

The Forum on the Science and Technology of Silicon Materials 2010

November 14(Sun) – 17(Wed), 2010

Okayama University 50th Anniversary Hall (Okayama city)

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H. Ono (Kanagawa Ind. Tech. Center), S. Murakami (Hitachi, Ltd.)

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T. Sato (Top Wave Co., Ltd.), M. Shabani (SUMCO Corp.), K. Shirai (Osaka Univ.),
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M. Minami (Phenitec Semiconductor Corp.), Y. Yamashita (Okayama Univ.),
Y. Yoshida (Shizuoka Institute of Science and Technology)

Secretaries: Y. Yamashita (Okayama Univ.), and K. Sueoka (Okayama Prefectural Univ.)

Editors : Y. Kamiura, A. Ogura and Y. Yamashita

Preface

The Forum on the Science and Technology of Silicon Materials was founded by Professor Emeritus Koji Sumino (Tohoku University) in 1997, and the first two forums were held in 1997 and 1999 at Kazusa Academia Park in Chiba Prefecture. Following them, the third and fourth forums were held in 2001 and 2003 at the Shonan Village Center of Hayama-cho in Kanagawa Prefecture. The last one was held in 2007 at Toki Messe in Niigata Prefecture. The fundamental policy of the forum has been: (1) the promotion of the mutual cooperation between the people in the industry and the academia, (2) the education and stimulation of young scientists and engineers, and (3) the realization of face-to-face discussion on various issues concerning silicon materials at the international level. The forum has played an important role in the field of the science and technology of silicon materials, as one of a few international conferences that Japanese scientists and engineers voluntarily organize. The numbers of participants has been 50-100 persons, depending on the business environment of semiconductor industries. The scope of the forum has been extended from the original topics (growth technologies of bulk silicon and epi wafers, characterization and control of defects and impurities, gettering and wafer technologies etc.) to SIMOX, SOI, SGOI and strained wafer technologies, SiC for high-power devices, solar cells and photovoltaic materials.

The present forum, the 6th one, was organized by the Organizing Committee comprised of 25 members last year. The committee decided to move the location of the forum to Okayama, which is the first place located in the western area of Japan. The present forum has been for the first time co-organized by The 145th Committee on Processing and Characterization of Crystals of Japan Society for the Promotion of Science (JSPS) together by the Organizing Committee of the Silicon Materials Science and Technology Forum. The scope of the present forum is further extended from those of the past forums to various new application fields including Si photonics and Si MEMS. Thanks to the outstanding teamwork of the Organizing Committee, we have gathered more than 60 papers and more than 100 participants for the present forum. We expect a wide variety of interesting presentations and heated, fruitful discussion throughout the forum. We believe that the present forum will mark an important milestone in the progress of the science and technology of silicon materials.

We have five invited speakers from abroad: Dr. G. Kissinger (IHP, Germany), Prof. J. Vanhellefont (Ghent Univ., Belgium), Dr. J. Michel (MIT, USA), Dr. M. Schubert (Fraunhofer ISE, Germany) and Dr. B. Sopori (NREL, USA). On behalf of the Organizing

Committee, we are grateful to them for their outstanding contribution to the forum with their interesting talks, stimulating discussion and comprehensive papers contributing to this volume of the proceedings. We are also very thankful all of domestic invited speakers for their contribution to the forum with their talks, discussion and papers, all of which play important roles to enhance the forum activities. Finally, we thank all the attendees for their contribution by presenting posters and papers and participating in discussion.

We would like to express our sincere thanks to the Industry Club of Japan for their financial contribution for partial support of the cost associated with preparing this volume of proceedings by “Special Fund for the Promotion of Science” which was made available by Japan Society for the Promotion of Science (JSPS).

October 20, 2010



Yoichi Kamiura
Hiroshi Yamada-Kaneta
Susumu Murakami
Haruhiko Ono
Koichi Kakimoto

PROGRAM

November 14 (Sunday)

- 16:00-19:00 **Registration**
- 18:00-20:00 **Welcome Party**

November 15 (Monday)

- 8:25-8:35 **Opening address**
Y. Kamiura
Okayama Univ. Japan

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- 8:35-9:00 **In Remembrance of Prof. Goesele**
Chair: Y. Kamiura (Okayama Univ.)
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Farewell Ulrich Goesele
K. Wada
The Univ. of Tokyo, Japan

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- 9:00-10:40 **Crystal Growth**
Chair: K. Kashima (Covalent Materials Corp.)
Co-chair: K. Sueoka (Okayama Prefectural Univ.)
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- 9:00-9:40 **Point Defects in Silicon Melt Growth from the Experimental Results**
Takao Abe, Toru Takahashi
SEH Isobe R&D Center, ShinEtsu Handotai, Japan

- 9:40-10:10 **450 MM WAFER GENERATION – CHALLENGES FOR THE SILICON PRODUCER**
A. Ikari
Siltronic Japan

- 10:10-10:40 **Czochralski growth of Ge crystal from the melt partially covered by B₂O₃ liquid for reduction of dislocation density**
Toshinori Taishi ¹, Yoshio Hashimoto ², Hideaki Ise ³, Yu Murao ³,
Takayuki Ohsawa ³, Yuki Tokumoto ³, Yutaka Ohno ³, Ichiro Yonenaga ³
1 Institute of Carbon Science and Technology, Shinshu Univ., Japan
2 Faculty of Engineering, Shinshu Univ., Japan
3 Institute for Materials Research, Tohoku Univ., Japan

- 10:40-11:00 **Coffee Break**

11:00-12:40	Defect Control and Characterization Chair: H. Yamada Kaneta (Niigata Univ.) Co-chair: H. Ono (Kanagawa Ind. Tech. Center)
11:00-11:40	Initial Stages of Oxygen and Vacancy Agglomeration: Kinetics and Getter Effects G. Kissinger ^{1,2} , D. Kot ^{1,2} , J. Dabrowski ¹ , W. Häckl ³ , V. Akhmetov ^{1,2} , A. Sattler ³ <i>1 IHP, Germany</i> <i>2 BTU/IHP Joint Lab, Germany</i> <i>3 Siltronic AG, Germany</i>
11:40-12:10	Technology Trends and Business Challenges in Silicon Wafer Industry S. Kohyama <i>Covalent Materials Corporation, Japan</i>
12:10-12:40	Process-induced Metal Contamination in Silicon Substrate and its Gettering Behavior K. Saga <i>Sony Corporation, Japan</i>
12:40-13:40	Lunch
13:40-15:10	Defect Characterization Chair: H. Ono (Kanagawa Ind. Tech. Center) Co-chair: Y. Kamiura (Okayama Univ.)
13:40-14:10	Characterization of crystalline defects in CMOS LSI Katsuto Tanahashi <i>Device Analysis Center, FUJITSU SEMICONDUCTOR LIMITED, Japan</i>
14:10-14:40	EBIC and Cathodoluminescence Study on the Grain Boundaries and Fe Impurities in Multicrystalline Si for Solar Cell Application Takashi Sekiguchi ^{1,2} , Jun Chen ¹ , Bin Chen ^{1,3} , Woong Lee ^{1,2} , Hisashi Onodera ^{1,2} , <i>1 Advanced Electronic Materials Center, National Institute for Materials Science (NIMS), Japan</i> <i>2 Graduate School of Pure and Applied Sciences, Univ. of Tsukuba, Japan</i> <i>3 National Institute of Advance Industrial Science and Technology (AIST), Japan</i>
14:40-15:10	Photo-assisted Kelvin Probe Force Microscopy on Multicrystalline Si Solar Cell Materials Takuji Takahashi ^{1,2} , Masaki Takihara ¹ <i>1 Institute of Industrial Science, The Univ. of Tokyo, Japan</i> <i>2 Institute for Nano Quantum Information Electronics, The Univ. of Tokyo, Japan</i>
15:10-15:30	Coffee Break

15:30-17:10	SiGe, Ge	Chair: H. Nakashima (Kyushu Univ.) Co-chair: K. Sueoka (Okayama Prefectural Univ.)
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15:30-16:10	Intrinsic point defect clustering during Czochralski growth of silicon and germanium J. Vanhellemont ¹ , Piotr Śpiewak ² <i>1 Department of Solid State Science, Ghent Univ., Germany</i> <i>2 Material Design Division Faculty of Materials Science and Engineering Warsaw Univ. of Technology, Poland</i>	
16:10-16:40	Prospective and critical issues of Ge-based CMOS Devices Shinichi Takagi, Mitsuru Takenaka <i>Department of Electrical Engineering and Information Systems, The Univ. of Tokyo, Japan</i>	
16:40-17:10	Non-planar SiGe-on-Insulator (SGOI) MOSFETs Tsutomu Tezuka <i>Advanced LSI Laboratory, Corporate R&D Center, Toshiba Corporation, Japan</i>	
17:10-17:30	Coffee Break	

17:30-19:00	Short presentation for Poster session	Chair: Y. Yoshida (Shizuoka Institute of Science and Technology)
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19:00-20:00	Supper	
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20:00-21:30	Poster session	Chair: Y. Yoshida (Shizuoka Institute of Science and Technology)
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November 16 (Tuesday)

8:30-10:10 Si Photonics

Chair: Y. Ishikawa (The Univ. of Tokyo)

Co-chair: K. Wada (The Univ. of Tokyo)

8:30-9:10 Monolithic Germanium Photonic Devices on Silicon

Jurgen Michel

Microphotonics Center, Massachusetts Institute of Technology, USA

9:10-9:40 Integrated Silicon Photonics for Telecommunications Applications.

K. Yamada¹, T. Tsuchizawa¹, T. Watanabe¹, H. Shinojima¹, H. Nishi¹, S. Park¹,
H. Fukuda¹, H. Takesue², Y. Tokura², Y. Ishikawa³, K. Wada³ and S. Itabashi¹

1 NTT Microsystem Integration Laboratories, Japan

2 NTT Basic Research Laboratories, NTT Corporation, Japan

3 Department of Materials Engineering, The Univ. of Tokyo, Japan

9:40-10:10 Silicon Photonics

Toshihiko Baba^{1,2,3}

1 Yokohama National Univ., Department of Electrical and Computer Engineering, Japan

2 CREST Project of Japan Science and Technology Agency, Japan

3 PECST of FIRST Program of Japan Society for the Promotion of Science, Japan

10:10-10:30 Coffee Break

10:30-12:00 Si MEMS

Chair: T. Sato (Top Wave Co., Ltd.)

Co-chair: H. Yamada-Kaneta (Niigata Univ.)

10:30-11:00 MEMS SENSOR AND MARKET TREND

Ryoji Okada

Mechanical Engineering Research Laboratory, Hitachi, Ltd., Japan

11:00-11:30 On-chip Immunoassay Using Magnetic Beads Manipulation

Tomohiro Ishikawa

Hiroshima Univ., Japan

11:30-12:00 Micro Machining of Silicon, Germanium and Silicon Carbide

Jiawang Yan

Department of Nanomechanics, Tohoku Univ. Japan

12:00 Group photo

12:30-18:00 Excursion (Lunch)

18:00-21:30 Banquet

November 17 (Wednesday)

8:30-10:00 **SiC, Power Si**

Chair: N. Ohtani (Kwansei Gakuin Univ.)
Co-chair: S. Murakami (Hitachi, Ltd.)

8:30-9:00 **Control of Defects and Carrier Lifetimes in SiC for Power Device Applications**

T. Kimoto, J. Suda, and Y. Nishi
Department of Electronic Science and Engineering, Kyoto Univ., Japan

9:00-9:30 **Next Generation Wafer Technology for Green Electronics Age**

S. Nishizawa
National Institute of Advanced Industrial Science and Technology, Japan

9:30-10:00 **Silicon power devices in automotive applications**

Takahide Sugiyama, Masahiro Yamazaki, Atsushi Tanida*, Fumikazu Niwa*,
Tetsuya Kanata*
Power Device Div., Toyota Central R&D Labs., Inc., Japan
** Electronics engineering div. III, TOYOTA MOTOR Corp., Japan*

10:00-10:20 **Coffee Break**

10:20-12:00 **Solar Cell (1)**

Chair: K. Kakimoto (Kyushu.Univ.)
Co-chair: M. Shabani (SUMCO Corp.)

10:20-11:00 **Defects in Multicrystalline Silicon: Influence on the Solar Cell Performance**

Bhushan Sopori¹, P. Rupnowski¹, S. Shet¹, V. Mehta¹, M. Seacrist², G. Shi²,
J. Chen², A. Deshpande²
1 National Renewable Energy Laboratory, USA
2 MEMC Electronic Materials, USA

11:00-11:30 **New Solar Grade Silicon and Applicability for Multi-crystalline Type Solar Cell**

Satoru Wakamatsu
Specialty Products Development Dept. Tokuyama Corporation, Japan

11:30-12:00 **Toward realization of high-quality multicrystalline silicon for solar cells**

Noritaka Usami
Institute for Materials Research (IMR), Tohoku Univ., Japan

12:00-12:40 **snack**

12:40-14:20 **Solar Cell (2)**

Chair: A. Ogura (Meiji Univ.)

Co-chair: T. Sekiguchi (National Institute for Materials Science)

12:40-13:20

CHARACTERIZATION OF SILICON FOR PHOTOVOLTAICS

M. C. Schubert, P. Gundel, J. Schön, H. Habenicht, W. Kwapil, B. Michl, M. Rüdiger,
F. Schindler, F. Heinz, W. Warta
Fraunhofer Institute of Solar Energy Systems, Germany

13:20-13:50

Study on the Fixed Abrasive Diamond Wire Saw Slicing of Silicon Ingot for Photovoltaic Applications

N. Iwamoto, T. Ogata, Y. Tokunaga
Japan Fine Steel Co., Ltd, Japan

13:50-14:20

Donor-Acceptor Pair Luminescence and its Application to Impurity Analysis in Solar-Grade Si

Michio Tajima¹, Takaaki Iwai¹, Hiroyuki Toyota¹, Simona Binetti²,
Daniel Macdonald³
1 Institute of Space and Astronautical Science/JAXA, Japan
2 CNISM and Department of Material Science, Univ. of Milano-Bicocca, Italy
3 School of Engineering, The Australian National Univ., Australia

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Closing remarks

Y. Kamiura (Okayama Univ.)

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