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

MATERIALS RESEARCH SOCIETY
SYMPOSIUM PROCEEDINGS VOLUME 610

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

Symposium held April 24–27, 2000, San Francisco, California, U.S.A.

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CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Mexico City

Cambridge University Press
32 Avenue of the Americas, New York NY 10013-2473, USA

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9781107413177

Materials Research Society
506 Keystone Drive, Warrendale, PA 15086
http://www.mrs.org

First published 2001
First paperback edition 2013

Single article reprints from this publication are available through
University Microfilms Inc., 300 North Zeeb Road, Ann Arbor, MI 48106

CODEN: MRSPDH

ISBN 978-1-107-41317-7 Paperback

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PREFACE

This volume contains the proceedings of Symposium B, "Si Front-End Processing—Physics and Technology of Dopant-Defect Interactions II," held April 24-27 at the 2000 MRS Spring Meeting in San Francisco, California. As indicated by the series number, this symposium continues the theme of the previous year's front-end symposium by concerning itself with formation of electrical junctions in the front-end processing of devices sized for the approaching end-of-the-roadmap.

In general, dopant diffusion and activation are controlled by interactions of the dopant with native- or other defects, with other dopant atoms, and with the various interfaces in a device. Examples of these interactions include enhanced dopant diffusion, dopant-defect clustering, dopant precipitation, dopant out-diffusion or segregation, and Fermi-level as well as stress-effects on dopant diffusion. It is not only desirable but essential to formulate physics-based models of these phenomena for the development of an accurate, and truly predictive, front-end process simulation capability. To achieve this it is necessary both to apply advanced characterization techniques, such as two-dimensional junction profiling, to more precisely describe the observed phenomena and to take advantage of the insight offered by advanced simulation methods such as atomistic techniques, which can now be used to model the whole device. To address these issues materials scientists, silicon technologists and TCAD researchers were brought together in this symposium to share experimental results and physical models that describe phenomena which control the three-dimensional dopant profile.

The symposium was organized into eleven sessions over three and one-half days, with 11 invited speakers and 70 contributed talks. Approximately 200 persons attended each session. Session topics were the challenges of device scaling, 2-D dopant characterization, Si front-end processing, ion implantation and shallow junction technology, group III diffusion and activation, carbon diffusion and activation, group V diffusion and activation, vacancy-type defects, re-grown amorphous layers, and structure and properties of point and extended defects.

Highlights of the presentations and discussions:

- Through a number of excellent industrial talks, future issues in device scaling were quantitatively linked with the requirements placed on dopant profile and junction formation, emphasizing not only shallow junction depth and high-concentration activation, but also the extremely tight limits on junction abruptness.

- Multiple implant and annealing schemes were presented to improve the relationship between junction depth and sheet resistance, as required for future device technologies. The anneal processes spanned from extremely low-temperature pre-anneals to extremely high-temperature pulsed laser processing. Experimental data and modeling of dopants after spike anneals were presented. A number of papers evaluating implantation of alternative chemical species for defect engineering, including C, N, F, O, Cl, S, Se and Br, showed interesting results. For defects, high energy MeV implants into thin SOI layers were used to effectively implant vacancies and dramatically alter dopant diffusion.

- In probing the dopant-defect interaction, new experimental data for the early phases of cluster formation was presented together with modeling which furthered their understanding. At the same time, critical analysis of the predictive power of ab-intio calculations was given, pointing out how the underlying assumptions can dramatically change the resulting calculations of defect energetics. A talk was given which showed how genetic algorithms can be applied to materials science as a new method to extract fundamental parameters.

- A session on dopant characterization discussed the state of the art for some prominent 2D profiling techniques, including SCM, SSRM, and electron holography. As several talks on device scaling pointed out, the requirements on junctions for sub-100nm devices are 2D in nature, so that 2D profile measurements are necessary for on-going development.

- To mark this year-2000 symposium, Professor R. Fair gave an excellent historical overview of the field of implant and annealing in silicon devices.

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May 2000

ACKNOWLEDGMENTS

We thank all of the speakers and attendees for their active participation in this symposium. We also thank those participants who reviewed the manuscripts that make up this proceedings volume.

Most of the sessions contained one or more invited presentations. We thank each of the invited speakers for sharing their experience and insights:

Taur, Yuan
Gossmann, H.-J.
Kleiman, Rafi
Eyben, P.
Orchowski, A.
Stolk, Peter
Fair, Richard B.
Cowern, N.
Gosele, Ulrich
Venezia, Vincent
Jaraiz, M.

We acknowledge financial support from the following companies which enabled pre-paid student registration fees, complimentary copies of these proceedings, an outstanding beer party, and souvenir symposium mugs.

Applied Materials, Inc.
Axcelis Technologies, Inc.
(known as Eaton at the time of this Meeting)
Intel Corporation
Lucent Technologies, Bell Laboratories
Sula Technologies
Varian Semiconductor Equipment Association

Lastly, we are grateful to the MRS staff for their outstanding assistance in organizing the Meeting and publishing these proceedings.

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