ANNUAL RESEARCH REPORT

Vol. 9

April 2016 - March 2017

研究成果報告書

第９巻

平成 28 年４月—平成 29 年３月

RESEARCH INSTITUTE FOR NANODEVICE AND BIO SYSTEMS
HIROSHIMA UNIVERSITY

広島大学 ナノデバイス・バイオ融合科学研究所

Preface

The Research Institute for Nanodevice and Bio Systems (RNBS) was founded on May 1, 2008 with the faculty members of the Department of Semiconductor Electronics and Integration Science and the Department of Molecular Biotechnology at the Graduate School of Advanced Sciences of Matter as well as the Graduate School of Biomedical Sciences. RNBS consists of four research divisions; (1) Nanointegration Research Division, (2) Integrated Systems Research Division, (3) Molecular Bioinformation Research Division, and (4) Nanomedicine Research Division.

The forerunner of this institute was The Research Center for Integrated Systems (RCIS) which was founded in 1986 as a ministerial ordinance. The first center was reorganized after 10 years and The Research Center for Nanodevices and Systems (RCNS) was established in May, 1996.

It has been 31 years since the first RCIS was established by the first Director Dr. Masataka Hirose, Emeritus Advisor of National Institute of Advanced Industrial Science and Technology, Professor Emeritus of Hiroshima University. We also would like to thank the first Associate Director, Prof. Mitsumasa Koyanagi, Tohoku University, and Dr. Yasuhiro Horiike, Fellow Emeritus, National Institute for Materials Science, specially appointed Professor of University of Tsukuba.

The research at RNBS has been focused on silicon integrated circuits, devices, processes and materials so that the significant research results have been achieved as one of the prominent research institute among the national universities. The RNBS plays important roles not only as a research laboratory but also as an education institute, where graduate students and under graduate students as well as postdoctoral researchers have been studying on the most advanced leading-edge technologies to become independent leading researchers who conduct their researches by themselves in future semiconductor industries. The reputations of the graduates from the RNBS have been extremely high in the semiconductor industries.

The RNBS has achieved numerous projects supported by Japanese and local governments such as Nanotechnology Platform, Ministry of Education, Culture, Sports, Science and Technology, Strategic Basic Research Programs (CREST), Development of Systems and Technology for Advanced Measurement and Analysis, Japan Agency for Medical Research and Development, Grant-in-Aid for Scientific Research (A) by the Japan Society for the Promotion of Science (JSPS). The RNBS has also been selected as one of the members of the National University Research Institute and Research Center Council.
In April 2016, the Research Center of Biomedical Engineering (RCBE) was established in collaboration with the Institute of Biomaterials and Bioengineering at Tokyo Medical and Dental University, the Laboratory for Future Interdisciplinary Research of Science and Technology at Tokyo Institute of Technology, the Research Center for Nanodevice and Bio Systems at Hiroshima University, and the Research Institute of Electronics at Shizuoka University, with the support of the Minister of Education, Culture, Sports, Science and Technology (MEXT), Japan, The RCBE aims at promoting innovative researches in the field of biomedical engineering with strong network of these four institutes.

This annual report offers comprehensive information about the recent research activities and achievements at the RNBS to those who are engaged in the fields of advanced technologies. We hope this report will contribute to the mutual exchange of ideas and future progress of the researches on advanced integration of nanodevice and bio systems.

December 1, 2017

Shin Yokoyama
Director
Research Institute for Nanodevice and Bio Systems
Hiroshima University, Japan

Shin Yokoyama

巻頭言

広島大学ナノデバイス・バイオ融合科学研究所は2008年5月1日に大学院先端物質科学研究科半導体集積科学専攻の研究グループと分子生命機能科学専攻の研究グループおよび大学院医歯薬学総合研究科、歯学部の研究グループの協力を得て学内措置で設立されました。これまでの半導体研究の実績に加えて、医学・医療との融合をめざした基盤技術の研究を推進するため、研究領域はナノ集積科学、集積システム科学、分子生命情報科学、集積医科学の4つからなっています。

本研究所の前身は文部科学省の省令センターとして1986年に設立された集積化システム研究センターです。1996年5月にはナノデバイス・システム研究センターが新たな省令センターとして改組設立されました。 最初のセンター設立から22年目に本研究所を設立いたしました。

30年以上の実績を有するセンターは初代センター長の廣瀬全孝先生(現産業技術総合研究所研究顧問、広島大学名誉教授)をリーダーに、初代センター主任の小柳光正先生（元広島大学教授、現東北大学客員教授）、クリーンルーム立ち上げにご尽力いただいた堀池靖浩先生（元広島大学教授、現物質材料研究機構名誉フェロー、筑波大学数理物質系特命教授）をはじめとする諸先輩の努力の賜です。

広島大学ナノデバイス・バイオ融合科学研究所は我が国の大学の中でもユニークな存在です。30年間一貫して、シリコン集積回路、デバイス、プロセス、材料の研究を続けており、この分野では国内でも有数の研究機関としてその研究成果を着実にあげてきました。さらに、我が国の半導体産業の将来を担う、学部学生、大学院生、博士研究員らの人材育成にも力を入れてきました。最先端技術の研究を通して、世界に発信できる研究者を育成すべく、学生、研究員が自ら研究を企画し、自立して研究開発を進める能力を持つことができるよう教育指導しており、その実績は産業界から高く評価されております。

これまでの研究実績として、文部科学省ナノテクノロジープラットフォーム、戦略的創造研究推進事業(CREST)、日本医療研究開発機構(AMED)医療分野研究成果展開事業、科学研究費助成基盤研究費(A)などの大型プロジェクトに採択されて、研究を加速推進しております。
ナノデバイス・バイオ融合科学研究所は，2016 年 4 月に、文部科学大臣から全国共同利用・共同研究拠点「生体医歯工学共同研究拠点」の認定（2016-2021 年度）を受け、東京医科歯科大学生体材料工学研究所、東京工業大未来産業技術研究所、静岡大学電子工学研究所とともに共同研究ネットワークを構築して、本研究所の強み・特色であるナノバイオ・メディカル・エレクトロニクス分野における革新的医療技術創出の拠点を構築します。

アニュアルリサーチレポートはナノデバイス・バイオ融合科学研究所の最近1年間の研究活動と研究成果の一端をまとめて、先端技術の研究・教育に携わる方々に最新情報を共有していただくために発行しています。このレポートが今後ともこの分野での研究交流の一助になれば幸いです。

2017年12月1日

広島大学
ナノデバイス・バイオ融合科学研究所
所長　　　　　　横山　新

CONTENTS

1. Organization of Research Institute for Nanodevice and Bio Systems (RNBS)

ナノデバイス・バイオ融合科学研究所組織

Executive Committee
運営委員会

Director
所長

Adviser
顧問

Nanointegration Research Division
ナノ集積科学研究部門

6 Professors,3 Visiting Professors,3 Associate Professors,
1 Special Appointment Associate Professor,
1 Visiting Associate Professors, 1 Assistant Professors,
1 Special Appointment Assistant Professor
教授 6名（専任: 2, 併任: 4）, 客員教授 3名, 准教授 3名（専任: 2, 併任: 1）,
特任准教授 1名, 客員准教授 1名, 助教 1名（併任）, 特任助教 1名

Integrated Systems Research Division
集積システム科学研究部門

4 Professors, 4 Associate Professors, 1 Assistant Professor
教授 4名（専任: 1, 併任: 3）, 准教授 4名（専任: 1, 併任: 3）, 助教 1名（併任）

Molecular Bioinformation Research Division
分子生命情報科学研究部門

4 Professors, 3 Visiting Professors, 1 Assistant Professor
教授 4名（専任: 1, 併任: 3）, 客員教授 3名, 助教 1名（併任）

Nanomedicine Research Division
集積医科学研究部門

4 Professors, 1 Visiting Professor, 1 Associate Professor,
1 Assistant Professor
教授 4名（併任）, 客員教授 1名, 准教授 1名（併任）, 助教 1名（併任）

Nanotechnology Platform
ナノテクノロジー・プラットフォーム

1 Special Appointment Associate Professor
特任准教授 1名

Cooperative Research Staff (Faculty Members)
研究員（学内）、関連学部・学科

Visiting Scientists (Universities, Industries)
客員研究員（他大学、企業）

2. Staff of Research Institute for Nanodevice and Bio Systems (RNBS)

ナノデバイス・バイオ融合科学研究所構成員
（2016年10月1日時点）

Nanointegration Research Division

ナノ集積科学研究部門

Takamaro Kikkawa 吉川　公麿	Director of RNBS and Professor 研究所長，教授
Shin Yokoyama 横山　新	Associate Director and Professor 副研究所長，教授
Seiichiro Higashi 東　清一郎	Professor 教授（併任）
Johji Ohshita 大下　浄治	Professor 教授（併任）
Kazuo Takimiya 瀧宮　和男	Professor 教授（併任）
Manabu Shimada 島田　学	Professor 教授（併任）
Anri Nakajima 中島　安理	Associate Professor 准教授
Shin-Ichiro Kuroki 黒木　伸一郎	Associate Professor 准教授
Shuhei Amakawa 天川　修平	Associate Professor 准教授（併任）
Tetsuo Tabei 田部井　哲夫	Associate Professor (Special Appointment) 特任准教授
Hiroaki Hanafusa 花房　宏明	Assistant Professor 助教（併任）
Yoshiteru Amemiya 雨宮　嘉照	Assistant Professor (Special Appointment) 特任助教

Integrated Systems Research Division

集積システム科学研究部門

Hans Jürgen Mattausch マタウシュ ハンス ユルゲン	Professor 教授
Minoru Fujishima 藤島　実	Professor 教授(併任)
Idaku Ishii 石井　抱	Professor 教授(併任)
Kazufumi Kaneda 金田　和文	Professor 教授(併任)
Tetsushi Koide 小出　哲士	Associate Professor 准教授
Tsuyoshi Yoshida 吉田　毅	Associate Professor 准教授(併任)
Toru Tamaki 玉木　徹	Associate Professor 准教授(併任)
Takeshi Takaki 高木　健	Associate Professor 准教授(併任)
Tadayoshi Aoyama 青山　忠義	Assistant Professor 助教(併任)

Molecular Bio-information Research Division

分子生命情報科学研究部門

Masakazu Iwasaka 岩坂　正和	Professor 教授
Akio Kuroda 黒田　章夫	Professor 教授(併任)
Takashi Yamada 山田　隆	Professor 教授(併任)
Seiji Kawamoto 河本　正次	Professor 教授(併任)

Takeshi Ikeda 池田　丈	Assistant Professor 助教（併任）

Nanomedicine Research Division

集積医科学研究部門

Kazuaki Chayama 茶山　一彰	Professor 教授（併任）
Michihiro Hide 秀　道広	Associate Director and Professor 副研究所長，教授（併任）
Hiroki Nikawa 二川　浩樹	Professor 教授（併任）
Koichi Kato 加藤　功一	Professor 教授（併任）
Kazuhiro Tsuga 津賀　一弘	Associate Professor 准教授（併任）
Yuhki Yanase 柳瀬　雄輝	Assistant Professor 助教（併任）

Nanotechnology Platform

ナノテクノロジープラットフォーム

Tetsuo Tabei 田部井　哲夫	Chief and Associate Professor (Special Appointment) 主任，特任准教授

Visiting Professor

客員教授

Yuji Miyahara 宮原　裕二	Visiting Professor 客員教授
Takashi Ito 伊藤　隆司	Visiting Professor 客員教授

Hiroshi Ohki | Visiting Professor
大木　博 | 客員教授

Hiroshi Ohki 大木　博	Visiting Professor 客員教授
Seiichi Miyazaki 宮崎　誠一	Visiting Professor 客員教授
Ryo Miyake 三宅　亮	Visiting Professor 客員教授
Shigeto Yoshida 吉田　成人	Visiting Professor 客員教授
Koichi Ito 伊藤　公一	Visiting Professor 客員教授
Hideki Murakami 村上　秀樹	Visiting Associate Professor 客員准教授

Researchers
研究員

Hoang Anh Tuan ホアン アイン トゥワン	Post Doctoral Researcher 機関研究員
Tadashi Sato 佐藤　旦	Researcher, Nanotechnology Platform ナノテクノロジープラットフォーム研究員
Yutaka Furubayashi 古林　寛	Researcher, NEDO "Thermal Management Materials and Technology Research Association (TherMAT)" NEDO研究員 （未利用熱エネルギー革新的活用技術研究開発プロジェクト）
Tatsuya Meguro 目黒　達也	Researcher 研究員
Shinji Yamada 山田　真司	Research Associate 教育研究補助職員
Kazushi Okada 岡田　和志	Research Associate 教育研究補助職員
Yuri Mizukawa 水川　友里	Research Fellow of Japan Society for the Promotion of Science 日本学術振興会特別研究員

Advisory Board

顧問

Masataka Hirose 廣瀬 全孝	Professor Emeritus, Hiroshima University 広島大学名誉教授

Visiting Staff

客員スタッフ

Hirofumi Fukumoto 福本 博文	Visiting Scientist, Asahi Kasei Corporation 客員研究員，旭化成(株) (2007.12～)
Tomonori Maeda 前田 知徳	Visiting Scientist, Phenitec Semiconductor Corporation 客員研究員，フェニテックセミコンダクター(株) (2009.11～)
Seiji Ishikawa 石川 誠治	Visiting Scientist, Phenitec Semiconductor Corporation 客員研究員，フェニテックセミコンダクター(株) (2011.4～)
Hiroshi Sezaki 瀬崎 洋	Visiting Scientist, Phenitec Semiconductor Corporation 客員研究員，フェニテックセミコンダクター(株) (2012.7～)
Toshiaki Hirota 廣田 俊明	Visiting Scientist, Tazmo Corporation 客員研究員，タツモ(株)
Hirofumi Tanaka 田中 博文	Visiting Scientist, Mitsui Chemicals Incorporated 客員研究員，三井化学(株)
Shoko Ono 小野 昇子	Visiting Scientist, Mitsui Chemicals Incorporated 客員研究員，三井化学(株)
Yasuhisa Kayaba 茅場 靖剛	Visiting Scientist, Mitsui Chemicals Incorporated 客員研究員，三井化学(株)
Takeshi Kumaki 熊木 武志	Visiting Scientist, Department of VLSI System Design, College of Science & Enginnering, Ritsumeikan University 客員研究員，立命館大学理工学部電子情報デザイン学科
Shozo Takada 高田 省三	Visiting Scientist, Asahi Kasei E-materials Corporation 客員研究員，旭化成イーマテリアルズ(株)

Kenji Sakamoto
坂本　憲児

Visiting Scientist, Center for Microelectronic System, Kyusyu Institute of Technology
客員研究員，九州工業大学マイクロ化総合技術センター

Akihiro Toya
外谷　昭洋

Visiting Scientist, Kure National College of Technology
客員研究員，呉工業高等専門学校

Takafumi Tanehira
種平　貴文

Visiting Scientist, MAZDA Motor Corporation
客員研究員，マツダ(株)

Takuo Hirano
平野　拓男

Visiting Scientist, MAZDA Motor Corporation
客員研究員，マツダ(株)

Toshihiko Ohta
太田　年彦

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Hiromasa Watanabe
渡邉　礼方

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Ataru Yamaoka
山岡　中

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Tadashi Murata
村田　格

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Nobuyuki Tokuda
徳田　信之

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Yoshinori Hiramatsu
平松　祥典

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Yohei Kondo
近藤　洋平

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Jyunichi Sunada
砂田　潤一

Visiting Scientist, Sharp Takaya Electronic Industry Corporation
客員研究員，シャープタカヤ電子工業(株)

Jyunichi Somei
染井　潤一

Visiting Scientist, Sharp Corporation
客員研究員，シャープ(株)

Eiji Suematsu
末松　英治

Visiting Scientist, Sharp Corporation
客員研究員，シャープ(株)

Yuichi Watarai
渡来　友一

Visiting Scientist, Sharp Corporation
客員研究員，シャープ(株)

Atsushi Iwata
岩田　穆

Visiting Scientist, Sharp Corporation
客員研究員, (株)エイアールテック

Yositaka Murasaka
村坂　佳隆

Visiting Scientist, Sharp Corporation
客員研究員, (株)エイアールテック

Takafumi Ohmoto
大本　貴文

Visiting Scientist, Sharp Corporation
客員研究員, (株)エイアールテック

Toshifumi Imamura
今村　俊文

Visiting Scientist, Sharp Corporation
客員研究員, (株)エイアールテック

Tomoaki Maeda
前田　智晃

Visiting Scientist, Sharp Corporation
客員研究員, (株)エイアールテック

Masahiro Ono
小野　将寛

Visiting Scientist, Sharp Corporation
客員研究員, (株)エイアールテック

Supporting Staff
支援スタッフ

Shusaku　Mohri
毛利　周作

Finance Affairs
財務担当

Masahide Sasaki
佐々木　雅英

General Affairs
総務担当

Fumitaka Nishiyama
西山　文隆

Technical Assistant
技術補佐員

Chikahisa　Machida
町田　親久

Office Assistant
事務補佐員

Chiaki Ashihara
葦原　千秋

Office Assistant
事務補佐員

Naoko Nakatani
中谷　尚子

Office Assistant
事務補佐員

Akiko Sakata
坂田　朗子

Office Assistant
事務補佐員

Aimi Yamano
山野　あいみ

Research Associate
研究補助職員

3. Executive Committee Members of Research Institute for Nanodevice and Bio Systems (RNBS)

ナノデバイス・バイオ融合科学研究所運営委員会委員

Takamaro Kikkawa 吉川　公麿	Director and Professor 研究所長・教授	RNBS ナノデバイス・バイオ融合科学研究所
Shin Yokoyama 横山　新	Associate Director and Professor 副研究所長・教授	RNBS ナノデバイス・バイオ融合科学研究所
Michihiro Hide 秀　道広	Associate Director and Professor 副研究所長（~2016年12月31日）・教授	Graduate School of Biomedical Sciences 医歯薬保健学総合研究院（医）
Hiroki Nikawa 二川　浩樹	Associate Director and Professor 副研究所長（2017年1月1日～）・教授	Graduate School of Biomedical Sciences 医歯薬保健学総合研究院（歯）
Hans Jürgen Mattausch マタウシュ ハンス ユルゲン	Professor 教授	RNBS ナノデバイス・バイオ融合科学研究所
Masakazu Iwasaka 岩坂　正和	Professor 教授	RNBS ナノデバイス・バイオ融合科学研究所
Seiichiro Higashi 東　清一郎	Professor 教授	Graduate School of Advanced Sciences of Matter 先端物質科学研究科
Toshikazu Ekino 浴野　稔一	Professor 教授	Graduate School of Integrated Arts and Sciences 総合科学研究科
Yoshihiro Kuroiwa 黒岩　芳弘	Professor 教授	Graduate School of Science 理学研究科
Toshio Tsuji 辻　敏夫	Professor 教授	Institute of Engineering 工学研究院
Yoshihiro Sanbongi 三本木　至宏	Professor 教授	Graduate School of Biosphere Sciences 生物圏科学研究科
Hiroki Nikawa 二川　浩樹	Professor 教授	Graduate School of Biomedical Sciences 医歯薬保健学総合研究院（歯）
Anri Nakajima 中島 安理	Associate Professor 准教授	RNBS ナノデバイス・バイオ融合科学研究所
Tetsushi Koide 小出 哲士	Associate Professor 准教授	RNBS ナノデバイス・バイオ融合科学研究所

Shin-Ichiro Kuroki 黒木 伸一郎	Associate Professor 准教授	RNBS ナノデバイス・バイオ融合科学研究所

2016年8月1日付より任命

Koichi Kato 加藤　功一	Professor 教授	Graduate School of Biomedical Sciences 医歯薬保健学総合研究院（歯）

2016年12月5日付より任命

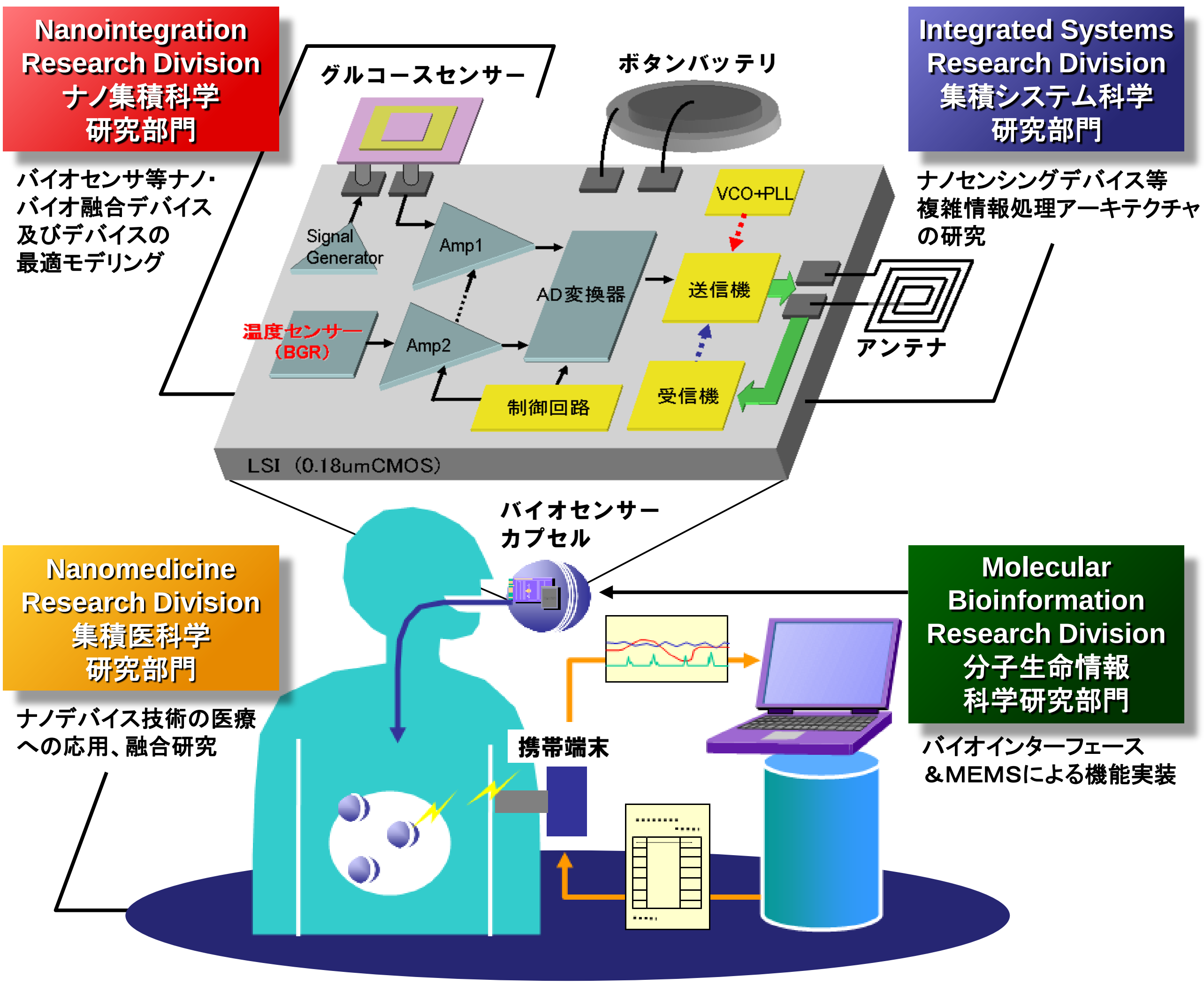
Yutaka Kadoya 角屋　豊	Professor 教授	Graduate School of Advanced Sciences of Matter 先端物質科学研究科
Minoru Fujishima 藤島　実	Professor 教授	Graduate School of Advanced Sciences of Matter 先端物質科学研究科
Yositake Takane 高根　美武	Professor 教授	Graduate School of Advanced Sciences of Matter 先端物質科学研究科

4. Research Divisions of Research Institute for Nanodevice and Bio Systems (RNBS)

ナノデバイス・バイオ融合科学研究所の研究領域

The Research Institute for Nanodevice and Bio Systems was founded on May 1, 2008, aiming to develop the fundamental technologies necessary to achieve global excellence in electronic and bio integrated sciences for preventive medicine and ubiquitous diagnoses on early stages of illnesses in the future advanced medical-care society beyond the present information society. The research field includes Nanointegration, Integrated Systems, Molecular Bioinformation and Nanomedicine.

ナノデバイス･バイオ融合科学研究所は情報化社会の先にある高度医療保障社会に向けた、予防医学やユビキタス病気早期診断を実現するためのエレクトロニクスとバイオテクノロジーの集積科学基盤技術を開発するグローバルな教育研究拠点を構築することを目的として設立された。研究領域はナノ集積科学、集積システム科学、分子生命情報科学、集積医科学の4つからなる。



Research Divisions
研究領域

4.1 Nanointegration Research Division

ナノ集積科学研究部門

At the Nanointegration Research Division we focus the research on nanodevices, fabrication processes, nanointegration, nano-bio integration devices, photonic devices, nano-quantum devices, thin film devices, nanodevice modeling and functional materials. The outlines of researches at the Nanointegration Research Division are as follows.

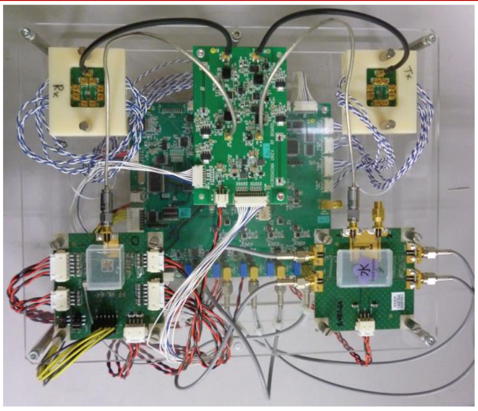
ナノ集積科学研究部門では、ナノデバイス、プロセス、ナノインテグレーション、ナノバイオ融合デバイス、フォトニックデバイス、ナノ量子デバイス、薄膜デバイス、ナノデバイスモデリング、機能性材料等に関する研究を行っている。ナノ集積科学研究部門における研究の主なものの概要を紹介する。

乳がん検出レーダーシステムの開発
Breast Cancer Detection Radar System

教授　吉川　公麿
Prof. Takamaro Kikkawa

インパルス超広帯域電波を使った乳がん検出レーダーシステムプロトタイプ2を開発し、乳がんファントムの共焦点画像に成功した。これにより、大きさ 1cm の乳がん組織は検出可能であることが示された。

A prototype of a breast cancer detection radar system using impulse-radio ultra-wide-band (IR-UWB) was developed. A breast cancer phantom was detected by confocal algorithm. It is confirmed that a 1cm-size breast cancer tissue could be detected by this system.
(International Journal of Antenna and Propagation, 2017)



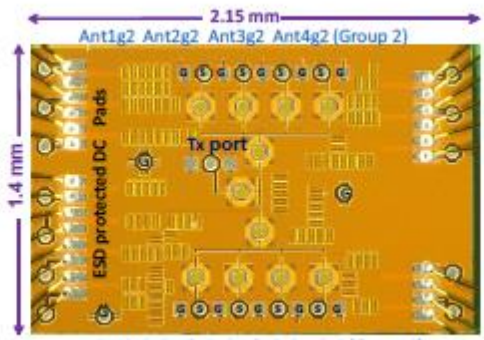
インパルス電波を用いる乳がん検出レーダーシステムのプロトタイプ2
A photograph of a prototype-2 of IR-UWB-based breast cancer detection radar system.

CMOS スイッチングマトリクス回路
CMOS Switching Matrix Circuits

教授　吉川　公麿
Prof. Takamaro Kikkawa

超広帯域インパルス電波を用いた乳がん検出用 65nmCMOS スイッチングマトリクス回路を設計試作した。1 入力8出力のチップ2個で 16 個のアンテナアレイの組み合わせを制御できる。

65 nm CMOS impulse-radio ultra-wide-band switching matrix integrated circuits were designed and fabricated. 2 single-port eight-throw matrix chips can control 16 array antennas.
(Japanese Journal of Applied Physics, 2016)



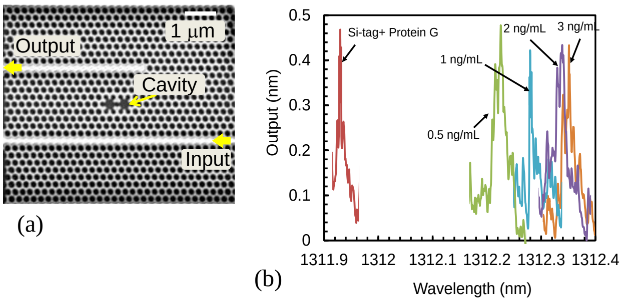
アンテナアレイ制御用 CMOS スイッチングマトリクス回路チップ写真
A photograph of CMOS single-port eight-throw switching matrix circuit.

シリコン光共振器抗原・抗体反応センサー
Antigen-antibody reaction sensor by silicon optical resonators

教授　横山　新
Prof. Shin Yokoyama

家庭で手軽に利用できるバイオセンサーを目的として、シリコンリング及びフォトニック結晶光共振器によるバイオセンサーの研究を行っている．非常に急峻な共振特性をもつダブルキャビティー型フォトニック結晶光共振器を製作し、前立腺特異抗原を実用感度で検出した。

We are studying Si ring and photonic-crystal (PhC) optical-resonator biosensors in order to develop affordable biosensors at home. The PhC crystal double cavity resonators with very sharp resonance characteristics were fabricated and Prostate Specific Antigen (PSA) was detected in the practical sensitivity.



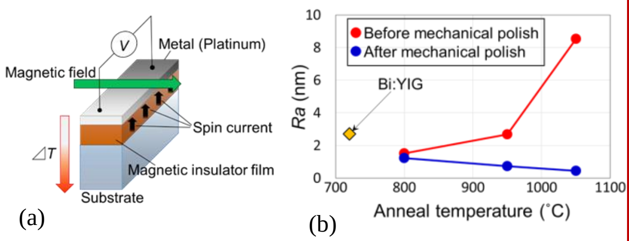
(a) 電子ビームリソグラフィーにより作製したシリコンフォトニック結晶ダブルキャビティー共振器の走査電子顕微鏡写真、(b) 前立腺特異抗原(PSA)検出の例
(a) Scanning electron microscope image of the photonic crystal double cavity resonator fabricated by using electron beam lithography, and (b) resonance spectra for various Prostate Specific Antigen (PSA) concentration.

スピンゼーベック熱電変換素子
Spin Seebeck thermoelectric conversion devices

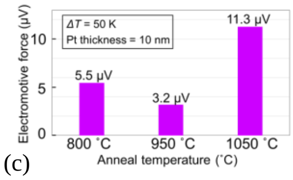
教授　横山　新
Prof. Shin Yokoyama

スピンゼーベック効果は、磁性体中に温度勾配で発生するスピン流を電気に変換するもので、電子の実移動による熱伝導がなく高効率熱電変換が期待されている。我々は、従来のビスマス鉄ガーネットより大きな発電効果が期待されるセリウム鉄ガーネットにおいて、表面平坦性が発電に重要であることを初めて見出した。

Spin Seebeck effect is the conversion effect of thermal spin flow in the magnetic insulator into the electromotive force. High conversion efficiency is expected because of no actual flow of electrons. We have, for the first time, found that the surface smoothness is important in $Ce_1Y_2Fe_5O_{12}$ (Ce:YIG)instead of conventional $Bi_1Y_2Fe_5O_{12}$ (Bi:YIG).



(a) スピンゼーベック素子の構造、(b) アニール温度と研磨前後の表面荒さ、(c) 研磨デバイスの熱起電力とアニール温度の関係



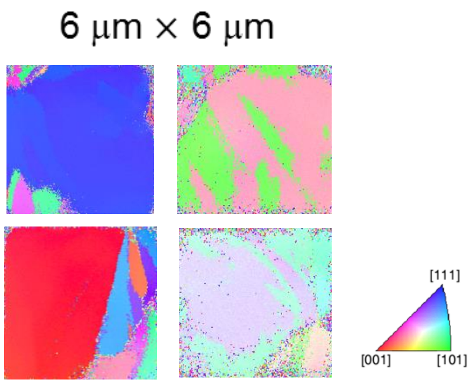
(a) Structure of spin Seebeck device, (b) anneal temperature versus surface roughness of Ce:YIG before and after mechanical polish, and (c) electromotive force versus anneal temperature.

ハイパワー熱プラズマジェットによるアモルファスシリコン薄膜の核生成制御
Nucleation Control in Amorphous Si by Ultra-high Power Thermal Plasma Jet Annealing

教授　東　清一郎（併任）
Prof. Seiichiro Higashi

Ar ガス流量を 18 L/min に増加させることで発生したハイパワー大気圧プラズマジェット照射により、アモルファスシリコンの溶融・結晶化過程における核生成を制御する技術を開発した。急冷による自発核生成を制御することで、孤立パターン内での核生成を 1 回に限定し、単結晶領域を形成可能であることが明らかになった。

Nucleation control during melting and regrowth of amorphous silicon by ultra-high-power atmospheric pressure thermal plasma jet has been investigated. By increasing the cooling rate, spontaneous nucleation in undercooled molten silicon is induced and the single nucleation event in isolated silicon island can be controlled, which enable single-crystalline growth in the island.



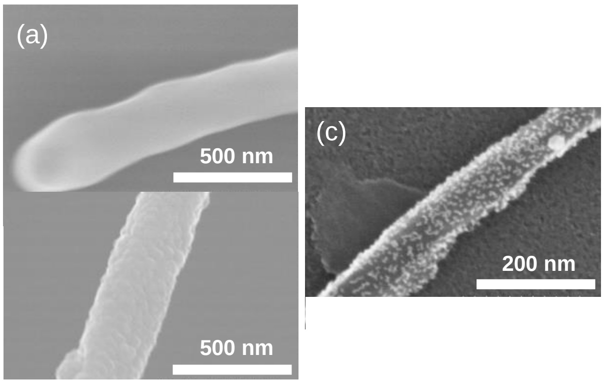
ハイパワー熱プラズマジェットにより結晶化したシリコン孤立パターン(6mm□)の EBSD マッピング
EBSD mapping of thermal plasma jet crystallized silicon islands (6mm□).

ナノ物質の堆積による材料創製と表面汚染
Preparation of Materials and Surface Contamination by Deposition of Nanoobjects

教授　島田　学（併任）
Prof. Manabu Shimada

ナノサイズのクラスター・粒子状物質を合成し、ガス中に浮遊、堆積させて、有用な構造・組成をもつ薄膜、粒子、およびそれらの複合物を創製する研究を行っている。ナノサイズ物質が汚染物質として表面付着したときの影響も検討している。

Preparation of thin-films, particles, and their composites having useful structure and composition is being studied by synthesizing nano-sized clusters and particulate matter suspended in gases and depositing them in the gas phase. The effects of surface deposition of nanoobjects as contaminants are also being investigated.



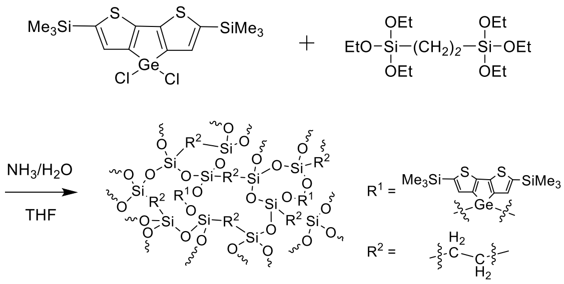
プラズマ中浮遊コーティング法によって多層カーボンナノチューブ表面に形成した薄膜、(a) 酸化シリコン薄膜、(b) 酸化チタン薄膜、(c) 酸化アルミニウム薄膜
Thin films fabricated on the surface of multi-wall carbon nanotubes by 'in-flight' coating technique in plasma. (a) silica thin film; (b) titania thin film; (b) alumina thin film.

14 族元素をベースとした有機電子デバイス材料の設計と合成
Design and Synthesis of Organic Electronic Device Materials Based on Group 14 Elements

教授　大下浄治（併任）Prof. Joji Ohshita

有機電子デバイスの材料の開発を目指して、14 族元素を有する新規な色素を合成し、それらの物性・機能を検討している。

Aiming at developing new materials for organic electronic devices, organic dyes containing group 14 elements are prepared and their properties and functionalities are investigated.



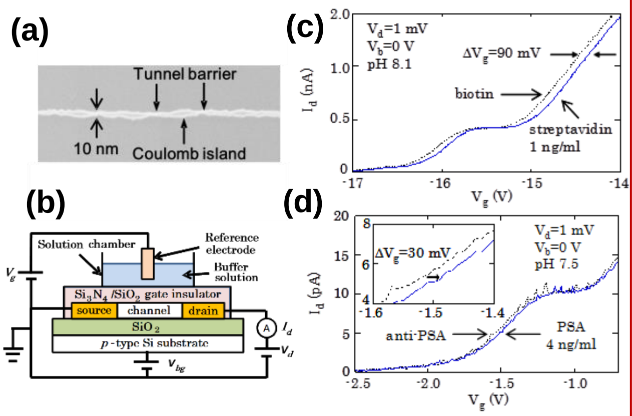
ニトロ芳香族検知用ジチエノゲルモール含有ポリシルセスキオキサン
Dithienogermole-containing polysilsesquioxane films for sensing nitroaromatics.

Si単一電子トランジスタを用いたイオン・バイオ分子検出
Biomolecule and ion detection based on Si single-electron chip

准教授　中島安理
Assoc. Prof. Anri Nakajima

高感度検出のために、Si 単一電子トランジスタ（SET）を用いたバイオ分子やイオンの検出を行っている。SET の室温動作は極めて難しいために、それまで SET を利用したバイオセンサーの報告は無かった。Si 多重ドットチャネル構造を用いて SET の室温動作を実現している。

Biomolecule and ion detection is performed using a Si single-electron transistor (SET) for highly-sensitive detection. Owing to the difficulties in room temperature (RT) operation of SETs, there had been no reports of an SET-based biosensor. A Si multiple-island channel-structure is used for the SET to enable room-temperature operation.



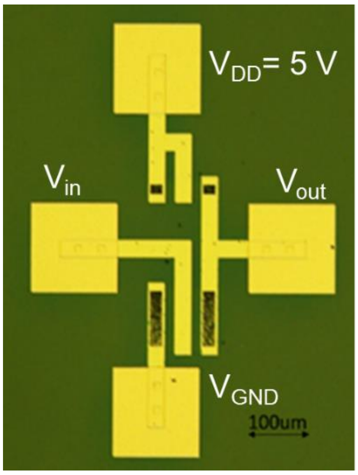
(a) 作製した Si 多重ドットの SEM 像、(b) SET バイオセンサーの構造図、(c) ストレプトアビジン検出における I-V 特性、(d) PSA 検出における *I-V* 特性
(a) SEM image of fabricated Si multiple dots. (b) Schematic diagram of SET biosensor. (c) I-V characteristics for the detection of streptavidin. (d) I-V characteristics for the detection of PSA.

シリコンカーバイド極限環境エレクトロニクス
Silicon Carbide Harsh Environment ElectronicsElectronics

准教授　黒木伸一郎
Assoc. Prof. Shin-Ichiro Kuroki

シリコンカーバイド(SiC)半導体を用いた極限環境用集積回路の研究を進めている。極限環境集積回路用の 4H-SiC MOSFETs を試作し、113 Mrad (1.13MGy)の高ガンマ線曝露後動作および450℃の極高温動作の実証を行った。本研究はスウェーデン王立工科大学、量研機構、およびフェニテックセミコンダクター(株)との共同研究として進めている。

Research on SiC harsh environment electronics has been carried out. 4H-SiC nMOS inverters and pseudo-CMOS inverters were fabricated and demonstrated. And the pseudo-CMOS was operated under high-temperature up to 450°C. This research is carried out under the collaboration with KTH Royal Institute of Technology, Sweden, QST and Phenitec Semiconductor Co. Ltd., Japan.



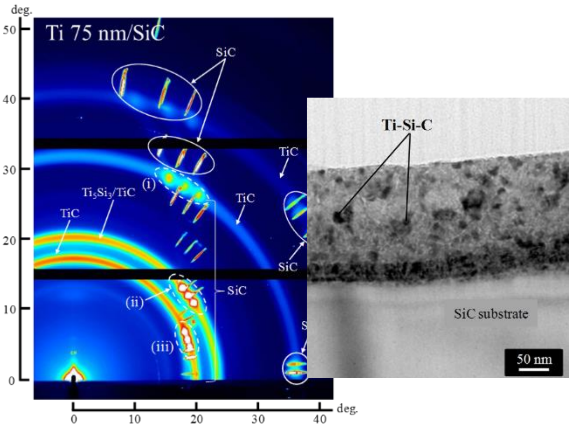
4H-SiC nMOS インバータ
4H-SiC nMOS inverter

シリコンカーバイド・パワー半導体デバイス
Silicon Carbide Power Semiconductor Devices

准教授　黒木伸一郎
Assoc. Prof. Shin-Ichiro Kuroki

シリコンカーバイド(SiC)パワー半導体デバイスの研究・開発を進めた。1kV 級パワーデバイスの設計・開発を進めるとともに、特に低抵抗化の要となる金属/SiC 間接触において、Ti-Si-C 電極を形成し、高効率パワー半導体デバイスを実現した。本研究はフェニテックセミコンダクター(株)、および住友重機械工業(株)との共同研究として進めている。

1kV SiC power devices had been developed and research on ohmic contact between silicide and SiC, which was critical element for low resistance, was carried out. This research has been carried out under the collaboration with Phenitec Semiconductor Co. Ltd., and Sumitomo Heavy Industries Ltd, Japan.



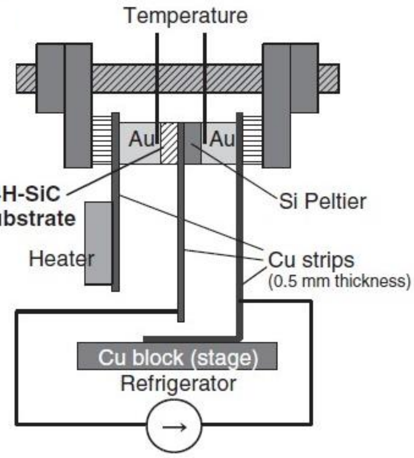
4H-SiC 上の低抵抗 Ti-Si-C 電極の 2D-XRD と TEM 断面像
Low-resistance Ti-Si-C electrodes on 4H-SiC

車載用パワーモジュールのための半導体吸熱素子の研究
Heat Transfer Module for Automobiles

准教授　黒木伸一郎
Assoc. Prof. Shin-Ichiro Kuroki

車載用の吸熱構造付き SiC パワー半導体デバイスと冷却モジュールの融合デバイスを実証し、その試作と通電試験から、熱移動効果の発現を確認し、 またパワーデバイス吸熱デバイスの技術コンセプトを構築した。この研究は NEDO 国立研究開発法人新エネルギー・産業技術総合開発機構の「未利用熱エネルギーの革新的活用技術研究開発プロジェクト」受託研究として進めている。

Heat transfer device with 3-D integration of 4H-SiC-based Schottky barrier diodes and Si-based film Peltier device, separated by intrinsic SiC layer, was realized by using conventional Si-based process flow. This research is carried out under TherMAT in New Energy and Industrial Technology Development Organization (NEDO) of Japan.



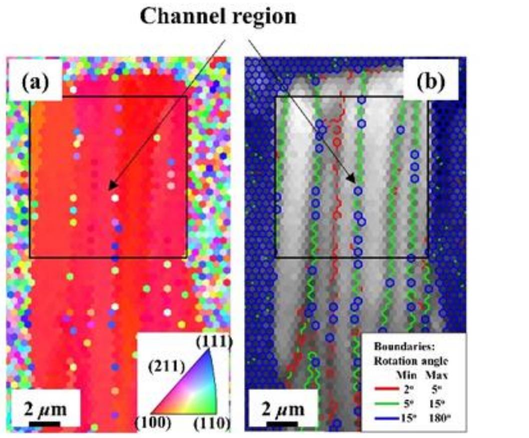
熱電効果の評価システムの概略図
Schematic of an apparatus for thermoelectric effects

連続発振レーザ結晶化による高性能薄膜トランジスタ
Multi-Line Beams CLC and Poly-Si TFTs

准教授　黒木伸一郎
Assoc. Prof. Shin-Ichiro Kuroki

マルチラインビーム連続発振レーザ結晶化により、(100)面方位に制御した多結晶シリコン薄膜を形成に成功した。このシリコン薄膜を用いて 1010 cm^2/Vs の高電子移動度 TFT を実現した。この結果は APEX 誌で発表し、また iMID2017 で招待講演を行った。

Poly-Si thin films with (100) crystal grains were successfully fabricated by continuous-wave laser lateral crystallization with double-line beam, and its high-performance TFT with electron mobility of 1010 cm^2/Vs was also demonstrated.



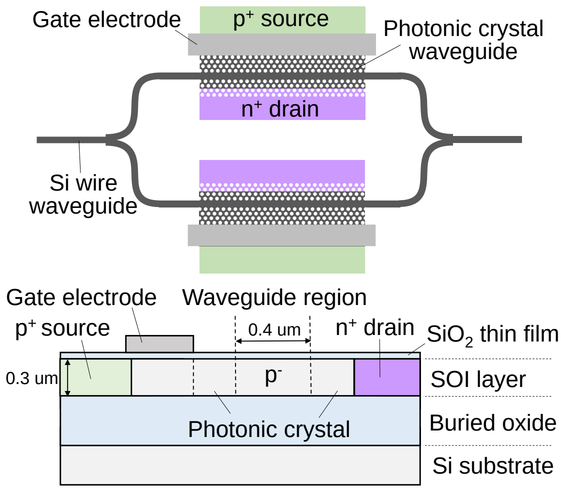
作製した TFT のチャネル部の電子線後方散乱回折マッピング像
EBSD mapping of poly-Si TFT's channel region

トンネル電界効果トランジスタを用いた極低電圧シリコン光変調器の研究
Ultralow drive voltage Si optical modulator using tunnel field-effect transistor

准教授　田部井哲夫(特任)
Assoc. Prof. Tetsuo Tabei

低電圧でのスイッチングが可能なバンド間トンネル型電界効果トランジスタを位相変調器として利用した、極低電圧で駆動するマッハツェンダ型シリコン光変調器の研究を行っている。

We study a Mach-Zehnder type silicon optical modulator driven by an extremely low voltage using a band-to-band tunneling field effect transistor that can switch at low voltage as a phase shifter.



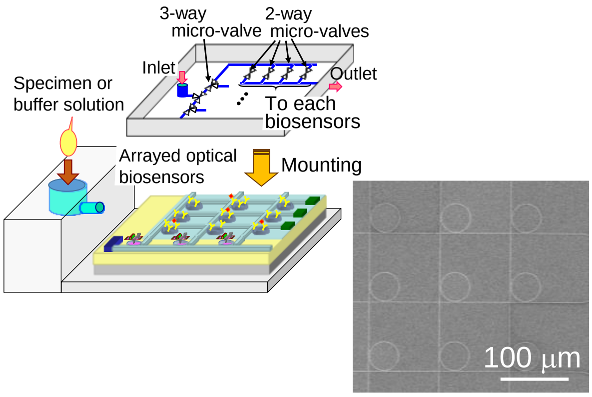
提案する光変調器の上面及び断面構造
Schematic of top and cross-sectional structure of the proposed optical modulator.

多項目検出 MEMS 光バイオセンサー
Multiple-item detection optical biosensor

助教　雨宮嘉照(特任)
Assist. Prof. Yoshiteru Amemiya

多項目検出バイオセンサーチップの開発を目的として、シリコンフォトニクス技術を用いた光バイオセンサーの集積化チップの作製および小型で低電圧動作が可能なマイクロ電子機械システム(MEMS) 型のバルブを付加させた流路の研究を行っている。

For a development of multiple-item detection biosensor chips, we study the fabrication of arrayed optical biosensors using silicon photonics technology and small-size Micro-Electro-Mechanical-Systems (MEMS) valves with low-voltage operation.



提案している多項目検出光バイオセンサーチップの概略図とアレイ化した光バイオセンサーの SEM 像
Schematic of the proposed multiple-item detection optical biosensor chip and SEM image of arrayed optical biosensors.

4.2 Integrated Systems Research Division

集積システム科学研究部門

The Integrated Systems Research Division focuses on basic research for terabit-capacity highly-functional memories, super-parallel processing, bio-sensing, wireless interconnection and 3-dimensional integration. With the obtained results we aim at the realization of artificial-brain technology exceeding humans in intelligent-processing speed, storage capacity and adaptive learning. The outlines of researches at the Integrated Systems Research Division are as follows.

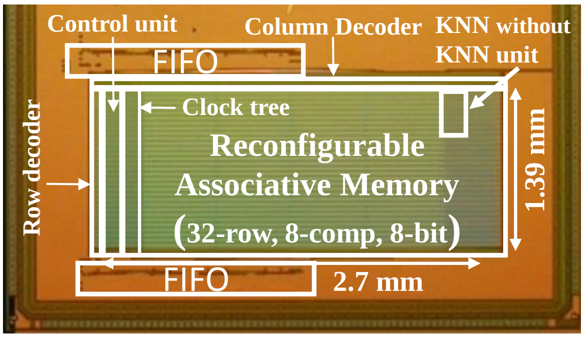
集積システム科学部門では、テラビット容量と高機能メモリ、超並列演算、バイオセンシング、無線インタフェース、3次元集積に関する基盤研究を推進している。そして、これらの基盤技術を用いて、人間の脳より速い認知処理、大規模な記憶容量、環境に適応する学習機能を有する集積ブレインの実現を目指す。集積システム科学部門における研究プロジェクトの主なものの概要を紹介する。

機能メモリの設計及び応用
Functional Memories and their Application

教授　マタウシュ ハンスユルゲン
Prof.　Hans Jürgen Mattausch

高速検索かつ超低消費電力を有するデジタル連想メモリ及び任意のアプリケーションを実装できる人工知能システムの研究開発。

Research and development on high-speed-searching digital associative memory with ultra-low power consumption and on artificial intelligence systems with capability to implement any arbitrary application.



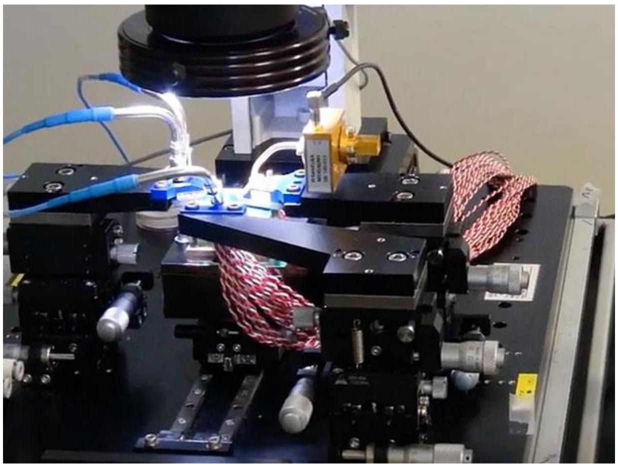
統合された KNN クラシファイア、設定可能な並列性およびデュアルストレージスペースを備えた柔軟性の高い最近接検索連想メモリ
Highly flexible nearest-neighbor-search associative memory with integrated KNN classifier, configurable parallelism and dual-Storage Space.

テラヘルツ波デバイス基盤技術の研究
Study on Fundamental Technologies for Terahertz-Wave Devices

教授　藤島 実（併任）
Prof. Minoru Fujishima

私たちは、ミリ波からテラヘルツ波まで含む超高周波 CMOS デバイスの研究を行っている。すでに実用化されている 79GHz 帯車載レーダーの CMOS 化や 100Gbps を超える通信速度を可能にする 300GHz 帯通信の研究を行っている。

We are studying ultra-high-frequency CMOS devices covering millimeter-wave to terahertz band. Current interests are CMOS devices for 79GHz-band automotive radars and 300GHz-band transceivers enabling near-fiber-optic speed wireless link.



105Gbps 300GHz 帯 CMOS 送信器の実験
Experiment of 105 Gbps 300 GHz band CMOS transmitter.

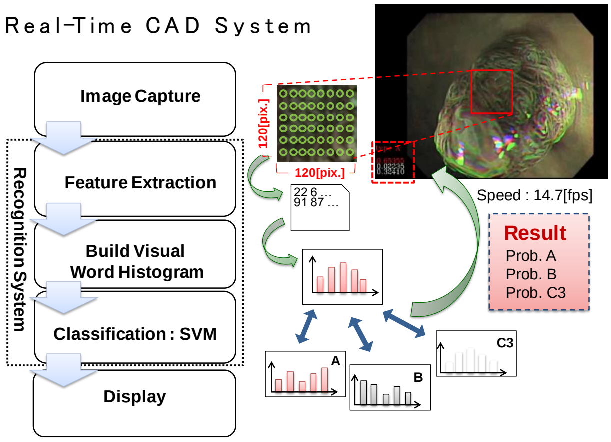
大腸 NBI 拡大内視鏡映像のリアルタイム診断支援プロトタイプシステムの構築

Development of a Real-time Colorectal Tumor Classification System for Narrow-band Imaging zoom-video-endoscopy

准教授　小出哲士　Assoc. Prof. Tetsushi Koide

大腸癌は全世界的にも最もよく認められる癌の1つであり、日本でも年々増加傾向にあるが、大腸癌は、初期段階で発見し適切な治療を行うことで、完治が望める疾患であるため、内視鏡診断が非常に重要である。我々が開発している大腸癌の認識 CAD システムは、内視鏡から出力される映像を直接キャプチャし、大腸 NBI 拡大内視鏡画像をリアルタイムで診断支援することができる。実際に広島大学病院にて、臨床試験も行った。

Colorectal endoscopy is important for the early detection and treatment of colorectal cancer and is used worldwide. A computer-aided diagnosis (CAD) system that provides an objective measure to endoscopists during colorectal endoscopic examinations would be of great value. Our system captures the video stream from an endoscopic system and transfers it to a desktop computer. The captured video stream is then classified by a pretrained classifier and the results are displayed on a monitor. The experimental results show that our developed system works efficiently in actual endoscopic examinations and is medically significant.



大腸 NBI 拡大内視鏡映像のリアルタイム診断支援プロトタイプシステムの概要
Overview of the Development of a Real-time Colorectal Tumor Classification System for Narrow-band Imaging zoom-video-endoscopy. https://arxiv.org/abs/1612.05000v2.

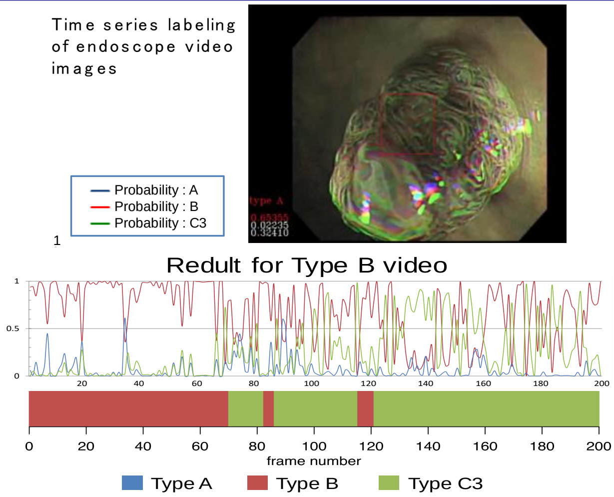
リアルタイム大腸 NBI 拡大内視鏡診断支援のための動画像の平滑化手法の開発

Development of Stable Endoscopic Video-frame Recognition in Real-Time Computer-aided Diagnosis for Narrow-Band imaging of Magnifying Colonoscopy

准教授　小出哲士　Assoc. Prof. Tetsushi Koide

内視鏡による動画像のリアルタイム診断支援が必要不可欠である。そこで、我々が開発しているリアルタイム大腸 NBI(Narrow Band Imaging) 拡大内視鏡診断支援システムを、動画像に適用するために、各フレームにおける事後確率出力をパーティクルフィルタの尤度に用いることで、時系列データの平滑化を行う手法を提案し、実動画像を用いた実験により、安定した認識結果を得ることを確認した。

A real-time diagnosis support of endoscope video is indispensable. Therefore, in order to apply our real-time computer-aided diagnosis (CAD) support system to the videos, by using the posterior probability output in each frame as the likelihood of the particle filter. We proposed a method to smooth time series data and confirmed that stable recognition results are obtained by experiments using actual video data.



動画像の平滑化手法の適用例
Example of a Stable Endoscopic Video-frame Recognition.

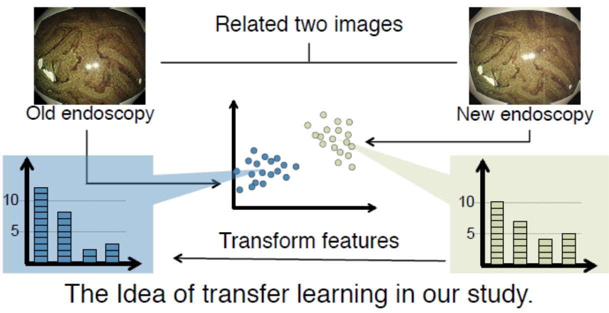
大腸内視鏡画像認識のための転移学習手法

Transfer Learning for Endoscopic Image Classification

准教授　小出哲士
Assoc. Prof. Tetsushi Koide

近年、大腸内視鏡の進歩はめざましく、最新の内視鏡と旧世代の内視鏡では視野、明るさ、コントラストなどの性能が向上している。この様なアップデートは機械学習をベースとしたコンピュータ診断支援システムにとって、学習画像データベースの再収集を必要とするため、診断支援システムの更新に高いコストを必要とする。そこで本研究では転移学習の枠組みを用い、旧世代の内視鏡で用いられた学習画像データベースを再利用することで最新の内視鏡の学習画像データベース構築のコストを低減する手法を提案した。

Recent advances in colonoscopy are remarkable, and performance of the latest endoscope and old generation endoscope is improved such as field of view, brightness, contrast, etc. Such an update requires a high cost for updating the computer-aided diagnosis (CAD) system because it requires re-collection of the learning image database for a computer diagnosis support system based on machine learning. In this research, we proposed a method to reduce the cost of building the latest endoscopic learning image database by reusing the learning image database used in the old generation endoscope using the framework of metastasis learning.



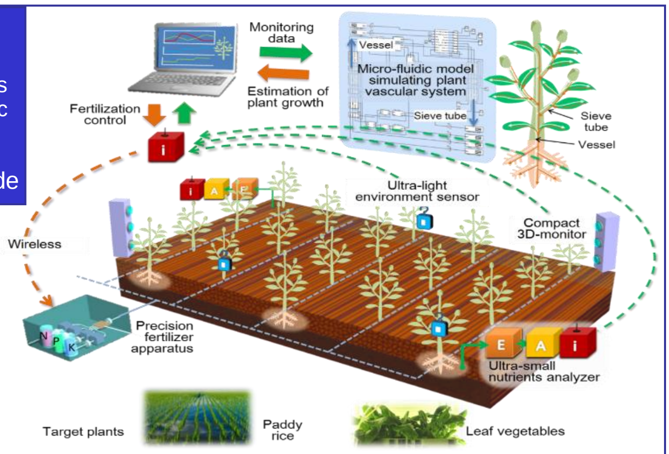
転移学習を用いた大腸 NBI 拡大内視鏡診断支援の概念
A Concept of Transfer Learning for Endoscopic Image Classification.
An example of appearance difference of different endoscope systems. (a) An image taken by an older system (video system center: Olympus EVIS LUCERA CV-260, endoscopy: Olympus OLYMPUS EVIS LUCERA CF-H260AZL/I). (b) An image of the same scene taken by an newer system (video system center: Olympus EVIS LUCERA ELITE CV-290, endoscope: OLYMPUS EVIS LUCERA ELITE CF-HQ290ZL/I).

フィールド向け頑健計器と作物循環系流体回路モデルによる形質変化推定技術の研究
Development of plant growth estimation technologies combined with robust field monitors and micro-fluidic model simulating plant vascular system

准教授　小出哲士　Assoc.Prof. Tetsushi Koide

長期間、作物の近傍に設置して、作物の栄養の吸収や作物周辺の環境（光、温湿度、CO2等）を逐次観測することのできる小型の計器類と、それと連動して動く、作物体内の水分や養分などの循環の状態を予測する作物体内循環系流体回路モデルを作成し、肥料添加や作物周辺環境が、その成長にどのように影響していくかを推定する技術を開発をしています。（JST CREST Project）

We are going to develop an ultra-small nutrients analyzer, a compact 3D-monitor (shape, color, etc.), and an ultra-light environment sensor (light intensity, temperature, humidity, CO2, etc.), which can be installed near plants. Accordingly, plant growth estimation technologies based on micro-fluidic circuit model simulating plant vascular system are being developed. (JST CREST Project)



フィールド向け頑健計器と作物循環系流体回路モデルによる形質変化推定技術の概要
Overview of Development of plant growth estimation technologies combined with robust field monitors and micro-fluidic model simulating plant vascular system.
https://www.jst.go.jp/kisoken/crest/en/project/1111090/15666253.html

4.3　Molecular Bioinformation Research Division
分子生命情報科学研究部門

Molecular Bioinformation Research Division is specialized in the research for MEMS (Micro Electro Mechanical Systems), immobilization of bio molecule, bio-sensing technology, and environmental monitoring. The outlines of researches at the Molecular Bio-information Research Division are as follows.

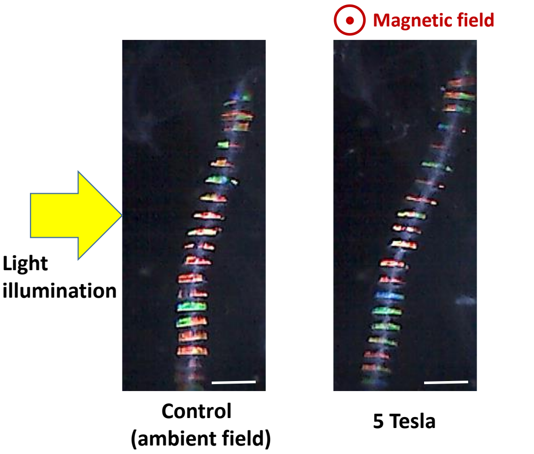
分子生命情報科学研究部門は、MEMS、バイオ分子固定、バイオセンシング、環境情報センシングに関する研究を行っている。分子生命情報科学研究部門における研究の主なものの概要を紹介する。

新たな磁気応答バイオリフレクターの探索
Exploring new magnetically responsible Bio-reflectors

教授　岩坂正和
Prof. Masakazu Iwasaka

生体が有する光制御技術を模倣する新たなるバイオミメティクスの開拓のため、海洋生物の構造色パーツの磁気応答の検証を進めた。今年度は、クシクラゲの櫛板の構造色の磁場中観察系を構築した。細胞内骨格タンパクと同じ成分の光制御を評価した。

A new biomimicry for light control in living system was explored. Magnetic responses in structural colors of living creatures in sea were investigated. In this year, we developed a in-situ observation system under magnetic field for the structural colors in cilia plate of comb jelly fish which has a same protein with cytoskeleton.



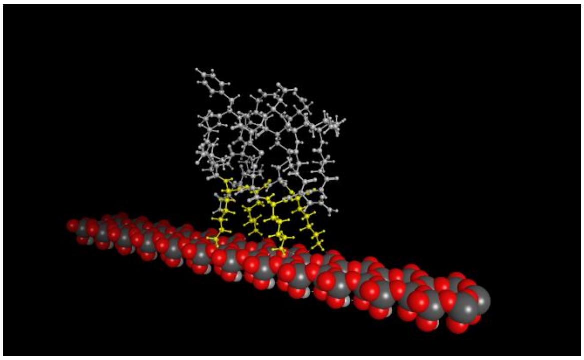
クシクラゲの櫛板における構造色の発現
Structural color in cilia plate of comb-jelly.

シリコンとバイオの界面制御の研究
Interface technology between silicon and biomolecules

教授　黒田章夫（併任）
Prof. Akio Kuroda

Si デバイスの表面に、活性を保ったままバイオ分子を固定化する技術は新しい半導体バイオセンサーの開発に必要である。平坦な表面構造を有するタンパク質分子を改変して、Si との親和性が高いアミノ酸を平面状に配置することで、新規の Si 結合タンパク質の開発を進めている。

The ability to target proteins to specific sites on a Si device while preserving their functions is necessary for the development of new biosensors. We are developing a novel Si-binding protein by engineering a protein to display amino acids with affinity for Si on the flat surface.



作製した Si 結合タンパク質の結合モデル図
平面状に配置したアミノ酸(黄色)が Si 表面と相互作用する
Molecular model of the Si-binding protein.

Si 結合ペプチドの発見とタンパク質固定化への利用

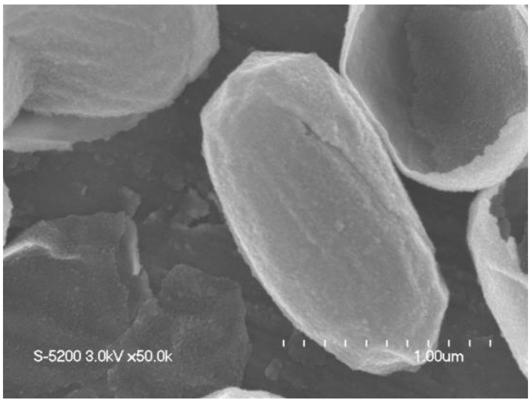
Application of Si-binding peptides for protein immobilization on Si materials

助教　池田　丈（併任）

Assist. Prof. Takeshi Ikeda

細胞内に SiO_2 を蓄積する土壌細菌 *Bacillus cereus* より、14 残基のアミノ酸からなる新規の Si 結合ペプチドを取得した。本ペプチドを接着分子として利用することで Si 表面上に任意のタンパク質分子を固定化できるため、新たな半導体バイオ融合デバイスの開発が可能となると期待される。

We found a novel Si-binding peptide of 14 amino acids from a soil bacterium *Bacillus cereus*, which accumulates SiO_2 in the cell. Because of its small size and high affinity for Si, this peptide should be a powerful tool for developing Si-based biodevices.



B. cereus が形成した殻状 SiO_2 構造体の SEM 像

SEM image of a shell-shaped SiO_2 structure isolated from *B. cereus*.

4.4 Nanomedicine Research Division

集積医科学研究部門

Nanomedicine Research Division is specialized in the research for integration between medicine and nanotechnology, nanomedicine, nanodentistry, nano-pharmacy. The outlines of researches at the Nanomedicine Research Division are as follows.

集積医科学研究部門では、ナノメディシン、ナノデンティストリー、ナノファーマシー等、医療とナノ技術の融合研究を行っている。現在行われている集積医科学研究部門における研究の主なものの概要を紹介する。

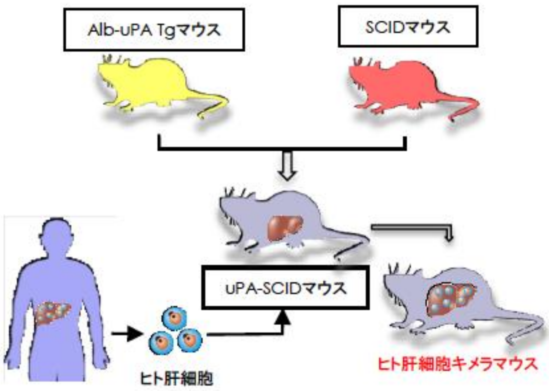
ウイルス性肝疾患に関する研究
Research on hepatitis viruses and liver disease

教授　茶山一彰（併任）
Prof. Kazuaki Chayama

B 型あるいは C 型肝炎ウイルスの増殖機構とその制御に関する研究を行っている。マウス肝臓が高度にヒト肝細胞に置換されたヒト肝細胞キメラマウスは肝炎ウイルス感染モデルとして有用であり、培養細胞株を用いた reverse genetics による研究も可能である。またウイルス性肝炎の病態に関与する SNPs および肝臓癌のゲノム解析も行っている。

We are currently investigating hepatitis B and C viruses virology and developing treatment against these viruses using human hepatocyte chimeric mouse, which enables us to perform reverse genetics of hepatitis viruses.

We are also analyzing SNPs and cancer genomes associated with viral hepatitis.



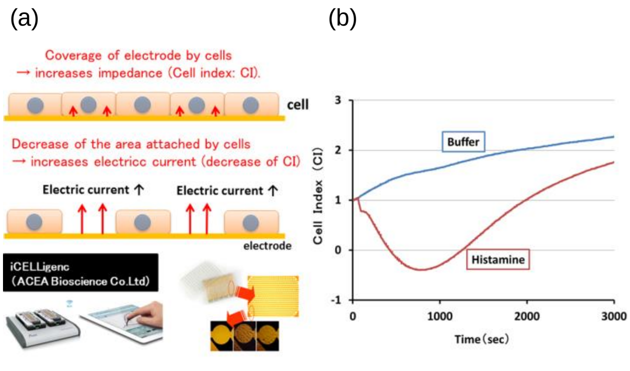
ヒト肝細胞キメラマウス
Humna hepatocyte chimeric mouse

インピーダンスセンサによるリアルタイム血管透過性評価法の開発
Real-time monitoring of vascular permeability by impedance sensor

教授　秀　道広（併任）
Prof. Michihiro Hide

インピーダンスセンサの電極上にヒト血管内皮細胞を培養し、刺激に伴う細胞間隙の変化（血管透過性の変化に相当）をリアルタイムに評価可能な手法を開発した。さらに本手法を利用して、ヒスタミン等の血管透過性を高める物質の影響をモニタリングすることに成功した。

We developed a technique to monitor the permeability of vascular endothelial cells cultured on the electrode of impedance sensor. We could evaluated the effect of molecules, such as histamine, on the change of vascular permeability.



(a) インピーダンスセンサによる透過性評価法の原理と、
(b) ヒスタミンの血管透過性への影響評価チップ
(a) Principle of real-time permeability analysis by impedance sensor. (b) Effect of histamine on the change of vascular permeability.

L8020乳酸菌のバクテリオシン

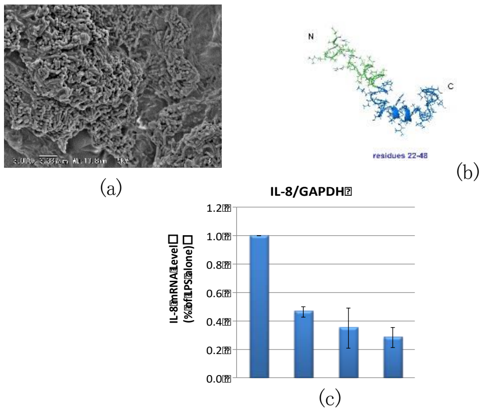
Bacteriocin derived from *L. rhamunosus* L8020

教授　二川浩樹（併任）

Prof. Hiroki Nikawa

虫歯・歯周病を抑制する L8020 乳酸菌のバクテリオシン Kog1 には、抗菌作用だけでなく、歯周病菌の内毒素 LPS を不活性化させる作用がある。

Kog1, a bacteriocin produced by *L. rhamunosus* L8020 which suppress both cariogenic bacteria and periodontal burdens in oral cavity, inactivate the LPS produced by periodontal burdens.



L8020 乳酸菌(a)のバクテリオシン Kog1(b)は、歯周病菌の内毒素 LPS を不活性化させる作用がある(c)

Kog1(b), a bacteriocin produced by *L. rhamunosus* L8020 (a) inactivate the LPS produced by periodontal burdens (c).

上皮間葉相互作用解析プラットフォーム

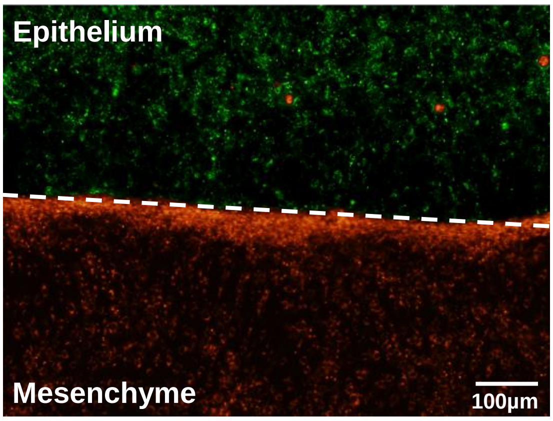
Cell culture platforms for analyzing epithelial-mesenchymal interactions

教授　加藤 功一（併任）

Prof. Koichi Kato

複雑な構造をもつ組織や器官の発生機序を理解するには、上皮間葉相互作用に基づく形態形成過程について深く理解することが重要である。我々は、抗体の 2 次元ディスプレイ法を確立し、異種細胞の相対位置を制御しながら共培養することを可能にした。この方法を用いて、歯の発生過程の再現を試みている。

A microfabrication method has been utilized to establish co-culture of epithelial and mesenchymal cells in a spatially-controlled manner on a single substrate. This co-culture system is used to duplicate *in vitro* an early step toward tooth development.



上皮細胞（緑）と間葉細胞（赤）の境界部に、歯の発生初期にみられる細胞凝集と類似した構造形成が観察された

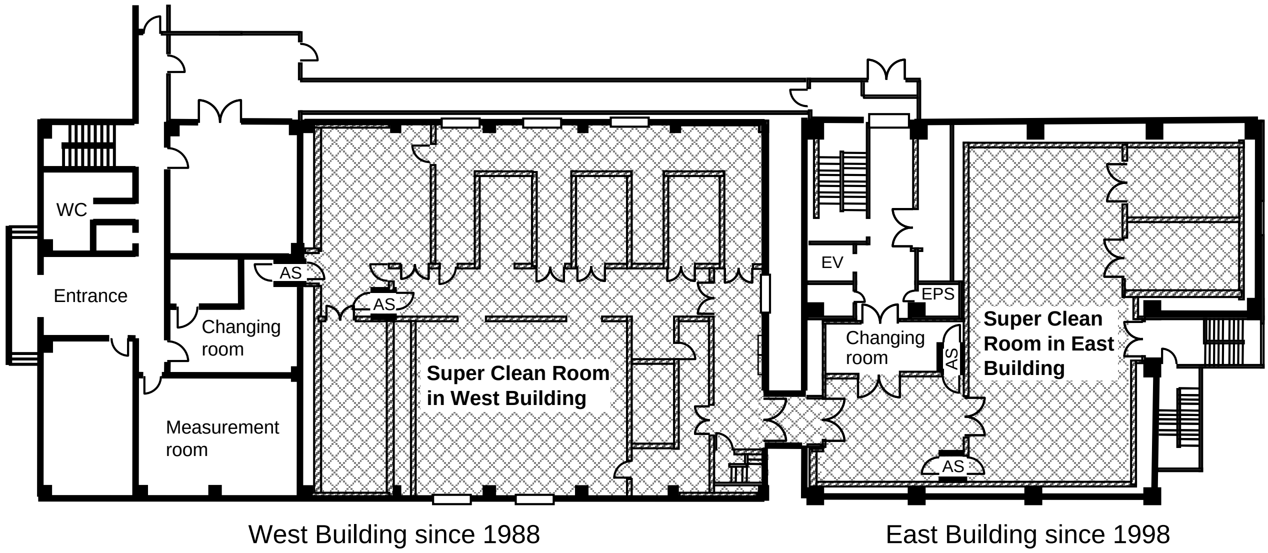
The formation of cell aggregates observed at the epithelial-mesenchymal border (dotted line) seem to mimic the “condensation” process seen in tooth development.

5. Research Facilities of RNBS
研究設備

5.1 Super clean rooms
スーパークリーンルーム

Super clean rooms, partly class 10 at 0.1-μm particles, are used for fabrication of advanced devices and LSI's.

先端デバイス及び LSI の製作はスーパークリーンルームで行われる。最も清浄度の高いセクションはクラス 10（1 立方フィート内に 0.1μm 以上の粒径の粒子が 10 個以下）である。



Plan view of clean rooms in west and east buildings. The total clean room area measures 830 m^2. Chemical filters are set in the east clean room to avoid hazardous gases.

西棟及び東棟クリーンルーム平面図。クリーンルーム総面積は 830m^2。東棟クリーンルームには危険ガス除去用のケミカルフィルターが設置されている。

Super clean room in west building.
西棟スーパークリーンルーム

Super clean room in east building.
東棟スーパークリーンルーム

5.2 Equipment for advanced devices and LSI fabrication

先端デバイス及びLSI作製のための設備

5.2.1 Lithography

リソグラフィー

◆ Variable rectangular-shaped electron beam lithography system (Hitachi HL700DII)

可変成形型電子ビーム描画装置
（日立　HL700DII）Resolution 50nm

◆ Point-beam type electron beam lithography system (JEOL JBX-5DII)　Resolution 50 nm

ポイントビーム型電子ビーム描画装置
（日本電子　JBX-5DII）Resolution 50nm

◆ Point-beam type electron beam lithography system (ELIONIX ELS-G100)

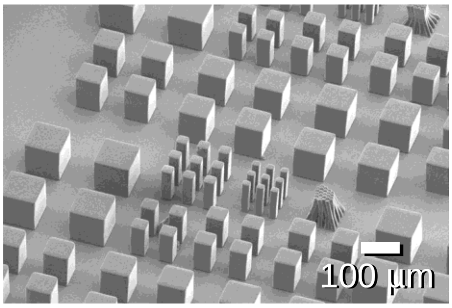
ポイントビーム型電子ビーム描画装置
（エリオニクス　ELS-G100）Resolution 6nm

◆ i-line optical stepper (Nikon NSR i8a)

i-線ステッパー
（ニコン　NSR i8a）Resolution 350nm

◆ Maskless photolithography system (Nanosystem Solutions D-light DL-1000)

マスクレス露光装置（ナノシステムソリューションズ　D-light DL-1000）　Resolution 1μm



Photoresist patterns by D-light DL-1000.
D-light DL-1000によるレジストパターン

5.2.2 Dry etching
ドライエッチング

◆ ICP (Inductively Coupled Plasma) etcher for Si (YOUTEC)

Si用ICP（誘導結合プラズマ）エッチング装置（ユーテック） Cl_2, HBr, N_2, O_2 使用可能

◆ ECR (Electron Cyclotron Resonance) etchers for Si (KOBELCO)

Si用ECR（電子サイクロトロン共鳴）エッチング装置（神戸製鋼） Cl_2, BCl_3, HBr, N_2, O_2 使用可能

◆ Si deep etching system (Sumitomo Precision Products)

Si用深堀りエッチング装置（住友精密工業） C_4F_6, SF_6, Ar 使用可能

◆ ICP etcher for highly selective etching of SiO_2 (AYUMI INDUSTRY)

SiO_2用ICPエッチング装置（アユミ工業） CF_4, H_2, O_2, Ar 使用可能

◆ ICP etcher for SiO_2 (SAMCO)

SiO_2用ICPエッチング装置（サムコ） CF_4, H_2, O_2, Ar 使用可能

◆ RIE (Reactive Ion Etching) system for SiO_2 (KOBELCO)

SiO_2用RIE(反応性イオンエッチング)装置（神戸製鋼） CF_4, H_2, O_2 使用可能

◆ ICP etcher for Al
(YOUTEC)

Al用ICPエッチング装置
（ユーテック）Cl_2, BCl_3, N_2 使用可能

◆ Magnetron RIE system for Al
(KOBELCO)

Al用マグネトロンRIE装置
（神戸製鋼）Cl_2, BCl_3, N_2 使用可能

◆ Chemical dry etching system for
Si_3N_4 and poly-Si (KOBELCO)

Si_3N_4及びSiO_2用ケミカルドライエッチング装置
（神戸製鋼）CF_4, N_2, O_2 使用可能

◆ Plasma asher for removing
photoresist (KOBELCO)

レジスト除去用プラズマアッシング装置
（神戸製鋼）N_2, O_2 使用可能

エッチング装置メンテナンス作業風景

During maintenance of dry etcher

酸化・拡散炉キャリア搬送風景

Wafer loading into furnace

5.2.3 Oxidation, annealing, and doping
酸化、アニール、不純物注入

◆ Oxidation and diffusion furnaces
(Tokyo Electron)

酸化･拡散炉
(東京エレクトロン) Max. Temp. 1150℃


◆ Ion implanter
(ULVAC)

イオン注入装置　Max 200 keV
(アルバック)　B, As, P 等注入可能

◆ RTA (Rapid Thermal Annealing) system
(Samco HT-1000)

高速熱処理装置
(サムコ　HT-1000) Max. Temp. raise rate 200℃/s

◆ Phosphorus diffusion furnaces
(SHINKO SEIKI)

リン拡散炉
(神港精機) Max. Temp.　900℃

◆ Annealing furnaces for general purpose
(Koyo Thermo System)

汎用熱処理装置 H_2, N_2, O_2, Low Pressure
(光洋サーモシステム) Max. Temp.　1000℃

酸化炉講習風景
Training of oxidation

5.2.4 Dielectric film deposition and epitaxial growth

絶縁膜堆積・エピタキシャル成長

- Low-pressure chemical vapor deposition (CVD) reactors for SiO_2, SiN, poly-Si (Tokyo Electron)

減圧CVD（化学気相成長）炉 (東京エレクトロン)
SiO_2, SiN, poly-Si堆積可能

- Atmospheric pressure CVD reactor for SiO_2 Doping of P and B possible (AMAYA)

SiO_2堆積用常圧CVD装置
(天谷製作所)　PおよびBドープ可能

- Parallel plate type clean plasma CVD reactor for SiN, SiO_2, and amorphous Si (ULVAC)

平行平板型プラズマCVD装置 (アルバック)
SiN, SiO_2, アモルファスSi 堆積可能

- Molecular beam epitaxial growth system for GaAs and AlGaAs: Si, Be doping possible (EIKO)

分子線エピタキシャル成長装置
(エイコー)　GaAs 等堆積可能

- Atomic layer CVD (ALCVD) reactor for SiN (Thermo Riko)

原子層CVD炉
(サーモ理工)　SiN 堆積可能

常圧CVDウェハセッティング風景

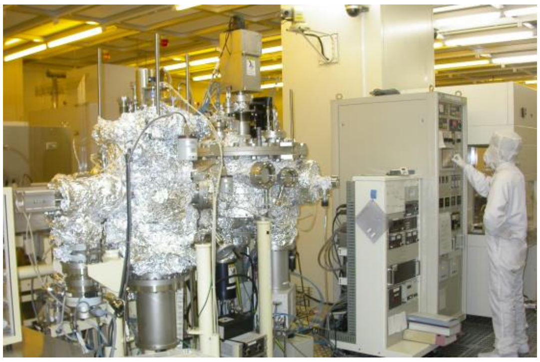
Wafer setting to atmospheric CVD reactor

5.2.5 Metal deposition

金属薄膜堆積

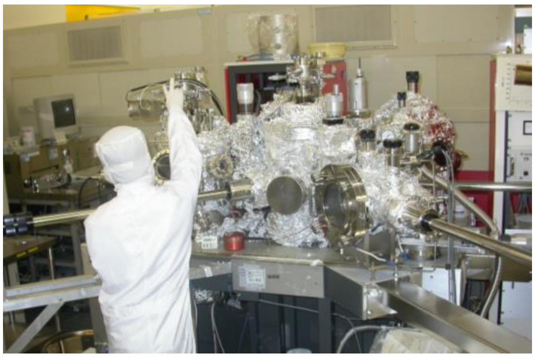
◆ Metal/dielectrics sputtering system for BiSrTiO compound etc. (ULVAC)

金属/絶縁膜スパッタリング装置 (アルバック)
BiSrTiO等堆積可能



◆ Sputtering machine for metal interconnects for Al, Ti, TiN (EIKO)

金属配線用スパッタリング装置 (エイコー)
Al, Ti, TiN 堆積可能



◆ Electron beam evaporation system for many kinds of metals (EIKO)

電子ビーム蒸着装置
(エイコー) 多種材料堆積

◆ Sputtering system for general purpose for variety materials (EIKO)

汎用スパッタ装置
(エイコー) 広範な材料堆積

◆ Vacuum evaporation system for variety of metals (Donated: RICOH)

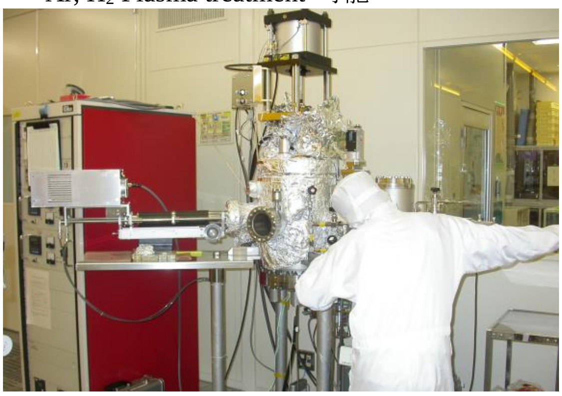
真空蒸着装置
(寄贈:リコー) Al 等堆積可能

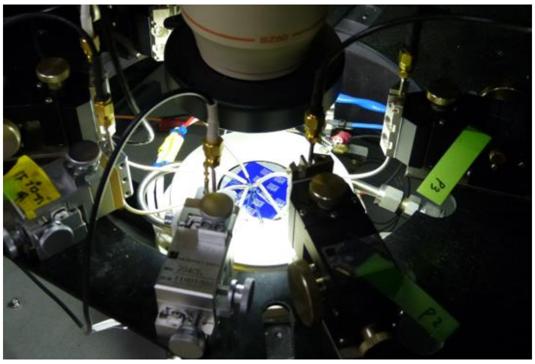
5.2.6 Others

その他

◆ Surface-activated bonding system (EIKO)

表面活性化接合装置 (エイコー)
Ar, H_2 Plasma treatment 可能





マニュアルプローバーによる電気特性測定

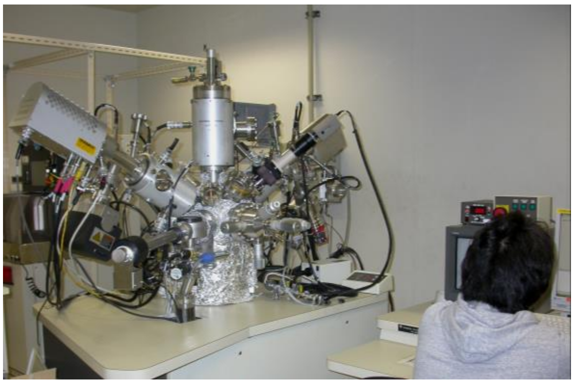
Measuring electrical properties using manual prober

5.3 Characterization and diagnostics equipment

評価・分析装置

◆ Secondary ion mass spectroscopy (SIMS) system with Cs and O ion gun (ULVAC-PHI PHI-6650)

2次イオン質量分析装置（アルバック-ファイ PHI-6650） Cs, Oガン装備



◆ Total reflection of X-ray fluorescence spectrometer (Technos TREX-610)

全反射蛍光X線分析装置（Technos TREX-610）
感度(Cr-Zn)　10^{10} atom/cm^2

◆ Fourier-transform infrared spectrometer (FTIR) (JEOL)

フーリエ変換赤外分光光度計
（日本電子）Resolution 0.5cm^{-1}

◆ Atomic force microscope (AFM) (Seiko Instruments Inc. SPI3800)

原子間力顕微鏡（セイコーインスツルメンツ SPI3800）Resolution Z:0.01nm, X, Y:0.1nm

◆ High resolution X-ray diffractometer (Rigaku ATX-E)

高解像度X線回折装置
(リガク　ATX-E) Angle resolution 0.0002°

◆ X-ray diffractometer (Rigaku RINT2100)

X線回折装置
(リガク　RINT2100)

- ◆ Ellipsometer
  (Rudolph Research Auto EL)

エリプソメーター（ルドルフリサーチ Auto EL）
Measurable thickness > 10nm

- ◆ Spectroscopic ellipsometer
  (J.A.Woollam JAPAN M-2000D)

分光エリプソメーター（ジェー・エー・ウーラム・ジャパン M-2000D）Measurable thickness > 10nm

- ◆ Hall effect measurement system
  (ACCENT HL5500PC)

ホール効果測定装置（ACCENT HL5500PC)
Input impedance $10^{10}\,\Omega$

- ◆ High-resolution X-ray photoelectron spectroscopy
  (XPS) system (KRATOS ESCA-3400)

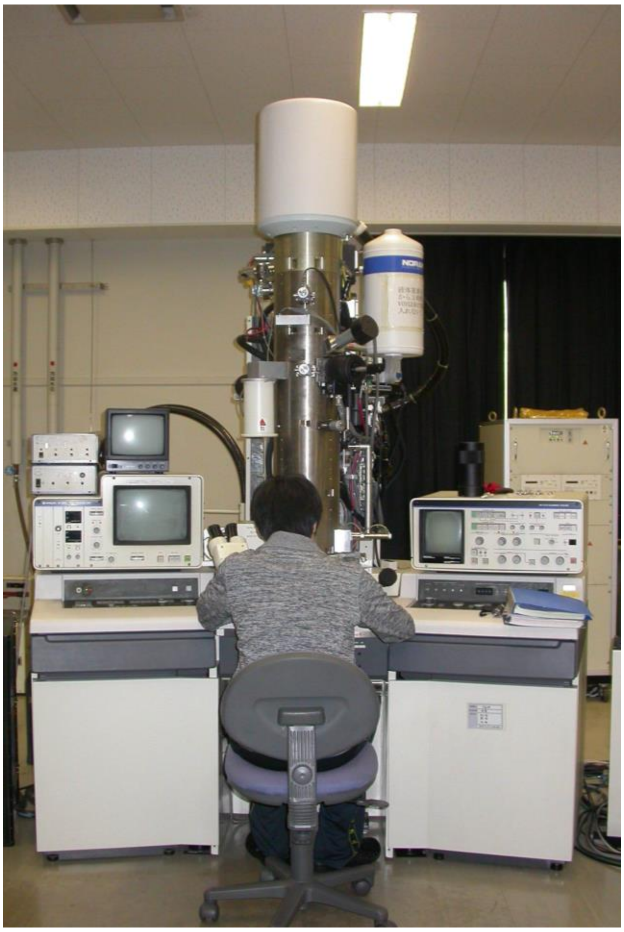
X線光電子分光分析装置
(KRATOS ESCA-3400) X ray source：Mg, Ka

- ◆ High-resolution X-ray photoelectron spectroscopy (XPS) system (VG Scienta ESCA-300)

X線光電子分光分析装置（VGシエンタ ESCA-300）Radius of analyzer：300mm, X-ray source：4kW

◆ 200-kV field emission-transmission electron microscopy (FE-TEM) (Hitachi HF-2100)

透過電子顕微鏡
(日立 HF-2100) Lattice resolution 0.102nm

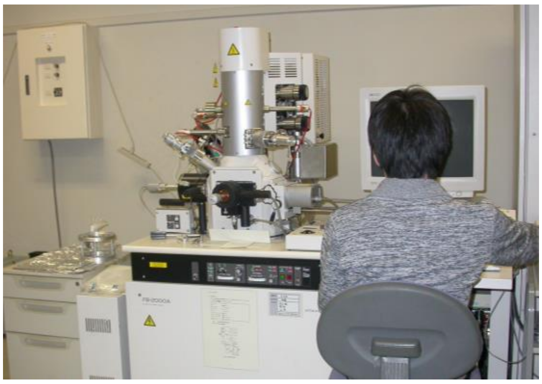


◆ Field emission scanning electron microscope (FE-SEM) (Hitachi S4700)

電界放出型走査電子顕微鏡
（日立 S4700）Resolution 1.5nm

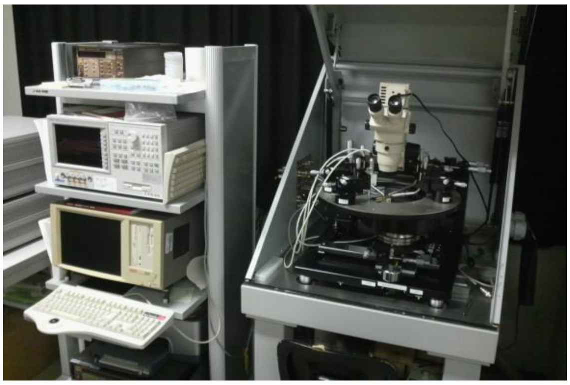
◆ Focused ion (Ga) beam (FIB) system (Hitachi FB-2000)

集束イオン(Ga)ビーム加工装置
（日立 FB-2000）Min. beam diameter 10nm



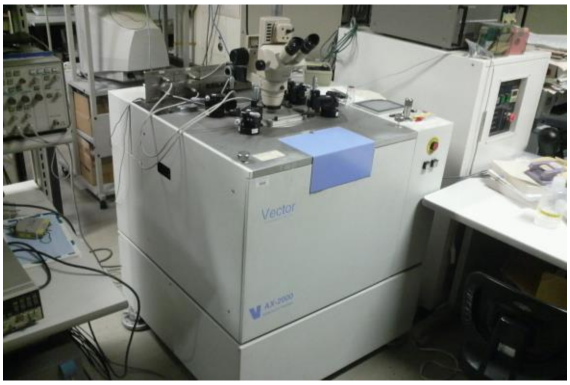
◆ Manual wafer prober (Vector Semiconductor) and semiconductor parameter analyzer (Keithley)

マニュアルプローバー(ベクターセミコン)及び
半導体パラメーターアナライザー(ケースレー)



◆ Semi-automatic wafer prober (Vector Semiconductor AX-2000)

セミオートプローバー
(ベクターセミコンAX-2000)



5.4 VLSI CAD environment

VLSI設計用CAD環境

5.4.1 Hardware

ハードウェア

Workstations

◆ SUN: 11 machines (SunFire X4600×1, SunFire V440×2, SunBlade2500×2, SunBlade2000×3, SunBlade1000×3)

◆ HP: 9 machines (ProLiant DL580G5×3, xw9300×1, xw8600×1, j6750×1, c8000×2, b2000×1)

Workstations for TCAD and LSI design
TCAD及びLSIデザイン用ワークステーション

5.4.2 Software

ソフトウェア

TCAD tools

◆ Process/Device Simulators: SYNOPSYS TSUPREM4/MEDICI, ISE TCAD, SYNOPSYS Sentaurus, Selete ENEXSS

Other simulators

◆ Electromagnetic Field Simulators: ANSOFT HFSS, CST Microwave Studio

◆ Optical Wave-guide Simulator: Apollo Photonics APSS

LSI design tools

◆ Layout Design: CADENCE Virtuoso*, JEDAT alpha-SX(ISMO), Silvaco Expert*

- ◆ Schematic Design: CADENCE Composer*, JEDAT alpha-SX(ASCA), Silvaco Gateway
- ◆ Functional Simulators: CADENCE SPW*, Mathworks MATLAB
- ◆ Circuit Simulators: CADENCE Artist*, Spectre*, Silvaco SmartSpice*, SYNOPSYS Star-HSPICE*, HSIM*, TimeMill/PowerMill*, NanoSim*
- ◆ Logic Simulators: CADENCE NC-Verilog*, VerilogXL*, MENTOR ModelSim*, SYNOPSYS VSS*
- ◆ Logic Synthesis: ALTERA QuartusII, CADENCE HDL Compiler*, SYNOPSYS Design Compiler*, FPGA Compiler*, XILINX ISE Foundation
- ◆ Automatic P&R: SYNOPSYS Milkyway*, Astro*, IC-Compiler*, CADENCE SoC-Encounter*
- ◆ Verification: CADENCE Diva*, Dracula*, Assura*, JEDAT Layver, MENTOR Calibre*, SYNOPSYS Hercules*

Notice that various kinds of popular CAD software (marked with “*”) which support Verilog HDL/VHDL simulation, synthesis, layout design and verification for digital/analog VLSIs are provided by VLSI Design and Education Center (VDEC), the University of Tokyo.

6. List of Publications

6.1 Advanced device, process, and material technologies for ULSI

6.1.1 Fabrication techniques for MOS devices and TFTs

[1] M. De Silva, S. Ishikawa, T. Kikkawa, and S-I. Kuroki, “Low resistance ohmic contact formation on 4H-SiC c-face with NbNi silicidation using nano-second laser annealing,” Mat. Sci. Forum, **858**, pp549-552, 2016.

[2] H. Nagatsuma, S-I. Kuroki, M. De Silva, S. Ishikawa, T. Maeda, H. Sezaki, T. Kikkawa, M. Östling, and C.-M. Zetterling, “4H-SiC nMOSFETs with As-doped S/D and NbNi Silicide ohmic contacts,” Mat. Sci. Forum, **858**, pp573-576, 2016.

[3] S-I. Kuroki, H. Nagatsuma, M. De Silva, S. Ishikawa, T. Maeda, H. Sezaki, T. Kikkawa, T. Makino, T. Ohshima, M. Östling, and C.-M. Zetterling, “Characterization of 4H-SiC nMOSFETs in Harsh Environments, High-Temperature and High Gamma-Ray Radiation,” Mat. Sci. Forum, **858**, pp864-867, 2016.

[4] Y. Furubayashi, T Tanehira, K Yonemori, N Seo, and S-I. Kuroki, “3D Integration of Si-based Peltier device onto 4H-SiC power device,” Mat. Sci. Forum, **858**, pp1107-1111, 2016.

[5] M. De Silva, T. Maeda, S. Ishikawa, H. Sezaki, T. Miyazaki, T. Kikkawa, and S-I. Kuroki, “Characterization of Grapho-Silicidation on n+ 4H-SiC C-Face for Back Side Ohmic Contacts of Power Devices,” ECS J. Solid State Sci. Technol., **5** (9) P457-P460, 2016.

[6] M. De Silva, S. Ishikawa, T. Miyazaki, T. Kikkawa, and S-I. Kuroki, “Formation of amorphous alloys on 4H-SiC with NbNi film using pulsed-laser annealing,” Appl. Phys. Lett. **109**, pp. 012101-1 - 012101-5, 2016.

[7] T. T. Nguyen, M. Hiraiwa, T. Hirata and S-I. Kuroki, “Characterization of (100)-Dominantly Oriented Poly-Si Thin Film Transistors using Multi-Line Beam Continuous-Wave Laser Lateral Crystallization,” ECS Transactions, **75** (10), pp. 49-54, 2016.

[8] S. S. Suvanam, S-I. Kuroki, L. Lanni, R. Hadayati, T. Ohshima, T. Makino, A. Hallen, C.-M. Zetterling, “High Gamma Ray Tolerance for 4H-SiC Bipolar Circuits,” IEEE Tran. Nucl. Sci., **64**, pp. 852-858, 2017.

[9] Y. Furubayashi, T. Tanehira, K. Yonemori, N. Seo, and S-I. Kuroki, “Transient observation of Peltier effect for PtSix-coated n-type silicon; cooler for 4H-SiC-based power devices,” ECS J. Solid State Sci. Technol. **6** (3), N3089-N3094, 2017.

[10] S-I. Kuroki, H. Nagatsuma, T. Kurose, M. De Silva, S. Ishikawa, T. Maeda, H. Sezaki, T. Kikkawa, T. Makino, T. Ohshima, M. Östling, and C.-M. Zetterling, "4H-SiC MOSFETs and Logic Inverters for Radiation-Hardened Electronics," International Workshop on Radiation Resistant Sensors and Related Technologies for Nuclear Power Plant Decommissioning (R2SRT2016), Iwaki, Fukushima, pp. 36-37, 2016 (Invited).

[11] T. T. Nguyen, M. Hiraiwa, T. Hirata, and S-I. Kuroki, "Ultrahigh-Performance Poly-Si Thin Film Transistor Using Multi-Line Beam Continuous-Wave Laser Lateral Crystallization," The proceedings of The 23rd International Workshop on Active-Matrix Flatpanel Displays and Devices (AM-FPD16), 4-3, pp277-279, 2016.

[12] S.-I. Kuroki, H. Nagatsuma, T. Kurose, S. Ishikawa, T. Maeda, H. Sezaki, T. Kikkawa, T. Makino, T. Ohshima, M. Östling, and C.-M. Zetterling, "4H-SiC Pseudo-CMOS Logic Inverters for Harsh Environment Electronics," 11th European Conference on Silicon Carbide and Related Materials (ECSCRM2016), Halkidiki, Greece, WeP-27, pp. 537-538, 2016.

[13] K. Muraoka, H. Sezaki, S. Ishikawa, T. Maeda, T. Sato, T. Kikkawa and S-I. Kuroki, "Enhanced-oxidation and interface modification on 4H-SiC(0001) substrate using alkaline earth metal," 11th European Conference on Silicon Carbide and Related Materials (ECSCRM2016), Halkidiki, Greece, WeP-37, pp. 557-558, 2016.

[14] M. De Silva, T. Kawasaki, T. Kikkawa, and S-I. Kuroki, "Low resistance Ti-Si-C ohmic contacts for 4H-SiC power devices using Laser annealing," 11th European Conference on Silicon Carbide and Related Materials (ECSCRM2016), Halkidiki, Greece, WeP-39, pp. 561-562, 2016.

[15] T. T. Nguyen, M. Hiraiwa, and S-I. Kuroki, "Effect of (100) Si Crystal Orientation on Characteristics of Poly-Si Thin Film Transistors," The 3rd International Symposium on Frontiers in Materials Science (28-30 September 2016, Hanoi, Vietnam, pp68, 2016.

[16] M. Hiraiwa, T. T. Nguyen, and S. I. Kuroki, "Charge-Trap Inactivation of Multi-Line-Beam CLC poly-Si TFTs using Channel Impurity Doing," PRiME2016, 230th Meeting of ECS, Honolulu, USA, H03-2117, 2016.

[17] T. T. Nguyen, M. Hiraiwa, T. Hirata, and S. I. Kuroki, "Characterization of (100)-Dominantly Oriented Poly-Si Thin Film Transistors using Multi-Line Beam Continuous-Wave Laser Lateral Crystallization," PRiME2016, 230th Meeting of ECS, Honolulu, USA, H03-2118, 2016.

[18] R. Mizukami, S. Takeshima, T. Yamashita, and S. Higashi, "Fabrication of single crystalline silicon thin film transistors and logic circuits on plastic substrate by meniscus force mediated layer transfer technique" 13th Int. Thin-Film Transistor Conf. 2017 (ITC2017), Austin, USA, pp. 17-18, 2017

[19] T. Hieda, R. Shin, H. Hanafusa, and S. Higashi, "Micro-thermal-plasma-jet Crystallization of Amorphous

Silicon Films on Flexible Glass Substrate," 34th Symposium on Plasma Processing (SPP34) / The 29th Symposium on Plasma Science for Materials (SPSM29), 17pB5, 2017.

[20] R. Nakashima, R. Shin, H. Hanafusa, and S. Higashi, "Generation of Ultra High Power Thermal Plasma Jet (Super TPJ) and Its Application to Crystallization of Amorphous Silicon Films," Proc. Int. Symp. Dry Process (DPS2016), Sapporo, Japan, pp. 33-34, 2016.

[21] H. Harada, R. Shin, H. Hanafusa, and S. Higashi, "Crystallization and Activation of P+ Dope a-Ge Film by Atmospheric Pressure Micro-Thermal-Plasma-Jet," Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2016), Tsukuba, Japan, D-2-03, 2016.

[22] 11. H. Hanafusa, R. Ishimaru, and S.Higashi, "High-temperature Oxidation of 4H-SiC by Thermal-Plasma-Jet," 11th European Conference on Silicon Carbide and Related Materials (ECSCRM2016), Halkidiki, Greece, pp. 243-244, 2016

[23] R. Mizukami, S. Takeshima, T. Yamashita, and S. Higashi, "Improvement of transfer yield of single-crystalline silicon films and fabrication of thin-film transistors on polyethylene terephthalate substrate," International Conference on Flexible and Printed Electronics (ICFPE2016), Yamagata, Japan, O12-4. p. 88, 2016.

[24] S. Higashi, H. Harada, andT. Nakatani, "Atmospheric pressure micro-thermal-plasma-jet irradiation on amorphous germaniumstrips and its application to thin film transistor fabrication," 2016 Asia-Pacific Workshop Fundamentals and Applications of Advanced Semiconductor Dev. (AWAD2016), Hakodate, Japan, pp. 427-429, 2016.

[25] S. Higashi, "Activation of Impurity Atoms in 4H-SiC Wafer by Atmospheric Pressure Thermal Plasma Jet Irradiation" Ext. Abs. 2016 Int. Workshop Junction Tech. (IWJT-2016), Shanghai, China, pp. 68-71, 2016 (Invited).

6.1.2 Optical interconnects

[26] K. Noda, K. Okada, Y. Amemiya, and S. Yokoyama, "Magneto-Optical Switching Devices Based on Si Resonators," Jpn. J. App. Phys. **55** (4), pp. 04EN02-1-6, 2016.

[27] Y. Amemiya, K. Noda, T. Sennichi, and S. Yokoyama, "MEMS Optical Switches Using Slot Ring Resonator for Low Voltage Operation," Jpn. J. App. Phys. **55** (4), pp. 04EC15-1-5, 2016.

6.1.3 Wireless interconnects

[28] A. Azhari, T. Sugitani, X. Xiao, and T. Kikkawa,"DC–17-GHz CMOS single-pole-eight-throw switching matrix for radar-based image detection," Jpn. J. App. Phys. **55**, 127301-7, 2016.

[29] X. Xiao, H. Qi, Y. Tao, and T. Kikkawa, “Study on the interfacial adhesion property of low-k thin film by the surface acoustic waves with cohesive zone model,” Appl. Surf. Sci. **388**, pp. 448-454, 2016.

[30] L. Wang, X. Xiao, and T. Kikkawa, “MRI-aided tissues interface characterization: An accurate signal propagation time calculation method for UWB breast tumor imaging,” Appl. Surf. Sci. **388**, pp. 24-34, 2016.

[31] X. Xiao, H. Qi, X. Sui, and T. Kikkawa,”Evaluation and criterion determination of the low-k thin film adhesion by the surface acoustic waves with cohesive zone model,” Appl. Surf. Sci. **399,** pp. 599-607, 2017.

[32] H. Song, A. Azhari, X. Xiao, E. Suematsu, H. Watanabe, and T. Kikkawa, “Microwave Imaging Using CMOS Integrated Circuits with Rotaing 4x4 Antenna Array on a Breast Phantom,” International Journal of Antenna and Propagation, Article ID 6757048, 2017.

[33] 平野拓一，吉川公麿，広川二郎，安藤真，“人体検査用広帯域五角形パッチアンテナ,” “Wideband pentagonal patch antenna for body diagnosis,”　電子情報通信学会論文誌 C, Vol.J99-C No.8, pp. 365-372, 2016.

[34] H. Song, H. Kohno, X. Xiao, and T. Kikkawa, “Propagation of Gaussian Monocycle Pulses in Breast Phantoms with Slot Antenna Arrays,” Proc. 10th European Concerence on Antennas and Propagation, p.129, Davos, Switzerland, 2016.

[35] T. Kikkawa, “A radar-based breast cancer detection system using CMOS integrated circuits,” Proc. Ireland-Japan Biomaterials & Tissue Engineering Meeting Galway, Ireland, 2016.

[36] H. Song, Y. Seo, H. Sato, T. Uruma, and T. Kikkawa,” Breast cancer imaging with a dome antenna array using a radar-based Ultra-wideband CMOS detection system,” Extended Abstract International Solid-State Devices and Materials, H-4-03, Tsukuba, Japan, 2016.

[37] H. Song, H. Kono, Y. Seo, A. Azhari, X. Xiao, and Takamaro Kikkawa, “Confocal imaging by turning antennas with CMOS integrated circuits for breast cancer detection,” Proc. International Symposium on Antenna and Propagation, Okinawa, Japan, 2016.

[38] H. Song, S. Kubota, X. Xiao, and T. Kikkawa, “Design of UWB Antennas for Breast Cancer Detection,” in Proc. International Conference on Electromagnetics in Advanced Applications (ICEAA), No. 140, p.321, Session 38, Cairns, Australia, 2016.

[39] H. Song, H. Sato, X. Xiao, and T. Kikkawa, “A Portable Breast Cancer Imaging System with Cross-shaped Dome Antenna Array,” Proc. EuCAP, p. 3486, Paris, France, 2017.

6.1.4 CVD and contamination/particle control

[40] N. Shinohara, T. Nakazato, K. Ohkawa, M. Tamura, N. Kobayashi, Y. Morimoto, T. Oyabu, T. Myojo, M. Shimada, K. Yamamoto, H. Tao, M. Ema, M. Naya, and J. Nakanishi, "Long-term Retention of Pristine Multi-walled Carbon Nanotubes in Rat Lungs after Intratracheal Instillation," J. Appl. Toxicol. **36** (4), pp. 501-509, 2016.

[41] Y. Morimoto, H. Izumi, Y. Yoshiura, T. Tomonaga, B.-W. Lee, T. Okada, T. Oyabu, T. Myojo, M. Shimada, M. Kubo, K. Yamamoto, S. Kitajima, E. Kuroda, M. Horie, K. Kawaguchi, and T. Sasaki, "Comparison of Pulmonary Inflammatory Responses Following Intratracheal Instillation and Inhalation of Nanoparticles," Nanotoxicol. **10** (5), pp. 607-618, 2016.

[42] M. Kubo, K. Kusdianto, H. Masuda, and M. Shimada, "Fabrication of a Metal Oxide Layer on a Multi-walled Carbon Nanotube Surface by In-flight Coating using Gas-phase Deposition," Ceramics International, **42** (7), pp. 9162-9169, 2016.

[43] Y. Morimoto, H. Izumi, Y. Yoshiura, T. Tomonaga, T. Oyabu, T. Myojo, K. Kawai, K. Yatera, M. Shimada, M. Kubo, K. Yamamoto, S. Kitajima, E. Kuroda, K. Kawaguchi, and T. Sasaki, "Evaluation of Pulmonary Toxicity of Zinc Oxide Nanoparticles following Inhalation and Intratracheal Instillation," Int. J. Mol. Sci. **17**, 1241, 2016.

6.1.5 Organic electronic devices

[44] M. Nakashima, N. Murata, Y. Suenaga, H. Naito, T. Sasaki, Y. Kunugi, and J. Ohshita, "Disilanobithiophene-dithienylbenzothiadiazole alternating polymer as donor material of bulk heterojunction polymer solar cells," Syn. Met. **215**, pp. 116-120, 2016.

[45] M. Nakashima, Y. Ooyama, T. Sugiyama, H. Naito, and J. Ohshita, "Synthesis of a Conjugated D-A Polymer with Bi(disilanobithiophene) as a New Donor Component," Molecules, **21**, 789, 2016.

[46] J. Ohshita, K. Yamamoto, D. Tanaka, M. Nakashima, Y. Kunugi, M. Ohashi, and H. Nakano, "Preparation and Photocurrent Generation of Silicon Nanosheets with Aromatic Substituents on the Surface," J. Phys. Chem. C, **120**, pp. 10991-10996, 2016

[47] M. Nakashima, M. Miyazaki, Y. Ooyama, Y. Fujita, S. Murata, Y. Kunugi, and J. Ohshita, "Synthesis of silicon- or carbon-bridged polythiophenes and application to organic thin-film transistors," Polym. J. **48**, pp. 645-651, 2016.

[48] M. Morisue, Y. Hoshino, M. Nakamura, T. Yumura, S. Machida, Y. Ooyama, M. Shimizu, and J. Ohshita; Group 14 Dithienometallole-Linked Ethynylene-Conjugated Porphyrin Dimers; Inorg. Chem. **55**, pp. 7432-7441, 2016.

[49] F. B. Zhang, Y. Adachi, Y. Ooyama, and J. Ohshita, "Synthesis and Properties of Benzofuran-Fused Silole and Germole Derivatives: Reversible Dimerization and Crystal Structures of Monomers and Dimers," Organometallics, **35**, pp. 2327-2332, 2016.

[50] M. Nakamura, Y. Ooyama, S. Hayakawa, M. Nishino, and J. Ohshita, "Synthesis of Poly(dithienogermole)s," Organometallics, **35**, pp. 2333-2338, 2016.

[51] Y. Ooyama, N. Yamaguchi, J. Ohshita, and Y. Harima, "Impacts of molecular structure and adsorption mode of D-π-A dye sensitizers with pyridyl group for dye-sensitized solar cells on adsorption equilibrium constant for dye-adsorption to TiO2 surface," Phys. Chem. Chem. Phys. **18**, pp. 32992-32998, 2016.

[52] Y. Ooyama, K. Furue, T. Enoki, Y. Adachi, M. Kanda, and J. Ohshita, "Development of Type-I/Type-II hybrid dye sensitizer with both pyridyl group and catechol unit as anchoring group for Type-I/Type-II dye-sensitized solar cell," Phys. Chem. Chem. Phys. **18**, pp. 30662-30676, 2016,.

[53] Y. Ooyama, M. Hato, T. Enoki, S. Aoyama, K. Furue, N. Tsunoji, and J. Ohshita, "BODIPY sensor for water based on photo-induced electron transfer method with fluorescence enhancement and attenuation systems," New J. Chem. **40**, pp. 7278-7281, 2016.

[54] J. Ohshita, "Group 14 metalloles condensed with heteroaromatic systems," Org. Photonics Photovolt. **4**, pp. 52–59, 2016.

[55] A. Naka, K. Fujishima, E. Okada, M. Noguchi, J. Ohshita, Y. Adachi, Y. Ooyama, and M. Ishikawa, "Synthesis of pentamethyldisilanyl-substituted starlike molecule with triazine core and its application to dye-sensitized solar cells," J. Organomet. Chem. **825**, pp. 63-68, 2016.

[56] A. Harada, S. Koge, J. Ohshita, and Y. Kaneko, "Preparation of a Thermally Stable Room Temperature Ionic Liquid Containing Cage-Like Oligosilsesquioxane with Two Types of Side-Chain Groups," Bull. Soc. Chem., Jpn, **89** (9), pp. 1129-1135, 2016.

[57] Z. Lu, K. Murakami, S. Koge, T. Mizumo, and J. Ohshita, "Palladium-catalyzed dehydrogenative amination of polyhydrosiloxanes," J. Organomet. Chem. **808**, pp. 63-67, 2016.

[58] J. Ohshita, Y. Hayashi, K. Murakami, T. Enoki, and Y. Ooyama, "Singlet oxygen generation sensitized by

spiro(dipyridinogermole)(dithienogerrnole)s," Dalton Trans. **45** (39), pp. 15679-15683, 2016.

[59] Y. Adachi, Y. Ooyama, N. Shibayama, and J. Ohshita, "Synthesis of organic photosensitizers containing dithienogermole and thiadiazolo[3,4-c]pyridine units for dye-sensitized solar cells," Dalton Trans. **45** (35), pp. 13817-13826, 2016.

[60] 山本一樹，大下浄治，"有機架橋型元素ブロックを用いたオルガノシリカ連続膜の作製とその分離能，" セラミックス協会誌, **51** (11), pp. 770-772, 2016.

[61] S. Nagaoka, T. Kakiuchi, J. Ohshita, O. Takahashi, and Y. Hikosaka, "Site-Specific Electron-Relaxation Caused by Si:2p Core-Level Photoionization: Comparison between F3SiCH2CH2Si(CH3)3 and Cl3SiCH2CH2Si(CH3)3 Vapors by Means of Photoelectron Auger Electron Coincidence Spectroscopy," J. Phys. Chem. A, **120**, pp. 9907-9915, 2016.

6.1.6 Spintronic devices

[62] S. Hirata, T. Ono, Y. Amemiya, T. Tabei, and S. Yokoyama, "Influence of Surface Smoothing on Spin Seebeck Effect of Ce1Y2Fe5O12 Deposited by Metal Organic Decomposition," Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2016), Tsukuba, Japan, PS-12-13, pp. 933-934, 2016.

6.2 Self-assembling technologies and quantum structure

[63] A. Nakajima, "Application of Single-Electron Transistor to Biomolecule and Ion Sensors," Appl. Sci. **6** (4), pp. 94-107, 2016 (Review paper).

6.3 Technologies for intelligent systems

6.3.1 Associative memories and their application for intelligent system integration

[64] X. Zhang, F. An, L. Chen, and H. J. Mattausch, "Reconfigurable VLSI implementation for learning vector quantization with on-chip learning circuit," Jpn. J. Appl. Phys. **55** (4), SI, 04EF02, 2016.

[65] F. An, K. Mihara, S. Yamasaki, L. Chen, and H. J. Mattausch, "Highly flexible nearest-neighbor-search associative memory with integrated KNN classifier, configurable parallelism and dual-Storage Space," Jpn. J. Appl. Phys. **55** (4), SI, 04EF10, 2016.

[66] F. An, K. Mihara, S. Yamasaki, L. Chen, and H. J. Mattausch, ”K-Nearest Neighbor Associative Memory with Reconfigurable Word-Parallel Architecture“, Journal of Semiconductor Technology and Science, **16** (4), pp. 405-414, 2016.

[67] F. An, X. Zhang, L. Chen, and H. J. Mattausch, ”A Memory-based Modular Architecture for SOM and LVQ with Dynamic Configuration,“ IEEE Trans. on Multi-Scale Computing Systems, **2** (4), pp. 234-241, 2016.

[68] J. Guan, F. An, X. Zhang, L. Chen, and H. J. Mattausch, “Real-Time Straight-Line Detection for XGA-Size Videos by Hough Transform with Parallelized Voting Procedures,” Sensors, **17** (2), pp. 270-283, 2017.

[69] F. An, X. Zhang, L. Chen, and H. J. Mattausch, “Dynamically Reconfigurable System for LVQ-Based On-chip Learning and Recognition,” Proc. IEEE Int. Symposium on Circuits and Systems (ISCAS’16), 525-528, Canada, Montreal, 1338-1341, 2016.

[70] X. Zhang, F. An, N. Nakashima, L. Chen, and H. J. Mattausch, “Cell-Scan-based Hardware Architecture for HOG-Feature Extraction”, Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2016), Tsukuba, Japan, pp. 455-456, 2016.

[71] A. Luo, F. An, Y. Fujita, X. Zhang, L. Chen, and H. J. Mattausch, “Real-Time Haar-like Feature Extraction Coprocessor with Pixel-Based Pipelined Hardware Architecture for Flexible Low-Power Object Detection and Recognition”, Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2016), Tsukuba, Japan, pp. 457-458, 2016.

[72] F. An, X. Zhang, L. Chen, and H. J. Mattausch, ”Parallel-Elementary-Stream Architecture for Nearest-Neighbor-Search-based Self-Organizing Map“, Proceedings of the International Conference on Solid-State and Integrated-Circuit Technology (ICSICT’2016), Hangzhou, China, 2016 (Invited).

[73] Y. Fujita, F. An, A. Luo, X. Zhang, L. Chen, and H. J. Mattausch, “Pixel-Based Pipeline Hardware Architecture for High-Performance Haar-like Feature Extraction,” Proceedings of the 2016 IEEE Asia Pacific Conference on Circuits and Systems (APCCAS’2016), Jeju, Korea, Japan, pp. 611-612, 2016.

6.3.2 Digital real-time moving-picture segmentation

[74] T. Hoang, T. Okamoto, and T. Koide, “Prototype Speed Limit Sign Recognition System Implementation on Rapid Prototyping Platform,” Proceedings of the 20th Workshop on Synthesis And System Integration of Mixed Information technologies (SASIMI 2016), pp. 201-202, 2016.

6.3.3 Massive-parallel mobile-embedded processor

[75] T. Kumaki, T. Koide, and T. Fujino, “Secure data processing with massive-parallel SIMD matrix for embedded SoC in digital-convergence mobile devices,” IEEJ Transactions on Electrical and Electronic Engineering, **12** (1), 2016.

6.3.4 Millimeter-wave wireless communication

[76] M Fujishima, “300GHz CMOS Wireless Communication with 32 Quadrature-Amplitude-Modulation Capability,” ECS Transactions **72** (3), pp. 105-111, 2016 (Invited).

[77] K Takano, K Katayama, S Amakawa, T Yoshida, and M Fujishima, “Wireless digital data transmission from a 300-GHz CMOS transmitter,” Electronics Letters, **52** (15), pp. 1353-1355, 2016.

[78] S. Hara, K. Katayama, K. Takano, I. Watanabe, N. Sekine, A. Kasamatsu, T. Yoshida, S. Amakawa, and M. Fujishima, “Compact 141-GHz Differential Amplifier with 20-dB Peak Gain and 22-GHz 3-dB Bandwidth,” IEICE Transactions on Electronics, **99** (10), pp. 1156-1163, 2016.

[79] T. Mitsunaka, D. Sato, N. Ashida, A. Saito, K. Iizuka, T. Suzuki, Y. Ogawa, and M. Fujishima, “CMOS biosensor IC focusing on dielectric relaxations of biological water with 120 and 60 GHz oscillator arrays,” IEEE Journal of Solid-State Circuits, **51** (11), pp. 2534-2544, 2016.

[80] K. Katayama, K. Takano, S. Amakawa, S. Hara, A. Kasamatsu, K. Mizuno, K. Takahashi, T. Yoshida, and M. Fujishima, “A 300 GHz CMOS transmitter with 32-QAM 17.5 Gb/s/ch capability over six channels,” IEEE Journal of Solid-State Circuits, **51** (12), pp. 3037-3048, 2016.

[81] K. Katayama , K. Takano , S. Amakawa , S. Hara , A. Kasamatsu , K. Mizuno , K. Takahashi , T. Yoshida , and M. Fujishima, “A 300GHz 40nm CMOS Transmitter with 32-QAM 17.5Gb/s/ch Capability over 6 Channels,” Digest of Technical Papers IEEE International Solid-State Circuits Conference (ISSCC) 2016, pp. 342-343, 2016.

[82] T. Mitsunaka, N. Ashida, A. Saito, K. Iizuka, T. Suzuki, Y. Ogawa, and M. Fujishima, “CMOS Biosensor IC Focusing on Dielectric Relaxations of Biological Water with 120GHz and 60GHz Oscillator Arrays,” Digest of Technical Papers IEEE International Solid-State Circuits Conference (ISSCC), pp. 478-479, 2016.

[83] K. Takano, S. Hara, K. Katayama, S. Amakawa, T. Yoshida, and M. Fujishima, “Quintic Mixer: A Subharmonic Up-Conversion Mixer for THz Transmitter Supporting Complex Digital Modulation,” 2016 IEEE International Microwave Symposium (IMS2016), pp. 1-3, 2016.

[84] K. Katayama, K. Takano, S. Amakawa, S. Hara, T. Yoshida, and M. Fujishima, “CMOS 300-GHz 64-QAM Transmitter,” 2016 IEEE International Microwave Symposium (IMS2016), pp. 1-4, 2016.

[85] K. Katayama, K. Takano, S. Amakawa, T. Yoshida, and M. Fujishima, “14.4-dB CMOS D-band Low-Noise Amplifier with 22.6-mW Power Consumption Utilizing Bias-Optimization Technique,” The 2016 IEEE International Symposium on Radio-Frequency Integration Technology (RFIT2016), pp. 1-3, 2016.

[86] T. Yoshida, H. Adachi, K. Takano, K. Katayama, S. Amakawa, and M. Fujishima, “System-level evaluation of 300GHz CMOS wireless transmitter using cubic mixer,” The 2016 IEEE International Symposium on Radio-Frequency Integration Technology (RFIT2016), pp. 1-3, 2016.

6.3.5 Computer aided diagnosis system

[87] T. Hirakawa, T. Tamaki, B. Raytchev, K. Kaneda, T. Koide, S. Yoshida, Y. Kominami, and S. Tanaka, “Defocus-aware Dirichlet particle filter for stable endoscopic video frame recognition,” Artificial Intelligence in Medicine, **68**, pp. 1-16, 2016.

[88] T. Hirakawa, T. Tamaki, T. Kurita, B. Raytchev, K. Kaneda, C. Wang, L. Najman, T. Koide, S. Yoshida, H. Mieno, and S. Tanaka, “Discriminative subtree selection for NBI endoscopic image labeling,” The ACCV2016 workshop on mathematical and computational methods in biomedical imaging and image analysis (MCBMIIA2016), 2016.

[89] Y. Kominami, S. Yoshida S, S. Tanaka, Y. Sanomura, T. Hirakawa, B. Raytchev, T. Tamaki, T. Koide, K. Kaneda, and K. Chayama, “Computer-aided diagnosis of colorectal polyp histology by using a real-time image recognition system and narrow-band imaging magnifying colonoscopy,” Gastrointest Endosc. 83:643-9. 2016.

[90] S. Sonoyama, T. Tamaki, T. Kurita, T. Hirakawa, B. Raytchev, K. Kaneda, T. Koide, S. Yoshida, H. Mieno, and S. Tanaka, “Transfer Learning for Endoscopic Image Classification,” Proceedings of the 22nd Korea-Japan joint Workshop on Frontiers of Computer Vision (FCV 2016).

[91] T. Tamaki, S. Sonoyama, T. Hirakawa, B. Raytchev, K. Kaneda, T. Koide, S. Yoshida, H. Mieno and S. Tanaka, "Computer-Aided Colorectal Tumor Classification in NBI Endoscopy Using CNN Features", Proceedings of the 22nd Korea-Japan joint Workshop on Frontiers of Computer Vision (FCV 2016).

[92] T. Koide, T. Okamoto, K. Sugi, T. Shimizu, A. T. Hoang, T. Tamaki, B. Raytchev, K. Kaneda, S. Yoshida, H. Mieno, and S. Tanaka, “A Hardware Accelerator for Bag-of Features based Visual Word Transformation in

Computer Aided Diagnosis for Colorectal Endoscopic Images," Proceedings of the 31st International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC2016), pp. 233-236, 2016.

[93] T. Koide, T. Okamoto, T. Shimizu, K. Sugi, A. T. Hoang, T. Tamaki, B. Raytchev, K. Kaneda, S. Yoshida, H. Mieno, and S. Tanaka, "Compact and High-Speed Hardware Feature Extraction Accelerator for Dense Scale-Invariant Feature Transform," Proceedings of the 31st International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC2016), pp. 387-390, 2016.

[94] T. Koide, A. T. Hoang, "HW/SW Co-Design of Automotive and Medical Applications on Rapid Prototyping Platform Protium," CDN Live Japan Cadence User Conference 2016, 2016 (Invited).

[95] T. Okamoto, T. Koide, A. T. Hoang, T. Shimizu, K. Sugi, T. Tamaki, T. Hirakawa, B. Raytchev, K. Kaneda, S. Yoshida, H. Mieno, and S. Tanaka, "An FPGA Implementation of SVM for Type Identification with Colorectal Endoscopic Images," Proceedings of the 20th Workshop on Synthesis And System Integration of Mixed Information technologies (SASIMI 2016), pp. 81-86, 2016.

[96] 吉田成人，小南陽子，田中信治，玉木徹，小出哲士，茶山一彰，"リアルタイム大腸 NBI 拡大内視鏡画像認識システムによる大腸ポリープ組織診断に関する検討，" INTESTINE, Vol. 21, No. 2, pp. 182-184, 2017，日本メディカルセンター.

[97] 小出哲士，玉木徹，吉田成人，"画像処理／学習，医療アプリケーションへの応用――大腸 NBI 拡大内視鏡画像のリアルタイム診断支援システム――，" 電子情報通信学会誌, Vol.100, No. 2, pp. 92--97, 2017.

[98] 岡本 拓巳，小出 哲士，清水 達也，杉 幸樹，Anh-Tuan Hoang，佐藤 光，玉木 徹，Bisser Raytchev，金田 和文，吉田 成人，三重野 寛，田中 信治，"ハードウェア・ソフトウェア協調設計による SVM を用いた大腸内視鏡診断支援システム，" Design Automation シンポジウム, pp.110-115, 2016-09-14－2016-09-16, 2016.

[99] 小出哲士，"大腸・胃がんの内視鏡診断をサポートする学習機能を有する診断支援システムの基盤技術開発，" 次世代医療システム産業化フォーラム 2016,（招待講演）.

6.4 Bioscience and technology

6.4.1 Sensing devices and systems

[100] T. Taniguchi, S. Yokoyama, Y. Amemiya, T. Ikeda, A. Kuroda, and S. Yokoyama, "Differential Si Ring Resonators for Label Free Biosensing," Jpn. J. App. Phys. **55** (4), pp. 04EM04-1-7, 2016.

[101] A. K. Sana, Y. Amemiya, and S. Yokoyama, “High Sensitivity and High Quality-Factor Silicon Photonic Crystal Resonator with Double Nanocavities for Label Free Biosensing,” Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2016), Tsukuba, Japan, H-1-02, pp. 361-362, 2016.

[102] A. K. Sana, Shu. Yokoyama, Y. Nakashima, Y. Amemiya, and S. Yokoyama, “Thermal Change in Resonance Wavelength of Si Resonator Sensors on Si on Insulator Substrate and Solution by Differential Operation,” Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2016), Tsukuba, Japan, K-3-04, pp. 487-488, 2016.

[103] A. K. Sana, Y. Amemiya, T. Ikeda, A. Kuroda, and S. Yokoyama, “Detection of prostate specific antigen using silicon photonic crystal nanocavity resonator,” IEEE SPIE Photonics West Proceedings Volume 10111: Quantum Sensing and Nano Electronics and Photonics XIV, San Francisco, 2017.

[104] M. A. Abdelhamid, T. Ikeda, K, Motomura, T, Tanaka, T, Ishida, R, Hirota, A, Kuroda, “Application of volcanic ash particles for protein affinity purification with a minimized silica-binding tag,” J. Biosci. Bioeng. **122** (5), pp. 633-638, 2016.

6.4.2 Research for magnetic effect of biological materials

[105] Y. Takeuchi, and M. Iwasaka, “Detection of Monosodium Urate Crystals for Gout Diagnosis Using Magnetic Fields and Near-Infrared Light,” IEEE Transactions on Magnetics **52** (7), pp. 1-4, 2016.

[106] M. Iwasaka, Y. Mizukawa, and N. W. Roberts, “Magnetic control of the light reflection anisotropy in a biogenic guanine microcrystal platelet,” Langmuir **32** (1), pp. 180-187, 2016.

6.5 Medical science and technology

6.5.1 Research for digestive and liver diseases

[107] S. DebRoy, N. Hiraga, M. Imamura, C. N. Hayes, S. Akamatsu, L. Canini, A. S. Perelson, R. T. Pohl, S Persiani, S. L. Uprichard, C. Tateno, H. Dahari, and K. Chayama “Hepatitis C virus dynamics and cellular gene expression in uPA-SCID chimeric mice with humanized livers during intravenous silibinin monotherapy,” J Viral Hepat. **23**, pp. 708-717, 2016.

[108] H. Abe-Chayama, C. N. Hayes, and K. Chayama, “Pan-genotypic cell culture system for propagation of hepatitis C virus clinical isolates,” Hepatology. **64**, pp. 1356-1358, 2016.

[109] S. Aizawa, T. Okamoto, Y. Sugiyama, T. Kouwaki, A. Ito, T. Suzuki, C. Ono, T. Fukuhara, M. Yamamoto, M. Okochi, N. Hiraga, M. Imamura, K. Chayama, R. Suzuki, I. Shoji, K. Moriishi, K. Moriya, K. Koike, and Y. Matsuura, “TRC8-dependent degradation of hepatitis C virus immature core protein regulates viral propagation and pathogenesis,” Nat Commun. **7**, 113792016, 2016.

[110] A. Fujimoto, M. Furuta, Y. Totoki, T. Tsunoda, M. Kato, Y. Shiraishi, H. Tanaka, H. Taniguchi, Y. Kawakami,

M. Ueno, K. Gotoh, S. Ariizumi, C. P. Wardell, S. Hayami, T. Nakamura, H. Aikata, K. Arihiro, K. A. Boroevich, T. Abe, K. Nakano, K. Maejima, A. Sasaki-Oku, A. Ohsawa, T. Shibuya, H. Nakamura, N. Hama, F. Hosoda, Y. Arai, S. Ohashi, T. Urushidate, G. Nagae, S. Yamamoto, H. Ueda, K. Tatsuno, H. Ojima, N. Hiraoka, T. Okusaka, M. Kubo, S. Marubashi, T. Yamada, S. Hirano, M. Yamamoto, H. Ohdan, K. Shimada, O. Ishikawa, H. Yamaue, K. Chayama, S. Miyano, H. Aburatani, T. Shibata, and H. Nakagawa, "Whole-genome mutational landscape and characterization of noncoding and structural mutations in liver cancer," Nat Genet. **48**, pp. 500-509, 2016.

[111] H. Kan, M. Imamura, T. Uchida, N. Hiraga, C. N. Hayes, M. Tsuge, H. Abe, H. Aikata, G. N. Makokha, S. Chowdhury, D. Miki, H. Ochi, Y. Ishida, C. Tateno, and K. Chayama, "Protease Inhibitor Resistance Remains Even After Mutant Strains Become Undetectable by Deep Sequencing," J Infect Dis. **214**, pp. 1687-1694, 2016.

[112] M. Kawashima, Y. Hitomi, Y. Aiba, N. Nishida, K. Kojima, Y. Kawai, H. Nakamura, A. Tanaka, M. Zeniya, E. Hashimoto, H. Ohira, K. Yamamoto, M. Abe, K. Nakao, S. Yamagiwa, S. Kaneko, M. Honda, T. Umemura, T. Ichida, M. Seike, S. Sakisaka, M. Harada, O. Yokosuka, Y. Ueno, M. Senju, T. Kanda, H. Shibata, T. Himoto, K. Murata, Y. Miyake, H. Ebinuma, M. Taniai, S. Joshita, T. Nikami, H. Ota, H. Kouno, H. Kouno, M. Nakamuta, N. Fukushima, M. Kohjima, T. Komatsu, T. Komeda, Y. Ohara, T. Muro, T. Yamashita, K. Yoshizawa, Y. Nakamura, M. Shimada, N. Hirashima, K. Sugi, K. Ario, E. Takesaki, A. Naganuma, H. Mano, H. Yamashita, K. Matsushita, K. Yamauchi, F. Makita, H. Nishimura, K. Furuta, N. Takahashi, M. Kikuchi, N. Masaki, T. Tanaka, S. Tamura, A. Mori, S. Yagi, K. Shirabe, A. Komori, K. Migita, M. Ito, S. Nagaoka, S. Abiru, H. Yatsuhashi, M. Yasunami, S. Shimoda, K. Harada, H. Egawa, Y. Maehara, S. Uemoto, N. Kokudo, H. Takikawa, H. Ishibashi, K. Chayama, M. Mizokami, M. Nagasaki, K. Tokunaga, and M. Nakamura, "Genome-wide association studies identify PRKCB as a novel genetic susceptibility locus for primary biliary cholangitis in the Japanese population," Hum Mol Genet. **26**, pp. 650-659, 2017.

[113] M. Furuta, M. Ueno, A. Fujimoto, S. Hayami, S. Yasukawa, F. Kojima, K. Arihiro, Y. Kawakami, C. P. Wardell, Y. Shiraishi, H. Tanaka, K. Nakano, K. Maejima, A. Sasaki-Oku, N. Tokunaga, K. A. Boroevich, T. Abe, H. Aikata, H. Ohdan, K. Gotoh, M. Kubo, T. Tsunoda, S. Miyano, K. Chayama, H. Yamaue, and H. Nakagawa, "Whole genome sequencing discriminates hepatocellular carcinoma with intrahepatic metastasis from multi-centric tumors," J Hepatol. **66**, pp. 363-373, 2017.

6.5.2 Diagnosis and regenerative medical technologies

[114] Y. Yanase, K. Sakamoto, K. Kobayashi, and M. Hide, "Diagnosis of immediate-type allergy using surface plasmon resonance," Opt Mater Express. **6** (4), pp. 1339-1348, 2016.

[115] K. Kobayashi, K. Sakamoto, Y. Yanase, M. Hide, and R. Miyake, "Micro cell isolation column for allergic diagnosis," Jpn. J. Appl. Phys. **55**, 03DF08, 2016.

[116] K. Harada-Hada, S. Mimura, G. Hong, T. Hashida, H. Abekura, H. Murata, M. Nishimura, and H. Nikawa, "Accelerating effects of cellulase in the removal of denture adhesives from acrylic denture bases," Journal of Prosthodontic Research, **352**, pp. 1-8,2016.

[117] T. Kihara, Y. Yoshimi, T. Taji, T. Murayama, K. Tanimoto, H. Nikawa, "Accuracy of a three-dimensional

dentition model digitized from an interocclusal record using a non-contact surface scanner," The European Journal of Orthodontics, **38** (4), pp. 435-439 ,2016.

[118] S. Mimura, M. Suga, K. Okada, M. Kinehara, H. Nikawa, and M. K. Furue, "Bone morphogenetic protein 4 promotes craniofacial neural crest induction from human pluripotent stem cells," The International Journal of Developmental Biology, **60**, pp. 21-28, 2016.

[119] S. Mimura, M. Ohara, I. Hayashi, M. Okada, and H. Nikawa, "Fluoresceination of Lactobacillus rhamnosus through the expression of green fluorescent protein," International Journal of Research in Engineering and Science, **4**, pp. 76-85, 2016.

[120] T. Shuto, T. Nakatani, K. Okamoto, N. Saizaki, S. Mimura, S. Kunitsugu, H. Nikawa, "Differentiation of osteoblast and osteoclast cells on hydrogenated-tetrahedral amorphous carbon coated titanium," Journal of Photopolymer Science and Technology, **29** (3), pp. 413-418, 2016.

[121] T. Tsunematsu, N. Fujiwara, M. Yoshida, Y. Takayama, S. Kujiraoka, G. Qi, M. Kitagawa, T. Kondo, A. Yamada, R. Arakaki, M. Miyauchi, I. Ogawa, Y. Abiko, H. Nikawa, S. Murakami, T. Takata, N. Ishimaru, and Y. Kudo, "Human odontogenic epithelial cells derived from epithelial rests of Malassez possess stem cell properties," Laboratory Investigation, **96**, pp. 1063-1075, 2016.

[122] 恒松美輪子, 木原琢也, 宮口英樹, 二川浩樹, 安井 弥, "大学間連携による医学・情報学・工学の異分野融合教育の実践と今後の展望:臨床情報医工学に卓越した地域の先進医療をチームで担う人材育成," 医療情報学, **36**, pp. 1018-1021, 2016.

[123] 板木咲子, 冨來博子, 山根次美, 金久弥生, 田地　豪, 吉川峰加, "指定介護療養型医療施設および介護老人保健施設における要介護高齢者の口腔清掃の現状と課題,":日本歯科衛生学会雑誌, 11 (1), 50-56, 2016.

[124] 秋葉陽介, 渡邉 恵, 峯 篤史, 池戸泉美, 二川浩樹, "歯科金属アレルギーの現状と展望　補綴主導の歯科金属アレルギー診療ガイドライン策定," 日本補綴歯科学会誌, **8** (4), pp. 327-339, 2016.

[125] 大島　浩, 二川浩樹, 下江宰司ほか, "最新歯科技工士教本「歯科理工学」全国歯科技工士教育協議会編集," 医歯薬出版（東京）, 2016.

[126] 二川浩樹, "衛生製品とその材料開発．第７節　新しい固定化抗菌剤の開発とその抗菌・抗ウィルス作用," 技術情報協会（東京）, 120-127 頁, 2016.

[127] M. Nakamura, K. Arai, T. Mimura, J. Tagawa, H. Yoshida, K. Kato, T. Nakaji-Hirabayashi, Y. Kobayashi, and T. Watanabe, "Engineering of artificial lymph node," Synthetic Immunology, T. Watanabe, Y. Takahama, eds., Springer, Chapter 9, pp.181-200, 2016.

7. List of Forthcoming or Published Papers after April 2017

[1] K. Muraoka, H. Sezaki, S. Ishikawa, T. Maeda, T. Sato, T. Kikkawa, and S-I. Kuroki, “Enhanced-Oxidation and Interface Modification on 4H-SiC(0001) Substrate Using Alkaline Earth Metal,” Mat. Sci. Forum, **897**, pp348-351, 2017.

[2] M. De Silva, T. Kawasaki, T. Kikkawa, and S-I. Kuroki, “Low Resistance Ti-Si-C Ohmic Contacts for 4H-SiC Power Devices Using Laser Annealing,” Mat. Sci. Forum, **897**, pp399-402, 2017.

[3] S-I. Kuroki, T. Kurose, H. Nagatsuma, S. Ishikawa, T. Maeda, H. Sezaki, T. Kikkawa, T. Makino, T. Ohshima, M. Östling, and C.-M. Zetterling, “4H-SiC Pseudo-CMOS Logic Inverters for Harsh Environment Electronics,” Mat. Sci. Forum, **897**, pp. 669-672, 2017.

[4] T. T. Nguyen, M. Hiraiwa, and S-I. Kuroki, “Ultrahigh-performance (100)-oriented polycrystalline silicon thin-film transistors and their microscopic crystal structures,” Appl. Phys. Express, **10**, 056501-1 -056501-4, 2017.

[5] M. De Silva, T. Kawasaki, T. Miyazaki, T. Koganezawa, S. Yasuno, and S-I. Kuroki, "Formation of epitaxial Ti-Si-C Ohmic contact on 4H-SiC C face using pulsed-laser annealing," Appl. Phys. Lett. **110**, 252108-1 - 252108-5, 2017.

[6] Y. Furubayashi, T. Tanehira, A. Yamamoto, K. Yonemori, S. Miyoshi, and S-I. Kuroki, “Peltier Effect of Silicon for Cooling 4H-SiC-based Power Devices”, ECS Transaction **80** (5), pp. 77-85, 2017.

[7] T. Tanehira, Y. Furubayashi, A. Yamamoto, K. Yonemori, S. Miyoshi, and S-I. Kuroki, “Calculation of Seebeck Coefficients for Advanced Heat Transfer Modules”, ECS Transaction **80** (5), pp. 57-62, 2017.

[8] T. T. Nguyen, M. Hiraiwa, T. Koganezawa, S. Yasuno, and S-I. Kuroki, “Formation of (100) Oriented Large Poly-Si Thin Films with Multi-Line Beam Continuous-Wave Laser Lateral Crystallization,” Jpn. J. Appl. Phys., accepted, 2017.

[9] S-I. Kuroki, T. T. Nguyen, and M. Hiraiwa, “(211) and (100) Surface Oriented Poly-Si Thin Film Transistors with Continuous-Wave Laser Lateral Crystallization,” The 17th International Meeting on Information Display (iMID2017), Busan, Korea, C35-2, 157, 2017 (Invited).

[10] M. De Silva, T. Kawasaki, and S-I. Kuroki, “Electrical properties of Ti-Si-C Ohmic contact on ion-implanted n-type 4H-SiC C face,” The International Conference on Silicon Carbide and Related Materials 2017 (ICSCRM2017), Washington, D.C., USA, TU.CP.7, 2017.

[11] K. Kobayakawa, K. Muraoka, H. Sezaki, S. Ishikawa,T. Maeda, and S.-I. Kuroki, “Effects of CF4 surface etching on 4H-SiC MOS Capacitors,” The International Conference on Silicon Carbide and Related Materials 2017 (ICSCRM2017), Washington, D.C., USA, WE.CP.9, 2017.

[12] K. Muraoka, S. Ishikawa, H. Sezaki, T. Maeda, and S.-I. Kuroki, “Correlation between field effect mobility and accumulation conductance at 4H-SiC MOS interface with barium,” The International Conference on Silicon Carbide and Related Materials 2017 (ICSCRM2017), Washington, D.C., USA, TH.CP.2, 2017.

[13] T. Kurose, S.-I. Kuroki, S. Ishikawa, T. Maeda, H. Sezaki, T. Makino, T. Ohshima, M. Östling, and C.-M. Zetterling, "Low-parasitic-capacitance self-aligned 4H-SiC nMOSFETs for harsh environment electronics," The International Conference on Silicon Carbide and Related Materials 2017 (ICSCRM2017), Washington, D.C., USA, TH.CP.3, 2017.

[14] J. Kajihara, S-I. Kuroki, S. Ishikawa, T. Maeda, H. Sezaki, T. Makino, T. Ohshima, M. Östling, and C.-M. Zetterling, "4H-SiC pMOSFETs with Al-doped S/D and NbNi silicide ohmic contacts," The International Conference on Silicon Carbide and Related Materials 2017 (ICSCRM2017), Washington, D.C., USA, WE.DP.4, 2017.

[15] Y. Furubayashi, T. Tanehira, K. Yonemori, S. Miyoshi, and S-I. Kuroki, "Peltier Effect of Silicon for cooling 4H-SiC-based power devices", 232nd Electrochemical Society Meeting , National Harbor, MD, USA, #1186, 2017 (Invited).

[16] T. Tanehira, Y. Furubayashi, A. Yamamoto, K. Yonemori, S. Miyoshi, and S-I. Kuroki, "Calculation of Seebeck Coefficients for Advanced Heat Transfer Modules", 232nd Electrochemical Society Meeting, National Harbor, MD, USA, #1177, 2017.

[17] S-I. Kuroki, "4H-SiC MOSFETs and Logic Inverters for Harsh Environment Electronics," 19th Takayanagi Kenjiro Memorial Symposium, 2017 (Invited).

[18] H. Hanafusa, W. Nakano, R. Nakashima, and S. Higashi, "Extremely High-power-density Atmospheric Pressure Thermal-Plasma-Jet Generated by Nitrogen-boost Effect," Proc. Int. Symp. Dry Process (DPS2017), Tokyo, Japan, pp. 33-34, 2017.

[19] H. Hanafusa, T. Taniguchi, and S. Higashi, "Silicidation-Less Ohmic Contact Formation on N-Type 4H-SiC with Silicon Cap Annealing," International Conference on Silicon Carbide and Related Materials (ICSCRM 2017), Washington, D.C., 2017.

[20] T. Hieda, H. Hanafusa, and S. Higashi, "Investigation on Crack suppression by Thermal-Plasma-Jet Crystallization of Amorphous Silicon Films on Flexible Glass Substrate," 231st Electrochem. Soc. (ECS) Meeting, New Orleans, LA, USA, #1019, 2017.

[21] R. Nakashima, R. Shin, H. Hanafusa, and S. Higashi, "Generation of ultra high-power thermal plasma jet and its application to crystallization of amorphous silicon films," Jpn. J. Appl. Phys. **56** (6S2), 06HE05-1 - 06HE05-4, 2017.

[22] H. Hanafusa, R. Ishimaru, and S. Higashi, "High-temperature and high-speed oxidation of 4H-SiC by atmospheric pressure thermal plasma jet," Jpn. J. Appl. Phys. **56** (4), 040304-1 - 040304-3, 2017.

[23] S. Hirata, T. Ono, Y. Amemiya, T. Tabei, and S. Yokoyama, "Influence of Surface Smoothing on Spin Seebeck Effect of Ce1Y2Fe5O12 Deposited by Metal Organic Decomposition," Jpn. J. App. Phys. **56** (4), pp. 04CN04-1-4, 2017.

[24] A. K. Sana, Y. Amemiya, and S. Yokoyama, “High-Sensitivity Double-Cavity Silicon Photonic-Crystal Resonator for Label-Free Biosensing,” Jpn. J. App. Phys. **56** (4), pp. 04CM06-1-5, 2017.

[25] A. K. Sana, J. Maeda, Shu. Yokoyama, Y. Amemiya, and S. Yokoyama, “Temperature Dependence of Resonance Characteristics of Silicon Resonators and Thermal Stability Improvement by Differential Operation Method,” Jpn. J. App. Phys. **56** (4), pp. 04CC06-1-5, 2017.

[26] Y. Amemiya, and S. Yokoyama, "Characteristics of stacked multi-slot ring resonator sensors," Sensor Review, **37** (3), pp. 357-363, 2017.

[27] T. Ono, S. Hirata, Y. Amemiya, T. Tabei, and S. Yokoyama, “Spin Seebeck Devices Using CexY3-xFe5O12 Deposited by Metal Organic Decomposition -Influence of Composition and Long Time Annealing Effect,” Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2017), Sendai, Japan, PS-12-16, pp. 999-1000, 2017.

[28] T. Ono, S. Hirata, Y. Amemiya, T. Tabei, and S. Yokoyama, “Anomalous Nernst Effect of Ni-Al Alloys and Application to Spin Seebeck Devices,” Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2017), Sendai, Japan, PS-12-12, pp. 991-992, 2017.

[29] T. Ono, S. Hirata, Y. Amemiya, T. Tabei, and S. Yokoyama, “Anomalous Nernst Effect of Ni-Al Alloys and Application to Spin Seebeck Devices,” to be published in Jpn. J. App. Phys. **57**.

[30] K. Tanimoto, Y. Amemiya, and S. Yokoyama, “Optical Waveguides with Memory Effect Using Photochromic Material for Neural Network,” Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2017), Sendai, Japan, B-4-02, pp. 97-98, 2017.

[31] A. K. Sana, Y. Amemiya, T. Ikeda, A. Kuroki, and S. Yokoyama, “Label Free Detection of Prostate Specific Antigen Using Photonic Crystal Nanocavity Resonator,” Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2017), Sendai, Japan, F-4-03, pp. 287-288, 2017.

[32] Y. Amemiya, A. K. Sana, Y. Nakashima, J. Maeda, and S. Yokoyama, “Silicon Photonic Biosensors with MEMS Flow Control,” Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2017), Sendai, Japan, H-2-02, pp. 367-368, 2017.

[33] A. Nakajima, T. Tabei, and T. Yasukawa, “Fullerene-Containing Electrically Conducting Electron Beam Resist for Ultrahigh Integration of Nanometer Lateral-Scale Organic Electronic Devices,” Scientific Reports **7**, pp. 4306-4314, 2017.

[34] K. Kusdianto, D. Jiang, M. Kubo, and M. Shimada, “Fabrication of TiO2-Ag Nanocomposite Thin Films via One-step Gas-phase Deposition, Ceramics International, **43** (6), pp. 5351-5355, 2017.

[35] M. Kubo, T. Saito, and M. Shimada, “Evaluation of the Parameters Utilized for the Aerosol-assisted Synthesis of HKUST-1,” Microporous and Mesoporous Materials, **245**, pp. 126-132, 2017.

[36] M. Kubo , T. Taguchi, and M. Shimada, “Preparation of Nanoparticle-embedded Thin Films by Simultaneous Feeding of Gaseous and Solid Raw Materials in Plasma-Enhanced Chemical Vapor Deposition process,” Thin

Soild Films, **632**, pp. 55-65, 2017.

[37] K. Kusdianto, D. Jiang, M. Kubo, and M. Shimada, “Effect of Heat Treatment on the Photocatalytic Activity of Ag-TiO2 Nanocomposite Films by One-step Gas-Phase Deposition,” Materials Research Bulletin, in press, 2017.

[38] T. Mizumo, M. Nakashima, and J. Ohshita, “Oligosiloxanes with Silatrane Moieties for Use in Lithium-ion Conductive Matrices,” Silicon, **9** (1), pp. 85-96, 2017.

[39] K. Yamamoto, S. Koge, T. Gunji, M. Kanezashi, T. Tsuru, and J. Ohshita, “Preparation of POSS-derived robust RO membranes for water desalination,” Desalination, **404**, pp. 322-327, 2017.

[40] Y. Adachi, Y. Ooyama, N. Shibayama, and J. Ohshita, “Dithienogermole-containing D-π-A-π-A Photosensitizers for Dye-sensitized Solar Cells,” Chem. Lett. **46**, pp. 310-312, 2017.

[41] M. Nakamura, K. Shigeoka, Y. Adachi, Y. Ooyama, S. Watase, and J. Ohshita, “Preparation of Dithienogermole-containing Polysilsesquioxane Films for Sensing Nitroaromatics,” Chem. Lett. **46**, pp. 438-441, 2017.

[42] K. Yamamoto, J. Ohshita, T. Mizumo, M. Kanezashi, and T. Tsuru, “Synthesis of organically bridged trialkoxysilanes bearing acetoxymethyl groups and applications to reverse osmosis membranes,” Appl. Organomet. Chem. **31**, e3580, 2017.

[43] L. Yu, M. Kanezashi, H. Nagasawa, J. Oshita, A. Naka, and T. Tsuru, “Pyrimidine-bridged organoalkoxysilane membrane for high-efficiency CO2 transport via mild affinity,” Separation and Purification Technology, **178**, pp. 232–241, 2017.

[44] J. Ohshita, Y. Adachi, R. Sagisaka, M. Nakashima, Y. Ooyama, and Y. Kunugi, “Synthesis of dithienogermole-containing Polythiophenes,” Syn. Met. **227**, pp. 87-92, 2017.

[45] K. Yamamoto, M. Kanezashi, T. Tsuru, and J. Ohshita, “Preparation of bridged polysilsesquioxane-based membranes containing 1,2,3-triazole moieties for water desalination,” Polym J. **49**, pp. 401-406, 2017.

[46] F.-B. Zhang, Y. Ooyama, and J. Ohshita, “Synthesis of (Benzofurano)(benzothieno)germole,” Chem. Select, **2**, pp. 3106-3109, 2017.

[47] J. Ohshita, T. Tsuchida, K. Komaguchi, K. Yamamoto, A. Adachi, Y. Ooyama, Y. Harima, and K. Tanaka, “Studies on Spherically Distributed LUMO and Electron-Accepting Properties of Caged Hexakis(germasesquioxane)s,” Organometallics, **36**, pp. 2536-2540, 2017.

[48] M. Tanabe, T. Hagio, K. Osakada, M. Nakamura‡ Y. Hayashi, and J. Ohshita, “Synthesis of 4,4-Dihydrodithienosilole and Its Unexpected Cyclodimerization Catalyzed by Ni and Pt Complexes,” Organometallics, **36**, 1974-1980, 2017.

[49] L. Yu, M. Kanezashi, H. Nagasawa, J. Ohshita, A. Naka, and T. Tsuru, “Fabrication and Microstructure Tuning of a Pyrimidine-Bridged Organoalkoxysilane Membrane for CO2 Separation,” Ind. Eng. Chem. Res. **56**, pp. 1316–1326, 2017.

[50] K. Yamamoto, S. Koge, K. Sasahara, T. Mizumo, Y. Kaneko, M. Kanezashi, T. Tsuru, and J. Ohshita, "Preparation of bridged polysilsesquioxane membranes from bis[3-(triethoxysilyl)propyl]amine for water desalination," Bull. Chem. Soc. Jpn, **90**, pp. 1035-1040, 2017.

[51] X. Zhang, F. An, I. Nakashima, A. Luo, L. Chen, I. Ishii, and H. J. Mattausch, "A hardware-oriented HOG algorithm and its VLSI implementation," Jpn. J. Appl. Phys. **56** (4) SI, pp. 04CF01 1-7, 2017.

[52] A. Luo, F. An, Y. Fujita, X. Zhang, L. Chen, and H. J. Mattausch, "Low-Power Coprocessor for Haar-Like Feature Extraction with Pixel-Based Pipelined Architecture," Jpn. J. Appl. Phys. **56** (4) SI, pp. 04CF06 1-9, 2017.

[53] F. An, X. Zhang, A. Luo, L. Chen, and H. J. Mattausch, "A Hardware Architecture for Cell-based Feature-Extraction and Classification Using Dual-Feature Space," IEEE Trans. on Circuits and Systems for Video Technology, **27**, in press, 2017.

[54] J. Guan, F. An, X. Zhang, L. Chen, and H. J. Mattausch, "Parallelization of Hough Transform for High-Speed Straight-Line Detection in XGA-Size Videos," Proceedings of the IEEE International Conference on Consumer Electronics (ICCE-TW'2017), Taipei, Taiwan, pp. 315-316, 2017.

[55] A. Luo, F. An, X. Zhang, L. Chen, and H. J. Mattausch, "Reconfigurable Block-based Normalization Circuit for On-chip Object Detection", Extend. Abst. Int. Conf. on Solid State Devices and Materials (SSDM2017), Sendai, Japan, in press, 2017.

[56] T. Kasama, W. P. Bula, Y. Endo, T. Koide, T. Okamoto, A-T. Hoang, M. Komine, A. Ogawa, C. Sone, and R. Miyake," Development of novel hydroponic culture system for real-time montoring of root and leaf lettuces", Proc. of 7th int. multidisciplinary conf. of optfluidics 2017, Singapore, 2017.

[57] W. P. Bula, T. Kasama, Y. Endo, T. Koide, Y. Yaji, and R. Miyake," 3D printed microfluidic platform for non-invasive smart agriculture sample collection", Proc. of the 9th Int. Symposium on Microchemistry and Microsystems (ISMM 2017), Tasmania, Austraria, 2017.

[58] W. P. Bula, T. Kasama, Y. Endo, T. Koide, Y. Yaji, and R. Miyake," Low cost field-deployable environmental sensor network for smart agriculture", Proc. of the 9th Int. Symposium on Microchemistry and Microsystems (ISMM 2017), Tasmania, Austraria, 2017.

[59] 岡本 拓巳, 小出 哲士, 玉木 徹, Bisser Raytchev, 金田 和文, 吉田 成人, 三重野 寛, 田中 信治, 戸石 浩司, 菅原 崇之, 辻 雅之, 小田川 真之, 丹場 展雄, "CNN 特徴と SVM 分類を適用した大腸内視鏡画像がん診断支援システムのカスタマイザブル DSP コアへの実装," Design Automation シンポジウム (DA シンポジウム 2017), 4A-2, pp. 1-6, 2017.

[60] 岡本 拓巳, 小出 哲士, 玉木 徹, Bisser Raytchev, 金田 和文, 吉田 成人, 三重野 寛, 田中 信治, "リアルタイム大腸内視鏡画像診断支援システムのための CNN 特徴と SVM 分類を用いた識別手法," Design Automation シンポジウム (DA シンポジウム 2017), 4A-1, pp. 1-6, 2017.

[61] 小出哲士, 岡本拓巳, A.-T. Hoang, 笠間敏博, W. P. Bula, 遠藤喜重, 三宅 亮, 小川敦史, 小峰正史,

曽根千晴，金田吉弘，矢冶幸夫，“レタスの水耕栽培における葉と根のリアルタイム生長分析，” 第 20 回画像の認識・理解シンポジウム(MIRU2017), PS3-9, 2017.

[62] 岡本 拓巳，小出 哲士, Anh-Tuan Hoang, 玉木 徹，平川 翼, Bisser Raytchev, 金田 和文，吉田 成人，三重野 寛，田中 信治，“大腸 NBI 拡大内視鏡を用いた大腸ガン診断支援システム，” 第 20 回画像の認識・理解シンポジウム(MIRU2017), DS-8, 2017.

[63] 小出哲士，岡本拓巳，A.-T. Hoang，笠間敏博，W. P. Bula，遠藤喜重，三宅 亮，小川敦史，小峰正史，曽根千晴，金田吉弘，矢冶幸夫，“レタスの水耕栽培における葉と根の生長分析のための画像解析の一手法，” 第 23 回画像センシングシンポジウム (SSII2017), IS1-11, SO1-IS1-11, 2017.

[64] M. Fujishima, and S. Amakawa, “Integrated-Circuit Approaches to THz Communications: Challenges, Advances, and Future Prospects,” IEICE TRANSACTIONS on Fundamentals of Electronics, Communications and Computer Sciences, **100** (2), pp. 516-523, 2017.

[65] T. A. Vu, and M. Fujishima, “A 300 GHz CMOS Transmitter Front-End for Ultrahigh-Speed Wireless Communications,” International Journal of Electrical and Computer Engineering (IJECE), **7** (4), 2017.

[66] K. Takano, S. Amakawa, K. Katayama, S. Hara, R. Dong, A. Kasamatsu, I. Hosako, K. Mizuno, K. Takahashi, T. Yoshida, and M. Fujishima, “17.9 A 105Gb/s 300GHz CMOS transmitter,” 2017 IEEE International Solid-State Circuits Conference (ISSCC), pp. 308-309, 2017.

[67] A. Takeshige, K. Katayama, S. Amakawa, K. Takano, T. Yoshida, and M. Fujishima, “DC and RF characterization of RF MOSFET embedding structure,” 2017 International Conference of Microelectronic Test Structures (ICMTS), pp. 1-5, 2017.

[68] A. Takeshige, Y. Ito, K. Takano, K. Katayama, T. Yoshida, M. Fujishima, and S. Amakawa, “Causal transmission line model incorporating frequency-dependent linear resistors,” 2017 IEEE 21st Workshop on Signal and Power Integrity (SPI), pp. 1-4, 2017.

[69] K. Katayama, S. Amakawa, K. Takano, T. Yoshida, M. Fujishima, K. Hisamitsu, and H. Takatsuka, “An 80–106 GHz CMOS amplifier with 0.5 V supply voltage,” 2017 Radio Frequency Integrated Circuits Symposium (RFIC), pp. 308-311, 2017.

[70] K. Takano, K. Katayama, S. Amakawa, T. Yoshida, and M. Fujishima, “56-Gbit/s 16-QAM Wireless Link With 300-GHz-Band CMOS Transmitter,” 2017 IEEE International Microwave Symposium (IMS2017), pp. 1-4, 2017.

[71] S. Hara, K. Katayama, K. Takano, R. Dong, I. Watanabe, N. Sekine, A. Kasamatsu, T. Yoshida, S. Amakawa, and M. Fujishima, “A 32 Gbit/s 16QAM CMOS Receiver in 300 GHz Band,” 2017 IEEE International Microwave Symposium (IMS2017), pp. 1-4, 2017.

[72] K. Takano, S. Amakawa, T. Yoshida, and M. Fujishima, “A figure of merit for terahertz transceiver modules,”Vietnam Japan Microwave 2017 Conference (VJMW 2017), 2017.

[73] S. Kohara, S. Amakawa, T. Yoshida, and M. Fujishima, “Noise-figure optimization of a multi-stage millimeter-wave amplifier with negative capacitance feedback,” 2017 Thailand-Japan Microwave (TJMW2017), 2017.

[74] K. Katayama, K. Takano, S. Amakawa, T. Yoshida, and M. Fujishima, “2.37-dBm-output 288-310 GHz frequency multiplier in 40 nm CMOS,” 2017 IEEE International Symposium on Radio-Frequency Integration Technology (RFIT2017), 2017.

[75] S. Hara, K. Katayama, K. Takano, R. Dong, I. Watanabe, N. Sekine, A. Kasamatsu, T. Yoshida, S. Amakawa, and M. Fujishima, “A 416-mW 32-Gbit/s 300-GHz CMOS receiver,” 2017 IEEE International Symposium on Radio-Frequency Integration Technology (RFIT2017), 2017.

[76] T. A. Vu, K. Takano, and M. Fujishima, “A 300 GHz single varactor doubler in 40 nm CMOS,” 2017 IEEE International Symposium on Radio-Frequency Integration Technology (RFIT2017), 2017.

[77] Y. Takeuchi, M. Sekiya, A. Hamasaki, M. Iwasaka, and M. Matsuda, “Magnetic orientational properties of monosodium urate crystals,” IEEE Transactions on Magnetics **53** (11), 5000404, 2017.

[78] Y. Takanezawa, H. Kashiwagi, and M. Iwasaka, “Remote sensing of microfluidic tracers by light scattering from microcrystals under magnetic fields,” AIP Advances **7** (5), 056732, 2017.

[79] H. Kashiwagi, Y. Mizukawa, M. Iwasaka, and S Ohtsuka, “Magnetic light cloaking control in the marine planktonic copepod Sapphirina,” AIP Advances **7** (5), 056731, 2017.

[80] H. Kashiwagi, A. Kashiwagi, and M. Iwasaka, “Effect of magnetic fields on green color formation in frog skin,” AIP Advances **7** (5), 056426, 2017.

[81] M. Iwasaka, K. Tagawa, and Y Kikuchi, “Magnetically tunable control of light reflection in an unusual optical protein of squid,” AIP Advances **7** (5), 056722, 2017.

[82] M. Iwasaka, and S. Ohtsuka, “Modulation of light localization in the iridophores of the deep-sea highlight hatchetfish Sternoptyx pseudobscura under magnetic field,” AIP Advances **7** (5), 056710, 2017.

[83] I. Mogi, M. Iwasaka, R. Aogaki, and K. Takahashi, “Communication—Visualization of Magnetohydrodynamic Micro-Vortices with Guanine Micro-Crystals,” Journal of The Electrochemical Society **164** (9), H584-H586, 2017.

[84] T. Uchida, M. Imamura, H. Kan, N. Hiraga, C. N. Hayes, M. Tsuge, H. Abe-Chayama, H. Aikata, G. N. Makokha, D. Miki, H. Ochi, Y. Ishida, C. Tateno, and K. Chayama, “Usefulness of humanized cDNA-uPA/SCID mice for the study of hepatitis B virus and hepatitis C virus virology,” J Gen Virol. **98**, pp. 1040-1047,2017.

[85] C. N. Hayes, and K. Chayama, “Interferon stimulated genes and innate immune activation following infection with hepatitis B and C viruses,” J Med Virol. **89**, pp. 388-396, 2017.

[86] C. N. Hayes, and K. Chayama, “Why highly effective drugs are not enough: the need for an affordable solution to eliminating HCV,” Expert Rev Clin Pharmacol. **10**, pp. 583-594, 2017.

[87] M. Tsuge, T. Uchida, N. Hiraga, H. Kan, G. N. Makokha, H. Abe-Chayama, D. Miki, M. Imamura, H. Ochi, C. N. Hayes, R. Shimozono, T. Iwamura, H. Narumi, T. Suzuki, M. Kainoh, T. Taniguchi, and K. Chayama, ”Development of a Novel Site-Specific Pegylated Interferon Beta for Antiviral Therapy of Chronic Hepatitis B Virus,” Antimicrob Agents Chemother. **61**, 2017.

[88] K. Morio, M. Imamura, Y. Kawakami, T. Nakahara, Y. Nagaoki, T. Kawaoka, M. Tsuge, A. Hiramatsu, H. Aikata, C. N. Hayes, G. N. Makokha, H. Ochi, H. Amano, K. Arataki, T. Moriya, H. Ito, K. Tsuji, H. Kohno, K. Waki, T. Tamura, T. Nakamura, K. Chayama, and Hiroshima Liver Study G, “ITPA polymorphism effects on decrease of hemoglobin during sofosbuvir and ribavirin combination treatment for chronic hepatitis C” J Gastroenterol. **52**, pp. 746-753, 2017.

[89] T. Uchida, M. Imamura, C. N. Hayes, N. Hiraga, H. Kan, M. Tsuge, H. Abe-Chayama, Y. Zhang, G. N. Makokha, H. Aikata, D. Miki, H. Ochi, Y. Ishida, C. Tateno, and K. Chayama, “Persistent Loss of HBV Markers in Serum without Cellular Immunity by Combination of PEG-IFN Plus ETV Therapy in Humanized Mice,” Antimicrob Agents Chemother. in press, 2017.

[90] Y. Yanase, S. Morioke, K. Iwamoto, S. Takahagi, K. Uchida, T. Kawaguchi, K. Ishii, I. Hide, and M. Hide, “Histamine and TLR ligands synergistically induce endothelial-cell gap-formation by the extrinsic coagulating pathway,” J Allergy Clin Immunol. in press, 2017.

[91] Y. Yanase, S. Takahagi, and M. Hide, “Chronic spontaneous urticaria and the extrinsic coagulation system,” Allergol Int. in press, 2017.

[92] M. Okazaki, M. Furuta, A. Matsugaki, T. Nakano, I. Hirata, K. Kato, T. Oda, and M. Sato, “Molecular level analyses of mechanical properties of PTFE sterilized by Co-60 gamma-ray irradiation for clinical use,” Radiation Phys. Chem. **139,** pp. 126-131, 2017.

Telephone, Facsimile, and E-mail

常任スタッフ連絡先 (2016年12月1日現在)

	Telephone International/Domestic 国外／国内	Facsimile International/Domestic 国外／国内	e-mail address
Director／所長			
Prof. Takamaro Kikkawa 吉川 公麿 教授	+81-82-424-6265 082-424-6265	+81-82-424-3499 082-424-3499	kikkawat@hiroshima-u.ac.jp
Nanointegration Research Division／ナノ集積科学研究部門			
Prof. Takamaro Kikkawa 吉川 公麿 教授	+81-82-424-7879 082-424-7879	+81-82-424-3499 082-424-3499	kikkawat@hiroshima-u.ac.jp
Prof. Shin Yokoyama 横山 新 教授	+81-82-424-6266 082-424-6266	+81-82-424-3499 082-424-3499	yokoyama-shin@hiroshima-u.ac.jp
Assoc. Prof. Anri Nakajima 中島 安理 准教授	+81-82-424-6274 082-424-6274	+81-82-424-3499 082-424-3499	anakajima@hiroshima-u.ac.jp
Assoc. Prof. Shin-Ichiro Kuroki 黒木 伸一郎 准教授	+81-82-424-6267 082-424-6267	+81-82-424-3499 082-424-3499	skuroki@hiroshima-u.ac.jp
Assoc. Prof. Tetsuo Tabei 田部井 哲夫 特任准教授	+81-82-424-6265 082-424-6265	+81-82-424-3499 082-424-3499	tabei@hiroshima-u.ac.jp
Assist. Prof. Yoshiteru Amemiya 雨宮 嘉照 特任助教	+81-82-424-6265 082-424-6265	+81-82-424-3499 082-424-3499	amemiya@hiroshima-u.ac.jp
Integrated Systems Research Division／集積システム科学研究部門			
Prof. Hans Jürgen Mattausch マタウシュ ハンス ユルゲン 教授	+81-82-424-6268 082-424-6268	+81-82-424-3499 082-424-3499	hjm@hiroshima-u.ac.jp
Assoc. Prof. Tetsushi Koide 小出 哲士 准教授	+81-82-424-6971 082-424-6971	+81-82-424-3499 082-424-3499	koide@hiroshima-u.ac.jp
Molecular Bioinformation Research Division／分子生命情報科学研究部門			
Prof. Masakazu Iwasaka 岩坂 正和 教授	+81-82-424-4372 082-424-4372	+81-82-424-3499 082-424-3499	iwasaka@iroshima-u.ac.jp
Nanotechnology Platform／ナノテクノロジー・プラットフォーム			
Assoc. Prof. Tetsuo Tabei 田部井 哲夫 特任准教授	+81-82-424-6265 082-424-6265	+81-82-424-3499 082-424-3499	tabei@hiroshima-u.ac.jp

Research Institute for Nanodevice and Bio Systems (RNBS), Hiroshima University
1-4-2 Kagamiyama, Higashihiroshima, Hiroshima 739-8527, JAPAN
広島大学ナノデバイス・バイオ融合科学研究所
〒739-8527 広島県 東広島市 鏡山1丁目 4-2

Tel 082-424-6265, Fax 082-424-3499
e-mail RNBS@hiroshima-u.ac.jp
URL http://www.RNBS.hiroshima-u.ac.jp/