

9th International WorkShop on New Group IV Semiconductor Nanoelectronics
and
JSPS Core-to-Core Program Joint Seminar
"Atomically Controlled Processing for Ultralarge Scale Integration"

January 11-12, 2016,
Conference Room (4th Floor),
Laboratory for Nanoelectronics and Spintronics,
Research Institute of Electrical Communication (RIEC), Tohoku University, Sendai, Japan

Co-sponsored by

- Japan Society for the Promotion of Science (JSPS): Core-to-Core Program "Atomically Controlled Processing for Ultralarge Scale Integration"
- Japan Society for the Promotion of Science (JSPS): 154th Committee on Semiconductor Interfaces and Their Applications in University-Industry Cooperative Research Committees
- Cooperative Research Project Program of the Research Institute of Electrical Communication, Tohoku University

Technical Program

January 11 (Monday), 2016

10:00 - 10:10

Introductory Junichi Murota (Tohoku Univ.)

[Session I: Invited & Regular Talks]

10:10 - 10:40 (30 min)

I-01. "Ge Epitaxial Growth in View of Optical Device Applications",

(Invited)

Roger Loo¹, Srinivasan Ashwyn Srinivasan^{1,2,3}, Yosuke Shimura^{1,4}, Clement Porret¹, Dries Van Thourhout^{2,3}, Rik Van Deun⁵, Toma Stoica⁶, Dan Buca⁶ and Joris Van Campenhout¹

¹ imec (Belgium)

² Photonics Research Group (INTEC), Ghent University-IMEC (Belgium)

³ Center for Nano- and Biophotonics (NB-Photonics), Ghent University (Belgium)

⁴ Instituut voor Kern- en Stralingsfysica, KU Leuven (Belgium)

⁵ L3 – Luminescent Lanthanide Lab, Department of Inorganic and Physical Chemistry, Ghent University (Belgium)

⁶ Peter Grünberg Institute 9 (PGI 9) and JARA-Fundamentals of Future Information Technologies, Forschungszentrum Jülich (Germany)

10:40 - 11:10 (30 min)

I-02. "N-type Atomic-Layer-Doping for Group IV Semiconductor Materials",

(Invited)

Y. Yamamoto¹, J. Murota² and B. Tillack^{1,3}

¹ IHP (Germany)

² Micro System Integration Center, Tohoku University (Japan)

³ Technische Universität Berlin (Germany)

11:10 - 11:30 (20 min)

O-01. "Structural and Electrical Properties of Low Temperature CVD-Grown SiGe Epitaxial Layers",

Shinichi Ike^{1,2}, Eddy Simoen³, Yosuke Shimura¹, Andriy Hikavyv³, Wilfried Vandervorst^{3,4}, Roger Loo³, Wakana Takeuchi¹, Osamu Nakatsuka¹ and Shigeaki Zaima^{1,5}

¹ Graduate School of Engineering, Nagoya University (Japan)

² Research Fellow of the Japan Society for the Promotion of Science (Japan)

³ imec (Belgium)

⁴ *Instituut voor Kern- en Stralingsfysica, KU Leuven (Belgium)*

⁵ *Institute of Materials and Systems for Sustainability, Nagoya University (Japan)*

11:30 - 11:50 (20 min)

O-02. "Mechanism of mobility enhancement in Ge p-MOSFET due to introduction of Al atoms in SiO₂/GeO₂ gate stacks",

Yuta Nagatomi¹, Shintaro Tanaka¹, Tomoki Tateyama¹, Keisuke Yamamoto², Dong Wang¹ and Hiroshi Nakashima²

¹ *Interdisciplinary Graduate School of Engineering Sciences, Kyushu University (Japan)*

² *Art, Science and Technology Center for Cooperative Research, Kyushu University (Japan)*

11:50 - 13:00 Lunch

[Session II: Invited & Regular Talks]

13:00 - 13:30 (30 min)

I-03. "High active Phosphorus concentration in *in-situ* doped Ge CVD layers using low growth temperature and high order Ge precursors: toward Group-IV optical interconnects",

(Invited)

Yosuke Shimura^{1,2,*}, Srinivasan Ashwyn Srinivasan^{1,3,4}, Dries Van Thourhout^{3,4}, Rik Van Deun⁵, Marianna Pantouvaki¹, Joris Van Campenhout¹ and Roger Loo¹

¹ *Imec (Belgium)*

² *Instituut voor Kern- en Stralingsfysica, KU Leuven (Belgium)*

³ *Photonics Research Group (INTEC), Ghent University-IMEC (Belgium)*

⁴ *Center for Nano- and Biophotonics (NB-Photonics), Ghent University (Belgium)*

⁵ *L³ – Luminescent Lanthanide Lab, Department of Inorganic and Physical Chemistry, Ghent University (Belgium)*

* *Present affiliation: Graduate School of Engineering, Nagoya University (Japan)*

13:30 - 14:00 (30 min)

I-04. "Effects of postdeposition treatments on the electrical properties of Al₂O₃/GeO₂ gate stack grown on Ge substrate by radical-enhanced atomic layer deposition",

(Invited)

Hiroshi Okamoto¹, Daichi Yamada², Hidefumi Narita¹, Yohei Otani², Chiaya Yamamoto³, Junji Yamanaka⁴, Tetsuya Sato³ and Yukio Fukuda²

¹ *Hirosaki University (Japan)*

² *Tokyo University of Science, Suwa (Japan)*

³ *University of Yamanashi (Japan)*

⁴ *University of Yamanashi (Japan)*

14:00 - 14:20 (20 min)

O-03. "Control of slow traps of ALD Al₂O₃/Ge-based gate stacks with post plasma process",

M. Ke^{1,2}, X. Yu^{1,2}, M. Takenaka^{1,2} and S. Takagi^{1,2}

¹ *School of Engineering, the University of Tokyo (Japan)*

² *JST-CREST (Japan)*

14:20 - 14:40 (20 min)

O-04. "Study of local polarization in ferroelectric HfO₂ films with piezo-response force microscope (PFM)",

Shigehisa Shibayama^{1,2}, Lun Xu¹, Shinji Migita³ and Akira Toriumi¹

¹ *The University of Tokyo (Japan)*

² *Research Fellow of Japan Society for the Promotion of Science (Japan)*

³ *National Institute of Advanced Industrial Science & Technology (AIST) (Japan)*

14:40 - 15:00 Break (20 min)

[Session III: Invited & Regular Talks]

15:00 - 15:30 (30 min)

I-05. " Excimer Laser assisted dopant diffusion and crystallization in a-Si:H/nc-Si:H multilayers",
(Invited)

S. Stefanov¹, E. Martín², C. Serra³, A. Benedetti³, P. Alpuim⁴, R. Delmdahl⁵ and S. Chiussi¹

¹ *Dpto. Física Aplicada, E. I. Industrial, Univ. de Vigo (Spain)*

² *Dpto. Mecánica, Máquinas, Motores Térmicos y Fluidos, Univ. de Vigo (Spain)*

³ *CACTI, Univ. de Vigo (Spain)*

⁴ *Centro de Física, Univ. Minho & INL (International Iberian Nanotechnology Laboratory) (Portugal)*

⁵ *Coherent LaserSystems GmbH & Co. KG (Germany)*

15:30 - 16:00 (30 min)

I-06. " Optically modulated electron emission from volcano-structured silicon field emitter arrays",
(Invited)

H. Shimawaki¹, M. Nagao², Y. Neo³, H. Mimura³, F. Wakaya⁴ and M. Takai⁴

¹ *Department of System and Information Engineering, Hachinohe Institute of Technology (Japan)*

² *National Institute of Advanced Industrial Science and Technology (Japan)*

³ *Research Institute of Electronics, Shizuoka University (Japan)*

⁴ *Graduate School of Engineering Science, Osaka University (Japan)*

16:00 - 16:20 (20 min)

O-05. " Thermodynamic Control of GeO_x Growth Suppression in SiGe Oxidation",
Woojin Song and Akira Toriumi

Department of Materials Engineering, The University of Tokyo (Japan)

16:20 - 16:40 (20 min)

O-06. " Evaluation of Electronic Properties of Si/SiGe/Si(100) Heterostructures Formed by ECR Ar Plasma CVD",
Naofumi Ueno, Masao Sakuraba, Hisanao Akima and Shigeo Sato

Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University (Japan)

18:00 - 20:00 Banquet (Hotel Bel Air Sendai, 1st Floor Restaurant)

January 12 (Tuesday), 2016

[Session IV : Short Talks for Poster]

09:00 - 09:05 (5 min)

P-01. " Characterization of defects in Ge substrates using deep-level transient spectroscopy (DLTS)",

Hiroki Ikegaya, Tomonori Nishimura and Akira Toriumi

Department of Materials Engineering, The University of Tokyo (Japan)

09:05 - 09:10 (5 min)

P-02. " Raman and XRD analysis of ferroelectric-phase HfO₂ films",

Kazutaka Izukashi¹, Tomonori Nishimura¹, Shinji Migita² and Akira Toriumi¹

¹ *Department of Materials Engineering, The University of Tokyo (Japan)*

² *National Institute of Advanced Industrial Science & Technology (AIST) (Japan)*

09:10 - 09:15 (5 min)

P-03. " C-mediated Ge quantum dot growth on Si (100) substrate",

Yuhki Satoh, Yuhki Itoh, Tomoyuki Kawashima and Katsuyoshi Washio

Graduate School of Engineering, Tohoku University (Japan)

09:15 - 09:20 (5 min)

P-04. " Characteristics of B Doping in Si Epitaxial Growth on Si(100) Using ECR Ar Plasma CVD",

Koya Motegi, Masao Sakuraba, Hisanao Akima and Shigeo Sato

Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University (Japan)

09:20 - 09:25 (5 min)

- P-05. " Phosphorus doping into Ge with low electrical damage by liquid immersion laser doping",
Kouta Takahashi ¹, Masashi Kurosawa ^{1,2,3}, Hiroshi Ikenoue ⁴, Mitsuo Sakashita ¹, Wakana Takeuchi ¹,
Osamu Nakatsuka ¹ and Shigeaki Zaima ^{1,2}
¹ Graduate School of Eng., Nagoya Univ. (Japan)
² Inst. of Mater. and Sys. for Sustainability, Nagoya Univ. (Japan)
³ Inst. for Advanced Research, Nagoya University (Japan)
⁴ Graduate School of Info. Sci. and Elec. Eng., Kyushu Univ. (Japan)

09:25 - 09:30 (5 min)

- P-06. " Crystalline and Electrical Properties of *in-situ* Sb-Doped Ge_{1-x}Sn_x Epitaxial Layers",
Jihee Jeon ¹, Takanori Asano ^{1,2}, Yosuke Shimura ¹, Wakana Takeuchi ¹, Masashi Kurosawa ^{1,3}, Mitsuo
Sakashita ¹, Osamu Nakatsuka ¹ and Shigeaki Zaima ^{1,3}
¹ Graduate School of Engineering, Nagoya University (Japan)
² Research Fellow of the Japan Society for the Promotion of Science (Japan)
³ Institute of Materials and Systems for Sustainability, Nagoya University (Japan)

09:30 - 09:35 (5 min)

- P-07. " Formation of GeSn layer sandwiched with strain-controlled GeSiSn layers",
Masahiro Fukuda ¹, Takashi Yamaha ^{1,2}, Takanori Asano ^{1,2}, Syunsuke Fujinami ¹, Yosuke Shimura ¹,
Masashi Kurosawa ^{1,3}, Osamu Nakatsuka ¹ and Shigeaki Zaima ^{1,3}
¹ Grad. Sc. of Eng., Nagoya Univ. (Japan)
² JSPS Research Fellow (Japan)
³ IMaSS, Nagoya Univ. (Japan)

09:35 - 09:40 (5 min)

- P-08. " Formation of poly-Si_{1-x-y}Sn_xC_y ternary alloy layer and characterization of its crystalline and optical
properties",
Shota Yano ¹, Takashi Yamaha ^{1,2}, Yosuke Shimura ¹, Wakana Takeuchi ¹, Mitsuo Sakashita ¹, Masashi
Kurosawa ^{1,3}, Osamu Nakatsuka ¹ and Shigeaki Zaima ^{1,3}
¹ Graduate School of Engineering, Nagoya University (Japan)
² Resarch Fellow of JSPS (Japan)
³ Institute of Materials and Systems for Sustainability, Nagoya University (Japan)

09:40 - 09:45 (5 min)

- P-09. " Influences of metal/Ge contact and surface passivation on direct band gap light emission and detection for
asymmetric metal/Ge/metal diodes",
Takayuki Maekura ¹ Chisato Motoyama ¹, Keisuke Yamamoto ², Hiroshi Nakashima ² and Dong Wang ¹
¹ Interdisciplinary Graduate School of Engineering Sciences, Kyushu University (Japan)
² Art, Science and Technology Center for Cooperative Research, Kyushu University (Japan)

09:45 - 09:50 (5 min)

- P-10. " Formation of GeSn Crystals with High Sn Concentration on Insulating Substrate by Pulsed Laser-
Annealing",
K. Moto ¹, R. Matsumura ^{1,2}, T. Sadoh ¹, H. Ikenoue ³ and M. Miyao ¹
¹ Dept. of Electronics, Kyushu Univ. (Japan)
² JSPS Research Fellow (Japan)
³ Dept. of Gigaphoton Next GLP, Kyushu Univ. (Japan)

09:50 - 09:55 (5 min)

- P-11. " Low Temperature (~150°C) Au-Induced Lateral Growth of a-GeSn on Insulator",
T. Sakai ¹, R. Matsumura ^{1,2}, T. Sadoh ¹ and M. Miyao ¹
¹ Department of Electronics, Kyushu University (Japan)
² JSPS Research Fellow (Japan)

09:55 - 10:00 (5 min)

- P-12. " Impact of Ge Capping Layer on Ta Nanodots Formation Induced by Remote Hydrogen Plasma",
Yaping Wang, Daichi Takeuchi, Akio Ohta, Mitsuhisa Ikeda, Katsunori Makihara and Seiichi Miyazaki
Graduate School of Engineering, Nagoya University (Japan)

10:00 - 10:05 (5 min)

P-13. " Evaluation of Electronic States of Thermally-grown SiO₂/4H-SiC",
Hiromasa Watanabe, Akio Ohta, Nobuyuki Fujimura, Katsunori Makihara and Seiichi Miyazaki
Graduate School of Engineering, Nagoya University (Japan)

10:05 - 10:10 (5 min)

P-14. " High Density Ti Nanodots Formation and Improvement of ReRAM Characteristics by Embedding Ti Nanodots",
Yusuke Kato, Akio Ohta, Katsunori Makihara and Seiichi Miyazaki
Grad. Sch. of Eng., Nagoya Univ. (Japan)

10:10 - 10:15 (5 min)

P-15. " Characterization of Electronic Charged States of FePt-NDs Stacked Structures by Kelvin Force Microscopy",
Taiga Kawase, Yuusuke Mitsuyuki, Akio Ohta, Katsunori Makihara, Takeshi Kato, Satoshi Iwata and Seiichi Miyazaki
Graduate School of Engineering, Nagoya University (Japan)

10:15 - 10:20 (5 min)

P-16. " Current and voltage dependence of STM induced hydrogen desorption on Si(111)",
Wu Li, Shigeo Sato, Hisanao Akima and Masao Sakuraba
Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University (Japan)

10:20 - 10:40 Break (20 min)

[Session V : Poster Presentation]

10:40 - 11:50 Poster Presentation (P-01 ~ P-17, 70 min)

11:50 - 13:00 Lunch

[Session VI: Invited & Regular Talks]

13:00 - 13:30 (30 min)

I-07. " SiGeSn - A direct semiconductor compound for electronic device applications?",
(Invited)
J. Schulze
Univ. Stuttgart (Germany)

13:30 - 14:00 (30 min)

I-08. " Investigation of binary and ternary SiGeSn MOS structures",
(Invited)
C. Schulte-Braucks¹, T. Lehndorff¹, S. Glass¹, N. von den Driesch¹, S. Wirths¹, J.M. Hartmann^{2,3}, Z. Ikonik⁴, S. Mantl¹, D. Buca¹
¹ *Peter Grünberg Institute (PGI 9) and JARA-FIT, Forschungszentrum Jülich GmbH (Germany)*
² *Univ. Grenoble Alpes (France)*
³ *CEA, LETI (France)*
⁴ *Institute of Microwaves and Photonics, School of Electronic and Electrical Engineering, University of Leeds (UK)*

14:00 - 14:20 (20 min)

O-07. " Control of Schottky barrier height at metal/Ge interface by insertion of Ge_{1-x}Sn_x layer",
Akihiro Suzuki¹, Osamu Nakatsuka¹, Shigehisa Shibayama^{1,2}, Mitsuo Sakashita¹, Wakana Takeuchi¹, Masashi Kurosawa^{1,3} and Shigeaki Zaima^{1,3}
¹ *Grad. Sch. of Eng., Nagoya Univ. (Japan)*
² *The Research Fellow of JSPS (Japan)*
³ *IMaSS, Nagoya Univ. (Japan)*

14:20 - 14:40 (20 min)

O-08. " Determination of Electron Affinity of Si-based Materials using by X-ray Photoelectron Spectroscopy",
Nobuyuki Fujimura, Akio Ohta, Katsunori Makihara and Seiichi Miyazaki
Grad. Sch. of Eng., Nagoya Univ. (Japan)

14:40 -15:00 (20 min)

O-09. " Study of Electron Field Emission from Multiply-Stacking Si Quantum Dots",
Daichi Takeuchi, Katsunori Makihara, Akio Ohta, Mitsuhsa Ikeda and Seiichi Miyazaki
Graduate School of Engineering, Nagoya University (Japan)

15:00 -15:20 (20 min)

O-10. " Analysis of carbon mediation in Ge quantum dot formation on Si(100) substrate",
Yuhki Itoh, Yuhki Satoh, Tomoyuki Kawashima and Katsuyoshi Washio
Graduate School of Engineering, Tohoku University (Japan)

15:20 - 15:40 Closing Remarks & Group Photo

