CURRICULUM VITAE

Gottlieb S. Oehrlein
Professor
Department of Materials Science and Engineering
University of Maryland
College Park, MD 20742

Phone: (301) 405-8931 (work)
Phone: (410) 531-7634 (home)
E-mail: oehrlein@glue.umd.edu

Background

Born: Dec. 25, 1954, Würzburg (Germany).
Marital Status: Married, 2 children.

Education

- Ph.D., Physics (with distinction), State University of New York, Albany, Dec. 1981.
- Ph.D. thesis, *A Study of Defect Interactions in Oxygen Containing Silicon*; advisor James W. Corbett.
- Vordiplom in Physics, Würzburg University (Germany), Sept. 1976.

Employment Experience

- Professor, Dept. of Materials Science and Engineering and Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD 20742, since Feb. 2000.
- Professor, Department of Physics, State University of New York, Albany, 1400 Washington Ave., Albany N.Y. 12222, September 1993 to Jan. 2000.
- Appointed to IBM Research Staff Management, 1986.
- Research Staff Member, IBM Research Division, Yorktown Heights, N.Y. 10598, April 1982 - August 1993.
- Visiting scientist at CNET Grenoble, France, Sept. 1989.
- Visiting scientist at Försvarets Forskningsanstalt, Linköping, Sweden, June-Aug. 1981.

Honors

- Fellow, International Union of Pure and Applied Chemistry (2000).
- Fellow, American Vacuum Society (1998).
- Thinker Award of Tegal Corporation, SEMICON West (1993).
- Electronics Division Award of the Electrochemical Society (1992).
- Six IBM Invention Plateau Awards (1982-1993).
- IBM Outstanding Technical Achievement Award for "Characterization and Control of Reactive Ion Etching Induced Damage and Contamination" (1989).
- Solid State Science and Technology Young Author's Award of the Electrochemical Society (1985).
- State University of New York Chancellor's *Honors Convocation Award for Academic Excellence and a Distinguished Dissertation* (1982).
- Fellow, Institute of International Education, New York (1980).
- State University of New York, Albany, Presidential Fellow (1978-1981).

Recent Professional Activities and Organizations

- Member, Plasma Science and Technology Division, AVS, Executive Committee (Nov. 2002)
- International Organizing Committee, 16th International Symposium on Plasma Chemistry, Taromina (June 2003).
- Co-Organizer of Materials Research Society Symposium on "*Materials, technology and reliability for advanced interconnects and low-k dielectrics"*, San Francisco (April 2000).
- US Organizer, BANPIS II, Tokyo, Japan (Jan. 2000)
- Scientific Committee, International Symposium on Plasma Chemistry 1999, Prague, 1999
- Associate Editor, Journal of Vacuum Science and Technology (1997-1999).
- Chairman, 1996 Tegal Symposium on Plasma Etching.
- National Research Council Panel *Data Needs in Plasma Processing of Materials* (1995-96).
- IUPAC Subcommittee Member on Plasma Chemistry (1995-1999).
- National Research Council Panel *NRL Strategic Series: Plasma Processing and Processing Science* (1993-94).
- Advisor of SEMATECH Plasma Etch Project (1991-93).
- Industrial Advisory Board of NSF Engineering Research Center for Plasma-Aided Manufacturing, University of Wisconsin, Madison (1988 to 1993).
- Member of Organizing or Scientific Committee of Various National and International Meetings including Electronic Materials Conference, Gordon Research Conference on Plasma Chemistry, CIPG, BANPIS '99 (since 1983).
- Member: American Vacuum Society, Materials Research Society, Electrochemical Society.

Areas of Professional Interest

Novel Materials, Low-Temperature Plasma Science & Technology, Physics and Chemistry of Nanostructure Fabrication, Nanolithography, Surface Chemistry and Physics, Thin Films, Real-time, In-situ Plasma and Process Diagnostics, Plasma-Surface Interactions, Defects.

Scientific Achievements

Plasma-Surface Interactions

- Measured for the first time quantitatively fundamental reaction rates of energy and mass-selected Ar^+ and fluorocarbon ions with SiO_2 and resist surfaces at ion energies of 15 eV to 300 eV by controlling the energetic neutral background, quantifying the variable flux density (due to variable ion beam diameter at energies less than 120 eV), charge neutralization and other effects that become dominant at low ion energies.
- Established the most detailed picture of plasma-induced surface and near-surface modifications of silicon-related materials and measured the dependence of the surface modifications on plasma process parameters for several model systems, e.g. exposure of a silicon surface to a fluorocarbon plasma during the formation of contact holes in SiO_2.
- Quantitatively established that directional plasma etching does not proceed layer-by-layer, but by ion-driven diffusion through substrate-dependent reaction layers that range in thickness from 0.5 to greater than 5 nm.
- Produced a mechanistically complete picture of the complex interplay of gas phase and surface processes in model remote plasma processing systems.The lack of ion bombardment in these systems dramatically increases the importance of reactive intermediates, e.g. plasma-formed NO, even when present at much smaller concentrations than other reactive species, e.g. atomic F or O.
- Ground-breaking studies on the role of hydrogen during plasma-processing of silicon materials. Secondary ion mass spectrometry, photoluminescence, transmission electron microscopy and lattice location studies by nuclear reaction analysis in conjunction with channeling and blocking were employed to elucidate dopant deactivation and extended defect formation mechanisms.

Physics and Chemistry of Micro- and Nanostructure Fabrication

- Conceived and demonstrated a novel approach of in-situ surface analysis of microstructures using regular arrays of microstructures that provides information at the length-scale of the microstructure. This approach enabled the first in-situ analysis of sidewall passivation chemistries in microstructures. This technique has been widely duplicated, and provides novel insights on 3-dimensional surface chemistry in microstructures not obtainable by other means.
- First unambiguous experimental proof that sidewall charging of insulating microstructures by electrons in a plasma is an important effect. Microtrenching, in conjunction with a weak magnetic field perpendicular to the axis of the microstructure, was used as a diagnostic.
- Proposed the current model for the dependence of the etching rate of insulating films on the width and etch depth of the microstructure based on careful measurements of a) the processing rate as a function of microstructure dimensions and b) the etch yield curve as a function of energy density to the surface.

Science and Technology of Plasma-Based Pattern Transfer

- Produced by application of multiple plasma diagnostic and surface measurement techniques key mechanistic insights on plasma-surface interaction processes that determine

etching selectivity to mask and underlayer, and etching directionality for essential plasma-assisted etching processes of silicon-related materials.

- World-leading contributions to the understanding of high-density low pressure plasmas used for the patterning of SiO_2 films and low dielectric constant insulating materials, including a description of the dramatic surface chemistry changes near the energy threshold for etching where a transition from an incidence flux limited regime at higher energy to a surface chemistry limited regime at lower energy occurs.
- My group was the first to produce ultra-fine trenches in SiO_2, with widths down to 20 nm, and aspect ratios of up to 10/1.

Diagnostics

- First to use real-time ellipsometric measurements on microstructures during plasma processing for in-line process control and provide a model.
- Ultra-high resolution depth profiling of layered structures, e.g. SiGe superlattices or ultra-thin oxide-nitride-oxide layers, using a combination of reactive etching and real-time ellipsometry.
- First demonstration of principal components analysis and artificial neural networks for spectral interpretation of real-time plasma optical emission and mass spectrometric data for tool-state determination, and automatic process control in plasma processing.

Advanced Materials & Processing, Defects

- Plasma-based growth of fluorinated carbon materials with a dielectric constant of 2-2.5 and leakage, breakdown strength and heat-cycling properties acceptable for copper/low k multilevel metallization structures.
- Plasma treatments of textiles.
- Pioneering work on plasma-based patterning of strained SiGe alloys. Discovered a novel interactive effect, where the presence of Ge in SiGe increases the volatilization rate of Si.
- Showed from a comparison of surface characterization data and process rates in chemical-mechanical planarization of Al and Cu microstructures that the mechanical interaction of the metal surface with a pad charged with a reactive slurry can either produce thinning of the metal oxide (Al) or increase the metal oxide thickness (Cu) relative to conditions without mechanical interaction. Only the oxide thinning mechanism had been considered in current mechanistic models.
- Observed for the first time anomalously fast diffusion of ion-implanted dopants (B, As, P) in silicon during rapid thermal processing and explained this phenomenon by the interaction of the dopants with ion-implantation related native defects.
- First demonstration of formation of VLSI-quality Ta_2O_5 insulating films in silicon technology. The dependence of the electrical parameters on deposition process and process parameters was established. Elucidation of the relationship between electrical, physical and chemical properties of the materials.
- Studied defect reactions in Czochralski-grown silicon crystals that contain about 10^{18} oxygen atoms per cm^3 during heat treatments or defect-producing processes, e.g. ion implantation and high-energy electron-irradiation. Oxygen related donors, IR

characterization, application of other spectroscopic methods, e.g. deep level transient spectroscopy, cluster formation kinetics and nucleation model.

Teaching Experience and Interests

- University of Maryland: Designed and taught university physics courses at both undergraduate and graduate level: *Structure of Engineering Materials, The Plasma State in Nature and Civilization* (Honors Course), *Low Temperature Plasma Processing, Introduction to Engineering Design*.
- State University of New York: Designed and taught university physics courses at both undergraduate and graduate level: *Introductory Physics*, *Modern Physics*, *Plasma Processing of Electronic Materials*, *Experimental Techniques of Materials Physics.*
- 1997 IEDM Short Course: *Giga-Scale CMOS Technology - Dry Etching.* Organized by IEEE (Washington DC, Dec. 1997).
- Lecturer at NATO Advanced Studies Institute on *Plasma Processing of Semiconductors*, (Chateau de Bonas, June 1996).
- *High-Density Plasma Processing of Electronic Materials.* A professional course designed and taught for the AVS (formerly American Vacuum Society), USA (since 1995).
- Co-organizer and instructor of *International Summer School on Plasma Chemistry, ISPC-12* (Minneapolis, Aug. 1995).

Students, Visitors and Post-Doctoral Research Fellows

Current Doctoral Students:

Li Ling, Xuefeng Hua

Doctoral Students Supervised (with Affiliations)

M. Doemling (Fysix Corp.); N. Rueger (Micron Technology); J. Hernandez (IPEC); M. Schaepkens (GE R&D Center); B.E.E. Kastenmeier (IBM); T.E.F.M. Standaert (IBM); P. J. Matsuo (Fysix Corp.), P. Wrschka (Infinion)

Master's Degree Students Supervised

Xiang Wang, Eric Joseph, Eric Sanjuan, Ingo Martini, Gregor Dasbach.

Visiting Scholar Awards

- Host of Ling Zheng, Assistant Faculty Researcher (Oct. 2002 – Oct. 2003)
- Host of Masanaga Fukasawa, SONY Research, recipient of a SONY Overseas Study Award (Aug. 2000 – October 2001).
- Host of Dr. Christer Hedlund, University at Uppsala, Sweden, recipient of an Oversea's Scholarship Award, Swedish Board of Technical Development, (Sept. 1998 - Aug. 1999).
- Host of Dr. Lin Bin, Chinese Academy of Sciences, Beijing, recipient of a Visiting Scholar Award, Chinese Academy of Sciences, Beijing (Nov. 1997 - Oct. 1998).
- Host of Dr. M. Tokushima, NEC Central Research, recipient of an NEC Overseas Study Program Award, involving an award to the guest researcher plus a research award to the host laboratory (Nov. 1996 - Oct. 1997).

Post-Doctoral Research Fellows

- Dr. Li Xi, Kyoto Institute of Technology (1998-present).
- Dr. Si Yi Li, University of Singapore (1999/2000).
- Dr. Hongjiang Sun, Philips (1994/96).
- Dr. Sjaak Beulens, ASM International, The Netherlands (1993/95).
- Dr. Olivier Joubert, CNET, France (1992/93).
- Dr. Ferdinand Bell, Siemens, Germany (1992/93).
- Dr. Ying Zhang, IBM Research Division (1990/93).
- Dr. Marco Haverlag, Philips, The Netherlands (1991/92).
- Dr. D. Vender, University of Dublin (1990/92).
- Dr. Gerrit Kroesen, Eindhoven University of Technology (1990).
- Dr. David Angell, IBM Microelectronics (1989/91).
- Dr. Phil Jones, Applied Materials (1989/90).
- Dr. Timothy Bestwick, Rutherford Appleton Laboratories, Oxford (1988/90).
- Dr. S. W. Robey, National Institute of Standards and Technology (1986/88).

Patents

1. *High area capacitor formation using material dependent etching*; with V. V. Patel, A. Grill, R. T. Hodgson, G. W. Rubloff. US Patent # 5155657. Issued: Oct. 13, 1992.
2. *High area capacitor formation using dry etching*; with G. W. Rubloff. US Patent # 5153813. Issued: Oct. 6, 1992.
3. *Plasma deposition of fluorocarbon*; with T. N. Nguyen, Z. A. Weinberg. US Patent # 5244730. Issued: Sept. 14, 1993.
4. *Plasma deposition of fluorocarbon*; with T. N. Nguyen, Z. A. Weinberg. US Patent # 5302420. Issued: Apr. 12, 1994.
5. *Adhesion promotion of fluorocarbon films*; with T. N. Nguyen, Z. A. Weinberg. US Patent # 5549935. Issued: Aug. 27, 1996.
6. *Method for controlling silicon etch depth*; with M. Arienzo, D. L. Harame. US Patent # 5395769. Issued: Mar. 7, 1995.
7. *Method for hot wall reactive ion etching using a dielectric or metallic liner with temperature control to achieve process stability*; with M. Haverlag, D. Vender, Y. Zhang. US Patent # 5637237. Issued: June 10, 1997.
8. *Promotion of the adhesion of fluorocarbon films*; with T. N. Nguyen, Z. A. Weinberg. US Patent # 5788870. Issued: Aug. 4, 1998.
9. *Apparatus for hot wall reactive ion etching using a dielectric or metallic liner with temperature control to achieve process stability*; with M. Haverlag, D. Vender, Y. Zhang. US Patent # 5798016. Issued: Aug. 25, 1998.
10. *Highly selective chemical dry etching of silicon nitride over silicon and silicon dioxide*; with B. E. Kastenmeier, P. Matsuo. US Patent # 6060400. Issued: May 9, 2000.

Invited Conference Talks

1. *Early Stages of Oxygen Clustering and its Influence on Electrical Behavior of Silicon*, Fall Meeting of the Materials Research Society, Boston, Nov. 1982.
2. *Physics of Reactive Ion Etching*, March Meeting of the American Physical Society, Las Vegas, March 31 - April 4, 1986.
3. *Anisotropic Dry Etching of SiO_2 on Si and Its Impact on Surface and Near-Surface Properties of the Substrate*, Spring Meeting of the Materials Research Society, Palo Alto, April 1986.
4. *Reactive Ion Etching Related Si Surface Residues and Subsurface Damage: Their Relationship to Fundamental Etching Mechanisms*, National Symposium of the American Vacuum Society, Baltimore, Oct. 1986.
5. *Surface Studies of Reactive Ion Etch Processes*, 8th International Symposium on Dry Processing, Tokyo, Nov. 1986.
6. *Application of RF Plasmas to Etching and Deposition Processes in Advanced Semiconductor Technology*, 7th American Physical Society Topical Conference on Applications of RF Power to Plasmas, Kissimmee, May 1987.
7. *Surface Damage after RIE Processing*, CIPG87 4th International Conference on Plasma Etching and Deposition in Microelectronics, Antibes, June 1987.
8. *Reactive Ion Etching and the Silicon Surface*, Summer Course on Characterization Techniques for VLSI and Advanced Semiconductor Devices, Interuniversity Micro-Electronics Center, Leuven, June 1987.
9. *RIE Damage*, Plasma Etching Symposium of the Northern California Chapter of the American Vacuum Society, San Jose, Sept. 1987.
10. *Surface Modifications of Electronic Materials Induced by Plasma Etching*, 173rd Meeting of The Electrochemical Society, Atlanta, May 1988.
11. *X-ray Photoelectron Studies of Surface Modifications of Electronic Materials Caused by Reactive Ion Etching*, 1988 Fourteenth Annual Plasma Technology Seminar, San Francisco, May 1988.
12. *Plasma Based Dry Etching of Electronic Materials: Studies of Fundamental Etching Mechanisms*, 13th Nordic Semiconductor Meeting, Saltsjobaden (Sweden) June 1988.
13. *Surface Damage of Electronic Materials Caused by Reactive Ion Etching*, Gordon Research Conference on Plasma Chemistry, Tilton, Aug. 1988.
14. *In-situ Surface Studies of Reactive Ion Etch Processes*, OPTCON '88, SPIE Conference on In-situ Plasma Monitoring and Control, Santa Clara, Oct. 31 - Nov. 2, 1988.
15. *Current View of Dry Etching Damage*, SRC Topical Research Conference on Plasma Etch, Cambridge, MA, Feb. 1989.
16. *Dry Etching Damage of Silicon: A Review*, European Materials Research Society Conference, Strasbourg, May 30 - June 2, 1989.
17. Studies of Surface Modifications of Silicon Substrates and Silicon Microstructures Caused by Reactive Ion Etching, CIPG89, 5th International Conference on Plasma Etching and Deposition in Microelectronics, Antibes, June 1989.
18. *Silicon Damage by Dry Etching*, Sematech Plasma Etch Workshop, Austin, Jan. 1990.

19. *Surface Modifications by Low Pressure Etching Plasmas: Their Role in the Achievement of Etch Directionality and Selectivity*, 2nd International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, Sept. 1990.
20. *Plasma-Based Etching of Si-Related Electronic Materials: Mechanistic Insights From In-Situ Surface Studies*, International Seminar on Reactive Plasmas, Nagoya, June 1991.
21. *Plasma Etching and Profiling of SiGe Alloys*, 4th Japanese Symposium on Plasma Chemistry, Kyoto, June 1991.
22. *Cryogenic Reactive Ion Etching*, American Vacuum Society Plasma Etch User's Group Workshop on Low Temperature Etching, Palo Alto, July 1991.
23. *In-Situ Surface Studies of Silicon Dry Etching Processes* Australian Institute of Physics Congress, Session on Plasma Processing, Melbourne, February 1992.
24. *Ion Bombardment Effects on Silicon Surface Properties in Plasma-Assisted Etching* SEMATECH Plasma Etch Damage Workshop, Austin, April 1992.
25. *Dry Etch Damage - Current Issues*, SRC Topical Research Conference on Plasma Etching, Princeton, NJ, May 1992.
26. *Surface Studies of Reactive Ion Etching Processes in Silicon Technology: From Surface Damage to High-Resolution Depth Profiling* 181st Meeting of The Electrochemical Society, St. Louis, May 1992.
27. *The Effect of Ion Bombardment on the Fluorine-Silicon Reaction Layer*, American Vacuum Society Symposium on Advances in Plasma and Sputter Processing, Pittsburgh, June 1992.
28. *In-Situ Surface Studies of RF Diode and ECR Etching Processes*, Gordon Research Conference on Plasma Chemistry, New London, NH, Aug. 1992.
29. *High-Density Plasma Etching of Silicon Dioxide and Silicon Using Fluorocarbon Gases*, 19th Annual Tegal Plasma Seminar, San Francisco, July 1993.
30. *Study of Plasma-Surface Interactions in High-Density Plasma Etching of Silicon Dioxide and Silicon*, National Symposium of the American Vacuum Society, Orlando, Oct. 1993.
31. *Real-Time Monitoring of Silicon Surface Modifications and Chamber Status in Plasma Etching*, Fall Meeting of the Materials Research Society, Boston, Nov. 1993.
32. *Mechanistic Studies of Silicon Dioxide in High-Density Plasmas*, CIPG95, International Conference on Plasma Etching and Deposition in Microelectronics, Antibes, June 1995.
33. *Study of Plasma-Surface Interactions: Chemical Downstream Etching vs. High-Density Plasma*, IUVSTA International Workshop on Plasma Sources and Surface Interactions in Materials Processing, Fuji-Yoshida, Japan, Sept. 1995.
34. *Mechanistic Studies of SiO_2 Etching in High-Density Plasmas*, Corporate Distinguished Speakers Program, Micron Technology, Boise, Nov. 1995.
35. SiO_2 Etching in High-Density Fluorocarbon Plasmas, NATO Advanced Study Institute, Plasma Processing of Semiconductors, Chateau de Bonas, France, June 1996.
36. *Remote Plasma Processing*, NATO Advanced Study Institute, Plasma Processing of Semiconductors, Chateau de Bonas, France, June 1996.
37. *Mechanistic Aspects of High-Density Plasma Etching of Silicon Dioxide*, National Symposium of the American Vacuum Society, Philadelphia, Oct. 1996.
38. *Surface Processes in Low Pressure Plasmas*, The Tenth Toyota Conference on Atomic, Molecular and Electronic Dynamic Processes on Solid Surfaces, Shizuoka, Japan, Nov. 1996.

39. *Surface Processes in Selective Fluorocarbon Etching of SiO_2 Over Si, Si_3N_4 and Resist Materials Using an Inductively-Coupled High-Density Plasma Reactor*, Workshop on Basic Aspects of Nonequilibrium Plasmas Interacting with Surfaces 1997 (BANPIS '97), Shirahama, Japan, Jan. 1997.
40. *Mechanistic Studies of Chemical Mechanical Polishing of Al Films*, 1997 Symposium on Chemical Mechanical Polishing, Lake Placid, Aug. 1997.
41. *Issues in Plasma-Assisted Etching Processes in the Silicon Integrated Circuit Technology*, 8. Bundesdeutsche Fachtagung, Plasma-Technologie, Dresden, Sept. 1997.
42. *Plasma-Assisted Etching: Data Needs on Elementary Processes Occuring on Planar Surfaces and in Microstructures*, International Conference on Atomic and Molecular Data and their Applications (ICAMDATA), Gaithersburg, Sept. 1997.
43. *High-Density Plasma Etching of Low Dielectric Constant Materials*, MRS Spring Meeting, San Francisco, April 1998.
44. *Plasma-surface Interaction Mechanisms in the High-density Plasma Etching of Dielectric Materials*, Gordon Research Conference on Plasma Processing Science, Tilton, NH, Aug. 1998.
45. *Plasma-surface Interactions and Microelectronics*, American Vacuum Society (New York Chapter Annual Meeting), Albany, Sept. 1998.
46. *Dry Etching of Low k Dielectric Materials*, European Workshop on Materials for Advanced Metallization (MAM '99), Oostende, March 1999.
47. *Mechanistic Studies of Copper CMP Processes for Damascene Structures*. *4th International Symposium on Chemical-Mechanical Polishing*, Lake Placid, NY, Aug. 1999 (presented by Ph.D. students J. Hernandez and P. Wrschka).
48. *Plasma-Surface Interactions in Dielectric Pattering Using High-Density Sources*, 52nd Annual Gaseous Electronics Conference, Norfolk, Oct. 5-8, 1999.
49. *Pattern Transfer into Low Dielectric Constant Materials Using High Density Plasmas*, Advanced Metallization Conference (AMC) 1999, Orlando, Sept. 28-30, 1999.
50. *Plasma-based Pattern Transfer into Dielectric Materials: Plasma-Surface Interaction Processes*, Second International Workshop on Basic Aspects of Non-equilibrium Plasmas Interacting with Surfaces (BANPIS-2000), Nagasaki, Japan, January 2000 (presented by Ph.D. student T. Standaert).
51. *Plasma-Assisted Etching: Elementary Processes on Planar Surfaces and in Microstructures*, Department of Energy Workshop on "Electron-Driven Processes: Scientific Challenges and Technological Opportunities", Newark, March 2000.
52. *Oxide Etching in Inductively Coupled Fluorocarbon*, 197th Meeting of the Electrochemical Society, Toronto, May 2000 (presented by Ph.D. student M. Schaepkens).
53. *Plasma-Assisted Etching Processes for Dielectric Materials: Technological Challenges and Elementary Processes on Planar Surfaces and in Microstructures*, 47th International Symposium of the American Vacuum Society, Boston, Oct. 2000.
54. *High Resolution Plasma Etching of Dielectric Films for Silicon Integrated Circuit Technology*, Ninth International Symposium on Gaseous Dielectrics, Ellicott City, May 2001.
55. *Pattern Transfer into Dielectric Films by High-Resolution Plasma Etching Techniques*, The Sixth International Symposium on Sputtering & Plasma Processes, Kanazawa, June 2001.
56. Current Issues in Pattern Transfer into Dielectric Films by High-Resolution Plasma Etching Techniques, 200th Meeting of the Electrochemical Society, Philadelphia, May 2002.

Books

G. S. Oehrlein, K. Maex, Y.-C. Joo, S. Ogawa, and J. T. Wetzel, editors, “Materials, Technology and Reliability for Advanced Interconnects and Low-k Dielectrics”, MRS Symposium Proceedings Volume 612 (Warrendale, 2001).

G. S. Oehrlein, *Plasma Processing of Electronic Materials,* Springer Verlag (Heidelberg, 2005).

Publications

1. G. S. Oehrlein, J. P. Karins, J. W. Corbett, P. M. Mooney, and B. Pajot, *Modeling of Radiation Damage in Silicon Solar Cells*, in Solar Cell High Efficiency and Radiation Damage, edited by D. T. Bernatowicz and H. W. Brandhorst, NASA Conf. Publ., Ext. Abst. (1980).
2. G. S. Oehrlein, J. L. Lindström, and J. W. Corbett, *Electrolytical Method for Hydrogenation of Silicon*, Phys. Lett. **81A,** 246 (1981).
3. G. S. Oehrlein, D. J. Challou, A. E. Jaworowski and J. W. Corbett, *The Role of Carbon in the Precipitation of Oxygen in Silicon*, Phys. Lett. **86A,** 117 (1981).
4. G. S. Oehrlein, J. L. Lindström, and J. W. Corbett, *Carbon-Oxygen Complexes as Nuclei for the Precipitation of Oxygen in Czochralski Silicon*, Appl. Phys. Lett. **40,** 241 (1982).
5. T. S. Shi, S.N. Sahu, G.S. Oehrlein, A. Hiraki, and J.W. Corbett, *Models for the Hydrogen-Related Defect-Impurity Complexes and Si-H Infrared Bands in Crystalline Silicon*, Phys. Stat. Sol. (a) **74,** 329 (1982).
6. J. L. Lindström, G. S. Oehrlein, A.E. Jaworowski, and J.W. Corbett, *The Mechanism of the Enhancement in Divacancy Production by Oxygen During Electron Irradiation of Silicon. I. Experimental*, J. Appl. Phys. **53,** 8686 (1982).
7. S. Oehrlein, I. Krafcsik, J.L. Lindström, A.E. Jaworowski, and J.W. Corbett, *The Mechanism of the Enhancement of Divacancy Production by Oxygen During Electron Irradiation of Silicon. II. Computer Modeling*, J. Appl. Phys. **54,** 179 (1983).
8. S. Oehrlein, J.L. Lindström, I. Krafcsik, A.E. Jaworowski, and J.W. Corbett, *A Quantitative Investigation of Divacancy Production Enhancement by Interstitial Oxygen in Electron-Irradiated Silicon*, Physica **116B,** 230 (1983).
9. E. Jaworowski, G.S. Oehrlein, and J.W. Corbett, *Electron Irradiation Effects in Edge-Definded-Film-Fed-Growth Ribbon Silicon*, Physica **116B,** 287 (1983).
10. G. S. Oehrlein, and J. W. Corbett, *Early Stages of Oxygen Clustering and its Influence on Electrical Behavior of Silicon*, in Defects in Semiconductors II, edited by S. Mahajan and J. W. Corbett, (Elsevier Sci. Publ. Co., New York 1983), pp. 107.
11. G. S. Oehrlein, *Silicon-Oxygen Complexes Containing Three Oxygen Atoms as the Dominant Thermal Donor Species in Heat-Treated Oxygen-Containing Silicon*, J. Appl. Phys. **54,** 5453 (1983).
12. G. S. Oehrlein, and A. Reisman, *Electrical Properties of Amorphous Tantalum Pentoxide Thin Films on Silicon*, J. Appl. Phys. **54,** 6502 (1983).
13. G. S. Oehrlein, F. M. d'Heurle, and A. Reisman, *Some Properties of Crystallized Tantalum Pentoxide Thin Films on Silicon*, J. Appl. Phys. **55,** 3715 (1984).
14. G. S. Oehrlein, S. A. Cohen, and T. O. Sedgwick, *Diffusion of Phosphorus During Rapid Thermal Annealing of Ion-Implanted Silicon*, Appl. Phys. Lett. **45,** 417 (1984).
15. T. O. Sedgwick, S. A. Cohen, G. S. Oehrlein, V. R. Deline, R. Kalish, and S. Shatas, *Enhanced Diffusion in Short Time Annealed Arsenic and Boron Ion Implanted Silicon*, in VLSI Science and Technology/1984, eds. K. E. Bean and G. A. Rozgonyi (Electrochem. Soc., Pennington, 1984), pp. 192.
16. R. Ghez, R. G. S. Oehrlein, T. O. Sedgwick, F. F. Morehead, and Y. H. Lee, *Exact*

Description and Data Fitting of Ion-Implanted Dopant Profile Evolution During Annealing, Appl. Phys. Lett. **45,** 881 (1984).

17. Kalish, G. S. Oehrlein, V. R. Deline, and S. A. Cohen, *Diffusion of Boron and Arsenic Implants in <111> and <100> Si During Rapid Thermal Annealing*, Nucl. Instr. Meth. Phys. Res. **B7/8,** 329 (1985).
18. G. S. Oehrlein, R. Ghez, J. D. Fehribach, E. F. Gorey, T. O. Sedgwick, S. A. Cohen, and V. R. Deline, *Diffusion of Ion-Implanted Boron and Phosphorus During Rapid Thermal Annealing of Silicon*, in Thirteenth International Conference on Defects in Semiconductors, eds. L. C. Kimerling and J. M. Parsey, Jr., (Metallurgical Soc. of AIME, 1985), pp. 539.
19. J. D. Fehribach, R. Ghez, and G. S. Oehrlein, *Asymptotic Estimates of Diffusion Times for Rapid Thermal Annealing*, Appl. Phys. Lett. **46,** 433 (1985).
20. R. Ghez, J. D. Fehribach, and G. S. Oehrlein, *The Analysis of Diffusion Data by a Method of Moments*, J. Electrochem. Soc. **132,** 2759 (1985).
21. J. L. Lindström, B. G. Svensson, J. W. Corbett, and G. S. Oehrlein, *On the Complex of the Oxygen Interstitial and the Silicon Interstitial in Silicon*, Phys. Stat. Sol. (a) **85,** K109 (1984).
22. G. S. Oehrlein, J. L. Lindström, and S. A. Cohen, *A Kinetic Study of Oxygen-Related Thermal Donor Formation*, in Thirteenth International Conference on Defects in Semiconductors, eds. L. C. Kimerling and J. M. Parsey, Jr., (Metallurgical Soc. of AIME, 1985), pp. 701.
23. T. O. Sedgwick, A. E. Michel, S. A. Cohen, V. R. Deline, and G. S. Oehrlein, *Investigation of Transient Diffusion Effects in Rapid Thermally Processed Ion Implanted Arsenic in Silicon*, Appl. Phys. Lett. **47,** 848 (1985).
24. G. S. Oehrlein, R.M. Tromp, Y.H. Lee, and E.J. Petrillo, *A Study of Silicon Contamination and Near-Surface Damage Caused by CF_4/H_2 Reactive Ion Etching*, Appl. Phys. Lett. **45,** 420 (1984).
25. M. Ransom, S.M. Chicokta, P. Spirito, G.S. Oehrlein, T.O. Sedgwick, and S.A. Cohen, *Short-Time Annealing of Dry-Etching Damage*, in Proceedings of the Fifth Symposium on Plasma Processing, eds. G. Smolinsky, G.C. Schwartz and G.S. Mathad (The Electrochemical Society, Pennington, 1985), 579.
26. G. S. Oehrlein, R.M. Tromp, J.C. Tsang, Y.H. Lee, and E.J. Petrillo, *Near-Surface Damage and Contamination after CF_4/H_2 Reactive Ion Etching of Si*, J. Electrochem. Soc. **132,** 1441 (1985).
27. J. C. Tsang, G. S. Oehrlein, Ivan Haller, and J. S. Custer, *Raman Spectroscopy of Reactive Ion Etching Induced Subsurface Damage*, Appl. Phys. Lett. **46,** 589 (1985).
28. G. S. Oehrlein, C. M. Ransom, S. N. Chakravarti, and Y. H. Lee, *Silicon Near-Surface Disorder and Etch Residues Caused by $CClF_3/H_2$ Reactive Ion Etching*, Appl. Phys. Lett. **46,** 686 (1985).
29. R. M. Feenstra, and G. S. Oehrlein, *Surface Morphology of Oxidized and Ion-Etched Silicon by Scanning Tunneling Microscopy*, Appl. Phys. Lett. **47,** 97 (1985).
30. J. C. Tsang, W. A. Thompson, and G. S. Oehrlein, *Raman Spectroscopy of Surface Layers on Crystalline Silicon*, J. Vac. Sci. & Technol. **B 3,** 1129 (1985).

31. G. J. Coyle and G. S. Oehrlein, *Formation of a Silicon-Carbide Layer During CF_4/H_2 Dry Etching of Silicon*, Appl. Phys. Lett. **47,** 607 (1985).
32. R. M. Feenstra and G. S. Oehrlein, *Summary Abstract: Surface Morphology of Oxidized and Ion-Etched Silicon by Scanning Tunneling Microscopy*, J. Vac. Sci. & Technol. **B 3,** 1136 (1985).
33. G. S. Oehrlein, R. G. Schad, and M. A. Jaso, *Mechanism of Silicon Surface Roughening by Reactive Ion Etching*, Surface Interface Analysis **8,** 243 (1986).
34. G. S. Oehrlein, *Oxidation Temperature Dependence of the dc Electrical Conduction Characteristics and Dielectric Strength of Thin Ta_{2O5} Films on Silicon*, J. Appl. Phys. **59,** 1587 (1986).
35. X. C. Mu, S. J. Fonash, G. S. Oehrlein, S. N. Chakravarti, C. Parks, and J. Keller, *A Study of $CClF_3/H_2$ Reactive Ion Etching Damage and Contamination Effects in Silicon*, J. Appl. Phys. **59,** 2958 (1986).
36. G. S. Oehrlein, *Rutherford Backscattering Studies of Plasma-Etched Silicon*, J. Appl. Phys. **59,** 3053 (1986).
37. P. Spirito, C. M. Ransom, and G. S. Oehrlein, *Schottky Diode Analysis for Evaluation of RIE Effects on Silicon Surfaces*, Solid State Electronics **29,** 607 (1986).
38. G. S. Oehrlein, G. J. Coyle, J. G. Clabes, and Y. H. Lee, *Study of Near-Surface Disorder and Surface Residues after Reactive Ion Etching of Silicon*, Surf. Interf. Analysis **9,** 275 (1986).
39. G. S. Oehrlein, J. G. Clabes, and P. Spirito, *Investigation of Reactive-Ion-Etching-Related Fluorocarbon Film Deposition onto Silicon and a New Method for Surface Residue Removal*, J. Electrochem. Soc. **133,** 1002 (1986).
40. G. J. Coyle and G. S. Oehrlein, *Formation of Silicon Carbide in Silicon Substrates During CF_4/H_2 Dry Etching*, Applied Surface Science **25,** 423 (1986).
41. G. S. Oehrlein, G. J. Coyle, J. C. Tsang, R. M. Tromp, J. G. Clabes, and Y. H. Lee, *Anisotropic Dry Etching of SiO_2 on Si and its Impact on Surface and Near-Surface Properties of the Substrate*, in Plasma Processing, eds. J. Coburn, R. A. Gottscho, and D. W. Hess, Materials Research Society Proceedings 68, pp. 367 (1986).
42. G. S. Oehrlein, I. Reimanis, and Y. H. Lee, *Plasma-Deposited Fluorocarbon Films on Silicon Studied by Ellipsometry*, Thin Solid Films **143,** 269 (1986).
43. G. S. Oehrlein, T. Y. Tan, R. L. Kleinhenz, and J. L. Lindström, *On the Question of Oxygen Diffusion During Oxygen Related Thermal Donor Formation in Silicon*, in Materials Issues in Silicon Integrated Circuit Processing, eds. M. Wittmer, J. Stimmell, M. Strathman, Materials Research Society Proceedings 71, pp. 65 (1986).
44. J. T. Borenstein, J. T. Jones, J. W. Corbett, G. S. Oehrlein, and R. L. Kleinhenz, *Quenched-in Defects in Flashlamp Annealed Silicon*, Appl. Phys. Lett. **49,** 199 (1986).
45. J. L. Lindström, G. S. Oehrlein, and J. W. Corbett, *A Study of the Annealing of the 830 cm^{-1} IR Band Observed in Electron-Irradiated Silicon*, phys. stat. sol. (a) **95,** 179 (1986).
46. G. S. Oehrlein, J. G. Clabes, G. J. Coyle, J. C. Tsang, and Y. H. Lee, *Summary Abstract: Reactive Ion-Etching-Related Si Surface Residues and Subsurface Disorder*, J. Vac. Sci. & Technol. **A 4,** 750 (1986).
47. G. S. Oehrlein, *Surface Studies of Reactive Ion Etching Processes*, in Proceedings of the

8th International Symposium on Dry Processing, ed. Jun-ichi Nishizawa, The Institute of Electrical Engineers of Japan, Tokyo, 1986, pp. 59.

48. G. S. Oehrlein, *Reactive-Ion Etching*, Physics Today, **39,** 26 (October 1986).
49. G. A. Northrop and G. S. Oehrlein, *Photoluminescence of Defects Produced by Reactive Ion Etching of Silicon*, in Materials Science Forum, **10-12,** 1253 (1986).
50. G. S. Oehrlein, *Applications of RF Plasmas to Etching Processes in Advanced Semiconductor Technology*, in Applications of RF Power to Plasmas, eds. S. Bernabei & R. W. Motley, (AIP Conference Proceedings **159,** New York, 1987), pp. 442.
51. G. S. Oehrlein and H. L. Williams, *Silicon Etching Mechanisms in a CF_4/H_2 Glow Discharge*, J. Appl. Phys. **62,** 662 (1987).
52. S. J. Jeng and G. S. Oehrlein, *Microstructural Studies of Reactive Ion Etched Silicon*, Appl. Phys. Lett. **50,** 1912 (1987).
53. S. J. Jeng and G. S. Oehrlein, *Silicon Near-Surface Damage Induced by Reactive Ion Etching*, in Proceedings of the 45th Annual Meeting of the Electron Microscopy Society of America, ed. G. W. Bailey, (San Francisco Press, San Francisco, 1987), pp. 244.
54. G. S. Oehrlein, S. J. Jeng, and G. A. Northrop, *Surface Damage After Reactive Ion Etching of Silicon*, Supplement a la Revue *Le Vide, les Couches Minces* **237,** 149 (1987).
55. G. S. Oehrlein and Y. H. Lee, *Reactive Ion Etching Related Si Surface Residues and Subsurface Damage: Their Relationship to Fundamental Etching Mechanisms*, J. Vac. Sci. & Technol. **A 5,** 1585 (1987).
56. J. L. Lindström, H. Weman, and G. S. Oehrlein, *Thermal Donors and Carbon-Oxygen Defects in Silicon*, phys. stat. sol. (a) **99,** 581 (1987).
57. D. Marwick, G. S. Oehrlein, and N. M. Johnson,*Structure of the Boron-Hydrogen Complex in Crystalline Silicon*, Phys. Rev. **B 36,** 4539 (1987).
58. Bright, S. Kaushik, and G. S. Oehrlein, *Plasma Chemistry of CF_4/O_2 in a Magnetron Ion Etching System*, J. Appl. Phys. **62,** 2518 (1987).
59. A.Bright, A. A., and S. Kaushik, S. Robey, and G. S. Oehrlein, *Plasma Chemical Aspects of Magnetron Ion Etching with CF_4-based Plasmas*, in Proceedings 8th Int. Symposium on Plasma Chemistry/Tokyo 1987, eds. K. Akashi and A. Kinbara, (Int. Union of Pure and Appl. Chemistry, Tokyo, 1987), pp. 511.
60. G. S. Oehrlein, S. W. Robey, and M. A. Jaso, *Mechanism of the Slow-Down of the Silicon Etch Rate by a Fluorocarbon Overlayer in CF_4/H_2 RIE of Silicon*, in Plasma Processing, D. Apelian and J. Szekely, eds., (Materials Research Society, Symposia Proceedings Series, Vol. **98,** Pittsburgh, 1987), pp. 229.
61. A. Bright, S. Kaushik, and G. S. Oehrlein, *Plasma Chemical Aspects of Magnetron Ion Etching with CF_4/O_2 and CF_4/H_2*, in Plasma Processing, D. Apelian and J. Szekely, eds., (Materials Research Society, Symposia Proceedings Series, Vol. 98, Pittsburgh, 1987), pp. 217.
62. G. S. Oehrlein, G. J. Scilla, and S.-J. Jeng, *Efficiency of Oxygen Plasma Cleaning of Reactive Ion Damaged Silicon Surfaces*, Appl. Phys. Lett. **52,** 907 (1988).
63. G. S. Oehrlein, *Capacitance-Voltage Properties of Thin Ta_2O_5 Films on Silicon*, Thin Solid Films **156,** 207 (1988).
64. G. S. Oehrlein, S. W. Robey, and J. L. Lindström, *Surface Processes in CF_4/O_2 Reactive*

Etching of Silicon Appl. Phys. Lett. **52,** 1170 (1988).

65. G. S. Oehrlein, S. W. Robey, J. L. Lindström, and M. A. Jaso, *X-ray Photoelectron Studies of Surface Modifications of Electronic Materials Caused by Reactive Ion Etching*, in 1988 Fourteenth Annual Plasma Seminar Proceedings, (Tegal Corp., Petaluma, CA, 1988), pp. 39.
66. Mark A. Jaso and G. S. Oehrlein, *Transient Fluorocarbon Film Thickness Effects Near the Silicon Dioxide/Silicon Interface in Selective Silicon Dioxide Reactive Ion Etching*, J. Vac. Sci. & Technol. **A 6,** 1397 (1988).
67. S. W. Robey and G. S. Oehrlein, *Valence-Band Photoemission and Electron Energy-Loss Studies of Reactive Ion Etched Silicon Dioxide*, J. Vac. Sci. & Technol. **A 6,** 1503 (1988).
68. G. S. Oehrlein, A. A. Bright, and S. W. Robey, *X-ray Photoemission Spectroscopy Characterization of Silicon Surfaces After CF_4/H_2 Magnetron Ion Etching: Comparisons to Reactive Ion Etching*, J. Vac. Sci. & Technol. **A 6,** 1989 (1988).
69. G. S. Oehrlein, *Plasma Based Dry Etching of Electronic Materials: Studies of Fundamental Etching Mechanisms*, in Proceedings of the 13th Nordic Semiconductor Meeting, ed. M. Ostling (Royal Institute of Technology, Stockholm, 1988), pp. 23.
70. Marwick, G. S. Oehrlein, and N. Johnson, *The Structure of the Boron-Hydrogen Complex in Silicon*, Materials Research Society Proceedings **104,** 259 (1988).
71. S.J. Jeng, G. S. Oehrlein, G. J. Scilla, *Hydrogen Induced Defects in Silicon*, Materials Research Society Proceedings **104,** 247 (1988).
72. G. S. Oehrlein, K. K. Chan, and M. A. Jaso, *In-Situ Spatially Resolved Surface Characterization of Realistic Semiconductor Structure After Reactive Ion Etching Process*, J. Appl. Phys. **64,** 2399 (1988).
73. S.J. Jeng, G. S. Oehrlein, G. J. Scilla, *Hydrogen Plasma Induced Defects in Silicon*, Appl. Phys. Lett. **53,** 1735 (1988).
74. M. Copel, R. M. Tromp, S. W. Robey and G. S. Oehrlein, *Medium Energy Ion Scattering Analysis of Reactive Ion Etched Si(001) Surfaces,* Appl. Phys. Lett. **53,** 2317 (1988).
75. G. S. Oehrlein, S. W. Robey, J. L. Lindström, K. K. Chan, M. A. Jaso, and G. J. Scilla, *Surface Modifications of Electronic Materials Induced by Plasma Etching*, in Plasma Processing: Proceedings of the 7th Plasma Processing Symposium, eds. D. Hess and G. S. Mathad (Electrochem. Society, Pennington, 1988), pp. 151.
76. G. Fortuno and G. S. Oehrlein, *Hollow Cathode Etching of Si and SiO_2 Using CF_4 and H_2*, in Plasma Processing: Proceedings of the 7th Plasma Processing Symposium, eds. D. Hess and G. S. Mathad (Electrochem. Society, Pennington, 1988), pp. 137.
77. S. J. Jeng, G. S. Oehrlein and G. J. Scilla, *Silicon near-Surface Defects Induced by Hydrogen Plasma Related Processes*, in Plasma Processing: Proceedings of the 7th Plasma Processing Symposium, eds. D. Hess and G. S. Mathad (Electrochem. Society, Pennington, 1988), pp. 166.
78. S. W. Robey and G. S. Oehrlein, *Fluorination of the Silicon Dioxide Surface During Reactive Ion and Plasma Etching in Halocarbon Plasmas*, Surface Science **210,** 429 (1989).
79. J. L. Lindström, G. S. Oehrlein, G. J. Scilla, A. S. Yapsir and J. W. Corbett, *Effects of Deuterium Plasmas on Silicon Near-Surface Properties*, J. Appl. Phys. **65,** 3297 (1989).

80. S. W. Robey, M. A. Jaso, and G. S. Oehrlein, *A Photoemission Investigation of Surface Processes Affecting the Reactive Ion Etching of $TiSi_2$ in CF_4,* J. Appl. Phys. **65,** 2951, (1989).
81. G. S. Oehrlein and R. Kalish, *Silicon loss and transient etch rate in selective reactive ion etching of oxide overlayers*, App. Phys. Lett. **54,** 2698 (1989).
82. G. S. Oehrlein, K. K. Chan, M. A. Jaso, and G. W. Rubloff, *Surface analysis of realistic semiconductor microstructures*, J. Vac. Sci. & Technol. **A 7,** 1030 (1989).
83. G. S. Oehrlein and J. L. Lindström, *Competitive reactions of fluorine and oxygen with W, WSi_2, and Si surfaces in reactive ion etching using CF_4/O_2,* J. Vac. Sci. & Technol. **A 7,** 1035 (1989).
84. G. S. Oehrlein, S. W. Robey, J. L. Lindström, K. K. Chan, M. A. Jaso, and G. J. Scilla, *Surface modifications of electronic materials induced by plasma etching*, J. Electrochem. Soc. **136,** 2050 (1989).
85. G. S. Oehrlein and G. J. Scilla, *Secondary ion mass spectrometry measurements of deuterium penetration into Si by low pressure rf glow discharges*, Radiation Effects & Defects in Solids, **111,** 299 (1989).

86. T. D. Bestwick, G. S. Oehrlein, D. Angell, P. L. Jones, and J. W. Corbett, *Study of oxygen addition to CF_3Br reactive ion etching plasmas: Effects on silicon surface chemistry and etching behavior*, App. Phys. Lett. **54,** 2321 (1989).
87. G. S. Oehrlein, S.-J. Jeng, and A. D. Marwick, *Studies of Surface Modifications of Silicon Substrates and Silicon Microstructures Caused by Reactive Ion Etching*, Supplement a la Revue *Le Vide, les Couches Minces* **237,** 54, (1989).
88. G. Fortuno-Wiltshire and G. S. Oehrlein, *Hollow Cathode Etching of Si and SiO_2 Using CF_4 and H_2*, J. Electrochem. Soc. **136,** 1447 (1989).
89. G. S. Oehrlein, T. D. Bestwick, and S. W. Robey, *Surface modifications of electronic materials by reactive ion etching and their role in the etching process*, in *Proceedings of the Second Int. Conf. on Solid State and Integrated Circuits Technology (ICSICT'89)*, (Chinese Institute of Electronics, Beijing, 1989), p. 317.
90. G. S. Oehrlein, *Dry Etching Damage of Silicon: A Review*, Materials Science and Engineering **B 4,** 441 (1989).
91. G. S. Oehrlein, *Reactive Ion Etching*, in: Handbook of Plasma Processing Technology, eds. S. M. Rossnagel, J. J. Cuomo, and W. D. Westwood (Noyes Publications, Park Ridge, 1990), pp. 196.
92. A. Henry, O. O. Awadelkarim, J. L. Lindström and G. S. Oehrlein, *Effects of deuterium plasma treatments on the electrical properties of boron-doped silicon*, Materials Science and Engineering **B 4,** 147 (1989).
93. H. Weman, J. L. Lindström and G. S. Oehrlein, *Photoluminescence of defects introduced by deuterium plasmas in silicon*, Materials Science and Engineering **B 4,** 461 (1989).
94. M. A. Jaso, S. W. Robey, and G. S. Oehrlein, *Etch selectivity of silicon dioxide over titanium silicide using CF_4/H_2 reactive ion etching*, J. Electrochem. Soc. **136,** 3812 (1989).
95. G. S. Oehrlein, T. D. Bestwick, P. L. Jones, and J. W. Corbett, *Selective dry etching of silicon with respect to germanium*, Appl. Phys. Lett. **56,** 1436 (1990).
96. G. S. Oehrlein, T. D. Bestwick, P. L. Jones, M. A. Jaso, and J. L. Lindström, *Selective dry etching of germanium with respect to silicon and vice versa*, in *Proceedings of the Eighth Symposium on Plasma Processing*, eds. G. S. Mathad and D. W. Hess, (Electrochem. Soc., Pennington, 1990), pp. 661.
97. S. Yapsir, G. S. Oehrlein, G. Fortuno-Wiltshire, and J. C. Tsang, *X-ray photoemission and Raman scattering spectroscopic study of surface modifications of silicon induced by electron-cyclotron resonance etching*, Appl. Phys. Lett. **57,** 590 (1990).
98. W. M. Chen, O. O. Awadelkarim, B. Monemar, J. L. Lindström, and G. S. Oehrlein, *Microscopic identification and electronic structure of a di-hydrogen-vacancy complex in silicon by optical detection of magnetic resonance*, Phys. Rev. Lett. **64,** 3042 (1990).
99. T. D. Bestwick, and G. S. Oehrlein, *Reactive ion etching of silicon using bromine containing plasmas*, J. Vac. Sci. & Technol. **A 8,** 1696 (1990).
100. T. D. Bestwick, G. S. Oehrlein, and D. Angell, *Cryogenic reactive ion etching of silicon in SF_6*, Appl. Phys. Lett. **57,** 431 (1990).
101. Angell and G. S. Oehrlein, *Reactive ion etch/real time monitor and control*, in *Proceedings of the Eighth Symposium on Plasma Processing*, eds. G. S. Mathad and D. W. Hess, (Electrochem. Soc., Pennington, 1990), pp. 171.

102. H. Weman, B. Monemar, G. S. Oehrlein, and S. J. Jeng, *Strain-induced quantum confinement of carriers due to extended defects in silicon*, Phys. Rev. **B 42,** 3109 (1990).

103. T. D. Bestwick, G. S. Oehrlein, G. M. W. Kroesen, F. Cardone, and G. J. Scilla, *Silicon etching in HBr reactive ion etching plasmas*, in *Proceedings of the Eighth Symposium on Plasma Processing*, eds. G. S. Mathad and D. W. Hess, (Electrochem. Soc., Pennington, 1990), pp. 285.

104. H. Weman, J. L. Lindström, G. S. Oehrlein, and B. G. Svensson, *Reactive-ion and plasma-etching-induced extended defects in silicon studied with photoluminescence*, J. Appl. Phys. **67,** 1013 (1990).

105. G. S. Oehrlein, J. F. Rembetski, and E. H. Payne, *Study of sidewall passivation and microscopic silicon roughness phenomena in chlorine-based reactive ion etching of silicon trenches*, J. Vac. Sci. & Technol. **B 8,** 1199 (1990).

106. J. P. Simko, G. S. Oehrlein, and T. M. Mayer, *Removal of fluorocarbon residues on CF_4/H_2 reactive-ion-etched Si surfaces using a hydrogen plasma*, J. Electrochem. Soc. **138,** 277 (1991).

107. A. Henry, O. O. Awadelkarim, B. Monemar, J. L. Lindström, T. D. Bestwick, and G. S.Oehrlein, *Luminescent centers in reactive ion etched n-type silicon*, in *Proceedings of the Eighth Symposium on Plasma Processing*, eds. G. S. Mathad and D. W. Hess, (Electrochem. Soc., Pennington, 1990), pp. 309.

108. Henry, O. O. Awadelkarim, C. Hallin, J. L. Lindström and G. S. Oehrlein, *Hole traps in annealed reactive ion etched silicon*, in *Proceedings of the Eighth Symposium on Plasma Processing*, eds. G. S. Mathad and D. W. Hess, (Electrochem. Soc., Pennington, 1990), pp. 317.

109. Angell, and G. S. Oehrlein, *Grazing angle optical emission interferometry for end-point detection*, Appl. Phys. Lett. **58,** 240 (1991).

110. G. M. W. Kroesen, G. S. Oehrlein, and T. D. Bestwick, *Nonintrusive wafer temperature measurement using in situ ellipsometry*, J. Appl. Phys. **69,** 3390 (1991).

111. G. S. Oehrlein, Y. Zhang, G. M. W. Kroesen, E. de Fresart, and T. D. Bestwick, *Interactive effects in the reactive ion etching of SiGe alloys*, Appl. Phys. Lett. **58,** 2252 (1991).

112. G. S. Oehrlein, T. D. Bestwick, P. L. Jones, M. A. Jaso, and J. L. Lindström, *Selective dry etching of germanium with respect to silicon and vice versa*, J. Electrochem. Soc. **138,** 1443 (1991).

113. Henry, O. O. Awadelkarim, B. Monemar, J. L. Lindström, T. D. Bestwick, and G. S. Oehrlein, *A study of luminescent centers in reactive ion etched silicon*, J. Electrochem. Soc. **138,** 1138 (1991).

114. Henry, O. O. Awadelkarim, C. Hallin, J. L. Lindström and G. S. Oehrlein, *Electrical studies on annealed D_2 plasma-exposed silicon*, J. Electrochem. Soc. **138,** 1456 (1991).

115. D. Marwick, G. S. Oehrlein, and M. Wittmer, *High hydrogen concentrations produced by segregation into p^+ layers in silicon*, Appl. Phys. Lett. **59,** 198 (1991).

116. G. S. Oehrlein, G. M. W. Kroesen, E. de Fresart, Y. Zhang and T. D. Bestwick, *Studies of the reactive ion etching of SiGe alloys*, J. Vac. Sci. & Technol. **A 9,** 768 (1991).

117. T. D. Bestwick, G. S. Oehrlein, Y. Zhang, G. M. W. Kroesen, and E. de Fresart, *Reactive ion etching of SiGe alloys using HBr,* Appl. Phys. Lett. **59,** 336 (1991).

118. J. P. Simko, and G. S. Oehrlein, *Reactive ion etching of silicon and silicon dioxide in CF_4 plasmas containing H_2 and C_2F_4 additives,* J. Electrochem. Soc. **138,** 2748 (1991).

119. G. S. Oehrlein, G. M. W. Kroesen, Y. Zhang, and E. deFresart *Cooperative phenomena in the plasma etching of SiGe-alloys*, in *Proceedings of the 10th International Symposium on Plasma Chemistry*, eds. U. Ehlemann, H. G. Lergon, and K. Wiesemann, (Bochum, 1991), pp. 2.2-3.

120. A.D. Marwick, M. Wittmer, G.S. Oehrlein, *An Isothermal Pumping Mechanism for the Introduction of High Hydrogen Concentrations in p^+ Layers in Silicon*, Materials Science Forum **83-87,** 39 (1991).

121. Y. Zhang, G. S. Oehrlein, E. deFresart, and J. W. Corbett, *Reactive ion etching of SiGe alloys using CF_2Cl_2*, J. Appl. Phys. **71,** 1936 (1992).

122. G. M. W. Kroesen, G. S. Oehrlein, E. deFresart, and G. J. Scilla, *Refractive index determination of SiGe using reactive ion etching/ellipsometry: Application for the depth profiling of the Ge concentration*, J. Appl. Phys. **60,** 1351 (1992).

123. J. L. Lindström, G. S. Oehrlein, and W. A. Lanford, *Reactive Ion Etching of Silicon Nitride Deposited by Different Methods in CF_4/H_2 Plasmas*, J. Electrochem. Soc. **139,** 317 (1992).

124. R. Shadmehr, D. Angell, P. B. Chou, G. S. Oehrlein, and R. S. Jaffe, *Principal Component Analysis of Optical Emission Spectroscopy and Mass Spectrometry: Application to Reactive Ion Etch Parameter Estimation Using Neural Networks*, J. Electrochem. Soc. **139,** 907 (1992).

125. G. S. Oehrlein, G. M. W. Kroesen, and J. L. Lindström, *Etching of Silicon in Low Pressure Plasmas Containing Fluorine and Oxygen: A Comparison of Real-Time and Post-Plasma Surface Studies*, J. Vac. Sci. & Technol. **A 10,** 3092 (1992).

126. G. S. Oehrlein and J. F. Rembetski, *Plasma-based dry etching techniques in silicon integrated circuit technology*, IBM J. Res. Devel. **36,** 140 (1992).

127. G. Tas, R. J. Stoner, H. J. Maris, G. W. Rubloff, G. S. Oehrlein, and J. M. Halbout, *Noninvasive picosecond ultrasonic detection of ultrathin interfacial layers: CF_x at the Al/Si interface*, Appl. Phys. Lett. **61,** 1787 (1992).

128. G. M. W. Kroesen G. S. Oehrlein, and W. Fukarek, *Applications of In-Situ Ellipsometry During Plasma Processing*, in *Proceedings of the Ninth Symposium on Plasma Processing*, G. S. Mathad and D. W. Hess, eds. (Electrochemical Society, Pennington, 1992), 88.

129. Angell, R. Shadmehr, P. B. Chou, and G. S. Oehrlein, *Principal Component Analysis for RIE Process Monitoring*, in *Proceedings of the Ninth Symposium on Plasma Processing*, G. S. Mathad and D. W. Hess, eds. (Electrochemical Society, Pennington, 1992), 127.

130. M. Haverlag and G. S. Oehrlein, *In situ ellipsometry and reflectometry during etching of patterned surfaces: Experiments and simulations*, J. Vac. Sci. & Technol. **B 10,** 2412, (1992).

131. J. J. Beulens, A. T. M. Wilbers, M. Haverlag, G. S. Oehrlein, G. M. W. Kroesen, and D. C. Schram, *Fast silicon etching using an expanding cascade arc plasma in a SF_6/argon mixture*, J. Vac. Sci. & Technol. **B 10,** 2387, (1992).

132. M. Haverlag, D. Vender and G. S. Oehrlein, *Ellipsometric study of silicon surface damage in electron cyclotron resonance plasma etching using CF_4 and SF_6*, Appl. Phys. Lett. **61,** 2875, (1992).

133. D. Vender, M. Haverlag and G. S. Oehrlein, *Ion-induced fluorination in electron cyclotron resonance etching of silicon studied by x-ray photoelectron spectroscopy*, Appl. Phys. Lett. **61,** 3136 (1992).

134. G. S. Oehrlein, *Effects of Ion Bombardment in Plasma Etching on the Fluorinated Silicon Surface Layer: Real-Time and Post-Plasma Surface Studies*, J. Vac. Sci. & Technol. **A 11,** 38 (1993).

135. G. M. W. Kroesen, G. S. Oehrlein, E. deFresart, and M. Haverlag, *Depth Profiling of the Ge Concentration in SiGe Alloys Using in-situ Ellipsometry During Reactive Ion Etching*, J. Appl. Phys. **73,** 8017 (1993).

136. A. Henry, B. Monemar, J. L. Lindström, G. S. Oehrlein, and J. C. Malinowski, *A photoluminescence study of CF_4 reactive ion etched silicon: various process conditions and magnetically enhanced etching*, J. Appl. Phys. **74,** 6349 (1993).

137. D. Vender and G. S. Oehrlein, *Selective Reactive Ion Etching of Phosphorus Doped Oxide Over Undoped SiO_2*, J. Vac. Sci. & Technol. **A 11,** 279 (1993).

138. Y. Zhang, G. S. Oehrlein, G. M. W. Kroesen, M. Wittmer and K. Stein, *High-Resolution Depth Profiling of Thin Silicon Oxide/Nitride/Oxide (ONO) Structures*, J. Electrochem. Soc. **140,** 1439 (1993).

139. Y. Zhang, G. S. Oehrlein, E. deFresart, and J. W. Corbett, *Reactive ion etching of SiGe alloys using fluorine-containing plasmas*, J. Vac. Sci. & Technol. **A 11,** 2492 (1993)

140. M. Haverlag, G. S. Oehrlein, and D. Vender, *Sidewall passivation during the etching of poly-Si in an electron-cyclotron-resonance-plasma of HBr*, J. Vac. Sci. & Technol. **B 12,** 96 (1994).

141. G. S. Oehrlein, Y. Zhang, D. Vender, and M. Haverlag, *Fluorocarbon High Density Plasmas I: Fluorocarbon film deposition and etching using CF_4 and CHF_3*, J. Vac. Sci. & Technol. **A 12,** 323 (1994).

142. G. S. Oehrlein, Y. Zhang, D. Vender, and O. Joubert, *Fluorocarbon High Density Plasmas II: Silicon dioxide and silicon etching using CF_4 and CHF_3*, J. Vac. Sci. & Technol. **A 12,** 333 (1994).

143. O. Joubert, G. S. Oehrlein, and Y. Zhang, *Fluorocarbon High Density Plasmas V: Influence of aspect ratio on the etch rate of silicon dioxide in an Electron-Cyclotron-Resonance plasma*, J. Vac. Sci. & Technol. **A 12,** 658 (1994).

144. O. Joubert, G. S. Oehrlein, and M. Surendra, *Fluorocarbon High Density Plasmas VI: RIE Lag Model for Contact hole silicon dioxide etching in an electron cyclotron resonance plasma*, J. Vac. Sci. & Technol. **A 12,** 665 (1994).

145. K. Kirmse, A. Wendt, G. S. Oehrlein, and Y. Zhang, *Fluorocarbon High Density Plasmas VIII: Study of the ion flux composition at the substrate in ECR etching processes using fluorocarbon gases*, J. Vac. Sci. & Technol. **A 12,** 1287 (1994).

146. O. Joubert, G. S. Oehrlein, M. Surendra, and Y. Zhang, *Reactive ion etching lag investigation of oxide etching in fluorocarbon electron cyclotron resonance plasmas*, J. Vac. Sci. & Technol. **A 12,** 1957 (1994).

147. F. H. Bell, O. Joubert, G. S. Oehrlein, Y. Zhang, and D. Vender, *Investigation of selective SiO_2-to-Si etching in an inductively coupled high-density plasma using fluorocarbon gases*, J. Vac. Sci. & Technol. **A 12,** 3095 (1994).

148. J. J. Beulens, B. E. E. Kastenmeier, P. J. Matsuo, and G. S. Oehrlein, *Chemical downstream etching of silicon nitride and polycrystalline silicon using $CF_4/O_2/N_2$: Surface chemical effects of O_2 and N_2 additives*, Appl. Phys. Lett. **66,** 2634 (1995).

149. G. S. Oehrlein, N. R. Rueger, M. Schaepkens, J. J. Beulens, M. Doemling, and J. M. Mirza, *Mechanistic studies of SiO_2 etching in high-density plasmas*, Supplement a la Revue *Le Vide: science, technique et applications* No. **275,** 187 (1995).

150. C. Tomasino, J. J. Cuomo, C. B. Smith, and G. S. Oehrlein, *Plasma treatments of textiles*, Journal of Coated Fabrics, **25,** 115 (1995).

151. I. A. Buyanova, A. Henry, B. Monemar, J. L. Lindström, and G. S. Oehrlein, *Photoluminescence of defects induced in silicon by SF_6/O_2 reaction ion etching*, J. Appl. Phys. **78,** 2002, (1995).

152. M.F. Doemling, N.R. Rueger, and G.S. Oehrlein, *Observation of Inverse Reactive Ion Etching (RIE) Lag for Silicon Dioxide Etching in Inductively Coupled Plasmas (ICP)*, Appl. Phys. Lett. **68**, 10 (1996).

153. G. S. Oehrlein, P. J. Matsuo, M. Doemling, N. Rueger, B. E. E. Kastenmeier, M. Schaepkens, and J. J. Beulens, *Study of Plasma-Surface Interactions: Chemical Dry Etching and High-Density Plasma Etching*, Plasma Sources Sci. Technol. **5,** 193 (1996).

154. B. E. E. Kastenmeier, P. J. Matsuo, J. J. Beulens, and G. S. Oehrlein, *Chemical dry etching of silicon nitride and silicon dioxide using $CF_4/O_2/N_2$: Gas Mixtures*, J. Vac. Sci. & Technol. **A 14,** 2802 (1996).

155. Y. Zhang, G. S. Oehrlein, and F. H. Bell, *Fluorocarbon High Density Plasmas VII: Investigation of selective SiO_2-to-Si_3N_4 high-density plasma etch processes*, J. Vac. Sci. & Technol. **A 14,** 2127 (1996).

156. P. J. Matsuo, B. E. E. Kastenmeier, J. J. Beulens, and G. S. Oehrlein, *Role of N_2 addition on $CF_4/O_2/N_2$ remote chemical dry etching of polycrystalline silicon*, J. Vac. Sci. & Technol. **A 15,** 1801 (1997).

157. J. Hernandez, P. Wrschka, H.J. Sun, Y. Hsu, T.-S. Kuan, G. S. Oehrlein, D. A. Hansen, J. King, and M. Fury, *Mechanistic studies of chemical-mechanical polishing of Al films*, in *1997 Proceedings of Chemical-Mechanical Polish for ULSI Multilevel Interconnection Conference (CMP-MIC)*, 97ISMIC-200P (Feb. 13-14, 1997), pp. 125.

158. G. S. Oehrlein, *SiO_2 Etching in High-Density Plasmas: Differences with Low-Density Plasmas*, in *Plasma Processing of Semiconductors*, ed. P. F. Williams, (Kluwer Academic Publishers, Dordrecht, 1997), pp. 73.

159. G. S. Oehrlein, *Remote Plasma Processing*, in *Plasma Processing of Semiconductors*, ed. P. F. Williams, (Kluwer Academic Publishers, Dordrecht, 1997), pp. 477.

160. G. S. Oehrlein, *Surface processes in low pressure plasmas*, Surface Science **386,** 222 (1997).

161. N. R. Rueger, J. J. Beulens, M. Schaepkens, M. F. Doemling, J. M. Mirza, T. E. F. M. Standaert, and G. S. Oehrlein, *The role of steady-state fluorocarbon films in the etching of silicon dioxide using CHF_3 in an inductively coupled plasma reactor*, J. Vac. Sci. & Technol. **A 15,** 1881 (1997).

162. T. E. F. M. Standaert, M. Schaepkens, N. R. Rueger, P. G. M. Sebel, G. S. Oehrlein, and J. M. Cook, *High-Density Fluorocarbon Etching of Silicon in an Inductively*

Coupled Plasma: Mechanism of Etching through a Thick Steady-State Fluorocarbon Layer, J. Vac. Sci. & Technol. **A16,** 239 (1998).

163. M. Schaepkens and G. S. Oehrlein, *Asymmetric microtrenching during ICP oxide etching in the presence of a weak magnetic field*, Appl. Phys. Lett. **72,** 1293 (1998).

164. B. E. E. Kastenmeier, P. J. Matsuo, G. S. Oehrlein, and J. G. Langan, *Remote Plasma Etching Etching of Silicon Nitride and Silicon Dioxide Using NF_3/O_2 Gas Mixtures*, J. Vac. Sci. & Technol. **A16,** 2047 (1998).

165. M. Schaepkens, T. E. F. M. Standaert, M. v. Kampen, G. S. Oehrlein, and J. M. Cook, *Influence of Reactor Wall Conditions on Etch Processes in Inductively Coupled Fluorocarbon Plasmas*, J. Vac. Sci. & Technol. **A16,** 2099 (1998).

166. M. F. Doemling, N. R. Rueger, G. S. Oehrlein, and J. M. Cook, *Photoresist erosion studied in an inductively coupled plasma reactor employing CHF_3*, J. Vac. Sci. & Technol. **B16,** 1998 (1998).

167. T.E.F.M. Standaert, P. J. Matsuo, S. Allen, G. S. Oehrlein, T. Dalton, T.-M. Lu, and R. Gutmann, *High-density plasma etching of low dielectric constant materials,* in Low-Dielectric Constant Materials IV, C. Chiang, P. S. Ho, T.-M. Lu, and J. T. Wetzel, eds., (Materials Research Society, Symposia Proceedings Series, Vol. 511, Pittsburgh, 1998), pp. 265.

168. M. Schaepkens, G. S. Oehrlein, Ch. Hedlund, L. B. Jonsson, and H.-O. Blom, *Differences in angular dependence of silicon dioxide and silicon nitride etching rates in an an inductively coupled fluorocarbon plasma*, J. Vac. Sci. & Technol. **A16,** 3281 (1998).

169. Y. Hsu, T.E.F.M. Standaert, G. S. Oehrlein, T. S. Kuan, E. Sayre, K. Rose, K. Y. Lee and S. M. Rossnagel, *Fabrication of Cu interconnects of 50 nm linewidth by electron-beam lithography and high-density plasm etching*, J. Vac. Sci. & Technol. **B16,** 3344 (1998).

170. G. S. Oehrlein and Y. Kurogi, *Sidewall Chemistry in Plasma Etching*, Materials Science and Engineering Reports **R24,** 153 (1998).

171. M. Schaepkens, T.E.F.M. Standaert, N.R. Rueger, P.G.M. Sebel, and G.S. Oehrlein, *Study of the SiO_2-to-Si_3N_4 etch selectivity mechanism in inductively coupled fluorocarbon plasmas and a comparison with the SiO_2-to-Si mechanism*, J. Vac. Sci. & Technol. **A17,** 26 (1999).

172. G. S. Oehrlein, M. F. Doemling, B. E. E. Kastenmeier, P. J. Matsuo, N. R. Rueger, M. Schaepkens, and T.E.F.M. Standaert, *Surface Science Issues in Plasma Etching*, IBM J. Res. & Develop. **43,** 181 (1999).

173. P. Wrschka, J. Hernandez, Y. Shu, T.-S. Kuan, G. S. Oehrlein, H.J. Sun, D. A. Hansen, J. King, and M. Fury, *Polishing parameter dependencies and surface chemistry of chemical-mechanical polishing of Al films*, J. Electrochem. Soc. **146**, 2689 (1999).

174. P. J. Matsuo, S. Allen, T.E.F.M. Standaert, G. S. Oehrlein, and T. Dalton, *Investigation of cleaning residual fluorocarbons from Al, Cu and TiN following a low-K dielectric etch: A comparison with silicon and silicon dioxide*, J. Vac. Sci. & Technol. **B 17**, (1999).

175. T.E.F.M. Standaert, P. J. Matsuo, S. Allen, G. S. Oehrlein, and T. Dalton, *Pattering of fluorine-, hydrogen-, and carbon-containing SiO_2-like low dielectric constant materials in fluorocarbon plasmas: Comparisons with SiO_2*, J. Vac. Sci. & Technol. **A17**, 741

(1999).

176. P. J. Matsuo, B. E. E. Kastenmeier, G. S. Oehrlein, and J. G. Langan, *Silicon Etching in NF3/O2 Remote Microwave Plasmas* (accepted, J. Vac. Sci. & Technol., 1999).

177. N. R. Rueger, M. F. Doemling, M. Schaepkens, J. J. Beulens, T. E. F. M. Standaert, and G. S. Oehrlein, *Selective Etching of SiO_2 Over Polycrystalline Silicon Using CHF_3 in an Inductively Coupled Plasma Reactor,* J. Vac. Sci. & Technol. **A 17**, 2492 (1999).

178. Xi Li, M. Schaepkens, G. S. Oehrlein, R. E. Ellefson, L. C. Frees, N. Mueller, and N. Korner, *Mass Spectrometric Measurements on Inductively Coupled Fluorocarbon Plasmas: Positive Ions, Radicals and Endpoint Detection,* J. Vac. Sci. & Technol. **A 17**, 2438 (1999).

179. M. Schaepkens, N. R. Rueger, J. J. Beulens, X. Li. T. E. F. M. Standaert, P. J. Matsuo, and G. S. Oehrlein, *The Effect of Capacitive Coupling on Inductively Coupled Fluorocarbon Plasma Processing,* J. Vac. Sci. & Technol. **A 17**, 3272 (1999).

180. J. Hernandez, P. Wrschka, Y. Shu, T.-S. Kuan, G. S. Oehrlein, H.J. Sun, D. A. Hansen, J. King, and M. Fury, *Chemical-mechanical polishing of Al and SiO_2 films: The role of consumables,* J. Electrochem. Soc. **146**, 4647 (1999).

181. B. E. E. Kastenmeier, P. J. Matsuo, and G. S. Oehrlein, *Highly selective etching of silicon nitride over silicon and silicon dioxide,* J. Vac. Sci. & Technol. **A 17**, 3179 (1999).

182. A. Jain, S. Rogjevic, S.V. Nitta, V. Pisupatti, W.N. Gill, P.C. Wayner, J.L. Plawsky, T.E.F.M. Standaert, and G.S. Oehrlein, *Processing and characterization of silica xerogel films for low-k dielectric applications,* Mat. Res. Soc. Symp. Ser. **565,** 29 (1999).

183. M. F. Doemling, B. Lin, N. R. Rueger, G. S. Oehrlein, and R. A. Haring, *Using a Quartz Crystal Microbalance (QCM) for Low Energy Ion Beam Etching Studies,* J. Vac. Sci. & Technol. **A 18,** 232 (2000).

184. P. Wrschka, J. Hernandez, G. S. Oehrlein, and J. King, *Chemical-mechanical planarization of coppper damascene structures,* J. Electrochem. Soc. **147**, 706 (2000).

185. M. Schaepkens, G.S. Oehrlein, K. G. Donohoe, and J. M. Cook, *Effect of RF bias power on SiO_2 feature etching in inductively coupled fluorocarbon plasmas*, J. Vac. Sci. & Technol. **B 18**, 848 (2000).

186. M. Schaepkens, G.S. Oehrlein, K. G. Donohoe, and J. M. Cook, *Effect of RF bias frequency and RF bias pulsing on SiO_2 feature etching in inductively coupled fluorocarbon plasmas*, J. Vac. Sci. & Technol. **B 18**, 856 (2000).

187. B. E. E. Kastenmeier, G. S. Oehrlein, J. G. Langan, and W. Entley, *Gas utilization in remote plasma cleaning and stripping applications,* J. Vac. Sci. & Technol. **A 18**, 2102 (2000).

188. G. S. Oehrlein, T. E. F. M. Standaert, P. J. Matsuo, Pattern transfer into low dielectric constant materials by high-density plasma etching, Solid State Technol. **43** (5): 125 (2000).

189. T. E. F. M. Standaert, E. A. Joseph, G. S. Oehrlein, A. Jain, W. N. Gill, P. C. Wayner, Jr., and J. L. Plawsky, *Etching of Xerogel in high-density fluorocarbon plasmas,* J. Vac. Sci. Technol. **A 18**, 2742 (2000).

190. T. S. Kuan, C. K. Inoki, G. S. Oehrlein, K. Rose, Y.-P. Zhao, G.-C. Wang, S. M. Rossnagel, and C. Cabral, Fabrication and performance limits of sub-0.1 μm Cu interconnects, Mat. Rese. Soc. Symp. Proc. **612**, D7.1.1 (2001).

191. B. E. E. Kastenmeier, P. J. Matsuo, G. S. Oehrlein, R. E. Ellefson and L. C. Frees,

Surface etching mechanism of silicon nitride in fluorine and nitric oxide containing plasmas, J. Vac. Sci. Technol. **A 19**, 25 (2001).

192. T. E. F. M. Standaert, P. J. Matsuo, G. S. Oehrlein, T.-M. Lu, R. Gutmann, C. T. Rosenmayer, J. W. Bartz, J. G. Langan and W. R. Entley, *High-density plasma patterning of low dielectric constant polymers: A comparison between Polytetrafluoroethylene, Parylene-N, and Poly(arylene ether)*, J. Vac. Sci. Technol. **A 19**, 435 (2001).

193. P.T. Wrschka, J. Hernandez, G.S. Oehrlein, J. A. Negrych, G. Haag, P. Rau, J. E. Currie, Development of a slurry employing a unique silica abrasive for the CMP of Cu Damascene structures, *J. Electrochem. Soc*. **148,** G321 (2001).

194. J. Hernandez, P. Wrschka, G. S. Oehrlein, *Surface Chemistry Studies of Copper Chemical-Mechanical Planarization*. J. Electrochem. Soc. **148,** G389 (2001).

195. M. Schaepkens, I. Martini, E. A. Sanjuan, X. Li, G. S. Oehrlein, W. L. Perry and H. M. Anderson, *Gas-phase studies in inductively coupled fluorocarbon plasmas*, J. Vac. Sci. & Technol. **A 19**, 2946 (2001).

196. M. Schaepkens, and G. S. Oehrlein, *A review of SiO_2 etching studies in inductively coupled fluorocarbon plasmas*, J. Electrochem. Soc. **148,** C211 (2001).

197. X. Li, X. Hua, L. Ling, G. S. Oehrlein, M Barela, and H.M. Anderson, *Fluorocarbon-Based Plasma Etching of SiO_2: Comparison of C_4F_6/Ar and C_4F_8/Ar Discharges*, J. Vac. Sci. & Technol. **A 20**, 2052 (2002).

198. G. S. Oehrlein, T. E. F. M. Standaert, P. J. Matsuo, Chapter 9, *Plasma etching of low dielectric constant materials*, Springer Series in Advanced Microelectronics, Vol. 9 Low Dielectric Constant Materials for IC Applications (Springer, Heidelberg, 2002).

199. X. Li, L. Ling, X. Hua, M. Fukasawa, G.S. Oehrlein, M. Barela and H.M. Anderson, *Effects of Adding Ar and O_2 to C_4F_8 Plasmas on SiO_2 Etching*, J. Vac. Sci. & Technol. **A 21**, 284 (2003).

200. X. Hua, X.Wang, D.Fuentevilla, G.S.Oehrlein, F. G. Celii and K. H. R. Kirmse, *Study of C_4F_8/N_2 and C_4F_8/Ar/N_2 discharges for high selective Organosilicate Glass (OSG) etching over Si_3N_4 and SiC*, J. Vac. Sci. & Technol. **A 21**, 1708 (2003).

201. X. Li, M. Schaepkens, G. S. Oehrlein, R. E. Ellefson and L. C. Frees, "*Spatially resolved mass spectrometric sampling of inductively coupled plasmas using a movable sampling orifice*", J. Vac. Sci. & Technol. **A 21,** 1971 (2003).

202. Xi Li, Li Ling, X. Hua, G. S. Oehrlein, Y. Wang, and H. M. Anderson, "Characteristics Of C_4F_8 Plasmas With Ar, Ne And He Additives For SiO_2 Etching In A Inductively Coupled Plasma (ICP) Reactor", J. Vac. Sci. & Technol. **A 21**, 1955 (2003).

203. X. Li, X. Hua, L. Ling, G. S. Oehrlein, E. Karwacki and B. Ji, *Surface Chemical Changes of Aluminum During NF3-Based In-Situ Chamber Cleaning: Critical Discharge Parameters*, J. Vac. Sci. & Technol. **A 22**, 158 (2004).

204. T. E. F. M. Standaert, C. Hedlund, E. A. Joseph, G. S. Oehrlein, and T. J. Dalton, *On the role of the fluorocarbon film formation in the etching of silicon, silicon dioxide, silicon nitride, and amorphous hydrogenated silicon carbide*, J. Vac. Sci. & Technol. **A 22**, 53 (2004).

205. L. Ling, X. Hua, X. Li, G. S. Oehrlein, F. G. Celii, K. H. R. Kirmse, P. Jiang and Y. Wang, *Study of C_4F_8/CO and C_4F_8/Ar/CO plasmas for highly selective etching of Organosilicate Glass (OSG) over Si_3N_4 and SiC*, J. Vac. Sci. & Technol. **A 22**, 236 (2004).

206. D. Humbird, D. B. Graves, X. Hua, and G. S. Oehrlein, *Molecular dynamics*

simulations of Ar^+-induced transport of fluorine through fluorocarbon films, Appl. Phys. Lett. **84,** 1073 (2004)

207. Xi Li, Li Ling, X. Hua and G. S. Oehrlein, Y. Wang, A. V. Vasenkov and M. J. Kushner, "Properties of C_4F_8 Inductively Coupled Plasmas, Part I: Studies of Ar/c-C_4F_8 Magnetically Confined Plasmas for Etching of SiO_2" J. Vac. Sci. Technol. **A 22**, xxx (2004).

208. A. V. Vasenkov, Xi Li, G. S. Oehrlein, and M. J. Kushner, "Properties of c-C_4F_8 Inductively Coupled Plasmas, Part II: Plasma Chemistry, Reaction Mechanism of Modeling of Ar/c-C_4F_8/O_2 Discharges" J. Vac. Sci. Technol. **A 22**, xxx (2004).