
Silicon Materials Science and Technology X

Editors:

H. Huff, *retired*
SEMATECH
Austin, Texas, USA

H. Iwai
Tokyo Institute of Technology
Yokohama, Japan

H. Richter
IHP Microelectronics
Frankfurt, Germany

Sponsoring Division:



Electronics and Photonics



Published by
The Electrochemical Society

65 South Main Street, Building D
Pennington, NJ 08534-2839, USA

tel 609 737 1902

fax 609 737 2743

www.electrochem.org

Electrochemical Society Transactions™

Vol. 2 No. 2

Copyright 2006 by The Electrochemical Society, Inc.
All rights reserved.

This book has been registered with Copyright Clearance Center, Inc.
For further information, please contact the Copyright Clearance Center,
Salem, Massachusetts.

Published by:

The Electrochemical Society, Inc.
65 South Main Street
Pennington, New Jersey 08534-2839, USA

Telephone 609.737.1902
Fax 609.737.2743
e-mail: ecs@electrochem.org
Web: www.electrochem.org

Printed in the United States of America

Table of Contents

Preface	iii
---------	-----

Plenary

* Forty Years of Moore's Law: Ever Smaller Transistors and Ever Larger Wafers <i>G. Hutcheson</i>	3
* Present and Future of Si-Based Transistor Technology for Memories <i>D. Park and B. Ryu</i>	11
* Front-End Process Technology for hp65/45 CMOS Devices <i>Y. Nara, F. Ootsuka and K. Nakamura</i>	27
* Trends in European R&D - Advanced Process Control Down to Atomic Scale for Micro- and Nanotechnologies <i>L. Pfitzner, M. Schellenberger, R. Oechsner, G. Roeder and M. Pfeffer</i>	33

300 mm

Introductory Remarks: 300 mm <i>D. Gilles and W. Huber</i>	57
* Parameters of Intrinsic Point Defects in Silicon Based on Crystal Growth, Wafer Processing, Self- and Metal-Diffusion <i>V. V. Voronkov and R. Falster</i>	61
An Atomically Accurate Model for Point Defect Aggregation in Silicon <i>T. Sinno, W. Haeckl and W. Von Ammon</i>	77
Growth Technologies for 300 mm Arsenic Heavily Doped Silicon Single Crystals <i>H. Tu, Q. Zhou, G. Zhang, X. Dai, Z. Wu and T. Jia</i>	89
Defect Formation Behaviors in Heavily Doped Czochralski Silicon <i>W. Sugimura, T. Ono, S. Umeno, M. Hourai and K. Sueoka</i>	95

* *invited paper*

* Wafer Strength and Slip Generation Behavior in 300 mm Wafers <i>T. Ono, W. Sugimura, T. Kihara and M. Hourai</i>	109
Warp of Silicon Wafers Produced from Wire Saw Slicing: Modeling, Simulation, and Experiments <i>P. Gupta and M. Kulkarni</i>	123
Lessons Learned from the 300 mm Transition <i>S. Kramer, J. Draina, D. Fandel and J. Ferrell</i>	135
Discussion on Issues toward 450 mm Wafer <i>M. Watanabe, T. Fukuda, A. Ogura, Y. Kirino and M. Kohno</i>	155
* 300 mm SOI for High Volume Manufacturing <i>G. Pfeiffer, M. Haag, M. Schmidt, R. Krause, P. Tsai and J. Lee</i>	167

Process Development and Modeling

Introductory Remarks: Process Development and Modeling <i>U. Goesele and P. Packan</i>	185
* Growth Kinetics and Electrical Properties of Ultrathin Silicon Dioxide Layers <i>H. Z. Massoud</i>	189
* Oxygen Vacancies at the Si(001)/SiO ₂ Interface <i>A. Korkin, J. Greer, T. M. Hendersen, G. Bersuker and R. Bartlett</i>	205
Defect Dynamics in the Presence of Oxygen in Growing Czochralski Silicon Crystals <i>M. Kulkarni</i>	213
Defect Dynamics in the Presence of Nitrogen and Oxygen in Growing Czochralski Silicon Crystals <i>M. Kulkarni</i>	229
* Analytical Modeling of the Interaction of Vacancies and Oxygen for Oxide Precipitation in RTA Treated Wafers <i>G. Kissinger, J. Dabrowski, A. Sattler, C. Seuring, T. Mueller, H. Richter and W. Von Ammon</i>	247
First Principles Calculation for Cu Gettering by Dopant or Dopant-Vacancy Complex in Silicon Crystal <i>K. Sueoka, S. Ohara, S. Shiba and S. Fukutani</i>	261

* *invited paper*

Analysis of Internal Gettering of Iron Based on the Nucleation Model of Iron Precipitation <i>K. Nakamura and J. Tomioka</i>	275
Silicon Self-Diffusion in Heavily B-Doped Si Using Highly Pure ³⁰ Si Epitaxial Layer <i>S. Matsumoto, S. R. Aid, S. Seto, K. Toyonaga, Y. Nakabayashi, M. Sakuraba, Y. Shimamune, Y. Hashiba, J. Murota, K. Wada and T. Abe</i>	287
Modeling Growth Behavior for Si _{1-x} Ge _x from SiH ₄ and GeH ₄ by CVD <i>X. Yang and M. Tao</i>	299

Materials and Process Integration

Introductory Remarks: Materials and Process Integration <i>S. Ikeda and M. Rodder</i>	313
* Scaled CMOS with SiON and High- <i>k</i> <i>K. Ishimaru, M. Takayanagi, T. Watanabe, S. Inaba, M. Fujiwara and D. Matsushita</i>	317
* Multiple Gate MOSFETs <i>W. P. Maszara, Z. Krivokapic, Q. Xiang and M. Lin</i>	329
* Mobility Enhancement and Strain Integration in Advanced CMOS <i>C. H. Diaz</i>	341
Defect Engineering Considerations for Strained Silicon Substrates <i>C. Claeys, G. Eneman, M. Scholz, R. Loo, P. Verheyen, K. De Meyer and E. R. Simoen</i>	349
Modeling of Morphological Changes by Surface Diffusion in Silicon Trenches <i>T. Mueller, D. Dantz, W. Von Ammon, J. Virbulis and U. Bethers</i>	363
Thermal Agglomeration of Ultrathin SOI and SSOI Films: A Quantitative Stability Study and Physical Model to Guide Ultrathin SOI Process Design <i>D. T. Danielson, J. Michel and L. Kimerling</i>	375
Impact of Defects in Silicon Substrate on Flash Memory Characteristics <i>Y. Hirano, K. Yamazaki, F. Inoue, K. Imaoka, K. Tanahashi and H. Yamada-Kaneta</i>	391
Low-Resistance Ti/n-type Si(100) Contacts by Monolayer Se Passivation <i>J. Zhu, X. Yang and M. Tao</i>	401
* <i>invited paper</i>	

Integrated Metrology and Diagnostics

Introductory Remarks: Integrated Metrology and Diagnostics <i>L. Fabry and T. Hattori</i>	413
* Breakthrough of In-Line Inspection Technology in Volume Production for 65 nm Node and Beyond <i>Y. Yamazaki</i>	415
* Scenario for a Yield Model Based on Reliable Defect Density Data and Linked to Advanced Process Control <i>A. Nutsch and R. Oechsner</i>	433
Standardization of Measurement of Nitrogen Concentration in CZ Silicon Crystals <i>N. Inoue, A. Karen, H. Yagi, K. Masumoto, M. Shinomiya, K. Kashima, K. Eifuku, M. Koizumi, T. Takahashi, T. Takenawa and K. Shingu</i>	453
Infrared Absorption Measurement of Carbon Concentration in Silicon Crystals <i>N. Inoue, M. Nakatsu and V. Akhmetov</i>	461
Standardization of Characterization of Bulk Microdefects and Denuded Zones in Annealed CZ Si <i>R. Takeda, N. Inoue, K. Moriya, K. Kashima, K. Nakashima, M. Kato, S. Kitagawa, T. Ono, H. Urushido, N. Nango and V. Akhmetov</i>	471
X-Ray Reciprocal Space Mapping and Synchrotron Radiation Topography of Strained Si/Si _{1-x} Ge _x on Bonded SOI <i>T. Ma, H. Tu, G. Hu, B. Shao and A. Liu</i>	485
SOI Low Frequency Noise and Interface Trap Density Measurements with the Pseudo MOSFET <i>V. A. Kushner, J. Yang, J. Choi, T. Thornton and D. Schroder</i>	491
1/f Noise as a Tool to Assess Fermi Level Pinning (EF) at the HfO ₂ /poly-Si Interface in High- <i>k</i> n-MOSFETs <i>P. Srinivasan, E. Simoen, L. Pantisano, C. Claeys and D. Misra</i>	503
Study of Inhibition Characteristics of Slurry Additives in Copper CMP Using Force Spectroscopy <i>M. K. Keswani, H. Lee, S. Babu, U. Patri, Y. Hong, L. Economikos, M. Goldstein, L. Borucki, A. Philipossian and Y. Zhuang</i>	515

* *invited paper*

Influence of Gas Velocity and Humidity on Diethyl Phthalate Adsorption and Desorption on Silicon Surface <i>H. Habuka, M. Tawada, K. Suzuki, T. Takeuchi and M. Aihara</i>	523
Strained Silicon	
Introductory Remarks: Strained Silicon <i>E. Weber and R. Wise</i>	539
Probing Nanoscale Local Lattice Strains in Advanced Si CMOS Devices by CBED: A Tutorial with Recent Results <i>M. Kim, J. Huang, P. Chidambaram, R. Irwin, P. Jones, J. Weijtmans, E. Koontz, Y. Wang, S. Tang and R. Wise</i>	541
Local Strain Measurement on Strained Si/SiGe Heterostructures Using Convergent Beam Electron Diffraction Analysis <i>W. Zhao, G. Duscher and G. Rozgonyi</i>	549
Analysis of Nanoscale Stress in Strained Silicon Materials and Microelectronics Devices by Energy-Filtered Convergent Beam Electron Diffraction <i>P. Zhang, A. Istratov, H. He, J. Ager, C. Nelson, E. Stach, J. Mardinly, C. Kisielowski, E. Weber and J. Spence</i>	559
* Threading vs Misfit Dislocations in Strained Si/SiGe Heterostructures: Preferential Etching and Minority Carrier Transient Spectroscopy <i>J. Lu, R. Zhang, G. Rozgonyi, E. Yakimov, N. Yarykin and M. Seacrist</i>	569
Author Index	579

* *invited paper*