLSI Processes Using Test Structures, Digest of the DoD/NBS Conf. on Microelectronic Electromagnetic Susceptibility, Gaithersburg, MD, Mar. 12-13, 1985, pp. 16-18 (1985).
24. Linholm, L. W., Yen, D., and Cresswell, M. W., Electrical Linewidth Measurement in the Near- and Sub-Micron Linewidth Region, Proc. Third Int. ECS Symp. on VLSI Sci. & Tech., Toronto, Ontario, May 12-17, 1985, pp. 299-308 (1985).
25. Lowney, J. R., Band-Gap Narrowing in the Space-Charge Region of Heavily Doped Silicon Diodes, Solid State Electronics 28, 187-191 (1985).
26. Marchiando, J. F., Roitman, P., and Albers, J., Boron Diffusion in Silicon, IEEE



Trans. Electron Devices ED-32, 2322-2330 (1985).

27. Mayo, S., Lowney, J. R., and Bell, M. I., Evidence of Lattice Relaxation in Platinum-Doped Silicon, Proc. Materials Research Society Spring Meeting, San Francisco, CA, April 1985, 46, pp. 297-306 (1985).
28. Mazer, J. A., Linholm, L. W., and Saxena, A. N., An Improved Test Structure and Kelvin-Measurement Method for the Determination of Integrated Circuit Front Contact Resistance, J. Electrochem. Soc. 132, 440-443 (1985).
29. Nyyssonen, D., Focused-Beam vs. Conventional Bright-Field Scanning Microscopy for Integrated Circuit Metrology, Proc. Soc. Photo-Optical & Instrum. Engrs., Micron and Submicron IC Metrology 565, 102-107 (1985).
30. Nyyssonen, D., A Practical Method for Edge Detection and Focusing for Linewidth Measurements on Wafers, Proc. Soc. Photo-Optical Instrum. Engrs., Optical Microlithography IV 538, 172-178 (1985).
31. Nyyssonen, D., and Postek, M. T., SEM-Based System for Calibration of Linewidth SRMs for the IC Industry, Proc. Soc. Photo-Optical & Instrum. Engrs., Micron and Submicron IC Metrology 565, 180-186 (1985).
32. Oettinger, F. F., Thermal Measurements of VLSI Packages - A Critical Overview, Abstracts of the IEEE/VLSI Packaging Workshop, Gaithersburg, MD, September 9-11, 1985, pp. 26-29 (1985).
33. Radack, D. J., Yao, C. T., Linholm, L. W., Galloway, K. F., and Lin, H. C., Comparison of Microelectronic Test Structures for Propagation Delay Measurements, Microelectronics Journal 16(6), 39-46 (1985).
34. Roenker, K. P., Harner, F. L., and Linholm, L. W., An NMOS Test Chip for Instruction in Semiconductor Parameter Measurements, Proc. 6th Biennial Univ/Govt/Industry Microelectronics Symp., Auburn, AL, June 11-13, 1985, pp. 100-105 (1985).
35. Roitman, P., Wilson, C. L., Blue, J. L., and Galloway, K. F., Measurements for Accurate MOS Transistor Simulation, Proc. 3rd Int. Workshop, Physics of Semiconductor Devices, Delhi, India, Nov. 1985, pp. 69-77 (1985).
36. Schafft, H. A., Standards for Electromigration Testing, Final Report, 1984 Wafer Reliability Assessment Workshop, Lake Tahoe, CA, Sept. 20-Oct. 3, 1984, pp. 91-106 (1985).
37. Schafft, H. A., Grant, T. C., Saxena, A. N., and Kao, C. Y., Electromigration and the Current-Density Dependence, Proc. 23d Annual Inter. Reliability Physics Symp., Orlando, FL, Mar. 26-28, 1985, pp. 93-99 (1985).
38. Stern, E. A., Ma, Y., and Bouldin, C. E., The Local Structure at Mn Sites in Icosahedral Mn-Al Quasicrystals, Phys. Rev. Lett. 55(20), 2172-2175 (1985).

39. Thurber, W. R., and Lowney, J. R., Electrical Transport Properties of Silicon. VLSI Handbook, Chapter 14 N. G. Einspruch Ed., pp. 177-190 (Academic Press, New York, NY, 1985).
40. Wilson, C. L., Using Silicon Device Modeling Techniques for GaAs Devices, Tech. Digest, 1985 Int. Electron Devices Meeting, Washington, DC, Dec. 1-4, 1985, pp. 78-81 (1985).
41. Wilson, C. L., and Blue, J. L., Accurate Current Calculation in Two-Dimensional MOSFET Models, IEEE Trans. Computer-Aided Design CAD-4, 504-512 (1985).
42. Wilson, C. L., and Blue, J. L., Accurate Current Calculation in Two-Dimensional MOSFET Models, IEEE Trans. Electron Devices ED-32, 2060-2068 (1985).
43. Wilson, C. L., and Blue, J. L., Semiconductor Measurement Technology: MOS1: A Program for Two-Dimensional Analysis of Si MOSFETs, NBS Spec. Publ. 400-77 (1985).
44. Wilson, C. L., Roitman, P., and Blue, J. L., High Accuracy Physical Modeling of Submicron MOSFETs, IEEE Trans. Electron Devices ED-32, 1246-1258 (1985).
45. Wilson, C. L., and Russell, T. J., Two-Dimensional Modeling of Channel Hot-Electron Effects in Silicon MOSFETs, Tech. Digest, 1985 Int. Electron Devices Meeting, Washington, DC, Dec. 1-4, 1985, pp. 72-75 (1985).
46. Witte, L. C., CSFIT: A FORTRAN Program for Charge-Sheet Model Fitting of MOSFET Data, NBSIR 85-3145 (1985).
47. Yen, D., Glendinning, W. B., and Linholm, L. W., An Electrical Test Structure and Proximity Effects Measurement and Correction, J. Electrochem. Soc. 132, 1726-1729 (1985).

## Publications for the Year 1984

1. Albers, J., Semiconductor Measurement Technology: TXYZ: A Program for Semiconductor IC Thermal Analysis, NBS Spec. Publ. 400-76 (1984).
2. Albers, J., and Berkowitz, H. L., The Relation Between Two-Probe and Four-Probe Resistances on Nonuniform Structures, *J. Electrochem. Soc.* 131, 392-398 (1984).
3. Albers, J., Wilson, C. L., and Blue, J. L., The Effect of Bevel Angle and Number of Points on Spreading Resistance Data Analysis, *Ext. Abs. of the Electrochemical Society, New Orleans, LA, Oct. 13-17, 1984, 84-2, p. 727 (1984).*
4. Baghdadi, A., The Effects of Instrumental Artifacts on the Quantitative Determination of Oxygen in Silicon by FTIR, *ASTM Special Technical Publication 850 (1984).*
5. Bennett, H. S., Improved Device Physics for Calculating the Gain of Bipolar Structures in Silicon. *The Physics of Submicron Structures* H. L. Grubin, K. Hess, G. J. Iafrate, and D. K. Ferry Eds., pp. 307-311 (Plenum Press, New York, NY, 1984).
6. Bennett, H. S., Comparison of Theoretical Empirical Lifetimes for Minority Carriers in Heavily Doped Silicon, *Solid-State Electronics* 27, 893-904 (1984).
7. Bennett, H. S., and Wilson, C. L., Statistical Comparisons of Data on Band-Gap Narrowing in Heavily Doped Silicon: Electrical and Optical Measurements, *J. Appl. Phys.* 55, 3582-3587 (1984).
8. Berkowitz, H. L., and Albers, J., Simplified Method for Calculating Four-Probe Resistances on Nonuniform Surfaces, *Ext. Abs. of the Electrochemical Society, New Orleans, LA, Oct. 13-17, 1984, 84-2, p. 751 (1984).*
9. Blackburn, D. L., and Berning, D. W., An Experimental Study of Reverse-Bias Second Breakdown. *Power Transistors: Device Design and Applications* B. J. Baliga, and D. Y. Chen Eds., pp. 55-59 (IEEE Press, New York, NY, 1984).
10. Blue, J. L., and Wilson, C. L., Numerical Methods for Solving Coupled Semiconductor Equations on a Minicomputer, *Elliptic Problem Solvers II*, 521-530 (1984).
11. Brodfuehrer, B. P., Galloway, K. F., and Wilson, C. L., Comparison of Simple Approximations and Numerical Solutions for the Threshold Voltage of Ion-Implanted Long-Channel MOSFETs, *IEEE Trans. Education* E-27, 3-6 (1984).
12. Candela, G. A., and Chandler-Horowitz, D., An Ellipsometry System for High Accuracy Metrology of Thin Films, *Proc. Soc. Photo-Optical Instrum. Engrs., Integrated Circuit Metrology II* 480, 2-8 (1984).
13. Carver, G. P., and Wachnik, R. A., TERRY-2: A Test Chip for Characterization of the Performance of Buried-Channel Charge-Coupled Device (CCD) Imagers, *NBSIR*



- 84-2894 (1984).
14. Cassard, J. M., A Sensitivity Analysis of SPICE Parameters Using an Eleven-Stage Ring Oscillator, *IEEE J. Solid State Circuits* SC-19, 130-135 (1984).
  15. Cassard, J. M., A Sensitivity Analysis of SPICE Parameters Using an Eleven-Stage Ring Oscillator, *IEEE Trans. Electron Devices* ED-31, 264-269 (1984).
  16. Chang, T. T., The Calibration Methods and the Reference Materials in ESR Spectroscopy, *Mag. Resonance Rev.* 9 (1-3), 65-124 (1984).
  17. Dodge, M. J., Refractive Properties of Magnesium Fluoride, *Appl. Opt.* 23(12), 1980-1985 (1984).
  18. Ehrstein, J. R., Downing, R. G., Stallard, B. R., Simons, D. S., and Fleming, R. F., Comparison Depth Profiling of 10B in Silicon Using Spreading Resistance Profiling, Secondary Ion Mass Spectrometry, and Neutron Depth Profiling, *ASTM Special Technical Publication* 850 (1984).
  19. Forman, R. A., Bell, M. I., Mayo, S., and Kahn, A. H., Effect of Spatial Averaging on the Compositional Analysis of Crystals by Absorption Spectroscopy, *J. Appl. Phys.* 55, 547-554 (1984).
  20. Forman, R. A., and Kratz, H. D., A Simple Vacuum Pump Exhaust Filter, *Rev. Sci. Instrum.* 55, 1503 (1984).
  21. Gaitan, M., and Russell, T. J., Measurement of Radiation-Induced Interface Traps Using MOSFETs, *IEEE Trans. Nucl. Sci.* NS-31, 1256-1260 (1984).
  22. Galloway, K. F., Measurements for VLSI Models, *Proc. 2nd Int. Workshop on the Physics of Semiconductor Devices, Delhi, India, Dec. 5-10, 1983*, pp. 98-105 (1984).
  23. Galloway, K. F., Gaitan, M., and Russell, T. J., A Simple Model for Separating Interface and Oxide Charge Effects in MOS Device Characteristics, *IEEE Trans. Nucl. Sci.* NS-31, 1497-1501 (1984).
  24. Harman, G. G., The Microelectronic Ball-Bond Shear Test - A Critical Review and Comprehensive Guide to Its Uses, *Solid State Technology* 27 (5), 186-197 (1984).
  25. Hinkley, J. A., Adsorption of Polystyrene on Thermally Oxidized Silicon, *Polymer Preprints* 25 (1), 178-179 (1984).
  26. Hower, P. L., Blackburn, D. L., Oettinger, F. F., and Rubin, S., Stable Hot Spots and Second Breakdown in Power Transistors. *Power Transistors: Device Design and Applications* B. J. Baliga, and D. Y. Chen Eds., pp. 42-54 (IEEE Press, New York, NY, 1984).
  27. Kowalski, P., Lankford, W. F., and Schafft, H. A., Nondestructive Measurement of Solar Cell Sheet Resistance Using a Laser Scanner, *IEEE Trans. Electron Devices*

ED-31, 566-570 (1984).

28. Larrabee, R. D., Neutron Transmutation Doping of Semiconductor Materials, Preface [Conference June 1-3, 1982], R. D. Larrabee, Ed., pp. vii-ix (Plenum Press, New York, NY, 1984).
29. Lowney, J. R., and Geist, J., Comparison of Models of the Built-In Electric Field in Silicon at High Donor Densities, *J. Appl. Phys.* 55, 3624-3627 (1984).
30. Lowney, J. R., and Thurber, W. R., Evidence of Band-Gap Narrowing in the Space-Charge Layer of Heavily Doped Silicon Diodes, *Electronics Letters* 20(3), 142-143 (1984).
31. Mazer, J. A., and Linholm, L. W., Comments on "Determining Specific Contact Resistivity from Contact End Resistance Measurements," *IEEE Electron Devices Letters* EDL-5, 347-348 (1984).
32. Moore, B. A., and Ruthberg, S., RADC/NBS Workshop - Moisture Measurement and Control for Semiconductor Devices, III, NBSIR 84-2852 (1984).
33. Nyyssonen, D., Optical Linewidth Measurement on Patterned Metal Layers, *Proc. Soc. Photo-Optical Instrum. Engrs., Integrated Circuit Metrology II* 480, 65-70 (1984).
34. Nyyssonen, D., A Review of NBS's Activities in the Area of Linewidth Measurement, Summary, SAMA Conference: Future Trends in Optical Technologies in the Semiconductor Industry, May 23, 1983, Sunnyvale, CA, pp. 1-7 (1984).
35. Oettinger, F. F., Thermal Evaluation of VLSI Packages Using Test Chips - A Critical Review, *Solid State Technology* 27 (2), 169-170 (1984).
36. Pande, K. P., and Seabaugh, A. C., Low Temperature Plasma-Enhanced Epitaxy of GaAs, *J. Electrochem. Soc.* 131, 1357-1359 (1984).
37. Roenker, K. P., and Linholm, L. W., An NMOS Test Chip for a Course in Semiconductor Parameter Measurements, NBSIR 84-2822 (1984).
38. Roitman, P., Albers, J., and Myers, D. R., An Investigation of the Two-Dimensional Shape of Ion-Implanted Regions, *J. Appl. Phys.* 55, 4436-4443 (1984).
39. Schafft, H. A., Younkens, C. D., Grant, T. C., Kao, C. Y., and Saxena, A. N., Effect of Passivation and Passivation Defects on Electromigration Failure in Aluminum Metalization, 22d Annual Proceedings, Reliability Physics 1984, Las Vegas, NV, April 3-5, 1984, pp. 250-255 (1984).
40. Seabaugh, A. C., Bell, M. I., Larrabee, R. D., and Oliver, J. D., High-Frequency Transient-Resistance Spectroscopy of Deep Levels in Semi-Insulated GaAs. Semi-Insulating III-V Materials: Kah-neeta 1984 D. C. Look, and J. S. Blakemore Eds., pp. 437-445 (Shiva Publishing, Ltd., Cheshire, England, 1984).

41. Suehle, J. S., Beginning an Engineering Career at a Government Agency, Eng. Horizons Spring, 152 (1984).
42. Suehle, J. S., Government Research, Engineering Horizons Fall, 226 (1984).
43. Suehle, J. S., Linholm, L. W., and Kafadar, K., Minimum Test Chip Sample Size Selection for Characterizing Process Parameters, IEEE J. Solid State Circuits SC-19, 122-129 (1984).
44. Suehle, J. S., Linholm, L. W., and Kafadar, K., Minimum Test Chip Sample Size Selection for Characterizing Process Parameters, IEEE Trans. Electron Devices ED-31, 257-264 (1984).
45. Thurber, W. R., Lowney, J. R., and Phillips, W. E., Measurement Techniques for High Power Semiconductor Materials and Devices: Annual Report, January 1, 1982 to March 31, 1983, NBSIR 84-2838 (1984).
46. Wilson, C. L., and Blue, J. L., Two-Dimensional Modeling of N-Channel MOSFETs Including Radiation-Induced Interface and Oxide Charge, IEEE Trans. Nucl. Sci. NS-31, 1448-1452 (1984).
47. Wilson, C. L., Roitman, P., Marchiando, J. F., and Blue, J. L., Modeling of the Process Sensitivity of Submicron Silicon MOSFETs, Ext. Abs. of the Electrochemical Society, New Orleans, LA, Oct. 13-17, 1984 84-2, p. 709 (1984).
48. Yen, D., and Linholm, L. W., Using Linewidth Measurement Test Structures to Evaluate Lithographic Processes and Equipment, Test & Measurement World, 46ff (1984).



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Publications for the Year 1983

1. Albers, J., Investigation of the Relation Between the Correction Factor and the Local Slope in Spreading Resistance, Ext. Abs. of the Electrochemical Society, Washington, D.C., Oct. 9-14, 1983, 83-2, pp. 514-515 (1983).
2. Albers, J., The Relation Between the Correction Factor and the Local Slope in Spreading Resistance, J. Electrochem. Soc. 130, 2076-2080 (1983).
3. Albers, J., Roitman, P., and Wilson, C. L., Verification of Models for Fabrication of Arsenic Source-Drains in VLSI MOSFET's, IEEE Trans. Electron Devices ED-30, 1453-1462 (1983).
4. Albers, J., Wilson, C. L., and Blue, J. L., Effect of Surface Beveling on Carrier Profiles, Ext. Abs. of the Electrochemical Society, San Francisco, CA, May 8-13, 1983 83-1, pp. 641-642 (1983).
5. Baghdadi, A., Implicit Apodization of Interferograms in Fourier Transform Spectroscopy, Appl. Spectrosc. 37(6), 520-523 (1983).
6. Baghdadi, A., Multiple-Reflection Corrections in Fourier Transform Spectroscopy. Defects in Silicon 83-9, W. M. Bullis, and L. C. Kimerling Eds., pp. 293-302 (Electrochemical Society, Pennington, NJ, 1983).
7. Baghdadi, A., Multiple Reflection Corrections in Fourier Transform IR Spectroscopy of Back Surface Damaged Wafers, Ext. Abs. of the Electrochemical Society, San Francisco, CA, May 8-13, 1983, 83-1, pp. 460-461 (1983).
8. Baylies, W. A., Scace, R. I., and Vieweg-Gutberlet, F. G., International Standards for Semiconductor Materials, ASTM Standardization News II, 21-23 (1983).
9. Bennett, H. S., Inequality of Hole Mobilities in Heavily Doped n-Type and p-Type Silicon, Ext. Abs. of the Electrochemical Society, Washington, DC, Oct. 9-14, 1983, 83-2, pp. 542-543 (1983).
10. Bennett, H. S., Improved Concepts for Predicting the Electrical Behavior of Bipolar Structures in Silicon, IEEE Trans. Electron Devices ED-30, 920-927 (1983).
11. Bennett, H. S., Hole and Electron Mobilities in Heavily Doped Silicon: Comparison of Theory and Experiment, Solid-State Electronics 26, 1157-1166 (1983).
12. Berkowitz, H. L., and Albers, J., The Relation Between Two-Probe and Four-Probe Resistances on Nonuniform Structures, Ext. Abs. of the Electrochemical Society, San Francisco, CA, May 8-13, 1983, 83-1, pp. 622-623 (1983).
13. Blackburn, D. L., Benedetto, J. M., and Galloway, K. F., The Effect of Ionizing Radiation on the Breakdown Voltage of Power MOSFETs, IEEE Trans. Nucl. Sci.

- NS-30, 4116-4121 (1983).
14. Blue, J. L., and Wilson, C. L., Two-Dimensional Analysis of Semiconductor Devices Using General-Purpose Interactive PDE Software, *IEEE Trans. Electron Devices* ED-30, 1056-1070 (1983).
  15. Blue, J. L., and Wilson, C. L., Two-Dimensional Analysis of Semiconductor Devices Using General-Purpose Interactive PDE Software, *SIAM J. Stat. Sci. Comput.* 4, 462-484 (1983).
  16. Bunding, K. A., and Bell, M. I., Surface-Enhanced Raman Spectroscopy of Pyridine Derivatives: Effects of Adsorption on Electronic Structure, *Surf. Sci.* 118, 329-344 (1983).
  17. Carver, G. P., Influence of Short-Channel Effects on Dopant Profiles Obtained from the DC MOSFET Profile Method, *IEEE Trans. Electron Devices* ED-30, 948-954 (1983).
  18. Cassard, J. M., The Sensitivity of SPICE Simulations to Input Parameter Variations, *Proc. 1983 Custom Integrated Circuits Conf., Rochester, NY, May 23-25, 1983*, pp. 224-228 (1983).
  19. Chandler-Horowitz, D., and Candela, G. A., On the Accuracy of Ellipsometric Thickness Determinations for Very Thin Films, *J. de Physique* 44, C10-23 - C10-26 (1983).
  20. Chen, D. Y., Lee, F. C., Blackburn, D. L., and Berning, D. W., Reverse-Bias Second Breakdown of High Power Darlington Transistors, *IEEE Trans. Aero. Elec. Sys.* AES-19, 840-847 (1983).
  21. Chen, D. Y., Lee, F. C., Blackburn, D. L., and Berning, D. W., Reverse-Bias Second Breakdown of High Power Darlington Transistors, *Proc. 6th Int. Power Conversion Conf., Orlando, FL, April 19-21, 1983*, pp. 15-25 (1983).
  22. Forman, R. A., Bell, M. I., Baghdadi, A., and Mayo, S., Effect of Striations on the Compositional Analysis of Silicon Crystals. *Defects in Silicon 83-9* W. M. Bullis, and L. C. Kimerling Eds., pp. 303-312 (Electrochemical Society, Pennington, NJ, 1983).
  23. Forman, R. A., Bell, M. I., Baghdadi, A., and Mayo, S., The Effect of Striations on the Compositional Analysis of Silicon Crystals, *Ext. Abs. of the Electrochemical Society San Francisco, CA, May 8-13, 1983*, 83-1, pp. 463-464 (1983).
  24. French, J. C., Galloway, K. F., and Scace, R. I., The Challenge of Semiconductor Metrology, *Proc. 1983 Mea. Sci. Conf., Palo Alto, CA, Jan. 19-20, 1983*, pp. 171-188 (1983).
  25. Harman, G. G., The Microelectronic Ball-Bond Shear Test - A Critical Review and Comprehensive Guide to Its Use, *Int. J. Hybrid Microelectronics* 6, 127-141 (1983).
  26. Hinkley, J. A., A Blister Test for Adhesion of Polymer Films to SiO<sub>2</sub>, *J. Adhesion* 16,



115-126 (1983).

27. Kahn, A. H., and Lowney, J. R., Multiple Scattering Theory of the Density of States in Semiconductors, *Solid State Commun.* 46, 229-233 (1983).
28. Lantz, M. D., and Galloway, K. F., Total Dose Effects on Circuit Speed Measurements, *IEEE Trans. Nucl. Sci.* NS-30, 4264-4269 (1983).
29. Larrabee, R. D., and Lowney, J. R., Measurement Techniques for High-Resistivity Detector-Grade Silicon: Progress Report, July 1, 1982 to June 30, 1983, NBSIR 83-2792 (1983).
30. Lowney, J. R., and Bennett, H. S., Effect of Ionized Donors on the Electron and Hole Densities of States in Silicon, *J. Appl. Phys.* 54, 1369-1374 (1983).
31. Lowney, J. R., Larrabee, R. D., and Thurber, W. R., The Relationship Between Deep-Level Measurements and Lifetime in Devices, Proc. 1983 Custom Integrated Circuits Conference, Rochester, NY, May 23-25, 1983, pp. 152-156 (1983).
32. Mattis, R. L., Semiconductor Measurement Technology: A FORTRAN Program for Analysis of Data from Microelectronic Test Structures, NBS Spec. Publ. 400-75 (1983).
33. Mattis, R. L., and Zucker, R., Release Notes for STAT2 Version 1.31: An Addendum to NBS Special Publication 400-75, NBSIR 83-2779 (1983).
34. Mazer, J. A., Linholm, L. W., Pramanik, D., Tsai, S., and Saxena, A. N., Comparison of Aluminum/Silicon Contact Resistance Values Obtained by Contact Chain and Kelvin Measurement Structures, Ext. Abs. of the Electrochemical Society, Washington, D.C., Oct. 9-14, 1983, 83-2, pp. 453-454 (1983).
35. Mazer, J. A., Linholm, L. W., Pramanik, D., Tsai, S., and Saxena, A. N., Effects of Phosphorus Contact Doping and Sheet Resistance Variations on Al/Si Interfacial Contact Resistance, Proc. 1983 Custom Integrated Circuits Conf., Rochester, NY, May 23-25, 1983, pp. 291-294 (1983).
36. Pande, K. P., and Seabaugh, A. C., Preparation of Device Quality GaAs Using Plasma-Enhanced MO-CVD Technique. III-V Opto-Electronics Epitaxy and Device Related Processes, 83-13, V. G. Keramidas, and S. Mahajan Eds., pp. 201-209 (Electrochemical Society, Pennington, NJ, 1983).
37. Phillips, W. E., and Lowney, J. R., Analysis of Nonexponential Transient Capacitance in Silicon Diodes Heavily Doped with Platinum, *J. Appl. Phys.* 54, 2786-2791 (1983).
38. Phillips, W. E., Thurber, W. R., and Lowney, J. R., Improved Analysis Procedures for Deep-Level Measurements by Transient Capacitance. Defects in Silicon 83-9 W. M. Bullis, and L. C. Kimerling Eds., pp. 485-490 (Electrochemical Society, Pennington, NJ, 1983).
39. Proctor, S. J., and Linholm, L. W., A Direct Measurement of Interfacial Contact

Resistance, Proc. Flat-Plate Solar Array Research Forum Photovoltaic Metallization Systems, Pine Mt., GA, March 16-18, 1983, pp. 99-102 (1983).

40. Proctor, S. J., Linholm, L. W., and Mazer, J. A., Direct Measurements of Interfacial Contact Resistance, End Contact Resistance, and Interfacial Contact Layer Uniformity, IEEE Trans. Electron Devices ED-30, 1535-1542 (1983).
41. Russell, T. J., Description of a CMOS Test Chip, NBS-39, NBSIR 83-2683 (1983).
42. Russell, T. J., Wilson, C. L., and Gaitan, M., Determination of the Spatial Variation of Interface Trapped Charge Using Short-Channel MOSFETs, IEEE Trans. Electron Devices ED-30, 1662-1671 (1983).
43. Suehle, J. S., Linholm, L. W., and Kafadar, K., A Method for Selecting a Minimum Test Chip Sample Size to Characterize Microelectronic Process Parameters, Proc. 1983 Custom Integrated Circuits Conf., Rochester, NY, May 23-25, 1983, pp. 308-312 (1983).
44. Yen, D., Linholm, L. W., Glendinning, W. B., Bass, J. F., and Cheville, D. E., An Electrical Measurement Technique for Estimating Proximity Effects in Electron-Beam Lithography, Ext. Abs. of the Electrochemical Society, Washington, D.C., Oct. 9-14, 1983, 83-2, pp. 333-334 (1983).
45. Zimmerman, D. D., and Schafft, H. A., VLSI Package Reliability Workshop Report, 21st Annual Proceedings, Reliability Physics 1983, Phoenix, AZ, April 5-7, 1983, pp. 320-323 (1983).

## Publications for the Year 1982

1. Albers, J., Spreading Resistance Probe-Spacing Experiment Simulations: Effects of Probe-Current Density and Layer Thickness, *J. Electrochem. Soc.* 129, 2788-2795 (1982).
2. Albers, J., Probe-Spacing Experiment Simulation and the Relation Between Spreading Resistance and Sheet Resistance, *J. Electrochem. Soc.* 129, 599-605 (1982).
3. Blackburn, D. L., and Berning, D. W., Power MOSFET Temperature Measurements, PESC '82 Record, IEEE Power Electronics Specialists Conference 1982, Cambridge, MA, June 14-17, 1982, pp. 400-407 (1982).
4. Blackburn, D. L., Berning, D. W., Benedetto, J. M., and Galloway, K. F., Ionizing Radiation Effects on Power MOSFETs During High Speed Switching, *IEEE Trans. Nucl. Sci.* NS-29, 1555-1558 (1982).
5. Bullis, W. M., and Nyssonen, D., Optical Linewidth Measurements on Photomasks and Wafers, Chapter 7. *VLSI Electronics: Microstructure Science Semiconductor Microlithography*, Vol. 3, N. G. Einspruch Ed., pp. 119-126 (Academic Press, New York, NY, 1982).
6. Carver, G. P., Mattis, R. L., and Buehler, M. G., Design Considerations for the Cross-Bridge Sheet Resistor, NBSIR 82-2548 (1982).
7. Chandler-Horowitz, D., Ellipsometric Accuracy and the Principal Angle of Incidence, *Proc. Soc. Photo-Optical Instrum. Engrs.*, Integrated Circuit Metrology 342, 121-130 (1982).
8. Chandler-Horowitz, D., and Candela, G. A., Principal Angle Spectroscopic Ellipsometry Utilizing a Rotating Analyzer, *Appl. Optics* 21, 2972-2977 (1982).
9. Cohen, E. C., and Ruthberg, S., Semiconductor Measurement Technology: NBS/RADC Workshop, Moisture Measurement Technology for Hermetic Semiconductor Devices, II, NBS Spec. Publ. 400-72 (1982).
10. Croarkin, M. C., and Varner, R. N., Measurement Assurance for Dimensional Measurements on Integrated-Circuit Photomasks, NBS Tech. Note 1164 (1982).
11. Harman, G. G., Semiconductor Measurement Technology: The Use of Acoustic Emission to Determine the Integrity of Large Kovar Glass-Sealed Microelectronic Packages, NBS Spec. Publ. 400-70 (1982).
12. Harman, G. G., How the "New" Technology Has Changed and Increased Classical Package-Related Failure Modes, Ext. Abs. VLSI Packaging Workshop (NBS/IEEE/CHMT), Gaithersburg, MD, Sept. 13-14, 1982, pp. 70-72 (1982).



13. Harman, G. G., Acoustic-Emission-Monitored Tests for TAB Inner Lead Bond Quality, *IEEE Trans. Components, Hybrids, and Manufacturing Technology* CHMT-5, 445-453 (1982).
14. Harman, G. G., Acoustic-Emission-Monitored Tests for TAB Inner Lead Bond Quality, *Proc. 32nd Electronic Components Conf., San Diego, CA, May 10-12, 1982*, pp. 268-276 (1982).
15. Harman, G. G., and Harmison, K. A., The Assessment of Hybrid Package Glass-Metal Seal Reliability Using Acoustic-Emission Measurement Techniques, *Int. J. Hybrid Microelectronics* 5, 248-259 (1982).
16. Hogan, S., and Schafft, H. A., Workshop Summary [of the Commercial Photovoltaics Measurements Workshop, Vail, CO, July 17-19, 1981], *Solar Cells* 7 (1-2), 3-22 (1982).
17. Jerke, J. M., Croarkin, M. C., and Varner, R. N., Semiconductor Measurement Technology: Interlaboratory Study on Linewidth Measurements for Antireflective Chromium Photomasks, *NBS Spec. Publ. 400-74* (1982).
18. Jerke, J. M., and Wendell, C. E., Use of the National Bureau of Standards (NBS) Antireflective (AR)-Chromium Optical Linewidth Standard for Measurements on Other Types of Chromium Photomasks, *Proc. Soc. Photo-Optical Instrum. Engrs., Integrated Circuit Metrology* 342, 15-26 (1982).
19. Johnson, N. M., DLTS Analysis of Residual Damage in Low-Dose Ion-Implanted Silicon, *NBS-GCR 81-364* (1982).
20. Kahn, A. H., and Lowney, J. R., Effect of Impurity Pairs on the Disappearance of Impurity Levels in Silicon, *J. Appl. Phys.* 53, 454-456 (1982).
21. Lowney, J. R., The Effect of Bandgap Narrowing on Diffusion Processes in Silicon. *VLSI Science and Technology/1982*, C. J. Dell'Oca, and W. M. Bullis Eds., pp. 123-129 (Electrochemical Society, Pennington, NJ, 1982).
22. Lowney, J. R., and Bennett, H. S., Effect of Donor Impurities on the Conduction and Valence Bands of Silicon, *J. Appl. Phys.* 53, 433-438 (1982).
23. Mattis, R. L., Till, L. J., and Frisch, R. C., A Computer Program for Analysis of Data from Microelectronic Test Structures, *NBSIR 82-2492* (1982).
24. Mayo, S., Lucatorto, T. B., and Luther, G. G., Laser Ablation and Resonance Ionization Spectrometry for Trace Analysis of Solids, *Anal. Chem.* 54, 553-556 (1982).
25. Nyyssonen, D., Theory of Optical Edge Detection and Imaging of Thick Layers, *J. Opt. Soc. Am.* 72, 1425-1436 (1982).
26. Nyyssonen, D., Calibration of Optical Systems for Linewidth Measurements on Wafers, *Opt. Eng.* 21 (5), 882-887 (1982).

27. Nyyssonen, D., Laser Micrometrology for Integrated Circuits, Proc. Inspection, Measurement, and Control Symp., ICALEO '82, Boston, MA, Sept. 20-23, 1982, pp. 24-30 (1982).
28. Nyyssonen, D., Design of an Optical Linewidth Standard Reference Material for Wafers, Proc. Soc. Photo-Optical Instrum. Engrs., Integrated Circuit Metrology 342, 27-34 (1982).
29. Oettinger, F. F., and Albers, J., Thermal Test Chips for VLSI Package Evaluation, Ext. Abs., VLSI Packaging Workshop (NBS/IEEE/CHMT), Gaithersburg, MD, Sept. 13-14, 1982, pp. 46-47 (1982).
30. Phillips, W. E., Improved Thermometry for Deep-Level Measurements, J. Phys. E 15, 499-501 (1982).
31. Proctor, S. J., and Linholm, L. W., A Microelectronic Test Structure for Measuring Contact Resistance in Integrated Circuits, Ext. Abs. of the Electrochemical Society 82-1, 372-373 (1982).
32. Proctor, S. J., and Linholm, L. W., A Direct Measurement of Interfacial Contact Resistance, IEEE Electron Device Letters EDL-3, 294-296 (1982).
33. Russell, T. J., Production-Compatible Microelectronic Test Structures for the Measurement of Interface State Density and Neutral Trap Density, NBSIR 81-2413 (1982).
34. Ruthberg, S., Semiconductor Measurement Technology: Graphical Solution for the Helium Leak Detector and Radioisotope Methods of Hermetic Test, Master Graphs and Instructions, NBS Spec. Publ. 400-73 (1982).
35. Ruthberg, S., Hermetic Testing of Large Hybrid Packages, Int. J. Hybrid Microelectronics 5, 215-232 (1982).
36. Ruthberg, S., Leak Testing of Hermetically Sealed Electronic Components, Proc. Qualtest I, ASNT, Pittsburgh, PA, Oct. 4-7, 1982, pp. 431-436 (1982).
37. Scafe, R. I., The Semiconductor Equipment and Materials Institute Specifications for Solar Cell Silicon, Solar Cells 7 (1-2), 77-78 (1982).
38. Schafft, H. A., Measurements for Commercial Photovoltaics: A Status Report, Solar Cells 7 (1-2), 23-46 (1982).
39. Stahlbush, R. E., and Forman, R. A., Vibronic Spectrum of the U2 Isoelectronic Center in Si:In, J. Luminescence 26, 227-232 (1982).
40. Suehle, J. S., Linholm, L. W., and Marshall, G. M., Evaluation of a CMOS/SOS Process Using Process Validation Wafers, NBSIR 82-2514 (1982).
41. Thomas, D. B., An Approved Laboratory Program for Photovoltaic Reference Cell Development, Solar Cells 7 (1-2), 131-134 (1982).

42. Thomas, D. B., A Certification Program for Photovoltaic Modules, *Solar Cells* 7 (1-2), 183-186 (1982).
43. Thurber, W. R., Forman, R. A., and Phillips, W. E., A Novel Method to Detect Nonexponential Transients in Deep Level Transient Spectroscopy, *J. Appl. Phys.* 53, 7397-7400 (1982).
44. Thurber, W. R., Phillips, W. E., and Larrabee, R. D., Measurement Techniques for High Power Semiconductor Materials and Devices: Annual Report, October 1, 1980 to December 31, 1981, NBSIR 82-2552 (1982).
45. Waksman, D., Solar Collector Certification Activities and Experiences, *Solar Cells* 7 (1-2), 187-196 (1982).
46. Wilson, C. L., and Blue, J. L., CS1: A Two-Dimensional Finite Element Charge-Sheet Model of a Short-Channel MOS Transistor, NBSIR 82-2471 (1982).
47. Wilson, C. L., and Blue, J. L., Modeling of Ionizing Radiation Effects in Short-Channel MOSFETs, *IEEE Trans. Nucl. Sci.* NS-29, 1676-1680 (1982).
48. Wilson, C. L., and Blue, J. L., Two-Dimensional Finite Element Charge-Sheet Model of a Short-Channel MOS Transistor, *Solid-State Electronics* 25, 461-477 (1982).
49. Wilson, R. G., and Jamba, D. M., Semiconductor Measurement Technology: Differential Capacitance-Voltage Profiling of Schottky Barrier Diodes for Measuring Implanted Depth Distributions in Silicon, NBS Spec. Publ. 400-71 (1982).
50. Wilson, R. G., and Weglein, R. D., Reflection Acoustic Microscopy, NBS-GCR 82-401 (1982).
51. Yen, D., Electrical Test Methods for Evaluating Lithographic Processes and Equipment, *Proc. Soc. Photo-Optical Instrum. Engrs.*, Integrated Circuit Metrology 342, 73-81 (1982).
52. Yen, D., Linholm, L. W., and Buehler, M. G., A Cross-Bridge Test Structure for Evaluating the Linewidth Uniformity of an Integrated Circuit Lithography System, *J. Electrochem. Soc.* 129, 2313-2318 (1982).



## Publications for the Year 1981

1. Baghdadi, A., and Forman, R. A., Tertiary Interferograms in Fourier Transform Spectroscopy, *Appl. Spectrosc.* 35(5), 473-475 (1981).
2. Bennett, H. S., Upper Limits for the Number of Bound States Associated with the Yukawa Potential, *J. Res. Natl. Bur. Standards* 86, 503-508 (1981).
3. Bennett, H. S., and Lowney, J. R., Effect of Donor Impurities on the Density of States near the Band Edge in Silicon, *J. Appl. Phys.* 52, 5633-5642 (1981).
4. Berning, D. W., Use of Vacuum Tubes in Test Instrumentation for Measuring Characteristics of Fast High-Voltage Semiconductor Devices, *IEEE Trans. Instrumentation and Measurement* IM-30, 226-227 (1981).
5. Berning, D. W., and Blackburn, D. L., The Effect of Magnetic Package Leads on the Measurement of Thermal Resistance of Semiconductor Devices, *IEEE Trans. Electron Devices* ED-28, 609-611 (1981).
6. Blackburn, D. L., Power Transistor Switching Characterization, NBSIR 81-2204 (1981).
7. Blackburn, D. L., Robbins, T. C., and Galloway, K. F., VDMOS Power Transistor Drain-Source Resistance Radiation Dependence, *IEEE Trans. Nucl. Sci.* NS-28, 4354-4359 (1981).
8. Blue, J. L., and Wilson, C. L., Calculating Eigenvalues and Eigenfunctions Using an Interior Constraint, *J. Computational Physics* 44, 70-83 (1981).
9. Buehler, M. G., and Linholm, L. W., Toward a Standard Test Chip Methodology for Reliable, Custom Integrated Circuits, *Proc. 1981 Custom Integrated Circuits Conf., Rochester, NY, May 11-13, 1981*, pp. 142-146 (1981).
10. Buehler, M. G., and Linholm, L. W., The Role of Test Chips in Coordinating Logic and Circuit Design and Layout Aids for VLSI, *Proc. 2d Cal. Tech. Conf. on VLSI, Pasadena, CA, Jan. 19-21, 1981*, pp. 135-151 (1981).
11. Buehler, M. G., and Linholm, L. W., Role of Test Chips in Coordinating Logic and Circuit Design and Layout Aids for VLSI, *Solid State Technology* 24, 68-74 (1981).
12. Buehler, M. G., and Perloff, D. S., Microelectronic Test Chips and Associated Parametric Testers: Present and Future. *Semiconductor Silicon/1981*, H. R. Huff, R. J. Kriegler, and Y. Takeishi Eds., pp. 859-867 (Electrochemical Society, Pennington, NJ, 1981).
13. Bullis, W. M., Advancement of Reliability, Processing and Automation for Integrated Circuits with the National Bureau of Standards (ARPA/IC/NBS), NBSIR 81-2224 (1981).

14. Bullis, W. M., Integrated Circuit Metrology, EDN Magazine 26 (20), 120- 122ff (1981).
15. Bullis, W. M., and Ehrstein, J. R., Reference Materials and the Semiconductor Industry, Solid State Technology 24(11), 56-63 (1981).
16. Bullis, W. M., and Scafe, R. I., The Department of Commerce and the Role of Government Standards. VLSI Electronics, Microstructure Science, Vol.1, N. G. Einspruch Ed., pp. 281-286 (Academic Press, New York, NY, 1981).
17. Candela, G. A., Galloway, K. F., Liu, Y. M., and Fine, J., Measurement of the Interlayer Between Aluminum and Silicon Dioxide Using Ellipsometric, Capacitance-Voltage and Auger Electron Spectroscopy Techniques, Thin Solid Films 82, 183-193 (1981).
18. Carver, G. P., Development of Test Structures for Characterization of the Fabrication and Performance of Radiation-Hardened Charge-Coupled Device (CCD) Imagers: Annual Report, May 15, 1980 to May 14, 1981, NBSIR 81-2319 (1981).
19. Carver, G. P., and Cullins, W. A., Semiconductor Measurement Technology: A Manual Wafer Probe Station for an Integrated Circuit Test System, NBS Spec. Publ. 400-68 (1981).
20. Carver, G. P., Mattis, R. L., and Buehler, M. G., Microelectronic Test Patterns NBS-12 and NBS-24, NBSIR 81-2234 (1981).
21. Ehrstein, J. R., and Seabaugh, A. C., Gallium Arsenide Materials Characterization: Annual Report, October 12, 1978 to October 12, 1979, NBSIR 81-2403 (1981).
22. Forman, R. A., Bell, M. I., and Myers, D. R., Comments on "Raman Scattering from Boron-Implanted Laser Annealed Silicon," J. Appl. Phys. 52, 4337-4339 (1981).
23. Forman, R. A., Larrabee, R. D., Myers, D. R., Phillips, W. E., and Thurber, W. R., Processing Effects on the Electrical and Optical Properties of Sulfur-Related Defect Centers in Silicon and Similarities to the Oxygen Donor. Defects in Semiconductors, J. Narayan and T. Y. Tan Eds., pp. 79-84 (North Holland, NY, 1981).
24. Geist, J., and Lowney, J. R., Effect of Band-Gap Narrowing on the Built-In Electric Field in n-Type Silicon, J. Appl. Phys. 52, 1121-1123 (1981).
25. Harman, G. G., The Use of Acoustic Emission as a Test Method for Electronic Interconnections and Joints, Proc. Int. Conf. Soft Soldering in Electronics & Precision Mechanics, Munich, Germany, Nov. 11-12, 1981, pp. 104-110 (1981).
26. Helms, C. R., Schwarz, S. A., Spicer, W. E., and Taylor, N. J., Innovative Measurement Technology for the Semiconductor Device Industry Based on Electron Spectroscopy, NBS-GCR 81-345 (1981).
27. Lankford, W. F., Kowalski, P., and Schafft, H. A., Laser Scanning Measurements on Solar Cell Test Pattern NBS-22, NBSIR 81-2260 (1981).



28. Larrabee, R. D., Phillips, W. E., and Thurber, W. R., Measurement Techniques for High Power Semiconductor Materials and Devices: Annual Report, October 1, 1979 to September 30, 1980, NBSIR 81-2325 (1981).
29. Larrabee, R. D., Thurber, W. R., and Bullis, W. M., Electrical Parameters of Extrinsic Silicon, *Circuits Manufacturing* 21(5), 82-100 (1981).
30. Leedy, T. F., McLane, G. F., and Guenzer, G. C., Temperature Dependence of Transient Electron Radiation Upset in TTL Circuits, *IEEE Trans. Nucl. Sci.* NS-28, 4597-4605 (1981).
31. Lehovec, K., and Fedotowsky, A., Solar Cell Mathematical Analysis and Computer Simulation, NBS-GCR 80-285 (1981).
32. Li, S. S., Conductivity Mobility, Hall Mobility, and Resistivity in n-Type Silicon, NBS-GCR 81-334 (1981).
33. Lin, J. F., Li, S. S., Linares, L. C., and Teng, K. W., Theoretical Analysis of Hall Factor and Hall Mobility in p-Type Silicon, *Solid-State Electronics* 24, 827-833 (1981).
34. Linares, L. C., and Li, S. S., An Improved Model for Analyzing Hole Mobility and Resistivity in p-Type Silicon Doped with Boron, Gallium, and Indium, *J. Electrochem. Soc.* 128, 601-608 (1981).
35. Linholm, L. W., Semiconductor Measurement Technology: The Design, Testing, and Analysis of a Comprehensive Test Pattern for Measuring CMOS/SOS Process Performance and Control, NBS Spec. Publ. 400-66 (1981).
36. Linholm, L. W., Mattis, R. L., Frisch, R. C., and Reeve, C. P., Characterizing and Analyzing Critical Integrated Circuit Process Parameters. *Semiconductor Silicon/1981* H. R. Huff, R. J. Kriegler, and Y. Takeishi Eds., pp. 906-920 (Electrochemical Society, Pennington, NJ, 1981).
37. Lowney, J. R., Kahn, A. H., Blue, J. L., and Wilson, C. L., Disappearance of Impurity Levels in Silicon and Germanium Due to Screening, *J. Appl. Phys.* 52, 4075-4080 (1981).
38. McCarthy, D., Acevedo, J., and Herman, D., Advanced Planar Silicon Test Structures, NBS-GCR 81-327 (1981).
39. Mitchell, M. A., and Linholm, L. W., Semiconductor Measurement Technology: Test Patterns NBS-28 and NBS-28A: Random Fault Interconnect Step Coverage and Other Structures, NBS Spec. Publ. 400-65 (1981).
40. Mitchell, M. A., Linholm, L. W., Russell, T. J., and Carver, G. P., Electrical Test Structures for Characterization and Control of Microelectronics Processing. *Proc. Microelectronics Measurement Technology Seminar*, San Jose, CA, March 17-18, pp. VI-1 - VI-29 (Benwill Publishing Co., Boston, MA, 1981).

41. Myers, D. R., Comas, J., and Wilson, R. G., Effect of Silicon Dioxide Surface-Layer Thickness on Boron Profiles for Directly Aligned Implants into (100) Silicon, *J. Appl. Phys.* 52, 3357-3359 (1981).
42. Novotny, D. B., Photoresist Sensitometry and Exposure Modeling, *Solid State Technology* 24 (3), 83-88, (1981).
43. Peckerar, M. C., and Galloway, K. F., Informal Survey of Federal Government Microelectronics Processing Facilities. *Proc. 4th Biennial Univ/Industry/Govt Microelectronics Symp.*, Mississippi State Univ., May 1981, p. III (1981).
44. Roitman, P., Albers, J., Ehrstein, J. R., and Myers, D. R., Investigation of the Two-Dimensional Shape of Ion-Implanted Regions, NBSIR 81-2398 (1981).
45. Ruthberg, S., Graphical Solution for the Back Pressurization Method of Hermetic Test, *IEEE Trans. Components, Hybrids, and Manufacturing Tech.* CHMT-4, 217-224 (1981).
46. Sawyer, D. E., Kessler, H. K., Russell, T. J., Lankford, W. F., and Schafft, H. A., Measurement Techniques for Solar Cells, Annual Report, December 15, 1978 to December 14, 1979, NBSIR 80-2181 (1981).
47. Scace, R. I., Semiconductor Technology for the Non-Technologist, NBSIR 81-2197 (1981).
48. Scace, R. I., The Semiconductor Equipment and Materials Institute Specifications for Solar Cell Silicon, *Proc. Commercial Photovoltaics Measurements Workshop*, Vail, CO, July 17-19, 1981, pp. 107-108 (1981).
49. Schafft, H. A., Measurements for Commercial Photovoltaics: A Status Report, *Proc. Commercial Photovoltaics Measurements Workshop*, Vail, CO, July 17-19, 1981, pp. 7-29 (1981).
50. Schafft, H. A., Ruthberg, S., and Cohen, E. C., Semiconductor Measurement Technology: ARPA/NBS Workshop V. Moisture Measurement Technology for Hermetic Semiconductor Devices, NBS Spec. Publ. 400-69 (1981).
51. Schwarz, S. A., Helms, C. R., Spicer, W. E., and Taylor, N. J., Semiconductor Measurement Technology: The Capabilities and Limitations of Auger Sputter Profiling for Studies of Semiconductors, NBS Spec. Publ. 400-67 (1981).
52. Thomas, D. B., A Certification Program for Photovoltaic Modules, *Proc. Commercial Photovoltaics Measurements Workshop*, Vail, CO, July 17-19, 1981, pp. 275-278 (1981).
53. Thomas, D. B., An Approved Laboratory Program for Photovoltaic Reference Cell Development, *Proc. Commercial Photovoltaics Measurements Workshop*, Vail, CO, July 17-19, 1981, pp. 201-204 (1981).

54. Thurber, W. R., Mattis, R. L., Liu, Y. M., and Filliben, J. J., Semiconductor Measurement Technology: The Relationship Between Resistivity and Dopant Density for Phosphorus- and Boron-Doped Silicon, NBS Spec. Publ. 400-64 (1981).
55. Vasquez, R. P., Klein, J. D., Barton, J. J., and Grunthaner, F. J., Application of Maximum-Entropy Spectral Estimation to Deconvolution of XPS Data, *J. Electron. Spectrosc.* 23, 63-81 (1981).
56. Waksman, D., Solar Collector Certification Activities and Experiences, Proc. Commercial Photovoltaics Measurements Workshop, Vail, CO, July 17-19, 1981, pp. 279-280 (1981).
57. Wilson, R. G., Measurement Technology for Critical Ion Implantation Parameters, NBS-GCR 81-325 (1981).
58. Wilson, R. G., and Weglein, R. D., Reflection Acoustic Microscope Measurement Technology, NBS-GCR 81-363 (1981).



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Publications for the Year 1980

1. Albers, J., Continuum Formulation of Spreading Resistance Correction Factors, *J. Electrochem. Soc.* 127, 2259-2263 (1980).
2. Albers, J., Comparison of Spreading Resistance Correction Factor Algorithms Using Model Data, *Solid-State Electronics* 23, 1197-1205 (1980).
3. Albers, J., and Novotny, D. B., Intensity Dependence of Photochemical Reaction Rates for Photoresists, *J. Electrochem. Soc.* 127, 1400-1403 (1980).
4. Blackburn, D. L., and Berning, D. W., An Experimental Study of Reverse-Bias Second Breakdown, *Tech. Digest, 1980 Int. Electron Devices Meeting, Washington, D.C., Dec. 8-10, 1980*, pp. 297-301 (1980).
5. Buehler, M. G., Effect of the Drain-Source Voltage on Dopant Profiles Obtained from the d-c MOSFET Profile Method, *IEEE Trans. Electron Devices ED-27*, 2273-2277 (1980).
6. Buehler, M. G., The Use of Electrical Test Structure Arrays for Integrated Circuit Process Evaluation, *J. Electrochem. Soc.* 127, 2284-2290 (1980).
7. Buehler, M. G., The D-C MOSFET Dopant Profile Method, *J. Electrochem. Soc.* 127, 701-704 (1980).
8. Bullis, W. M., *Semiconductor Measurement Technology: Metrology for Submicrometer Devices and Circuits*, NBS Spec. Publ. 400-61 (1980).
9. Bullis, W. M., Characterizing Semiconducting Materials, *Semiconductor International* 3 (9), 79-91 (1980).
10. Bullis, W. M., and Scace, R. I., The NBS Semiconductor Technology Program and VLSI, NBSIR 80-2057 (1980).
11. Carver, G. P., and Buehler, M. G., An Analytical Expression for the Evaluation of Leakage Current in the Integrated Gated-Diode Electrometer, *IEEE Trans. Electron Devices ED-27*, 2245-2252 (1980).
12. Carver, G. P., Linholm, L. W., and Russell, T. J., Use of Microelectronic Test Structures to Characterize IC Materials, Processes, and Processing Equipment, *Solid State Technology* 23 (9), 85-92 (1980).
13. Carver, G. P., and Rubin, S., Development of Test Structures for Characterization of the Fabrication and Performance of Radiation-Hardened Charge-Coupled Device (CCD) Imagers: Annual Report, December 1, 1978 to November 30, 1979, NBSIR 80-2000 (1980).

14. Comas, J., and Wilson, R. G., Channeling and Random Equivalent Depth Distributions of 150 keV Li, Be, and B Implanted in Silicon, *J. Appl. Phys.* 51, 3697-3701 (1980).
15. DeBlasio, R., Forman, S., Hogan, S., Nuss, G., Post, H., Ross, R., and Schafft, H. A., Interim Performance Criteria for Photovoltaic Energy Systems, SERI Report TR 742-654 (1980).
16. Duffy, M. T., Zanzucchi, P. J., Ham, W. E., Corboy, J. F., and Cullen, G. W., Semiconductor Measurement Technology: Method to Determine the Quality of Sapphire, NBS Spec. Publ. 400-62 (1980).
17. Ehrstein, J. R., Some Considerations Regarding Film Thickness Standards for the Semiconductor Industry, NBSIR 80-2158 (1980).
18. Ehrstein, J. R., Spreading Resistance Calibration for Gallium- or Aluminum-Doped Silicon, *J. Electrochem. Soc.* 127, 1403-1404 (1980).
19. Ehrstein, J. R., Some Considerations Regarding Film Thickness Standards for the Semiconductor Industry, Proc. Microelectronic Measurement Technology Seminar, San Jose, CA, March 12-13, 1980, pp. 324-334 (1980).
20. Forman, R. A., Optical Study of Isotopic Effects in the Sulfur Deep Level in Silicon, *Appl. Phys. Letters* 37, 776-778 (1980).
21. Galloway, K. F., Radiation Damage Estimates and Control in Ion-Beam Lithography, *J. Electrochem. Soc.* 127, 1862-1864 (1980).
22. Grunthaner, F. J., Lewis, B. F., Vasquez, R. P., Maserjian, J., and Madhukar, A., Reduced Oxidation States and Radiation-Induced Trap Generation at Si/SiO<sub>2</sub> Interface. The Physics of MOS Insulators, G. Lucovsky, S. T. Pantelides and F. L. Galeener Eds., pp. 290-295 (Pergamon Press, New York, NY, 1980).
23. Grunthaner, F. J., Lewis, B. F., Zamini, N., Maserjian, J., and Madhukar, A., XPS Studies of Structure-Induced Radiation Effects at the Si/SiO<sub>2</sub> Interface, *IEEE Trans. Nucl. Sci.* NS-27, 1640-1646 (1980).
24. Ham, W. E., Semiconductor Measurement Technology: Comprehensive Test Pattern and Approach for Characterizing SOS Technology, NBS Spec. Publ. 400-56 (1980).
25. Harman, G. G., The Use of Acoustic Emission to Determine the Integrity of Large Hybrid Packages, NBSIR 80-2055 (1980).
26. Hasegawa, S., Performance Characteristics of a Thin-Film Aluminum Oxide Humidity Sensor, Proc. 30th Electronic Components Conf., San Francisco, CA, April 28-30, 1980, pp. 386-391 (1980).
27. Jerke, J. M., Semiconductor Measurement Technology: Accurate Linewidth Measurements on Integrated-Circuit Photomasks, NBS Spec. Publ. 400-43 (1980).

28. Kasdan, H. L., Linewidth Measurement by Diffraction Pattern Analysis, NBS-GCR 79-175 (1980).
29. Kenney, J. M., Semiconductor Measurement Technology: Modulation Measurements for Microwave Mixers, NBS Spec. Publ. 400-16 (1980).
30. Lankford, W. F., and Schafft, H. A., Drafting Test Methods for Photovoltaic Systems, NBSIR 80-2060 (1980).
31. Larrabee, R. D., Interpretation of Hall Measurements, J. Electrochem. Soc. 127, 1640-1643 (1980).
32. Larrabee, R. D., and Blackburn, D. L., Theory and Application of a Nondestructive Photovoltaic Technique for the Measurement of Resistivity Variations in Circular Semiconductor Slices, Solid-State Electronics 23, 1059-1068 (1980).
33. Larrabee, R. D., and Thurber, W. R., Theory and Application of a Two-Layer Hall Technique, IEEE Trans. Electron Devices ED-27, 32-36 (1980).
34. Larrabee, R. D., Thurber, W. R., and Bullis, W. M., Semiconductor Measurement Technology: A FORTRAN Program for Calculating the Electrical Properties of Extrinsic Silicon, NBS Spec. Publ. 400-63 (1980).
35. Lehovec, K., and Fedotowsky, A., Scanning Light Spot Analysis of Faulty Solar Cells, Solid-State Electronics 23, 565-576 (1980).
36. Lowney, J. R., and Larrabee, R. D., The Use of Fick's Law in Modeling Diffusion Processes, IEEE Trans. Electron Devices ED-27, 1795-1798 (1980).
37. Lucatorto, T. B., McIlrath, T. J., Mayo, S., and Furumoto, H. W., High-Stability Coaxial Flashlamp-Pumped Dye Laser, Appl. Optics 19, 3178-3180 (1980).
38. Myers, D. R., Semiconductor Measurement Technology: Technical Impediments to a More Effective Utilization of Neutron Transmutation Doped Silicon for High-Power Device Fabrication, NBS Spec. Publ. 400-60 (1980).
39. Myers, D. R., Koyama, R. Y., and Phillips, W. E., An Implantation Predeposition Technique for the Introduction of Deep-Level Chemical Impurities, Radiation Effects 48, 145-150 (1980).
40. Myers, D. R., Roitman, P., Mayo, S., and Horowitz, D., Electronic Properties of Ion-Implanted Silicon Annealed with Microsecond Dye-Laser Pulses. Laser and Electron Beam Processing of Mater., C. W. White and P. S. Percy Eds., pp. 285-290 (Academic Press, New York, NY, 1980).
41. Myers, D. R., and Wilson, R. G., Alignment Effects on Implantation Profiles in Silicon, Radiation Effects 47, 91-94 (1980).
42. Novotny, D. B., Experimental Photoresist Sensitometry and Exposure Modeling, Proc.



- Soc. Photo-Optical Instrum. Engrs., Semiconductor Microlithography V, 221, 184-193 (1980).
43. Nyyssonen, D., Calibration of Optical Systems for Linewidth Measurements on Wafers, Proc. Soc. Photo-Optical Instrum. Engrs., Semiconductor Microlithography V, 221, 119-126 (1980).
  44. Nyyssonen, D., Linewidth Measurement Spotlight, Semiconductor International 3 (3), 39-56 (1980).
  45. Oettinger, F. F., and Larrabee, R. D., Measurement Techniques for High Power Semiconductor Materials and Devices: Annual Report, October 1, 1978 to September 30, 1979, NBSIR 80-2061 (1980).
  46. Patrick, S., and Giuntini, R., Terrestrial Solar Simulators for Photovoltaic and Combined Photovoltaic and Thermal Device Measurement and Evaluation, NBS-GCR 80-279 (1980).
  47. Quate, C. F., Innovative Measurement Technology for the Semiconductor Device Industry - "The Acoustic Microscope - A New Instrument for Viewing Integrated Circuits," NBS-GCR 80-204 (1980).
  48. Ruthberg, S., A Rapid Cycle Method for Gross Leak Testing with the Helium Leak Detector, IEEE Trans. Components, Hybrids, and Manufacturing Tech. CHMT-3, 564-570 (1980).
  49. Ruthberg, S., A Rapid Cycle Method for Gross Leak Testing with the Helium Leak Detector, Proc. 30th Electronic Components Conf., San Francisco, CA, April 28-30, 1980, pp. 128-134 (1980).
  50. Sawyer, D. E., and Kessler, H. K., Laser Scanning of Solar Cells for the Display of Cell Operating Characteristics and Detection of Cell Defects, IEEE Trans. Electron Devices ED-27, 864-872 (1980).
  51. Sawyer, D. E., Kessler, H. K., and Schafft, H. A., Measurement Techniques for Solar Cells, Annual Report for the Period September 15, 1977 to December 14, 1978, NBSIR 80-2027 (1980).
  52. Scace, R. I., ASTM Standard Test Methods for the Semiconductor Industry, Proc. 1st SEMI European Symp. on Materials & Processing, Zurich, Switzerland, March 13, 1981, pp. 202-209 (1980).
  53. Thomas, D. B., Information and Guidelines for a Proposed Laboratory Accreditation and Product Certification Program for Photovoltaic Energy Conversion Systems, NBSIR 80-2028 (1980).
  54. Thurber, W. R., A Comparison of Measurement Techniques for Determining Phosphorus Densities in Semiconductor Silicon, J. Electron. Mater. 9, 551-560 (1980).

55. Thurber, W. R., Mattis, R. L., Liu, Y. M., and Filliben, J. J., Resistivity-Dopant Density Relationship for Phosphorus-Doped Silicon, *J. Electrochem. Soc.* 127, 1807-1812 (1980).
56. Thurber, W. R., Mattis, R. L., Liu, Y. M., and Filliben, J. J., Resistivity-Dopant Density Relationship for Boron-Doped Silicon, *J. Electrochem. Soc.* 127, 2291-2294 (1980).
57. Vasquez, R. P., and Grunthaner, F. J., Intensity Analysis of XPS Spectra to Determine Oxide Uniformity: Application to SiO<sub>2</sub>/Si Interfaces, *Surface Science* 99, 681-688 (1980).
58. Wilson, C. L., Correction of Differential Capacitance Profiles for Debye Length Effects, *IEEE Trans. Electron Devices* ED-27, 2262-2267 (1980).
59. Wilson, C. L., and Blue, J. L., Semiconductor Device Simulation, *Proc. Conf. Elliptic Problem Solvers*, Sante Fe, NM, June 30-July 2, 1980, pp. 435-439 (1980).
60. Wilson, R. G., Atom and Carrier Depth Distribution for 300 keV Arsenic Channelled in the <110> of Silicon as a Function of Alignment Angle and Ion Fluence, *Radiat. Eff. Lett.* 57, 109-113 (1980).
61. Wilson, R. G., and Comas, J., Correlation of Atomic Distribution and Implantation Induced Damage Profiles in Be-Ion Implanted Si, *Radiat. Eff.* 47, 137-142 (1980).
62. Wilson, R. G., and Weglein, R. D., Acoustic Material Signatures Using the Reflection Acoustic Microscope, *Ultrasonic Mater. Characterization*, H. Berger and M. Linzer Eds., NBS Spec. Publ. 596 (1980).



## Publications for the Year 1979

1. Adachi, T., and Helms, C. R., Electron Energy Loss Spectroscopy Studies of the Si-SiO<sub>2</sub> Interface, *Appl. Phys. Lett.* 35, 199-201 (1979).
2. Baum, M., A Little Less Witchery, A Little More Craft - Improvements for Semiconductor Quality Control, *Dimensions/NBS* 63(10), 12-20 (1979).
3. Berning, D. W., Semiconductor Measurement Technology: A Reverse-Bias Safe Operating Area Transistor Tester, *NBS Spec. Publ.* 400-54 (1979).
4. Bhar, T. N., Dat, R., Koyama, R. Y., and Galloway, K. F., Effect of Ionising Radiation on Mobile-Ion Density in M.O.S Oxides, *Electron. Lett.* 15, 16-17 (1979).
5. Blackburn, D. L., Semiconductor Measurement Technology: An Automated Photo-voltaic System for the Measurement of Resistivity Variations in High-Resistivity Circular Silicon Slices, *NBS Spec. Publ.* 400-52 (1979).
6. Blackburn, D. L., and Berning, D. W., Reverse-Bias Second Breakdown in Power Transistors, *Proc. Electrical Overstress/Electrostatic Discharge Symp.*, Denver, CO, Sept. 24-27, 1979, pp. 116-121 (1979).
7. Buehler, M. G., Comprehensive Test Patterns with Modular Test Structures: The 2 by N Probe-Pad Array, *Proc. Microelectronics Measurement Technology Seminar*, San Jose, CA, Feb. 6-7, 1979, pp. 27-38 (1979).
8. Buehler, M. G., Comprehensive Test Patterns with Modular Test Structures: The 2 by N Probe-Pad Array Approach, *Solid State Technology* 22 (10), 89-94 (1979).
9. Bullis, W. M., Metrology for Submicrometer Devices and Structures, *Proc. Micro-circuit Engineering '79 - Microstructure Fabrication*, Aachen, West Germany, Sept. 25-27, 1979, pp. 271-282 (1979).
10. Carver, G. P., and Buehler, M. G., The Development of Test Structures for Characterization of the Fabrication and Performance of Radiation-Hardened CCD Imagers, *NBSIR* 79-1744 (1979).
11. Chang, T. T., Detection of Phosphorus in Epitaxial Silicon by EPR, *NBSIR* 79-1748 (1979).
12. Dickey, D. H., and Ehrstein, J. R., Semiconductor Measurement Technology: Spreading Resistance Analysis for Silicon Layers with Nonuniform Resistivity 400-48 (1979).
13. Dumin, D. S., and Buehler, M. G., A Low Cost Approach to Modernize Undergraduate Electron Laboratory Instruction, *Conference Record, 3rd Biennial Univ/Industry/Govt Microelectronics Symp.*, Lubbock, TX, May 21-23, 1979, pp. 168-170 (1979).

14. Ehrstein, J. R., Two-Probe (Spreading Resistance) Measurements for Evaluation of Semiconductor Materials and Devices. *Nondestructive Evaluation of Semiconductor Materials and Devices*, J. N. Zemel Ed., pp. 1-66 (Plenum Press, New York, NY, 1979).
15. Galloway, K. F., VLSI Processing, Radiation and Hardening, *Semiconductor International* 2 (4), 65-73 (1979).
16. Galloway, K. F., and Mayo, S., Radiation Levels Associated with the Electron-Beam Metallization Process, *Solid State Technology* 22 (5), 96-100 (1979).
17. Galloway, K. F., Mayo, S., and Roitman, P., Radiation Levels Associated with Advanced Lithographic Techniques, *J. Electrochem. Soc.* 126, 2245-2248 (1979).
18. Gilsinn, D., and Kraft, R., Semiconductor Measurement Technology: DISTRIB I, An Impurity Redistribution Computer Program, NBS Spec. Publ. 400-57 (1979).
19. Goldsmith, N., and Mayer, A., High-Speed Spreading Resistance Probe, NBS-GCR 79-166 (1979).
20. Goodman, A. M., Extended Range MIS C(V) Measurement, A Technique for Monitoring Semiconductor Device Processing, NBS-GCR 78-155 (1979).
21. Grunthaner, F. J., Grunthaner, P. J., Vasquez, R. P., Lewis, B. F., Maserjian, J., and Madhukar, A., Local Atomic and Electronic Structure of Oxide/GaAs and SiO<sub>2</sub>/Si Interfaces Using High-Resolution XPS, *J. Vac. Sci. Technol.* 16, 1443-1453 (1979).
22. Grunthaner, F. J., Grunthaner, P. J., Vasquez, R. P., Lewis, B. F., Maserjian, J., and Madhukar, A., High-Resolution X-Ray Photoelectron Spectroscopy as a Probe of Local Atomic Structure: Application to Amorphous SiO<sub>2</sub> and the Si-SiO<sub>2</sub> Interface, *Phys. Rev. Letters* 43, 1683-1686 (1979).
23. Harman, G. G., Semiconductor Measurement Technology: Nondestructive Tests Used to Insure the Integrity of Semiconductor Devices, with Emphasis on Acoustic Emission Techniques, NBS Spec. Publ. 400-59 (1979).
24. Harman, G. G., Non-Destructive Tests Used to Insure the Integrity of Semiconductor Devices with Emphasis on Passive Acoustic Techniques. *Nondestructive Evaluation of Semiconductor Materials and Devices*, J. N. Zemel Ed., pp. 677-738 (Plenum Press, New York, NY, 1979).
25. Helms, C. R., Morphology and Electronic Structure of Si-SiO<sub>2</sub> Interfaces and Si Surfaces, *J. Vac. Sci. Technol.* 16, 608-614 (1979).
26. Helms, C. R., Johnson, N. M., Schwarz, S. A., and Spicer, W. E., Studies of the Effect of Oxidation Time and Temperature on the Si-SiO<sub>2</sub> Interface Using Auger Sputter Profiling, *J. Appl. Phys.* 50, 7007-7014 (1979).
27. Johnson, N. M., Bartelink, D. J., Gold, R. B., and Gibbons, J. F., Constant-Capacitance



- DLTS Measurement of Defect-Density Profiles in Semiconductors, *J. Appl. Phys.* 50, 4828-4833 (1979).
28. Koyama, R. Y., and Buehler, M. G., Semiconductor Measurement Technology: A Wafer Chuck for Use Between -196 and 350C, NBS Spec. Publ. 400-55 (1979).
  29. Koyama, R. Y., and Buehler, M. G., Novel Variable-Temperature Chuck for Use in the Detection of Deep Levels in Processed Semiconductor Wafers, *Rev. Sci. Instrum.* 50, 983-987 (1979).
  30. Larrabee, G. B., and Dobrott, R. D., Techniques for the Preparation and Analysis of Standard Silicon Semiconductor Specimens for the Ion Microprobe Mass Analyzer, NBS-GCR 79-158 (1979).
  31. Leedy, T. F., Large Scale Integration Digital Testing - Annotated Bibliography: 1969 - 1978, NBS Tech. Note 1102 (1979).
  32. Li, S. S., Semiconductor Measurement Technology: The Theoretical and Experimental Study of the Temperature and Dopant Density Dependence of Hole Mobility, Effective Mass, and Resistivity in Boron-Doped Silicon, NBS Spec. Publ. 400-47 (1979).
  33. Linholm, L. W., CMOS/SOS Test Patterns for Process Evaluation and Control: Annual Report, March 1 to November 1, 1978, NBSIR 79-1595 (1979).
  34. Linholm, L. W., Carver, G. P., and Russell, T. J., The Use of Microelectronic Test Structures to Characterize IC Materials, Processes, and Processing Equipment, *Proc. Measurement Sci. Conf., San Luis Obispo, CA, Nov. 30 - Dec. 1, 1979*, pp. 129-150 (1979).
  35. Mayo, S., and Evans, W. H., Development of Hydrogen and Hydroxyl Contamination in Thin Silicon Dioxide Thermal Films, NBSIR 78-1558 (1979).
  36. Myers, D. R., and Phillips, W. E., Observation of Unequal Densities for Sulfur Defects in Silicon Predeposited by Low Fluence Ion Implantation, *J. Electron. Mat.* 8, 781-788 (1979).
  37. Myers, D. R., Roitman, P., and Mayo, S., Electrical Characterization of Low-Dose Ion-Implanted Silicon Annealed with Microsecond Laser Pulses. *Laser-Solid Interactions and Laser Processing - 1978*, AIP Conference Proc. 50, S. D. Ferris, H. J. Leamy, and J. M. Poate Eds., pp. 563-568 (American Institute of Physics, New York, NY, 1979).
  38. Myers, D. R., Wilson, R. G., and Comas, J., Considerations of Ion Channeling for Semiconductor Microstructure Fabrication, *J. Vac. Sci. Technol.* 16, 1893-1896 (1979).
  39. Nyyssonen, D., Spatial Coherence: The Key to Accurate Optical Micrometrology, *Proc. Soc. Photo-Optical Instrum. Engrs., Applications of Optical Coherence* 194, 34-44 (1979).



40. Nyysönen, D., and Jerke, J. M., Optical Linewidth Measurement - A Basic Understanding, Proc. Microelectronic Measurement Technology Seminar, San Jose, CA, Feb. 6-7, 1979, pp. 251-266 (1979).
41. Oettinger, F. F., Measurement Techniques for High Power Semiconductor Materials and Devices, Annual Report, October 1, 1977 to September 30, 1978, DoE/RA-0041, NBSIR 79-1756 (1979).
42. Phillips, W. E., Koyama, R. Y., and Buehler, M. G., Suppression of Measurement Interferences from Interface States and Mobile Ions in Thermally Stimulated Current Measurements in an MOS Capacitor, J. Electrochem. Soc. 126, 1979-1981 (1979).
43. Quate, C. F., The Acoustic Microscope, Sci. Am. 241(4), 62-70 (1979).
44. Quate, C. F., Atalar, A., and Wickramasinghe, H. K., Acoustic Microscopy with Mechanical Scanning - A Review, Proc. IEEE 67, 1092-1114 (1979).
45. Rubin, S., and Oettinger, F. F., Semiconductor Measurement Technology: Thermal Resistance Measurements on Power Transistors, NBS Spec. Publ. 400-14 (1979).
46. Russell, T. J., and Maxwell, D. A., Semiconductor Measurement Technology: A Production-Compatible Microelectronic Test Pattern for Evaluating Photomask Misalignment, NBS Spec. Publ. 400-51 (1979).
47. Russell, T. J., Maxwell, D. A., Reimann, C. T., and Buehler, M. G., A Microelectronic Test Pattern for Measuring Uniformity of an Integrated Circuit Fabrication Technology, Solid State Technology 22 (2), 71-74 (1979).
48. Sawyer, D. E., Kessler, H. K., and Schafft, H. A., Measurement Techniques for Solar Cells, Quarterly Report for the Period April 1 to June 30, 1978, NBSIR 79-1909 (1979).
49. Sawyer, D. E., Kessler, H. K., and Schafft, H. A., Solar Cell Measurement Technique Development and Other Services, Proc. Photovoltaic Advanced Materials Review Meeting, Oct. 24-26, 1978, SERI/TP-49-105, CONF. 781017, pp. 41-50 (1979).
50. Sawyer, D. E., and Schafft, H. A., Semiconductor Measurement Technology: NBS/DOE Workshop, Stability of (Thin Film) Solar Cells and Materials, NBS Spec. Publ. 400-58 (1979).
51. Scace, R. I., Zinc Oxide Varistors for Lightning Arrester Service, NBSIR 79-1939 (1979).
52. Scace, R. I., Technology of Semiconductor Manufacturing, Product Development, and Product Types, Appendix to A Report on the U.S. Semiconductor Industry, U.S. Dept. of Commerce, 105-132 (1979).
53. Schafft, H. A., Semiconductor Measurement Technology: Reliability Technology for Cardiac Pacemakers III - A Workshop Report, NBS Spec. Publ. 400-50 (1979).

54. Schafft, H. A., Standards for Photovoltaic Energy Conversion Systems, NBSIR 79-1743 (1979).
55. Schafft, H. A., and Sawyer, D. E., A Perspective of a Workshop on Stability of (Thin Film) Solar Cells and Materials, NBSIR 79-1778 (1979).
56. Schwarz, S. A., and Helms, C. R., A Statistical Model of Sputtering, J. Appl. Phys. 50, 5492-5499 (1979).
57. Schwarz, S. A., and Helms, C. R., Model of Ion Knock-On Mixing with Application to Si-SiO<sub>2</sub> Interface Studies, J. Vac. Sci. Technol. 16, 781-783 (1979).
58. Sulouff, R. E., Investigation of Moisture Measurement, Failure Rate, and Leak Rate and Study of Moisture Infusion, NBS-GCR 79-170 (1979).
59. Weglein, R. D., A Model for Predicting Acoustic Material Signatures, Appl. Phys. Letters 34, 179-181 (1979).
60. Weglein, R. D., and Wilson, R. G., An Acoustic Gray Scale for Scanning Acoustic Microscopy and Diagnostic Ultrasound, Ultrasound Imaging 1, 89-100 (1979).

## Publications for the Year 1978

1. Atalar, A., An Angular-Spectrum Approach to Contrast in Reflection Acoustic Microscope, *J. Appl. Phys.* 49, 5130-5139 (1978).
2. Blackburn, D. L., Photovoltaic Technique for Measuring Resistivity Variations of High Resistivity Silicon Slices, *NBS J. Res.* 83, 265-271 (1978).
3. Blackburn, D. L., and Berning, D. W., Some Effects of Base Current on Transistor Switching and Reverse-Bias Second-Breakdown, *Tech. Digest, 1978 Int. Electron Devices Meeting, Washington, D.C., Dec. 4-6, 1978*, pp. 671-675 (1978).
4. Blackburn, D. L., and Larrabee, R. D., Automated Photovoltaic Technique for Nondestructively Measuring Resistivity Variations of High Resistivity Silicon Wafers. *Semiconductor Characterization Techniques, 78-3*, P. A. Barnes and G. A. Rozgonyi Eds., pp. 168-179 (Electrochemical Society, Princeton, NJ, 1978).
5. Buehler, M. G., Microelectronic Test Patterns for Use in Procuring LSICs, *Proc. Industry/Joint Services Automatic Test Conf. and Workshop, San Diego, CA, April 5-7, 1978*, pp. 233-235 (1978).
6. Buehler, M. G., Limitations and Applications of the DC MOSFET Profile Method. *Semiconductor Characterization Techniques, 78-3*, P. A. Barnes and G. A. Rozgonyi Eds., pp. 241-252 (Electrochemical Society, Princeton, NJ, 1978).
7. Buehler, M. G., Grant, S. D., and Thurber, W. R., Bridge and van der Pauw Sheet Resistors for Characterizing the Line Width of Conducting Layers, *J. Electrochem. Soc.* 125, 650-654 (1978).
8. Buehler, M. G., and Thurber, W. R., An Experimental Study of Various Cross Sheet Resistor Test Structures, *J. Electrochem. Soc.* 125, 645-650 (1978).
9. Bullis, W. M., Government Programs on Advanced Technology and Manufacturing Techniques: Comments on U.S.A., Japan, and Europe, *NBSIR 78-1482* (1978).
10. Bullis, W. M., Cooperative Research Can Strengthen U.S. Lead in Microelectronics, *Microelectronic Manufacturing and Testing 1 (2)*, 18-19 (1978).
11. Christou, A., Semiconductor Measurement Technology: Automated Scanning Low-Energy Electron Probe (ASLEEP) for Semiconductor Wafer Diagnostics, *NBS Spec. Publ.* 400-30 (1978).
12. Christou, A., Nelson, G., Jenkins, W., Davey, J. E., and Wilkens, N., Characterization of Semiconductor Wafer Defects by ASLEEP, SEM, and Scanning AES, *Scanning Electron Microscopy/1978 O'Hare, IL, April 17-21, 1978 1*, pp. 273-282 (1978).
13. Galloway, K. F., VLSI Processing, Radiation, and Hardening, *IEEE Trans. Nucl. Sci.*



NS-25, 1469-1472 (1978).

14. Galloway, K. F., and Mayo, S., On the Compatibility of X-Ray Lithography and SOS Device Fabrication, *IEEE Trans. Electron Devices* ED-25, 549-550 (1978).
15. Galloway, K. F., and Mayo, S., Radiation Dose at the Silicon-Sapphire Interface Due to Electron-Beam Aluminization, *J. Appl. Phys.* 49, 2586-2588 (1978).
16. Grunthaner, F. J., and Maserjian, J., Chemical Structure of the Transitional Region of the SiO<sub>2</sub>/Si Interface. *The Physics of SiO<sub>2</sub> and Its Interfaces* S. T. Pantelides Ed., pp. 389-395 (Pergamon Press, New York, NY, 1978).
17. Harman, G. G., and Cannon, C. A., The Microelectronic Wire Bond Pull Test - How to Use It, How to Abuse It, *IEEE Trans. Components, Hybrids, and Manufacturing Technology* CHMT-1, 203-210 (1978).
18. Harman, G. G., and Cannon, C. A., The Microelectronic Wire Bond Pull Test - How to Use It, How to Abuse It, *Proc. 1978 IEEE Electronic Components Conference, Anaheim, CA, April 25, 1978*, pp. 291-299 (1978).
19. Helms, C. R., Johnson, N. M., Schwarz, S. A., and Spicer, W. E., Auger Sputter Profiling Studies of the Si-SiO<sub>2</sub> Interface. *The Physics of SiO<sub>2</sub> and Its Interfaces*, S. T. Pantelides Ed., pp. 366-372 (Pergamon Press, New York, NY, 1978).
20. Helms, C. R., Johnson, N. M., Schwarz, S. A., and Spicer, W. E., Auger Sputter Profiling Studies of the Si-SiO<sub>2</sub> Interface. *Semiconductor Characterization Techniques*, 78-3, P. A. Barnes and G. A. Rozgonyi Eds., pp. 136-138 (Electrochemical Society, Princeton, NJ, 1978).
21. Helms, C. R., Spicer, W. E., and Johnson, N. M., New Studies of the Si-SiO<sub>2</sub> Interface Using Auger Sputter Profiling, *Solid State Communications* 25, 673-676 (1978).
22. Helms, C. R., Strausser, Y. E., and Spicer, W. E., Observation of an Intermediate Chemical State of Silicon in the Si-SiO<sub>2</sub> Interface by Auger Sputter Profiling, *Appl. Phys. Letters* 33, 767-769 (1978).
23. Hilten, J. S., Lederer, P. S., Mayo-Wells, J. F., and Vezzetti, C. F., Loose-Particle Detection in Microelectronic Devices, *NBSIR* 78-1590 (1978).
24. Jamba, D. M., Secondary Particle Collection in Ion Implantation Dose Measurement, *Rev. Sci. Instrum.* 49, 634-638 (1978).
25. Johannessen, J. S., Spicer, W. E., Gibbons, J. F., Plummer, J. D., and Taylor, N. J., Observation of Phosphorus Pile-Up at the SiO<sub>2</sub>-Si Interface, *J. Appl. Phys.* 49, 4453-4458 (1978).
26. Koyama, R. Y., Detection of Deep Levels in High Power Semiconductor Materials and Devices, *NBS J. Res.* 83, 273-281 (1978).

27. Koyama, R. Y., Wafer Mapping of Electrically Active Defects. Semiconductor Characterization Techniques, 78-3, P. A. Barnes and G. A. Rozgonyi Eds., pp. 220-228 (Electrochemical Society, Princeton, NJ, 1978).
28. Koyama, R. Y., Techniques for Characterizing Defects in Starting Silicon Wafers Using TSM. Semiconductor Characterization Techniques, 78-3, P. A. Barnes and G. A. Rozgonyi Eds., pp. 53-60 (Electrochemical Society, Princeton, NJ, 1978).
29. Koyama, R. Y., Blackburn, D. L., and Oettinger, F. F., Measurement Techniques for High Power Semiconductor Materials and Devices. Proc.: Light-Fired Thyristor Workshop, EPRI Report WS 77-049 (1978).
30. Koyama, R. Y., Phillips, W. E., Myers, D. R., Liu, Y. M., and Dietrich, H. B., The Energy Levels and the Defect Signature of Sulfur-Implanted Silicon by Thermally Stimulated Measurements, Solid-State Electronics 21, 953-955 (1978).
31. Kuczer, P., Hook, H. O., and Goodman, A. M., A Versatile High-Voltage Bias Supply for Extended Range MIS C(V) and G(V) Measurements, RCA Rev. 39, 309-339 (1978).
32. Larrabee, R. D., Interpretation of Hall Measurements. Semiconductor Characterization Techniques 78-3 P. A. Barnes, and G. A. Rozgonyi Eds., pp. 71-76 (Electrochemical Society, Princeton, NJ, 1978).
33. Larrabee, R. D., and Thurber, W. R., Theory and Application of a Two-Layer Hall Technique, NBSIR 78-1553 (1978).
34. Leedy, T. F., and Liu, Y. M., Semiconductor Measurement Technology: Microelectronic Processing Laboratory at NBS, NBS Spec. Publ. 400-53 (1978).
35. Li, S. S., The Dopant Density and Temperature Dependence of Hole Mobility and Resistivity in Boron Doped Silicon, Solid-State Electronics 21, 1109-1117 (1978).
36. Marsden, C. P., Tabulation of Published Data on Electron Devices of the U.S.S.R. Through December 1976, NBSIR 78-1564 (1978).
37. Mattis, R. L., and Doggett, M. R., A Microelectronic Test Pattern for Analyzing Automated Wafer Probing and Probe Card Patterns, Solid State Technology 21 (11), 76-79 (1978).
38. Mayo, S., and Evans, W. H., Thermodynamic Considerations in the Use of Polysilicon Oxidation Tubes for Clean SiO<sub>2</sub> Film Preparation, J. Electrochem. Soc. 125, 106-110 (1978).
39. Mayo, S., Koyama, R. Y., and Leedy, T. F., Control of Mobile Ion Contamination in Oxidation Ambients for MOS Device Processing, NBSIR 77-1404 (1978).
40. McCarthy, D., Acevedo, J., Stamps, B., Lonky, M., and Buehler, M. G., An Advanced Integrated Test Structure for High Speed Measurement of Generation Lifetime, 1978



Government Microcircuit Applications Conf. Digest of Papers, Monterey, CA, Nov. 14-16, 1978, pp. 37-38 (1978).

41. Myers, D. R., Koyama, R. Y., and Phillips, W. E., An Implantation Predeposition Technique for the Introduction of Deep-Level Chemical Impurities, Proc. Ion Beam Modification of Mater. Conf., Budapest, Hungary, Sept. 4-8, 1978, pp. 439-448 (1978).
42. Myers, D. R., and Phillips, W. E., Existence of an Isotope Shift for the Sulfur Deep Level in Silicon, Appl. Phys. Letters 32, 756-758 (1978).
43. Myers, D. R., and Wilson, R. G., Alignment Effects on Implantation Profiles in Silicon, Proc. Ion Beam Modification of Mater. Conf., Budapest, Hungary, Sept. 4-8, 1978, pp. 103-111 (1978).
44. Novotny, D. B., and Ciarlo, D. R., Semiconductor Measurement Technology: Automated Photomask Inspection, NBS Spec. Publ. 400-46 (1978).
45. Novotny, D. B., and Ciarlo, D. R., Automated Photomask Inspection, Solid State Technology 21 (5), 51-59 (May 1978).
46. Novotny, D. B., and Ciarlo, D. R., Automated Photomask Inspection, Solid State Technology 21 (6), 59-67 (June 1978).
47. Nyyssonen, D., Optical Linewidth Measurements on Wafers, Proc. Soc. Photo-Optical Instrum. Engrs., Developments in Semiconductor Microlithography III 135, 115-119 (1978).
48. Nyyssonen, D., and Jerke, J. M., Linewidth Measurement: From Fine Art to Science, Tech. Digest, 1978 Int. Electron Devices Meeting, Washington, D. C., Dec. 4-6, 1978, pp. 437-440 (1978).
49. Oettinger, F. F., Measurement Techniques for High Power Semiconductor Materials and Devices: Annual Report, January 1 to December 31, 1977, Dept. of Energy Report HCP/T6010/A021-02, NBSIR 78-1474 (1978).
50. Oroshnik, J., and Croll, W. K., Threshold Adhesion Failure: An Approach to Aluminum Thin-Film Adhesion Measurement Using the Stylus Method. Adhesion Measurement of Thin Films, Thick Films, and Bulk Coatings, ASTM STP 640, K. L. Mittal Ed., pp. 158-183 (Am. Soc. for Testing and Matls., Philadelphia, PA, 1978).
51. Roitman, P., Electron Beam Induced Currents in Metal Oxide Silicon Devices, Proc. 13th Annual Conf., Microbeam Analysis Soc., Ann Arbor, MI, June 19-23, 1978, pp. 36A-36C (1978).
52. Russell, T. J., Maxwell, D. A., Reimann, C. T., and Buehler, M. G., A Microelectronic Test Pattern for Measuring the Uniformity of an Integrated Circuit Fabrication Technology, 1978 Government Microcircuit Applications Conf. Digest of Papers, Monterey,



- CA, Nov. 14-16, 1978, pp. 33-36 (1978).
53. Sawyer, D. E., A Technique for Using An Optical Scanner to Reveal Solar Cell Defects, Proc. 13th IEEE Photovoltaic Specialists Conference, Washington, D.C., June 5-8, 1978, pp. 1249-1250 (1978).
  54. Sawyer, D. E., Kessler, H. K., and Schafft, H. A., Measurement Techniques for Solar Cells, Quarterly Report: September 15 to December 31, 1977, NBSIR 78-1488 (1978).
  55. Sawyer, D. E., Kessler, H. K., and Schafft, H. A., Measurement Techniques for Solar Cells, Quarterly Report: January 1 to March 31, 1978, NBSIR 78-1513 (1978).
  56. Scace, R. I., An Assessment of High-Power Thyristor Technology, NBSIR 78-1559 (1978).
  57. Schafft, H. A., Performance Criteria for Photovoltaic Power Conditioning, Control, and Storage, Proc. DOE Photovoltaic Tech. Development & Applications Program Rev., Arlington, VA, Nov. 7-9, 1978, pp. 2-29 - 2-51 (1978).
  58. Schwarz, S. A., Helms, C. R., and Spicer, W. E., High Resolution Auger Sputter Profiling Study of the Effect of Phosphorus Pileup on the Si-SiO<sub>2</sub> Interface Morphology, J. Vac. Sci. Technol. 15, 227-230 (1978).
  59. Stach, J., Das, M. B., and Tressler, R. E., Development of Measurement Techniques for Monitoring Chemical Purity of Materials Used in Digital IC Processing, NBS-GCR 78-134 (1978).
  60. Strausser, Y. E., and Majumder, K. S., Chemical Structure of the Al/SiO<sub>2</sub> Interface, J. Vac. Sci. Technol. 15, 238-239 (1978).
  61. Strausser, Y. E., Scheibner, E. J., and Johannessen, J. S., Observations of Al<sub>2</sub>O<sub>3</sub> and Free Silicon in the Interface Between Aluminum Films and SiO<sub>2</sub>, Thin Solid Films 52, 203-214 (1978).
  62. Sulouff, R. E., A Study of Leak Rate Versus Reliability of Hybrid Packages, Proc. 1978 Int. Microelectronics Symp., Minneapolis, MN, Sept. 25-27, 1978, pp. 121-124 (1978).
  63. Swyt, D. A., Design of a Pattern on a Photomask-Like Physical Standard for Evaluation and Calibration of Linewidth-Measuring Systems, Solid State Technology 21 (1), 35-42 (1978).
  64. Swyt, D. A., Rosberry, F. W., and Nyssonen, D., Photomask Linewidth Measurement, Circuits Manufacturing 18 (9), 20 (1978).
  65. Thurber, W. R., and Buehler, M. G., Semiconductor Measurement Technology: Microelectronic Test Pattern NBS-4, NBS Spec. Publ. 400-32 (1978).
  66. Thurber, W. R., and Carpenter, B. S., Boron Determination in Silicon by the Nuclear

- Track Technique, *J. Electrochem. Soc.* 125, 654-657 (1978).
67. Thurber, W. R., Mattis, R. L., and Liu, Y. M., Resistivity-Dopant Density Relationship for Silicon. *Semiconductor Characterization Techniques*, 78-3, P. A. Barnes and G. A. Rozgonyi Eds., pp. 81-92 (Electrochemical Society, Princeton, NJ, 1978).
  68. Weglein, R. D., Gray Scale for Scanning Acoustic Microscopy, *Electron. Lett.* 14, 656-657 (1978).
  69. Weglein, R. D., and Wilson, R. G., Characteristic Material Signatures by Acoustic Microscopy, *Electron. Lett.* 14, 352-354 (1978).
  70. Wilson, R. G., and Comas, J., Correlation of Atomic Distribution and Implantation Induced Damage Profiles in Be-Ion Implanted Silicon, *Proc. Ion Beam Modification of Mater. Conf.*, Budapest, Hungary, Sept. 4-8, 1978, pp. 547-556 (1978).
  71. Wilson, R. G., Dunlap, H. L., Jamba, D. M., and Myers, D. R., Semiconductor Measurement Technology: Angular Sensitivity of Controlled Implanted Doping Profiles, *NBS Spec. Publ.* 400-49 (1978).
  72. Zanzucchi, P. J., and Duffy, M. T., Surface Damage and the Optical Reflectance of Single-Crystal Silicon, *Appl. Optics* 17, 3477-3481 (1978).
  73. Zanzucchi, P. J., Duffy, M. T., and Alig, R. C., Optical Reflectance Method for Determining Surface Quality of Sapphire, *J. Electrochem. Soc.* 125, 299-305 (1978).

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Publications for the Year 1977

1. Atalar, A., Quate, C. F., and Wickramasinghe, H. K., Phase Imaging in Reflection with the Acoustic Microscope, *Appl. Phys. Letters* 31, 791-793 (1977).
2. Blackburn, D. L., Semiconductor Measurement Technology: Safe Operating Area Limits for Power Transistors - Videotape Script, NBS Spec. Publ. 400-44 (1977).
3. Blackburn, D. L., Koyama, R. Y., Oettinger, F. F., and Rogers, G. J., Measurement Techniques for High Power Semiconductor Materials and Devices: Annual Report, January 1 to December 31, 1976, ERDA Report CONS/3800-2, NBSIR 77-124 (1977).
4. Blackburn, D. L., and Rubin, S., A Nondestructive Method for the Determination of Forward-Biased Safe-Operating-Area Limits for Power Transistors, PESC '77 Record, IEEE Power Electronics Specialists Conference 1977, Palo Alto, CA, June 14-16, 1977, pp. 17-22 (1977).
5. Buehler, M. G., Dopant Profiles Determined from Enhancement Mode MOSFET DC Measurements, *Appl. Phys. Letters* 31, 848-850 (1977).
6. Buehler, M. G., Microelectronic Test Patterns for Use in Procuring Custom and Highly Reproducible Integrated Circuits. Proc. Symp. on Utilization of LSICs in Military Systems, Arlington, VA, Aug. 9-11, 1977, pp. III102-III117 (1977).
7. Buehler, M. G., and Sawyer, D. E., Microelectronic Test Patterns Aid Production of Custom ICs, *Circuits Manufacturing* 17 (2), 46-56 (1977).
8. Buehler, M. G., and Thurber, W. R., Measurement of the Resistivity of a Thin Square Sample with a Square Four-Probe Array, *Solid-State Electronics* 20, 403-406 (1977).
9. Bullis, W. M., The NBS Semiconductor Technology Program, Proc. Symp. on Utilization of LSICs in Military Systems, Arlington, VA, Aug. 9-11, 1977, pp. III87 - III101 (1977).
10. Bullis, W. M., and Galloway, K. F., Semiconductor Electronics at the National Bureau of Standards: Programs and Opportunities Paper IX-I, Proc. 2nd IEEE (G-PHP)/ISHM Univ/Industry/Govt Microelectronics Symp., Albuquerque, NM, Jan. 3-5, 1977, (1977).
11. Bullis, W. M., and Vieweg-Gutberlet, F. G., Current Trends in Silicon Characterization Techniques. Semiconductor Silicon/1977 H. R. Huff, and E. Sirtl Eds., pp. 360-366 (Electrochemical Society, Princeton, NJ, 1977).
12. Comizzoli, R. B., Nondestructive, Reverse Decoration of Defects in IC Passivation Overcoats, *J. Electrochem. Soc.* 124, 1087-1095 (1977).
13. David, J. M., and Buehler, M. G., A Numerical Analysis of Various Cross Sheet



Resistor Test Structures, *Solid-State Electronics* 20, 539-543 (1977).

14. Devaney, J. R., Leedy, K. O., and Keery, W. J., *Semiconductor Measurement Technology: Notes on SEM Examination of Microelectronic Devices*, NBS Spec. Publ. 400-35 (1977).
15. Dobrott, R. D., Keenan, J. A., and Larrabee, G. B., *Ion Microprobe Analysis of Integrated Circuit Structures*, 15th Annual Proceedings, Reliability Physics 1977, Las Vegas, NV, April 12-14, 1977, pp. 54-60 (1977).
16. Ehrstein, J. R., *Effect of Specimen Preparation on the Calibration and Interpretation of Spreading Resistance Measurements*. *Semiconductor Silicon/1977*, H. R. Huff and E. Sirtl Eds., pp. 377-386 (Electrochemical Society, Princeton, NJ, 1977).
17. Erickson, N. E., *ESCA Studies of Clean Si (111) Surfaces*, *Physica Scripta* 16, 462-465 (1977).
18. French, J. C., *The Measurement Challenge in Electronic Technology*, *Dimensions/NBS* 61 (2), 12-15 (1977).
19. Galloway, K. F., and Roitman, P., *Some Aspects of Using a Scanning Electron Microscope for Total Dose Testing*, NBSIR 77-1235 (1977).
20. Galloway, K. F., and Roitman, P., *Important Considerations for SEM Total Dose Testing*, *IEEE Trans. Nucl. Sci. NS-24*, 2066-2070 (1977).
21. Goodman, A. M., *Semiconductor Measurement Technology: Suppression of Premature Dielectric Breakdown for High-Voltage Capacitance Measurements*, NBS Spec. Publ. 400-37 (1977).
22. Goodman, A. M., *Semiconductor Measurement Technology: A 25-kV Bias-Isolation Unit for 1-MHz Capacitance and Conductance Measurements*, NBS Spec. Publ. 400-40 (1977).
23. Goodman, A. M., *Suppression of Premature Dielectric Breakdown for High-Voltage Capacitance Measurements*, *RCA Rev.* 38, 436-442 (1977).
24. Goodman, A. M., *A 25-kV Bias-Isolation Unit for 1-MHz Capacitance and Conductance Measurements*, *RCA Rev.* 38, 512-532 (1977).
25. Goodman, A. M., and Weitzel, C. E., *The Effect of Electron-Beam Aluminization on the Si-Sapphire Interface*, *Appl. Phys. Letters* 31, 114-117 (1977).
26. Grunthaner, F. J., and Maserjian, J., *Experimental Observations of the Chemistry of the SiO<sub>2</sub>/Si Interface*, *IEEE Trans. Nucl. Sci. NS-24*, 2108-2112 (1977).
27. Ham, W. E., *Intrachip and Spatial Parametric Integrity - An Important Part of IC Process Characterization*, *Tech. Digest, Int. Electron Devices Meeting*, Washington, D.C., Dec. 5-7, 1977, pp. 406-409 (1977).

28. Harman, G. G., The Use of Acoustic Emission in a Test for Beam-Lead, TAB, and Hybrid Chip Capacitor Bond Integrity, *IEEE Trans. Parts, Hybrids, and Packaging PHP-13*, 116-127 (1977).
29. Harman, G. G., and Albers, J., The Ultrasonic Welding Mechanism as Applied to Aluminum- and Gold-Wire Bonding in Microelectronics, *IEEE Trans. Parts, Hybrids, and Packaging PHP-13*, 406-412 (1977).
30. Helms, C. R., Garner, C. M., Miller, J., Lindau, I., Schwarz, S. A., and Spicer, W. E., Studies of Si/SiO<sub>2</sub> Interfaces by Auger Sputter Profiling and Photoelectron Spectroscopy Using Synchrotron Radiation, *Proc. 7th Int. Vac. Congr. & 3rd Int. Conf. Solid Surfaces*, Vienna, Sept. 1977, pp. 2241-2243 (1977).
31. Jamba, D. M., Semiconductor Measurement Technology: Some Aspects of Dose Measurement for Accurate Ion Implantation, *NBS Spec. Publ. 400-39* (1977).
32. Jerke, J. M., Hartman, A. W., Nyssonen, D., Swing, R. E., Young, R. D., and Keery, W. J., Comparison of Linewidth Measurements on an SEM/Interferometer System and an Optical Linewidth-Measuring Microscope, *Proc. Soc. Photo-Optical Instrum. Engrs., Developments in Semiconductor Microlithography, II*, 100, 37-45 (1977).
33. Johannessen, J. S., Helms, C. R., Spicer, W. E., and Strausser, Y. E., Auger Depth Profiling of MNOS Structures by Ion Sputtering, *IEEE Trans. Electron Devices ED-24*, 547-551 (1977).
34. Kern, W., and Comizzoli, R. B., Semiconductor Measurement Technology: Techniques for Measuring the Integrity of Passivation Overcoats on Integrated Circuits, *NBS Spec. Publ. 400-31* (1977).
35. Kern, W., and Comizzoli, R. B., New Methods for Detecting Structural Defects in Glass Passivation Films, *J. Vac. Sci. Technol.* 14, 32-39 (1977).
36. Kompfner, R., and Quate, C. F., Acoustic Radiation and Its Use in Microscopy, *Physics in Technology* 8, 231-237 (1977).
37. Kuczer, P., Hook, H. O., and Goodman, A. M., Semiconductor Measurement Technology: A Versatile High-Voltage Bias Supply for Extended Range MIS C(V) and G(V) Measurements, *NBS Spec. Publ. 400-41* (1977).
38. Leedy, K. O., Measurement of Transistor Collector-Emitter Saturation Voltage, *NBSIR 77-1231* (1977).
39. Leedy, K. O., A Bibliography on Electron Beam Induced Current Analysis of Semiconductor Devices, *Solid State Technology* 20 (2), 45-48 (1977).
40. Li, S. S., Semiconductor Measurement Technology: The Dopant Density and Temperature Dependence of Electron Mobility and Resistivity in N-Type Silicon, *NBS Spec. Publ. 400-33* (1977).



41. Li, S. S., and Thurber, W. R., The Dopant Density and Temperature Dependence of Electron Mobility and Resistivity in n-Type Silicon, *Solid-State Electronics* 20, 609-616 (1977).
42. Mattis, R. L., and Buehler, M. G., A New Method for Calculating Background Dopant Density from p-n Junction Capacitance-Voltage Measurements, *J. Electrochem. Soc.* 124, 1918-1923 (1977).
43. Mayo, S., and Evans, W. H., Development of Sodium Contamination in Semiconductor Oxidation Atmospheres at 1000C, *J. Electrochem. Soc.* 124, 780-785 (1977).
44. Novotny, D. B., Sensitometry of Photoresists for Microelectronics, *Photographic Science and Engineering* 21, 351-355 (1977).
45. Nyyssonen, D., Linewidth Measurement with an Optical Microscope: The Effect of Operating Conditions on the Image Profile, *Appl. Optics* 16, 2223-2230 (1977).
46. Nyyssonen, D., Optical Linewidth Measurements on Silicon and Iron-Oxide Photomasks, *Proc. Soc. Photo-Optical Instrum. Engrs., Developments in Semiconductor Microlithography, II*, 100, 127-134 (1977).
47. Quate, C. F., A Scanning Acoustic Microscope. *Semiconductor Silicon/1977*, H. R. Huff and E. Sirtl Eds., pp. 422-430 (Electrochemical Society, Princeton, NJ, 1977).
48. Rubin, S., and Blackburn, D. L., A Test Unit for the Nondestructive Determination of Forward-Biased Safe-Operating-Area Limits for Power Transistors, *Conference Record, IEEE IAS Annual Meeting, Los Angeles, CA, Oct. 3-6, 1977*, pp. 666-673 (1977).
49. Russell, T. J., Leedy, T. F., and Mattis, R. L., A Comparison of Electrical and Visual Alignment Test Structures for Evaluating Photomask Alignment in Integrated Circuit Manufacturing, *Tech. Digest, Int. Electron Devices Meeting, Washington, D.C., Dec. 5-7, 1977*, pp. 7A-7F (1977).
50. Ruthberg, S., Hermetic Test Procedures and Standards for Semiconductor Electronics. *ASTM STP 624, Nondestructive Testing Standards - A Review*, H. Berger Ed., pp. 246-259 (Am. Soc. for Testing and Matls., Philadelphia, PA, 1977).
51. Ruthberg, S., Gas Infusion into Doubled Hermetic Enclosures, *IEEE Trans. Parts, Hybrids, and Packaging PHP-13*, 110-116 (1977).
52. Ruthberg, S., Neff, G. R., and Martin, B. D., Radioisotope Hermetic Test Precision, *Proc. 1977 Int. Microelectronics Symp., Baltimore, MD, Oct. 24-26, 1977*, pp. 131-137 (1977).
53. Sawyer, D. E., Solar Cell Measurement Technique Development and Other Services, *Proc. Photovoltaics Program Semi-Annual Review, Adv. Materials R&D Branch, Golden, CO, Oct. 4-6, 1977*, pp. 708-713 (1977).



54. Sawyer, D. E., and Berning, D. W., Semiconductor Measurement Technology: A Laser Scanner for Semiconductor Devices, NBS Spec. Publ. 400-24 (1977).
55. Sawyer, D. E., Berning, D. W., and Lewis, D. C., Laser Scanning of Active Integrated Circuits and Discrete Semiconductor Devices, Solid State Technology 20 (6), 37ff (1977).
56. Schafft, H. A., Semiconductor Measurement Technology: Reliability Technology for Cardiac Pacemakers II - A Workshop Report, NBS Spec. Publ. 400-42 (1977).
57. Spicer, W. E., Lindau, I., and Helms, C. R., Frontiers in Surface and Interface Analysis, R/D: Research/Development 28(12), 20-31 (1977).
58. Swyt, D. A., An NBS Physical Standard for the Calibration of Photomask Linewidth Measuring Systems, Proc. Soc. Photo-Optical Instrum. Engrs., Effective Utilization of Optics in Quality Assurance 129, 98-105 (1977).
59. Swyt, D. A., and Rosberry, F. W., A Comparison of Some Optical Microscope Measurements of Photomask Linewidths, Solid State Technology 20 (8), 70-75 (1977).
60. Swyt, D. A., Rosberry, F. W., and Nyyssonen, D., Calibration of Optical Microscopes for Photomask Linewidth Measurements, Proc. Microelectronics Seminar - Interface '77, Monterey, CA, Oct. 5-7, 1977, pp. 131-144 (1977).
61. Tressler, R. E., Stach, J., and Metz, D., Gas Phase Composition Considerations in the Thermal Oxidation of Silicon in Cl-H-O Ambients, J. Electrochem. Soc. 124, 607-609 (1977).
62. Weglein, R. D., and Wilson, R. G., Image Resolution of the Scanning Acoustic Microscope, Appl. Phys. Letters 31, 793-796 (1977).
63. Weglein, R. D., Wilson, R. G., and Bonnell, D. M., Scanning Acoustic Microscopy - Application to Fault Detection, 15th Annual Proceedings, Reliability Physics 1977, Las Vegas, NV, April 12-14, 1977, pp. 37-43 (1977).
64. Wilson, R. G., Dunlap, H. L., and Jamba, D. M., Angular Sensitivity of Controlled Implanted Doping Profiles. Semiconductor Silicon/1977, H. R. Huff and E. Sirtl Eds., pp. 1023-1034 (Electrochemical Society, Princeton, NJ, 1977).
65. Wilson, R. G., Weglein, R. D., and Bonnell, D. M., Scanning Acoustic Microscopy for Integrated Circuit Diagnostics. Semiconductor Silicon/1977, H. R. Huff and E. Sirtl Eds., pp. 431-440 (Electrochemical Society, Princeton, NJ, 1977).
66. Young, R. D., Length Calibrations in the Micrometer and Sub-Micrometer Range, Ann. CIRP 25, 245-250 (1977).

## Publications for the Year 1976

1. Albers, J., Semiconductor Measurement Technology: The Destructive Bond Pull Test, NBS Spec. Publ. 400-18 (1976).
2. Blackburn, D. L., Rubin, S., and Rogers, G. J., Measurements of Power Transistor Thermal Instabilities, Stable Hot-Spots, and Second-Breakdown, Tech. Digest, 1976 Int. Electron Devices Meeting, Washington, D.C., Dec. 6-8, 1976, pp. 151-154 (1976).
3. Buehler, M. G., Semiconductor Measurement Technology: Microelectronic Test Pattern NBS-3 for Evaluating the Resistivity-Dopant Density Relationship of Silicon, NBS Spec. Publ. 400-22 (1976).
4. Buehler, M. G., Semiconductor Measurement Technology: Defects in PN Junctions and MOS Capacitors Observed Using Thermally Stimulated Current and Capacitance Measurements - Videotape Script, NBS Spec. Publ. 400-26 (1976).
5. Buehler, M. G., and Phillips, W. E., A Study of the Gold Acceptor in a Silicon p+n Junction and an n-type MOS Capacitor by Thermally Stimulated Current and Capacitance Measurements, Solid-State Electronics 19, 777-788 (1976).
6. Buehler, M. G., and Sawyer, D. E., Microelectronic Test Patterns for Use in Procuring Reliable, Custom Integrated Circuit Chips, 1976 Government Microcircuit Applications Conf. Digest of Papers, Orlando, FL, Nov. 9-11, 1976, pp. 62-65 (1976).
7. Buehler, M. G., and Thurber, W. R., A Planar Four-Probe Test Structure for Measuring Bulk Resistivity, IEEE Trans. Electron Devices ED-23, 968-974 (1976).
8. Galloway, K. F., and Buehler, M. G., The Application of Test Structures and Test Patterns to the Development of Radiation Hardened Integrated Circuits: A Review, NBSIR 76-1093 (1976).
9. Galloway, K. F., Leedy, K. O., and Keery, W. J., Electron-Beam-Induced Currents in Simple Device Structures, IEEE Trans. Parts, Hybrids, and Packaging PHP-12, 231-236 (1976).
10. Galloway, K. F., Leedy, K. O., and Keery, W. J., Electron-Beam-Induced Currents in Simple Device Structures, Proc. 26th Electronic Components Conf., San Francisco, CA, April 26-28, 1976, pp. 257-262 (1976).
11. Goodman, A. M., Semiconductor Measurement Technology: Safe Operation of Capacitance Meters Using High Applied-Bias Voltage, NBS Spec. Publ. 400-34 (1976).
12. Goodman, A. M., Safe Operation of Capacitance Meters Using High Applied-Bias Voltage, RCA Rev. 37, 491-514 (1976).



13. Harman, G. G., The Use of Acoustic Emission in a Test for Beam Lead Bond Integrity, 14th Annual Proceedings, Reliability Physics 1976, Las Vegas, NV, April 20-22, 1976, pp. 86-97 (1976).
14. Hower, P. L., Blackburn, D. L., Oettinger, F. F., and Rubin, S., Stable Hot Spots and Second Breakdown in Power Transistors, PESC '76 Record, IEEE Power Electronics Conference 1976, Cleveland, OH, June 8-10, 1976, pp. 234-246 (1976).
15. Jerke, J. M., Hartman, A. W., Nyssonen, D., Rosberry, F. W., Swing, R. E., Swyt, D. A., and Young, R. D., Accurate Linewidth Measurements at the National Bureau of Standards, Proc. Microelectronics Seminar - Interface '76, Monterey, CA, Oct. 3-5, 1976, pp. 51-59 (1976).
16. Johannessen, J. S., Spicer, W. E., and Strausser, Y. E., Use of Auger Electron Spectroscopy to Determine the Structure of Silicon Oxide Films, Semiconductor Measurement Technology: ARPA/NBS Workshop IV, Surface Analysis for Silicon Devices, NBS Spec. Publ. 400-23 (1976).
17. Johannessen, J. S., Spicer, W. E., and Strausser, Y. E., Auger Depth Profiling of Interfaces in MOS and MNOS Structures, J. Vac. Sci. Technol. 13, 849-855 (1976).
18. Johannessen, J. S., Spicer, W. E., and Strausser, Y. E., A Study of the Chemical Composition of MOS and MNOS Structures by Auger Electron Spectroscopy, Thin Solid Films 32, 311-314 (1976).
19. Kasdan, H. L., and George, N., Linewidth Measurement by Diffraction Pattern Analysis, Proc. Soc. Photo-Optical Instrum. Engrs., Developments in Semiconductor Microlithography 80, 54-63 (1976).
20. Keery, W. J., Leedy, K. O., and Galloway, K. F., Electron Beam Effects on Microelectronic Devices, Scanning Electron Microscopy/1976, Toronto, Canada, April 5-9, 1976, pp. 507-514 (1976).
21. Kenney, J. M., Semiconductor Measurement Technology: Permanent Damage Effects of Nuclear Radiation on the X-Band Performance of Silicon Schottky-Barrier Microwave Mixer Diodes, NBS Spec. Publ. 400-7 (1976).
22. Lieberman, A. G., Semiconductor Measurement Technology: ARPA/NBS Workshop IV. Surface Analysis for Silicon Devices, NBS Spec. Publ. 400-23 (1976).
23. Lieberman, A. G., Introductory Concepts for Silicon Surface Analysis, Semiconductor Measurement Technology: ARPA/NBS Workshop IV, Surface Analysis for Silicon Devices, NBS Spec. Publ. 400-23 (1976).
24. Mayo, S., Galloway, K. F., and Leedy, T. F., Radiation Dose Due to Electron-Gun Metallization Systems, IEEE Trans. Nucl. Sci. NS-23, 1875-1880 (1976).



25. Mayo, S., Keller, R. A., Travis, J. C., and Green, R. B., Detection of Sodium Trace Contamination in Furnace Atmospheres at 1000C, *J. Appl. Phys.* 47, 4012-4016 (1976).
26. Novotny, D. B., Photoresist Exposure - Measurement and Control, *Proc. Soc. Photo-Optical Instrum. Engrs., Developments in Semiconductor Microlithography* 80, 9-13 (1976).
27. Oettinger, F. F., Blackburn, D. L., and Rubin, S., Thermal Characterization of Power Transistors, *IEEE Trans. Electron Devices* ED-23, 831-838 (1976).
28. Sawyer, D. E., and Berning, D. W., Semiconductor Measurement Technology: Laser Scanning of Active Semiconductor Devices - Videotape Script, *NBS Spec. Publ.* 400-27 (1976).
29. Sawyer, D. E., and Berning, D. W., Thermal Mapping of Transistors With a Laser Scanner, *Proc. IEEE* 64, 1634-1635 (1976).
30. Sawyer, D. E., and Berning, D. W., Mapping Nonlinearities Over the Active Regions of Semiconductor Devices, *Proc. IEEE* 64, 1635-1637 (1976).
31. Sawyer, D. E., and Berning, D. W., Laser Scanning of MOS IC's Reveals Internal Logic States Nondestructively, *Proc. IEEE* 64, 393-394 (1976).
32. Schafft, H. A., Semiconductor Measurement Technology: ARPA/NBS Workshop III. Test Patterns for Integrated Circuits, *NBS Spec. Publ.* 400-15 (1976).
33. Schafft, H. A., Semiconductor Measurement Technology: NBS/FDA Workshop, Reliability Technology for Cardiac Pacemakers 400-28 (1976).
34. Strausser, Y. E., and Johannessen, J. S., An Auger Electron Spectroscopy Study of Si Spectra from SiO, SiO<sub>2</sub>, and Si<sub>3</sub>N<sub>4</sub>, *Semiconductor Measurement Technology: ARPA/NBS Workshop IV, Surface Analysis for Silicon Devices*, *NBS Spec. Publ.* 400-23 (1976).
35. Swing, R. E., The Theoretical Basis of a New Optical Method for the Accurate Measurement of Small Line-Widths, *Proc. Soc. Photo-Optical Instrum. Engrs. Developments in Semiconductor Microlithography* 80, 65-77 (1976).
36. Swyt, D. A., NBS Program in Photomask Linewidth Measurements, *Solid State Technology* 19 (4), 55-61 (1976).
37. Taylor, N. J., Johannessen, J. S., and Spicer, W. E., Crater-Edge Profiling in Interface Analysis Employing Ion-Beam Etching and AES, *Appl. Phys. Letters* 29, 497-499 (1976).
38. Weglein, R. D., Acoustic Properties of Sputtered Glass at Microwave Frequencies, *Solar Cells* 29, 277-279 (1976).

39. Wilson, R. G., Planar and Axial Channeling of 800 keV As in  $\langle 110 \rangle$  Silicon, Appl. Phys. Letters 29, 770-772 (1976).

## Publications for the Year 1975

1. Blackburn, D. L., An Electrical Technique for the Measurement of the Peak Junction Temperature of Power Transistors, 13th Annual Proceedings, Reliability Physics 1975, Las Vegas, NV, April 1-3, 1975, pp. 142-150 (1975).
2. Blackburn, D. L., and Oettinger, F. F., Transient Thermal Response Measurements of Power Transistors, IEEE Trans. Industrial Electronics and Control Instrumentation IECI-22, 134-141 (1975).
3. Buehler, M. G., David, J. M., Mattis, R. L., Phillips, W. E., and Thurber, W. R., Semiconductor Measurement Technology: Planar Test Structures for Characterizing Impurities in Silicon, NBS Spec. Publ. 400-21 (1975).
4. Ciarlo, D. R., Schultz, P. A., and Novotny, D. B., Automated Inspection of IC Photomasks, Proc. Soc. Photo-Optical Instrum. Engrs., Photofabrication Imagery 55, 84-89 (1975).
5. Duffy, M. T., Zanzucchi, P. J., and Cullen, G. W., Method to Determine Quality of Sapphire, NBS-GCR 76-61 (1975).
6. Galloway, K. F., Keery, W. J., and Leedy, K. O., Integrated Circuit Damage Resulting from SEM Examination, Proc. 25th Electronic Components Conf., Washington, D.C., May 12-14, 1975, pp. 263-266 (1975).
7. Jerke, J. M., Semiconductor Measurement Technology: Optical and Dimensional-Measurement Problems with Photomasking in Microelectronics, NBS Spec. Publ. 400-20 (1975).
8. Jesch, R. L., and Hoer, C. A., Characterization of a High Frequency Probe Assembly for Integrated Circuits Measurements, NBS Tech. Note 663 (1975).
9. Johannessen, J. S., Chemical Shifts of Auger Lines Seen in  $\text{SiO}_2$  and  $\text{SiO}_2$ -Si Interfaces, Faraday Discuss. Chem. Soc. 60, 306-309 (1975).
10. Johannessen, J. S., Electron Beam Effects in AES of Silicon Oxides, Faraday Discuss. Chem. Soc. 60, 313-316 (1975).
11. Johannessen, J. S., Spicer, W. E., and Strausser, Y. E., Phase Separation in Silicon Oxides as Seen by Auger Electron Spectroscopy, Appl. Phys. Letters 27, 452-454 (1975).
12. Kraft, R., Finite Difference Techniques for Diffusion and Redistribution Problems with Segregation-Type Boundary Conditions, Proc. AICA Int. Symp. on Computer Methods for Partial Differential Equations, Bethlehem, PA, June 17-19, 1975, pp. 328-334 (1975).



13. Lewis, D. C., On the Determination of the Minority Carrier Lifetime from the Reverse Recovery Transient of pnR Diodes, *Solid-State Electronics* 18, 87-91 (1975).
14. Lieberman, A. G., Problems in Using Surface Analysis Techniques for the Depth Profiling of Microelectronic Materials, *Tech. Digest, 1975 Int. Electron Devices Meeting, Washington, DC, Dec. 1-3, 1975*, pp. 126-129 (1975).
15. Mattis, R. L., and Buehler, M. G., Semiconductor Measurement Technology: A BASIC Program for Calculating Dopant Density Profiles from Capacitance-Voltage Data, *NBS Spec. Publ. 400-11* (1975).
16. Pease, R. L., Galloway, K. F., and Stehlin, R. A., Radiation Damage to Integrated Injection Logic Cells, *IEEE Trans. Nucl. Phys. NS-22*, 2600-2604 (1975).
17. Rogers, G. J., Sawyer, D. E., and Jesch, R. L., Semiconductor Measurement Technology: Measurement of Transistor Scattering Parameters, *NBS Spec. Publ. 400-5* (1975).
18. Rubin, S., Thermal Resistance Measurements on Monolithic and Hybrid Darlington Power Transistors, *PESC '75 Record, IEEE Power Electronics Specialists Conf., 1975, Culver City, CA, June 9-11, 1975*, pp. 252-261 (1975).
19. Rudenberg, H. G., Automated Integrated Circuit Processing and Assembly, *NBS-GCR 76-64* (1975).
20. Sawyer, D. E., and Berning, D. W., Laser Scanning of Active Semiconductor Devices, *Tech. Digest, 1975 Int. Electron Devices Meeting, Washington, D.C., Dec. 1-3, 1975*, pp. 111-114 (1975).
21. Sher, A. H., Semiconductor Measurement Technology: Improved Infrared Response Technique for Detecting Defects and Impurities in Germanium and Silicon p-i-n Diodes, *NBS Spec. Publ. 400-13* (1975).
22. Steigerwalt, S. T., and Lagnado, I., The CCD as a Test Structure for Semiconductor Process Control, *Microelectronics J.* 7, 23-29 (1975).

## Publications for the Year 1974

1. Blackburn, D. L., and Oettinger, F. F., Transient Thermal Response Measurements of Power Transistors, PESC '74 Record, IEEE Power Electronics Specialists Conference 1974, Murray Hill, NJ, June 10-12, 1974, pp. 140-148 (1974).
2. Buehler, M. G., Semiconductor Measurement Technology: Microelectronic Test Patterns: An Overview, NBS Spec. Publ. 400-6 (1974).
3. Bullis, W. M., Standard Measurements of the Resistivity of Silicon by the Four-Probe Method, NBSIR 74-496 (1974).
4. Ehrstein, J. R., Improved Surface Preparation for Spreading Resistance Measurements on p-Type Silicon, Semiconductor Measurement Technology: Spreading Resistance Symposium, NBS Spec. Publ. 400-10 (1974).
5. Ehrstein, J. R., Semiconductor Measurement Technology: Spreading Resistance Symposium, NBS Spec. Publ. 400-10 (1974).
6. Forman, R. A., Thurber, W. R., and Aspnes, D. E., Second Indirect Band Gap in Silicon, Solid-State Communications 14, 1007-1010 (1974).
7. Harman, G. G., Semiconductor Measurement Technology: Microelectronic Ultrasonic Bonding, NBS Spec. Publ. 400-2 (1974).
8. Harman, G. G., Metallurgical Failure Modes of Wire Bonds, presented as part of a Workshop on Metallurgical Failure Modes, 12th Annual Proceedings, Reliability Physics 1974, Las Vegas, NV, April 2-4, 1974, pp. 131-141 (1974).
9. Harman, G. G., A Metallurgical Basis for the Non-Destructive Bond Pull-Test, 12th Annual Proceedings, Reliability Physics 1974, Las Vegas, NV, April 2-4, 1974, pp. 205-210 (1974).
10. Sandow, P. M., A Transistor with Simultaneously Diffused Emitter and Base, Solid-State Electronics 17, 404-405 (1974).
11. Schafft, H. A., Semiconductor Measurement Technology: ARPA/NBS Workshop I. Measurement Problems in Integrated Circuit Processing and Assembly, NBS Spec. Publ. 400-3 (1974).
12. Schafft, H. A., Semiconductor Measurement Technology: ARPA/NBS Workshop II. Hermeticity Testing for Integrated Circuits, NBS Spec. Publ. 400-9 (1974).
13. Sher, A. H., Semiconductor Nuclear Radiation Detector Studies - A Final Report, NBSIR 74-626 (1974).

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Publications for the Year 1973

1. Buehler, M. G., Thermally Stimulated Measurements: The Characterization of Defects in Silicon p-n Junctions. Semiconductor Silicon/1973, H. R. Huff and R. R. Burgess Eds., pp. 549-560 (Electrochemical Society, Princeton, NJ, 1973).
2. Harman, G. G., and Kessler, H. K., The Use of Capacitor Microphones to Study Vibrations in Microelectronic Ultrasonic Bonding Equipment, Ultrasonics 11 (1), 5-6 (1973).
3. Kessler, H. K., and Sher, A. H., Microelectronic Interconnection Bonding with Ribbon Wire, NBS Tech. Note 767 (1973).
4. Leedy, K. O., Scanning Electron Microscope Examination of Wire Bonds from High-Reliability Devices, NBS Tech. Note 785 (1973).
5. Oettinger, F. F., and Gladhill, R. L., Thermal Response Measurements for Semiconductor Device Die Attachment Evaluation, Tech. Digest, 1973 Int. Electron Devices Meeting, Washington, DC, Dec. 3-4, 1973, pp. 47-50 (1973).
6. Sawyer, D. E., Rogers, G. J., and Huntley, L. F., Measurement of Transit Time and Related Transistor Characteristics, AFWL TR 73-54 (1973).
7. Schafft, H. A., Methods for Testing Wire-Bond Electrical Connections, NBS Tech. Note 786 (1973).
8. Schafft, H. A., Failure Analysis of Wire Bonds, 11th Annual Proceedings, Reliability Physics 1973, Las Vegas, NV, April 3-5, 1973, pp. 98-104 (1973).
9. Thurber, W. R., Lewis, D. C., and Bullis, W. M., Resistivity and Carrier Lifetime in Gold-Doped Silicon, AFCRL-TR 73-0107 (1973).



## Publications for the Year 1972

1. Blackburn, D. L., Schafft, H. A., and Swartzendruber, L. J., Nondestructive Photo-voltaic Technique for the Measurement of Resistivity Gradients in Circular Semicon-ductor Wafers, *J. Electrochem. Soc.* 119, 1773-1778 (1972).
2. Harman, G. G., and Leedy, K. O., An Experimental Model of the Microelectronic Ultrasonic Wire Bonding Mechanism, 10th Annual Proceedings, Reliability Physics 1972, Las Vegas, NV, April 5-7, 1972, pp. 49-56 (1972).
3. Liu, Y. M., and Coleman, J. A., Radiation Damage Effects by Electrons, Protons, and Neutrons in Si(Li) Detectors, *IEEE Trans. Nucl. Sci.* NS-19, 346-352 (1972).
4. Mattis, R. L., and Baroody, A. J., Carrier Lifetime Measurement by the Photocon-ductive Decay Method, *NBS Tech. Note* 736 (1972).
5. Oettinger, F. F., and Rubin, S., The Use of Current Gain as an Indicator for the Formation of Hot Spots due to Current Crowding in Power Transistors, 10th Annual Proceedings, Reliability Physics 1972, Las Vegas, NV, April 5-7, 1972, pp. 12-18 (1972).
6. Phillips, W. E., Interpretation of Steady-State Surface Photovoltage Measurements in Epitaxial Semiconductor Layers, *Solid-State Electronics* 15, 1097-1102 (1972).
7. Sawyer, D. E., Prevalent Error Sources in Transistor Delay-Time Measurements, *IEEE Trans. Nucl. Sci.* NS-19, 121-124 (1972).
8. Schafft, H. A., Wire-Bond Electrical Connections: Testing, Fabrication and Degrada-tion - A Bibliography 1957-1971, *NBS Tech. Note* 593 (1972).
9. Schafft, H. A., Testing and Fabrication of Wire-Bond Electrical Connections - A Comprehensive Survey, *NBS Tech. Note* 726 (1972).
10. Sher, A. H., and Keery, W. J., Improved Infrared-Response Technique for Determining Impurity and Defect Levels in Semiconductors, *Appl. Phys. Letters* 20, 120-122 (1972).
11. Sher, A. H., Keery, W. J., and Dyson, H. E., Improved Infrared Response Measure-ments in Semiconductor Nuclear Radiation Detectors, *IEEE Trans. Nucl. Sci.* NS-19, 341-344 (1972).
12. Sher, A. H., Liu, Y. M., and Keery, W. J., Infrared Response Measurements on Radiation-Damaged Si(Li) Detectors, *IEEE Trans. Nucl. Sci.* NS-19, 312-317 (1972).
13. Thurber, W. R., and Bullis, W. M., Resistivity and Carrier Lifetime in Gold-Doped Silicon, *AFCRL* 72 0076 (1972).

---

Publications for the Year 1971

1. Brenner, D. J., A Technique for Measuring the Surface Temperature of Transistors by Means of Fluorescent Phosphor, NBS Tech. Note 591 (1971).
2. Harman, G. G., and Kessler, H. K., Application of Capacitor Microphones and Magnetic Pickups to the Tuning and Trouble Shooting of Microelectronic Ultrasonic Bonding Equipment, NBS Tech. Note 573 (1971).
3. Liu, Y. M., and Coleman, J. A., Electron Radiation Damage Effects in Silicon Surface-Barrier Detectors, IEEE Trans. Nucl. Sci. NS-18, 192-199 (1971).
4. Marsden, C. P., Tabulation of Data on Semiconductor Amplifiers and Oscillators at Microwave Frequencies, NBS Tech. Note 597 (1971).
5. Rubin, S., and Oettinger, F. F., Thermal Hysteresis and Its Possible Effect in Restricting the Hot-Spot-Free Operating Range of Some Power Transistors, IEEE Trans. Electron Devices ED-18, 393-394 (1971).
6. Sher, A. H., Carrier Trapping in Ge(Li) Detectors, IEEE Trans. Nucl. Sci. NS-18, 175-183 (1971).
7. Sher, A. H., Croll, W. K., and Thurber, W. R., Determination of Oxygen in Germanium Below 20 Parts per Billion by Measurements of Lithium Mobility and Precipitation, Anal. Chem. 43, 1831-1834 (1971).
8. Sher, A. H., and Thurber, W. R., Minority Carrier and Lithium-Ion Drift Mobilities and Oxygen Concentration in p-Type Germanium, J. Appl. Phys. 42, 4508-4509 (1971).
9. Thurber, W. R., Determination of Deep Impurities in Silicon and Germanium by Infrared Photoconductivity, NBS Tech. Note 570 (1971).

---

Publications for the Year 1970

1. Bullis, W. M., Measurement Methods for Microcircuits, Paper No. 31, Space Simulation, NBS Spec. Publ. 336 (1970).
2. Bullis, W. M., Thurber, W. R., Pyke, T. N., Jr., Ulmer, F. H., and Koenig, A. L., Time Shared Computers in Experimental Environments, Instruments and Control Systems 43(10), 105-110 (1970).
3. Marsden, C. P., Silicon Device Processing, NBS Spec. Publ. 337 (1970).
4. Sher, A. H., Nomographs for Use in the Fabrication and Testing of Ge(Li) Detectors, NBS Tech. Note 537 (1970).
5. Sher, A. H., and Coleman, J. A., Lithium Driftability in Detector Grade Germanium, IEEE Trans. Nucl. Sci. NS-17, 125-129 (1970).
6. Sher, A. H., and Keery, W. J., Variation of the Effective Fano Factor in a Ge(Li) Detector, IEEE Trans. Nucl. Sci. NS-17, 39-43 (1970).
7. Thurber, W. R., Determination of Oxygen Concentration in Silicon and Germanium by Infrared Absorption, NBS Tech. Note 529 (1970).



---

Publications for the Year 1969

1. Bullis, W. M., Measurement Methods for the Semiconductor Device Industry - A Review of NBS Activity, NBS Tech. Note 511 (1969).
2. Bullis, W. M., and Scafe, R. I., Measurement Standards for Integrated Circuit Processing, Proc. IEEE 57, 1639-1646 (1969).
3. Bullis, W. M., Thurber, W. R., Pyke, T. N., Jr., Ulmer, F. H., and Koenig, A. L., Use of a Time-Shared Computer to Control a Hall Effect Experiment, NBS Tech. Note 510 (1969).
4. Harman, G. G., Topological Features of Hot Carrier Induced Anisotropic Breakdown on Silicon Diode Surfaces, J. Res. Natl. Bur. Standards 73A, 321-331 (1969).
5. Sher, A. H., Lithium-Ion Drift Mobility in Germanium, J. Appl. Phys. 40, 2600-2607 (1969).

## Publications for the Year 1968

1. Bullis, W. M., Measurement of Carrier Lifetime in Semiconductors - An Annotated Bibliography Covering the Period 1949-1967, NBS Tech. Note 465 (1968).
2. Bullis, W. M., Measurement Problems in Microcircuit Processing, 1968 Government Microcircuits Applications Conf. Digest of Papers, pp. 215-217 (1968).
3. Bullis, W. M., Brewer, F. H., Kolstad, C. D., and Swartzendruber, L. J., Temperature Coefficient of Resistivity of Silicon and Germanium near Room Temperature, *Solid-State Electronics* 11, 639-646 (1968).
4. Bullis, W. M., and Coleman, J. A., Characterization of Germanium and Silicon for Nuclear Radiation Detectors. *Nucleonics in Aerospace*, P. Polishuk Ed., pp. 166-175 (Plenum Press, New York, NY, 1968).
5. Coleman, J. A., Love, D. P., Trainor, J. H., and Williams, D. J., Effects of Damage by 0.8 MeV - 5.0 MeV Protons in Silicon Surface-Barrier Detectors, *IEEE Trans. Nucl. Sci.* NS-15, 363-372 (1968).
6. Coleman, J. A., Love, D. P., Trainor, J. H., and Williams, D. J., Low-Energy Proton Damage Effects in Silicon Surface-Barrier Detectors, *IEEE Trans. Nucl. Sci.* NS-15, 482-490 (1968).
7. Mattis, R. L., Phillips, W. E., and Bullis, W. M., Measurement and Interpretation of Carrier Lifetime in Silicon and Germanium, AFML-TR 68-81 (1968).
8. Schafft, H. A., Second Breakdown in Transistors, *Proc. Second Symp. on Reliability in Electronics*, Budapest, October 1968, pp. 225 (1968).
9. Schafft, H. A., Photovoltaic Method for the Measurement of Resistivity in Germanium and Silicon, RADC-TR 68-64 (1968).
10. Schafft, H. A., and Needham, S. G., A Bibliography on Methods for the Measurement of Inhomogeneities in Semiconductors (1953-1967), NBS Tech. Note 445 (1968).
11. Swartzendruber, L. J., Ulmer, F. H., and Coleman, J. A., Direct Reading Instrument for Silicon and Germanium Four-Probe Resistivity Measurements, *Rev. Sci. Instrum.* 39, 1858-1863 (1968).

---

Publications for the Year 1967

1. Bullis, W. M., Standard Measurements of the Resistivity of Silicon by the Four-Probe Method, NASA-CR 86032 (1967).
2. Harman, G. G., and Gordy, L. H., The Use of Semiconductors for the Study of Boiling Heat Transfer to Low Temperature Liquids, *Cryogenics* 7, 89-92 (1967).
3. Schafft, H. A., Second Breakdown in Semiconductor Devices - A Bibliography, NBS Tech. Note 431 (1967).
4. Schafft, H. A., Second Breakdown: A Comprehensive Review, *Proc. IEEE* 55, 1272-1288 (1967).



---

Publications for the Year 1966

1. Coleman, J. A., and Swartzendruber, L. J., Effective Charge Carrier Lifetime in Silicon p-i-n Junction Detectors, *IEEE Trans. Nucl. Sci.* NS-13, 240-244 (1966).
2. Dodge, W. R., Coleman, J. A., and Domen, S. R., A Scattering Chamber for Use with Cooled Large Area Lithium-Compensated Silicon Radiation Detectors, *Nucl. Instrum. & Meth.* 42, 181-187 (1966).
3. Dodge, W. R., Coleman, J. A., Domen, S. R., and Whittaker, J. K., Lithium-Compensated Silicon Focal Plane Detectors for Electron Scattering Spectrometers, *Rev. Sci. Instrum.* 37, 1151-1159 (1966).
4. Dodge, W. R., Domen, S. R., Leedy, T. F., and Skopik, D. N., Measurement of the Mean Energy Required to Create an Electron-Hole Pair in Silicon Between 6 and 77 K, *Phys. Rev. Letters* 17, 653-655 (1966).
5. Harman, G. G., Avalanche Radiation from the Bulk of Long, Thin, Forward-Biased p+-p-n+ Silicon Diodes, *Appl. Phys. Letters* 9, 207-209 (1966).
6. Kessler, H. K., Cooler for Semiconductor Light Emitters, Lasers, and Photodetectors, *Rev. Sci. Instrum.* 37, 517-518 (1966).
7. Schafft, H. A., Avoiding Second Breakdown, *Proc. 13th Int. Scientific Congress on Electronics, Rome, June 1966*, pp. 117-130 (1966).
8. Schafft, H. A., and French, J. C., A Survey of Second Breakdown, *IEEE Trans. Electron Devices* ED-13, 613-618 (1966).
9. Schafft, H. A., and French, J. C., Second Breakdown and Current Distributions in Transistors, *Solid-State Electronics* 9, 681-688 (1966).
10. Schafft, H. A., Schwuttke, G. H., and Ruggles, R. L., Second Breakdown and Crystallographic Defects in Transistors, *IEEE Trans. Electron Devices* ED-13, 738-742 (1966).
11. Winogradoff, N. M., and Kessler, H. K., Radiative Recombination Lifetimes in Laser-Excited Silicon, *Appl. Phys. Letters* 8, 99-101 (1966).

---

Publications for the Year 1965

1. Schafft, H. A., and French, J. C., Breakdown Characteristics of Semiconductor Materials, *Electro-Technology* 75, 77-82 (1965).

---

Publications for the Year 1964

1. French, J. C., Bibliography for the Measurement of Bulk Resistivity of Device Semiconductor Materials for Electron Devices, NBS Tech. Note 232 (1964).
2. Reber, J. M., Potential Distribution in a Rectangular Semiconductor Bar for Use with Four-Point Probe Measurements, *Solid-State Electronics* 7, 525-529 (1964).
3. Schafft, H. A., Average Power Dissipated in a Diode Swept Along Its Reverse Characteristic, NBS Tech. Note 240 (1964).
4. Swartzendruber, L. J., Correction Factor Tables for Four-Point Probe Resistivity Measurements on Thin, Circular Semiconductor Samples, NBS Tech. Note 199 (1964).
5. Swartzendruber, L. J., Calculations for Comparing Two-Point and Four-Point Probe Resistivity Measurements on Rectangular Bar-Shaped Semiconductor Samples, NBS Tech. Note 241 (1964).
6. Swartzendruber, L. J., Four-Point Probe Measurement of Non-Uniformities in Semiconductor Sheet Resistivity, *Solid-State Electronics* 7, 413-422 (1964).



---

Publications for the Year 1963

1. Harman, G. G., Raybold, R. L., and Meyer, O. L., Direct Observation of Charge Storage in the Surface States of Silicon, *J. Appl. Phys.* 34, 380-383 (1963).
2. Swartzendruber, L. J., Applications of a Semiconductor-Surface-State Charge-Storage Device, *Solid-State Electronics* 6, 59-61 (1963).

---

Publications for the Year 1962

1. Harman, G. G., and Higier, T., Some Properties of Dirty Contacts on Semiconductors and Resistivity Measurements by a Two-Terminal Method, *J. Appl. Phys.* 33, 2198-2206 (1962).
2. Harman, G. G., Higier, T., and Meyer, O. L., Some Electrical Properties of the Porous Graphite Contact on p-Type Silicon, *J. Appl. Phys.* 33, 2206-2208 (1962).
3. Schafft, H. A., and French, J. C., "Second Breakdown" in Transistors, *IRE Trans. Electron Devices* ED-9, 129-236 (1962).
4. Swartzendruber, L. J., Single-Trace Sweep Adapter for Transistor-Curve Tracers, *Rev. Sci. Instrum.* 33, 560-562 (1962).

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