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Si Front-End Processing—Physics and Technology of Dopant-Defect Interactions III

Editors: Erin C. Jones, Kevin S. Jones, Martin D. Giles, Peter Stolk and Jiro Matsuo

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EDITORS:

Erin C. Jones

IBM T.J. Watson Research Center
Yorktown Heights, New York, U.S.A.

Kevin S. Jones

University of Florida
Gainesville, Florida, U.S.A.

Martin D. Giles

Intel Corporation
Portland, Oregon, U.S.A.

Peter Stolk

Philips Research Leuven
Leuven, Belgium

Jiro Matsuo

Kyoto University
Kyoto, Japan



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Warrendale, Pennsylvania

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PREFACE

This volume contains the proceedings of Symposium J, "Si Front-End Processing—Physics and Technology of Dopant-Defect Interactions III," held April 17-19 at the 2001 MRS Spring Meeting in San Francisco, CA, the third MRS symposium on this topic. The foci of the symposium were the phenomena which control the three-dimensional dopant profile in deep submicron devices. As device sizes continue to shrink, increasing the dopant activation while simultaneously decreasing the junction depth requires increasing control and understanding of dopant movement. As dopant diffusion and activation are determined by interactions with defects, other atoms, and interfaces, control of dopant behavior requires specific knowledge of these processes. To take advantage of atomistic simulation methods which can be used to model not only the dopant behaviors but now the properties of whole devices, high-precision advanced characterization techniques (e.g., two-dimensional junction profiling) are essential. These problems are by nature cross-disciplinary, and therefore the goal of this symposium was to bring together materials scientists, silicon technologists, and TCAD researchers to share experimental results and physical models, demonstrate their importance to the technologies, and identify key issues for future research in this field.

The theme of the symposium was set on the first day by a series of invited papers, addressing the need for shallow junctions and dopant control for future silicon technologies. A considerable part of the symposium was aimed at unraveling the complex potpourri of atomistic processes that are activated during the annealing of ion-implanted dopant atoms. Various papers attested to the impressive level that has been reached over recent years in the understanding of how ion-generated vacancies and interstitials evolve through the formation of clusters and extended defects during annealing. These and other insightful experimental results have significantly improved the ability with which dopant, defect and impurity profiles can be predicted through numerical simulations. Transient enhanced diffusion and dopant clustering severely hinder the formation of shallow, low-resistive junctions, in particular for p-type dopants. Furthermore, sputtering effects have been found to restrict the efficiency with which dopants are introduced into silicon at low implantation energies (e.g., 0.2 keV B). At the symposium, various approaches to improving junction performance were presented and discussed, among them the co-implantation of impurities such as fluorine, the optimization of rapid thermal annealing conditions, and the use of pulsed-laser annealing. These methods clearly hold promise for meeting the future industry needs, but further tailoring of the involved dopant-defect interactions is needed to ensure successful implementation into silicon processing.

Erin C. Jones
Kevin S. Jones
Martin D. Giles
Peter Stolk
Jiro Matsuo

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