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# MEMOIRS OF THE

# Institute of Scientific and Industrial Research

ISIR
OSAKA UNIVERSITY

# Contents

# Foreword

## At the departure of the Network Joint Research Center and the new stage of the academia-industry relationship

**Akihito Yamaguchi**
**Director, Institute of Scientific and Industrial Research**

Japan's first nation-wide national university's collaboration network named "Network Joint Research Center for Materials and Devices" has been started on 1st April, 2010. In addition, SANKEN Incubation Building including Osaka University's first on-campus rental laboratories for private corporations (Company Research Park) as a novel open innovation core has been completed in April, 2010. On the basis of these two epoch-making achievements in addition to the reorganization of ISIR in last year toward the new stage of our multidisciplinary research, ISIR stands at the starting point for developing our new history.

ISIR was founded in 1939 with only 3 laboratories by the financial support from industries of KANSAI area to promote basic science for the development of industry. From then, ISIR has emphasized basic and applied researches to promote the multidisciplinary science for ultimate contribution to the industries in three main research areas, i.e., material science, information science and bio-science. In 2002, we founded the Japan's first university-attached Nanoscience & Nanotechnology Center. At present, we have 27 full-size laboratories divided into three divisions, i.e., Division of Information and Quantum Sciences, Division of Materials and Beam Sciences, and Division of Biological and Molecular Sciences, and Nanoscience & Nanotechnology Center. Now we aim to develop multidisciplinary sciences focusing Green Nanoscience and Bio-Nanoscience.

ISIR has also close contact with six graduate schools of Osaka University including Graduate Schools of Engineering, Science, Engineering Science, Pharmaeutical Science, Frontier Bioscience and Information Science and Technology. Started from 2010, we promote the Strategic Alliance Project for Creation of Nano-Materials, Nano-devices and Nano-systems with five university-attached institutes, i.e., RIES of Hokkaido Univ., IMRAM of Tohoku Univ., CRL of Tokyo Inst. Tec., ISIR of Osaka Univ. And IMCE of Kyushu Univ.

This publication "Memoirs of the Institute of Scientific and Industrial Research (ISIR)" is our annual publication summarizing the scientific activities of ISIR. We hope this annual publication will be useful and stimulating for all researchers and young scientists outside as well as inside our institute.

ISIR will continue to make contributions to the development of industry through basic science and technology and inspire the future.

# Outline of ISIR

## 1. Research Activities

### 1) History and Organization

The Institute of Scientific and Industrial Research (ISIR) was founded in 1939 as a part of Osaka University, based on the strong desire of the business leaders of private enterprises in Osaka area. The purpose of the Institute is to study science necessary for industry and their applications. Since then, the institute had developed into one of the leading research organizations for science and engineering in Japan.

In 1939 ISIR had only 3 departments, however it had increased research areas and laboratories in the fields of electronic engineering, computer science, metallurgy and inorganic chemistry, organic chemistry, biochemistry, and beam science.

Modern industry in this country is, however, coming to a major turning point. There is a strong requirement to develop interdisciplinary sciences, or new fields which are away from conventional area in order to advance basic and applied sciences coping with social changes.

Since this Institute has researchers in a wide variety of fields and is suitable for making a new organization for interdisciplinary areas, it was restructured in 1995 to an Institute with 6 divisions with 24 departments for the purpose of promoting sciences on materials, information and biology. For solving problems related to energy, earth ecology, aging and advanced information technology, interdisciplinary and comprehensive studies have been conducted in the Institute. From 2002 through 2006, we have awarded as the best group in 21st Century COE program that is originally the top 20 group plan in Japan. This involves the positive exchange between different laboratories which yield results of the global level with respect to material, information and biotechnology.

In 2002, Nanoscience and Nanotechnology Center has started after restructuring Research Center for Intermaterials and Radiation Laboratory. The new Center focuses its research on nanomaterials and devices, beam science for nanotechnology and industrial nanotechnology. In 2003, the Center Building was constructed. In the new Center Building, there is a Nanotechnology Process Foundry for supporting the nationwide research in the nanotechnology field.

In 2006, Materials Science &Technology Research Center for Industrial Creation between ISIR and IMRAM (Tagenken) in Tohoku Univ. has started and then expanded to the Post-Silicon Materials and Devices Research Alliance including RIES

(Denshiken) in Hokkaido Univ. and CRL (Shigenken) in TIT next year. In 2006, Academia Industry Relation Office (AIR-Office) has been settled in order to strengthen cooperation between the institute and industries. In 2008, Division of special project has been founded for promotion of research by young faculties.

In 2009, we have made a great restructuring since 1995 in order to develop the novel interdisciplinary research fields and exercise leadership in nanotechnology research field into 3 great divisions (Division of Information and Quantum Sciences, Division of Material and Beam Sciences, and Division of Biological and Molecular Sciences) and expanded Nanoscience and Nanotechnology Center. We newly established the Center for Research Education and Training and the Center for International Collaboration. Former Materials Analysis Center was joined with Electron Microscope Laboratory and restricted into the Comprehensive Analysis Center. Research Laboratory for Quantum Beam Science was separated from Nanoscience and Nanotechnology Center for facilitating the collaboration in the beam science field.

In order to establish a core for academia-industry collaboration and open innovation, we constructed the SANKEN Incubation Building including Osaka University's first on-campus rental laboratories for private corporations (Company Research Park) in 2010. ISIR Manufacturing Factory has been moved into the building. In addition, Nanoscience Techno-Core, Company Research Park and Osaka University Renovation Center was settled in the building.

In 2010, the Network Joint Research Center for Materials and Devices including ISIR, IMRAM, RIES, CRL and IMCE (Sendoken) in Kyushu Univ. has been started. ISIR is a headquarters of this 5 institutes network.

| Divisions | Departments |
|---|---|
| **Division 1** | |
| **Information & Quantum Sciences** | Photonic and Electronic Materials |
| | Semiconductor Electronics |
| | Advanced Electronics |
| | Intelligent Media |
| | Reasoning for Intelligence |
| | Knowledge Systems |
| | Architecture for Intelligence |
| | Quantum Information Photonics |
| | (Alliance Laboratory of ISIR, Osaka Univ. and RIES, Hokkaido Univ.) |
| **Divison 2** | |
| **Advanced Materials &** | Quantum Functional Materials |
| **Beam Science** | Semiconductor Materials and Processes |
| | Metallic Materials Process |
| | Advanced Interconnection Materials |
| | Excited Solid-State Dynamics |
| | Accelerator Science |
| | Beam Materials Science |
| **Division 3** | |
| **Biological & Molecular Sciences** | Molecular Excitation Chemistry |
| | Synthetic Organic Chemistry |
| | Regulatory Bioorganic Chemistry |
| | Organic Fine Chemicals |
| | Structural Molecular Biology |
| | Cell Membrane Biology |
| | Biomolecular Energetics |
| **Next Industry Generation** | New Industrial Projection |
| | New Industry Generation System(s) |
| | Intellectual Property Research |
| **Special Projects** | |
| **Laboratories of 1st Project** | |
| **Laboratories of 2nd Project** | Laboratory of Microbiology and Infections Diseases |
| | Laboratory of Atomic Scale Materials Processing |
| **Laboratories of 3rd Project** | Beam Application Frontier Research Laboratory |
| | Department of Disease Glycomics (Seikagaku Corporation-Endowed Chair) |

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**Research Centers**

**Nanoscience and Nanotechnology Center**

Functional Nanomaterials and Nanodevices
Advanced Nanofabrication
Nanocharacterization for Nanostructures and Functions
Theoretical Nanotechnology
Soft Nanomaterials
Bio-Nanotechnology
Nanotechnology Environmental and Energy Applications
Nano-Inteligent Systems
Nanodevices for Medical Applications
Nanosystem Design
Nanodevice Characterization
Nanotechnology for Industrial Applications
Simulation for Nanotechnology
Nanoelectronics
Nano-Function Characterization
Nano-Medicine
Nano-Biology
Nano Information Technology

**Open Laboratory**

**Nanofabrication Shop**

**Advance Nanotechnology Instrument Laboratory**

**Handai Multi-Functional Nanofoundry**

**Comprehensive Analysis Center**
**Research Laboratory for Quantum Beam Science**
**Center for Research Education and Training**
**International Collaboration Center**
**Materials Science & Technology Research Center for Industrial Creation**

| | |
|---|---|
| **Materials Research Project** | Hard Materials Research Group |
| | Soft Materials Research Group |
| **Human Interface Research for** | Medical Sciences Research Group |
| **Safety and Security Project** | Human Interface Research Group |

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**Nano –Macro Materials, Devices and System Research Alliance**

Next Generation Electronics Research Group
New Energy Harvesting Materials and Devices Research Group
Medical Treatment Materials and Devices Research Group
Environmental Harmonized Materials and Devices Research Group

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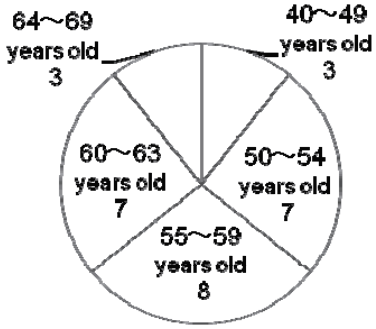
**Service Facilities**

Workshop
Laboratory for Radio-Isotope Experiments
Electronic Processing Laboratory
Office of Information Network

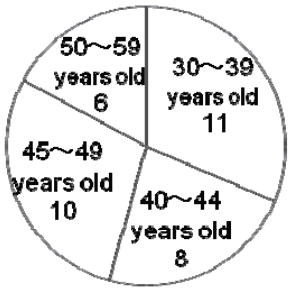
| | |
|---|---|
| | Academia Industry Relations Office |
| | Public Relations Office |
| | Library |
| **Technical** | Machine Group |
| | Measurement Group |
| **Administrative Office** | Facilities Planning Office |
| | General Affairs Division |
| | Research Cooperation Division |

## Staffs' Age (years old) –As of 3.31.2011

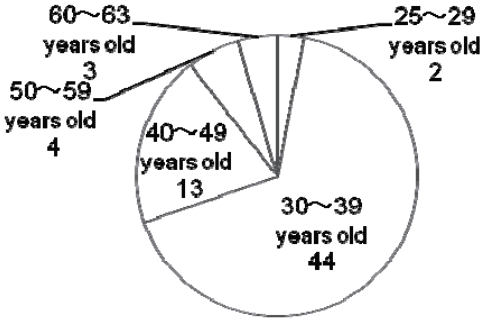
**Professors**




**Associate Professors**

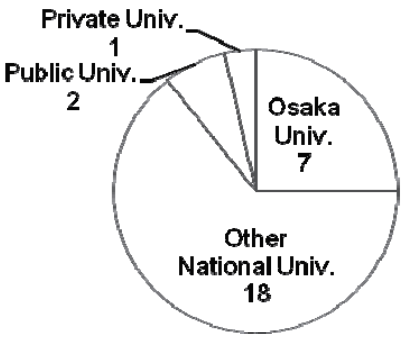



**Assistant Professors**

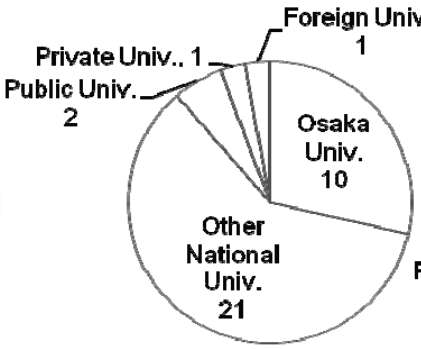



## Staffs' Alma Master –As of 3.31.2011

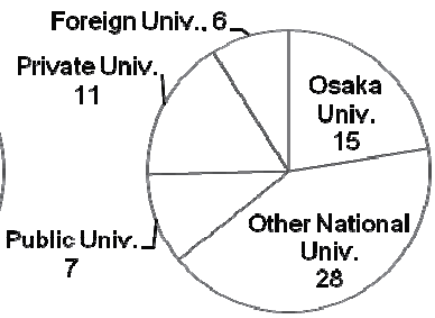
**Professors**




**Associate Professors**




**Assistant Professors**




### 2) Administration

Administration and management of ISIR are conducted by the Director elected from the full professors of ISIR. The term of the Director is two years. Reappointment is possible, but the Director can not be in the position for more than 4 years. Professor Akihito Yamaguchi has been a Director since April 1, 2008.

Important matters of ISIR are discussed and determined by the Faculty Council, which consists of the Director and all professors of ISIR. Various committees such as

International Exchange, Self-Review, Circumstances and so on are working for each purpose.

Administration of the Institute-associated Centers is conducted by Director of each Center and its Executive Committee.

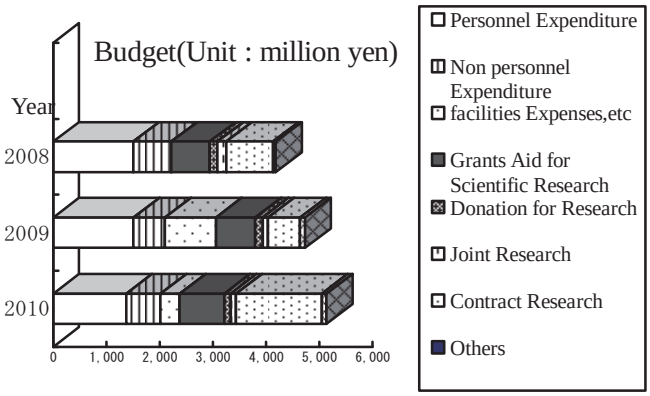
Evaluation Committee composed of outside experts in academic societies was established and the committee evaluated several items such as management, budget, facilities and research activities.

The new organization was highly evaluated, but with change of their structure to National University Agencies in April 2004, our management system needs reshaping. A Board of Directors under the Director has been formed, and Advisory Board has been set up to introduce opinions from outside into the Institute.

### 3) Research Budget

The budget of ISIR is mainly composed of Subsidy for operating expenses, Grants-in-Aid for Scientific Research of Ministry of Education, Sports, Culture, Science and Technology, Donations for Research, and Budget of Joint Research. The recent trend in the expenditure of ISIR is as follows.

Grants-in Aid for Scientific Research of Ministry of Education, Culture, Sports, Science and Technology are delivered to researchers and the total budget in 2010 is 842,733,000yen.




Donation for Research

Donation for Research is accepted after the Judgement of Committee and the amount are as follows.

(Unit : kilo yen , ( ) Number)

| Division / Year | Information and Quantum Sciences | Advanced Materials and Beam Science | Biological and Molecular Sciences | Nanoscience and Nanotechnology Center |
|---|---|---|---|---|
| 2010 | 7, 800 (8) | 20, 702 (17) | 17, 715 (21) | 1, 850 (2) |

| Division / Year | Special Projects | Others | Total |
|---|---|---|---|
| 2010 | 4, 000 (2) | 4, 000 (7) | 56, 067 (57) |

**4) Cooperative Research**

Cooperative Researches and Contract Researches in the fiscal year 2010-2011 are as follows: Cooperative Researches are carried out with 43 organizations and the budget for the fiscal year 2010-2011 is 102,482,000 yen. The number of Contract Researches is 44 and the budget for the fiscal year 2010-2011 is 1,607,336,000 yen.

**5) International Research**

| | | | |
|---|---|---|---|
| Department of Intelligent Media | Peking University | China | Computer vision |
| Department of Intelligent Media | MIT | USA | Computer vision |
| Department of Intelligent Media | MSRA | China | Computer vision |
| Department of Advanced Electron Devices | Canbridge University | UK | Elucidating electronic properties of polymers and organic crystals |
| Department of Semiconductor Material and Processes | Slovak Academy of Science | Slovakia | Development of low temperature semiconductor processes and spectroscopic and electrical analyses |
| Department of Semiconductor Material and Processes | Inner Mongolia Normal University | China | Development of nitric acid oxidation method |
| Department of Molecular Excitation Chemistry | Jongbuk National University | Korea | Study on Energy and Electron Transfer Using Two-color Two-lasers |
| Department of Molecular Excitation Chemistry | Konkuk University | Korea | Study on OLED of π-Conjugated Polymer Thin Films |
| Department of Molecular Excitation Chemistry | Korea University | Korea | Study on Next-generation Solar Responsible New Materials |
| Department of Molecular | POSTECH | Korea | Study on Visible-light Responsible TiO2 |

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|---|---|---|---|
| Excitation Chemistry | | | Photocatalyst |
| Department of Molecular Excitation Chemistry | National Taiwan University | Taiwan | Study on Rapid Excitation Energy Transfer in Supramolecules and Oligomers |
| Department of Molecular Excitation Chemistry | National Tsing-Hua University | Taiwan | Study on Developmment of Light-emitted Materials Based on Quinoxaline/Diphenylfluorene and cis-Stilbene/Fluorene Ortho Connected Molecules |
| Department of Knowledge Systems | Laboratory for Applied Onotology, Delft University of Technology,etc. | EU(Italy, Netherlands, Poland） | EU the Marie Curie "EuJoint" project (IRSES 247503) |
| Fepartment of Regulatory Bioorganic chemistry | K.U.Leuven, Massachusetts Institute of Technology, Harvard University | USA,Belgium | The biological role of repeat sequences in genomes |
| Fepartment of Regulatory Bioorganic chemistry | National University of Singapore | Singapore | The Virus detection method using hairpin primer with 2,7-diamino-1,8-naphthyridine derivative |
| Department of Biomolecular Energetics | Sutuugart University | Germany | Single-molecule measurement of rotation speed of ATP synthase working in living cells |
| Dept. of Excited Solid-Stae Dynamics | University College London | UK | Excited Surface Science |
| Department of Nanocharacterization for Nanostructures and Functions | Utrecht University | Netherlands | Structural transformation of gold nanorods in gases |
| Department of Nanocharacterization for Nanostructures and Functions | Lawrence Berkeley National Laboratory | USA | High resolution TEM observations of Au nanoparticles supported on metal oxides catalysts |
| Department of Accelerator Science | Synchrotron Light Research Institute | Thailand | Development of a Superconducting Multipole Wiggler |
| Department of Organic fine Chemicals | Max Planck Society, Chemical Genomics | Germany | Modulation of 14-3-3 Protein Functions by Small Molecules |

| | | | |
|---|---|---|---|
| | Centre | | |
| Department of Cell Membrane Biology | Franch National Institute for Agricultural Research | France | Identification of intrinsic and environmental regulations of the Ram locus involved in the multidrug resistance of Salmonella |
| Department of Advanced Interconnection Materials | Siemens | Germany | A study on the advanced lead-free packaging |
| Department of Synthetic Organic Chemistry | University of Bourgoge | France | Application of P-Chirogenic Compounds |
| Department of Synthetic Organic Chemistry | RWTH Aachen University | Germany | Development of Asymmetric Organocatalysis |
| Department of Functional Nanomaterials and Nanodevices | CNR | Italy | Oxide MEMS |
| Department of Functional Nanomaterials and Nanodevices | Indian Academy of Sciences | India | Oxide Nanospintronics |
| Department of Architecture for Intelligence | De La Salle University | Philippine | Empathic Computing |
| Department of Metallic Materials Process | Fraunhofer | Germany | Fabrication of lotus-type porous Mg alloy |
| Department of Metallic Materials Process | Inha university | Korea | Fabrication and mechanical properties of Lotus type porous NiAl |
| Laboratories of third project | Universite Paris-Sud | France | Formation of Metal Nanoparticles in Polymer Films by ionizing radiation |

## 6) Symposia, Seminars, Workshops and Lectures

| | |
|---|---|
| 2010/5/6～10 | International Workshop on Organic Field-effect Transistors and Functional Interfaces |
| 2010/5/14 | Comprehensive Ａnalysis Center　1st　Year Anniversary Seminar |
| 2010/6/14 | Symposium on Nanonet EB Lithography |
| 2010/7/11～12 | Symposium on Molecular Chirality 2010 |
| 2010/8/6～7 | The 2nd SANKEN Nanotechnology Young Scientist Seminar |
| 2010/8/20～21 | Emergence in Chemistry Second Annual Meeting |
| 2010/9/3～4 | FIRST project Briefing session at the midterm of 2010 |

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|---|---|
| 2010/9/14～17 | The 71st Autumn Meeting, 2010,The Japan Society of Applied Physics |
| 2010/9/26 | Research meeting for functional porous materials |
| 2010/10/1～3 | Japan-Korea Symposium on Organometallic Chemistry |
| 2010/10/6～9 | 7th International Symposium on Chemistry and Biological Chemistry of Vanadium |
| 2010/10/23-26 | 2010 Korea-Japan International Symposium on Frontier Photoscience |
| 2010/11/17～18 | International EUV Resist Symposium |
| 2010/11/18～20 | The 36th Annual Symposium of The Japan Bioenergetics Group & Symposium of "Innovative Nanoscience of Supermolecular Motor Proteins" |
| 2010/11/22 | 66th Symposium on a special topic and subsequent conference for presenting results of research activities made by the members of the Institute |
| 2010/12/11 | 6th International Symposium on Boron, Bordies and Related Materials |
| 2010/12/15～17 | Pacifichem2010, Metal Catalysis for Asymmetric Synthesis |
| 2011/1/24～26 | ISSMA2011 International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules |
| 2011/1/25～26 | The 14th SANKEN International Symposium / The 9th SANKEN Nanotechnology Symposium |
| 2011/1/27 | International Workshop on Promotion of Nanoscience and Nanotechnology Research |
| 2011/1/29 | 2010 Symposium on Advanced Beam-Functionalized Chemistry |
| 2011/2/4～5 | Emergence in Chemistry Second Symposium |
| 2011/2/15～16 | Workshop on Photo-induced Phase Transitions |
| 2011/2/17 | FIRST project Public Symposium |
| 2011/2/18～19 | FIRST project Briefing session at the end of 2010 |
| 2011/3/8～12 | 18th Computational Materials Design Workshop |
| 2011/3/24～27 | The 58th Spring Meeting, 2011 The Japan Society of Applied Physics |
| 2011/3/31 | Seminar of Radiation Chemistry |

## Other Lectures and Seminars

| | | | | |
|---|---|---|---|---|
| 2010/4/8 | Ashok Veeraraghavan | Mitsubishi Electronics Research Laboratories (MERL) | Research Scientist | Lecture on computer vision |
| 2010/4/21 | Toshiki Ito | Kobe University. Graduate School of Medicine/School of Medicine | Associate professor | Mechanisms of membrane deformation by lipid-binding domains |
| 2010/4/22 | Yasuyuki | Microsoft Research | Lead | Lecture on computer vision |

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| | Matsushita | Asia (MSRA) | Researcher | |
| 2010/4/27 | Yasuyuki Matsushita | Microsoft Research Asia (MSRA) | Lead Researcher | Lecture on computer vision |
| 2010/6/3 | Masahide Yasuda | Miyazaki University | Professsor | Seminar on Porphrin Photochemistry |
| 2010/6/4 | Zhen Huang | Georgia State University | Professor | Lecture of Chemistry and Structural Biology of Selenium Nucleic Acids |
| 2010/6/7 | Jugé Sylvain | University of Bourgogne | Professor | Synthesis and Application of Chiral Phosphine Compounds |
| 2010/6/7 | Tsuneo Imamoto | Chiba University | Grand Fellow, Chiba University | Catalytic Asymmetric Synthesis Using P-Chirogenic Phosphine Ligands |
| 2010/6/11 | Hideaki Takayanagi | Tokyo University of Science | Director | Nanodevices |
| 2010/6/11 | Syuji Hisaeda | CambridgeSoft, | Manager | Instruction of ChemBioOffice |
| 2010/6/24 | Takeshi Akasaka | Tsukuba University | Professor | Synthetic chemistry |
| 2010/6/28 | Hiroaki Kohno | Kouno Hiroaki Patent Firm | patent attorney | Strategy of patents for solar cells |
| 2010/7/1 | Yuichi Taguchi | Mitsubishi Electronics Research Laboratories (MERL) | Visiting Scientist | Lecture on computer vision |
| 2010/7/16 | Hiroaki Kohno | Kouno Hiroaki Patent Firm | patent attorney | International development of patents for solar cells |
| 2010/7/26 | Hiroaki Kohno | Kouno Hiroaki Patent Firm | patent attorney | Strategy of patents for semiconductor devices |
| 2010/8/6 | Michael Borsch | Universitat Stuttgart | Research Group Reader | Single ATP- and proton-driven membrane transporters monitored by FRET |
| 2010/8/6 | Hiroaki Kohno | Kouno Hiroaki Patent Firm | patent attorney | Strategy of domestic and international patents for low temperature processes applied to semiconductor devices |
| 2010/8/16 | Yago | Girona University | Researcher | Lecture on computer vision |
| 2010/8/27 | Aixin Yan | School of Biological Sciences, University of Hong Kong | Associate professor | Regulation, Function, and Physiological Roles of Multi-Drug Efflux Pumps During Anaerobic Adaptation in E. coli |
| 2010/9/13 | Zoran Ren | University of | Professor | Dynamic compressive deformation of |

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|---|---|---|---|---|
| | | Maribor | | foamed aluminum |
| 2010/9/13 | Peter Bäeuerle | Institute of Organic Chemistry II and Advanced Materials, University of Ulm, Germany | Professor | Sunny Times for Organic Photovoltaics |
| 2010/10/20 | Yasuko Rikihisa | Ohio State University | Professor | Anaplasma phagocytophilum: the enemy within |
| 2010/10/25 | Harald Gröger | University of Erlangen-Nuremberg, Germany | Professor | Asymmetric Catalysis with Isolated Enzymes and “Designer Cells” |
| 2010/11/8 | Yitzhak Tor | University of California | Professor | Lecture of Exploring Nucleic Acids with Fluorescent Nucleosides |
| 2010/11/9 | Hiroaki Kohno | Kouno Hiroaki Patent Firm | patent attorney | Let's utilize patents! |
| 2010/11/24 | Kai Ming Ting | Monash University | Associate Professor | Speach on Feature-Subspace Aggregating |
| 2010/11/27 | Saso Dzeroski | Jozef Stefan Institute | Professor | Speech on Machine Learning and Ontologies |
| 201011/18 | Doris Entner | University of Helsinki | Ph.D. Candidaye | Speech on Discovering unconfounded causal relationships |
| 2010/12/3 | Hiroshi Yoneyama | Graduate School of Agricultural Science, Faculty of Aguricalture, Tohoku University | Associate Professor | Construction of screening system that targets novel twin-arginine translocation system |
| 2010/12/9 | Hiroyuki Akinaka | AIST | Research Scholar | Construction of all functional oxide electronics |
| 2010/9/24 | Luca Pellegrino | CNR | Research Scholar | All Oxide Micro-Electro-Mechanical-Systems (MEMS) |
| 2010/11/16 | Osamu Yoshinari | Nagoya Institute of Technology | Professor | Diffusion of hydrogen in metals and hydrogen permeable films |
| 2010/11/30 | Hiroshi Masumoto | Tohoku University | Professor | Research on integrated new functional materials by controlling interfaces |
| 2010/11/19 | Kay Kanazawa | Stanford University | Professor | Application of Quartz Crystal Microbalance (QCM) to Lithography |

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|---|---|---|---|---|
| 2011/12/7 | D. Arivuoli | Anna University, India | Professor | Directed self assembly of semiconductor quantum dots |
| 2010/12/20 | Kiyohito Ishida | Tohoku University | Professor | Phase diagram of alloys and design of advanced materials |
| 2011/1/27 | Wolfgang Sprengel | Graz University of Technology | Professor | Atomic Defects in Ultrafine-Grained Metals: Direct and Specific Studies for their Characterization and of their Kinetics |
| 2011/1/27 | Ole Martin Lovvik | University of Oslo | Professor | Discussion on the first-principles calculations of hydrogen-storage materials |
| 2011/2/3 | Kinbara Kazushi | Tohoku University | Professor | Bio-inspired functional molecule development |
| 2011/2/14 | Hiroaki Kohno | Kouno Hiroaki Patent Firm | Patent attorney | Evaluation of fair reward for empolyee invention in the lawsuit |
| 2011/2/24 | Kirk S. Schanze | University of Florida | Professor | Seminar on Charge Transfer of pi-Conjugted Polymers |
| 2011/2/25 | Hiroaki Kohno | Kouno Hiroaki Patent Firm | patent attorney | Examples for evaluation of patents |
| 2011/3/5 | August Marcelli | Istituto Nazionale de Fisica Nucleare, Italy | Researcher | IKNO-a user facility for coherent THz and UV synchrotron radiation |
| 2011/3/5 | Luca Giannessi | SPARC-FEL,/ENEA (Centro Ricerche Frascati), Italy | Researcher | Free Electron Laser Seeding Experiments at SPARC |
| 2011/3/10 | Rhia Trogo | De La Salle University | Assistant Professor | Invited Lecture |
| 2011/3/16 | Teruo Shunmyozu | Kyushu University | Professor | Seminar on Cyclophanes Compounds |
| 2011/3/17 | Jay LaVerne | University of Notre Dame | professor | Role of Excited States in the Radiolysis of Simple Aromatic Liquid |
| 2011/3/17 | Hidetada Hirakawa | Department of Microbiology, University of Washington, Seattle WA, USA | Postdoctoral Fellow | Aryl-homoserine lactone quorum sensing system in the phototrophic soil bacterium Rhodopseudomonas palustris |
| 2011/3/17 | Fumitoshi Kakiuchi | Keio University | Professor | Novel Cross-Coupling Reactions by Activation of Inactive Carbon Bonds |

### 7) Public Information Activity

Public information activity of ISIR in 2010 is as follows:

- Bulletin of ISIR 2010 (in both Japanese and English)
- Memoirs of the Institute of Scientific and Industrial Research, Osaka University Vol.67 2010 (in English)
- Annual Report of ISIR 2010 (in Japanese)
- SANKEN News Letters, 40-42(in Japanese)
- Report on SANKEN TECHNO SALON 2010 (in Japanese)
- WWW home-page (http://www.sanken.osaka-u.ac.jp/) (English version is available.)

### 8) Research Reports

The number of scientific and technological papers published in 2010 is 539. The details are described in the part of activity of divisions and facilities.

### 9) Scientific Awards

| | | |
|---|---|---|
| A.YAMAGUCHI | 2010 The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, Prizes for Science and Technology(Research Category) | 2010/4/13 |
| M.TANIGUCHI | Young scientist Prize, The Commendation for Science & Technology by the Minister of Education, Culture, Sports, Science and Technology | 2010/4/13 |
| M. NOGI | Young scientist Prize, The Commendation for Science & Technology by the Minister of Education, Culture, Sports, Science and Technology | 2010/4/13 |
| T. DONO | CSJ Presenter Award 2009 | 2010/4/14 |
| C.INOSHITA | The First Prize CVIM Thesis Session | 2010/5/28 |
| H.ASAHI | IPRM Award (IEEE Photonics Society) | 2010/6/1 |
| T.YANAGIDA | International Conference on Core Research and Engineering Science of Advanced Materials Student Poster Awards | 2010/6/3 |
| K.TANIHATA | The Ceramic Society of Japan Contribution Award | 2010/6/4 |
| S.KURIHARA | The Japanese Society for Artificial Intelligence, Incentive Award | 2010/6/10 |

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|---|---|---|
| M. NUMAO | The Japanese Society for Artificial Intelligence, Incentive Award | 2010/6/10 |
| K. OHTSUBO | Award for the best presentation, 19th Annual Meeting of JAMR | 2010/6/16 |
| Y. YOSHIDA | Radiation Physics and Chemistry Top Cited Article 2005-2010 | 2010/6/18 |
| S.TAGAWA | Radiation Physics and Chemistry Top Cited Article 2005-2010 | 2010/6/18 |
| Y.YAGI | The 13th Meeting on Image Recognition and Understanding, Best Paper Honorable Mention | 2010/7/28 |
| R.MIZOGUCHI | JSAI Annual Conference Award | 2010/7/16 |
| T. KOZAWA | Radiation Physics and Chemistry Top Cited Article 2005-2010 | 2010/6/18 |
| Y. MUKAIGAWA | The 13th Meeting on Image Recognition and Understanding, Best Paper Honorable Mention | 2010/7/28 |
| H. TANAKA | 2nd Global COE Student Conference on Innovative Electronic Topics 2010 Poster Award | 2010/7/29 |
| T. KANKI | 2nd Global COE Student Conference on Innovative Electronic Topics 2010 Poster Award | 2010/7/29 |
| A. HATTORI | 2nd Global COE Student Conference on Innovative Electronic Topics 2010 Poster Award | 2010/7/29 |
| T. MAJIMA | BCSJ Award | 2010/8/4 |
| M. FUJITUKA | BCSJ Award | 2010/8/4 |
| S. TOJO | BCSJ Award | 2010/8/4 |
| T.KAWAI | Top Cited Article2005-2010Award（Physica E:Low-Dimensional Systems and Nanostructures) | 2010/8/5 |
| M.TANIGUCHI | Top Cited Article2005-2010Award（Physica E:Low-Dimensional Systems and Nanostructures) | 2010/8/5 |
| M. TAKAHASHI | The Society for Dicrete Variational Xa Award for Creative Work | 2010/8/6 |
| R.MIZOGUCHI | JsiSE Best Paper Award | 2010/8/27 |
| K.SUGANUMA | 19th Micro-Electronics Symposium Best Paper Award | 2010/9/9 |
| K.KIM | 19th Micro-Electronics Symposium Best Paper Award | 2010/9/9 |
| T. UEMURA | Very High Mobility in Solution-Processed Organic Thin-Film Transistors of Highly Ordered | 2010/9/14 |
| T.YANAGIDA | 17th International Workshop on Oxide Electronics Best Poster Award | 2010/9/22 |
| K.NAGASHIMA | 17th International Workshop on Oxide Electronics Best Poster Award | 2010/9/22 |
| N.KATO | Asian Core Program Lectureship Award | 2010/11/10 |

| | | |
|---|---|---|
| H.NAKAJIMA | Distinguished Service Medal, Japan Research Institute for Advanced Copper-Base Materials and Technology | 2010/11/4 |
| K.SUGANUMA | IMPS 43rd International Symposium on Microelectronics Best Paper of Session | 2010/11/4 |
| Y.YAGI | Pattern Recognition and Machine Intelligence Association The Fourth Pacific-Rim Symposium on Image and Video Technology Best Paper Award | 2010/11/16 |
| T.YANAGIDA | Poster winner of 2010 MRS Fall Meeting Non-volatile resistive Switching Effect in Limited Nanospace of a Single NiO Heterostructured Nanowaire | 2010/12/1 |
| K.NAGASHIMA | Poster winner of 2010 MRS Fall Meeting Non-volatile resistive Switching Effect in Limited Nanospace of a Single NiO Heterostructured Nanowaire | 2010/12/1 |
| K.NAGASHIMA | Research Award The Association of Powder Process Industry and Engineering JAPAN (APPIE) | 2010/12/2 |
| M. TANE | The12th International Symposium of Eco-materials Processing and Design "Excellence Award of Poster Presentation | 2011/1/10 |
| M. SASAJIMA | The 14th SNAKEN International Symposium 2011,The 9th SANKEN Nanotechnology Symposium Best Poster Award | 2011/1/26 |
| Y. IE | Incentive Award in Synthetic Organic Chemistry, Japan, 2010 | 2011/2/18 |
| T.YANAGIDA | 2nd Workshop on Semiconductor Electronics 2010 Best Presentation Award | 2011/2/25 |
| K.NAGASHIMA | 2nd Workshop on Semiconductor Electronics 2010 Best Presentation Award | 2011/2/25 |
| K.SUGANUMA | The Minerals ,Metals & Material Society Poster Award | 2011/2/27 |
| H.NAKAJIMA | 4th Symposium of Osaka University Global COE Program-Center of Excellence for Advanced Structural and Functional Materials Design/Best Poster Award | 2011/3/19 |
| R. NAKAMURA | 4th Symposium of Osaka University Global COE Program-Center of Excellence for Advanced Structural and Functional Materials Design/Best Poster Award | 2011/3/19 |

## 2. Education

ISIR accepts graduate students (211) from the Graduate Schools of Science,

Engineering, Engineering Science, Pharmaceutical Science, Information Science and Technology, and Frontier Biosciences, and also researchers for special training, including those from industry and from abroad.

Staff members also belong to various Faculties: Faculty of Science, Faculty of Engineering, Faculty of Engineering Science, Faculty of Pharmaceutical Science, Faculty of Information Science and Technology, and Faculty of Frontier Biosciences. Some members belong to two Faculties. They give lectures for graduate and undergraduate students in each Faculty.

Number of graduate students as of March 31, 2011 is as follows.

| Field / Course | Science | Engineering | Engineering Science | Pharmaceutical Science | Information Science and Technology | Frontier Biosciences | Total |
|---|---|---|---|---|---|---|---|
| Master Course | 57 | 46 | 14 | 7 | 15 | 11 | 150 |
| Doctor Course | 20 | 28 | 3 | 1 | 6 | 3 | 61 |
| Total | 77 | 74 | 17 | 8 | 21 | 14 | 211 |

Number of students who had obtained Bachelor’s, Master's or Doctor's Degree in 2010 is as follows.

| Field / Degree | Science | Engineering | Engineering Science | Pharmaceutical Science | Information Science and Technology | Frontier Biosciences | Total |
|---|---|---|---|---|---|---|---|
| Doctor Degree | 2 | 12 | 0 | 2 | 1 | 0 | 17 |
| Master Degree | 16 | 18 | 0 | 7 | 5 | 3 | 49 |
| Bachelor | 0 | 8 | 0 | 3 | 2 | 0 | 13 |
| Total | 18 | 38 | 0 | 12 | 8 | 3 | 79 |

## 3. International Exchange

### 1) Exchange Agreement

Academic Exchange Agreements are now concluded with the following 24 organizations.

○Faculty of Natural Science, Otto-von-Gueriche University Magdeburg (Germany)
○Forschungszentrum Jülich GmbH (Germany)
○University College London (U.K.)

○College of Natural Sciences, Pusan National University (Korea)
○Research Institute of Industrial Science, Hanyang University (Korea)
○College of Science, National Taiwan University (Taiwan)
○Pacific Northwest National Laboratory (U.S.A.)
○Centre National de la Researche scientifique : CNRS (France)
○Rwth Aachen University (Germany)
○College of Natural Science, Chungnam National University (Korea)
○Institute of Romote Sensing and Geographical Information System、Peking University (China)
○College of Science, National Taiwan Normal University (Taiwan)
○Faculty of Science, University of Geneva (Switzerland)
○Inner Mongolia Normal University (China)
○Korea University , College of Science and Technology (Korea)
○Indian Institute of technology Delhi, Department of Physics (India)
○University of Augsburg(Germany)
○College of Computer Studies,De La Salle University (Philippine)
○University of Augsburg(Germany)
○Department of Chemistry, Korea Advanced Institute Science and Technology (Korea)
○School of Enviromental Science and Engineering/Department of Chemical Engineering, Pohang University of Science and Technology(Korea)
○Gachon Bionano Research Institute, Kyungwon University (Korea)
○Institute of Fisheries Sciences, Pukyong National University (Korea)
○Faculty of Science, Assiut University(Egypt)

**2) Foreign Researchers and Students**

Number of foreign researchers and students staying in ISIR as of March 31, 2011 is 66 in total. Details are, Assistant Professor(Include of Specially Appointed ) (6), Specially Appointed Researcher(2), Part-time Employee (18), Graduate Students (39:Doctor Course,19, Master Course,20). Their nationalities are: China(24), Korea(16), Philippine(4),Thailand(3),India(3), Viet Nam(3), Italia(3), Bangladesh(2),Germany(1), U.S.A. (1), Russia(1), Brazil(1), Malaysia (1), France(1),Egypt(1),Iran(1),Turkey(1)
Foreign visitors in 2010 are as follows:
Korea (25), China(21) ,Taiwan(1) ,India (1) , Viet Nam(8) , Italia(1), U.S.A. (1), Russia (1), Brazil(1), Bangladesh(2), Thailand(5),Malaysia (1), Venezuela(1), Egypt(1), Iran(1) , Turkey(1),Canada(3),Mexico(2), Germany (3), Netherland(1), Switzerland(1) Total 50.

### 3) International Conferences and Symposiums

Number of presentations (plenary, invited, oral and poster in various international conferences and symposia) by staff of ISIR is 525 in total.

Number of ISIR staffs who have been working as committee members of International Conferences or Editorial Board of international academic journals are 179 in total. For more details, see the part of activity of divisions and facilities.

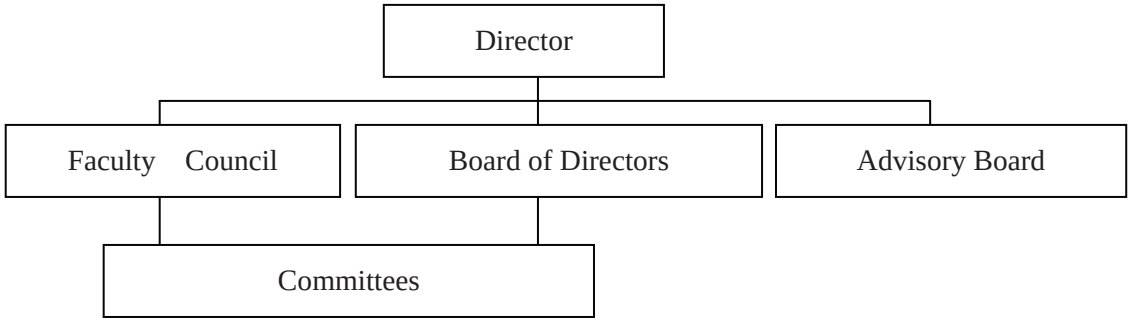
## 4. Concluding Remarks

### (1) Organization and Management System

After the reorganization in April 2009, ISIR has three major research divisions, Division of Information and Quantum Sciences, Division of Materials and Beam Sciences, and Division of Biological and Molecular Sciences, and one permanent research center “Nanoscience and Nanotechnology Research Center”. In addition, ISIR contains two divisions for special purposes named “Division of Next Industry Creation” and “Division of Special Project Research”. The latter division contains independent laboratories supervised by associate professors with limited terms selected from young assistant professors of ISIR for promotion of young scientists. ISIR also has two research supporting centers, “Comprehensive Analysis Center” and “Research Laboratory for Quantum Beam Science”. Inter-institute project research, “Materials Science & Technology Research Center for Industrial Creation” and “Post-Silicon Materials and Devices Research Alliance” has been successfully finished in 2009 and the new inter-institute collaboration named “Strategic Alliance Project for Creation of Nano-Materials, Nano-Devices and Nano-Systems” on the basis of the Network Joint Research Center for Materials and Devices has been started in 2010. In the ISIR, the following facilities are also installed; Workshop, Office of Information Network, Laboratory of Radio-isotope Experiments, Library, Academia-Industry Relation Office, Public Relations Office and Technical Division.

Management of ISIR is performed by the Director and the Board of Directors supervised by the Faculty Council composed of all ISIR professors. Advisory Board has been set up to introduce opinions from outside into the Institute. Advisory Board has been set up to introduce opinions from outside into the Institute.

【Organization of ISIR】




**(2) Research Activities**

In 1997, Harmonized Materials Research Group was designated as one of the Centers of Excellence (COE) of Ministry of Education, indicating the high research activity of the Institute.

From 2002 through 2006, we have awarded as the best group in 21 Century COE program that is originally the top 20 group plan in Japan. This involves the positive exchange between different laboratories which yield results of the global level with respect to material, information and biotechnology.

In 2005, Materials Science & Technology Research Center for Industrial Creation has launched as a joint Center between ISIR and Institute of Multidisciplinary Research for Advanced Materials, Tohoku University. It was expanded to Post-Silicon Materials and Devices Research Alliance for collaboration with four university institutes in 2006.

In 2010, nationwide Network Joint Research Center for Materials and Devices including five university institutes has been started. ISIR is a headquarter of the network.

ISIR's research environment as facilities and equipments has been becoming better. A new building was constructed in 2001 and 2003 to the increased number of scientists and the development of Nanotechnology, respectively and Nanosocience and Nanotechnology Center started in April 2002. In addition, the total repair of the old buildings into the earthquake-resistant structures has been completed in 2010. A new building named "SANKEN Incubation Building" has been completed in 2010 for open innovation by academia-industry collaboration.

**(3) Education**

Considering objective of ISIR, supporting the graduate and undergraduate education is one of the important missions.

ISIR has over 200 graduate students coming from 6 different graduate schools

and faculties such as Science, Engineering, Engineering Science, Pharmaceutical Science, Frontier Biosciences and Information Science and Technology.

In 2009, we have set up the Centre for Research Education and Training in order to promote the ISIR original education on research. We already have ISIR original lecture “Nano Engineering” in Graduate School of Engineering. We aim to expand the ISIR original lectures authorized by various graduate schools in Osaka University as a sub-program.

The Sanken Techno-Salon is one of forums to exchange information between our staff member and the people from industries specializing in electronics, organic chemicals, semiconductors, drugs, etc. We have also seminars for providing seeds of new technologies to the industrial communities. The Institute aim to grow researchers and students with the best humanity, capable of innovation of their specific fields of research from basic point of view.

**(4) Contribution to Societies**

As the fast–paced advancement of science and technology and the rapid alteration of social and industrial structures, we must further recognize as the Institute open to society and industry. We consistently strive to deepen our cooperation with society through positively opening of facilities, intellectual properties and achievements to meetings (ex. Sanken Techno Salon) and publications. Through them, we will be able to transfer our industrial seeds for new technology and exchange ideas for new materials. They have been highly evaluated that we have done joint researches with other university/industry.

In April 2005, AIR-office (Academia Industry Relations Office) has been settled in order to strengthen cooperation between the Institute and industries.

In 2008, Research Association of Industry and Science (RAIS), which is ISIR-supporting association having a history of 70 years, was reorganized, set up bureau office in ISIR and the bureau chief was adopted in order to promote and support the academia-industry cooperation.

In 2010, “Company Research Park” opens in the new SANKEN Incubation Building as Osaka University’s first rental laboratories for business enterprises.

**(5) International Exchange**

International Exchange is one of indispensable element for our Institute. We are trying to open the door widely to invite more researchers and students from other countries, and we have 3 kind of International exchange, Academic Exchange, Student

Exchange and branches in France and USA. At present (March, 2008), 57 foreign researchers and students join in the Institute. International Conferences sponsored by our Institute have been held twice a year since 1998. It's so important to release our results towards all over the world and have a chance to exchange opinions with foreign scientists.

In 2009, International Collaboration Center was started for promoting the foreign exchange. Under the Center, 3 collaborative laboratories between foreign universities have been set up or in preparation as follows: ICT Collaborative Laboratory between the School of Electronics Engineering and Computer Science, Peking Univ. and ISIR, Collaborative Laboratory between College of Science and Technology. Korea Univ. and ISIR, and Collaborative Laboratory between Faculty of Mathematical and Physical Sciences, Univ. College of London and ISIR in Areas Relating to Excited Surface Science.

**(6) Future Plan and Prospect**

In 2010, nationwide "Network Joint Research Center for Materials and Devices" has been started. It is a greatest collaboration network between university institutes in Japan. ISIR plays a leading role in the network as the headquarters. At the same time, our SANKEN Incubation Building will open for the core of academia-industry collaboration. So, we will advance to the next step of our ISIR in the next year.

In order to respond with flexibility to our quickly changing society, along with the rapid development of science and technology, we must understand our role of society and in order to stay effective and relevant Institute for industries, we must make independent researches and release widely our intellectual properties and achievement.

Keeping development of science and technology in Japan, we must cultivate researchers capable of producing academic and professional results that will benefit the people living on this planet. ISIR grow researchers and students who can active in the world.

You can see about ISIR on the following URL. (http://www.sanken.osaka-u.ac.jp/) The Institute of Scientific and Industrial Research keeps making efforts toward higher level contribution to science and industries, and keeps learning.

# Activities of Divisions

# Division of Information and Quantum Sciences

## Outline

The advent of the digital society where tremendous amount of information is electronically accessible has brought the intelligent information processing technologies indispensable. This division consists of eight departments; Information Science Departments (Knowledge Systems, Intelligent Media, Architecture for Intelligence, Reasoning for Intelligence), Quantum Science Departments (Photonic and Electronic Materials, Semiconductor Electronics, Advanced Electron Devices, and Quantum Information Photonics [Alliance Laboratory of ISIR, Osaka Univ. and RIES, Hokkaido Univ.]). The former four and the latter four departments aim to establish fundamental techniques to support the advanced digital society in terms of software and hardware technologies respectively. The departments on the former software technologies work on the task of computerizing the intelligent human information processing capability to help solving difficult engineering problems and assist intellectual activities. The departments on the latter hardware technologies pursue various approaches in the fields of electronic materials design and tailoring, surface physics, nanometer scale materials fabrication and characterization, semiconductor nanostructures for quantum devices, semiconductor-based new bio/chemical sensors, organic materials and biomolecules

We challenge to output world-widely significant achievements under our systematic cooperation, and further collaborate with researchers of domestic and overseas universities, research institutes and private companies. Moreover, we educate many graduate students belonging to Graduate School of Science (Department of Physics), Graduate School of Engineering (Department of Electrical, Electronic and Information Engineering, Department of Applied Physics), Graduate School of Engineering Science (Department of Materials Engineering Science), and Graduate School of Information Science and Technology (Department of Computer Science, Department of Information and Physical Sciences) under the aim to grow young researchers having both advanced knowledge and wide research scopes.

## Achievements

* Crystal growth, characterization and device application of new semiconductors
* Quantum nanodevices and biosensor application using graphene and nanochube
* Development of solution-crystalized organic transistors with the highest mobility
* Commercial tool named OntoloGear for describing functional knowledge
* Dense 3D Reconstruction Method Using a Single Pattern for Fast Moving Object
* Introduction of sensors to Constructive Adaptive User Interfaces
* Knowledge discovery from complex data, causal analysis and combinatorial discovery
* The photonic quantum circuit combining single-photon-level optical nonlinearities.

# Department of Photonic and Electronic Materials

Professor: Hajime ASAHI
Associate Professor: Shigehiko HASEGAWA
Assistant Professor: Shuichi EMURA
Assistant Professor: Yi-Kai ZHOU
Post Doctoral Fellow: Daivasigamani KRISHNAMURTHY
Graduate Students: Hiroyuki TAMBO, Siti Nooraya MOHD TAWIL
Kang-Min KIM, Takasi KUCHIYAMA, Kotaro HIGASHI
Daijiro ABE, Shogo NONOGUCHI, Peng-Han FAN,
Takaaki FURUYA, Fumio YUKAWA, Junichi KUKUCHI
Hiroya ICHIHARA, Mai UENAKA, Takahiro SHIMOI
Li ZHOU, Yuki NAKATANI, Ayumi BEPPU
Yousuke MITSUNO
Undergraduate Student: Satio KOMORI, Masaru YONEOKA
Support Staff: Akiko WATANABE

## Outline

The department of Photonic and Electronic Materials makes research on materials, mainly semiconductors and related materials, and processing on them. Four steps are required in materials research, that is, materials design, materials synthesis (crystal growth) and processing, materials characterization, and device application. In materials design, study on finding required characteristics by changing the combination and ratio of atoms is conducted. In materials synthesis, study on molecular-beam epitaxy growth is mainly carried out. In materials characterization, structure investigation by electron diffraction, X-ray diffraction, STM, EXAFS and Raman scattering, optical characterization by photoluminescence, optical absorption and so on, electrical characterization by Hall measurement, and magnetic characterization by SQUID are carried out. In device application, basic researches on photonic devices, electronic devices, and spintronic devices are conducted.

## Current Research Projects

**1. Crystal Growth and Properties of Diluted Magnetic Semiconductors**

Diluted magnetic semiconductors are gathering great interest as a candidate for new functional materials. In 2001, we succeeded in the growth of GaCrN and observed the room temperature ferromagnetism as well as the PL emission. We also observed room temperature ferromagnetism and sharp PL emission for the GaGdN. Then, tunnel magnetoresistance effect was observed for the GaCrN/AlN/GaCrN tunnel diodes. Low temperature growth of high Gd concentration GaGdN with improved ferromagnetism was realized. Further increase of magnetization was obtained by Si co-doping. In 2010, long wavelength light emission diluted magnetic semiconductor (DMS), InGaGdN, with as high as 35% InN mole fraction was successfully obtained. Magnetic characteristics were improved in InGaGdN/GaN superlattice structures and Si co-doped samples. New DMS, GaDyN/AlGaN superlattices were grown and good magnetic properties were observed. GaGdN nano-rod structures, where lateral carrier confinement is expected, were also successfully formed.

**2. Growth, Characterization and Device Application of Semiconductor-Semimetal Mixed Crystals; New Semiconductors Including Tl**

In 1995, we proposed new semiconductors TlInGaAs in which the bandgap energy is independent of temperature. In 2005, we obtained the small temperature variation of lasing peak wavelength as small as 0.06 nm/K for the TlInGaAs/TlInP/InP SCH LDs.

We also proposed the TlInGaAsN/AlGaAs for both temperature-stable wavelength and threshold current LDs. It was found that the addition of N enhances the incorporation of Tl and by optimizing the layer structures of TlInGaAsN/TlGaAs/GaAs multi-quantum well (MQW) structures, relatively strong PL emission was obtained. In 2010, the high temperature annealing effect was studied. Annealing increased the PL intensity, but also induced the short wavelength shift. The XPS study revealed that the origin of this shift was due to the change of atomic arrangement around the N atoms and not due to the inter-diffusion of atoms at the hetrointerfaces.

**3. Spin Injection from Ferromagnets to Dilute Magnetic Semiconductors and Nanoscaled Characterization of Their Magnetic Properties**

Spin injection from ferromagnets to dilute magnetic semiconductors (DMSs) is a very important subject to realize semiconductor spintronic devices as well as to investigate magnetic properties of DMSs using spin-polarized scanning tunneling microscopy (SP-STM). In 2010, we examined magnetic properties of ordered Fe nanodots on GaN coexisting with disordered ones under external magnetic field by using SP-STM. It was found that domains of ordered Fe nanodots were always observed lower in height than those of disordered ones by SP-STM. The difference in height between the ordered and disordered domains showed a hysteresis loop as a function of the external magnetic field. This indicates that boundaries between the ordered and disordered domains correspond to boundaries of magnetic domains.

**4. XAFS Characterization of New Functional Materials**

XAFS is a spectroscopy-based new characterization technique for analyzing atomic scale structures of materials and is only one technique directly analyzing the atomic arrangements/coordination for amorphous materials as well as very low density elements in materials. Furthermore, this research technique also has an advantage of specific element selectivity. The atomic arrangements/coordination in the new functional materials, GaCrN and GaGdN, was characterized and it was showed that the Cr (Gd) atoms substitutionally occupy the group III sites. In 2010, GaGdN/AlGaN multi-quantum well (MQW) structures and the MQW in rod form including Gd is vigorously examined on the coordination of Gd by the XAFS method. The Gd ions possibly locate at the interfaces because of the ultra- thin thickness of the well layer GaGdN. This may strongly affect to the ferromagnetism. Under the present growth conditions, we have no remarkable evidence for such situation. As new result, a vacancy of nitrogen ion adjacent to the Gd ion was found. It depends on the growth conditions.

# Department of Semiconductor Electronics


Professor: Kazuhiko MATSUMOTO
Associate Professor: Koichi INOUE, Kenzo MAEHASHI
Assistant Professor: Yasuhide OHNO
Graduate Students: Yasuki YAMAMOTO, Takahiro OHORI, Yasufumi HAKAMATA, Yusuke YAMASHIRO, Satoshi OKUDA, Yasuyuki SOFUE, Yusuke IMAI
Under Graduate Students: Shogo OKAMOTO, Kenta GUMI, Yusuke FUJII
Supporting Staff: Misa KURIO


## Outlines

Semiconductors quantum structures, where electrons and photons play remarkable roles owing to quantum effects, are expected to show superior properties. We study the basic problems in the fabrication and the characterization of such quantum structures in the atomic scale. The research activities include applications to new devices based on the quantum effects with the coherent ballistic transport of carriers and electron-photon interactions.

Carbon nanotubes (CNTs), especially single-walled carbon nanotubes (SWNTs), and single-layer graphene, are promising materials to realize quantum-effect devices because of their unique nano-structures. As a sensor of single charge or spin with the high sensitivity, the formation and characterization of field-effect transistors (FETs) and single electron devices using carbon nanotubes and graphene are studied using thermal chemical vapor deposition method, Raman scattering spectroscopy, scanning probe microscopy, and photoluminescence spectroscopy.

## Current Research Project

### Quantized characteristics in carbon nanotube-based single-hole memory with a floating nanodot gate

We have fabricated floating-gate carbon nanotube field-effect transistors (CNT-FETs), in which Au floating dots are expected to act as charge storage nodes. The fabricated floating-gate CNT-FETs clearly exhibited the memory effect, in addition to single-hole memory operation. A staircase relation between the gate threshold voltage and the charging voltage was obtained. Quantized shifts in the gate threshold voltage as a function of charging time and retention time were also observed. The quantized characteristics are attributed to the effect of single-hole charging in the Au floating dot.

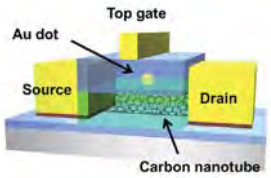



Fig. 1 Schematic of the CNT-FET memory.

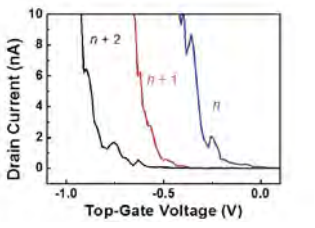



Fig. 2 $I_d$-$V_g$ characteristics.

**External-Noise-Induced Small-Signal Detection with Solution-Gated Carbon Nanotube Transistor**

A solution-gated carbon nanotube field-effect transistor (CNT-FET) based on stochastic resonance (SR) was investigated in order to enhance small-signal detection under ambient noise conditions. When noise with optimal intensity was introduced at the reference electrode in a nonlinear CNT-FET, the electric double layer in the solution was modulated, resulting in SR behavior. Moreover, when the CNT-FET was used as a pH sensor, high sensitivity was achieved, which enabled the detection of small differences in pH. The best results were obtained in a noisy environment; therefore, a solution-gated SR-based CNT-FET operated in the subthreshold regime is a promising high-sensitivity sensor.

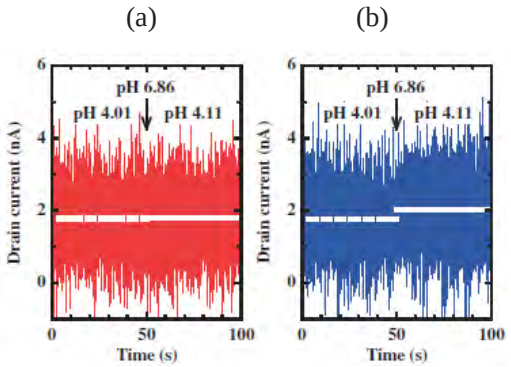



Fig. 3 Real-time current response to a step change in the pH from 4.01 to 4.11, (a) without the noise and (b) with external noise.

**Label-Free Biosensors Based on Aptamer-Modified Graphene Field-Effect Transistors**

A label-free immunosensor based on an aptamer modified graphene field-effect transistor (G-FET) is demonstrated. Immunoglobulin E (IgE) aptamers with an approximate height of 3 nm were successfully immobilized on a graphene surface, as confirmed by atomic force microscopy. The aptamer-modified G-FET showed selective electrical detection of IgE protein. From the dependence of the drain current variation on the IgE concentration, the dissociation constant was estimated to be 50 nM, indicating good affinity and the potential for G-FETs to be used in biological sensors.

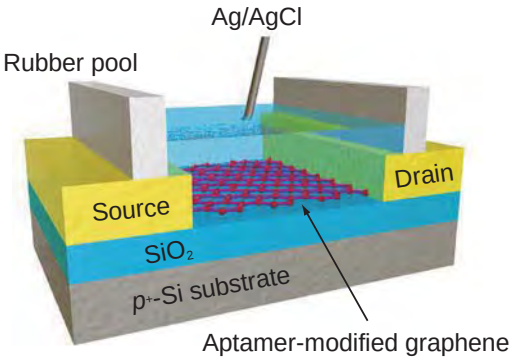



Fig. 4 Schematic of the graphene FET sensor.

# Department of Advanced Electron Devices

Professor: Jun TAKEYA
Associate Professor: Koichi SUDOH
Specially Appointed Associate Professor: Toshihiro OKAMOTO(2010.11.1-)
Assistant Professor: Takafumi UEMURA(2010.5.1-)
Research Fellow: Kazumoto MIWA, Yuri HIROSE, Wanyan LI(2010.5.16-)
Research Assistant: Naoko NANBA, Jung Hee HONG
Graduate Students: Masakazu YAMAGISHI, Yugo OKADA, Kengo NAKAYAMA, Junshi SOEDA, Yuichi TAKATSUKI, Junya CHIBA
Under Graduate Students: Yu MIZUNO
Supporting Staff: Mako UENO(2010.6.1-)

## Outlines

Facing to the global environmental change and rapidly aging society in many countries, innovative technologies are anticipated to emerge in order to sustain our comfortable way of living even in such circumstances. Next-generation electronic devices, therefore, are required to diverse functions to help human life minimizing their burden to the environment in their production processes. Organic electronics are attracting much attention as a practical candidate to meet the requirement because such devices can be fabricated by printing at a low cost without processes at high temperatures. In addition, their mechanical flexibility appends further attractiveness, enabling unique devices that fit human shapes, for example. In Department of Advanced Electron Devices, we have been developing new organic transistors and organic photovoltaic cells, which are two of the fundamental devices for organic electronics.

## Current Research Project

### High-power and high-speed organic three-dimensional transistors

Three-dimensional organic field-effect transistors (3D-OFET) with high current density and high switching speed are developed with multiple submicrometer channels arranged perpendicularly to substrates. The short channel length is defined by the height of a multicolumnar structure without an electron-beam-lithography process. For devices using dinaphtho[2,3 -b:2',3'-f]thieno[3,2-b]thiophene, extremely high current density exceeding 10 A/cm2 and fast switching within 0.2 μs are realized with an on-off ratio of

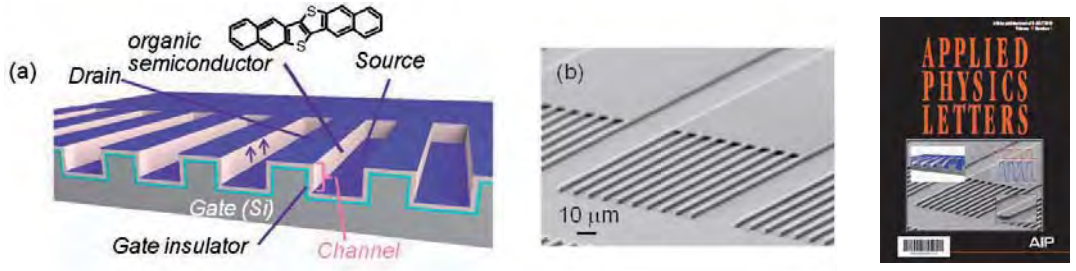


Fig.1 (a) Schematic illustration of the 3D-OFET structure. (b) SEM image of the 3D-OFET.

$10^5$. The unprecedented performance is beyond general requirements to control organic light-emitting diodes, so that even more extensive applications to higher-speed active-matrices and display-driving circuits can be realized with organic semiconductors.

**Thermal conductivity of rubrene single crystals**

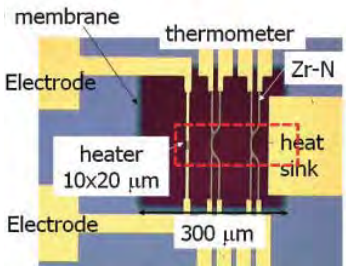


Fig.2 A newly developed homemade MEMS device for thermal conductivity

Thermal conductivity of rubrene single crystals is measured for both bulk and film-like crystals down to 0.5 K in order to estimate the density of crystalline defects quantitatively from their phonon mean-free paths. The temperature profile of the rubrene crystals exhibit a pronounced peak at ~ 10 K in the thermal conductivity due to very long mean-free paths of their phonons, which indicates extremely low-level defect density in the region of $10^{15}$ – $10^{16}$ $cm^{-3}$ depending on different growth methods. The crystals grown from the gas phase tend to have less defects than those grown from solution. The method is applied even for micrometer-thick crystals used for field-effect transistors developed for a new membrane device for thermal-conductivity measurement of film-like samples.

**Monolithic Complementary Inverters Based on Organic Single Crystals**

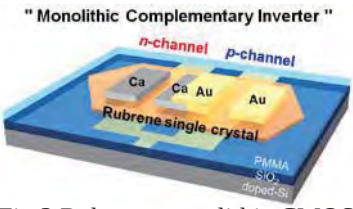


Fig.3 Rubrene monolithic CMOS

A novel monolithic complementary inverter is fabricated on a single platform of an organic semiconductor crystal only by patterning low- and high-work-function metals to inject electrons and holes separately. With the benefit of using high-performance organic single-crystal transistors, the inverter indeed shows excellent performances with very low power consumption, high output gain, large noise margin, and small hysteresis.

**Patternable Solution-Crystallized Organic Transistors with High Carrier Mobility**

Patternable solution-crystallized organic transistors are developed with very high carrier mobility that exceeds 10 $cm^2V^{-1}s^{-1}$. The devices feature a newly synthesized air-stable compound 2,9-didecyldi-naphtho[2,3-b:2',3'-f]thieno[3,2-b]thiophene ($C_{10}$-DNTT) and are formed from hot solution. A method of oriented growth is introduced to obtain the single-crystalline films of $C_{10}$-DNTT, regulating the crystallizing direction and the positions in a single process.

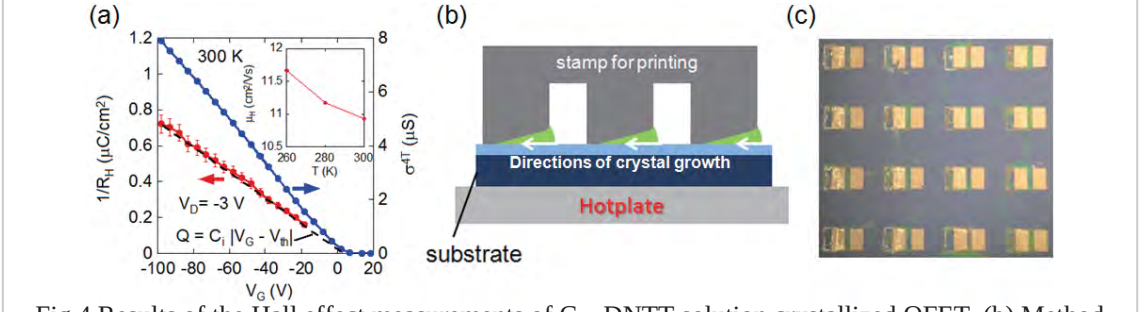


Fig.4 Results of the Hall effect measurements of $C_{10}$-DNTT solution crystallized OFET. (b) Method for fabricating the $C_{10}$-DNTT transistor arrays (c) An microscopy image of the transistor arrays.

# Department of Intelligent Media

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Specially Appointed Assistant Professor: Junqiu WANG (2010.9.1-), Chunsheng HUA (2010.9.1-)
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Secretary: Masako KAMURA, Noriko YASUI, Makiko FUJIMOTO,
Technical Staff: Aya IIYAMA, Yoko IRIE, Yshiko MATSUMOTO, Yoshimi OHKOHCHI (2010.10.16-), Mika IGUCHI (2010.11.1-)

## Outlines

The studies in this laboratory focus on computer vision and media processing including basic technologies such as sensor design and camera calibration, and applications such as an intelligent system with visual processing functions. Some of our major research projects are development of a novel vision sensor, including an omnidirectional mirror, calibration of an omnidirectional vision system, video analysis for endoscopic diagnosis assistance, measurement of detailed reflectance properties, gait identification, modeling of environments.

## Current Research Project

### Linear solution for oneshot 3D reconstruction using multiple projectors for moving objects

In this work, we propose a system that consists of a camera and multiple projectors and each of the projectors projects a parallel line patterns instead of grid patterns. Shape is reconstructed from the intersection points between those two sets of parallel lines. It is shown that a unique linear solution is possible for such a system, thus, dense grid patterns with uniform intervals can be used to increase density of the pattern. Furthermore, by using two projectors, blind areas caused by occlusion and self-occlusion are drastically reduced. In the experiment, we built a system which consists of two projectors and a single camera, i.e. a minimum configuration of the method, and successfully captured a dense shape of fast moving object with video rate.

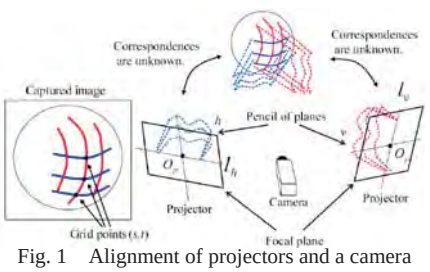

Fig. 1 Alignment of projectors and a camera alignment

**BRDF Estimation Considering Scatterings of Illumination and Reflection**

Fig. 2 CG with reflectance of white acryl board

The observed reflectance features change, if they are put in scattering media. This phenomenon is caused by scattering of illuminated and reflected lights. The incident light from the light source scatters before it reaches at the surface of the object. Similarly, the reflected light scatters before it reaches at the cam- era. In this paper, we propose a new reflectance model which can express the interaction between the transmittance feature of the media and the reflectance feature of the object by taking the scattering of illuminated and reflected lights into account. Based on the reflectance model, the transmittance feature in the scattering media and the reflectance feature of the object are sequentially estimated by two steps using a reference object whose reflectance feature is known. We examined the validity of the proposed model by the simulation experiment. We also examined the accuracy of the estimation of the reflectance feature which takes into account the scattering in the media.

**Tracking Abnormality in Video Capsule Endoscopy by using Supporters Interpolated from Image Features**

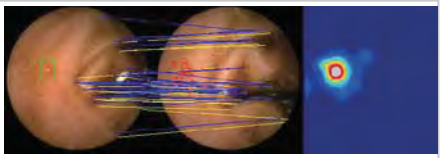

Fig. 3 Abnormality region candidate by using supporters interpolated from image features.

This paper describes a method to track abnormalities on successive frames in a capsule endoscopic image sequence. The exact tracking of abnormalities is useful for supporting diagnosis such as estimating duration appeared on images. The shape of an abnormality is changeable on the successive images, which makes it difficult to track abnormalities precisely. The proposed method uses not only abnormality image features but also surrounding features. Surrounding features, called supporters, are also difficult to track in the images, so they are treated mutually in the proposed method.

**Performance Evaluation of Gait Recognition with the Large Scale Gait Database**

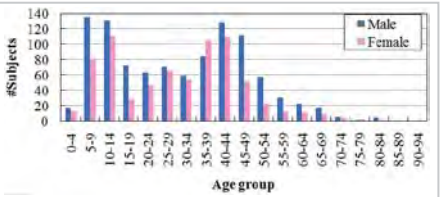


Fig. 4 Statistics of gait database

Methods of gait-based person identification have been proposed for a decade. The gait recognition performances of the existing methods were evaluated with approximately 100 subjects at most and the statistical reliability was not sufficient. Therefore, we construct the largest gait database in the world which includes 1035 subjects with ages ranging from 2 to 94 years old. Then, the performance evaluation for the existing gait recognition approaches such as averaged silhouette, frequency-domain feature, and gait manifold in eigenspace is executed with CMC curve and ROC curve. Finally, the necessity of the large scale database is shown by comparing the result for subsets of 100 subjects picked up from the original database and the whole set of 1035 subjects.

# Department of Reasoning for Intelligence

| | |
|---|---|
| Professor: | Takashi WASHIO |
| Assistant Professor: | Akihiro INOKUCHI, Shohei SHIMIZU |
| | Yoshinobu KAWAHARA |
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| | Yasuhiro SOGAWA, Marina DEMESHKO, Hiroaki IKUTA, |
| | Takanori INAZUMI, Takuya KISHIMOTO, |
| | Shuji MATSUDA, Hongping LI, Qixin LIU |
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| Under Graduate Students: | Tatsuya TASHIRO, Ayumu YAMAOKA |
| Supporting Staff: | Hiroko OKADA |

## Outlines

We, humans, extract variety of knowledge from given data by the full use of our reasoning. However, such reasoning ability of humans is so limited that most of the massive and complex data acquired through computer network are wasted without any humans' inspection. To provide efficient remedies to this difficulty, our department studies novel reasoning approaches to extract knowledge from the massive and complex data by using computers. These techniques are named data mining and knowledge discovery. We also study the application of these techniques to variety of fields such as science, information network, quality/risk management, medicine, security, marketing and finance. Recently, we obtained significant outcomes in the research topics of information estimation and knowledge discovery from extremely high dimensional data, knowledge discovery from graph sequence data, discovery of hidden causal structures in data and combinatorial approach to knowledge discovery from high-dimensional data.

## Current Research Project

### Information estimation and knowledge discovery from extremely high dimensional data

Data consisting of massive variables (extremely high dimensional data) representing numerous events and/or states became available by developments of computer network, ubiquitous sensing and scientific measurement technologies. Examples are sales data of a large scale shopping center under various conditions, global climate data consisting of various and massive meteorological measurements and the profile data of thousands of gene expressions in biological systems. We study novel techniques to estimate variable relations and dynamic mechanisms from such data acquired from large scale and complex structured systems. In this year, we studied a Monte Carlo method to simulate state transitions of molecules in a state space having dozens or hundreds of dimensions. An efficient method to simulate extremely rare transitions has been developed by introducing weighted importance samplings. We demonstrated a simulation on rare coupling reactions of two molecules having complex shapes by applying this method.

**Knowledge discovery from graph sequence data**

A graph is a powerful data expression that can be used to represent arbitrary relations among entities. In addition, graph sequences can be used to model dynamic changes of objects for many real world applications. For example, a human network is represented by a graph where each human and each relationship of every human pair correspond to a vertex and an edge, respectively. If a person joins or leaves a community, the numbers of vertices and edges in the graph increase or decrease. Similarly, a gene network consisting of genes and their interactions produces a graph sequence in their evolutionary history. In this year, we developed methods, called GTRACE-RS and SiGTRACE, for discovering frequent patterns from complex and massive graph sequence data. GTRACE-RS mines all frequent patterns from a set of graph sequences based on the Reverse Search principle, whereas SiGTRACE mines all frequent patterns from a single graph sequence. We confirmed that GTRACE-RS is some orders of magnitude faster than the conventional method.

**Discovering hidden causal structures in data**

We develop advanced statistical methods for discovering useful causal structures in data. Such a causal structure is estimated in the form of a graph or a diagram that graphically represents causal relations in an objective system so that it is easily understandable by application experts. The key idea is to extract considerably more information from data than conventional approaches by utilizing non-Gaussianity of data. The idea of non-Gaussianity distinguishes our research from previous works on this line. A promising application is neuroimaging data analysis such as functional magnetic resonance imaging (fMRI) and magnetoencephalograph (MEG). Our method can be applied to brain connectivity analysis. One could model the connections as causal relations between active brain regions. Gene network estimation from microarray data in bioinformatics would be another promising application. Our framework also is a new useful alternative to financial data analysis in economics and traditional questionnaire data analysis in psychology and sociology. In this year, we developed a method for learning multiple datasets obtained from different subjects or under different experimental conditions simultaneously and showed that the new method enables more accurate estimation of causal structures.

**Combinatorial approach to knowledge discovery from high-dimensional data**

Against a backdrop of accelerating progress of data acquisition technologies, there are more scenes where we deal with high-dimensional data in a variety of engineering problems, such as bioinformatics, natural language processing and image data processing. Such data processing often requires combinatorial computation, where we select the subset of all dimensions that optimizes some criteria. One example is the problem where we seek to find a small number of genes most related to some disease or symptom in gene sequence data consisting of a huge number of genes. But this kind of computation often becomes intractable in practice because of combinatorial explosion caused by the high-dimensionality of data. In this year, we developed efficient algorithms applicable to such problems using discrete structure of data, especially submodularity (discrete convexity) with respect to several types of problems that are important in applications. And, we aimed at discovering important knowledge in a variety of applications by applying the developed algorithms to real-world data.

# Department of Knowledge Systems

| | |
|---|---|
| Professor: | Riichiro MIZOGUCHI |
| Associate Professor: | Yoshinobu KITAMURA, Kouji KOZAKI |
| Assistant Professor: | Munehiko SASAJIMA |
| Specially Appointed Assistant Professors: | Yusuke HAYASHI(to Oct. 31), Hiroko KOU(from Jun. 16), Yuki YAMAGATA (from Oct. 1) |
| Graduate Students: | Mamoru OHTA, Kohei SUMITA, Jun NAKAYAMADA, Satoshi NISHIMURA, Keisuke HIHARA |
| Under Graduate Students: | Ryosuke FUKUI, Toshiyuki BABA |
| Supporting Staff: | Akiko HASHIMOTO |

## Outlines

This division has been run under the philosophy that it contributes not only to the promotion of knowledge science but also to prosperity of the real world by the feedback of the research results to it in the information era. The major topic includes an investigation of Ontological Engineering to establish basic theories and technologies for the next-generation knowledge science. The current research projects include: methodology for ontology development and its support environment based on basic theories of ontological engineering, sharing of technical knowledge, intelligent educational/training systems, and ontology-aware authoring systems. In 2010, an EU's international collaborative research project: EuJoint with distinguished researchers in Europe was started. By intensive discussions in many mutual visits of its members, we have obtained several remarkable results about the issues described below.

## Current Research Project

**1. Ontology: Theoretical Foundation of Knowledge Engineering**

We theorized about the fundamental issues on ontology from both scientific and engineering viewpoints. One of the most remarkable achievements is the fact that a book on "Ontological Engineering" has been published from Ohm-sha Ltd. In January, 2005 which is the first book on the topic in Japan. HOZO, an environment for ontology building/utilization, has been augmented to make it a usable tool by revising its GUI and reimplementation of some functions. It has been extended to cope with distributed development of a large ontology and to improve the compliance with the WWW standards. The latest achievements include the following; 1)We developed a consensus-building support system based on viewpoint specific ontology exploration and have evaluated it through an role-play experiment in the biofuel domain. 2) We have refined a comprehensive ontology of about 6000 diseases from 12 clinical divisions and proposed a new ontological definition of diseases based on a theory of causal chains. 3) We developed an ontology for interoperability of phenotype descriptions of genomics in the collaboration with experts of RIKEN. 4) We have developed a theory and method on on-demand *is-a* hierarchy organization and implemented it as an extended function of Hozo. 5) As a part of the EuJoint project, we have investigated an innovative theory of roles by employing the notion of meta-role

and on a new theory of parts. 6) We released an upper ontology named YAMATO, which we have been investigated for years, on the home page of HOZO.

## 2. Systematization of Functional Design Knowledge

The goal of this research is to promote sharing of knowledge about functionality of artifacts among engineers. To this, we have developed an ontology-based modeling framework, which provides rich concepts for describing consistent and reusable knowledge. The framework has been deployed successfully in some manufacturing companies. Based on the framework, a functional knowledge externalization and sharing tool named OntoloGear was developed and is going to be a software product. We have also developed a phase-oriented model of function along the product life-cycle and an evolutional model along the evolutional history of creatures. In 2010, as a part of the EuJoint project, we have collaboratively investigated the notion of artifacts and then identified the relationship among some different definitions of artifacts.

Furthermore, we have generalized this framework into a goal-oriented modeling framework for procedural knowledge. In the collaborative research with a public hospital, we have described models of the nursing procedures, which are going to be deployed with tablet-style computers as described below. In addition, we have investigated the notion of services and then identified their essential definition.

## 3. Methodology for Building Learning Support Systems

The goal of research on intelligent educational systems is to implement the intellectual capability of human teachers on computer systems. Huge efforts have been devoted to the research for the last two decades. However, the research field has not been growing methodologically because of lack of theoretical foundation. In this research project, we have investigated the essential structure of a variety of educational tasks in detail and have proposed of Ontology-Awareness aiming at marriage of learning and educational theories and technology. The latest achievements include the following; 1) investigations of the effectiveness of our authoring system and multi-agent system for ICT education design in lesson plan design and refinement with real teachers in Tokyo and Okayama, 2) integration of ontologies for individual and collaborative learning, and 3) refinement of an improved framework of meta-cognition and suggestions for improvement of representative learning support systems for meta-cognition.

## 4. Academic-Industrial Alliance for Ontology-based Application Design Theory

Along with the progress of the ontology engineering technologies for both fundamental and developmental theories, the importance of theories for ontology-based application design/development is increasing. To realize practical design/development theories for building applications, we have been promoting several academic-industrial alliance research projects. This year, we focused on (1) ontology-based activity modeling framework for mobile service navigation with a mobile phone service company, (2) design method for the ambient information space inside automobiles with a Japanese leading car manufacturer, (3) electronic instruction manuals for emergency aid procedures with a city hospital in Hyogo prefecture and a college for nurses. For each project, cooperating with domain experts, we investigated problems to be solved and designed ontology-based prototype systems. We plan to carry out experiments in the real world to evaluate the feasibility of our systems.

# Department of Architecture for Intelligence

| | |
|---|---|
| Professor: | Masayuki NUMAO |
| Associate Professor: | Satoshi KURIHARA |
| Assistant Professors: | Koichi MORIYAMA, Ken-ichi FUKUI |
| Post Doctoral Fellow: | Roberto LEGASPI |
| Graduate Students: | Mitsuhiro MATSUMOTO, Kazushi NAKAMURA, Rafael CABREDO, Kohei IWAO, Akinobu UEDA, Asami NINOMIYA, Kazuya MARUO, Teppei KITAGAWA, Yujiro KONAKA, Takashi SHIRAI |
| Under Graduate Students: | Daiki INABA, Syunya NAKASE |
| Research Students: | Paul Salvador Inventado (2010.10.1 -), Danaipat Sodkomkham (2010.10.1 -) |
| Exchange Students: | Juan Hagad (- 2010.9.30), Alex Wauters (2010.10.1-2011.2.28) |
| Supporting Staff: | Misuzu YUKI (2010.4.1 -), |

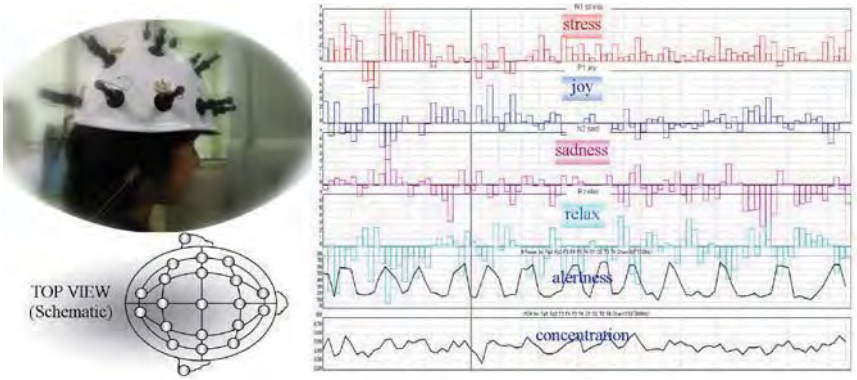
## Outlines

The main research objective is to explore basic technology for computer systems, which support human learning and understanding, beyond conventional artificial intelligence. We particularly focus on the process of human-computer interaction to discover and create architecture of intelligence for such systems. We try to produce highly original research with findings from cognitive science, psychology, education, and computer science. Principal issues addressed are as follows: 1. Constructive Adaptive User Interfaces, 2. Intelligent Tutoring System, and 3. Intelligent Ubiquitous Sensor-Networks.

## Current Research Project

### Constructive Adaptive User Interfaces

This department is developing a computer with learning ability, for which it researches efficient learning algorithms, acquisition of background knowledge for learning, application to Intelligent Tutoring Systems. These are applied to adaptive user interfaces. The conventional adaptive user interfaces only select a good response out of some previously given ones. Although this helps to use interfaces, such as a navigation system, it is not sufficient to stimulate human intelligence or creativity. The department has developed a method to compose a new content adaptively. This technology enables automatic acquisition of human feelings, and

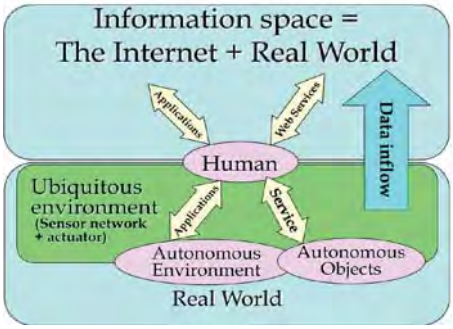


automatic music composition system adapted to personality and emotion of its user.

**Intelligent Tutoring System**

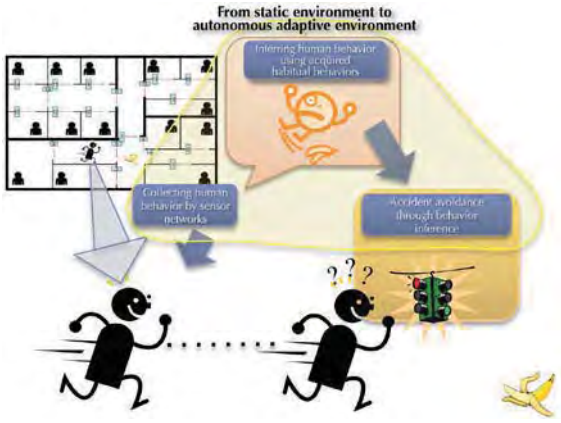
To have an instructional plan guide the learning process is significant to various teaching styles and an important task in an ITS. Though various approaches have been used to tackle this task, the compelling need is for an ITS to improve on its own the plans established in a dynamic way. We hypothesize that the use of knowledge derived from student categories can significantly support the improvement of plans on the part of the ITS. This means that category knowledge can become effectors of effective plans. We have conceived a Category-based Self-improving Planning Module (CSPM) for an ITS tutor agent that utilizes the knowledge learned from learner categories to support self-improvement. The learning framework of CSPM employs unsupervised machine learning and knowledge acquisition heuristics for learning from experience. We have experimented on the feasibility of CSPM using recorded teaching scenarios.

**Intelligent Ubiquitous Sensor-Networks**




In recent years, progress in computer technology, the appearance of IPv6, the development of various radio technology including IEEE802.11, and the practical use of radio-tags like RFID have greatly activated studies of ubiquitous computing like sensor-networks. But, the purpose of many proposed ubiquitous systems is to present information of the virtual-world like the Internet to humans living in the real-world by using physical properties like monitors and loudspeakers, etc. On the other hand, our purpose is to construct a framework to enable flexible and real-time interaction between humans and the real-world. Keyword is resonance. Each human has his own natural frequency, which is a metaphor for personality or daily habitual behaviors. In the proposed framework, each human behavior reacts with the environment and the environment performs sensor-data mining and extracts each human's natural frequency.

The real-world that we assume in this study is homes and offices, etc., where daily habitual behaviors of humans are easy to extract. So, we call the real-world “the environment.” The environment learns the daily habitual behaviors of each human, and performs the most suitable interaction to whoever should receive it. To embody this interaction framework, the environment must be an autonomous action entity, and it is necessary to construct this entity as a massively multi-agent system to enable management and control of various broadly dispersed sensors and physical properties for interaction and to enable real-time interaction with humans. To begin with, we have set up several interaction devices between humans and the environment as well as various kinds of many sensors.



# Department of Quantum Information Photonics

## (Alliance Laboratory of ISIR, Osaka Univ. and RIES, Hokkaido Univ.)

| | |
|---|---|
| Professor: | Shigeki TAKEUCHI |
| Assistant Professor: | Ryo OKAMOTO |
| Assistant Professor: | Masazumi FUJIWARA |
| Post Doctoral Fellow: | Hideaki TAKASHIMA |
| Post Doctoral Fellow: | Hong-Quan ZHAO |
| Post Doctoral Fellow: | Masayuki OKANO (2010.4.1-) |
| Post Doctoral Fellow: | Shanthi SUBASHCHANDRAN (2010.4.1-) |
| Post Doctoral Fellow: | Takafumi ONO (2010.8.1-) |
| Graduate Students: | Masato TANIDA, Akira TANAKA, Kiyota TOUBARU, Minako IEFUJI, Tetsuya NODA, Takaaki YOKOI |
| Supporting Staff: | Izumi KASAGI, Ryouko ITO (2010.10.1-) |

## Outlines

By using quantum nature of light, it is predicted that we can drastically enhance the performance of information processing (Quantum Computer), secure communication (Quantum Cryptography) and even sensing (Quantum Metrology). We carry on experimental researches into the realization and the application of the novel states of light, by generating individual single photons and controlling the quantum correlation between these photons. Toward the perfect control of single photons, we investigate nano-scale photonic structures for optical quantum devices and single photon sources. Using those devices, we are constructing quantum optical systems and optical quantum circuits for quantum information processing, quantum metrology and quantum lithography. Our research topic also includes the generation and characterization of entangled photons, single molecular spectroscopy, and highly efficient single photon detectors**.**

## Current Research Projects

- **Realization of a photonic quantum circuit combining effective optical nonlinearities**

Quantum information science addresses how uniquely quantum mechanical phenomena such as superposition and entanglement can enhance communication, information processing and precision measurement. Photons are appealing for their low noise, light-speed transmission and ease of manipulation using conventional optical components . However, the lack of highly efficient optical Kerr nonlinearities at single photon level was a major obstacle. In a breakthrough, Knill,

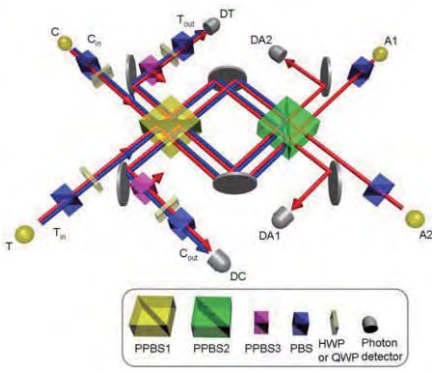



Fig. 1. Schematic of experimental setup

Laflamme and Milburn (KLM) showed that such an efficient nonlinearity can be achieved using only linear optical elements, auxiliary photons, and measurement [(2001) Nature 409:46-52]. They proposed a heralded controlled-NOT (CNOT) gate for scalable quantum computation using a photonic quantum circuit to combine two such nonlinear elements. We experimentally demonstrated a KLM CNOT gate. We developed a stable architecture to realize the required four-photon network of nested multiple interferometers based on a displaced-Sagnac interferometer and several partially polarizing beamsplitters (Fig. 1). This result confirms the first step in the original KLM `recipe' for all-optical quantum computation, and should be useful for on-demand entanglement generation and purification. Optical quantum circuits combining giant optical nonlinearities may find wide applications in quantum information processing, communication and sensing.

- **Generation of broadband spontaneous parametric fluorescence toward high-resolution quantum optical coherence tomography**

Optical coherence tomography (OCT) based on Michelson interferometer has widely been utilized in biology and medicine as a type of optical biopsy. In contrast, quantum optical coherence tomography (QOCT), which is based on two-photon interferometer of quantum entangled photon pairs, has better axial resolution and can compensate the group velocity dispersion effect, due to the frequency correlation of photon pairs. Because high-resolution of QOCT requires broad bandwidth of entangled photons, here we propose and demonstrate novel method that utilizes a combination of multiple bulk nonlinear crystals to generate broadband entangled photons. We have generated spontaneous parametric fluorescence as quantum entangled photon pairs from two nonlinear crystals (BBO) and the bandwidth of spectrum of generated photons from two BBO crystals has been broadened up to approximately 170 nm, which is twice broader than that from one BBO crystal (~ 80 nm) as shown in Fig. 2. This bandwidth can lead to sub-micron axial resolution of QOCT.

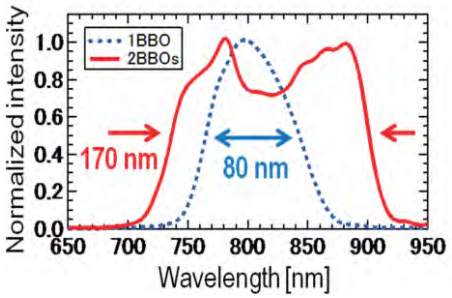


Fig. 2 : Spectra of spontaneous parametric fluorescence generated from one (blue dotted line) and two (red solid line) BBO crystals.

- **Observation of phase-shift spectrum of the fiber-microsphere cavity system at cryogenic temperatures**

To realize the solid-state quantum phase gate (QPG) using fiber-microsphere cavity system, we need to cool the system in order to suppress the thermal perturbation. We recently succeeded in coupling microsphere and tapered fiber at cryogenic temperatures. However, we did not quantify depolarization, which was supposed to come from cryogenic effects like mechanical vibrations and temperature-change induced distortions. It may become a significant drawback in photonic quantum phase gate wherein polarization encoded qubits used. The results have shown that the degree of polarization (DOP) was conserved in the range of 0.964–1.072 over the course of temperature change from 8 to 32 K. This high stability of DOP therefore enables the realization of the QPG.

# Division of Advanced Materials and Beam Science

## Outline

This division is composed of seven departments with the following research fields: Quantum Functional Materials, Advanced Interconnection Materials, Semiconductor Materials and Processes, Metallic Materials Process, Excited Solid-State Dynamics, Beam Materials Science, and Accelerator Science. We aim to generate novel and new highly functional materials, which provide basis of rapid future developments in several important fields of information, energy, environmental and medical technologies. Emphasis is placed both on establishment of deep and full understanding of fundamental mechanisms of the functions and on evolutional progress of material processing, including hybridizing different kinds of materials which are well designed and controlled with respect to their structures, dimensions, and physical and chemical properties. We also aim to develop new sources of quantum beams with high brightness and high quality, and use the quantum beams in a new field of beam-induced materials science.

## Achievements

- Developments of topological insulators and elucidation of their basis properties
- Explorations of topological superconductors and other novel superconductors
- Development of chemical surface treatment of Si for reducing metallic contamination to $10^{-5}$ monolayer
- Creation of $SiO_2$/Si structure with ultra-high performance by gas-phase nitric-acid oxidation
- Development of continuous-casting technique for producing lotus-type porous metals by thermal decomposition of compound gasses
- Creation of lotus-type porous Al with high porosity
- Development of Ag-based inks and characterization of their basic properties
- Clarification of Sn whisker growth mechanism and developing high-temperature solders
- Direct observation of ultrafast structural phase transition of Si using time-resolved transmission electron diffractionUltrafast dynamics of holes injected into Si valence band using two-photon photoemission spectroscopy
- Photoinduced structural phase transition of graphite induced by coherently localized electronic packet
- Development of L-band RF photocathode
- Characterization of free-electron laser coherence

# Department of Quantum Functional Materials

Professor: Yoichi ANDO
Associate Professor: Kouji SEGAWA
Assistant Professor: Satoshi SASAKI, Alexey TASKIN
Specially-Appointed Assistant Professor: Eiji Wada (2011.2.1-)
Post Doctoral Fellows: Zhi REN, Markus KRIENER
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Ryohei YOSHIDA, Shohei WADA
Under Graduate Students: Hiroaki TAKAGAWA
Supporting Staff: Mariko HATTORI

## Outlines

The research of the Department of Quantum Functional Materials focuses on growths of high-quality singe crystals and top-notch transport measurements of novel materials, such as topological insulators or unconventional superconductors. Our emphasis is on precise and systematic measurements of basic physical properties, which allows one to unveil the peculiar electronic states of novel materials. This is achieved by combining the expertise in solid-state physics and applied chemistry. Our goal is two-fold: Creating innovative materials for solving urgent issues of the human society, while exploring fundamental new physics in condensed matter.

## Current Research Project

### Basic Research of Topological Insulators

Topological insulator (TI) is an emerging class of materials that host a new quantum-mechanical state of matter where an insulating bulk state supports an intrinsically metallic surface state that is "topologically protected"; namely, the quantum-mechanical wavefunction of the bulk insulating state of a TI bears a "$Z_2$ topological invariant" distinct from that of the vacuum, which makes a smooth transition from a TI to the vacuum impossible without closing the energy gap along the way, making the surface of a TI to be intrinsically conducting. Intriguingly, the resulting metallic surface state is expected to be "helically spin-polarized" (i.e., right- and left-moving electrons carry up and down spins, respectively) and consist of "massless Dirac fermions" (i.e., the energy of quasiparticles is linearly dependent on the momentum). Those peculiar properties of the surface state open exciting new opportunities for novel spintronics devices with ultra-low energy consumptions.

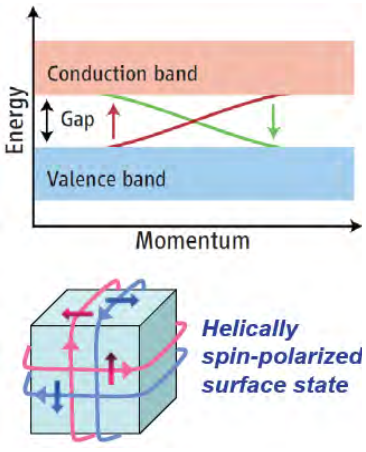


**Fig.1 Peculiar surface state of a topological insulator**

1) Insulating Behavior in Topological Insulators

The 3D topological insulator is a novel quantum state of matter that is supposed to show insulating behavior in the bulk and spin-dependent metallic conduction on the surface. In practice, however, it is very difficult to get rid of the residual bulk conduction originating from defects in the crystals of such materials. As a result, transport studies of the topological surface state have been quite challenging. We have synthesized a new topological insulator, $Bi_2Te_2Se$, which approaches insulating behavior in the bulk with a high resistivity, thanks to the peculiar chemistry associated with its layered structure. We observed clear Shubnikov-de Haas oscillations coming from the 2D surface state and were able to determine the transport mechanism in the bulk, paving the way for exploiting the unique surface conduction properties of topological insulators. [This work was spotlighted in the APS online journal *Physics*.]

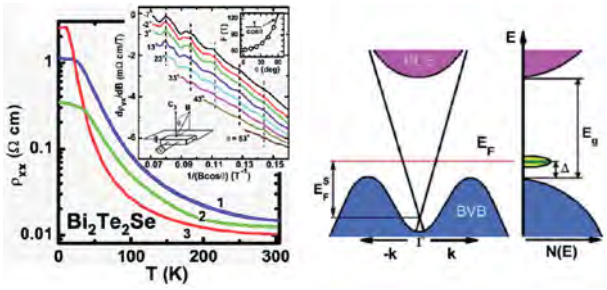


**Fig.2 Insulating resistivity behavior and the Shubnikov-de Haas oscillations observed in the new topological insulator $Bi_2Te_2Se$ (left). Schematic diagram of its energy-band structures (right).**

2) A Big Step toward Discovering a Topological Superconductor

Soon after the discovery of topological insulators, a new class of condensed matter phase called "topological superconductor" was theoretically predicted and generated great interest. Finding its first concrete example would make an important landmark in physics. One of its prime candidates is the electron-doped topological insulator $Cu_xBi_2Se_3$, which was found in 2009 to superconduct below ~3 K. However, this material is very difficult to synthesize, and samples with only a small fraction of superconducting volume had been available. Using a rather simple electrochemistry technique, we have managed to produce high-quality crystals of $Cu_xBi_2Se_3$ with a large superconducting volume fraction. Our specific-heat measurement elucidated that $Cu_xBi_2Se_3$ is a bulk strong-coupling superconductor with a full energy gap, which qualifies this system to be topological. This is a big step towards the goal of identifying the new topological phase of matter, whose applications include the fault-tolerant topological quantum computing.

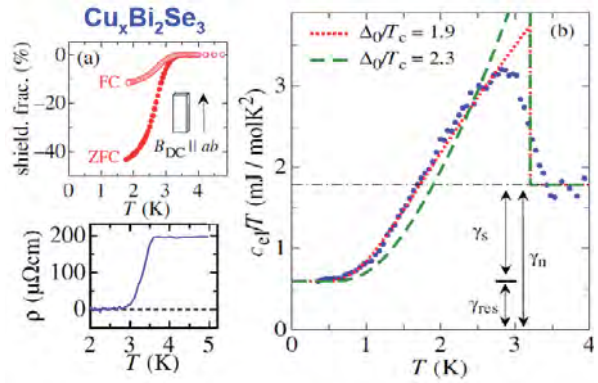


**Fig.3 Superconducting transition in $Cu_xBi_2Se_3$ observed in magnetic susceptibility, resistivity, and the specific heat. The superconducting shielding fraction of 43% is the largest ever achieved in this material, and this is the first time that the specific-heat anomaly associated with the superconductivity is observed.**

# Department of Semiconductor Materials and Processes

Professor: Hikaru KOBAYASHI
Associate Professor: Masao TAKAHASHI
Assistant Professor: Taketoshi MATSUMOTO
Specially Appointed Professor: Hitoo IWASA, Toshio KASAI, Sumio TERAKAWA, Takashi TOMITA, Yoshihiro NAKATO,
Specially Appointed Assistant Professor: Woo-Byoung KIM,
Research Technical Expert: Masami SHOJI
Researchers: Mikihiro YAMADA
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Research Student: Hu Buqin
Under Graduate Students: Yuki SEINO
Support Staff: Chika KUROSAKI, Reiko NOZAKURA

## Outlines

The modern society is based on semiconductor technology. Our research is aiming to improve the characteristics of semiconductor devices and to develop semiconductor devices with new structures. For this purpose, we have developed new semiconductor chemical processes such as low temperature Si oxidation method by use of nitric acid and room temperature defect passivation method. Semiconductor devices studied in this department are: 1) Si solar cells, 2) Si or SiC-based metal-oxide-semiconductor (MOS) devices for LSI, 3) thin film transistors (TFT) for display devices.

## Current Research Project

**Fabrication of low reflectivity poly-crystalline Si surfaces by structure transfer method**

A method to fabricate low reflectivity poly-crystalline Si (poly-Si) surface structures for solar cells has been developed by use of catalytic activity of a metal film (Figure 1). Immersion of Si contacted with platinum (Pt) films in hydrogen peroxide plus hydrofluoric acid solutions results in etching of Si only in the contacted areas. When the Pt surface possesses a pyramidal structure, an inverted pyramidal structure is formed on Si(111) and poly-Si surfaces on which the conventional alkaline

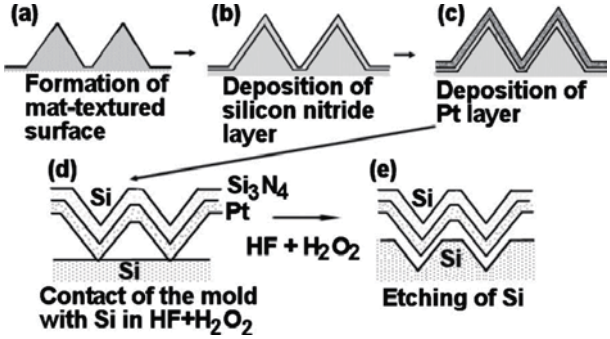


Figure 1 Methods of fabrication of inverted pyramidal structure on Si surfaces.

etching method cannot form mat-textured surfaces (Figure 2). Poly-Si surfaces with the inverted pyramidal structure possess a reflectivity lower than that of the mat-textured surfaces on a Si(100) surface.

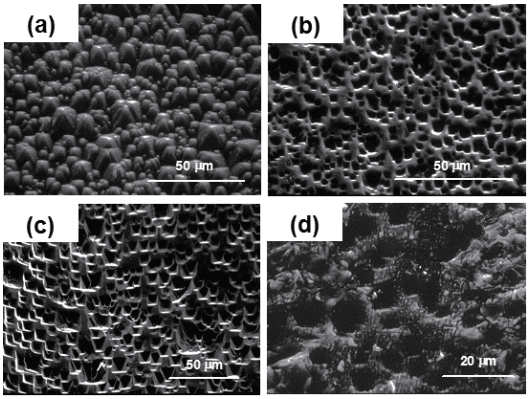


Figure 2 Scanning electron micrographs of the following surfaces: (a) ⟨Pt/SiN/mat-textured Si(100)⟩ structure; (b) Si(100); (c) Si(111); and (d) poly-Si.

**Low temperature fabrication of 5–10nm $SiO_2$/Si structure using advanced nitric acid oxidation of silicon (NAOS) method**

We have developed the advanced nitric acid oxidation of Si (NAOS) method to form relatively thick (5–10 nm) $SiO_2$/Si structure with good electrical characteristics. This method simply involves immersion of Si in 68 wt% nitric acid aqueous solutions at 120 °C with polysilazane films. Fourier transform infrared absorption (FT-IR) measurements show that the atomic density of the NAOS $SiO_2$ layer is considerably high even without post-oxidation anneal (POA), i.e., $2.28\times10^{22}$ atoms/cm$^2$, and it increases by POA at 400 °C in wet-oxygen ($2.32\times10^{22}$ atoms/cm2) or dry-oxygen ($2.30\times10^{22}$ atoms/cm2). The leakage current density is considerably low (e.g., $10^{-5}$ A/cm$^2$ at 8 MV/cm) and it is greatly decreased ($10^{-8}$ A/cm$^2$ at 8 MV/cm) by POA at 400 °C in wet-oxygen. POA in wet-oxygen increases the atomic density of the $SiO_2$ layer, and decreases the density of oxide fixed positive charges.

**Submicrometer ultralow-power TFT with 1.8 nm NAOS $SiO_2$/20 nm CVD $SiO_2$ gate stack structure**

We have fabricated submicrometer ultralow-power thin-film transistors (TFTs) with stack gate dielectric structure formed by the nitric acid oxidation of Si (NAOS) method. A 1.8 nm NAOS $SiO_2$ layer effectively blocks the leakage current, and consequently, the thickness of a gate oxide layer deposited on the NAOS $SiO_2$ layer can be made as thin as 20 nm. Because of the thin gate oxide layer, submicrometer TFTs with gate length in the range of 0.6–0.9 μm can be fabricated. The operation voltage of the TFTs can be set as low as 1.5 V because of the low threshold voltages (i.e., −0.6 V for P-ch TFT and 0.6 V for N-ch TFT). The drain current versus source–drain voltage curves possess an ideal feature with sufficiently high saturation currents even at 1.5 V operation voltage (Figure 3). The drain current versus gate voltage curves show a sharp current increase, and the subthreshold swing value is ~80 mV/dec for both P-ch and N-ch TFTs. The on/off ratio is ~109 for both P-ch and N-ch TFTs, and the channel mobility is ~100 cm$^2$/Vs for P-ch TFT and ~200 cm$^2$/Vs for N-ch TFT.

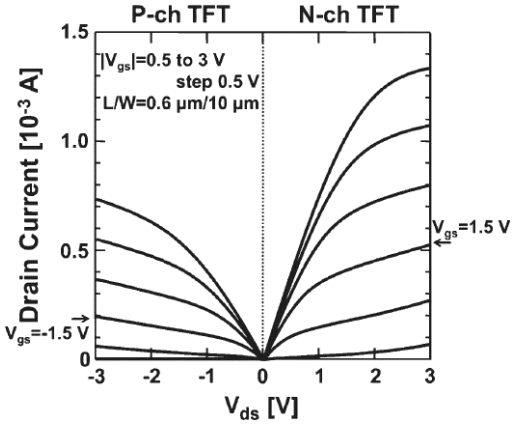


Figure 3 $I_d$-$V_{ds}$ curve for the P-ch and N-ch TFTs with 1.8-nm NAOS $SiO_2$/20 nm CVD $SiO_2$ stack gate dielectric structure having 0.6 μm gate length.

# Department of Metallic Materials Process


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Research Supporting Staff: Yoshitada NAKAI
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Fei ZHAO, Kota TANAKA, Akihiro TSUNEMI
Supporting Staff: Satoko MATSUMOTO


## Outlines

Metals are fundamental materials indispensable to various structural and functional materials. The main purpose of this department is to investigate physics of metallic materials and develop novel processing of the metallic materials. The department has undertaken the following several topics of the metallic materials science and engineering. Lotus-type porous metals (lotus metals) developed by this department are unique materials which exhibit extraordinary superior mechanical strength. The materials have been fabricated by unidirectional solidification of the melts under pressurized gases. In order to fabricate lotus aluminum with high porosity, lotus aluminum was systematically fabricated through the continuous casting technique under controlling solidification condition. And the effect of solidification conditions (solidification velocity, hydrogen partial pressure, temperature gradient and molten temperature) on pore formation of lotus aluminum was investigated in this year. In order to develop lotus metals with superior energy absorption, the effect of unidirectional pores on the dynamic compressive behavior was investigated using the Hopkinson pressure bar method.

Furthermore, we are studying the formation mechanism on nanovoids during annealing of amorphous oxides to establish the principle for fabricating novel nanoporous materials. In this year, we obtained the results that amorphous $Al_2O_3$ and $WO_3$ with 20-30% lower density than their crystalline phases became nanoporous structures as a result of annealing in air.

## Current Research Project

### Fabrication and Pore Formation Mechanism of Lotus-type Porous Aluminum

In order to fabricate lotus aluminum with high porosity, the effect of solidification conditions (solidification velocity, hydrogen partial pressure, temperature gradient and molten temperature) on pore formation of lotus aluminum was investigated. Especially, the solidification velocity that is very slower than that usually selected for fabrication of lotus metal were selected in order to achieve hydrogen flux. Figure 1 shows the typical pore morphology perpendicular (upper row) and parallel (lower row) to the solidification direction of the lotus aluminum fabricated at various transfer velocities((a)0.5, (b)0.6, (c)0.7, (d)0.8, and (e)0.9 mm/min). The porosity and average pore diameter decrease with increasing transfer velocity. Even for aluminum with low

solubility, higher porosity can be obtained through the unidirectional solidification at slow solidification velocity.

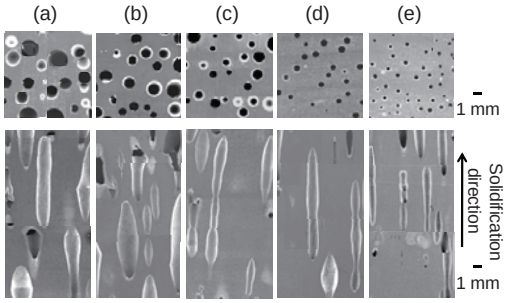


Fig. 1 Pore morphology perpendicular (upper row) and parallel (lower row) to the solidification direction of the lotus aluminum fabricated at various transfer velocities((a)0.5, (b)0.6, (c)0.7, (d)0.8, and (e)0.9 mm/min).

## Dynamic Compressive Deformation Behavior of Lotus Carbon Steel

Dynamic compressive deformation behavior of lotus carbon steel (S15CK) was investigated using the Hopkinson pressure bar method. Figure 2 shows the dynamic compressive stress-stain curves in the direction parallel to the pore direction. At room temperature (298 K), the flow stress monotonically increases with increasing strain. On the other hand, a plateau stress region appears in the dynamic compression at a low temperature (77 K). Similar plateau stress region does not appear in the compression perpendicular to the pore direction. Accordingly, it is deduced that the appearance of plateau stress region is related to the anisotropic porous structure.

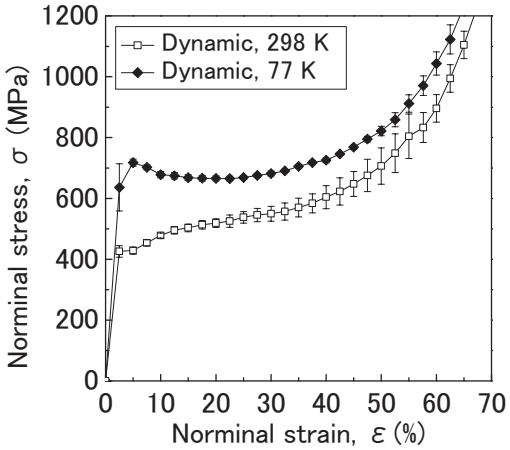


Fig. 2 Dynamic compressive stress-strain curves of lotus-type porous carbon steel in direction parallel to the pore direction.

## Fabrication of Nanoporous Oxides via Annealing of Amorphous Oxides

Formation behavior of nanovoids through the annealing of amorphous oxides was studied by transmission electron microscopy. It was found that amorphous $Al_2O_3$ and $WO_3$ with 20-30% lower density than their crystalline phases became nanoporous structures as a result of annealing in air. Figure 3 shows TEM images of $WO_3$ (a) before and (b) after crystallization. The common features of $Al_2O_3$ and $WO_3$ are as follows; (i) nanovoids were generated before crystallization and (ii) they grew larger as a result of crystallization. The results suggest that a large difference in density between the amorphous and crystalline phases seems to be an important factor for void formation.

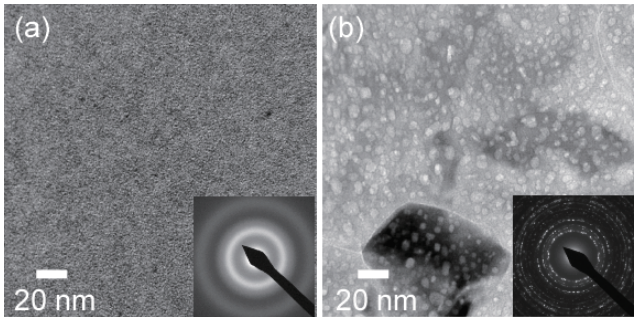


Fig. 3 TEM images of (a) as-deposited amorphous $WO_3$ and (b) annealed $WO_3$ at 673 K for 1hr and the corresponding electron diffraction patterns.

# Department of Advanced Interconnection Materials

| | |
|---|---|
| Professor: | Katsuaki SUGANUMA |
| Assistant Professor: | Masahiro INOUE, Keun-Soo KIM, Masaya NOGI |
| Post Doctoral Fellows: | Jinting JIU |
| Graduate Students: | Masafumi KURAMOTO, Alongheng BAATED, Ki-Ju LEE, Hitoshi SAKURAI, Chang-Jae KIM, Natsuki KOMODA, Takehiro TOKUNO, Soichi SAKAMOTO, Sung-Won PARK, Junglae JO, Nobuaki CHO, Teppei ARAKI |
| Support Staff: | Mariko HATAMURA, Noriko KAGAMI, Kyoko HAMASAKI, Misa MATSUSHITA, Kayo SATO |

## Outlines

Through nanotechnologies and knowledge for organic/inorganic materials, we are conducting the development of environmentally conscious fine technologies for electronics packaging area, i.e., lead-free soldering and conductive adhesives, and the composite materials based on metals and intermetallic compounds.

## Current Research Project

### Printed Electronics

There is a great interest in “printed electronics” that can fabricate electronic devices under the ambient conditions, like printings of newspapers or magazines. Our research project is to improve the printed electronics and the fabrication of their devices.

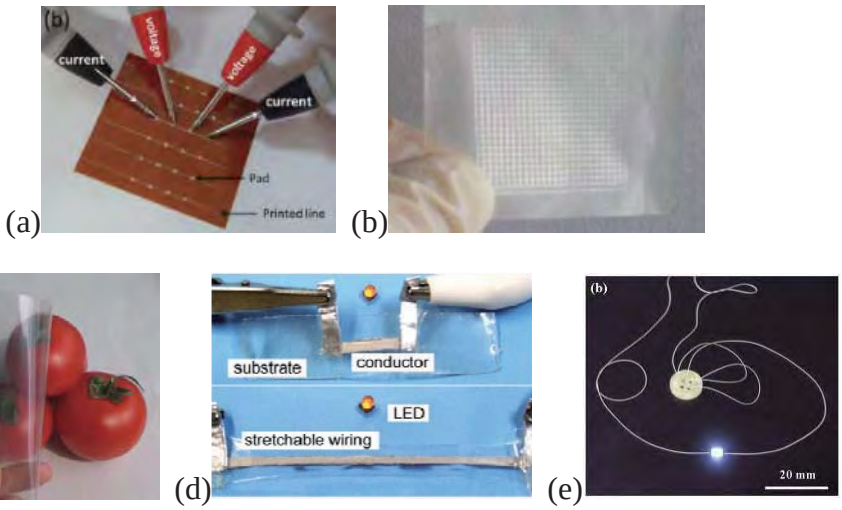


Fig. 1 Printed electronics technologies and their devices. (a) Inkjet-printed silver nanoparticles lines and thei evaluation systems of their resistivity. (b) Printed lines on cellulose nanopapers. (c) Transparent conductive films using silver nanowires under the room temperature fabrications. (d) Printable and Stretchable Conductive Wirings Comprising Silver Flakes and Elastomer. (e) Stretchable fibers with high conductivity fabricated by injection forming.

**Development of soft human/machine interfaces using super-flexible wiring technology**

Using the super-flexible wiring, stretchable tactile sensor systems including piezoelectric sensor and novel electrostatic sensor systems for humanoid robots and related applications were successfully fabricated. In addition, these sensor systems were connected to a self-organized network of distributed processors in order to realize the fail-safe data processing system and shown to work successfully.

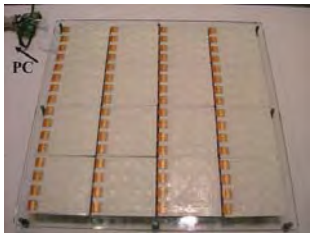


Fig. 2 A large-area tactile sensor system fabricated by integrating the stretchable sensor sheets and the self-organized network of distributed processors (256 channels).

**Technology for high-temperature soldering**

The purpose of the project is to understand the conductive adhesives as the alternative to leaded solders, focusing on their characteristics of high temperature resistance and of low temperature manufacturing process.

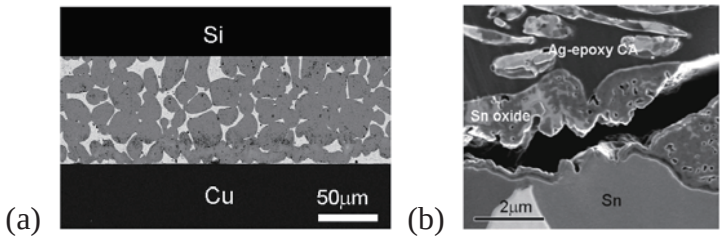


Fig. 3 (a) Interface microstructure of Si die attach with TiN barrier coating on Si die and Cu with Zn-30Sn soldered joint after the 2000 cycles of thermal cycling test.

(b) Cross-sectional images of the failed interface by external stress after the humid test for 1000 hours.

**Sn whisker growth in aerospace environment**

Sn whisker failure is one of the most serious concerns for the space electronics. In our group, the influence of vacuum thermal cycling on the formation of tin whiskers was investigated. Sn whiskers grow thinner and longer in temperature cycling in high vacuum as compared with air while whisker density is not influenced by atmosphere.

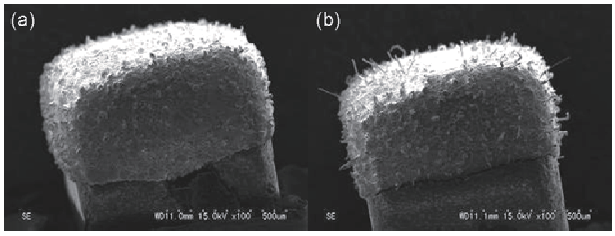


Fig. 4 Chip capacitor electrodes after 500 thermal cycles in air (a) and high vacuum (b).

# Department of Excited Solid-State Dynamics


Professor: Katsumi TANIMURA
Associate Professor: Shin'ichiro TANAKA
Associate Professor: Jun'ichi KANASAKI
Assistant Professor. Ei'ichi INAMI,
Assistant Professor. Nobuyasu NARUSE
Designated Researcher Yoshie MUROOKA
Designated Researcher Gilberto TEOBALDI
Designated Researcher Giret YVELIN
Support Staff Misako SHIMIZU


## Outlines

For fabricating highly functional nano-structured devices in future technology, it is essential to establish the ways to control structures and compositions of materials at the atomic level. In this department, we aim to establish the fundamentals for controlling the modes of atomic binding in solids via excitation-induced atomic reactions. For this purpose, we have carried out extensive experimental studies in the following three categories:

1) the primary processes of the photoinduced structural phase transitions,
2) ultrafast carrier dynamics on semiconductor surfaces,
3) excitation-induced structural changes of semiconductor surfaces,

In our studies, the main emphasis is placed on direct experimental determination of photoinduced changes of electronic and lattice systems at ultrafast temporal domains and at the atomic levels. As topics in the first category, we have studied the photoinduced phase transition in low dimensional crystals, like quasi one-dimensinal organic solids and two-dimensional solids like graphite. As topics of the second categories, we have studied carrier dynamics on Si surfaces by means of femtosecond two-photon photoemission spectroscopy. And as the third topic, we have studied laser- or low-energy electron induced structural changes of clean surfaces of Si and InP by means of not only the direct imaging of the surface atomic structure and its changes by STM. Also, in order to reveal direct determination of crystalline structural changes in femtosecond temporal domains, we have successfully constructed a ultrafast high-energy electron diffractomator with 100-fs temporal resolution.

## Current Research Project

### 1. Ultrafast carrier dynamics in semiconductors and on their surfaces studied by femtosecond two-photon photoemision spectroscopy

The excitation induced structural instabilities are triggered by several modes of ultrafast relaxation of electronic excited states, like carriers, excitons, and electron-hole plasma. In order to elucidate the dynamics of photogenerated surface carriers, which play crucial roles in several photoinduced reactions in solids and on solid surfaces, it is essential to study the ultrafast carrier dynamics with resolving their evolutions in momentum and energy spaces. Use of femtosecond laser for pump and probe pulses has

a strong advantage for resolving the carrier dynamics directly. In particular, the new system based on a tunable OPA laser for pump pulses of 50-fs temporal width and on a two-dimensional imaging detection of photoelectrons with respect to energy and momentum has opened a new breakthrough for studying the dynamics extensively.

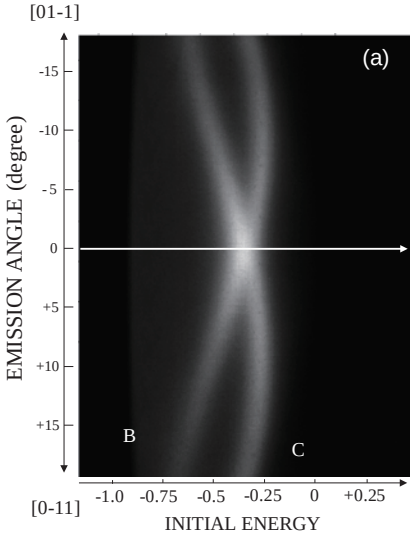

Fig.1

By probing electrons populated near the conduction band minimum of Si, we have elucidated directly the ultrafast processes of intra- and inter-vellay relaxation and energy relaxation of highly excited hot electrons. Furthermore, by using 6-eV probe photons, we can study the dynamics of photogenerated holes in bulk valence band, which can be probed as a time-dependent small depression of occupied-state photoemission intensities. A typical result is shown in Fig.1, where the of dispersion of the photo- emission peak from low-lying valence band, probed by s-polarized light for Si(111) surface, is imaged as a function of kinetic energy and emission angle representing parallel momenta. Holes generated in the valence band decays via two modes; one is the dynamical relaxation within 1 ps of excitation, and the other is the transfer-limited process of electron-hole recombination. The result provides new light for understanding photoinduced effects in semiconductors.

**2. Ultrafast structural dynamics of solids by transmission electron diffraction with 100-fs temporal resolution**

In order to reveal ultrafast structural dynamics involved in photo-induced structural phase transformation, we constructed an electron diffractometer with transmission mode and with ultrafast temporal resolution less than 100 fs.

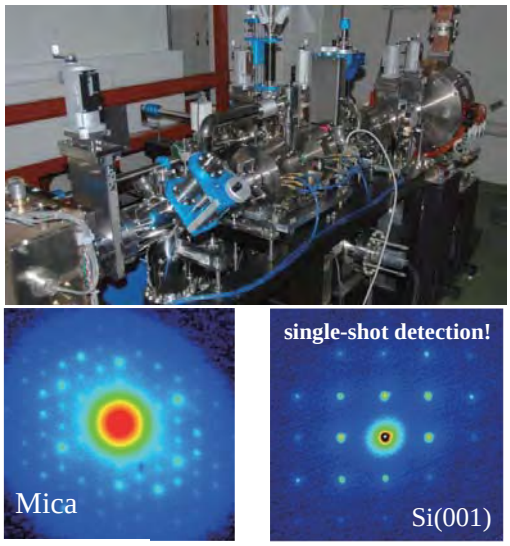

Fig.2

Our diffractometer uses relativistic electron beams generated by fs-laser induced RF photocathode, and collimated beams are dispersed on the phosphor screen to display the diffraction patterns. In Fig.1, we show typical results measured for Si and Mica, together with a picture of the diffractometer. Important point which should be emphasized is that a single-shot diffraction images can be measured clearly for Si, thus making possible to study irreversible processes of structural changes. This machine has been used to study real-time observation of the ultrafast structural dynamics in photo-induced structural phase transitions in several solids, like Si, Au, Graphite, and $Ge_2Sb_2Te_5$.

# Department of Accelerator Science

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Associate Professor: Ryukou KATO
Assistant Professor: Keigo KAWASE (2010.8.1-)
Specially Appointed Assistant Professor: Akinori IRIZAWA (2010.8.1-)
Visiting Professor: Shigemasa SUGA
Graduate Students: Yoshikazu TERASAWA, Naoya SUGIMOTO, Jen SHEN, Sho HIRATA, Masaki FUJIMOTO

## Outlines

Particle accelerators are widely used from basic science to industrial applications. In this department, we conduct research on accelerators with the object of producing quantum beams, including the high-brilliant electron beam and light. Because new kinds of quantum beams extend the world we can see with, they will be used in a large variety of fields extending from basic research to applications. To put it concretely, we conduct researches on production of a highly brilliant electron beam with a linear accelerator and related beam dynamics, development of an infrared FEL as well as applications to study on solid state physics or relevant fields using coherent radiation, and SASE (Self-Amplified Spontaneous Emission) in the infrared region.

## Current Research Project

### Upgrade of the L-Band Electron Linac

The L-band electron linac has a thermionic electron gun of the triode type and can generate electron beams of different lengths by applying pulsed voltages of various durations to its grid. A multi-bunch electron beam of an 8 μs duration is used in FEL experiments, which comprises a series of electron bunches with charge 0.5 nC separated by 9.2 ns for 8 μs. The round-trip time of a light pulse is 37 ns, so that four light pulses are bouncing in the optical resonator and they are amplified by successive electron bunches. Because the FEL gain increases proportionally to charge in a bunch, it can be increased higher if the linac can accelerate an electron beam with higher charge in bunches. It is possible to increase charge in bunches four times higher if intervals between bunches are expanded four times larger or 37 ns, for which the average beam current is maintained at the same level. We are developing a new electron gun with a grid pulser system that can generate a series of pulses at 37 ns intervals for more than 8 μs.

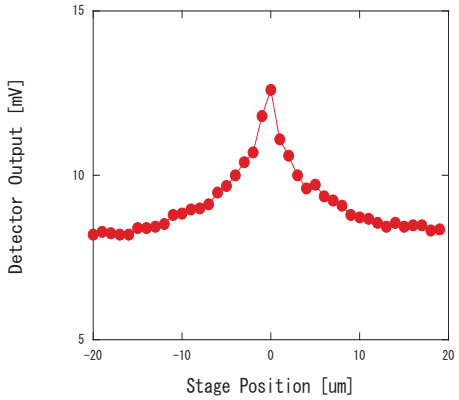



Fig. 1. Interference intensity between the injected Ti-sapphire laser light to the optical resonator and stored light measured as a function of the optical cavity length. The peak position corresponds to the origin of the optical resonator.

### Development of Free Electron Laser

We have developed a method to measure the absolute value of the optical resonator, which has significant effects on FEL operation. A Ti-Sapphire laser light (λ = 790

ns, $\Delta t < 80$ fs) is operated at 81.3 MHz, which is 1/16 frequency of the RF frequency of the linac 1.3 GHz and injected to the optical resonator, so that three optical pulses can be stored in the resonator. The stored light is taken out and interference with the input light is measured with a PIN photodiode. When the distance between the mirrors is equal to the resonance position of successive light pulses or electron bunches, an interference enhancement of the signal may be observed. Fig. 1 shows the PIN photodiode signal plotted as a function of the longitudinal position of a stage for the optical resonator. It is possible to determine the resonance length of the optical resonator within 1 μm accuracy.

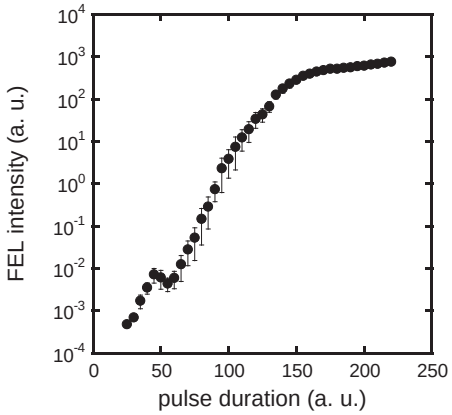



Fig. 2. Development of the FEL power with increasing number of amplifications.

As a part of basic studies on FEL, we study to obtain FEL gain from time development of the FEL power. We measure the FEL power in the macropulse as a function of the electron pulse length or the number of amplifications to obtain development of the FEL power with time. Fig. 2 shows the FEL intensity measured with a silicon bolometer as a function of the electron pulse length. The wavelength of FEL is 103 μm for the electron energy 15.2 MeV and the wiggler gap 30 mm. The length of the optical resonator is chosen so that the saturation power is the maximum. We could measure development of the FEL power in the range of six orders of magnitude.

**Application of High Intensity THz Radiation**

In addition to studies on FEL physics, we start to upgrade measuring equipment and test experiment for brazing a trial and promotion of application of high power pulsed THz radiation. We conduct experiments in the lower energy region using technologies developed in the infrared region in order to have information not available in the past, and aim to develop experiment techniques to make best use of characteristics of FEL, including its time structure, brightness, and coherence. A problem in such experiments is pulse-to-pulse fluctuation and long-term drift of the intensity of FEL light. We divide monochromatic light using a beam splitter so that one is used for reference and the other for measurement. We could obtain reflectivity spectra of higher quality by normalizing the measured intensities using the intensity monitor. Another important factor in optical measurement is the spatial distribution of the light beam. Fig. 3 shows intensity profiles of FEL light measured at the exit of the monochromator using a pyrocam. The left figure shows the intensity profile as it is, which are not focused well, but it could be focused to 1.3 mm (FWHM) using an off-axis parabolic mirror as can be seen in the right figure.

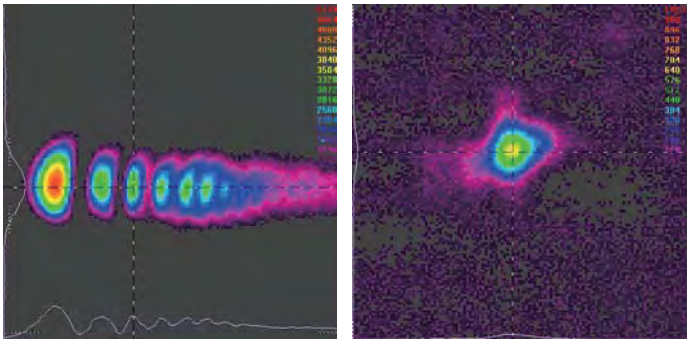


Fig.3. Intensity profiles of FEL light measured at the exit of the grating monochromator. Left: without focusing, right: focused with an off-axis parabolic mirror

# Department of Beam Materials Science

Assistant Professor: Kazuo KOBAYASHI
Graduate Students: Mayu FUJIKAWA

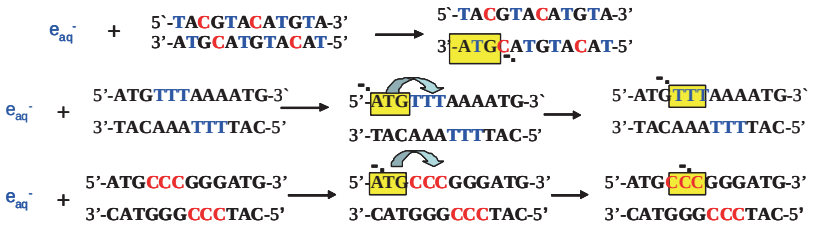
## Outlines

The group of the Department of beam materials science conducts with the L-band electron linac and the $^{60}$Co γ-ray irradiation facility. The aim of our research program is to fully characterize the process by which ionizing radiation alters the chemical structure of functional materials and biological molecules.

## Current Research Project

### Dynamics of Electrons in DNA

In early stage of radiation-induced DNA damage, high-energy radiation ionizes nucleic acid bases, generating positive holes and electrons within DNA strand. Identification of the DNA sites that trap holes and electrons is essential to understanding the process of DNA damage caused directly by ionizing radiation. Theoretical calculations show that the anion radical of the bases are strongly influenced by neighboring nucleobases. In the present work, we present spectral intermediates of a systematic series of electron adducts of oligonucleotides (ODNs). The transient spectra of excess electrons of the double-stranded ODNs show that excess electrons localize on the bases C and T, but not on A and G.. We proposed that the following electron transfer occur in ODNs, as shown in Scheme 1.




Scheme 1 Schematic presentation of charge transfer of excess electrons in a systematic series of ODNs

### Electron transfer reactions of candidate tumor suppressor 101F6 protein, a cytochrome $b_{561}$ homologue, with ascorbate and monoascorbate radical

The candidate human tumor suppressor 101F6 protein is a homologue of adrenal chromaffin granule cytochrome $b_{561}$, which is involved in the electron transfer from cytosolic ascorbate to intravesicular monodehydroascorbate radical (Fig. 1). Since the proposed tumor suppressor activity of 101F6 protein was enhanced in the presence of ascorbate, it was suggested that 101F6 protein might utilize a similar transmembrane electron transfer reaction of the cytochrome $b_{561}$ protein family. Detailed kinetic analyses were conducted on the detergent-solubilized recombinant human 101F6

protein for the electron transfer reactions with ascorbate and monodehydroascorbate radical by using pulse radiolysis techniques. The reaction rates of the electron donation from the ascorbate-reduced 101F6 protein to monodehydroascorbate radical had a second order rate constant of 5.0 x $10^7$ $M^{-1}s^{-1}$, which was about two-fold faster than the rate of bovine chromaffin granule cytochrome $b_{561}$, suggesting that human 101F6 protein is very effective for scavenging monodehydroascorbate radicals in cells. Present observations implied that 101F6 protein employs distinct electron transfer mechanisms on both side of the membranes different from those of other members of the cytochrome $b_{561}$ protein family.

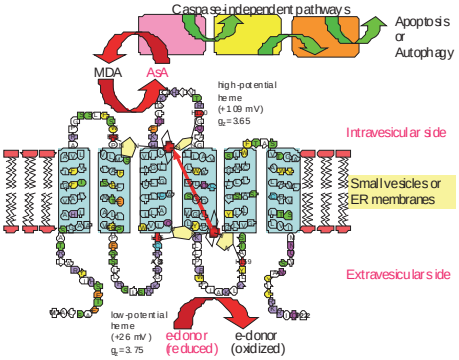



Fig. 1 Proposed topological model and function of the human tumor suppressor 101F6 protein in cell.

**Protein conformational changes in the oxidative-stress sensor, SoxR, upon redox change of the [2Fe-2S] cluster probed with ultraviolet resonance Raman spectroscopy**

Members of the MerR family function as transcriptional activators in response to a variety stress conditions, including exposure to heavy metals, reactive oxygen species and antimicrobials. Upon activation, in response to the appropriate stimulus, these proteins undergo conformational changes that unwind the promoter region, allowing RNA polymerase to initiate transcription. SoxR, which belongs to the MerR family, regulates an oxidative stress response to superoxide and nitric oxide in *Escherichia coli*. In the current study, we first investigated conformational changes in SoxR upon reduction of the [2Fe-2S] cluster. Ultraviolet resonance Raman (UVRR) spectroscopic analysis of SoxR revealed conformational changes upon reduction of the [2Fe-2S] cluster in the absence and presence of promoter oligonuleotide. UVRR spectra reflected environmental or structural changes of Trp following reduction. Notably, the environment around Trp91 contacting the [2Fe-2S] cluster was altered to become more hydrophilic, whereas that around Trp98 became more hydrophobic. On the other hand, the environment around Tyr was barely affected by [2Fe-2S] reduction. Binding of the promoter oligonuleotide triggered changes in Tyr located in the DNA-binding domain, but not Trp. Furthermore, the conformational changes induced upon reduction of DNA-bound SoxR were not significantly different from those of DNA-free SoxR.

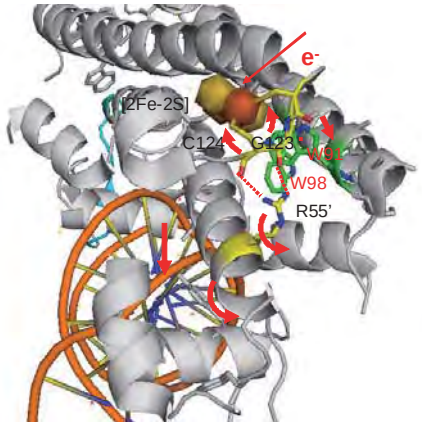


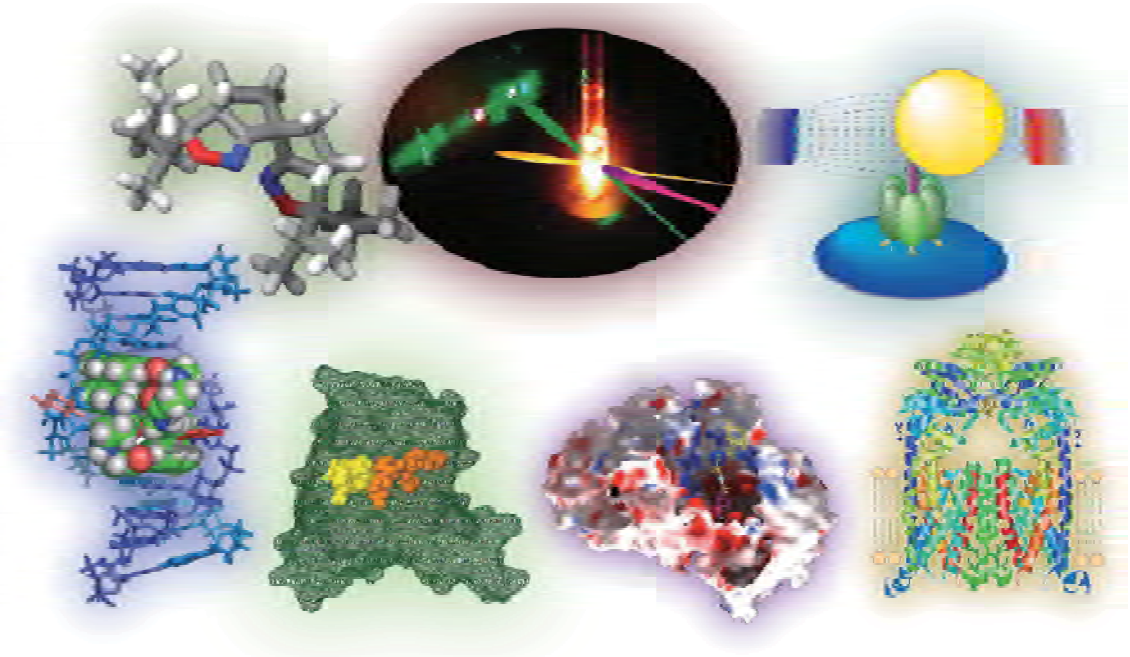

Fig. 2 Proposed model of the redox dependent regulation of SoxR

# Division of Biological and Molecular Sciences

## Outline

The Molecular Science Group of this division is composed of four departments; Dept. of Molecular Excitation Chemistry, Dept. of Synthetic Organic Chemistry, Dept. of Regulatory Bioorganic Chemistry, and Dept. of Organic Fine Chemicals. The research field of the Molecular Science Group covers organic chemistry, physical chemistry, catalytic chemistry, surface chemistry, beam-induced chemistry, materials chemistry, bio-functional molecular chemistry, and chemical biology. The division also has a Biological Science Group, which is composed of three departments; Dept. of Structural Molecular Biology, Dept. of Cell Membrane Biology, and Department of Biomolecular Science and Engineering. These departments are engaged in research in various fields of biological science including molecular enzymology, signal transduction, energy transformation, membrane transport, energy transport, and the mechanism of gene expression.

Within each department, own research topics are ongoing. Joint projects involving several departments are also underway.



# Department of Molecular Excitation Chemistry

Professor: Tetsuro MAJIMA
Associate Professors: Mamoru FUJITSUKA, Kiyohiko KAWAI
Assistant Professor: Takashi TACHIKAWA
Specially Appointed Professor: Akira SUGIMOTO
JSPS Research Fellow: Jungkweon CHOI (2010.4.1–2011.1.31)
Postdoctoral Fellows: Takumi KIMURA, Zhenfeng BIAN (2010.10.16–),
Jungkweon CHOI (2011.2.1–)
Research Fellows: Lingli CHENG (2009.8.1–2010.5.10),
Nan WANG (2009.9.1–2010.10.1)
Graduate Students: Man Jae PARK, Jun Rye CHOI, Shi-Cong CUI,
Eri MATSUTANI, Soichiro YAMASHITA,
Sooyeon KIM, Mitsuo HAYASHI, Tomoyuki YONEZAWA
Under Graduate Student: Mayuka ISHIKAWA
Supporting Staff: Sanae TOMINAGA

## Outlines

"Beam-induced molecular chemistry" based on photo- and radiation-induced chemistry of organic compounds has been investigated from both basic and beam-functional points of view. The research topics are underway with respect to developments of new beam-controlled chemistry, new synthetic chemistry, and new molecular devices and functional materials.

1. Formation and reactivities of reactive intermediates in photochemistry and radiation chemistry, and photochemistry of reactive intermediates
2. Multi-beam chemistry with irradiation by two-color laser-laser and electron pulse-laser flash
3. Multiple-photon chemistry of organic compounds using UV, visible, and infrared lasers
4. Beam-controlled chemistry of artificial biomolecules such as modified DNA and proteins

## Current Research Project

### Multi-beam Chemistry

Multi-beam chemistry has been studied using pulse radiolysis-laser flash photolysis combined method, two-color two-laser photolysis and three-color three-laser photolysis. Photochemistry of reaction intermediates and short-lived chemical species generated from the reaction induced by the first beam excitation of a starting molecule (two-step excitation method), and moreover, photochemistry of other chemical species generated from the reaction of the short-lived intermediate induced by the second beam excitation (three-step excitation method) can be studied. This year, we have investigated the driving force dependence of intramolecular hole transfer via excited state of radical cation of oligothiophenes. Furthermore, we have investigated the charge delocalization process of the stacked chromophore using cyclophanes as model compounds. From the

transient absorption measurements during the pulse radiolysis of three- and four-layered cyclophanes, we have successfully observed the charge delocalization process among multi-layers. In addition, transient behavior due to the distribution change of conformers upon oxidation was observed.

**Photocatalytic formation of I-I bonds using DNA which enables detection of SNPs**

We recently found that the charge transfer efficiency through DNA can be drastically increased by replacing A with its analog 7-deazaadenine or diaminopurine (D), both of which have HOMO-levels closer to that of G without disturbing the complemental base-pairing. In particular, D can fully replace A during PCR and thus can be used to construct DNA with increased CT efficiency by PCR amplification of DNA sequences of interest. In this study, by using DNA in which the A-T base-pairs were replaced with D-T base-pairs in order to achieve a high charge transfer efficiency, we established a functionalized DNA system which can convert the absorbed photon energy to produce $I_2$. A photo-induced charge-separated state was generated in the genomic DNA sequences containing single nucleotide polymorphisms (SNPs), where the presence of a mismatch causes the perturbation of the pi-stacks, resulting in a decrease of charge transfer efficiency and subsequent charge separation yield. The absorbed photon-energy was used to catalytically oxidize iodide ion with the aid of super oxide dismutase (SOD) to ultimately produce $I_2$, which enabled the detection of SNPs in the genomic DNA sequence using the well known iodine starch reaction.

**Single-Molecule, Single-Particle Spectroscopic Studies on the Mechanisms of Photocatalytic Reactions**

Heterogeneous photocatalysts have both potential and demonstrated applications for use in the water-splitting reaction that produces hydrogen, the degradation of organic pollutants, the surface wettability conversion, etc. We have investigated the interfacial electron transfer on individual $TiO_2$ particles using single-molecule, single-particle spectroscopy with a novel redox-responsive fluorescent dye. It has been demonstrated that the locations of reactive sites determined using centroid analysis of each fluorescent spot are evenly distributed on the surface of the particle. The dependence of the product formation rate on the concentration of the probe molecules was found to be described by Langmuir-Hinshelwood equation. Furthermore, we have examined the photocatalytic activity of individual Au nanoparticle-loaded $TiO_2$ particles. The Au/$TiO_2$ samples showed much higher photocatalytic ability than $TiO_2$, because the loaded Au nanoparticles greatly enhance the charge separation within the nanocomposites by collecting electrons from $TiO_2$.

**Unfolding dynamics of cytochrome *c* revealed by single-molecule and ensemble-averaged spectroscopy**

Denaturant-induced conformational change of yeast iso-1-cytochrome c (Cytc) has been comprehensively investigated in the single-molecule and bulk phases. In this study, we clearly show that the unfolding process of Cytc-A488 observed in the single-molecule and bulk phases takes place through an intermediate with a native-like compactness. By quantitative analysis of fluorescence correlation spectroscopy (FCS) data, we were able to observe a relaxation time of 1.5 μs corresponding to segmental motion and fast folding dynamics of 55 μs in the unfolded state of Cytc.

# Department of Synthetic Organic Chemistry

| | |
|---|---|
| Professor: | Hiroaki SASAI |
| Associate Professor: | Shinobu TAKIZAWA |
| Assistant Professors: | Junko ICHIHARA, Kazuhiro TAKENAKA |
| Postdoctoral Researchers: | Naohito INOUE, Chennan RAMALINGAN (–2011.1.31)<br>Jokar MAHBOUBEH (–2010.9.30),<br>Volodymyr SEMENIUCHENKO,<br>Sridharan VELLAISAMY (2010.10.30–) |
| Graduate Students: | Kazem GHOZATI (–2010.9.30),<br>Gabr Randa Kassem MOHAMED,<br>Suman Chandra MOHANTA, Kimiko KIRIYAMA,<br>Shuichi HIRATA, Yogesh Daulat DHAGE (2010.10.1–),<br>Mitsutoshi AKITA, Shuhei TAKATANI,<br>Shinya MURAKAMI, Tue Minh-Nhat NGUYEN,<br>Xianjin LIN, Kenta IEKI, Yuka ISHIZAKA,<br>Shinya MATSUSHIMA, Yasushi YOSHIDA,<br>Donglin ZHAO (2010.10.1–),<br>Maria Odaise Silva dos SANTOS (2010.10.1–) |
| Under Graduate Student: | Junpei KODERA |
| Research Student: | Lulu FAN (2010.11.1–) |
| Supporting Staff: | Fumiyo WATANABE (2010.7.1–) |

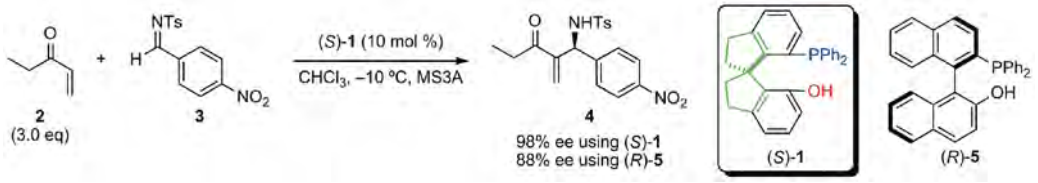
## Outlines

Asymmetric synthesis, a phenomenon fine-tuned to perfection by nature, forms the central theme of our research efforts. We have been interested in the design and syntheses of a novel class of chiral ligands that are unique in promoting new asymmetric reactions. The mechanisms of these organic reactions are also studied by means of physical organic techniques. Novel chiral spiro ionic liquids and organocatalysts have been synthesized with a focus on developing environmentally benign asymmetric processes.

## Current Research Project

**Spiro-Type Acid–Base Organocatalyst with High Enantiocontrol: Application to the Aza-Morita–Baylis–Hillman Reactions**

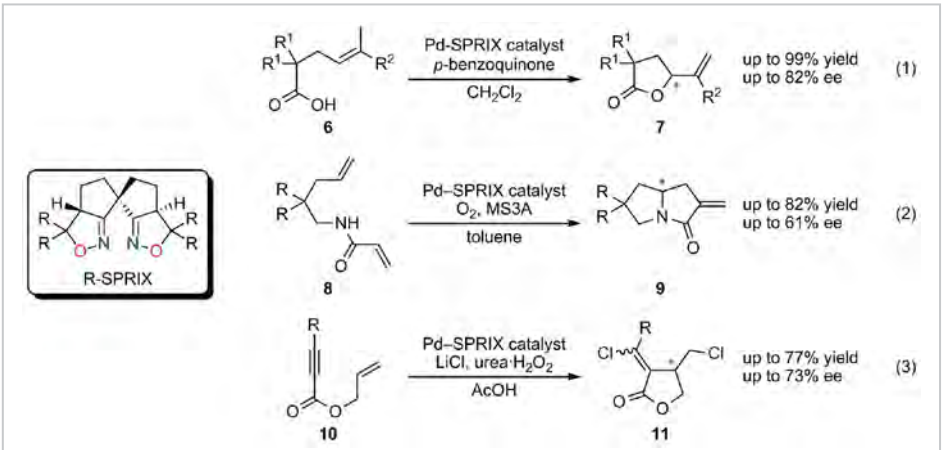
Owing to our interest in the development of novel acid–base organocatalysts, we focused on 1,1′-spirobiindane as a potential platform for bifunctional organocatalysts. Herein we have developed a new spiro-type bifunctional organocatalyst (*S*)-**1** for the enantioselective aza-Morita-Baylis-Hillman (aza-MBH) reaction. The spiro organocatalyst was found to show high asymmetric induction in the reaction of enone **2** and imine **3** to yield product **4** in 98% ee. Notably, (*S*)-**1** provided better results compared to the analogous binaphthyl catalyst (*R*)-**5** (Scheme 1).




Scheme 1. Enantioselective Aza-MBH Reaction Promoted by Spiro-Type Organocatalyst **1**

## Enantioselective Oxidative Cyclization Catalyzed by Pd−SPRIX Complexes

Novel enantioselective reactions promoted by the Pd–SPRIX catalyst have been developed (Scheme 2). Oxidative cyclizations of 4-alkenoic acids **6** (eq 1), alkenyl acrylamides **8** (eq 2), and allyl propiolates **10** (eq 3) proceed enantioselectively to give γ-lactones **7**, 2-methylenetetrahydro-pyrrolizin-3-one derivatives **9**, and chlorinated α-methylene-γ-lactones **11** in high yields, respectively. All the products are known to be a valuable synthon for many biologically active substances.




Scheme 2. Novel Enantioselective Oxidative Cyclizations Catalyzed by Pd-SPRIX

## Development of Novel Chiral Ligands Based on Spirobilactams

We have successfully prepared new spiro compounds by thionation of spirobilactams which are readily available through an enantioselective Pd-catalyzed intramolecular *N*-arylation of malonamides. The spirobithiolactams smoothly coordinate to a variety of transition metals such as Pd and Au via their sulfur atoms of the thioamide groups to give the corresponding complexes in high yields. These spirobithiolactams are the first example of a sulfur-donor spiro chiral ligand.

## Green Powder-phase Oxidation Using Apatite Powder

We have developed a green powder-phase oxidation reaction for an organic compound, which has such advantages that the system does not require any organic solvent which may adversely affect the global environment, has a high product yield, and enables to reuse a catalyst and the like. The oxidation reaction is performed with the powder mixture comprising of a tungstate catalyst powder dispersed on apatite powder, and the added liquid reactants, an organic compound and aqueous hydrogen peroxide. By use of the powder epoxidation system, halogen-free epoxides were easily prepared. Further improvements toward practical use are under consideration. The idea of the powder-phase oxidation reaction was developed to preparing radical polymers in powder-state.

# Department of Regulatory Bioorganic Chemistry

Professor: Kazuhiko NAKATANI
Assistant Professors: Masaki HAGIHARA, Chikara DOHNO, Fumie TAKEI
Specially Appointed Assis. Prof.: Takeo FUKUZUMI (2010.6~)
Specially Appointed Researcher: Asako MURATA (2010.6~)
Graduate Students: Shiori Umemoto, Changfeng Hong, Hiroshi Atsumi, Tomonori Shibata, Keisuke Yoneda, Seongwang Im, Hiroki Nakagawa, Shizuka Matsunaga, Tomoyuki Mizunashi, Xi Chen, Lanxian Chen, Izumi Kohyama, Takahiro Otabe, Mariko Toda, Shingo Makishi
Research Assistance: Mayo SENDA (~2010.11), Maki Kimura (2010.5~) Yasue Harada (2010.5~)
Research Students: Jin Song (2010.10~), Gaigai Yu (2010.10~)
Supporting Staff: Yuriko YAGUCHI

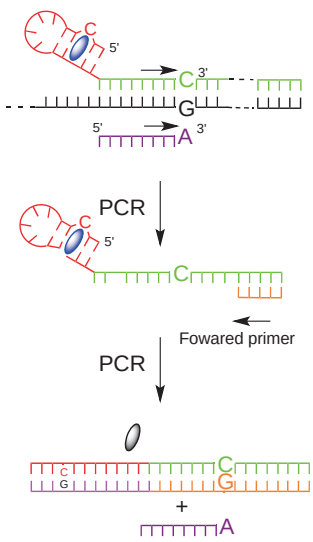
## Outlines

We have studied on “Chemical Biology” and “Nano-Technology” based on synthetic organic chemistry. For chemical biology, we focused our attention on 1) molecular design of mismatch binding ligands, and 2) in vitro selection of RNA aptamer binding specific nucleic acid structure. Because DNA is not only a genetic materials but also an important organic materials consisting of C, H, O, N, and P atoms with ability of spontaneously forming a double helix. To use DNA as precision organic materials in nano-technology, we have studied on the chemical properties of DNA and on the synthesis of chemically modified DNA.

## Current Research Project

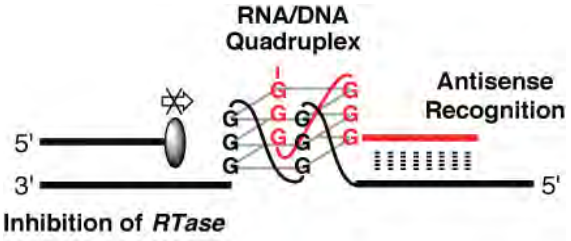
**Development of Technology for Single Nucleotide Polymorphisms (SNP)**

The technique for promptly detecting the genetic mutation is expected as a basis technology that supports the personalized medicine. We have reported a new SNP typing method from DNA secondary structure-inducible ligand fluorescence, from which can be also used as the real-time PCR. In this SNP typing method, the hairpin tag is dissolved by a PCR and is transformed into a duplex. As a result, the primer losses of the DANP binding sites, and the fluorescence intensity decreases. This time, we have focused on the method to improve the allele specificity of the PCR using hairpin primers with competitor primers, and the SNP alleles are discriminated by fluorescence. This is the simple method to increase the allele specificity without optimized a PCR conditions. As a result, the allele specificity is dramatically increased by this method.



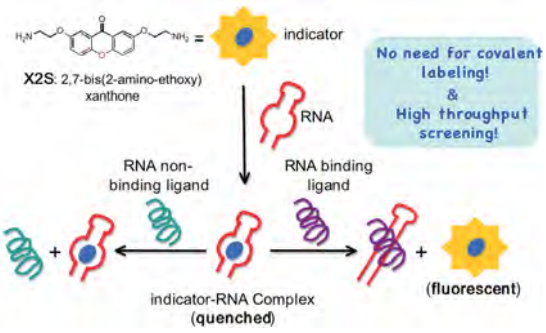
**Development of Guanine-Tethered Antisense Oligonucleotides**

We reported a novel antisense strategy using guanine-tethered antisense oligonucleotides (g-ASs) that introduce an RNA−DNA hetero−quadruplex structure on RNA templates in a predictable and sequence-specific manner, which in practice effectively inhibited reverse transcription on a variety of RNA sequences, including the HIV-1 RNA genome. The *RTase* stop assay, together with other biophysical analyses, provided direct evidence for RNA−DNA hetero–quadruplex formations in target RNAs upon g-AS binding［**Original Paper 2**］. The remarkable inhibiting ability of reverse transcription by guanine-tethered antisenses could make possible the development of novel antiretroviral gene therapies based on blocking the replication of RNA genomes to DNA that is a critical step for integration into the host's genome.




**Fluorescent displacement assay for the detection of RNA-ligand interactions**

Non-cording RNA (ncRNAs) are involved in many biological processes including development, differentiation and carcinogenesis. Small-molecule modulators of ncRNAs would be important tools for the elucidation of the detailed mechanisms of ncRNA function and would be lead compounds for the development of new drugs that target ncRNAs. We have developed a fluorescent displacement assay for RNA-ligand interactions based on a novel fluorescent indicator, a 2,7-disubstituted 9*H*-xanthen-9-one derivative (X2S). X2S is non-fluorescent when bound to RNA but fluoresces when it is displaced from RNA. Our assay was found to be applicable for screening new ligands that bind to RRE (Rev-responsive element) RNA from a chemical library. We also performed a high-throughput screen of a large chemical library (9600 compounds) using our system to identify small molecule that bind to specific pre-miRNA stem-loop and found several candidate compounds.




**Fluorescent indicator displacement assay**

In order to find a new synthetic ligand for ncRNA, constructing one's own "high quality" chemical library is very important. We have designed a novel ligand molecule, 8-heteroaromatic purine. This purine couples with other heterocyclic moiety via Suzuki reaction and a large number of library was conveniently prepared. With the fluorescent displacement assay, the compound library allowed to study ligand-RNA interactions.

**Small synthetic ligand triggered formation of DNA nanostructure.**

DNA is one of the most promising molecular materials for constructing a designed nanostructure using the bottom-up process. We have demonstrated that a small synthetic ligand can be used as a key building component for DNA nanofabrication. Using naphthyridinecarbamate dimer as a molecular glue for DNA hybridization, we demonstrated NCD-triggered formation of a DNA tetrahedron **[Original Paper 1]**.

# Department of Organic Fine Chemicals

| | |
|---|---|
| Professor: | Nobuo KATO |
| Associate Professor: | Junko OHKANDA |
| Assistant Professors: | Hajime NITTA, Shunro YAMAGUCHI, Kunihiro KAIHATSU |
| Research Associate: | Nobuyuki TANAKA |
| Graduate Students: | Yu HARANOSONO, Yusuke HIGUCHI, Shinjiro SAWADA, Yuriko MARUYAMA, Takuya OHZAWA, Yoshinobu YAMAGUCHI, Tomohiro WATANABE, Chiaki OURA, Takashi KANNO, Michiko TAKAHASHI |
| Research Student: | Yiting ZHOU (2010.10.01–2011.03.31) |
| Technical Assistants: | Hiroyo MATUMURA, Azusa OHTA, Junko HIKITA (–2010.11.30) |
| Supporting Staff: | Misuzu TANNO (–2010.10.15) |

## Outlines

The major goal of this department is to identify promising lead compounds for drug discovery. Based on chemical proteomic approaches, our research interests focus on the rational design and synthesis of small organic compounds that potentially modulate/inhibit protein-protein interactions. These compounds are also utilized as a tool in our chemical genomic study to elucidate intracellular signaling pathways.

## Current Research Project

### Key enzymes to determine the aglycon structures of fusicoccane diterpene glycosides

In the course of our studies on the biosynthesis of fusicoccane diterpenoids that can modulate 14-3-3 protein functions, we have confirmed that α-ketoglutarate dependent dioxygenases are responsible for the introduction of the 1,2-double bond with/without the introduction of 3α-OH in the aglycon moiety. A dioxygenase (PaDOX) that originates from *Phomopsis amygdali*, a fusicoccin producing fungus, afforded 8β-hydroxy-fusicocca-1,10(14)-dien-16-al from its biosynthetic precursor, fusicocca- 2,10(14)-diene-8β,16-diol. Whereas another dioxygenase (AbDOX) that originates from *Alternaria brassicicola*, of which metabolites have a cotylenin-type aglycon, gave fusicocca-1,10(14)-diene-3α,8β,16-triol from the same precursor. Moreover, we showed that short-chain dehydrogenase/reductase (SDR) located in the fusicoccin biosynthetic gene cluster catalyzes the reduction of the aldehyde to yield fusicocca-1,10(14)- diene-8β,16-diol. These findings provide significant insights into the biosynthesis of the fusicoccin-type and cotylenin-type aglycons.

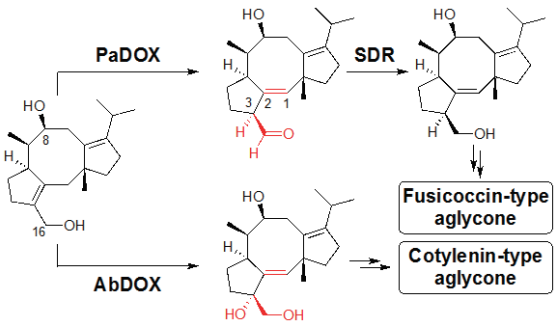



**Fig. 1.** Enzymatic conversions of fusicocca-2,10(14)-diene-8β,16-diol by PaDOX and AbDOX.

**Bivalent inhibitors for disrupting protein-protein interactions and for dual inhibition of protein prenyltransferases**

Pancreatic cancer is one of the most aggressive and severe human cancers. Oncogenic K-Ras is responsible for 90% of human pancreatic cancer and its posttranslational modification regulated by FTase has been a clinical target for anticancer therapy. However, disrupting K-Ras prenylation by conventional FTase inhibitors turned out extremely difficult as K-Ras facilitates protein- protein interactions (PPIs) with both FTase and GGTase-I. In this study we designed a series of bivalent compounds that anchor to the enzyme active site to deliver a minimally sized surface-binding module to the targeted surface involved in transient PPI with a substrate. A significant improvement in inhibitory activity (>200-fold) against farnesylation of the K-Ras4B peptide was observed when the gallate module was attached to the CVIM tetrapeptide (Fig. 2). Furthermore, the bivalent compounds had submicromolar inhibitory activity against geranylgeranylation of the K-Ras4B peptide catalyzed by GGTase I, which has an α-subunit identical to that of FTase. This anchoring strategy would be useful for designing a new class of PPI inhibitors, as well as dual enzyme inhibitors targeting common surface structures.

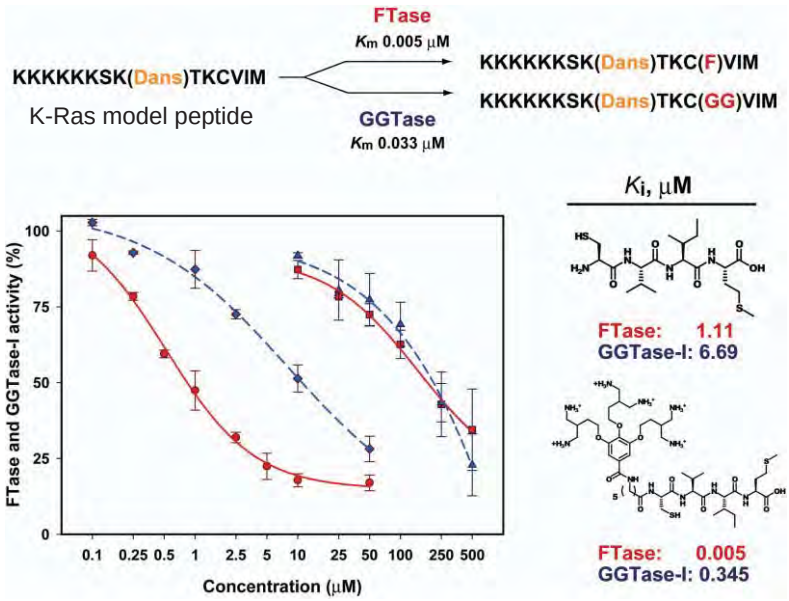



**Fig. 2.** Dose-response curves for the inhibition of FTase (red) by CVIM (squares) and the bivalent compound (circles), and inhibition of GGTase-I (blue) by the CVIM (triangles) and the bivalent compound (diamonds).

**Inactivation of pathogens with polyphenol fatty acid derivatives**

A major green tea polyphenol component, epigallocatechin-3-*O*-gallate, was modified with fatty acid derivatives by lipase-catalyzed transesterification. In the collaboration work with Department of Cell Membrane Biology in ISIR, we confirmed that EGCG-fatty acid derivatives showed enhanced antibacterial activities against Gram-positive, Gram-negative, antifungal activities.

**Diagnosis of influenza virus strain by hairpin-type peptide nucleic acid**

A highly conserved 15-base viral genome sequence among influenza A/H1N1 viruses was identified by CONSERV software. We synthesized peptide nucleic acid (PNA), an analogue of DNA/RNA, which has a complementary sequence against the conserved viral genome sequence and immobilized it on a plate. By using this hairpin-type PNA, we developed a method to capture influenza A virus in a virus strain and visualized the virus genome by naked eyes.

# Department of Structural Molecular Biology

| | |
|---|---|
| Professor: | Katsuyuki TANIZAWA |
| Invited Professor: | Shun'ichi KURODA |
| Associate Professor: | Toshihide OKAJIMA |
| Assistant Professors: | Kenji TATEMATSU, Tadashi NAKAI<br>Takashi MATSUZAKI |
| Graduate Students: | Sayaka ISHII, Shigehiro MIZUNO, Shouta TSUCHIDA,<br>Yuri KATO, Seigo KIKUKAWA, Yuki NAKAGAKI,<br>Hidehiro IWASAKI, Takafumi DEGUCHI, Hiroto ITO,<br>Kazuhiro YAMADA, Jurina YAGI |
| Supporting Staff: | Mayuko MURAI |

## Outlines

The research of this laboratory is focused on the biochemical and molecular biological studies on various enzymes. Their active-site structures and catalytic mechanisms are being investigated by site-directed mutagenesis, various spectroscopies, and X-ray crystallography. Previous conspicuous findings are the copper ion-dependent, post-translational modification mechanism for the biogenesis of the topa quinone cofactor in copper amine oxidase and the very unique structure of quinohemoprotein amine dehydrogenase (QHNDH) containing a novel built-in type quinone cofactor and internal thioether crosslink structures. Furthermore, we determine crystal structures of the protein domains involved in the bacterial two component signal transduction system (TCS) and elucidate the mechanisms of signal sensing and transcriptional regulation. Furthermore, we have developed hollow bio-nanoparticles displaying various bio-recognition molecules, which are expected to be an ideal vector for the tissue- and cell type-specific gene and drug delivery system.

## Current Research Project

### Catalytic Mechanism of Copper Amine Oxidase: X-Ray Crystal Structure of the Intermediates Formed in the Oxidative-Half Reaction

The catalytic reaction of copper amine oxidase comprises two half-reactions. In the former reductive-half reaction, substrate amine reduces the Tyr-derived cofactor, topaquinone (TPQ), to an aminoresorcinol form ($TPQ_{red}$), which is in rapid equilibrium with the TPQ semiquinone radical ($TPQ_{sq}$) by intramolecular electron transfer to Cu(II). In the latter oxidative-half reaction, the molecular oxygen acts as an electron acceptor for $TPQ_{sq}$–Cu(I), concomitant with the formation of an iminoquinone intermediate ($TPQ_{imq}$). The initial oxidized form of TPQ is regenerated by subsequent hydrolysis of $TPQ_{imq}$. We have analyzed the oxidative half-reaction in the crystals of the enzyme from *Arthrobacter globiformis* by single-crystal microspectrophotometry and x-ray crystallography. After anaerobic reduction with a substrate amine, the crystals were transferred aerobically to the buffer containing 45% glycerol as a cryoprotectant to generate intermediary states of the oxidative-half reaction in the crystal and incubated for various time (5~50 min), followed by flash-freezing in liquid Freon for

spectrophotometric and x-ray diffraction analyses. In the crystals reduced with 2-phenylethylamine, TPQ was found to have an 'on-copper' conformation, in which the C4-OH group ligated axially to Cu(I). After 5~15-min incubation in the aerobic buffer, TPQ had both 'on-copper' and 'off-copper' conformations with approximately equal occupancies. After 15~50-min incubation, TPQ completely changed to an 'off-copper' conformation and showed an absorption peak at 434 nm, which was assignable to $TPQ_{imq}$. Also in this state, a cylinder-like electron density map was identified at a position connecting Cu (II) and the C5 carbonyl oxygen of $TPQ_{imq}$, which could be assigned to a reduced oxygen species (most likely $HOO^-$ or $H_2O_2$) (Fig. 1). Furthermore, the product aldehyde remained in the substrate-binding pocket. In contrast, in the crystals reduced with a less preferred substrate, histamine, the oxidative-half reaction proceeded without accumulating $TPQ_{imq}$ and without retaining the product aldehyde. These results show that the oxidative-half reaction proceeds with accompanying the conformational change of TPQ from 'on-copper' to 'off-copper' positions, which facilitates electron transfer from Cu(I) to $O_2$ in a concerted manner. It is conceivable that the product aldehyde remaining in the substrate-binding pocket promotes trans-imination from $TPQ_{imq}$ to the substrate-Schiff base ($TPQ_{ssb}$).

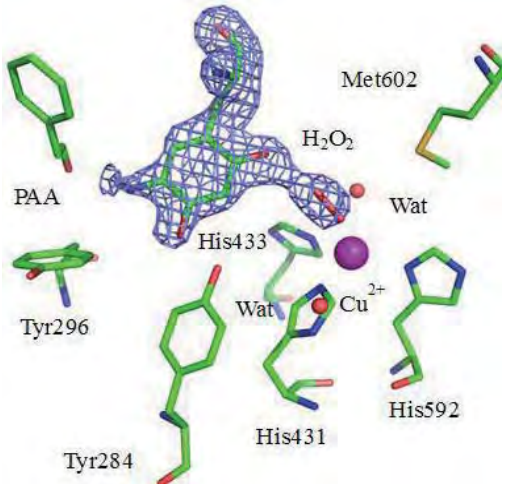



Fig. 1. Active-site structure of an intermediate formed during the oxidative half-reaction.

**X-Ray Crystal Structure of the DNA-Binding Domain of Response Regulator WalR Essential to the Cell Viability of *Staphylococcus aureus* and Interaction with Target DNA**

A bacterial two-component signal transduction system, WalK/WalR, is essential to the cell viability of Gram-positive bacteria and is therefore a potential target for the development of a new class of antibiotics. We have solved the X-ray crystal structure of the DNA-binding domain of the response regulator WalR (WalRc) from a Gram-positive pathogen *Staphylococcus aureus*, currently causing serious problems in public health through the acquisition of multi-drug resistance. The structure contains a winged helix-turn-helix motif and closely resembles those of WalRs of *Bacillus subtilis* and *Enterococcus faecalis*, and also that of PhoB of *Escherichia coli*. Gel mobility shift assays with mutant WalRs revealed specific interactions of WalR with the target DNA, as elaborated by *in silico* modeling of the WalRc-DNA complex (Fig. 2).

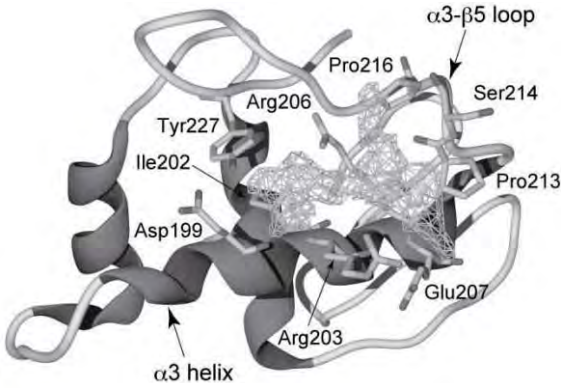



Fig. 2. Prediction of the potential site for binding of antibiotics in the WalRc structure.

# Department of Cell Membrane Biology


| | |
|---|---|
| Professor: | Akihito YAMAGUCHI |
| Visiting Professor: | Yoshimi MATSUMOTO |
| Associate Professor: | Tsuyoshi NISHI |
| Assistant Professor: | Ryosuke NAKASHIMA |
| Specially Appointed Assistant Professor: | Keisuke SAKURAI |
| Post Doctoral Fellows: | Syoko NISHI, Yu HISANO |
| Graduate Students: | Eiji NIKAIDO, Eiji OGAWA, Manabu OJIMA, Shiro HAMANAKA, Tsukasa HORIYAMA, Yuko YOSHIMOTO, Aiko OONO, Seiji YAMASAKI |
| Under Graduate Students: | Masaki MASHITA, Saya NAGASAWA |
| Supporting Staff: | Aiko FUKUSHIMA, Kimie KITAGAWA, Sumie MATSUOKA |


## Outlines

Xenobiotic extruding pumps have recently been known to be widely distributed in living organisms from mammalian to bacteria as a host-defense mechanism in cellular level. These pumps not only confer multidrug resistance of cancer cells and pathogenic bacteria but also cause hereditary diseases through the mutation. The purposes of our laboratory are to elucidate the molecular structures and the molecular mechanisms of these xenobiotic exporters and the roles of these exporters in cell functions.

We determined the crystal structure of bacterial major xenobiotic exporter AcrB and elucidated the molecular mechanism of xenobiotic export and the structural basis of multidrug recognition by determining the crystal structure of the drug-binding form of AcrB. In 2010, we continued to analyze crystal structures of the substrate-binding form of AcrB, and we successfully found new substrate binding pocket, proximal binding pocket, in the crystal structure of AcrB in complex with high molecular weight drugs. In addition, studies on the exporters for lipophilic signal transducers in mammalian cells have also been advanced as described below.

## Current Research Project

### Crystallographic analysis of xenobiotic exporters.

We have succeeded to determine the first crystal structure of bacterial multidrug efflux transporter AcrB in 2002. This is the first crystal structure for transporter proteins. Then we solved the structure of AcrB in complex with its substrates, minocyclin and doxorubicin, in 2006.

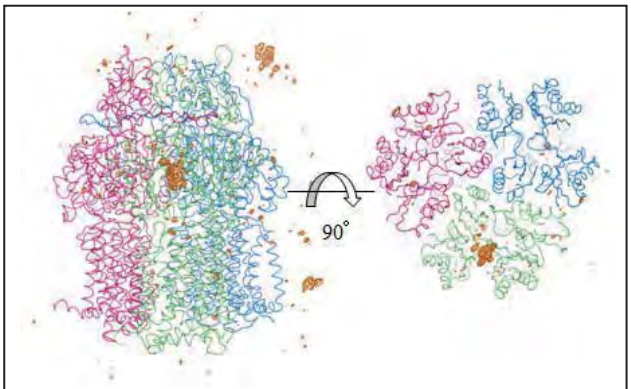



Fig.1 Structure of the AcrB–substrate complex
The difference fourier map ($F_{(drug)}$ - $F_{(free)}$) of bound substrate is depicted by an orange-colored cage contour at

The AcrB-substrate complex consists of three protomers, each of which represents one functional state of transport cycle. Bound substrate was found in the periplasmic domain of one of the three protomers. The structure clearly reveled that drugs are exported by three-step functionally rotating ordered binding change mechanism. The multidrug recognition is revealed to be based on the multi-site binding of drugs. For further understanding of substrate recognition and transport mechanism of AcrB, we solved crystal structures of AcrB in complex with substrate having high molecular weight. Unexpectedly, the bound substrates were found in the proximal pocket of access monomer, which is separated from the phenylalanine cluster region (distal pocket). Crystal structures indicate that there are two discrete multisite-binding pockets along the intra-molecular channel. Drugs are bound to the proximal pocket in the access state and then forced into the distal pocket in the binding state by a peristaltic mechanism. The presence of two discrete voluminous multisite-binding pockets contributes to the extraordinarily broad substrate recognition of AcrB.

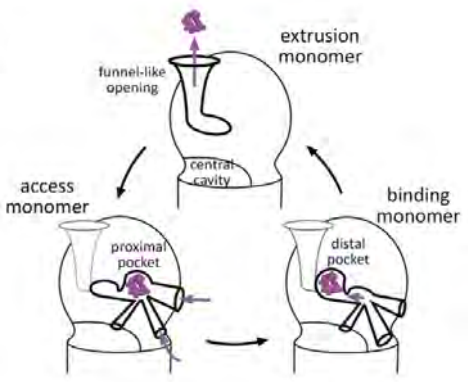


Fig.2 Schematic drawing of the peristaltic drug transport mechanism of AcrB

**Functional analysis of the human sphingosine 1-phosphate transporter, SPNS2.**

Sphingosine 1-phosphate (S1P) is one of the most important lipid mediators and essential for cell migration such as lymphocyte, preosteoclast cells and endothelial cells in mammalian. We have been trying to identify the physiologically functional S1P transporter which supplies S1P into blood plasma in mammalians. We demonstrated that platelet and erythrocyte have an ability to export S1P and similar ATP-dependent S1P export system. However, we could not identify the S1P transporter molecular in these cells.

Recently, we success to identify the essential gene (*Spns2*) for migration of myocardial precursors to form normal heart in zebrafish is act as a physiologically functional S1P transporter. *Spns2* has orthologues in human and mouse genome (*hSpns2* and *mSpns2*, respectively) and encoded proteins of these orthologues have S1P transport activity as similar extent to zebrafish *Spns2*. To identify the enzymatic properties of hSPNS2, we analyzed substrate specificity and energy requirement for its activity. S1P transport activity is increased along with increase of intracellular amount of S1P. Various ionophores and inhibitors for already known transporters and channels were not affected the S1P transport activity of SPNS2. These results suggested that SPNS2 transports S1P with passive diffusion along with the S1P concentration gradient generated at the plasma membrane. We also identified that hSPNS2 transport not only S1P but also S1P structure analogues, such as DH-S1P, phyto-S1P, $C_{17}$-S1P and FTY720-P. FTY720-P is phosphorylated form of FTY720 is an immunosuppressive drug and the first oral drug for treating inflammatory disease, multiple sclerosis. Secretion of FTY720-p from the cells following conversion of FTY720 to FTY720-P by sphingosine kinase 2 is essential for showing the effect of the drug through binding to the S1P receptor. Our results indicated that FTY720-P is secreted by the SPNS2 from the cells with common transport mechanism to that of the S1P.

# Department of Biomolecular Energetics

| | |
|---|---|
| Professor: | Hiroyuki NOJI |
| Associate Professor: | Yoh WADA |
| Assistant Professors: | Kazuhito TABATA, Ryota IINO |
| PREST Researcher: | Hiromi IMAMURA |
| Post Doctoral Fellows: | Daichi OKUNO, Sawako ENOKI, Kumiko HAYASHI, Rikiya WATANABE |
| Graduate Students: | You HUIJUAN, Mizue TANIGAWARA, Hideyuki YAGINUMA, Uner Naciye ESMA, Yuki MATSUKAGE, Huynh Nhat Phuong KIM, Suguru ARAKI, Takuya OSAKA, Keisuke TOMIYAMA Sulaiman SINTAWEE, Sino IWAI, |
| Under Graduate Students: | Kosuke TORIGATA, Hideaki SHIOMI |
| Supporting Staff: | Rie HASEGAWA, Kohei HAYAMA, Kazuyo SAKAI |

## Outlines

We are focusing on the relevance of endocytic function of the mammalian cells, especially their specific roles in establishing higher-ordered physiological function. We are studying two major issues: the function of vacuolar-type proton transporting ATPase (V-ATPase) and mechanism how the cells establish and maintain the endocytic pathway. The vacuolar-type proton-translocating ATPases (V-ATPases), multimeric proton pumps, are involved in a wide variety of physiological processes. We created mouse lacking the V-ATPase function by developmental and molecular biological techniques, and characterizes phenotypes associated to the mutant. The assembly of the endocytic compartments requires numerous molecules including Rab small GTP binding proteins, syntaxins, and membrane tethering factors which orchestrate the membrane and information flow within the cytoplasm. We pursue genetic and developmental studies to unveil their significance in highly differentiated mammalian cells and tissues.

## Current Research Projects

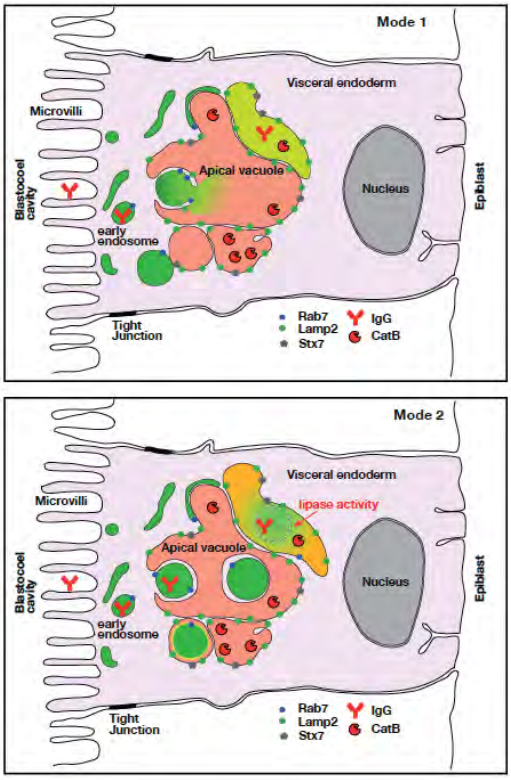
### Generation of chicken monoclonal antibodies against the *a*1, *a*2, *and a*3 subunit isoforms of vacuolar-type proton ATPase

The vacuolar-type proton pump ATPase (V-ATPase) plays several pivotal roles in the acidification of diverse intracellular compartments and the extracellular environment. The *a* subunit isoforms *a*1, *a*2, and *a*3, constituting the membrane-embedded section, are expressed in various tissues, and they are involved in the regulation of subcellular localization and activity of the holocomplex. Therefore, the characterization of their properties is indispensable for dissection of the physiological roles of the V-ATPase in highly differentiated cells. We generated and characterized chicken monoclonal antibodies (MAbs) against these mouse *a*1, *a*2 and *a*3 subunit isoforms. These MAbs are shown to be suitable for both immunoblotting and immunofluorescence. The MAbs obtained in this study are useful in understanding the pathological basis of V-ATPase dysfunction.

### Membrane Dynamics in perigastrulation mouse embryos

A single-cell zygote gives rise to a complex organism composed of various cell types during embryogenesis. The visceral endoderm (VE), surrounding the epiblast and extraembryonic ectoderm, comprises an absorbing epithelium that supplies nutrients required for embryonic growth, thus its differentiation/formation is essential for embryogenesis. The VE cells develop numerous microvilli on their apical surface and

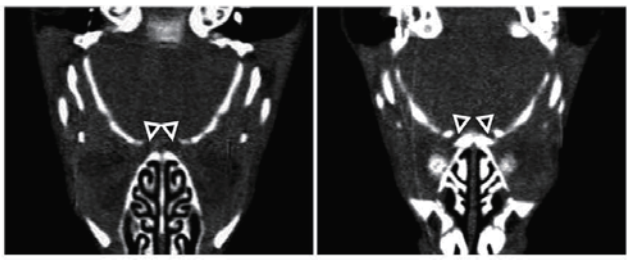
actively internalizes various molecules. We characterized the endocytic apparatus in gastrulating mouse embryos, and confirmed that the endosomal and lysosomal proteins were accumulated in distinct compartments in the VE cells. This endocytic system is unique compared with those in other cell types or tissues. Endocytic delivery to the apical vacuoles, large organelles equivalent to lysosomes, involves a distinct mechanism. The assembly of this large digestive compartment requires the function of phosphoinositide 3-phosphate signaling, and the small GTP binding protein rab7. Loss of these functions resulted in severe alteration in the morphology, dysfunction of endocytic pathway and simultaneously, caused defective embryogenesis. Delivery of endosomes to the apical vacuoles involves unique, microautophagy-like process.




**Endosome/apical vacuole membrane dynamics.** Endocytosed molecules were transported from the cell surface to the apical vacuoles *via* early endosomes and spherical bodies in visceral endoderm cells. Delivery of the spherical bodies might occur through a canonical endosome-lysosome interaction involving fusion of the membranes limiting the two distinctive compartments (mode 1). However, our observation suggests other membrane dynamics. Apical vacuoles engulf endosomes by inwardly invaginating their limiting membranes. The surrounding membranes, which were originally the limiting membranes of the apical vacuoles, are then digested by lipases inside the apical vacuoles. Finally, the endosomal membranes (internalized inside the apical vacuoles) disintegrate, and the contents of endosomes appear in the lumen of the apical vacuoles. This process (mode 2) is topologically similar to microautophagy.

## Optic nerve compression and retinal degeneration in mutant mice

V-ATPase is involved in the proper development of visual function. Loss of the *a*3 subunit of V-ATPase, cause severe autosomal recessive osteopetrosis (ARO) in humans. ARO is often associated with impaired vision most likely because of nerve compression at the optic canal. We examined the ocular phenotype of mice. X-ray microtomography showed narrowed foramina in the skull, suggesting that optic nerve compression occurred in the *a*3-deficient mice. The retina of the mutant mice had normal architecture, but the number of apoptotic cells was increased at 2-3 wks after birth. Although the retina of the mutant mice had normal architecture, the number of apoptotic cells was increased. These observations are consistent with the view that retrograde retinal degeneration occurs due to optic nerve compression.



**Narrowed optic foramen in *Tcirg1*$^{-/-}$ mouse.** Micro-computed tomography scan sections of skull of wild-type (left) and mutant (right) mice at 3-wks after birth. 3-D models were constructed and horizontal sections (caudal up, rostral down) generated by ImageJ software. Images showing the widest opening at optic foramina indicated by white triangles.

# Specially Appointed Laboratory: Kawai FIRST Project

| | |
|---|---|
| Specially Appointed Professor: | Tomoji KAWAI |
| Specially Appointed Assis. Professors: | Takahito OHSHIRO, Masayuki FURUHASHI, Kazuki MATSUBARA |
| Specially Appointed Technical Expert: | Hiroe KOWADA |
| Specially Appointed Researchers: | Makusu TSUTSUI, He YUHUI, Sakon RAHONG, Kazumi KONDA, Chie HOTEHAMA, Tomoyo KAWASE, Sanae MURAYAMA, Rie YAMADA |
| Support Staff: | Yayoi KATAYAMA |

## Outlines

This research group was launched in 2010 as one of the FIRST Projects: “Research and Development of Innovative Nanobiodevices Based on Single-Molecule Analysis”, and directs toward developing innovative technologies and devices that enable single-molecular separation, detection, and analysis of biological substances of varied sizes such as DNA/RNA molecules, proteins, virus, and pollen allergens. Main subjects are (1) Identification of a DNA/RNA Monomer and Oligomer by Tunneling Current, (2) Development of Garing Nano/Micropore Device for Single-molecule Analysis, (3) DNA Separation and Elongation in a Nanostructure-integrated Microchannel, (4) Development of Optical Gating Nanopore Device for Single-molecule Detection.

## Current Research Project

### Identification of a DNA/RNA Monomer and Oligomer by Tunneling Current

We recently determined the single-molecule electrical conductance for all kinds of DNA (dGMP, dCMP, dAMP, and dTMP) and RNA (rGMP, rCMP, rAMP, and rUMP) monomers by tunneling current across nanogap electrodes. We also determined the conductance for chemical modified DNA monomers such as Methylated dCMP and oxidized dG that can unravel the epigenetic code and its function hidden in genome. Based on the magnitude order of the electron conductance of the monomers, we successfully identify time-sequential base-types in DNA oligomers (GTG, TGT, GAG, ATA, *etc*.) (Fig. 1). Furthermore, we determined fragment sequences of let7 micro RNA family (5’-UGAGGUA-3’) in the same manner, and then applied the read fragment sequences to “quasi-shotgun” resequencing method, resulting in successful reconstruction of the sample RNA sequence. This finding would be lead to realize development of a Next-next generation single-molecule electrical sequencer.

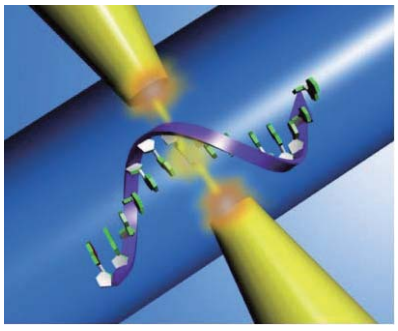


**Fig. 1** Schematic view of single-molecule sequencing of a DNA oligomer.

### Development of Garing Nano/Micro-pore Device for Single-molecule Analysis

We have simultaneously fabricated nanogap electrodes and a nanopore onto a silicon wafer, which sizes of the gap and the pore are comparable to molecule length of nucleotides (Fig. 2A), by utilizing a feedback-controlled electromigration break junction

technique. That is to say, we have successfully accomplished the preparation of an "in-plane-type" gating nanopore device. Besides, fine fabrication processes of in-plane-typed gating sub-micropore devices which the gap and pore sizes are equal to that of a pollen allergen (Fig. 2B) have been established using semiconductor micro-fabricating techniques. We confirmed that allergens flowing in the device were highspeedily detectable at the single particle level and that there was a correlation between the current changes and the transit speeds across the gap electrode.

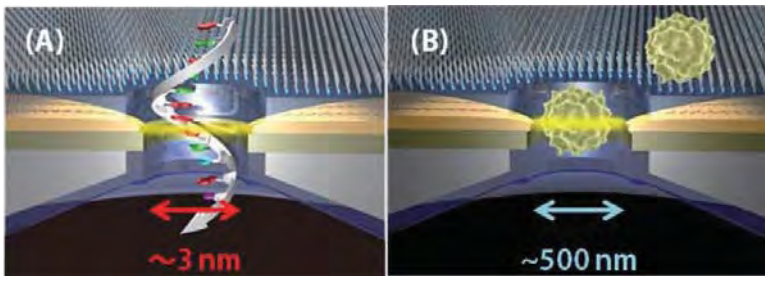



**Fig. 2** Schematic illustrations of gating nanopore devices composed of a solid state nanopore and a nanogap electrode for (A) DNA sequencing and (B) allergen detection.

## DNA Separation and Elongation in a Nanostructure-integrated Microchannel

Nanostructure-integrated micro-channels with a gating nanopore structure have been designed for realizeing highspeed separtion, elongation, and flow dynamics control of DNA molecules (Fig. 3). We fabricated $SnO_2$ nanowires with sub-10 nm in diameter in a 20-μm fluidic channel using the pulsed laser deposition (PLD) method, and that channel made a success of DNA separation of mixtures of 20 and 5 kbp via their electrophoresis. Alternatively, because extention and elongation of a DNA molecule would be essential to efficiently lead DNA molecules to a gating nanopre and to identify the sequences, we prepared a fluidic nanochannel with 30-nm depth and 300-nm width.

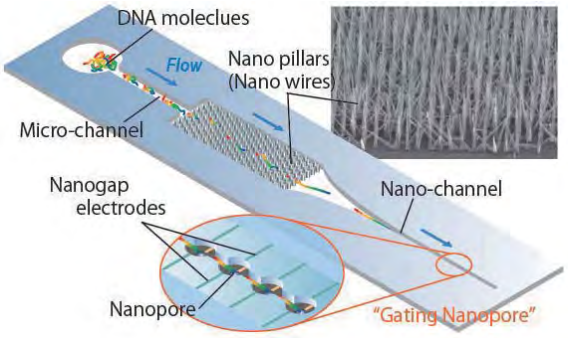



**Fig. 3** Model of a innovative Nanobiodevice in which integrated with gating nanopores and nanostructures into nano/micro fluidic channel for single DNA analysis. A SEM image of $SnO_2$ nanowires prepared in the micro fluidic channel by PLD method.

## Development of Optical Gating Nanopore Device for Single-molecule Detection

In view of an analogy to the nanogap electrodes as shown above, it is expected that using a pair of optical waveguides instead of metal electrodes allows single molecule detection by light. For this purpose, a channel optical waveguide composed of $TiO_2$ with both high refractive index and good transparency from infrared to visible region was fabricated using semiconductor micro-fabricating process. We have confirmed that the channels successfully guided light of 632.8 nm along linear and L-branched channels (Fig. 4).

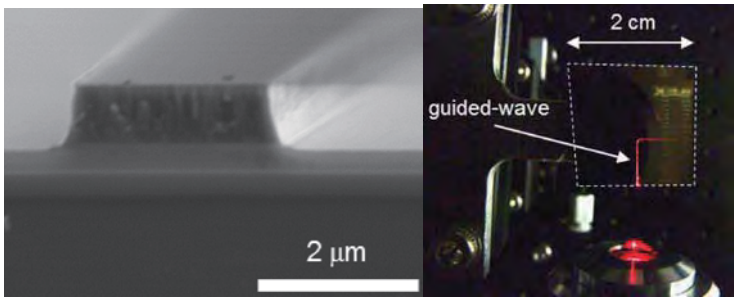



**Fig. 4** Cross sectional SEM image of a $TiO_2$ channel waveguide and a photograph of a red laser beam (632.8 nm) propagating in a L-branched waveguide.

# Division of Next Industry Generation

## Outline

Three new research departments have been established. The goal of each department is to provide advances in science and technology via close relationships with industry, which will lead to create a novel industry in the 21st century.

The departments are:

-Department of New Industrial Projection

Perform research on new projects that can lead to industrial-structure innovations in the next generation.

-Department of New Industry Generation System(s)

Investigate and develop novel business systems that enable transfer of academic research outcomes to a new industry effectively and promptly, and that intend to improve productivity through responding to social demands.

-Department of Intellectual Property Research

Perform the strategic world-leading study of intellectual property linked with potential needs of the society, where the academia is required to create intellectual properties efficiently from the wide-ranging knowledge accumulated from academic research of the new interdisciplinary fields of material, information, and biology.

# Department of Intellectual Property Research

Specially Appointed Professor: Hirokazu SHIMIZU
Specially Appointed Researcher: Seiichiro TAMAI

## Outlines

The object of this department is to perform the strategic world-leading study of intellectual property linked with potential needs of the society, where the academia is required to create intellectual properties efficiently from the wide-ranging knowledge accumulated from academic researches of the new interdisciplinary fields of material, information, and biology.

## Current Research Project

**Research on Patent-Academic Paper Linkage for Effective Utilization of Intellectual Properties of Universities**

We propose a new method to find possible application fields and/or industrial companies of intellectual properties developed in universities. Possible licensee of a patent may be picked out effectively by analyzing related publications and their citation expressed in a proposed patent-academic paper linkage form. It is also pointed out that the value of the intellectual property may be enhanced by the accumulation of related research papers in explicit expression of patent-academic paper linkage.

**Survey Research on Computational Material Design Method for Industrial application**

We have investigated the actual R&D condition of Computational Material Design Method which is developed by Osaka University and considered problems and measures for its industrial application. Business strategies are also proposed in collaboration with corporate members.

# Laboratory of Microbiology and Infectious Diseases

Associate Professor: Kunihiko NISHINO
Specially Appointed
Assistant Professor: Mitsuko NISHINO
Graduate Students: Eiji NIKAIDO, Manabu OJIMA, Tsukasa HORIYAMA, Seiji YAMASAKI
Under Graduate Students: Saya NAGASAWA
Supporting Staff: Aiko Fukushima

## Outlines

Multidrug-resistant bacteria are now encountered frequently and the rates of multidrug resistance have increased considerably in recent years. Genome annotation produces a considerable number of drug efflux pumps in bacteria. We previously identified efflux pumps related with bacterial multidrug resistance and virulence. Our discoveries support the notion that drug efflux pumps have specific physiological substrates because these pumps have been shown to have roles in bacterial virulence. We are trying to identify natural substrates of drug efflux pumps in order to understand physiological functions of pumps. This knowledge should promote the development of novel inhibitors or strategies that could counteract the contribution of efflux pumps to drug resistance and virulence.

## Current Research Project

**Effect of small noncoding DsrA RNA on multidrug efflux in *Escherichia coli***

Several putative and proven drug efflux pumps are present in *Escherichia coli*. Because many such efflux pumps have overlapping substrate spectra, it is intriguing that bacteria, with their economically organized genomes, harbor such large sets of multidrug efflux genes. To understand how bacteria utilize these multiple efflux pumps, it is important to elucidate the process of pump expression regulation. The aim of this study was to determine a regulator of the multidrug efflux pump in this organism.

We screened the genomic library of *E. coli* for genes that decreased drug susceptibility in this organism. We screened a host strain lacking a functional *acrB* gene in order to identify regulatory elements involved in the expression of other multidrug resistance systems. In one experiment, we found an eight-fold increase in oxacillin MIC over the transformant (data not shown). Sequencing of the plasmid revealed an insertion containing the complete coding sequence of *dsrA* and a partial coding sequence

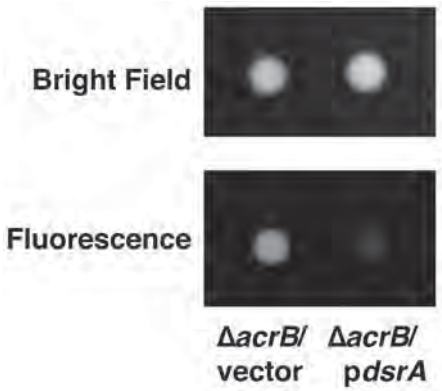



**Fig. 1.** Effect of *dsrA* overexpression on drug accumulation in *Escherichia coli* cells. Strains Δ*acrB*/vector and Δ*acrB*/p*dsrA* were spotted on LB agar plates containing 1 μg/mL of ethidium bromide at a final inoculum size of $10^5$ CFU/spot. After incubation, *E. coli* colonies were observed under visible white light (bright field) and UV light (fluorescence)

of *yedP*. We found that *dsrA* overexpression decreased the susceptibilities to cloxacillin, erythromycin, rhodamine 6G, and novobiocin. These results indicate that overexpression of DsrA induces multidrug resistance in *E. coli*.

A major mechanism of bacterial multidrug resistance is active drug efflux. Therefore, we investigated drug efflux activity in the *dsrA*-overexpressed strain, as previously described. Δ*acrB*/vector and Δ*acrB*/p*dsrA* cells were spotted on agar plates containing 1 mg/L of ethidium bromide, and plates were then incubated for 18 h. Accumulation of ethidium bromide in *E. coli* cells was observed from fluorescence of this compound under UV light (Fig. 1). As shown in Fig. 1, *dsrA* overexpression resulted in a drastic decrease in fluorescence. The results show active efflux of ethidium bromide from DsrA overproduced cells.

To determine the drug efflux pump that shows increased expression when *dsrA* is overexpressed, we used qRT-PCR to investigate changes in the levels of drug efflux gene mRNAs dependent on *dsrA* overexpression. Expression changes of 20 drug efflux pump genes and *tolC* were measured and we found that expression of *mdtE* was significantly increased by *dsrA* overexpression (Fig. 2).

To determine whether the decreased multidrug susceptibilities mediated by *dsrA* overexpression is because of increased expression of *mdtEF*, we investigated the effects of deleting these genes. In strain Δ*acrB mdtEF*, overexpression of *dsrA* did not change drug susceptibilities, whereas it decreased multidrug susceptibilities of strain Δ*acrB*. Thus, these data indicate that the decreased multidrug susceptibilities mediated by DsrA is because of increased expression of the *mdtEF* multidrug efflux genes.

In this study, we performed a genome-wide search for a regulator of multidrug efflux in *E. coli* by random shotgun cloning. We found that DsrA decreases susceptibility to oxacillin, cloxacillin, erythromycin, rhodamine 6G, and novobiocin by upregulating *mdtEF*. It was previously reported that DsrA is a regulator of capsular polysaccharide synthesis and many pathogenicity factors, including acid resistance genes and genes within the LEE. In this study, it was determined that DsrA modulates multidrug susceptibilities through activation of genes encoding the MdtEF multidrug efflux pump in *E. coli*. Further investigation of the regulation of multidrug efflux systems in several natural environments such as those within hosts is needed to elucidate the biological significance of their regulatory networks.

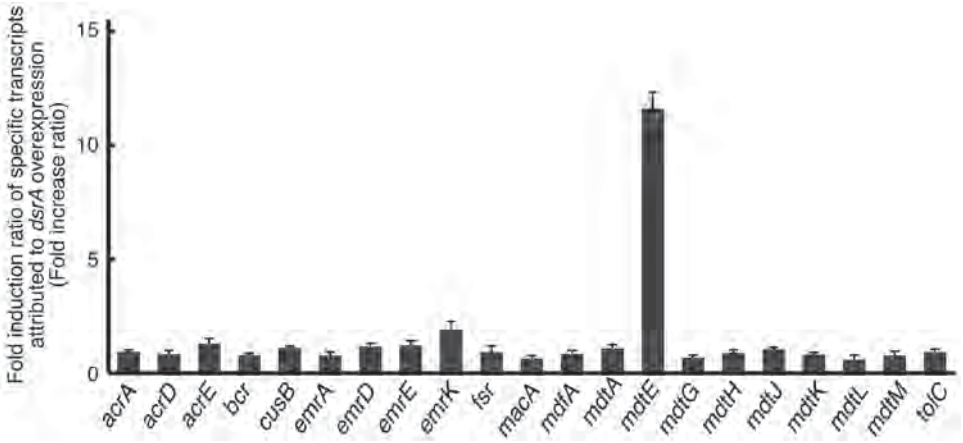



**Fig. 2.** Effect of DsrA on expression levels of drug efflux and outer membrane channel genes.
The level of mRNA transcript was determined by qRT-PCR. The fold change ratio was calculated by dividing the expression level of the gene in the *dsrA*-overexpressed strain by that in the parental strain.

# Laboratory of Atomic Scale Materials Processing

Associate Professor: Takeshi YANAGIDA
Specially Appointed Assitant Professor: Kazuki NAGASHIMA

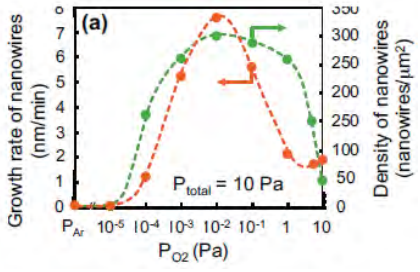
## Outlines

This research group investigates the atomic scale materials processing by taking over the principle being familiar to mother nature, in which their 3D hierarchical structures are naturally formed by utilizing extremely small energy and reacting in limited environments. We are trying to explore the construction of the atomic scale materials processing based on the natural law, and to create the higher-order hierarchical nanostructures, the functional properties and the unique nanodevices. Main subjects are (1) Creation and design of one-dimensional functional oxide nanowires via identifying fundamental principles of the atomic scale materials processing, (2) Search for nanoscale physical properties in a single oxide nanowire, (3) Developments of green-electronics devices (nonvolatile memory and energy conversion, etc.) and biomolecular analysis devices.

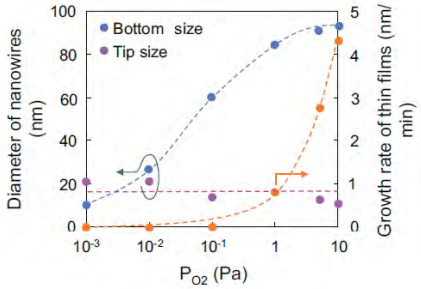
## Current Research Project

### Mechanism of One-dimensional Oxide Nanostructure Growth

Understanding the one-dimensional oxide nanowire growth is crucial to control the shape and property of oxide nanowires and also to fabricate the nanowire based nanodevice applications. Here we successfully identified the crucial role of oxygen on the oxide nanowire ($SnO_2$ nanowire) growth mechanism. When varying the surrounding oxygen ratio, the nanowire shape was systematically varied according to the modulation of the surface nucleation growth rate. Also the model was consistent with the simulation based on molecular dynamics. These findings might be the key to synthesize the novel oxide nanowires beyond the conventional materials.




Partial oxygen pressure dependence on growth rate and density of nanowires.

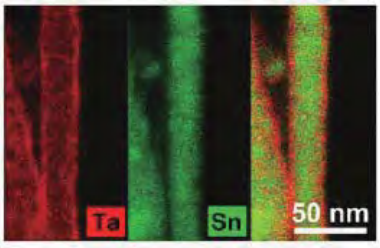



Partial oxygen pressure dependence on surface nucleation growth rate

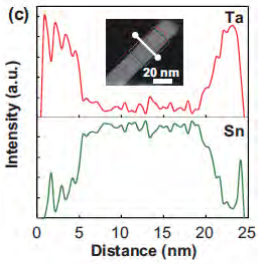
### Direct Observation of Impurity Dopant Distribution in Oxide Nanowire

Impurity doping is one of the most important technologies in semiconductor electronics. Here we, for the first time, demonstrate the dopant distribution in semiconductor oxide nanowire via the direct TEM observation. Considering totally the dopant distribution, the structural variation and the electrical properties of Ta doped $SnO_2$ nanowires, we understood the dopant incorporation dynamics on nanowire growth process. This implication indicates that the doping dynamics is important to control the

physical properties of oxide nanowire by impurity doping.



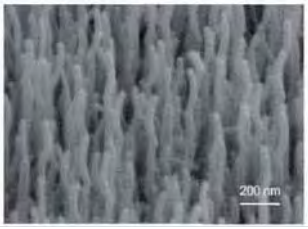

Partial oxygen pressure dependence on growth rate and density of nanowires.



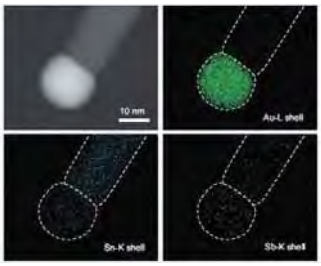

Partial oxygen pressure dependence on surface nucleation growth rate.

## Synthesis of Emergent Oxide Nanowire Structure

Conventionally, the impurity doping in semiconductor materials has been aiming to control the electric and magnetic properties. Here we demonstrate the role of impurity doping on the structural control of oxide nanowires for the first time. Doping the extra Sb on $SnO_2$ nanowire growth found to induce the periodic variation in interfacial energy at catalyst nanowire (liquid-solid) interface, resulted in the periodic arched shape nanowires. These finding imply the possibility of arbitrary control of growth direction and shape in nanowire growth, and also the three dimensional interconnection using nanowires.



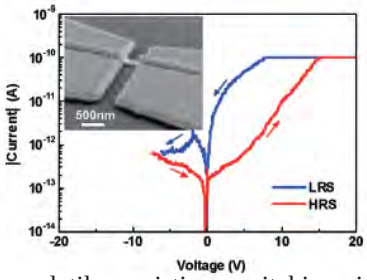

Periodic arched shape oxide nanowires.



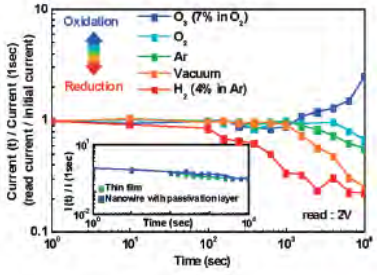

Dopant distribution in both oxide nanowire and catalyst.

## Nature of Nonvolatile Resistive Switching using a Single Oxide Nanowire

Resistive switching in metal/oxide/metal junction, so-called ReRAM or Memristor, has attracted much attention toward the next-generation nonvolatile memory. However, the lack of understanding as to the nanoscale switching mechanism has held back the range of device applications. The nanowire structure with the finite space allows us to capture and identify the intrinsic characteristics of resistive switching. Here we demonstrate the nonvolatile resistive switching effect in MgO/NiO nanowire (~10nm scale). Also we clarified the crucial role of redox reaction on the resistive switching by utilizing the surface reaction to ambient atmosphere. These results offer the platform to investigate the intrinsic nature of resistive switching using oxide nanowire.




Nonvolatile resistive switching in a single MgO/NiO nanowire device.




Atmosphere dependence on data retention properties.

# Department of Beam Application Frontier

| | |
|---|---|
| Specially Appointed Professor: | Seiichi TAGAWA |
| Specially Appointed Professor: | Masayuki ENDO |
| Specially Appointed Assistant Professor: | Kazuyuki ENOMOTO |
| Specially Appointed Assistant Professor: | Hiroki YAMAMOTO |
| Research Fellow: | Ravi JOSHI (2011.1.17~) |
| Supporting Staff: | Kaoru KOJIMA |

## Outlines

In department of Beam Application Frontier, we pursue the application of device systems which contribute to the forthcoming information society based on basic researches on materials and processes by applying beams to measurement and nanofabrication. The most important mission in our studies is the establishment of global science infrastructure. Therefore, we construct knowledge infrastructure and try to make new processes and high performance materials.

## Current Research Project

### 1. Study on Radiation chemistry in organic compounds by means of pulse radiolysis

Physico-chemical reactions, which occur within nano- and pico- second region, are considered to dominate followed reactions and products in molecular materials. High-accuracy spectrum acquisition system was developed using CCD camera, highly-stable femtosecond white light continuum, and double pulse detection technique. Using this system, the direct observation of reactive intermediates is carried out to elucidate the mechanisms and to control the reaction. In particular, the pulse radiolysis of poly(4-methoxystyrene) (PMOS) solution in $C_2H_4Cl_2$ and *p*-dioxane to clarify the transient absorption of PMOS radical cations. The dimer radical cation was produced in both solutions The characteristic charge resonance (CR) band was clearly observed. The absorption intensity of the CR band of the PMOS dimmer radical cation was higher than that of poly(4-hydroxystyrene) (PHS) dimmer radical cation in *p*-dioxane. The increase in the absorption intensity of the CR band is considered to be due to the increase in the yield of dimmer radical cations. In the presence of electron-accepting molecules such as halogenated hydrocarbon, the yield of PMOS dimer radical cations was enhanced by the formation of an ion/charge transfer complex. The deprotonation of PMOS radical cations occurred after the formation of an ion/charge transfer complex.

### 2. Enhancement of generation of the strongly acidic species in EUV chemically amplified resists combined with acid proliferation processes

Acid amplifiers can be provided an additional acid by nonlinear chemical reactions through the autocatalytic decomposition in the presence of a strong acid. Reactions of secondary electrons with triphenylsulfonium triflate (TPS-Tf) and pinanediol monosulfonate (PiTs and Pi3F) as an acid amplifier blended in PHS matrix have been measured using pulse radiolysis. The electrons reacted with PiTs and Pi3F to produce

the corresponding radical anion. Especially, the long-lived $Pi3F^{\bullet-}$ underwent the electron transfer to TPS-Tf with the rate constant of $6.3 \times 10^{10}$ $M^{-1}$ $s^{-1}$ to form $TPS\text{-}Tf^{\bullet-}$.

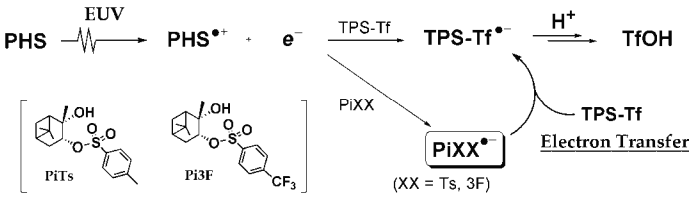



Fig.1. Schematic drawing of chemical reactions induced in EUV resists with acid amplifier.

## 3. Theoretical study on reactivity of polymers and photoacid generators and the acceleration of their realization

As the increase of resist sensitivity is important for EUV lithography, the structures of photoacid generators in chemically amplified resist was investigated. Gaussian 09 DFT quantum chemical calculation was performed. The absolute value of the difference in molecular energy between structures with and without electron addition was calculated and it was defined as the stabilization energy. It was clarified the incorporation of fluorine atom in onium salt enhances the electron affinity, which leads to increase of resist sensitivity. As the results of study of various substituents in onium salt, cyano group also enhances the stabilization energy.

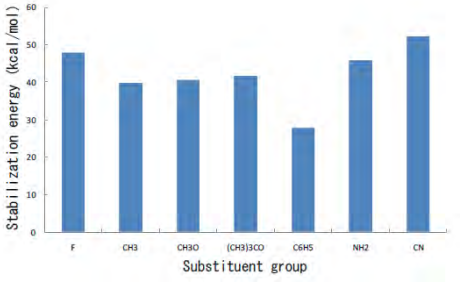



Fig.2 . Stabilization energy of tri(4-substituted phenyl) sulfonium trifluoromethanesulfonate.

## 4. Ionization potential of polymeric materials

The secondary electrons are generated from polymer upon exposure to EUV irradiation. Therefore, it is essential to know the ionization potential (IP) of backbone polymers in order to accomplish high sensitivity and ultra-fine pattern in EUV lithography. We investigated the photoelectron spectra of typical backbone polymers for chemically amplified EUV resists using ultraviolet photoelectron spectroscopy (UPS). The UPS spectra of PHS films were firstly obtained. The measured first IP of PHS was 5.4 eV while that of PS was 5.6 eV. Also, UPS spectra of PS and PHS with 10 wt% TPS-nf were measured. The difference between PHS with and without 10 wt% TPS-nf was observed. This is likely to originate in the interactions of hydroxyl groups in PHS with acid generator through hydrogen bonding. It will be necessary to consider the intermolecular interaction beyond 16 nm resist design.

## 5. Development of materials and processes in EB/EUV chemically amplified resists

Negative-tone chemically amplified molecular resists based on novel fullerene derivatives were developed and the lithographic performance of those was evaluated. When the fullerene derivative resist containing 10wt% TPS-tf and hexamethoxy methyl melamine was used, a semi-isolated pattern with the line width of 60 nm (pitch: 500nm) was delineated. In addition, this pattern shows high aspect ratio (~6) in spite of 60nm line pattern. Thus, fullerene derivative resists are promising candidates for the resist material for nanolithography.

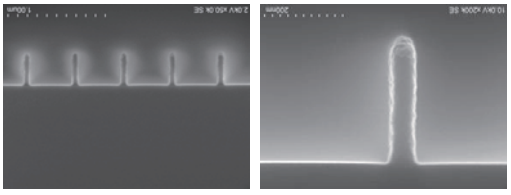


Fig.3. Cross-sectional views of L&S patterns delineated on fullerene derivative resist.

# Department of Disease Glycomics (Seikagaku Corporation-Endowed Chair)


| | |
|---|---|
| Professor: | Naoyuki TANIGUCHI |
| Associate Professor: | Kazuaki OHTSUBO |
| Assistant Professor: | C.X. GAO |
| Specially Appointed Assistant Professor: | Ayako MATSUMOTO |
| Specially Appointed Assistant Professor: | Kazuki NAKAJIMA |

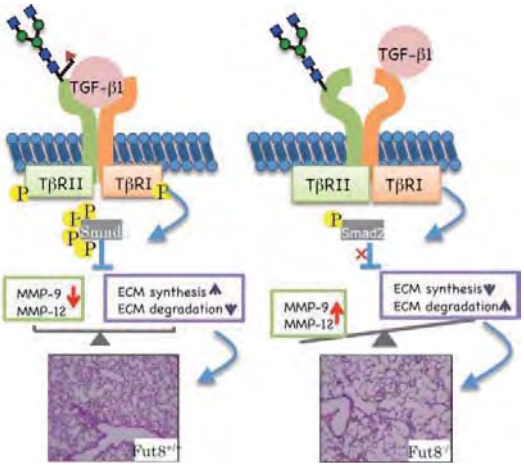

## Outlines

Higher organisms use “carbohydrate” as the energy source, as well as the transmitter “Sugar Chain” encoding enormous bio-information by constructing particular glycan structures. The bio-information encoded in glycan structure has been gradually decoded along with the development of glycobiology, and it is well known that sugar chain is essential for maintaining biological functions. Indeed, glycosylation defect evokes various intractable diseases and life-style-related diseases. This laboratory is engaged in biochemical and molecular genetic approach to elucidate the disease process associated with dysglycosylation, to develop diagnostic marker of disease manifestation, and to develop novel strategies for therapy.

## Current Research Project

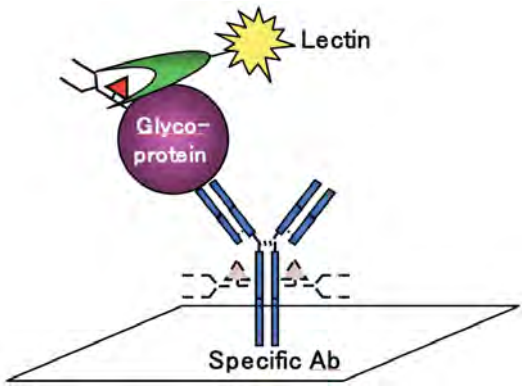
### The role of glycosylation in pathology of pulmonary emphysema

In Fut8 deficient mice, TGF-β receptor can not be fucosylated and diminishes the TGF-β signaling, that results in the MMP activation and lead to emphysematous changes.



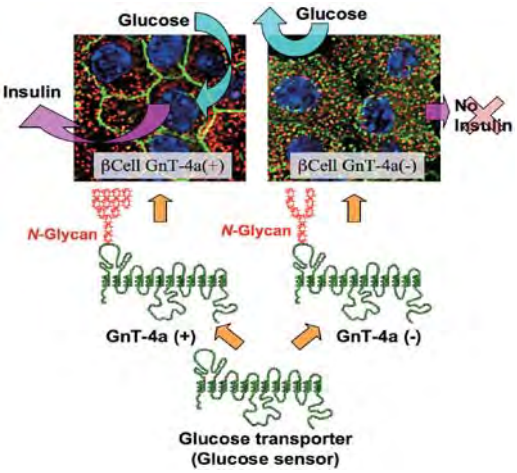

### Development of the highly-sensitive and -specific tumor diagnostic marker

We are developing a novel diagnostic technology for cancer by detecting altered protein-glycosylations associated with tumor progression using lectin which preferentially binds to glycan.



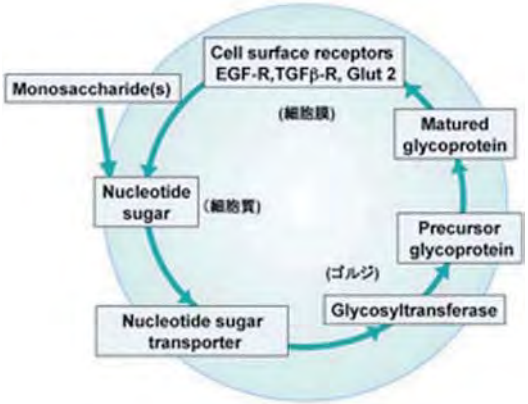
**Functional analyses of protein glycosylation in pathogenesis of diabetes mellitus**

The proper *N*-glycosylation of glucose sensor is required for the cell surface residency in pancreatic β cells that contributes to maintain insulin secretion. The failure of this mechanism evokes type 2 diabetes.



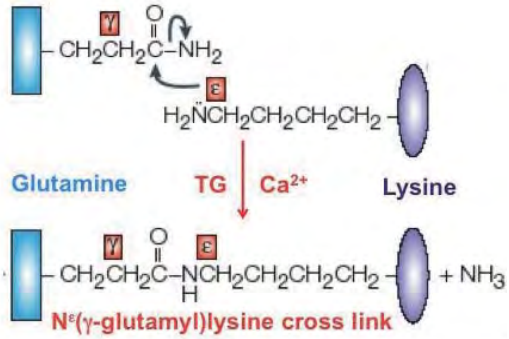

**In situ tracing of the fate of carbohydrate**

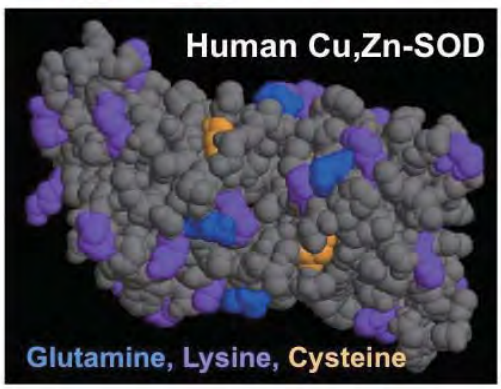
We develop a fundamental paradigm "Glycan Cycle" in which living cell regulates dynamic changes of glycans in response to cellular environments. We could grasp the dynamic cellular information by analyzing the glycan cycle.




**Transglutaminase: A pharmacological target for preventing toxic protein aggregation in neurodegenerative diseases.**

Trasnglutaminase (TG) catalyzes closslinking of Aβ, tau, α-synuclein, and polyglutaminylated proteins that causes progressive neuronal death in neurodegenerative disorders. We focused on TG2 as a pharmacological target for amyotrophic lateral sclerosis.



# Activities of Centers

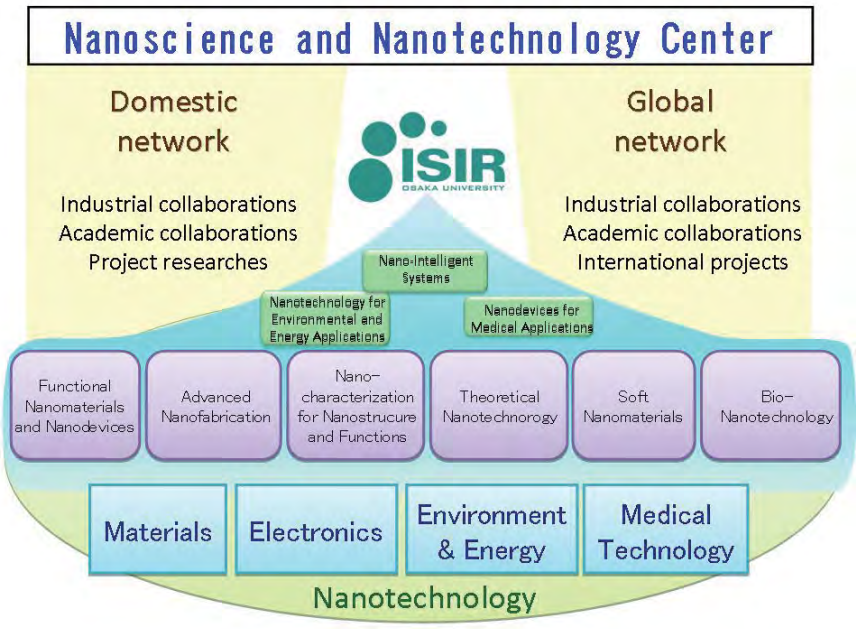
# Nanoscience and Nanotechnology Center

Director, Professor: Yoshio ASO
Supporting Staff: Masayo HAYASHI

## Outline

The Nanoscience and Nanotechnology Center was founded in ISIR in April 2002 as the first nanotechnology center in Japan for developing Bottom-up Nanotechnology, Top-down Nanotechnology, and their collaborated applications in industrial field. Following the reorganization in ISIR in 2009, the Center was strengthened to a new structure leaded by 6 full-time departments.

In the new Nanoscience and Nanotechnology Center, there are 18 research departments composed of 6 full-time departments, 3 departments on concurrently serving in ISIR, 6 departments on concurrently serving in Osaka Univ. 3 departments of domestic and foreign visiting professors. And the Advanced Nanotechnology Instrument Laboratory is newly opened in order to develop cutting edge researches on nanoscience and nanotechnology. The specified period of time set initially has been cancelled; now the Center focuses on nano-system creation in a wide variety of hard, soft, and bio-materials through the combination of top-down and bottom-up nanoprocess; and the new development generated by the interdisciplinary researches on theory and evaluation. Through these new innovations, nanotechnology research is expected to contribute to the interdisciplinary new science development. Furthermore, through constructing variety networks between Japan and oversea countries, the Center aims to become the hub in nanotechnology research.



# Department of Functional Nanomaterials and Nanodevices

Professor: Hidekazu TANAKA
Assistant Professor: Teruo KANKI
Assistant Professor: Azusa HATTORI
Assistant Professor: Kohei FUJIWARA (2011.2.1- )
Specially Appointed Professor: HeaYeon LEE (2010.4.1- )
Graduate Students: Hidefumi TAKAMI, Atsushi ONO, Takuya SAKAMOTO
Under Graduate Students: Kenichi KAWATANI, Takayoshi KUSHIZAKI, Yasushi FUJIWARA
Supporting Staff: Megumi IKEDA, Tomoko OKUMOTO (2010.7.1-)

## Outlines

We are aiming to create novel nanoscale electronic devices with low power requirements employing physical phenomena produced by *d*-electrons in transition metal oxides (TMOs). To understand, design, and enhance their functions in nanoscale and eventually couple them on a chip, we have devoted ourselves to developing a state-of-the-art fabrication process for oxide 3D nanostructures. A new device concept which enables us to generate a huge output with small excitation energy has been pursued with the understanding of physical properties of oxide nanostructures. Major achievements in FY2010 include the followings:

## Current Research Project

### Transport properties of a ferromagnetic oxide nanodot diode

Physical properties of TMOs are strongly affected by sample dimension even in clean systems without impurities and defects. For instance, (La,Pr,Ca)$MnO_3$, in which the critical competition between coexisting ferromagnetic metal and charge-ordered insulator states dominate the transport properties, can exhibit properties dramatically different from those in bulk form when reduced to nanoscale. Ferromagnets may be viewed as an analogue of such a complex system since the dimension should be sensitively reflected in the alignment of magnetic domains and their magnetic response. In this study, we fabricated a diode structure consisting of integrated nanodots of a ferromagnetic oxide, $Fe_{2.1}Zn_{0.9}O_4$, (Fig 1(a)), and investigated the size effect on transport properties. Using a nanoimprint-Mo nanomask lift-off method that has been developed by our group, we successfully grew high-quality $Fe_{2.1}Zn_{0.9}O_4$ nanodots on a Nb:$SrTiO_3$ substrate, and formed a potential barrier at the interface as evidenced by rectifying behaviors in current-voltage characteristics (Fig. 1(b)). From the detailed analysis on magnetoresistance, the enhancement of spin polarization in nanodot structures probably due to the stabilization of ferromagnetic domain was suggested. Being motivated by this result, we are attempting to fabricate nanostructures with electron-correlated systems.

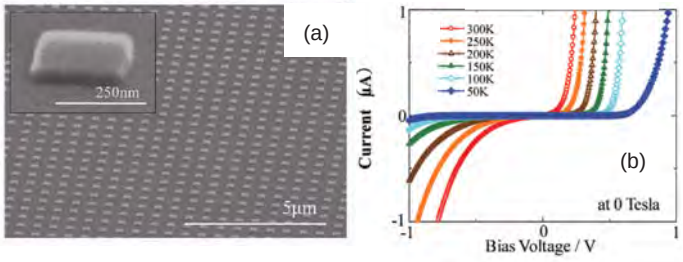



Fig. 1 (a) $(Fe_{3-x}Zn_x)O_4$ nanodots fabricated by a nanoimprint-Mo nanomask lift-off method. (b) Current-voltage characteristics of a $(Fe_{3-x}Zn_x)O_4$ nanodots ($300\times300$ nm$^2$) /Nb:$SrTiO_3$ diode structure.

## Evaluation of Temperature Coefficient on Resistivity in W-doped $VO_2$ thin films

$VO_2$ with a strongly correlated electron system has an appropriate electronic property for heat sensing devices because of dramatic change of resistivity against small temperature changes originated from the metal-insulator transition. Nevertheless, it is not applicable at room temperature because of the transition temperature ($T_{MI}$) at 340 K. It is necessary to control $T_{MI}$ down to room temperature. We controlled $T_{MI}$ by W-doping into $VO_2$ mother materials to obtain high TCR (Temperature Coefficient on Resistivity defined as $(1/\rho)(d\rho/dT)$), which is a performance index of heat sensors, at room temperature, and investigated the W-dopant effect. As a result, we achieved the TCR beyond 10%/K in $V_{0.99}W_{0.01}O_2$ thin films as shown Fig. 3. In order to understand detail mechanism of the high TCR at room temperature, we performed hard X-ray photoemission spectroscopy of the balance band states and the inner core states of V and W. It was found that the chemical state of doped W in $VO_2$ takes a 6+ valence state. This result shows that carrier density is controllable by filling-control of $V^{4+}$ to $V^{3+}$, making metallic states stable and enhancing TCR.

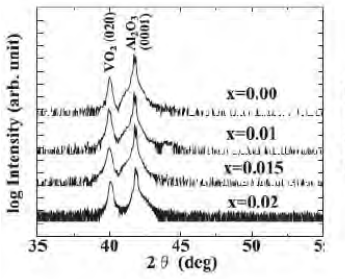



Fig. 2 X-ray diffraction patterns of $V_{1-x}W_xO_2$ ($0 \le x \le 0.02$) thin films.

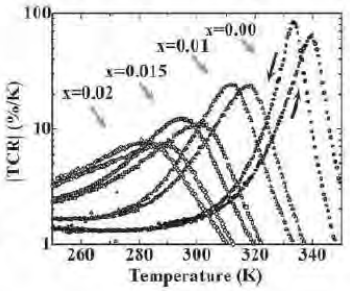



Fig. 3 Temperature dependence of TCR.

## Fabrication of stochastic resonance devices using huge non-linear response of $VO_2$ towards creation of novel information processers

$VO_2$ also shows a huge nonlinear response by applying a bias voltage. We propose and create a new concept device mimicking neurotransmission of bio-systems using the nonlinearity of $VO_2$. Biological systems detect weak signal in noisy environments and the detection ability sometimes enhances by the addition of noise, which is called stochastic resonance (SR). In this research, we succeeded in enhancement of the ability of signal transfer by the addition of noise in $VO_2$ thin films. Pulse signal was inputted into $VO_2$ films, which was lower level of amplitude (5.5 V) than a threshold of metal-insulator transition (8.0 V). Some output signals can be detected with increasing noise intensity. The signal-to-noise ratio between input and output signals ($C$) enhanced under a particular noise level (Fig. 4(a)-(c)), which is typical curve of SR(Fig. 4(d)). To evaluate the experimental results, we conducted a numerical simulation of SR behavior using the summing network model illustrated in Fig. 4(e). Surprisingly, the experimental results corresponded with the simulated SR behavior with multiple parallel units. This suggests that effective multiple channels should naturally exist in a $VO_2$ thin film. According to Collins *et al.* (*Nature*, **376** (1995) 236), $C$ was enhanced by increasing the number of parallel threshold units, and it remained high for a wide range of noise levels without tuning in a large number of summing networks. Thus we succeeded in obtaining the multiple network-type SR property in $VO_2$ thin films. This achievement has fully potential to novel information processers using noise as bio-systems.

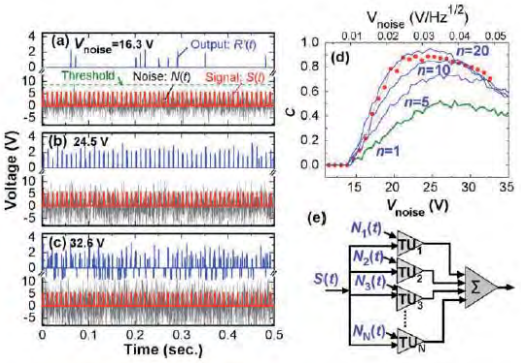



Fig. 4 (a)-(c) Input and output signals with time series, (d) the stochastic resonance property and (e) Configuration of the numerical SR simulation with the summing network model.

# Department of Advanced Nanofabrication

| | |
|---|---|
| Professor: | Yoichi YOSHIDA |
| Associate Professor: | Jinfeng YANG, Takahiro KOZAWA |
| Assistant Professor: | Takafumi KONDOH |
| Specially Appointed Assistant Professor: | Koichi KAN |
| Guest Professor: | Atsushi OGATA |
| Under Graduate Students: | Tomohiro TOIGAWA, Minori TAKECHI |
| Research Students: | Koh SHYO |
| Supporting Staff: | Mie KOBAYASHI, Anna CHIYO |

## Outlines

The basic and primary processes in materials are studied for the development of advanced nanofabrication by using quantum beam by means of the time-space reaction analysis method. In order to realize the reaction mechanism in nano-space, a femtosecond/attosecond pulse radiolysis are being developed using an advanced photocathode electron linac. The new advanced nanofabrication process and the interaction of quantum beams with the nano structure are also studied.

## Current Research Project

**Study of geminate ion recombination in dodecane by femtosecond pulse radiolysis**

The initial process of radiation chemistry in n-dodecane which is a typical non-polar solvent was studied by the femtosecond pulse radiolysis. Time dependent behaviors of geminate ion recombination of radical cation in dodecane were measured in neat dodecane and biphenyl-dodecane solutions, where biphenyl works as electron and cation scavenger. And concentration dependence of the time dependent behavior of radical cation in biphenyl solution was studied. According to the simulation analysis based on diffusion theory, the reaction rate constant of excited radical cation and biphenyl was determined at $3.5 \times 10^{11}$ $dm^3mol^{-1}s^{-1}$. This value is one order greater than the rate constant of radical cation with biphenyl, and which is similar to that of electron and biphenyl. The life time of excited radical cation in dodecane is 7ps. However excited radical cation reacts with biphenyl about 60% of total produced before relaxation. It was found that the excited radical cation plays an important role in reacting with solute in high concentrate solution.

**Femtosecond pulse radiolysis study of solvated electron in water and alcohol**

Radiation chemistry of water is very important on radiation therapy and cooling water of a nuclear power plant. It is well known that electrons produced by irradiation in water are stabilized by solvating with $H_2O$ molecules and then solvated electrons are produced. We developed successfully a femtosecond pulse radiolysis with a time resolution of 240 fs using a femtosecond photocathode electron linac and a femtosecond laser. The pulse radiolysis opened at the first time the study of radiation chemistry in the femtosecond time region. The formation and geminate recombination processes of solvated electron in water radiolysis were observed. Additionally, the formation processes of solvated

electron and pre-solvated electron as precursor of solvated electron in alcohols were observed. The experimental data indicated that the hydrated electron is formed during water radiolysis with a time constant of 550 ± 50 fs. About 10% of the hydrated electrons undergo geminate recombination with $H_3O^+$/OH radical pairs in the first ten picoseconds.

**Bunch length measurement using Coherent Cherenkov Radiation (CCR)**

In order to improve the time resolution of the pulse radiolysis, bunch length measurement with time resolution of <100 fs is essential. A method of bunch length measurement using Coherent Cherenkov Radiation (CCR), which can store Cherenkov radiation from an electron bunch in a slow-wave structure, was investigated. In the experiment using picosecond electron bunches produced by the photocathode RF gun linac, quasi-monochromatic THz generation of 0.4 THz corresponding to $TM_{09}$ mode was observed successfully. Furthermore, spikes in frequency spectra were explained by theoretical analysis and bunch length of 0.5 ps was estimated according to the intensity ratio of two modes. The other applications of the CCR are expected for a THz probe light and a non-invasive imaging.

**Development of femtosecond time-resolved electron microscopy**

MeV electron microscopy with a time-resolved function is a powerful and dreamy tool to reveal the ultrafast hidden dynamics of intricate molecular and atomic processes in materials. A time-resolved MeV electron microscopy based on a femtosecond rf electron gun is being developed in ISIR, Osaka University. A new structure rf gun has been developed to generates a high-brightness femtosecond-bunch electron beam. The MeV electron beam with energy of 1~3 MeV, bunch length of 180 fs, emittance of 0.3 mm-mrad and energy spread of $10^{-3}$ has been generated and expected to be used for the microscopy measurement. The transverse emittance, bunch length and energy spread were diagnosed as the functions of the laser injection phase, the laser pulse width and the bunch charge. The growths of the emittance, bunch length and energy spread due to the rf and the space charge effects in the rf gun were investigated.

**Study of EUV Lithography**

Chemically amplified resist system is one of the most practical candidates in the future technology in semiconductor fabrication. Reaction mechanisms in the system were analyzed upon exposure to electron beams, X-rays, and laser beams to design a new lithography technique in the present program. The correlation between $C_{37}$ parameter and acid generation efficiency was clarified. Electron beam lithography has the highest resolution among top-down writing systems. The ultimate spatial resolution is closely related to the reaction mechanism of resist materials. The relation between line edge roughness and reaction mechanisms was investigated by a subpicosecond pulse radiolysis. The feature sizes in micro-fabrication have shrunken with the progresses in lithography technology. The decrease in deviation of resist pattern has been also needed to molecular size. Thus, distribution of photo-acid generator (PAG) and orientation of polymer matrix have been important issues. X-ray reflectivity measurements were carried out to understand PAG distribution and polymer orientation from the resist film density map in-depth.

# Department of Nanocharacterization for Nanostructures and Functions


Professor: Seiji TAKEDA
Associate Professor: Manabu ISHIMARU
Assistant Professor: Hideto YOSHIDA
Graduate Students: Takahiro HATTORI, Hiroki OMOTE, Hitoshi YAMAMURA
Supporting Staff: Shigeko TOMII


## Outlines

We have been developing electron microscopy techniques for characterizing nanostructures and functions. In particular, we are aiming to characterize nanomaterials and nanodevices at the atomic scale when they actually exhibit their functions. We have already developed high-resolution environmental transmission electron microscopy (ETEM) that allows us to observe various dynamic phenomena in-situ; for instance, the nucleation and growth of carbon nanotubes from nanoparticle catalysts and the catalytic reaction on the surface of nanoparticle catalysts.

## Current Research Project

### Shape change of Pt nanoparticles supported on $CeO_2$

Noble nanoparticles supported on base metal oxides show catalytic activity for various chemical reactions. The catalytic activity of metal nanoparticles strongly depends on their size, shape, and structure. Thus, it is important to clarify the structural information of metal nanoparticles during catalytic reactions for the improvement of their catalytic activity. In this study, we have investigated the shape of Pt nanoparticles supported on $CeO_2$ ($Pt/CeO_2$) by ETEM.

$Pt/CeO_2$ catalysts (Fig. 1(a)) were prepared by solid grinding method. The conversion of CO to $CO_2$ was about 10% at room temperature (RT) and reached 100% at above 50 °C, as shown in Fig. 1(b).

We found that the Pt nanoparticles show temperature-dependent shape changes under realistic reaction conditions. The Pt nanoparticles are enclosed by low index facets such as {111} and {100} in vacuum (Fig. 2(a)). In CO/air of 100 Pa, the Pt nanoparticles became round (Fig. 2(b)). This is because the {110}, {311}, and higher index facets appeared on the surface. When the temperature

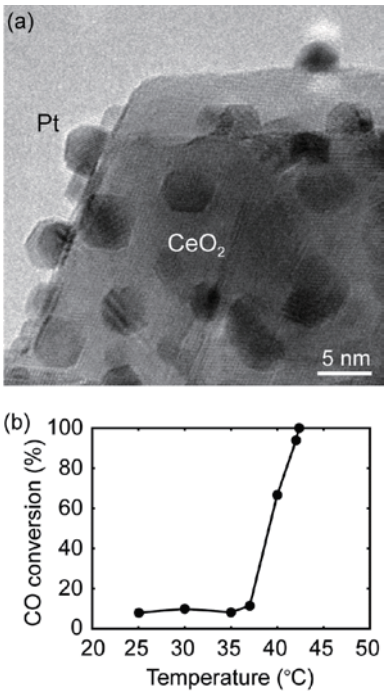



Fig. 1 (a) TEM image of the $Pt/CeO_2$ catalysts. (b) CO conversion over the $Pt/CeO_2$ catalysts as a function of temperature.

increased to 100 °C in CO/air, surprisingly, the Pt nanoparticle became partially faceted (Fig. 2(c)). Based on a comparison between the shapes of the Pt nanoparticles in vacuum, $N_2$, $O_2$, CO, and CO/air at RT, 100, and 200 °C, we propose that the change in shape of the Pt nanoparticles is induced by the adsorption of CO molecules and O atoms.

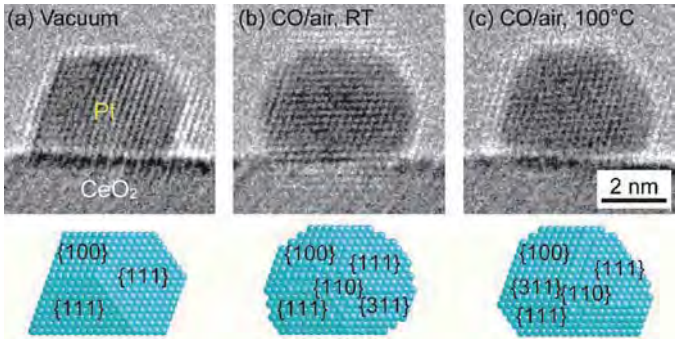



Fig. 2 ETEM images and the corresponding atomic models of a Pt nanoparticle on $CeO_2$ in (a) vacuum at RT, (b) 100 Pa CO/air at RT, and (c) 100 Pa CO/air at 100 °C.

**Development and application of aberration-corrected environmental transmission electron microscopy**

To analyze atomic arrangements on the surfaces and interfaces of solids in gases, we have recently started using an ETEM with a corrector of the spherical aberration of the objective lens (Cs corrector), as shown in Fig. 3(a). All the features of the prototype 200 kV ETEM have been transferred to this ETEM, and information limit even at 200 kV reaches to 0.12 nm in gases of high pressure. In addition, the base system of ETEM has been improved significantly. As an application of the ETEM, Pt nanoparticles supported on MgO (Pt/MgO) was observed in CO/air (Fig. 3(b)-(d)). Pt nanoparticles show multi-faceted shape in CO/air. The surface atomic arrangements of Pt nanoparticles can be seen clearly in CO/air of 500 Pa. Moreover, lattice fringes of Pt appear clearly even in CO/air of 2000 Pa. ETEMs are no longer specially dedicated TEMs, and have become standard scientific and engineering tools.

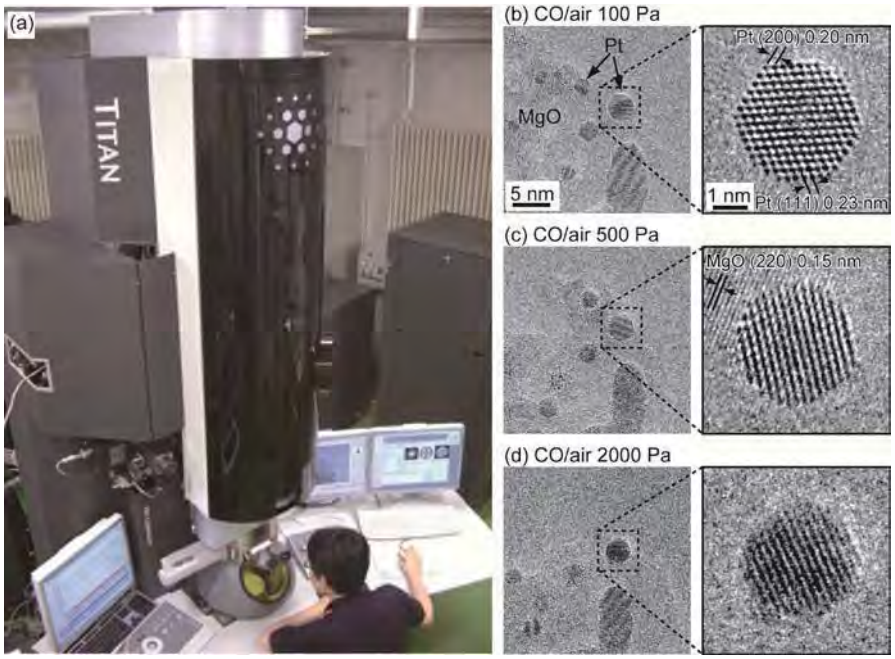



Fig. 3 (a) An ETEM with a corrector of the spherical aberration of the objective lens (Cs corrector). ETEM images of Pt/MgO in CO/air of (b) 100 Pa, (c) 500 Pa, and (d) 2000 Pa.

# Department of Theoretical Nanotechnology

| | |
|---|---|
| Professor: | Tamio OGUCHI (2010.8.1-) |
| Associate Professor: | Koun SHIRAI |
| Assistant Professor: | Kunihiko YAMAUCHI (2010.11.16- ) |
| Guest Professors: | Akira YANASE, Hiromitsu MOTOKAWA |
| Post Doctoral Fellows: | Hongbin HUANG, Mitsuru KODERA (2010.8.1-) |
| Graduate Students: | Naoki UEMURA, Yuji TANAKA, Takayoshi FUJIMURA, Shouhei KOMORI |
| Research Student: | Jagadeesh SURIYAPRAKASH (2010.10.1-) |
| Supporting Staff: | Minako KAKIUCHI |

## Outlines

We currently study the electronic structure of various kinds of solid and surface systems on the basis of first-principles calculation for the prediction of materials properties. By clarifying the underlying electronic mechanisms, we endeavor to design new materials with desired properties. The development of related theory and first-principles calculation methods is also carried out.

## Current Research Project

### Development of first-principles calculation methods

We test the recently proposed exchange-correlation functional AM05 for several systems. It is shown that the AM05 predicts better equilibrium volumes for non-spin polarized systems compared to LDA and GGA though the ferromagnetic bcc ground state for Fe is failed to be most stable [Original Paper 3]. Stress formulation within the all-electron FLAPW method is proposed and examined for various materials [Original Paper 7].

### Rashba effect of Si(557)-Au

Rashba effect is the spin splitting phenomenon seen in a 2D free electron system under electric field and expected to be a new mechanism to realize and control spin without magnetic field in the field of spintronics. Recently, Rashba effect has been observed for some surfaces by angle-resolved photoemission experiments and its electronic mechanism is explained by means of group theory. Rashba-like band splitting observed for Au 1D chains on Si(557) surface has been confirmed as proper Rashba effect and interpreted by first-principles calculation [Original Paper 5].

### Electronic structure and structural stability of hydrogen-storage materials

The electronic structure and structural stability of ammonia borane (AB) and transition-metal hydrides (TH) are investigated by first-principles calculations for their application to hydrogen storage. We explain the electronic structure of AB in terms of

molecular orbitals of constituent molecules. Structural optimization suggests the importance of dispersion force in addition to hydrogen and di-hydrogen bonds in the solid phase. We also study $FeH_x$, $CoH_x$, and $NiH_x$ and find that the electronic structure and magnetism are understood by *d*-band filling due to hydrogenation.

**Materials design utilizing atom dynamics**

*Ab-initio* electronic calculations handle the ground states of materials. However, nothing is done at $T$=0 in experiment. Integrated study of the ground-state properties and atom dynamics is one of the main research subjects in our group.

Graphite is a well know matrix for intercalation. Because pure graphite is very poor in the electronic carriers, it is usable only in a form of intercalation compounds. However, this method suffers from destroying the inter-layer interaction, which is needed for high-$T_c$ superconductors. Our study is different from the intercalation method. Applying high pressures can induce sufficient carriers. By our code Osaka 2k, it is predicted that graphite exhibits a good conductor around at 30GPa, which is a necessary condition for superconductivity [Original Paper 10].

Boron carbide is also a candidate for a high-$T_c$ superconducting material. A big technical problem of this semiconductor is difficulty in doping of sufficient amounts of carriers. Last year, we had disclosed that this difficulty is attributed to the intrinsic property of the crystal. To solve this difficulty, high-pressure technique is useful, because the strong favor of the crystal for having defects can be eliminated at high pressures. Our calculation shows that boron carbide retains its crystal structure up to 600GPa [Original Paper 12]. This stability of crystal is a good for futher study.

**Theoretical confirmation of magnetoelectric effect induced by spin-orbit coupling**

It has been recently reported that the asymmetric *p-d* hybridization under spin-orbit coupling (SOC) is responsible for the magnetically-controllable electric polarization observed in $Ba_2CoGe_2O_7$, where two neighboring Co spins are aligned in an antiferromagnetic configuration below 6.7K. By means of Landau phenomenological theory, a tight-binding model study, and DFT simulations, we revealed the microscopic mechanism of the magnetoelectric (ME) effect in $Ba_2CoGe_2O_7$. On the top of absence of the spatial inversion symmetry in the $P\text{-}42_1\,m$ symmetry, collinear antiferromagnetic spin configuration breaks the rotation symmetries so that spontaneous ferroelectric polarization is allowed. Our DFT calculation confirmed that the ferroelectric polarization is induced by anisotropic *pd* hybridization due to the asymmetric Co-*d* orbitals in the $CoO_4$ tetrahedron (Fig.1) under SOC. (K. Yamauchi, P. Barone, S. Picozzi, Phys. Rev. B **84**, 165137 (2011).)

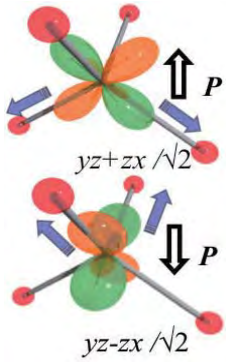


Fig. 1 Asymmetric Co-*d* orbitals responsible for the electric polarization *P*

Incidentally, we have also discussed a related ME mechanism in magnetite $Fe_3O_4$, where the crystal structure (with *Cc* space group) doesn't have inversion symmetry, while the *c*-glide symmetry which prohibits polarization is broken by the ferri-magnetic spin order under SOC. As supported by the symmetry analysis and the tight-binding model study, our DFT simulations are performed in optimum way.

# Department of Soft Nanomaterials


Professor: Yoshio ASO
Associate Professor: Yutaka IE
Assistant Professor: Makoto KARAKAWA
Graduate Students: Masaru ENDOU, Masashi NITANI, Tomoya HIROSE, Jianming HUANG (2010.10-), Takahiro SAKURAI, Kazufumi NISHIDA, Masashi UETA, Aya KOJIMA
Under Graduate Students: Kazunari TANAKA
Research Student: Jianming HUANG (2010.4-2010.9)
Supporting Staff: Ming-chun HSIEH (-2010.7), Etsuko TANI, Keiko YAMASAKI (2010.8-), Takeo MAKINO


## Outlines

The main subject in the Department of Soft Nanomaterials is the development of novel molecular-based materials with promising electronic and photoelectronic properties for organic electronics. The research is based on the design and synthesis of nano-scale p-conjugated molecular materials for organic electronics as well as molecular electronics and the elucidation of the relationship between molecular structures and physical properties to control and improve the functions. We have been focusing our research on the development and evaluation of (1) chemically modified pi-conjugated systems as organic semiconductors with high electron mobility, (2) photovoltaic materials based on pi-conjugated systems with increasing self-association tendency that forms carrier-transporting paths, and (3) functionalized molecular wires and metal-electrode-anchoring units applicable to molecular electronic devices.

## Current Research Project

### Organic Electronics Materials

We have developed organic materials for n-type field-effect transistors (FETs), p-type FETs.
It has been known that the introduction of electron-withdrawing groups into pi-conjugated systems increases their n-type character. We have designed difluoro-dioxocyclopentene-annelated thiophene and synthesized their based conjugated oligomers. On the basis of these findings, we have developed electronegative π-conjugated compounds based on difluorodioxocyclopentene-annelated thiophene and dialkyl-substituted naphtho[2,3-*c*]thiophene-4,9-dione as a candidate material for solution-processable n-type organic field-effect transistors. [Original Paper

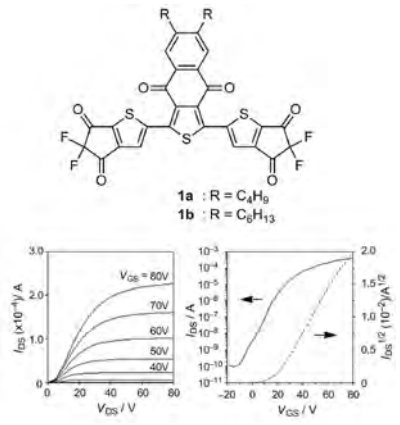


Fig. 1. Carbonyl-annelated oligomers.

1] (Fig. 1). Moreover, difluorodioxocyclopentene-annelated thiophene was converted to a dicyanomethylene-introduced thiophene derivative, and conjugated oligomers having its terminal unit have been developed. Their cyclicvoltammetry indicate fairly low LUMO levels, and their FET devices showed high n-type FET performance and air-stable operation as our expectations. In addition, some these oligomers reveal a broad absorption band in a visible and longer wavelength region, and a preliminary photovoltaic-device application indicate that they can be new acceptor materials for organic solar cells [Original Paper 7] (Fig. 2). We have synthesized new polymers having the branched structure and studied on the effects of branched structure to physical properties. Their FET devices showed a typical p-type characteristic, and the field-effect mobility increased with increasing the branch chains [Original Paper 6]. Moreover, in order to develop new pi-conjugated compounds applicable to organic memory materials, we have studied the synthesis, optical and electrical properties, and device characteristics of the twisted polythiophenes. As we expected, the polythiophene with twisted structure showed interesting conductance switching property in a thin film device.

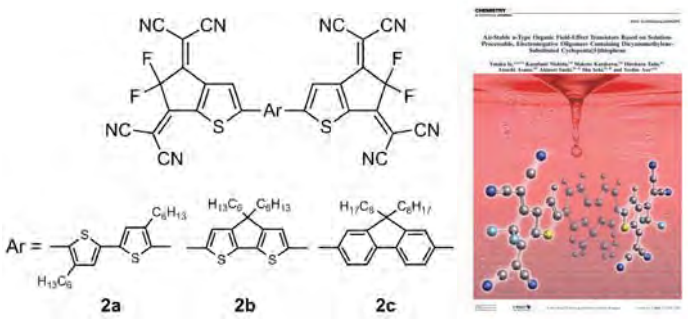


Fig. 2. Dicyanomethylene-introduced pi-conjugated systems.

**Molecular Electronics Materials**

In the field of molecular electronics, it is highly important to connect securely each molecule to a metal electrode and to realize efficient carrier injection. In this context, we have developed tetraphenylmethane tripodal anchor units with variety functional groups [Original Paper 3] and phenylene-ethynylene molecular wires with anchoring units on the both terminal ends. We have newly synthesized tripodal compounds with pyridyl and amino groups. Their monolayers on a gold electrode revealed that the surface coverage of the pyridyl tripodal anchor is smaller in one order compared with tripodal thiol anchor, and that of the amino anchor is comparable to that of tripodal thiol anchor. These results indicate that functional groups having weak adsorption nature can be also connected to gold electrodes by integrating into the tripodal structure. Moreover, the phenylene-ethynylene compound with tripodal pyridyl anchors showed a good electrical conductivity on the STM break-junction measurement [Original Paper 5]. The tripodal structure is expected to form a robust junction, and pyridine is predicted to achieve π-channel electric transport.

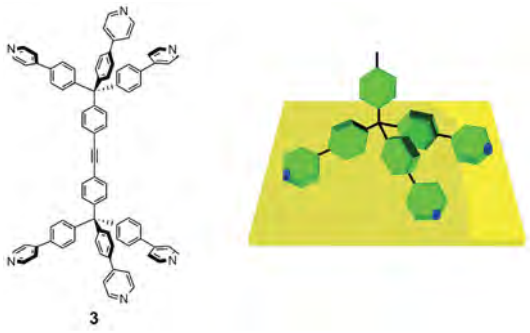


Fig. 3. Tripodal anchor unit.

# Department of Bionanotechnology

Associate Professors: Takuya MATSUMOTO, Masateru TANIGUCHI
Assistant Professor: Hiroyuki TANAKA,
Specially Appointed Researcher: Yoshiaki HIRANO
Supporting Staff: Noriko FUJIBAYASHI, Yumiko NOGI

## Outlines

This research group directs toward both nano-science and nanobio-technology in its activity. Main subjects are (1) Preparation of Function Harmonized Artificial Lattices, (2) Atomic Scale Surface Science, (3) Development of Bio-tip, and (4) Development of bio-molecular device constructed from DNA. By use of a laser molecular beam epitaxy technique under layer by layer growth conditions, we are challenging in development of highly sensitive IR-sensor by functional transition metal oxide nano-film. Observation and manipulation of a single atom or a molecule are undertaken on DNA molecules with Scanning Probe Microscopic (SPM) methods. And also we developed the ultrasensitive electrochemical gene sensing system by using nanowell array electrodes.

## Current Research Project

### Single Molecule Identification via Quantum Current Noise

We find that inelastic noise in a single-molecule tunneling junction increases in a stepwise fashion synchronous to the onsets of inelastic excitations of its distinct vibrational modes active in the electron-phonon interaction, which thereby enable single-molecule fingerprinting through examining the noise spectra. We are also able to identify the electron-phonon coupling strength and the symmetry of a single organic molecule from the distinct noise characteristics. As electron-vibration interactions exist in virtually any types of molecules, these findings suggest a potential use of inelastic noise as a useful molecular signature for single-molecule identifications with high specificity that may open new venues for practical realization of single-molecule sensors. (Fig. 1)

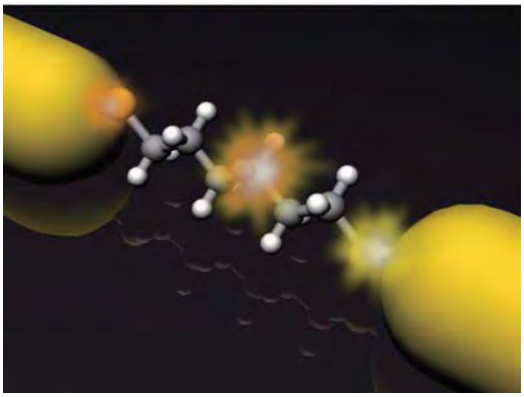


Fig.1 Schematic diagram of single-molecule junctions.

### Stochastic Resonance Emerging on Self-assembled Molecular Network Devices

We have aimed the emergence of novel device that can induce SR, constructing the molecular network by coupling bio substances and organic molecules with the self-organization. We have used cytochrome *c* (cyt c) and $Mn_{12}$ complex including a redox center and DNA (Poly(dA)Poly(dT) DNA or λ-DNA) which can assist the

fabrication of cyt *c* arrays which are charge transport route. Since the redox center in cyt *c* and $Mn_{12}$ is insulated, it is difficult to receive the influence of outside environment. Therefore, cyt *c* and $Mn_{12}$ arrays that the height of energy barriers is identical one after another are expected to be obtained. The I-V characteristics indicate that each cyt *c* and $Mn_{12}$ acts as Coulomb blockade element and the devices show the function of stochastic resonance. (Fig. 2)

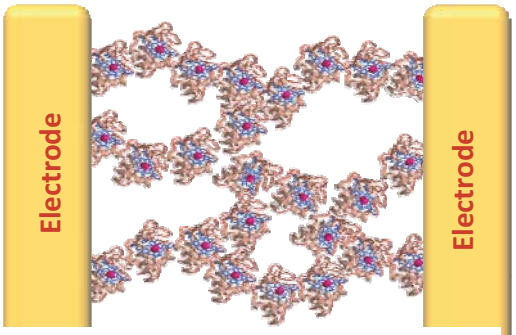



Fig. 2 Schematic illustration of cytochrome c/DNA network devic

**Development and Application of Rapid Fabrication of Teflon Micropores as a Platform of Stable Lipid Bilayer Formation**

Lipid bilayers formed on micropores possess excellent properties for electrical measurements given the low membrane capacitance and high voltage stability. However, conventional methods employed in the fabrication of micropores on semiconducting materials require large-scale equipment with many fabrication steps. To address this problem, we have developed a novel method that generates Teflon micropores in a few seconds by imposing a heated tip onto commercial Polyethylene, Polyethylene terephthalate, Polypropylene and Teflon films. These advantages promise to improve the performance of artificial lipid bilayers when employed in the development of flexible biosensors and a combination system with atomic force microscope (AFM). Thus we succeeded in activating a single channel protein by mechanically stimulating it with an AFM probe, indicating our novel technologies have the potential to be a very powerful tool for the analyses of the activation-deactivation dynamics in channel proteins. (Fig. 3)

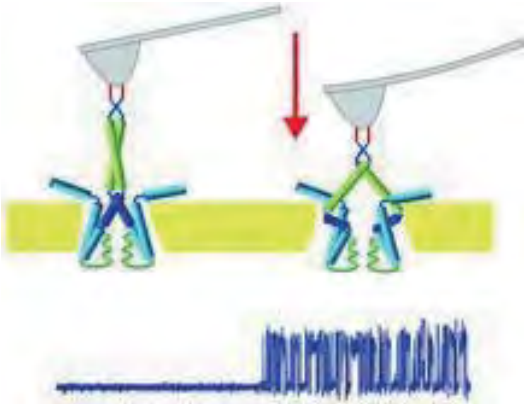


Fig. 3 Schematic illustration of the analyses of the activation-deactivation dynamics in channel proteins.

# Department of Nanotechnology for Environmental and Energy Applications

Professor: Yoichi ANDO

## Outlines

To address the urgent issues of environment and energy, we are studying basic properties of novel spintronics materials and unconventional superconductors by utilizing the facilities for micro/nano-fabrications available at the Nanoscience and Nanotechnology Center. This year, we mostly focused on topological insulators.

## Current Research Project

### Basic research of topological insulators for spintronics applications

This project explores new avenues of the spintronics to utilize the "helically spin-polarized" metallic state that exists on the surface of a *topological insulator*, which is a new state of matter discovered in 2008. In the helically spin-polarized surface state, the current direction and the spin polarization is directly coupled; namely, right- and left-moving electrons carry up and down spins, respectively. This allows a completely new way to generate and control spins with minimal energy dissipation.

The helically spin-polarized surface states of topological insulators have been observed by photoemission experiments, but its implications on the spin transport properties have not been fully understood. In fact, it is not clear how one can extract spin currents from those peculiar surface states. It is therefore important to develop suitable device designs for electrically detecting the surface spin currents, based on the practical understanding of the topological insulator materials. We are pursuing an idea of detecting the surface spin currents in topological insulators by utilizing the "inverse spin-Hall effect" in heavy-metal contacts, which generates voltage in response to the spin current (Fig. 1).

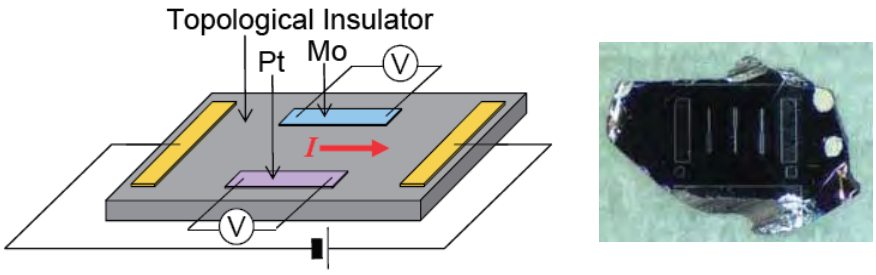



Fig. 1 Schematic drawing of the spin-current-detection device and the photograph of a prototype.

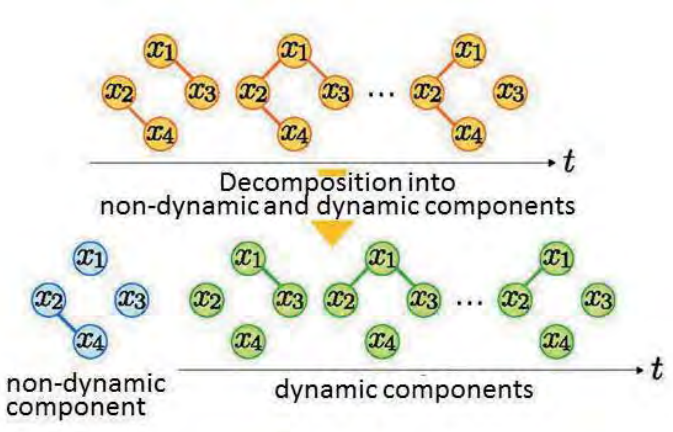
# Department of Nano-Intelligent Systems

Professor: Takashi WASHIO

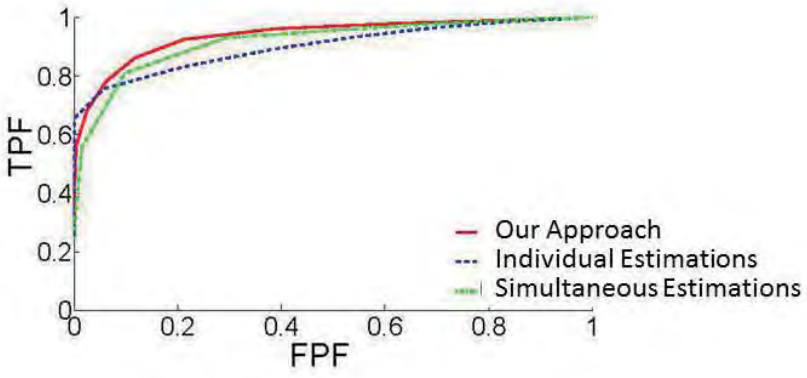
## Outlines

Massive data are being accumulated in nano-technology study along the development of experiment and measurement techniques. However, the fast extraction of meaningful knowledge from the massive data is difficult due to the limitation of human analyst's ability. To address this issue, we develop methods to efficiently extract or estimate meaningful knowledge from the massive data by applying various reasoning and searching mechanisms. Currently, we work on the development of an estimation method from data obtained in a large scale quantum experiments. Results of quantum experiments are known to satisfy a mathematical property named positive semi-definiteness due to their background physical nature. This study worked on the development of a method and its algorithm to derive the accurate estimation from a sample distribution and likelihood provided by the large scale non-stationary experimental results and the positive semi-definiteness.

## Current Research Project




Relations between states on state density matrices.




Comparisons of estimation accuracy between our method and conventional methods.

# Department of Nanodevices for Medical Applications

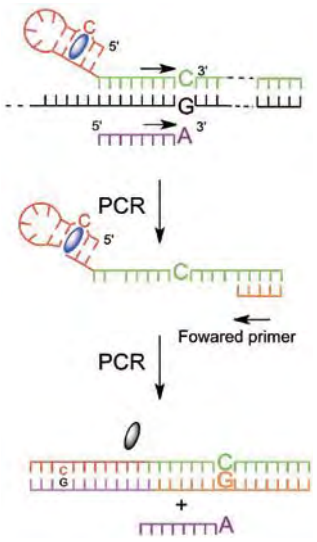
Professor: Kazuhiko NAKATANI

## Outlines

We are developing novel method and devices for rapid, simple, and cost-effective detection of genetic mutations on the basis of a proposal of new concept.

## Current Research Project

**Development of Technology for Single Nucleotide Polymorphisms (SNP)**




The technique for promptly detecting the genetic mutation is expected as a basic technology that supports the personalized medicine. We have reported a new SNP typing method based on DNA secondary structure-inducible ligand fluorescence. In this SNP typing method, the hairpin tag is unfolded by a PCR and is transformed into a duplex. As a result, the primer losses of the DANP binding sites, and the fluorescence intensity decreases. This time, we have focused on the method to improve the allele specificity of the PCR using hairpin primers with competitor primers, and the SNP alleles are discriminated by fluorescence. This is the simple method to increase the allele specificity without optimized a PCR conditions. The allele specificity is dramatically increased by this method.

This research is collaborative research with assistant professor Dr. Fumie Takei in department of regulatory bioorganic chemistry.

# Department of Nanosystem Design

Guest Professor: Hiroyuki AKINAGA (2010.10.1-2010.12.31)

## Outlines

Construction of functional oxide nanoelectronics

## Current Research Project

Development of nanodevices based on functional oxide materials has been conducted with the emphasis on the exploration of their potential application in nanoelectronics. The enhancement of device specifications for nonvolatile memories, including resistance switching device, field-effect transistor, and tunneling magnetoresistance device, was attempted by the downscaling of device structure. These emerging oxide devices will be eventually combined to semiconductor devices through our activities in Functional oxide electronics frontier research group, JSAP.
A presentation titled “Emerging Research Memories: for the sustainable development of electronic devices in the scaling trend to 1x nm” was given as an introductory talk to nanoelectronics for young researchers and graduate students on Dec. 9 2010.

# Department of Nanosystem Design

Guest Professor: Hitoshi KOBAYASHI (2011.1.1 - 2011.3.31)

## Outlines

To achieve the ultimate nano-fabrication, it is necessary to understand the quantum-beam-induced reaction process. While the femtosecond –attosecond pulse radiolysis system is developing for understanding initial process of radiation chemistry, the limitation in the time resolution by the difference in speed of light and electron beam in sample is a serious problem. The Equivalent velocity spectroscopy method is proposed to solve the problem. For the Equivalent velocity spectroscopy method, precise control method of electron beam pulse was investigated theoretically to achieve both of the pulse compression and the pulse rotation on the longitudinal plane.

## Current Research Project

**Development of electron beam pulse control method for the Equivalent velocity spectroscopy**

The Equivalent velocity spectroscopy method is a key technology for achievement of femtosecond-attosecond pulse radiolysis. On the Equivalent velocity spectroscopy method, precise controlling method of electron beam pulse is required for both of the pulse compression and the pulse rotation on longitudinal plane. In previous studies, both of the pulse compression and the rotation were difficult in same time. To overcome this difficulty, various technologies were studied theoretically and some new methods were proposed in the following.

When electron pulse is passed through the undulator, using the different orbits length of electron by the energy dispersion in electron pulse, the method of pulse rotation on the longitudinal plane at the undulator exit was proposed.

Both of optimization of the energy dispersion and the nonlinear energy modulation is needed to compress the electron pulse in femtosecond. These modulations of electron bunch were performed in one linear accelerator tube in current system. For more precise bunch controlling in the next stage, three different controls, accelerating, energy dispersion and cancellation of secondary effect, will be performed by using two accelerator tube, and sextupole magnets respectively. By optimization of control in each device, the method which achieve the pulse compression and rotation in same time was proposed.

And there was a problem that electron pulse rotated on the transverse plane by a solenoid magnet with the photocathode RF gun for emittance compensation. In order to solve the problem, use of reverse magnetic field solenoid was proposed.

# Department of Nanosystem Design

Guest Associate Professor: Shigenori UEDA (2010.4.1-2010.6.30)

## Outlines

Evaluation of electronic and magnetic properties of oxide nano-devices

## Current Research Project

We have collaborated in evaluation of electronic and magnetic properties for correlated electron oxide materials and heterojunctions by a Hard X-ray photoemission spectroscopy (HXPES) and a magnetic circular dichroism spectroscopy (MCD). The SPring-8/NIMS group has the world's most advanced apparatuses for HXPES and MCD. The feature of the HXPES and MCD using hard X-ray made by the synchrotron radiation at SPring-8 shows a high bulk sensitivity, that is, it is possible to evaluate 10nm-30nm inside electronic and spin states from a material surface. By using such apparatuses, we have clarified the working mechanism and the physical properties of oxide nano-devices.

# Department of Nanosystem Design

Guest Associate Professor: Yasushi KANAZAWA (2010.10.1-2010.12.31)

## Outlines

The studies in this laboratory focus on computer vision and media processing. In particular, medical image processing including intestine image analysis with an endoscope camera is a central topic of this department.

## Current Research Project

**Straightening an intestine volume for its shape analysis**

Three-dimensional (3D) shape of an entire intestine is one of helpful information for ease in endoscope diagnosis. Though some existing studies aim at the 3D shape recovery using the Structure-from-Motion (SfM) technique, it is still hard to recover dense 3D shape because feature points are extracted sparsely and they are not robust in intestine scenes. In our study, therefore, we propose to obtain an intestine model which well describes restriction of real intestines, and use it as well as the SfM technique to recover the dense 3D shape accurately. This paper particularly describes a shape extension image which is proposed for analyzing the intestine shape, process for obtaining this extension image from CT images, and frequency analysis of the extension image to consider a tendency of the shape.

Fig. 1 Endoscope

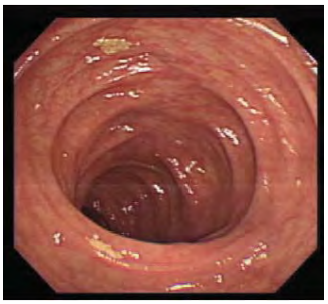


Fig. 2 Endoscopic image

Fig. 3 Entire intestine shape

Fig. 4 Centerline before optimization (green) and after optimization (red)

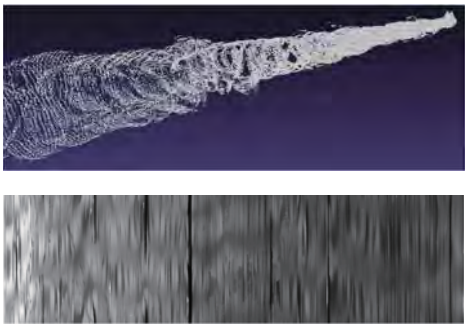


Fig. 5 Straightened intestine volume (top) and dissection shape image of intestine (bottom)

# Department of Nanosystem Design

Guest Associate Professor: Masamichi SAKAI (2010.10.1-2010.12.31)

## Outlines

Systematic fabrication of $YH_2$ films has been conducted since 2009 at ISIR, which aims to obtain nearly-zero Hall coefficient materials, because the nearly-zero Hall coefficient characteristic of $YH_2$ enables generation of pure spin-current, which is now considered as a key technique in realizing spintronics devices. Thus, high-quality crystallization of $YH_2$ is indispensable. Our process fabricating $YH_2$ consists of two procedures, i.e., (i) fabrication of Y film using conventional electron-beam deposition technique, followed by exposition of as-deposited Y films to atmosphere and (ii) reaction with hydrogen (3%)-argon (97%) mixed gas under moderately high temperatures around 600 K. The purpose of the present study is to investigate (i) correlation between the crystal quality of Y and that of $YH_2$ and (ii) effect of the cap layer, which is grown immediately after the growth of Y film, on crystal quality of $YH_2$.

## Current Research Project

Our findings are summarized for two cases (A) without cap layer and (B) with cap layer as follows. Case (A) yields (i) the presence of oxygen near surface region of Y, (ii) a positive correlation in crystal texture between Y and $YH_2$, and (iii) a very weak correlation in crystal domain size between Y and $YH_2$. Case (B) was studied using Au, Pd, and Gd as a cap layer. Although both Au and Pd cap-layers can prevent as-grown Y film from oxidization, Au cap-layer prohibits hydrogenation of Y, while Pd cap-layer allows it. The case (B) with Pd cap layer yields (i) a very weak correlation in crystal texture between Y and $YH_2$ and (ii) a negative correlation in crystal domain size between Y and $YH_2$, which are in contrast to the results of case (A). It follows from the study of the case (B) using Gd cap layer that (i) hydrogenation of Y is not prevented by the presence of Gd cap layer and (ii) $YH_2$ film having higher levels of crystal texture as well as larger sizes of crystal domain were obtained.

# Department of Nanosystem Design

Guest Professor: Fumitoshi KAKIUCHI (2011.1.1-2011.3.31)

## Outlines

Fused aromatic compounds have recently received much attention due to their potential utility for organic optical and electronic materials. Development of methods to prepare various derivatives of desired fused aromatic compounds is of great interest because derivatization of the fused aromatic compounds may adjust their optical and electronic properties as well as their solubility and packing structures in the crystals. Professor Kakiuchi and co-workers have initiated efforts toward short syntheses of multisubstituted fused aromatic compounds using the ruthenium-catalyzed CH arylation of aromatic ketones with arylboronates. Recently, they succeeded in two- and threestep syntheses of tetra- and hexaarylanthracenes from anthraquinone, taking advantage of the CH arylation method. In this work, we investigated the performance of organic field-effect transistors fabricated from these fused aromatic compounds.

## Current Research Project

A new convenient method for the synthesis of dibenzo[*a*,*h*]anthracenes and picenes using ruthenium-catalyzed regioselective CH arylation of aromatic ketones has been developed. Acetophenone derivatives and 1,4-benzenediboronates were coupled in 2:1 ratios to form *p*-terphenyl derivatives. Conversion of the acetyl group to an ethynyl group, followed by cycloaromatization provided the desired fused aromatic compounds. Organic field-effect transistors fabricated from one of these products gave moderate hole mobility. [1]

The performance of OFET of the compound was evaluated by employing bottom-contact configuration. The active layer was prepared by spin-coating from 1.0 wt% chloroform solution. As expected, this compound exhibited typical p-type characterisitcs, and the hole mobility is found to be $3.0 \times 10^{-4}$ $cm^2$ $V^{-1}$ $s^{-1}$ with the on/off current ratio of $1.3 \times 10^7$ and the threshold voltage of 0 V (Figure 1).

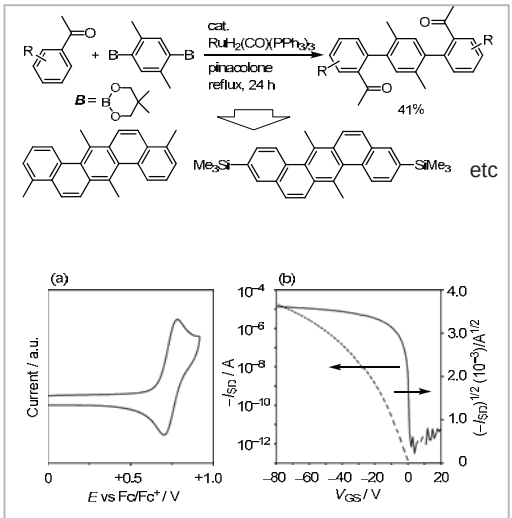



Figure 1. Synthesis of dibenzoanthracenes and electrochemical and FET properties

[1] Kitazawa, K.; Kochi, T.; Nitani, M.; Ie, Y.; Aso, Y.; Kakiuchi, F. *Chem. Lett.* **2011**, *40* , 300-302.

# Department of Nanodevice Characterization

Guest Professor: Stefano BORGO (2010.6.1-6.30)

## Outlines

Ontology Engineering is one of fundamental techniques for engineering knowledge management. The guest Prof. Stefano Borgo is a distinguished researcher in this field. The aim of this research is to formalize the semantics of the ontologies: YAMATO and FOCUS which have been developed by the Mizoguchi Lab. Furthermore, a deep consideration on the notion of artifacts has been done.

## Achievement

**Formalization of a top-level ontology YAMATO.**
The semantics of the top-level ontology YAMATO, which has been developed by Prof. Riichiro Mizoguchi, has been clarified by the axioms established in this research.

**Clear semantics of a suite of functional ontoloiges FOCUS.**
The semantics of the suite of functional ontologies: FOCUS, which has been developed by the Mizoguchi Lab., has been clarified by the implicit assumptions explicated in this research.

**Consideration on the notion of artifacts.**
The essential conditions of the notion of artifacts have been investigated and clarified. The two major viewpoints: production and selection (for use) and some levels of necessary conditions for artifacts have been identified. Then, the relationships among them have been clarified as shown in Fig. 1. From the viewpoint of production, we can distinguish the Natural-made Thing (NT), the By-product Artifact (BA), the Technological Artifact (TA) and the Engineering Artifact (EA). The Ontological Artifact (OA) from the viewpoint of selection can be created along either the line A (selection for use) or the line B (selection by production).

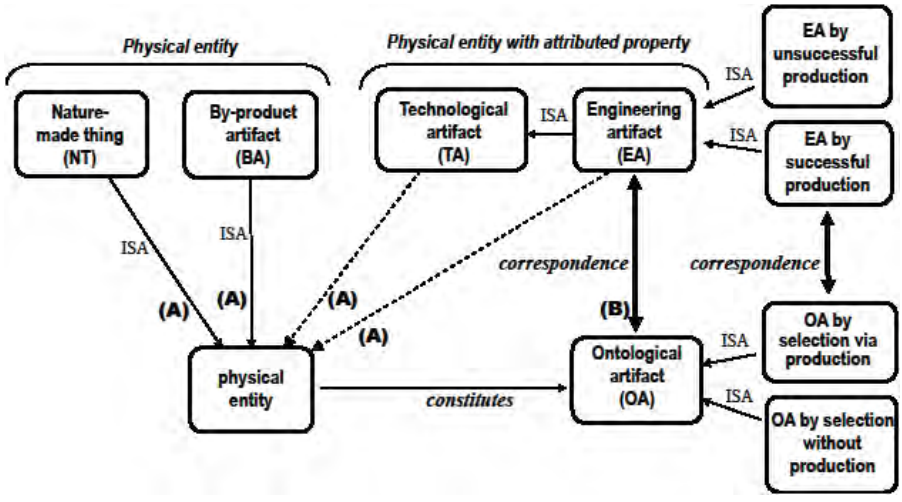



Fig. 1 The relationship among definitions of the notion of artifacts

# Department of Nanodevice Characterization

Visiting Associate Professor: Michael Börsch (2010.8.2-2010.9.1)

## Outlines

$F_oF_1$-ATP synthase ($F_oF_1$), a complex of two rotary nanomotors, is responsible for ATP synthesis in the oxidative phosphorylation and photosynthesis in living cells. Using single-molecule Förster resonance energy transfer (FRET) technique, we tried to measure the ATP synthesis/hydrolysis (rotation) rate of $F_oF_1$ working in living *E. coli*

## Current Research Project

### Single-molecule FRET measurement of $F_oF_1$ rotation reconstituted into the liposome

A $F_oF_1$ mutant, in which SNAP- and CLIP-tag were introduced into the stator a-subunit and rotor ε-subunit respectively, was generated. The mutant retained the ATP hydrolysis, proton transport and ATP synthesis activity. Specific introduction of benzylguanine-Alexa647 (acceptor) and benzylcytosine-TMR (donor) into a-SNAP and ε-CLIP of purified $F_oF_1$ were confirmed.

Single-molecule FRET measurement of fluorescently labeled $F_oF_1$ reconstituted into liposome showed three distinct FRET levels (L, M, H) expected from the three pausing angles of the rotor of $F_oF_1$. However, the fraction of molecules that showed ordered transition (H→M→L→H for synthesis, H→L→M→H for hydrolysis), corresponding to the rotation was only ~20%, and many molecules showed only alternating transitions between two levels such as L→M→L.

### Single-molecule imaging of $F_oF_1$ in *E. coli*

Fluorescent labeling of a-SNAP/ε-CLIP $F_oF_1$ in *E. coli* was examined. Specific localization of the benzylcytosine-TMR to the cell membrane was observed after labeling. Copy number of TMR-labeled $F_oF_1$ could be decreased by culturing the cells after the labeling. After cell divisions for several times, decrease in the copy number of TMR-labeled $F_oF_1$ was observed, and single-molecules were successfully imaged in real time. However, labeling efficiency of benzylguanine-Alexa647 was low due to low permeability to the membrane, and single $F_oF_1$ labeled by both donor and acceptor dyes has not been observed so far.

# Department of Nanodevice Characterization

Guest Professor: Emil Pinčík （2010.9.1 – 2010.10.29）

## Outlines

High-perfomance electronic devices are indispensable for the rapid progress in the modern society. Properties of both ultra-thin dielectric films and dielectric films/semiconductor interfaces greatly affect device characteristics and thus, studies on these physical properties are important for both basic and applied researches. For this aim, we have been developping the advanced transient charge processor. The findings obtained from the transient current measurements have been analyzed in conjunction with the optical and the crystal structural information to investigate the interface properties of dielectric films/semiconductor structures.

## Current Research Project

We have concentrated on the interface properties for ultra-thin $SiO_2$/Si structures for metal-oxide-semiconductor (MOS) devices. The electrical measurements using charge deep level transient spectroscopy (Q-DLTS) method, spectral ellipsometry, photoluminescence spectroscopy, AFM, and grazing incidence X-ray diffraction measurements were executed for the observation of metastable defect states and the characterization of interface properties. Chemical oxidation by use of nitric acid aqueous solutions, followed by passivation in HCN solutions was found to be the best technique for formation of ultra-thin $SiO_2$/Si structures having high quality interfaces. It was found from spectral ellipsometry that the real part of complex refractive index of the NAOS-$SiO_2$ layer has a higher value than that of α-quarts [i.e, refractive indices at 633 nm for the ultra-thin (1.5 nm) NAOS-$SiO_2$ layer and α-quarts are 1.72 and 1.48, respectively]. It has been found from FTIR measurements that atomic densities of the NAOS-$SiO_2$ layer are higher than that of thermal $SiO_2$. We suppose that this is the reason for higher values of the real part of refractive indices.

The Q-DLTS measurements of the NAOS-$SiO_2$ layer showed that the densities of interface states have been reduced from $10^{12}$ $cm^{-2}eV^{-1}$ to $10^{11}$ $cm^{-2}eV^{-1}$ by passivation with the cyanide method. The most intensive passivation process was observed on mid-gap levels in Si substrates. We have made the comparison between POA (post-oxidation annealing) and PMA (post-metallization annealing) treatments on $SiO_2$/Si structures. In Fig. 1, the amplitudes of Q-DLTS signals for the POA samples were more intense than those for the PMA samples. Because the amplitudes of Q-DLTS signals are proportional to an interface state density of MOS structures, the results indicate that the density of the interface states is reduced by the PMA treatment.

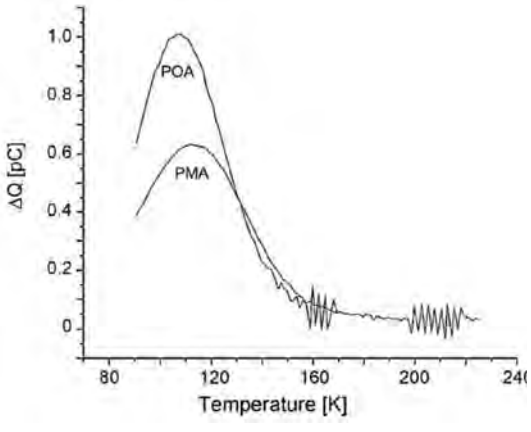



Fig. 1 Q-DLTS spectra of the <Al/$SiO_2$/Si> MOS structures with POA and PMA

# Department of Nanodevice Characterization

Guest Professor: Sung Sik KIM (2010.12.20-2011.2.21)

## Outlines

Molecular switch, which controls distribution of localized charge upon outer stimuli such as photoexcitation, is an important device in various supramolecular systems. In the present study, molecular design and synthesis of a novel dyad molecule for molecular switch with optimized functionalities have been carried out.

## Current Research Project

The charged state of a dyad molecule, in which functional molecules are connected by an adequate linker, can be generated by chemical oxidation or reduction. The charge distribution of the dyad molecule can be controlled by photoexcitation of the absorption band of the corresponding charged state. Such switching events can be monitored by ultrafast laser spectroscopy. According to the Marcus theory, the driving force of the charge transfer and the linker connecting chromophores have an important role to achieve high efficiency and rate of switching. For the dyad molecules, imide compounds have been employed for the dyad molecules, because optimization of these parameters is possible by selecting the substituents and linker. The synthesis of such dyad molecules have been carried out.

# Department of Nanotechnology for Industrial Applications

Guest Professor: Nicola Guarino (2010.4.7 - 2010.5.7)

## Outlines

In the context of the EuJoint project, which is an EU-authorized joint project between Mizoguchi lab and Laboratory for Applied Ontology (LAO), CNR, Trento, Italy with other European partners, Nicola Guarino, the leader of LAO stayed for one month. We discussed theory of roles, theory of artifacts and service ontology.

## Current Research Project

- **On role theory**
  We compared Osaka theory and Trento theory of roles and obtained a new idea of virtual player to enhance the treatment of vacant roles.
- **Theory of artifacts**
  Contrary to our intuition, definition of artifacts is a tough issue. We discussed this topic and came to an agreement on that artifacts should be defined based on its internal role structure played by its components/parts.
- **Service ontology**
  We did a comparative study on Nicola's ontology of services and ours, and found Nicola's ontology is ignorant of distinction of services from functions, while ours successfully distinguish between the two.

# Department of Nanotechnology for Industrial Applications

Guest Professor: Sylvain JUGÉ (2010.5.10-2010.6.11)

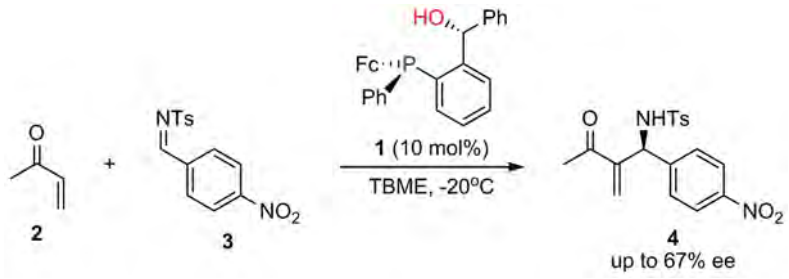
## Outlines

Asymmetric synthesis, a phenomenon fine-tuned to perfection by nature, forms the central theme of our research efforts. In this study, an environmentally benign asymmetric synthesis and a high-performance catalyst were tried to be developed through an application of chiral phosphine compounds invented by Prof. Jugé's group to an enantioselective organocatalysis which has been investigated in Prof. Sasai's group.

## Current Research Project

**Development of P-chirogenic organoctalyst and its application to aza-Morita-Baylis-Hillman reaction**

The P-chirogenic hydroxyphosphine **1** which functions as a multifunctional organocatalyst has been developed for the aza-Morita-Baylis-Hillman (aza-MBH) reaction. The aza-MBH reaction involves Michael/Mannich/H-transfer/retro-Michael sequences. A chiral Lewis base phosphine unit on the catalyst mediated the Michael reaction and the hydroxyl region accelerated the H-transfer step, resulting in a formation of **4** with up to 67% ee (Scheme 1).




Scheme 1. Enantioselective Aza-MBH Reaction Catalyzed by P-Chirogenic Hydroxyphosphine **1**

# Department of Nanotechnology for Industrial Applications

Guest Professor: Sung Sik KIM (2010.6.21-2010.8.20)

## Outlines

Site-selective reaction is quite useful for the formation of nano materials. In the present study, we have synthesized a novel molecule which can generate highly reactive intermediates upon two color two laser excitation techniques.

## Current Research Project

Imide compounds such as naphthaldiimides (NDI) have been employed to various supramolecular systems because of their high electron acceptor ability. Since radical anion of NDI exhibits a strong absorption band in the visible region, two-color two-laser flash photolysis will effectively generates excited radical anion with high reduction ability. From the preliminary study using pulse radiolysis, we have confirmed the high reduction ability of excited radical anion of NDI in the intermolecular reaction. Since the lifetime of excited radical anion is expected to be on the order of picoseconds, molecular dyad systems of NDI and another chromophore are essentially important for the effective intramolecular electron transfer. As a representative case, the dyad molecule of NDI and pyromellitic imide was synthesized.

# Department of Nanotechnology for Industrial Applications

Guest Associate Professor: Mohamed Almokhtar ABDEL-MOLA(2010.10.1-2011.3.31)

## Outlines

Multi-quantum-well (MQW) structure consisting of ferromagnetic and non-ferromagnetic layers is one of the most important structures for spintronic devices. On the other hand, nano-rod structure is also important structure for device applications because of their lateral carrier confinement and high crystalline quality. Quantum disc (QDisc) structure is a combination of these two structures. In this work, GaGdN/AlGaN QDisc structures are grown by plasma-assisted molecular beam epitaxy (MBE) and their structural, optical and magnetic properties are studied.

## Current Research Project

GaGdN/AlGaN QDisc structures were grown by radio-frequency plasma-assisted MBE on Si (001) substrate with thin SiO2 layer. Atomic force microscopy and cross-sectional transmission electron microscopy measurements show that QDisc structures are formed. Room temperature ferromagnetism was confirmed and with the increase of AlGaN barrier layers the saturation magnetization was increased because of carrier-induced ferro-magnetization effect. Photoluminescence emission was observed from the GaGdN QDiscs. Furthermore, the method for the separation of nano-rod structures with GaGaN/AlGaN QDiscs from the Si substrate was studied and established. By using this established method, it is possible to study on the optical properties from only one nano-rod with GaGaN/AlGaN QDisc.

# Open Laboratory

| | |
|---|---|
| Professor: | Kazuhiko NAKATANI |
| Technical Staff: | Kimihiro NORIZAWA |
| Supporting Staff: | Kayoko OHASHI |

## Outlines

Open Laboratory supports the comprehensive research for creative and advanced academic research on materials and devices, which should become the foundation of scientific and technological development on nanotechnology.

## Current Research Project

On 2010, the following 11 researchers used Open Laboratory.

| | |
|---|---|
| Prof. Kiichi FUKUI | Graduate School of Engineering |
| Prof. Kazuyoshi ITOH | Graduate School of Engineering |
| Prof. Yusuke MORI | Graduate School of Engineering |
| Prof. Takao YAMAMOTO | Graduate School of Engineering |
| Prof. Yoshimitsu YAMASAKI | Graduate School of Medicine |
| Prof. Hirotaro MORI | Research Center for Ultra-High Voltage Electron Microscopy |
| Prof. Tomoji KAWAI | Institute of Scientific and Industrial Research |
| Prof. Hikaru KOBAYASHI | Institute of Scientific and Industrial Research |
| Prof. Seiichi TAGAWA | Institute of Scientific and Industrial Research |
| Prof. Kazuhiko MATSUMOTO | Institute of Scientific and Industrial Research |
| Prof. Junichi TAKEYA | Institute of Scientific and Industrial Research |

# Nanofabrication Shop

Director, Professor: Hidekazu TANAKA
Technical Staff: Kimiaki TANIHATA, Shouichi SAKAKIHARA,

## Outlines

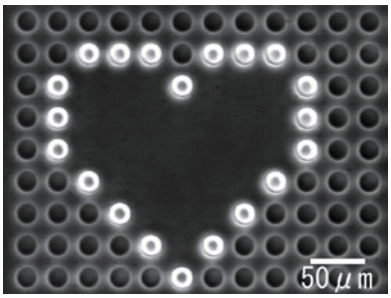
Nanofabrication Shop was established in order to promote nanotechnology-related research by use of equipments and special skills for nanotechnology researchers and students belonging to ISIR. In addition, this shop fabricates nano-devices for the ISIR researchers and develops devices for researchers who want to apply those devices for their own experiments.

## Achievements

In addition to conventional micro/nanofabrication, we carried out dry etching of a compound material by use of some gases combination and wet etching of a thick metal plate in 2010. These were new experience and made our skills expand. Though the number of requests had increased since 2005, it seems to reach to saturation number. The graph shows the number of clients and request.


### On demand fabrication requests

We have received requests from 10 laboratories in ISIR. Total number of their requests reached 86. Below figure shows an example of fabrication.




Water droplet array formed on a hydrophilic-in-hydrophobic patterned surface. A heart-mark formed by injection and suction.

### Participation in “nanotech 2011”

We demonstrated a offset printing chambers and showed a panel introducing our activity in the booth of Nanotechnology Center in the international nanotechnology exhibition and conference “nanotech 2011” which was held on 16th to 18th of February in 2011.

# Advanced Nanotechnology Instrument Laboratory

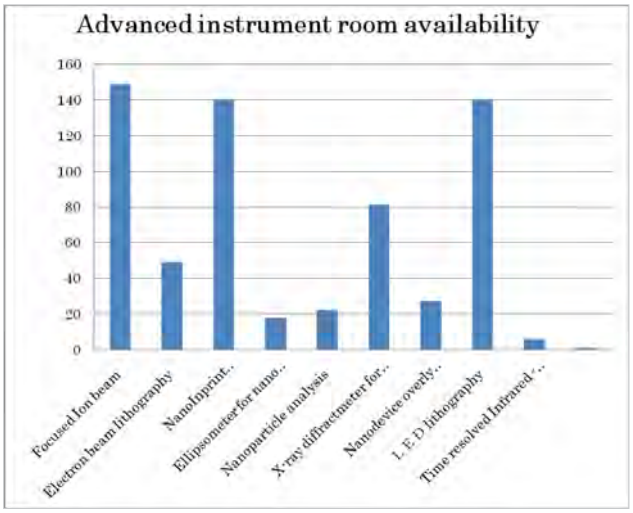
Director, Professor: Hidekazu TANAKA
Technical Staff: Michiko SAKUMA

## Outlines

Advanced Nanotechnology Instrument Laboratory has founded in the new Nanoscience and Nanotechnology center since 2009 in order to develop cutting edge researches on the nanoscience and nanotechnology. The fine nano-fabrication system based on electron beam lithography is installed at present to construct fine nano-structures. Within this fiscal year, the nano-device fabrication system and nano-device characterization systems on structure and electrical properties of nano device will be installed, and enable us to study various nano-materials and nano-devices composed of inorganic/ soft organic /bio materials. This laboratory will continuously develop and work to promote advanced Nanotechnology.

## Current Research Project

The right graph is summary of the used times of apparatuses in the laboratory. A total count of used times amounts to be 633. Especially focused Ion Beam , Nanoinprint , and LED lithography machines are frequently used for nanofabrication.




Lectures and Demonstrations
We held explanatory meeting for LED lithography - X-ray diffractmeter for nano-structured film , Ellipsometer for nano organic film evaluation and Time resolved Infrared - Terahertz spectrometer.

# Department of Handai Multi-Functional Nanofoundry

| | |
|---|---|
| Specially appointed Professor: | Tomoji KAWAI |
| Specially appointed Professor: | Seiichi TAGAWA |
| Professor: | Hedekazu TANAKA |
| Specially appointed Professor: | Hirotarou MORI |
| Professor: | Hidehiro YASUDA |
| Specially appointed researcher: | Akihiro OSHIMA |
| | Akira Kitajima |
| | Cong Que DINH (2011.2.1-) |
| Supporting staff | Masakazu MURASUGI |
| | Naomi YANAMORI |
| | Miki KASHIWAKURA |
| | Kouji HIGUCHI |
| | Keiko EMMI |

## Outlines

Handai Multi-Functional Nanofoundry was founded in Mission of Nanotechnology Network Japan, supported by Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. The purpose to start up the Nanofoundry is to establish a platform supporting Nanotechnology research and development, especially, for researchers outside of Osaka University. Nanofoundry started from April 2007, and our efforts resulted in supporting 105 research themes in 2010.

The Mission of Nanotechnology Network Japan was organized to respond to the requests that researchers belonging to pubic / private universities or companies hope to realize and to respond to researchers finding opportunity to use special facilities and equipments for their nanotechnology research and development program.

Institute of Science and Industrial Research (ISIR), Osaka University has played an important role in Nanotechnology fields by providing individual technologies and information. Our Nanofoundry supported lots of researchers inside / outside of Osaka University through “Nanofabrication”, “Molecular and thin film fabrication” and “Characterization & analysis”.

Focuses of Handai Multi-Functional Nanofoundry are shown below.

(1) Innovation by integrated and speedy nanotechnology support consisting of “Fabrication (top-down and bottom-up)”, “Observation and Measurement”.
(2) Creation of advanced interdisciplinary nanotechnology through integrated research and development of inorganic and organic materials, metals, semiconductor materials, and biomaterials.
(3) Fostering of scientists in the field of advanced interdisciplinary nanotechnology.

## Current Research Project

**Bring-up Handai Multi-Functional Nanofoundry**

The 105 research themes have been supported in this project in 2010. Considering they have been applied for by researchers in the universities, companies, and national institutes, we are able to see that Nanofoundry activates clearly nanotechnology field. Nanofoundry has been founded to support nanotechnology researchers through nanofabrication, molecular and thin film fabrication, characterization and analysis. These supports are divided into following four types. (a) Technical consulting, (b) Collaborative research, (c) equipment use, and (d) Technical substitution.

**Break-through toward Multi-functional Nanotechnology R&D**

Nanofoundry supports advanced nanotechnology research and development as well as fundamental study. The research on functional integration and system building based on nano scale materials is acceptable in the Nanofoundry.

**Fusion between Top-down and Bottom-up Nanotechnologies**

For top-down and bottom-up nanotechnologies, lots of useful equipment such as EB lithography system, FIB-CVD and PLD, and so on, are in operation. The fusion between top-down and bottom-up nanotechnologies will bring much important progress on nanotechnology in the near future.

# Comprehensive Analysis Center

| | |
|---|---|
| Professor Director: | Katsuaki SUGANUMA |
| Associate Professor: | Takeyuki SUZUKI |
| Assistant Professor: | Da-Yang ZHOU, Kaori ASANO |
| Specially AppointedAssistant Professor: | Mitsuko NISHINO |
| Technical Staff: | Takeshi ISHIBASHI, Takanori TANAKA, Tsuyoshi MATSUZAKI |
| Technical assistant Staff: | Yoshio TAKAI, Hitoshi HANEOKA |
| Support Staff: | Etsuko TANI |

## Outlines

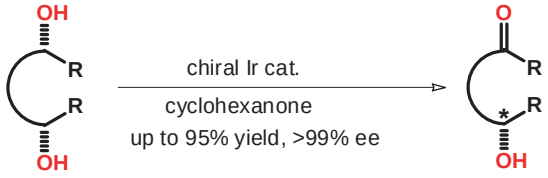
The Comprehensive Analysis Center was founded in 2009, whose project includes (1) analysis of samples provided from other research sections in ISIR and (2) original research for developing novel synthetic methods using a molecular catalyst.

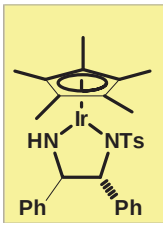
## Current Research Programs

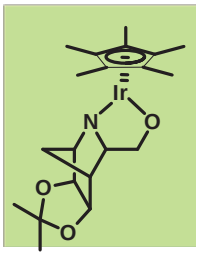
**Iridium-catalyzed oxidation: development and applications**

Development of catalytic reaction using clean oxidant is one of the most important themes in modern organic synthesis. In addition, desymmetrization of *meso* diols is the efficient methods for the synthesis of chiral building blocks. This time we have developed the catalytic asymmetric synthesis for the key intermediate of ottelione by using desymmetrization of *meso* diols, which exhibit prominent biological property such as antitumor activity. The appropriate selections of cooxidant, base, and protecting group are important to obtain high yield and selectivity in this reaction.

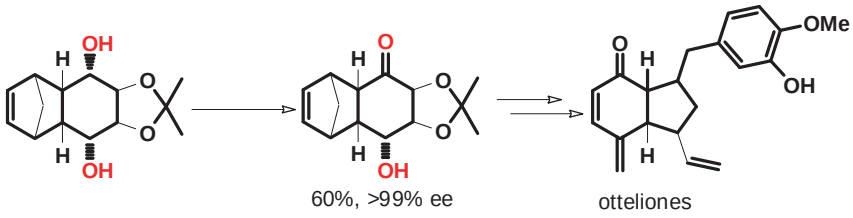
Oxidative desymmetrization of secondary diols




Formal total synthesis of otteliones



# Research Laboratory for Quantum Beam Science

Professor, Director: Yoichi YOSHIDA
Associate Professors: Yoshihide HONDA
Assistant Professors: Sachiko TOJO
Technical Staff: Tamotsu YAMAMOTO
Supporting Staff: Akira TOKUCHI, Kumiko KUBO (2010.4.1-2011.3.31)
(Concurrent members)
Professors Goro ISOYAMA, Tetsuro MAJIMA
Specially Appointed Professor: Seiichi TAGAWA
Associate Professors: Ryuko KATO, Mamoru FUJITSUKA, Takahiro KOZAWA, Kiyohiko KAWAI, Jinfeng YANG
Assistant Professors: Kazuo KOBAYASHI, Keigo KAWASE, Takafumi KONDO, Takashi TACHIKAWA, Nobuyasu NARUSE
Specially Appointed Assistant Professors: Akinori IRIZAWA, Hiroki YAMAMOTO, Kazuyuki ENOMOTO

## Outline

The Research Laboratory for Quantum Beam Science (RLQBS) was newly established in 2009 as a successor of Radiation Laboratory. All the facilities such as L-band linac and $^{60}$Co γ-ray irradiation facility were taken over. These are opened to users in Osaka University. Based on quantum beam science, frontier beam science relating to environmental material science, new energy sources and advanced medical technology as well as fundamental beam science are promoted with concurrent members. The management including operation, maintenance and the safety control of radiation related facilities are also conducted with the aid of concurrent members.

## Current Research Projects

**Facilities (L-band linac, S-band linac, RF-Gun S-band linac, $^{60}$Co γ-ray sources)**

L-band linac was operated for 197days, about 2,832 hours, for the use of research subjects. (Fig.1) Through the year, several troubles taken place in the SHPB system, the AVR system, the water-circulation system, the RF power splitter and the part of instrument managing system were repaired. Concerning 150 MeV S-band electron linac, the improvements of the modulator circuit and water circulation system were made. The new shielding was designed to protect the laser, which was used in RF-gun attached linac, against radiation hazard during the operation of 150 MeV linac. RF-gun attached S-band linac was operated for 53 days, about 712 hours, for the use of research subjects and also

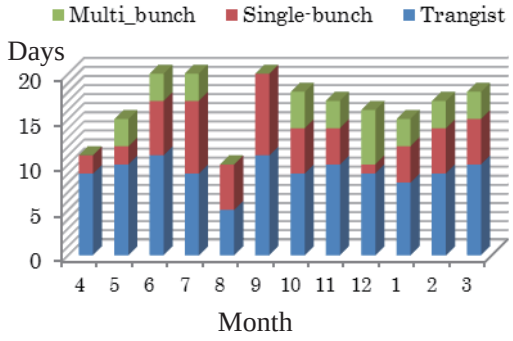



Fig.1 Progress of the operation days of L-band linac

operated for the new linac used for electron diffraction. Replacement of the capacitors was carried out and stable operation was able to be achieved. Cobalt-60 facility was used in 106 days, 2,545 hours, for 19 subjects, which were proposed not only by ISIR staffs but also by the member of other faculties, as shown in Fig.2. The air conditioner was equipped in the cage where the manipulators are equipped. Cleaning of the pool and the maintenance of lifter were performed.

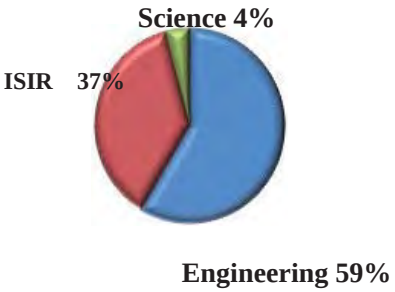



Fig.2 Usage rate of cobalt-60 among the faculties

**Management (Joint use & Radiation safety management)**

Accepted subjects relating to the facilities were 56 in total. Specially programmed meetings were held three times and the annual briefing session was held on March 11. More than 449 guests visited our laboratory. About radiation safety management, the educational and training courses were opened to the new users in May. The special signs relating to unsealed radioisotopes and RI filters were removed. Regulation on prevention of radiation hazard of the ISIR was renewed. Special inspection for the new 3 MeV linac was made in May. Unregistered isotope, which was found two years ago, was handed over to Radioisotope association. Transportation of the new cobalt-60 source was postponed until April 7 because of the aftereffect of catastrophic earthquake on Tohoku area.

**Analysis of degradation process in polymer electrolyte membrane**

The damage on the Nafion®117 due to the selected radicals which were produced separately was investigated mainly by solution analysis. The results showed that the location of scission was different between oxidative and reductive radicals, by taking into accounts of mole ratio of eluted carbon to sulfur (Table 1). The proton conductivity of the samples was not so different in the range less than 100 kGy, however, it was decreased significantly for the samples exposed to reductive radicals. These results showed that the reductive radicals affected membrane more seriously and caused the destruction of cluster structure.

Table 1. Mole ratio of carbon to sulfur for the samples exposed to the different radicals and absorbed dose.

| | OH· | $O_2^{-}$· | H· |
|---|---|---|---|
| 10kGy | 2.5 | 4.1 | 5.7 |
| 50kGy | 2.6 | 6 | 5.4 |
| 100kGy | 2.7 | 5.1 | 5.9 |
| 1 MGy | 1.5 | 7.1 | 7.1 |

**Formation and reactivities direct or indirect oxidation of aromatic sulfide in Nafion Membranes during pulse radiolysis.**

Quantum beam induced chemistry of organic compounds based on radiation-induced chemistry has been studied using electron beam and γ-ray. This year, we investigated the formation and reactivities of radical cations of aromatic sulfides included inside Nafion membranes using a pulse radiolysis technique. We have successfully generated the radical cation via direct or indirect oxidation in Nafion membranes.

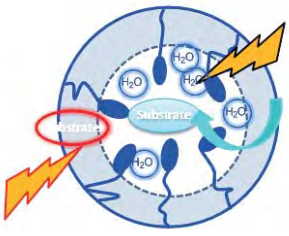



Fig.4 Direct or indirect oxidation in Nafion membranes during pulse radiolysis

# Center for Collaborative Research Education and Training

| | |
|---|---|
| Director: | Professor Yoshio ASO |
| Head of Educational Affaires Board: | Professor Yoichi YOSHIDA |
| Board Members: | Associate Professor Yasuhiro MUKAIGAWA |
| | Assistant Professor Satoshi SASAKI |
| Head of International Affaires Board: | Professor Riichiro MIZOGUCHI |
| Board Members: | Associate Professor Mamoru FUJITSUKA |
| | Associate Professor Koun SHIRAI |

## Outlines

One of the unique features of ISIR is that students from the six graduated schools in Osaka Univ. gathered together to carry out their research studies in the institute. To provide multidisciplinary education programs for them, the Center for Research Education and Training was founded in April 2009.

The Center will promote various kind of educational programs for the students, such as teaching interdisciplinary sciences by integrating our multidisciplinary research fields, giving internship opportunities with companies, exchanging students with foreign universities/research institutes and giving opportunities to acquire technical skills beyond their own research discipline.

# International Collaboration Center

## Outline

ISIR has promoted international collaboration with various universities and institutions all over the world based on the agreements on the academic exchange programs with the institutions and universities and by establishing the ISIR Branches in the foreign counties and so on. To further promote and to continuously support such international exchange and collaborations, International Collaboration Center was founded in April 2009. The center consists of several collaborative laboratories, which are established between ISIR and the universities / institutions in the foreign counties. Currently, three collaborative laboratories are working. Researchers and students who belong to the collaborative research projects stay at a collaborative laboratory on each side and perform the collaborative research.

## ICT lab.

The School of Electronics Engineering and Computer Science, Peking University, and the Institute of Scientific and Industrial Research, Osaka University, have established a cooperative research laboratory on information and communication technology (ICT) between both institutions. The studies in ICT collaborative laboratory focus on computer vision and media processing including basic technologies and applications.

1. Range sensing and 3D reconstruction
2. Image segmentation and object detection
3. Human motion analysis and human recognition

## AMR lab.

College of Science and Technology (CST), Korea University (KU), Korea, and the Institute of Scientific and Industrial Research (ISIR), Osaka University, Japan, based on the agreement on academic exchange between CST and ISIR, established a collaborative laboratory on each side on advance materials research between both institutions.

1. Fast　energy and electron transfer of photoresponsible materials
2. Redox reactions of substituted carboranes
3. Solar light conversion materials

## PMR lab.

School of Environmental Science and Engineering/Deapartment of Chemical Engineering (SES/DCE), Pohang University of Science and Technology (POSTECH), Korea, and the Institute of Scientific and Industrial Research (ISIR), Osaka University,

Japan, based on the agreement on academic exchange between SES/DCE and ISIR, established a collaborative laboratory on each side on photoresponsible materials research between both institutions.

1. $TiO_2$ photocatalysts
2. Visible-light resposible photocatalysts
3. Artificial photosynthesis by photocatalysts

## ESS lab.

In order to stimulate collaboration on the photo-induced structural changes of solid surfaces from both theoretical and experimental approaches, ISIR has had one post-doctoral researcher, who stayed at UCL to perform theoretical investigation on the following topics:

1. Photoinduced structural phase transition of Graphite
2. The first principle calculation of electronic structures of Si surfaces
3. Theoretical methodology of the first-principle excited-state molecular dynamics

# Nano-Macro Materials, Devices and System Research Alliance

## Outline

"Nano-Macro Materials, Devices and System Research Alliance" was started to attempt strategic development of "Materials, Devices, System" as a cooperative research project with Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Research Institute for Electronic Science, Hokkaido University, Chemical Resources Laboratory, Tokyo Institute of Technology, and Institute for Materials Chemistry and Engineering, Kyushu University in fiscal year 2010. This alliance consists of four research groups; (1) Next generation electronics research group, (2) New energy harvesting materials and devices research group, (3) Medical treatment materials and devices research group, and (4) Environmental harmonized materials and devices research group. The collaborative research alliance through interuniversity research institutes aims to develop innovative materials and devices by linking between nano and macroscopic worlds, toward realization of safety and secure society.

The Nano-Macro Materials, Devices and System Research Alliance was being run under the Steering Committee of 5 member Institutes. The Committee members from ISIR were Prof. H. Asahi (Chair), Prof. A. Yamaguchi, and Prof. H. Tanaka. The members of this Nano-Macro Materials, Devices and System Research Alliance from ISIR were as follows.

(1) Next generation electronics research group
Prof. K. Matsumoto (Group Leader), Prof. H. Asahi, Prof. H. Tanaka, Prof. J. Takeya, Prof. T. Washio, Prof. Y. Ando, Prof. Y. Aso, Prof. Oguchi

(2) New energy harvesting materials and devices research group
Prof. H. Kobayashi (Group Leader), Prof. M. Numao, Prof. K. Tanimura, Prof. K. Suganuma, Prof. S. Takeda, Assoc. Prof. Y. Honda, Assoc. Prof. T. Suzuki

(3) Medical treatment materials and devices research group
Prof. K. Nakatani (Group Leader), Prof. Y. Yagi, Prof. R. Mizoguchi, Prof. N. Kato, Prof. K. Tanizawa, Prof. A. Yamaguchi

(4) Environmental harmonized materials and devices research group
Prof. Y. Yoshida (Group Leader), Prof. H. Nakajima, Prof. T. Majima, Prof. H. Sasai, Prof. G. Isoyama

## Achievements

- Crystal Growth and Properties of Diluted Magnetic Semiconductors
- Ultrafast Carrier Dynamics on Semiconductor Surfaces Studied by Time-Resolved Two-photon Photoemission Spectroscopy
- Development of a New Method of Pinpoint Gene and Drug Delivery Systems Using Bionanocapsule Derived from Hepatitis B Virus Surface Antigen L Protein
- Development of New Method for an Efficient Synthesis of Spiro Bis(triazole) Derivatives and Their Applications to Asymmetric Catalysis

# New Next generation electronics Research Group

Professors: Kazuhiko MATSUMOTO (Group Leader),
Hajime ASAHI, Yoshio ASO, Hidekazu TANAKA, Youichi ANDO, Jun TAKEYA, Tamio OGUCHI, Takashi WASHIO

## Outline

New functional nano-electronics research group treated mainly the semiconductor and their material characteristics, physical evaluation, device performance, etc. are analyzed in details as follows:

The Synthesis and development of III-nitride semiconductor-based room temperature transparent ferromagnetic semiconductors with strong photoemission properties and their application to novel semiconductor nano-spintronics device fabrications were conducted. (Asahi)

Using the carbon nanotube as a treating material, the quantum functional device, field effect transistor, new nanomemory, FET type bio sensor, electrochemical biosensor are developed. Also, the fundamental growth process, such as a chirality control, growth directoin control are investigated. The research of graphene bio sensor is the newly developed (Matsumoto).

Our research is based on the design and synthesis of nano-scale pi-conjugated molecular materials for molecular electronics. We have focused our research on the development and evaluation of functionalized molecular wires and metal-electrode-anchoring units applicable to molecular electronic devices. (Aso)

Enhancement of spin polarization was observed in a transition metal oxide $(Fe,Zn)_3O_4$/Nb-$SrTiO_3$ ferromagnetic nanodot Schottky diode. The highly integrated oxide nanodot diodes were constructed using nanoimprint lithography based on a Mo lift-off method in combination with a pulsed laser deposition technique. (Tanaka)

To develop innovative device principles to utilize novel quantum functionalities, we are studying topological insulators and topological superconductors using high-quality single crystals and top-notch measurements of basic physical properties. This year, we have elucidated the quantum transport properties of topological insulators and discovered a couple of new topological-insulator materials showing superior properties. (Ando)

A new method of fabricating crystalline organic semiconductor films is developed. Unprecedentedly high carrier mobility exceeding 10 $cm^2/Vs$ is achieved for solution-processed organic transistors (Takeya).

Magnetic crystalline anisotropy is one of the key ingredients in magnetic memory devices. We have calculated the magnetic anisotropy energy for several magnetic multilayer systems by means of a first-principles approach and investigated the electronic mechanisms to realize large anisotropy. (Oguchi)

An estimation method to separate quantum states into invariant and variant components under condition changes in quantum experiments is developed. (Washio)

## Current Research Projects

### Crystal Growth and Properties of Diluted Magnetic Semiconductors

Aiming at realization of long wavelength emission spintronic devices, InGaGdN/GaN multi-quantum well structures as well as Si co-doping were studied and enhancement of magnetization was observed, which suggests the carrier-mediated ferromagnetism. PL emission from the InGaGdN/GaN MQW LED structures was also observed.

### Carbon Nanotube Nano Memory

Owing to the small diameter of the carbon nanotube(CNT), the electric field concentration was induced around the nanotube. Therefore, we could get the higher electric field even at the lower applied voltage. Using this phenomena, CNT was surrounded by two dielectric layers of $Si_3N_4/SiO_2$ for the memory structure. For this carbon nanotube nanomemory, only 2V is necessary for the write in and read out process. This is 10 times smaller value than the conventional planar type memory. Using the smaller size of the device, single charge memory effect could be detected even at room temperature.

### Graphene Bio Sensor

Using the graphene as a channel of the FET, the bio sensor was first fabricated. In the solution, the electrical double layer works as an infinitesimally thin gate dielectric of ~2nm, the FET showed 34times higher transconductance than measured from the backgate electrode. Using these features, the BSA was introduced in to the solution, and the change of the drain current of the graphene FET was linearly proportional to the concentration of the BSA. Thus, the first graphene biosensor was successful fabricated. Furthermore, the surface of the grafene was chemically modified by the recepter and selective sensing of the bio-molecule becomes possible.

### Molecular electronic materials

We have developed tetraphenylmethane tripodal anchor units with variety functional groups and phenylene-ethynylene molecular wires with anchoring units on the both terminal ends. The investigation of the monolayers of newly synthesized tripodal compounds with pyridyl and amino groups on a gold electrode indicates that functional groups having weak adsorption nature can be also connected to gold electrodes by integrating into the tripodal structure. The phenylene-ethynylene compound with tripodal pyridyl anchors showed a good electrical conductivity on the STM break-junction measurement, and theoretical calculation predicted that the pyridyl anchor contributes pi-channel electric transport.

## Construction of transition metal oxide nano structured devices

We have constructed the highly integrated oxide nanodot diodes by nanoimprint

lithography based on a Mo lift-off method in combination with a pulsed laser deposition technique. The junction magnetoresistance of diodes increased as diode size increased. The spin polarization estimated from the thermionic emission model is enhanced from P = 0.74 in a conventional film to P = 0.89 in a nanodot diode whose size is 300 × 300 $nm^2$.

**Basic Research of Topological Insulators**

We have succeeded in observing the quantum oscillations coming from the peculiar metallic surface state of topological insulators, and discovered novel angular-dependent magnetoresistance oscillations. Also, we discovered a new ternary topological insulator $TlBiSe_2$ which possesses the largest bulk band gap among topological-insulator materials. Furthermore, we discovered that a new topological insulator, $Bi_2Te_2Se$, presents the highest bulk-insulating properties observed so far and hence is best suited for transport studies of the topological surface state.

**Solution-crystallized high-mobility organic transistors**

In the past, we developed organic single-crystal transistors using platelets of organic semiconductor crystals grown from vapor. Though the devices showed 10 times higher carrier mobility than that in common polycrystalline devices, their production routes were not suitable for industry. Here, a new method of crystallizing organic semiconductors directly on substrates has enabled forming high-performance organic transistors with the mobility exceeding 10 $cm^2/Vs$, which is the best value among solution-processed organic devices.

**Magnetic Anisotropy in Transition-Metal Multilayers**

It is well known that FePt with $L_{10}$-type crystal structure has relatively large magnetic crystalline anisotropy. In the present study, magnetic anisotropy of CoPt in addition to FePt is estimated by a first-principles calculation and its microscopic mechanisms are analyzed. It is found that in CoPt, $L_{11}$-type structure realized by changing the layer stacking from [001] to [111] has large magnetic anisotropy comparable with that of $L_{10}$-type FePt.

**An estimation method of Quantum States for Quantum Experiments**

Devices for quantum information processing have potential power enabling revolutional information processing. Quantum states satisfy a mathematical property named positive semidefinite. This study aims to develop an estimation method to separate quantum states into invariant and variant components under condition changes in quantum experiments. We obtained its world's first theoretical framework. Results of quantum experiments are known to satisfy a mathematical property named positive semi-definiteness due to their background physical nature. This study worked on the development of a method and its algorithm to derive the accurate estimation from the large scale and complex experimental results based on the mathematical property. As a consequence, the feasibility of the accurate estimation by using projection of the large scale experimental results to high dimensional data space has been clarified.

# New Energy Material・Devices Research Group

Professors: Hikaru KOBAYASHI (Group Leader), Katsuaki SUGANUMA, Katsumi TANIMURA, Seiji TAKEDA, Masayuki NUMAO, Tateyuki SUZUKI, Yoshihide HONDA

## Outline

Using silver nanowires, transparent electrodes with high transparency and high conductivity as much as ITO were fabricated under the room temperatures. Moreover, Their flexibility is much higher than that of ITO electrodes. (Suganuma)

We study the dynamics of photogenerated carriers on semiconductor surfaces and interfaces by means of time-resolved two-photon photoemission spectroscopy with fs temporal resolution. We aim to reveal dynamical aspects of hot-carrier relaxation in the processes of light-to-energy conversion of semiconductor devices. (Tanimura)

Using environmental transmission electron microscopy that allows us to observe various dynamic phenomena in-situ, we have studied the catalytic mechanism of Au and Pt nanoparticle catalysts supported on oxides. (Takeda)

Towards constructing a fundamental technology for clarification of physical degradation and/or monitoring system of fuel cells, we develop the intelligent damage evaluation methodology based on data mining technique. (Numao)

The energy saving and environmentally benign process using transition metal catalysis is one of the most fundamental technologies. The efficient synthesis of chiral building blocks was developed by the oxidative desymmetrization. (Suzuki)

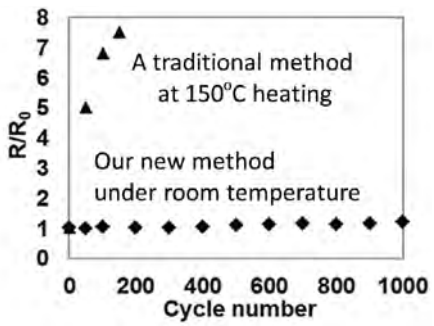
Radical-induced reactions in polymer electrolyte membrane for fuel cell, has been studied with the aids of several techniques such as gamma-ray, electron beam, laser and positron along with pulse radiolysis system. (Honda)

A method to produce Si nanoparticles has been developed by use of ball mill powdering and photochemical dissolution. pn-junction can be produced using the fabricated Si nanoparticles. (Kobayashi)

### Current Research Projects

**Conductive electrodes for solar cell under low temperature processes**

Flexible transparent conductive electrodes are critical components for the future-coming electronic devices such as solar cells and organic light emitting diodes lightings. The sheet resistance of traditional silver nanowire electrodes considerably increased under heating after only 100 cycles of bending tests. In contrast, our



transparent electrodes fabricated at room temperature maintained their sheet resistances even after 1,000 cycles.

**Ultrafast Carrier Dynamics on Semiconductor Surfaces Studied by Time-Resolved Two-photon Photoemission Spectroscopy**

The dynamics of photoinjected hot-holes in the Si bulk valence band has been studied using 6-eV probe pulse of 90 fs temporal width. The photogenerated non-equilibrium distribution of holes is quasi-equilibrated with time constant of 180 fs to form quasi-equilibrated hole distribution characterized with 1500 K effective temperature. The surface recombination processes are induced in later temporal domains till 100 ps.

**Temperature-dependent shape change of Pt nanoparticles during catalytic reaction**

We have found that the Pt nanoparticles supported on $CeO_2$ show temperature-dependent shape changes under realistic reaction conditions using environmental transmission electron microscopy. Based on a comparison between the shapes of the Pt nanoparticles in vacuum, $N_2$, $O_2$, CO, and CO/air, we propose that the change in shape of the Pt nanoparticles is induced by the adsorption of CO and O atoms.

**Inference of mechanical effects among structural members on fuel cells**

In order to infer mechanical effects of structural members on Solid Oxide Fuel Cell (SOFC), we proposed the algorithm that extracts frequently occurring damage patterns from a sequence of Acoustic Emission events of damage observation. We applied the proposed method to the damage test data of SOFC, and revealed that initial small cracks and contraction of the glass seal significantly affect to the total fracture process.

**Synthesis of ottelione using iridium-catalyzed oxidative desymmetrization**

A catalytic asymmetric synthesis of a key intermediate for ottelione has been achieved using oxidative desymmetrization as the critical step. This oxidative desymmetrization was efficiently promoted by an iridium diamine complex to give the desired hydroxy ketone in >99% ee and 60% yield.

**Study of radical reactions in polymer electrolyte membrane with pulse radiolysis**

Quantum beam induced chemistry of organic compounds based on radiation-induced chemistry has been studied using electron beam and γ-ray. This year, we investigated the formation and reactivities of radical cations of aromatic sulfides included inside Nafion membranes using a pulse radiolysis technique. We have successfully generated the radical cation via direct or indirect oxidation in Nafion membranes.

**Solar cells using Si nanoparticles**

Si nanoparticles with diameter in the range between 2 and 6 nm could be produced by use of ball mill powdering and chemical dissolution methods. The fabricated Si nanoparticles possess a broad photoluminescence peak, indicating band-gap broadening due to the quantum size effect. The p-type Si nanoparticles/n-type crystalline Si structure shows good rectifying behavior.

# Medical Treatment Materials, Devices, and System Research Group

Professors: Kazuhiko NAKATANI (Group Leader),
Yasuhi YAGI, Riichiro MIZOGUCHI, Nobuo KATO,
Katsuyuki TANIZAWA, Akihito YAMAGUCHI

## Outline

This research group focused attention on development of gene/drug delivery system, fluorescent labeling of proteins, an imaging device with polyhedral mirror, gene detection method and system, bioactive substances transporter, and a tool for describing human activity.

The bionanocapsule that can deliver drugs and genes to a specific organ or tissue has been developed and applied to gene/drug delivery systems. (Tanizawa)

The fluorescent labelling of 14-3-3 proteins, which have important roles in intracellular signal transductions as adapter proteins, has been achieved by use of a chemical probe derived from a natural diterpene glucoside. (Kato)

To clearly visualize a particular depth in a 3-D scene, an imaging device using a polyhedral mirror circumscribed in an ellipsoid was designed. By using the device, shallow depth-of-field imaging was realized. (Yagi)

A tool for describing human activity was developed. On the basis of positive reactions of its informal evaluation, we made an experimental plan for its evaluation of the tool by applying it to description of the guideline for emergency patients at Miki City Hospital. (Mizoguchi)

Sphingosine 1-phosphate transporter, SPNS2 was identified as an essential factor for spatial regulation of the novel class of immunosuppressive drug, FTY720. (Yamaguchi)

By optimizing the length and sequence of competitor primers, we have achieved the exceptionally high allele specificity with hairpin primer PCR method. (Nakatani)

## Current Research Projects

**Development of a New Method of Pinpoint Gene and Drug Delivery Systems Using Bionanocapsule Derived from Hepatitis B Virus Surface Antigen L Protein**

Bio-nanocapsule (BNC) is a virus-like empty nanoparticle made of phospholipids and envelope proteins derived from hepatitis B virus. Since it does not contain viral genome, BNC is nontoxic to cells *in vitro* and safe *in vivo* especially to humans when used as vaccines. BNC is now being developed as a novel drug delivery vector capable of specific delivery of genes, proteins, and pharmaceutical drugs to human hepatocytes with high efficacy. BNC potentially alters its target specificity when the PreS1 region is replaced with an appropriate bio-recognition molecule such as homing peptides, cytokines, and antibodies specific to cell surface proteins. (Tanizawa)

**Phosphopeptide-dependent fluorescent labelling of 14-3-3ζ protein by fusicoccins**

14-3-3 proteins play a crucial role in regulation of Ser/Thr kinase-dependent signalling pathways through protein-protein interactions. Recent our synthetic effort on the 14-3-3 binding natural product, fusicoccin, has led to a promising anticancer agent ISIR-042. In this study, we have successfully achieved phosphopeptide ligand-dependent fluorescent labelling of 14-3-3ζ isoform as well as detecting human endogenous 14-3-3 in cancer cells by a cell permeable chemical probe derived from ISIR-042. (Kato)

**Shallow DOF imaging by hemispherical synthetic aperture**

We have designed an imaging device using a polyhedral mirror circumscribed in an ellipsoid. By combining the polyhedral mirror with a camera, many virtual cameras are produced on a hemisphere with uniform density to synthesize a hemispherical aperture. Since this wide aperture realizes shallow depth-of-field imaging, a particular depth in the scene can be clearly observed. (Yagi)

**Development of a tool for describing human task-performing behaviors**

We developed a tool called CHARM for describing human behaviors. Its major features include computer-interpretable semantics, explicit representation of the purposes of actions and easy comparison among action-execution ways with explicit reasons of the way selection. It is now under evaluation of its utility in the Department of Nursing of Miki City Hospital. (Mizoguchi)

**Sphingosine 1-phosphate transporter, SPSN2 is functioning as an FTY720-P transporter (Yamaguchi)**

FTY720-P, phosphorylated form of FTY720, is an immunosuppressive drug and the first oral drug for treating inflammatory disease, multiple sclerosis. Secretion of FTY720-p from the cells following conversion of FTY720 to FTY720-P by sphingosine kinase 2 is essential for showing the effect of the drug through binding to the S1P receptor. We have successively shown that FTY720-P is secreted by the SPNS2 from the cells with common transport mechanism to that of the S1P.

**Development of Improved Hairpin Primer PCR Method (Nakatani)**

We have reported a new PCR technology using hairpin primer containing cytosine bulge named hairpin primer PCR as convenient and simple method for SNP typing. Hairpin primer PCR is one of variants of allele specific PCR methods, which need to be improved in terms of allele specificity. We have succeeded in improving the allele specificity by using competitor primer with hairpin primer. Having optimized the length and sequence of competitor primers, we have achieved the exceptionally high allele specificity.

# Environmental Harmonized Materials and Devices Research Group

Professors: Yoichi Yoshida (Group Leader),
Hideo NAKAJIMA, Tetsuro MAJIMA, Goro ISOYAMA,
Hiroaki SASAI

**Study of Environmental harmonized chemical reaction process by using quantum beam technology (YOSHIDA)**

Redox reaction of active species induced by quantum beam without using harmful oxidants or reductants is environmental friendly chemical reaction process. In order to clarify the formation process of active species which are very fast, femtosecond pulse radiolysis system was developed in ISIR. It was found that the pre-hydrated electron have reactivity of a magnitude higher than the hydrated electron. The excited radical cation which has high reactivity was found in n-dodecane, and observation of presolvated electron was succeeded in alkyl-ammonium ionic liquids as low environmental emission material. **Collaboration research projects:** The study was collaborated with the polymer hybrid nano-materials group in IMRAM,.

**Fabrication, Properties and Applications of Macro and Nano Porous Metals (NAKAJIMA)**

Mechanical properties of lotus-type porous metals with directional pores were investigated, which revealed that lotus iron exhibits superior impact energy absorption originating from the unidirectional pores. Furthermore, the fabrication process of nonporous oxide was investigated, which clarified that nano pores in amorphous oxides can be evolved through the structural relaxation in the amorphous thin films at high temperature. **Collaboration research projects:** Lotus iron ingots were fabricated by the continuous zone melting technique under hydrogen pressure of 2.5 MPa, using the world's highest purity (99.999mass%) iron, prepared in Issiki group (Institute of Multidisciplinary Research for Advanced Materials, Tohoku University) and commercial purity iron. It was concluded that, large pores are formed in the high purity iron, because the number of nucleation sites for the pore formation is small.

**Beam-induced Chemistry of Nanomaterials (MAJIMA)**

" Beam-induced Chemistry of Nanomaterials" based on photo- and radiation-induced chemistry of nanomaterials such as supramolecules, oligomers, polymers, DNA, proteins, metal oxides, semiconductors, and metals has been investigated from both basic and beam-functional points of view. We carried out the research projects such as .charge transfer in DNA, $TiO_2$ photocatalyst, energy and charge transfer in MOF, and dynamics of proteins and DNA. **Collaboration research projects:** We carried out the collaboration with the research group of Prof. Shinmyozu in Kyushu University where cyclophane compounds are synthesized. The $\gamma$ -radiolysis in the rigid matrix at 77 K and pulse radiolysis at room temperature were studied to discuss the intramolecular charge delocalization.

**Upgrade of a high intensity THz radiation source and its applications to research on environment-conscious materials (ISOYAMA)**

As a part of study to upgrade the high intensity THz radiation source based on free electron laser (FEL), we have developed a new method to measure the absolute length of the optical resonator of FEL, which has a significant influence on FEL operation, to an accuracy of 1 μm using a femto-second laser. We also have measured temporal development of the FEL power over the range of six orders of magnitude by changing the number of FEL amplifications. We are promoting improvement of the FEL beam line for application experiments of THz radiation. We have set up a system to obtain reflectivity of a sample by normalizing the measured intensity with the reference-light intensity and a focusing system of FEL light down to 1.3 mm (FWHM) using an off-axis parabolic mirror. **Collaboration research projects:** In order to find research groups for collaboration, we continue introducing our research activities at plenary meetings of the alliance and section meetings, and continue our deliberations on possibility of collaboration studies in the next year by studying research activities of other groups.

**Development of New Method for an Efficient Synthesis of Spiro Bis(triazole) Derivatives and Their Applications to Asymmetric Catalysis (SASAI)**

The spiro bis(triazole) derivatives were readily synthesized through intramolecular double azide cycloaddition with alkynes as a key step. The optically pure derivatives were obtained by separation with chiral stationary phase column. The spiro bis(triazole) derivatives could be converted to ionic liquids and *N*-heterocyclic carbenes which were known to serve as environmentally-benign media and organocatalysts, respectively. **ollaboration research projects:** e are trying to find novel utility of the spiro bis(triazole) derivatives through collaboration with the research group of Prof. Nagatsugi at Institute of Multidisciplinary Research for Advanced Materials in Tohoku University, who is a specialist in chemical biology.

# Activities of Facilities

# Workshop

Director Professor: Yasushi YAGI
Technical Staff
Machine Shop: Michiaki KAKUICHI, Masayoshi OHNISHI
Glassworks: Hiroaki MATSUKAWA, Noriyuki OGAWA

## Outline

A machine shop and a glass factory were set up at the same time when the Institute of Scientific and Industrial Research was founded. The machine shop and the glass factory were unified to be the Workshop when the Technical Division was established in 1982.

Since research fields studied in the institute covers a wide range, many of experimental apparatuses requested to the Workshop are various and novel. The Workshop, which consists of the Machine Shop and the Glassworks, plays an important role in activities of the institute and contributes to them by making and providing such experimental apparatuses.

The Machine Shop performs design and trial manufacture of experimental apparatuses for science and engineering as well as production of experimental tools made of various metals. Requests of experimental apparatuses for ultra high vacuum or ultra low temperature are increasing recently and accordingly we work in closer cooperation with researchers asking such apparatuses from the design phase to respond to the requests and make apparatuses best fit to experimental purposes. A gate-type machining center was introduced in 2002, and a CNC lathe was introduced in 2009, so that we can answer to advanced and difficult requests from researchers. A corner of the machine shop for joint-use, called an open shop, is attached and we coach researchers in technique properly.

The Glassworks performs design and trial manufacture of experimental tools and apparatuses made of various kinds of glass. We develop apparatuses necessary and suitable for experiments and we also devote ourselves to our studies and establishment of technique for improving functions of conventional apparatuses and for providing safer and easier-to-use apparatuses. Since we are recently asked to work with ceramics, we are trying to obtain machines for it. A CNC plain grinding machine was introduced in 2009, so that we can answer to advanced and difficult requests from researchers.

## Activities

We renewed a CNC plain grinding machine of the Glassworks. We also equipped with a CNC lathe. Moreover we equipped with peripheral devices and tools for the machining center for precise machining.

The members of the Workshop organized and participated in the national technical meeting and the symposium on glass works for all the engineers and technicians of universities and national laboratories in Japan.

**Number of jobs**

Machine Shop: 190 jobs (200 jobs in the previous year).
Glassworks: 144 jobs (145 jobs).

# Laboratory for Radio-isotope Experiments

Professor: Akihito YAMAGUCHI

## Outline

This laboratory is specially designed for biochemical and molecular biological experiments using the radioactive compounds labeled with $^{3}H$, $^{14}C$, $^{32}P$, $^{33}P$ or $^{35}S$. The main equipments are liquid scintillation counters and a bioimaging analyzer. Radioactive compounds are convenient tool for the research in the field of biochemistry, molecular biology, and cell biology. The use of radioisotopes is regulated with the national law for the prevention of radiation hazard. The facilities are inspected regularly with authorities and pass the required standard. Radioisotope users must attend the mandatory education program every year to get the knowledge for the safe use of radioisotopes.

Contributions of the facilities to the research projects are described in the section of each department

# Electronic Processing Laboratory

Professor: Hajime ASAHI
Associate Professor: Shigehiko HASEGAWA
Associate Professor: Takuya MATSUMOTO
Associate Professor: Koichi SUDOH
Associate Professor: Kenzo MAEHASHI
Assistant Professor: Yi-Kai ZHOU

## Outlines

Electronic Processing Laboratory was established as a sort of device fabrication work-shop in 1991. The aim of this laboratory is to contribute to the development of nanotechnology and related researches by setting up the equipment and systems for fabrication, required commonly for the researches related to the areas such as photonic and electronic materials, molecular device materials and organic device materials and by improving process technology for various device materials.

The equipment and systems are a small-size clean room, a double crystal X-ray diffractometer, an atomic force microscope, a digital optical microscope, a photolithography system, a sputter deposition system, a high vacuum evaporation system, an electron beam evaporation system, a reactive ion etching system, a focused ion beam system, a crystal cleaving system, a wire bonding system and personal computers for data analysis

This laboratory is utilized for experimental researches of surface structure analysis and electrode formation, for the measurements of electronic and other properties of various materials and also for the fabrication of photonic, electronic and molecular devices. Guidance to the users to the equipments and systems as well as the daily maintenance and repair of them were conducted. In the year of 2010, the equipment and systems were used about 150 times from 9 laboratories and facilities.

# Library

Professor: Hidekazu TANAKA
Commissioned Staff: Yasuko ONO
Supporting Staff: Kuniko HAMANAKA

## Outline

The ISIR Library houses technical books and journals for researchers. Most materials are on open shelves directly available to faculty and students. The library has a reading room with photocopiers on the second floor of the administration building.

The library office offers the following services; orders for books, survey and inquiry of literature, Interlibrary Loan services, photocopy request and so on.

Guide to the Library could be found on its home page (http://www.sanken.osaka-u.ac.jp/labs/lib-web/).

(As of March 31, 2011)

| | Number of books | Journals | Newspapers |
|---|---|---|---|
| Japanese | 8455 | 183titles | 4 titles |
| Foreign | 24587 | 565titles | 1 title |

# Office of Information Network

| | |
|---|---|
| Professor,Director: | Masayuki NUMAO |
| Professor: | Hidekazu TANAKA |
| Assistant Professor: | Koichi MORIYAMA |
| Assistant Professor: | Ryusuke NAKAMURA |
| Technical Staffs: | Takanori TANAKA, Senjin AIHARA, Yuka OKUMURA |
| Supporting Staff: | Miyuu SAKAMOTO |

## Outline

Office of Information Network was inaugurated in March, 1999, to organize the operation of the information network in ISIR, which had been started with support by volunteers, because of the rapid spread of the information network and the growth of its importance in the research environment. The information was constructed as a prototype by the departments in the division of Intelligent System Science in the late 1980's and has been expanded to the whole of ISIR with the development of ODINS (Osaka University Information Network System). Recently it has played an important role in ISIR to release/access the information available in the Internet. Office of Information Network is now supporting researchers and students in the variety areas.

## Activities

Office of Information Network have supported conference organizers by creating the web page, providing the on-line registration system, and broadcasting the conference. Total number of conferences was 14.

We produced the video “Introduction to I.S.I.R.”.

And we have offered poster printing services for ISIR researchers. Total number of poster printing was 527.

And we updated ISIR WEB pages. Total number of pages was 271.

And we issued ISIR CARD (access control card). Total number of issue was 330.

And we managed business servers (ex. Web, Mail, DNS, ..).

**Network Planning and Design**

Incubation Building

Administrative Building and Kusumoto Building

ODINS Wireless LAN

# Academia Industry Relations Office

| | |
|---|---|
| Director Professor: | Katsuaki SUGANUMA |
| Professors: | Kazuhiko MATSUMOTO, Hikaru KOBAYASHI |
| | Kazuhiko NAKATANI, Seiji TAKEDA |
| Specially Appointed Professor: | Hirokazu SHIMIZU |
| Research Fellow: | Seiichiro TAMAI |

## Outlines

The Academia Industry Relations Office (AIR Office) of the Institute of Scientific and Industrial Research (ISIR), is dedicated to reinforcing collaboration between ISIR and the industrial community, thereby combining and developing research potential of the two sectors and promoting activities for new industrial creation and innovation. The AIR Office organizes a variety of activities to inform the industrial community of the ISIR's research efficiently through the interaction with the industrial community such as SANKEN Techno Salon (four times a year) and various Lectures events, and studies on prediction of new industry, novel system of new Industry generation, and intellectual property.

The major activities of AIR Office are: 1) A network development between ISIR and Industry, 2) Responding to inquiries from industry, 3) A liaison between academia and industrial research activities, 4) Creation of complementary opportunities for science and technology progress. AIR Office will make proposals for new business opportunity between academia and industry. New venture business activities and novel industrial products are the vision of AIR Office.

## Activities

**Introduction of ISIR's research activities to industrial sector**

1) SANKEN Techno Salon: Quarterly seminar and get-together (May 7, Sep.3, Nov.12, 2010 and Feb.4, 2011)
2) Introduction of new technologies through WEB site
3) Publication of a booklet for introduction of ISIR's research activities
4) Technologies publicity at International Frontier Industrial Exhibition 2010 (Sep.9-10, 2010), Kansai Activation Fair (Nov.17-18, 2010) and International Nanotechnology Exhibition (Feb.16-18, 2011).

**Supporting Technology Transfer**

1) Study groups for the new industry generation
2) German/Japan 2nd Workshop on "Nanoanalytics", Feb.23, 2011
3) AIR-Office Seminar: "In-situ Microtribology with High Local Resolution," Innowep GmbH, Germany, April 1, 2010

**Interactive ISIR's Laboratory Tour**

1) Company group of Suita City, June 2, 2010
2) Korea Invention Promotion Association, Oct.26, 2010
3) Kyoto Electronic Packaging Technology Research Group, Feb.18, 2011

# Public Relations Office

Director, Professor: Yoshio ASO
Support Staff: Noriko MATSUMOTO, Naoko KAGITA (2010.8.- )

## Outlines

Public Relations Office was opened on February 1, 2006. We provide the right information of our Research Institute for the public effectively. The major activities of Public Relations Office are: 1) To collect any required file to generate the basic plan of the publicity, 2) To support editing and issue the Memoirs of ISIR (annual report) and publications, 3) To collect any required document for creating and editing of official WEB of ISIR, 4) To perform Press Release except the subjects related to the section of general affairs, 5) To collect and preserve of any press release related to ISIR.

# Technical Division

Head: Takeshi ISHIBASHI

## Outlines

The Technical Division was established in 1982 to deal with professional duties providing better service for researchers. In the ISIR organization, the technician group is independent of the management and the research groups. The organization was the first one among similar organizations established in the national universities of Japan. The Division consists of two groups: Group of Machine and Group of Measurement, in which each group has two sections: Section of Machine/Circuit, Section of Glass in Group of Machine and Section of Measurement/Information, Section of Analysis/Data in Group of Measurement. The technicians work at various places: the Comprehensive Analysis Center, the Workshop, the Office of Information Network, the Research Laboratory for Quantum Beam Science, and the Nanoscience and Nanotechnology Center. The Division gives not only high-quality service to research groups but technical training to the researchers and students. The annual report is published to help and encourage training and activities of the members of the Division. In addition, the Division has started the safety lecture for utilizing various machines in the ISIR since 2004. The Technical Division makes every effort to promote the ISIR more important development under an independent administration system.

## Administrative Office （31-March , 2011）

Director： Kazunari IWAKAWA

Facilities Planning Office

Staffs: Tomomi HIGASHIO
Aya NISHIDA

General Affairs Division

Staffs: Mitsuyoshi SHIRAHAMA
Masahito KAWAZOE
Akira KAMATANI
Manabu MAEDA

Supporting Staffs: Yukie YAMADA
Junko HANASHIMA
Mitsuru NISHISAKO
Sachiko MITSUMORI
Kazumi HAYASHI

Research Cooperation Division

Staffs: Katsumi UEDONO
Shigeo KASHIWAKURA
Kouichi YAMAMOTO
Hiroshi OKADA
Shizuo TSUNEISHI
Yuji SORIHASHI
Takayuki KOBAYASHI
Mutsuko TSUJI

Supporting Staffs: Hiroko YAMAUCHI
Yukako MORI
Mari KONISHI
Tamiko SHINDE
Kumiko TERADA
Mayuko TSUDA
Shigeo NAGAOKA
Miho YAGI

# List of Achievements

## Department of Photonic and Electronic Materials

### Original Papers

[1]Local-orbital ordering on Cr3+ ions doped in GaN, S. Emura, S. Kimura, K. Tokuda, Y.K. Zhou, S. Hasegawa and H Asahi: AIP Conf. Proc. Ser., 1199 (2010) 417-418.

[2]The third magnetic phase of GaGdN detected by SX-MCD, M. Takahashi, Y. Hiromura, S. Emura, T. Nakamura Y.K. Zhou, S. Hasegawa and H Asahi: AIP Conf. Proc. Ser., 1199 (2010) 411-412.

[3]Annealing effect in GaDyN on optical and magnetic properties, Y.K Zhou, M. Takahashi, S. Emura, S. Hasegawa and H. Asahi: Journal of Superconductivity and Novel Magnetism, 23 (2010) 103-105.

[4]Ultra-low turn-on field from ultra-long ZnO nanowire arrays emitters, Gang Meng, Xiaodong Fang, Yikai Zhou, JongUk Seo, Weiwei Dong, Shigehiko Hasegawa, Hajime Asahi, Hiroyuki Tambo, Mingguang Kong and Liang Li: Jounal of Alloys and Compounds, 491 (2010) 72-76.

[5]Magnetic properties of GaGdN studied by SQUID and SX-MCD, M. Takahashi, Y.K. Zhou, S. Emura, T. Nakamura, S. Hasegawa, and H Asahi: Journal of Superconductivity and Novel Magnetism, 23 (2010) 107-109.

[6]Growth and characterization of TlInGaAsN/TlGaAsN triple quantum wells on GaAs substrates, K.M. Kim, Y. Sakai, D. Krishnamurthy, S. Hasegawa and H. Asahi: Proceedings of the 22nd International Conference on Indium Phosphide and Related Materials, (2010) 469-472.

[7]Selective area growth of InP on nano-patterned SiO2/Si(100) substrates by molecular beam epitaxy, S. Hasegawa, A. Yamano, N.S. Ahn, N.G. Cha, T. Kanki, H. Tanaka and H. Asahi: Proceedings of the 22nd International Conference on Indium Phosphide and Related Materials, (2010) 228-231.

[8]Structural and magnetic properties of GaGdN/GaN superlattice structures, Y.K. Zhou, S.W. Choi, S. Kimura, S. Emura, S. Hasegawa and H. Asahi: Thin Solid Films, 518 (2010) 5659-5661.

[9]Growth and photoluminescence properties of TlInGaAsN/TlGaAsN triple quantum wells, K.M. Kim, S. Emura, D. Krishnamurthy, S. Hasegawa and H. Asahi: J. Appl. Phys., 108 (2010) 053501-1 – 053501-6.

[10]Effect of barrier layer composition and thickness on structural and optical properties of TlInGaAsN/TlGaAs(N) triple quantum wells, K.M. Kim, D. Krishnamurthy, Y. Sakai, J.U. Seo, S. Hasegawa and H. Asahi: J. Mater. Sci.: Mater. Electron., 21 (2010) 1024-1029.

[11]Characterization of InGaGdN layers prepared by molecular beam epitaxy, S.N.M. Tawil, R. Kakimi, D. Krishnamurthy, M. Ishimaru, S. Emura, H. Tambo, S. Hasegawa and H. Asahi: Phys. Stat. Sol. Rap. Res. Lett., 4 (11) (2010) 308-310.

[12]Combination of short-range periodicity and interfacial stress effects on vanlence band scheme in strained MQW (GaN/AlGaN)n, S. Emura, H. Tani, M. Kin, Y.K. Zhou, S. Hasegawa and H. Asahi: Phys. Stat. Sol. C, 7 (2010) 1919-1921.

[13]Local tunneling barrier height at and around subsurface dopant sites on p-GaAs(110), K. Kobayashi, S. Kurokawa, S. Hasegawa, and A. Sakai: Jpn. J. Appl. Phys., 49 (2010) 105201-1 – 105201-6.

[14]Photoluminescence and photoluminescence excitation spectra from AlN doped with Gd3+, K. Fukui, S. Sawai, T. Ito, S. Emura, T. Araki, and A. Suzuki: Phys. Status Solidi, C7 (2010) 131-135.

[15]Cu complex in silicon and its photoluminescence, K. Shirai, H. Yamaguchi, J. Ishisada, K. Matsukawa, A. Yanase, and S. Emura: AIP Conf. Proc., 1199 (2010) 91-92.

[16]A new metal-ion source with an electron-beam evaporator for surface modification, M. Nunogaki, S. Emura, A. Shigemoto, and S. Sugimoto: Rev. Sci. Instrum, 81 (2010) 043903-1 – 043903-4.

[17]Structures of the icosahedral clusters in Ni–Nb–Zr–H glassy alloys determined by first-principles molecular dynamics calculation and XAFS measurements, M. Fukuhara, N. Fujima, H. Oji, A. Inoue, and S. Emura: Journal of Alloys and Compounds, 497 (2010) 182–187.

[18]Correlation between local structure distortions and martensitic transformation in Ni-Mn-In alloys, D. N. Lobo, K. R. Priolkar, P. A. Bhobe, D. Krishnamurthy and S. Emura: Appl. Phys. Lett., 96 (2010) 232508-1 – 232508-3.

**International Conferences**

[1]Synthesis and Characterization of Gd-doped InGaN Thin Films and Superlattice Structure , S.N.M. Tawil, D. Krishnamurthy, R. Kakimi, M. Ishimaru, S. Emura, S. Hasegawa and H. Asahi: IEEE International NanoElectronics Conference (INEC 2010), Hong Kong, China, January 3-8, 2010.

[2]Studies on TlInGaAsN/TlGaAsN Triple Quantum Well Structures , K.M. Kim, Y. Sakai, D. Krishnamurthy, S. Hasegawa and H. Asahi: 13th SANKEN International Symposium, Osaka International Airport Conference Hall, Osaka, January 8, 2010.

[3]Studies on MBE grown Gd doped InGaN Epilayers and Superlattices for Applications in Longer Emitting Spintronics Devices , D. Krishnamurthy, S.N.M. Tawil, R. Kakimi, M. Ishimaru, S. Emura, S. Hasegawa and H. Asahi: 13th SANKEN International Symposium, Osaka International Airport Conference Hall, Osaka, January 8, 2010.

[4]MBE growth of GaGdN/AlGaN multiple quantum wells an their magnetic properties , S. Hasegawa, H. Tani, M. Kin, Y.K. Zhou and H. Asahi: 13th SANKEN International Symposium, Osaka International Airport Conference Hall, Osaka, January 8, 2010.

[5]Growth and characterization of TlInGaAsN/TlGaAsN triple quantum wells on GaAs substrates , K.M. Kim, Y. Sakai, D. Krishnamurthy, S. Hasegawa and H. Asahi: 22nd International Conference on Indium Phosphide and Related Materials, Takamatsu, Kagawa, Japan, May 31 – June 4, 2010.

[6]Selective area growth of InP on nano-patterned SiO2/Si(100) substrates by molecular beam epitaxy , S. Hasegawa, A. Yamano, N.S. Ahn, N.G. Cha, T. Kanki, H. Tanaka and H. Asahi: 22nd International Conference on Indium Phosphide and Related Materials, Takamatsu, Kagawa, Japan, May 31 – June 4, 2010.

[7]Structural and magnetic properties of diluted magnetic semiconductor GaGdN nanorods , H. Tambo, S. Hasegawa, K. Higashi, R. Kakimi, S.N.M. Tawil, Y.K. Zhou, S. Emura, H. Asahi: 37th International Symposium on Compound Semiconductor 2010 (ISCS2010), Takamatsu, Kagawa, Japan, May 31 - June 4, 2010.

[8]Co-ordination Alignments at the Vicinity of Dopant Cr Ions in AlN , S. Emura, S. Kimura, K. Tokuda, S. Hasegawa and H. Asahi: 37th International Symposium on Compound Semiconductor 2010 (ISCS2010), Takamatsu, Kagawa, Japan, May 31 - June 4, 2010.

[9]Influence of Si-doping on the Characteristics of InGaGdN/GaN MQWs Grown by MBE , S. N. M. Tawil, D. Krishnamurthy, R. Kakimi, M. Ishimaru, S. Emura, S. Hasegawa and H. Asahi: 37th International Symposium on Compound Semiconductor 2010 (ISCS2010), Takamatsu, Kagawa, Japan, May 31 - June 4, 2010.

[10]Enhanced Zeeman effect in GaGdN/AlGaN ferromagnetic semiconductor double quantum well superlattices , Y.K. Zhou, M. Almokhtar, H. Tani, H. Kubo, N. Mori, S. Emura, S. Hasegawa and H.

Asahi: 6th Handai Nanoscinece and Nanotechnology International Symposium, Osaka University, Osaka, June 1-2, 2010.

[11]Improvement in luminescence properties of TlInGaAsN/TlInP multi-layers grown by gas source molecular beam epitaxy , Y.K. Zhou, S. Nonoguchi, J.Q. Liu, Y. Tanaka, S. Hasegawa and H. Asahi: 6th Handai Nanoscinece and Nanotechnology International Symposium, Osaka University, Osaka, June 1-2, 2010.

[12]Magnetic property of Fe/Fe oxide core-shell clusters formed on GaN(0001) , T. Furuya, M. Sotani, H. Ichihara, S. Hasegawa and H. Asahi: 6th Handai Nanoscinece and Nanotechnology International Symposium, Osaka University, Osaka, June 1-2, 2010.

[13]Growth temperature dependence of Eu-doped GaN by organometallic vapor phase epitaxy , A. Nishikawa, T. Kawasaki, N. Furukawa, S. Anada, N. Woodward, V. Dierolf, S. Emura, H. Asahi, Y. Terai, and Y. Fujiwara: 6th Handai Nanoscinece and Nanotechnology International Symposium, Osaka University, Osaka, June 1-2, 2010.

[14]MBE growth and characterization of GaGdN/AlGaN magnetic semiconductor double quantum well superlattices , Y.K Zhou, M. Almokhtar, H. Tani, H. Kubo, N. Mori, S. Emura, S. Hasegawa and H. Asahi: 3rd International Symposium on Growth of III-Nitrides, Montpellier, France, July 4-8, 2010.

[15]Temperature dependence of photoluminescence peak energy in Ga(In)Nas , S. Emura, H. Nakamoto, F. Ishikawa, M. Kondow and H. Asahi: 30th International Conference on the Physics of Semiconductors, Seoul, Korea, July 25-30, 2010.

[16]Interfacial stress and thermal expansion effects for PL spectra in AlGaN/GaN MQW , S. Emura, H. Tani, H. Raebiger, Y.K. Zhou, S. Hasegawa and H. Asahi: 30th International Conference on the Physics of Semiconductors, Seoul, Korea, July 25-30, 2010.

[17]Enhanced magneto-optic effect in GaGdN/AlGaN ferromagnetic semiconductor double quantum well superlattices , Y.K Zhou, M. Almokhtar, H. Tani, H. Kubo, N. Mori, S. Emura, S. Hasegawa and H. Asahi: The 6th International Conference on the Physics and Applications of Spin Related Phenomena in Semiconductors, Tokyo, Japan, August 1-4, 2010.

[18]Naturally-Formed Nanoscale Phase Separation in Epitaxially-Grown III-V Semiconductor Alloys , M. Ishimaru, Y. Tanaka, S. Hasegawa, H. Asahi, K. Sato and T. J. Konno: Microscopy & Microanalysis 2010, Portland, Oregon, USA, August 1-5, 2010.

[19]Defect structure of MBE-grown GaCrN diluted magnetic semiconductor films , A. Yabuuchi, M. Maekawa, A. Kawasuso, S. Hasegawa, Y.K. Zhou and H. Asahi: 12th International Workshop on Slow Positron Beam Techniques, North Queensland, Australia, August 1-6, 2010.

[20]Studies on the InGaGdN/GaN magnetic semiconductor heterostructures grown by plasma-assisted molecular-beam epitaxy , S.N.M. Tawil, D. Krishnamurthy, R. Kakimi, S. Emura, S. Hasegawa and H. Asahi: 16th International Conference on Molecular Beam Epitaxy, Berlin, Germany, August 22-27, 2010.

[21]Low-temperature molecular beam epitaxy growth and properties of GaGdN nanorods , H. Tambo, H. Kameoka, Y.K. Zhou, S. Emura, S. Hasegawa and H. Asahi: 16th International Conference on Molecular Beam Epitaxy, Berlin, Germany, August 22-27, 2010.

[22]Large magneto-optical effect in low-temperature-grown GaDyN , Y. K. Zhou, S. Emura, S. Hasegawa and H. Asahi: International Workshop on Nitride semiconductors (IWN2010), Tampa, Florida, U.S.A., September 19 – 24, 2010.

[23]GaGdN/AlGaN multiple quantum disks grown by RF-plasma-assisted molecular-beam epitaxy , H. Tambo, S. Hasegawa, M. Uenaka, Y.K. Zhou, S. Emura and H. Asahi: International Workshop on Nitride semiconductors (IWN2010), Tampa, Florida, U.S.A., September 19 – 24, 2010.

[24]Magnetotransport properties in Gd-doped GaN grown by plasma-assisted molecular beam epitaxy , S. Hasegawa, M. Kin, D. Abe, K. Higashi, Y.K. Zhou and H. Asahi: International Workshop on Nitride semiconductors (IWN2010), Tampa, Florida, U.S.A., September 19 – 24, 2010.

[25]Reconsideration of Stress Effects in Nitride Semiconductors with Wurtzite Structure (P63mc) , S. Emura, K. Shirai and H. Asahi: International Workshop on Nitride semiconductors (IWN2010), Tampa, Florida, U.S.A., September 19 – 24, 2010.

[26]Structural characterization of MBE grown InGaGdN/GaN and InGaN/GaGdN superlattice structures , D. Krishnamurthy, S.N.M. Tawil, M. Ishimaru, S. Emura, Y.K. Zhou, S. Hasegawa and H. Asahi: International Workshop on Nitride semiconductors (IWN2010), Tampa, Florida, U.S.A., September 19 – 24, 2010.

[27]Growth and characterization of transition-metal and rare-earth doped III-nitride semiconductors for spintronics (invited), H. Asahi, S. Hasegawa, Y.K. Zhou and S. Emura: 2010 MRS Fall Meeting, Boston, USA, November 29-December 3, 2010.

[28]Transition-metal and rare-earth doped III-nitride semiconductors for nanospintronics (invited), H. Asahi, S. Hasegawa, Y.K. Zhou and S. Emura: International Workshop on Advanced Functional Nanomaterials, Chennai, India, February 21-24, 2011.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| H. ASAHI | 22nd International Conference on Indium Phosphide and Related Materials (International Steering Committee member) |
| H. ASAHI | 2010 International Conference on Solid State Devices and Materials (Program Committee member) |
| H. ASAHI | 18th International Colloquim on Scanning Probe Microscopy (Publication Committee member) |
| H. ASAHI | 3rd International Symposium on Growth of III-Nitrides （） (International Steering Committee member) |
| H. ASAHI | 16th International Conference on Molecular Beam Epitaxy (International Advisory Committee member) |
| H. ASAHI | 23rd International Conference on Indium Phosphide and Related Materials (International Advisory Committee member) |
| H. ASAHI | 17th International Conference on Molecular Beam Epitaxy (Organizing Committee Chair, Conference Chair, International Advisory Committee member) |
| H. ASAHI | Journal of Crystal Growth (Editor) |
| H. ASAHI | Current Applied Physics (Editorial Board member) |
| H. ASAHI | J. Materials Science: Materials in Electronics (Editorial Board member) |
| H. ASAHI | Journal of Ceramic Processing Research (Editor) |
| H. ASAHI | Journal of Physics: Condensed Matter (Advisory Editorial Board member) |
| H. ASAHI | e-Journal of Surface Science and Nanotechnology (Advisory Board member) |
| H. HASEGAWA | Second International Symposium on Growth of III-Nitrides (Financial Committee member) |
| H. HASEGAWA | 22th International Conference on Indium Phosphide and Related Materials (Program Committee member, Steering Committee member) |
| H. HASEGAWA | 14th International Conference on Modulated Semiconductor Structures (Local Arrangements Committee member) |
| H. HASEGAWA | 17th International Conference on Molecular Beam Epitaxy (General Affairs Chair) |
| S. EMURA | 18th International Conference on Molecular Beam Epitaxy (Steering Committee |

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|---|---|
| | member) |
| Y.K. ZHOU | 19th International Conference on Molecular Beam Epitaxy (Steering Committee member) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics | 21 papers |
| The Surface Science Society of Japan | 2 papers |
| Japanese Association for Crystal Growth | 1 paper |
| The Vacum Society of Japan | 1 paper |
| Electronic Materials Symposium | 2 papers |
| Japan Radioisotope Association | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Doctor Degree of Engineering<br>Takayuki HISAKA | Studies on the Degradation Mechanism and Improvement of AlGaAs/GaAs PHEMT under High Electric Field and High Moisture Atmosphere |
| Doctor Degree of Engineering<br>Masanobu HIROKI | Studies on the Crystal Growth of Nitride Semiconductor Hetero structures and their Field Effect Transistors |
| Doctor Degree of Engineering<br>Hiroyuki TAMBO | Studies on the Formation and Characterization of Diluted Magnetic Nitride Semiconductors |
| Doctor Degree of Engineering<br>Siti-Nooraya Mohd-Tawil | Studies on the Growth and Characterization of Rare-Earth Gd-Doped InGaN/GaN Magnetic Semiconductor Heterostructures |
| Doctor Degree of Engineering<br>KangMin KIM | Studies on the MBE Growth and Characterization of TlInGaAsN Quantum Well Structures |
| Master Degree of Engineering<br>Daijirou ABE | Characterization of Electrical and Magnetic Properties of Diluted Magnetic Semiconductor GaGdN |
| Master Degree of Engineering<br>Peng-Han FAN | Studies on the Low Temperature MBE Growth of Diluted Magnetic Semiconductor GaCrN and the Improvement of Magnetic Properties |
| Master Degree of Science<br>Takaaki FURUY | Growth Condition Dependence of Fe (110) Thin Film on GaN (0001) Substrate and its Band Theory Consideration toward Spin Injection |
| Bachelor Degree of Engineering<br>Satio KOMORI | Studies on the Improvement of Magnetic Properties of GaGdN and the Application to TMR devices |
| Bachelor Degree of Engineering<br>Ken YONEOKA | Formation and Characterization of Fe Nitride Thin Films on GaN (0001) Surface |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| H. Asahi | Study on Room Temperature Ferromagnetic Nitride Semiconductor Nanostructures and Application to Nanospintronics Devices | ¥5,200,000 |
| S. Hasegawa | Developments of spin-dependent ballistic electron emission microscopy and its application to spin injection into semiconductors | ¥2,700,000 |
| Y.K. Zhou | Study on control of magnetic properties in ferromagnetic nitride semiconductor nanostructures | ¥900,000 |
| H. Asahi | Study on Fabrication of InGaN-Based Long Wavelength Circular Polarized Semiconductor Lasers | ¥3,500,000 |
| H. Asahi | Development of properties and functionalities by precise control | ¥34,000,000 |

of rare-earth doping (Y. Fujiwara)

**Other Research Fund**

| | | |
|---|---|---|
| S. Hasegawa | Japan Science and Technology Agency | ¥2,000,000 |
| Kang-Min KIM | Marubun Research Promotion Foundation | ¥1,500,000 |

## Department of Semiconductor Electronics

**Original Papers**

[1]Improvement in Performance of Carbon Nanotube Field-Effect Transistors on Patterned SiO2/Si Substrates, K. Maehashi, S. Iwasaki, Y. Ohno, T. Kishimoto, K. Inoue and K. Matsumoto: J. Electron. Mater., 39 (4) (2010) 376-380.

[2]Dependence of sensitivity of biosensor for carbon nanotube field-effect transistor with top-gate structures, M. Abe, K. Murata and K. Matsumoto: J. Appl. Phys., 107 (8) (2010) 084504.

[3]Aligned Single-Walled Carbon Nanotube Arrays on Patterned SiO2/Si Substrates, K. Maehashi, S. Iwasaki, Y. Ohno, T. Kishimoto, K. Inoue and K. Matsumoto: Jpn. J. Appl. Phys., 49 (2010) 06GK01.

[4]Raman Scattering of Single-Walled Carbon Nanotubes in Early Growth Stages Using Laser-Irradiated Chemical Vapor Deposition, T. Tsuji, K. Inoue, Y. Ohno, K. Maehashi and K. Matsumoto: Jpn. J. Appl. Phys., 49 (2010) 06GJ03.

[5]Logic Gates Based on Carbon Nanotube Field-Effect Transistors with SiNx Passivation Films, T. Kishimoto, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: Jpn. J. Appl. Phys., 49 (2010) 06GG02.

[6]Single-Hole Charging and Discharging Phenomena in Carbon Nanotube Field-Effect-Transistor-Based Nonvolatile Memory, T. Ohori, S. Nagaso, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: Jpn. J. Appl. Phys., 49 (2010) 06GG13.

[7]Signal Enhancement Based on Stochastic Resonance in Carbon Nanotube Field-Effect Transistors, Y. Hakamata, Y. Ohno, K. Maehashi, S. Kasai, K. Inoue and K. Matsumoto: Proceeding of Fourth International Conference on Sensing Technology, (2010) 1-5.

[8]Highly Sensitive Electrical Detection of Chemical and Biological Molecules Based on Graphene Field-Effect Transistors, K. Maehashi, Y. Ohno and K. Matsumoto: Proceeding of Fourth International Conference on Sensing Technology, (2010) 325-328.

[9]Improving Faint-Signal Sensitivity of Electrolyte-Gated Carbon Nanotube Field-Effect Transistors Using External Noise, Y. Hakamata, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: Proceeding of 2010 IEEE Nanotechnology Materials and Devices Conference, (2010) 10-13.

[10]Single-Electron Memory Based on Floating-Gated Carbon Nanotube Field-Effect Transistors, T. Ohori, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: Proceeding of 2010 IEEE Nanotechnology Materials and Devices Conference, (2010) 300-303.

[11]Fabrication of High-Performance Voltage Inverters Based on Carbon Nanotube Field-Effect Transistors, K. Maehashi, T. Kishimoto, Y. Ohno, K. Inoue and K. Matsumoto: Proceeding of 2010 IEEE Nanotechnology Materials and Devices Conference, (2010) 343-346.

[12]Enhancement of weak-signal response based on stochastic resonance in carbon nanotube field-effect transistors, Y. Hakamata, Y. Ohno, K. Maehashi, S. Kasai, K. Inoue and K. Matsumoto: J. Appl. Phys., 108 (2010) 104313.

[13]Graphene field-effect transistors for label-free biological sensors, Y. Ohno, K. Maehashi and K. Matsumoto: Proceeding of 2010 IEEE Sensors Conference, (2010) 903-906.

[14]Chemical and biological sensing applications based on graphene field-effect transistors, Y. Ohno, K. Maehashi and K. Matsumoto: Biosens. Bioelectron., 26 (2010) 1727-1730.

[15]Label-Free Biosensors Based on Aptamer-Modified Graphene Field-Effect Transistors, Y. Ohno, K. Maehashi and K. Matsumoto: J. Am. Chem. Soc., 132 (2010) 18012-18013.

[16]Gate-Induced Cross-Over between Fabry–Perot Interference and Coulomb Blockade in a Single-Walled Carbon Nanotube Transistor with Double-Gate Structure, T. Kamimura and K. Matsumoto: Jpn. J. Appl. Phys., 50 (2011) 015101.

**International Conferences**

[1]Electrical detection of biomolecules based on graphene field-effect transistors (poster), Y. Ohno, K. Maehashi and K. Matsumoto: 20th Anniversary World Congress on Biosensors, Glasgow, UK, May 26-28, 2010.

[2]Graphene field-effect transistors for pH sensing (poster), Y. Sofue, Y. Ohno, K. Maehashi and K. Matsumoto: International Conference on Core Research and Engineering Science of Advanced Materials, Osaka, Japan, May 30 - June 4, 2010.

[3]Carbon nanotube single-electron transistors with nanogap electrodes using oxidized metal (poster), S. Okuda, T. Kishimoto, T. Ohori, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: International Conference on Core Research and Engineering Science of Advanced Materials, Osaka, Japan, May 30 - June 4, 2010.

[4]Improvement of Transfer Characteristics in CNTFETs with Au Nano-Clusters by Electrical Heating Process (poster), Y. Yamamoto, Y. Ohno, K. Maehashi and K. Matsumoto: The 34th International Symposium on Compound Semiconductors, Takamatsu, Japan, May 31 - June 4, 2010.

[5]Property transition from Single-Hole Transistor to Resonant Tunneling Transistor in a Single-Walled Carbon Nanotube Transistor with Double Gate Structure (poster), T. Kamimura and K. Matsumoto: The 34th International Symposium on Compound Semiconductors, Takamatsu, Japan, May 31 - June 4, 2010.

[6]Floating-Gated Carbon-Nanotube Memory with Dot Structures (poster), T. Ohori, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: The 34th International Symposium on Compound Semiconductors, Takamatsu, Japan, May 31 - June 4, 2010.

[7]Improvement in sensitivity of biosensor by Schottky barrier control carbon nanotube field effect transistor (oral), M. Abe, K. Murata, Y. Ohno and K. Matsumoto: The 34th International Symposium on Compound Semiconductors, Takamatsu, Japan, May 31 - June 4, 2010.

[8]Signal Enhancement Based on Stochastic Resonance in Carbon Nanotube Field-Effect Transistors (oral), Y. Hakamata, Y. Ohno, K. Maehashi, K. Inoue, S. Kasai and K. Matsumoto: The 4th International Conference on Sensing Technology, Lecce, Italy, June 3-5, 2010.

[9]Highly Sensitive Electrical Detection of Chemical and Biological Molecules Based on Graphene Field-Effect Transistors (oral), K. Maehashi, Y. Ohno and K. Matsumoto: The 4th International Conference on Sensing Technology, Lecce, Italy, June 3-5, 2010.

[10]Improvement of Transfer Characteristics in Carbon Nanotube Field-Effect Transistors with Au Nano Clusters (oral), Y. Yamamoto, Y. Ohno, K. Maehashi and K. Matsumoto: 52nd TMS Electronic Materials Conference, University of Notre Dame, USA, June 23-25, 2010.

[11]Carbon Nanotube Field-Effect Transistor Biosensor with Schottky Barrier Control Gate Electrode

(oral), M. Abe, K. Murata and K. Matsumoto: 52nd TMS Electronic Materials Conference, University of Notre Dame, USA, June 23-25, 2010.

[12]Label-Free Immunosensors Based on Aptamer-Modified Graphene Field-Effect Transistors (oral), Y. Ohno, K. Maehashi and K. Matsumoto: 2010 International Conference on Solid State Device and Materials, Tokyo, Japan, September 22-24, 2010.

[13]Improving Faint-Signal Sensitivity of Electrolyte-Gated Carbon Nanotube Field-Effect Transistors Using External Noise (oral), Y. Hakamata, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: 2010 IEEE Nanotechnology Materials and Device Conference, Monterey CA, USA, October 12-15, 2010.

[14]Single-Electron Memory Based on Floating-Gated Carbon Nanotube Field-Effect Transistors (oral), T. Ohori, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: 2010 IEEE Nanotechnology Materials and Device Conference, Monterey CA, USA, October 12-15, 2010.

[15]Fabrication of High-Performance Voltage Inverters Based on Carbon Nanotube Field-Effect Transistors (oral), K. Maehashi, T. Kishimoto, Y. Ohno, K. Inoue and K. Matsumoto: 2010 IEEE Nanotechnology Materials and Device Conference, Monterey CA, USA, October 12-15, 2010.

[16]Carbon Nanotube Nonvolatile Memory (oral), K. Matsumoto: AVS 57th International Symposium & Exhibition, Albuquerque Convention Center, NM, USA, October 17-22, 2010.

[17]Chemical- and Bio-sensors Based on Graphene Field-Effect Transistors (oral), Y. Ohno, K. Maehashi and K. Matsumoto: International Symposium on Graphene Devices: Technology, Physics, and Modeling, Sendai, Japan, October 27-29, 2010.

[18]Graphene field-effect transistors for label-free biological sensors (invited), Y. Ohno, K. Maehashi and K. Matsumoto: IEEE Sensors 2010 Conference, Hawaii, USA, November 1-4, 2010.

[19]Label-free Aptamer-Based Immunosensors using Graphene Field-Effect Transistors (oral), Y. Ohno, K. Meahashi, and K. Matsumoto: 23rd International Microprocesses and Nanotechnology Conference, Kokura, Japan, November 9-12, 2010.

[20]Enhancement of Small Signal based on Electrolyte-gated Carbon Nanotube Field-Effect Transistors in Subthreshold Regime (poster), Y. Hakamata, Y. Ohno, K. Maehashi, K. Inoue, and K. Matsumoto: 23rd International Microprocesses and Nanotechnology Conference, Kokura, Japan, November 9-12, 2010.

[21]Thickness Control of Graphene Overlayer via Layer-by-Layer Growth on Graphene Templates by Chemical Vapor Deposition (poster), R. Negishi, H. Hirano, Y. Kobayashi, Y. Ohno, K. Maehashi, and K. Matsumoto: 23rd International Microprocesses and Nanotechnology Conference, Kokura, Japan, November 9-12, 2010.

[22]Operation of Single-electron Memory using Floating-gated Carbon Nanotube Field-Effect Transistors (oral), T. Ohori, Y. Ohno, K. Maehashi, K. Inoue, and K. Matsumoto: 23rd International Microprocesses and Nanotechnology Conference, Kokura, Japan, November 9-12, 2010.

[23]Graphene Field-Effect Transistors for Chemical Sensors (oral), Y. Sofue, Y. Ohno, K. Maehashi, K. Inoue., and K. Matsumoto: 23rd International Microprocesses and Nanotechnology Conference, Kokura, Japan, November 9-12, 2010.

[24]Nanocarbon electronics and applications: Graphene and nanotube (oral), K. Matsumoto: 2010 International Chemical Congress of Pacific Basin Societies, Hawaii, USA, December 15-20, 2010.

[25]Na Ion-Cocentration Dependence of Transfer Characteristics of Graphene Field-Effect Transistors

(poster), Y. Sofue, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

[26]Improving the alignment of carbon nanotubes for high-density growth on quartz substrates (poster), S. Okuda, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

[27]Fabrication of Carbon Nanotube Field-Effect Transistors Based Nonvolatile Memory Using Atomic Layer Deposition (poster), Y. Fujii T. Ohori, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

[28]Synthesis of single-walled carbon nanotubes using laser-irradiated chemical vapor deposition (poster), K. Gumi, K. Inoue, Y. Ohno, K. Maehashi and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

[29]Carbon Nanotube Single-Electron Memory with Floating Nanodot Gate (poster), T. Ohori, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

[30]DNA sensors based on DNA-modified graphene field-effect transistors (poster), S. Okamoto, Y. Sofue, Y. Ohno, K. Maehashi, K. Inoue and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

[31]Solution pH sensor in noisy environment based on stochastic resonance in electrolyte-gated carbon nanotube transistors (poster), Y. Hakamata, Y. Ohno, K. Maehashi, K. Inoue, and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

[32]Generation of electronic band gap in bilayer graphene using ionic-liquid-gate (poster), Y. Yamashiro, Y. Ohno, K. Maehashi, K. Inoue, and K. Matsumoto: The 14th SANKEN International Symposium and the 9th SANKEN Nanotechnology Symposium, Otsu, Japan, January 25-26, 2011.

**Review Papers**

Sensing application based on graphene field-effect transistors, Y. Ohno (H. Horinaka), OYO BUTURI, The Japan Society of Applied Physics, 79[10] (2010), 223-228.

Highly sensitive biosensors based on nanocabon devices, K. Maehashi, Y. Ohno and K. Matsumoto, Molecular Electronics and Bioelectronics, The Japan Society of Applied Physics, 21[4] (2010), 223-228.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| K. MAEHASHI | 2010 International Conference on Solid State Device and Materials (Program Committee) |
| K. MAEHASHI | 23rd International Microprocesses and Nanotechnology Conference (Program Committee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics | 22 papers |
| IEEE Electron Devices Society Kansai Chapter | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree of Engineering<br>Y. Imai | Electric Properties of Carbon Nanotube FET with Ionic Liquid Gate |
| Master Degree of Engineering | Fabrication of Carbon Nanotube Single-Electron Mmemories with Floating Nano-gate |

| | |
|---|---|
| T. Ohori<br>Master Degree of Engineering | Weak Singnal Detection by Carbon Nanotube Transistors using Stochastic Resonance |
| Y. Hakamata<br>Master Degree of Engineering | Fabrication and Characterizaion of Graphene Nano-devices |
| Y. Yamashiro<br>Bachelor Degree of Engineering | Detection of DNA hybridization based on graphene field-effect transistors |
| S. Okamoto<br>Bachelor Degree of Engineering | Catalyst Formation and Growth of Single-Walled Carbon Nanotubes in the Laser-Irradiated Chemical Vapor Deposition |
| K. Gumi<br>Bachelor Degree of Engineering | Fabrication of Carbon-Nanotube Memory with High-k Dielectric |
| Y. Fujii | |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| K. MATSUMOTO | Carbon Nanotube-Biosensor | ¥18,400,000 |
| K. MATSUMOTO | Carbon Nanotube Nano-Electronics | ¥400,000 |
| Y.Yamamoto | Highly sensitive Label-free Multi-biosensors based on Carbon Nanotube Devices | ¥700,000 |
| Y. Onno | Biological sensors based on graphene field-effect transistors | ¥3,250,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| K.Matsumoto | Japan Science and Technology Agency (CREST) | Quantum nano devices by controlling quantum nano interface | ¥22,100,000 |

## Department of Advanced Electron Devices

**Original Papers**

[1]Low-temperature thermal conductivity of bulk and film-like rubrene single crystals, Y. Okada, M. Uno, Y. Nakazawa, K. Sasai, K. Matsukawa, M. Yoshimura, Y. Kitaoka, Y. Mori, and J. Takeya: Phys. Rev. B, 83 (2011) 113305.

[2]Linear- and Angular-Shaped Naphthodithiophenes: Selective Synthesis, Properties, and Application to Organic Field-Effect Transistors, S. Shinamura, I. Osaka, E. Miyazaki, A. Nakao, M. Yamagishi, J. Takeya, and K. Takimiya: J. Am. Chem. Soc., 133 (2011) 5024-5035.

[3]Optical pump-probe spectroscopy of photocarriers in rubrene single crystals, S. Tao, H. Matsuzaki, H. Uemura, H. Yada, T. Uemura, J. Takeya, T. Hasegawa, and H. Okamoto: Phys. Rev. B, 83 (2011) 75204.

[4]Patternable Solution-Crystallized Organic Transistors with High Charge Carrier Mobility, K. Nakayama, Y. Hirose, J. Soeda, M. Yoshizumi, T. Uemura, M. Uno, W. Li, M. Jin Kang, M. Yamagishi, Y. Okada, E. Miyazaki, Y. Nakazawa, A. Nakao, K. Takimiya, and J. Takeya: Adv. Mater., 23 (2011) 1626–1629.

[5]Microscopic mechanisms behind the high mobility in rubrene single-crystal transistors as revealed by field-induced electron spin resonance, K. Marumoto, N. Arai, H. Goto, M. Kijima, K. Murakami, Y. Tominari,J. Takeya, Y. Shimoi, H. Tanaka, S. Kuroda, T. Kaji, T. Nishikawa,T. Takenobu, and Y. Iwasa: Phys. Rev. B, 83 (2011) 75302.

[6]Three-dimensional organic field-effect transistors on plastic substrates: flexible transistors with very high output current, J. Takeya, M. Uno, and K. Nakayama,: Mater. Res. Soc. Symp. Proc., 1197 (2011)

D09.05.

[7]Air-stable and high-mobility organic thin-film transistors of poly(2,5-bis(2-thienyl)-3,6-dihexadecyltheino[3,2-b]thiophene) on low-surface-energy self-assembled monolayers, K. Nakayama, M. Uno, T. Nishikawa, Y. Nakazawa, and J. Takeya: Organic Electron., 11 (2010) 1620–1623.

[8]Polymorphs of rubrene crystal grown from solution, T. Matsukawa, M. Yoshimura, M. Uchiyama, M. Yamagishi, A. Nakao, Y. Takahashi, J. Takeya, Y. Kitaoka, Y. Mori, and T. Sasaki,: Jap. J. Appl. Phys., 49 (2010) 85502.

[9]Structure analysis of solution-crystallized 2,7-dioctylbenzothieno[3,2-b]benzothiophene thin films in very high-mobility transistors, J. Soeda, M. Yamagishi, Y. Hirose, T. Uemura, A. Nakao, Y. Nakazawa, S. Shinamura, K. Takimiya, and J. Takeya: Mater. Res. Soc. Symp. Proc., 1270 (2010) II09.79.

[10]Hall effect of solution-crystallized and vapor-deposited 2,7-dioctylbenzothieno[3,2-b]benzothiophene field-effect transistors, M. Yamagishi, T. Uemura, Y. Takatsuki, J. Soeda, Y. Okada, Y. Hirose, Y. Nakazawa, S. Shinamura, K. Takimiya, and J. Takeya: Mater. Res. Soc. Symp. Proc., 1270 (2010) II06.20.

[11]Monolithic Complementary Inverters Based on Intrinsic Semiconductors of Organic Single Crystals, T. Uemura, M. Yamagishi, Y. Okada, K. Nakayama, M. Yoshizumi, M. Uno, Y. Nakazawa, and J. Takeya: Mater. Res. Soc. Symp. Proc., 1270 (2010) II08.0.

[12]High-power Organic Field-effect Transistors Using a Three-dimensional Structure, M. Uno, Y. Hirose, K. Nakayama, T. Uemura, Y. Nakazawa, K. Takimiya, and J. Takeya: Mater. Res. Soc. Symp. Proc., 1270 (2010) II08.07.

[13]High-power and high-speed organic three-dimensional transistors with submicrometer channels, M. Uno, Y. Hirose, T. Uemura, K. Takimiya, Y. Nakazawa, and J. Takeya: Appl. Phys. Lett., 97 (2010) 13301.

[14]Free-electron-like Hall effect in high-mobility organic thin-film transistors, M. Yamagishi, J. Soeda, T. Uemura, Y. Okada, Y. Takatsuki, T. Nishikawa, Y. Nakazawa, I. Doi, K. Takimiya, and J. Takeya: Phys. Rev. B (Rapid Communications), 81 (2010) 161306.

[15]Monolithic complementary inverters based on organic single crystals, T. Uemura, M. Yamagishi, Y. Okada, K. Nakayama, M. Yoshizumi, M. Uno, and J. Takeya: Adv. Mater., 22 (2010) 3938-3941.

**International Conferences**

[1]Hall Effect and Charge Transport Mechanism in High-mobility Organic Transistors (oral), J. Takeya, T. Uemura, M. Yamagishi, Y. Okada, J. Soeda and Y. Nakazawa: 2010 MRS Fall Meeting.

[2]Air-stable Operation of High-mobility C60 TFTs with Organic/Inorganic Hybrid Encapsulations (oral), T. Uemura, K. Nakayama, M. Yoshizumi, Y. Nakazawa and J. Takeya: 2010 MRS Fall Meeting.

[3]Very high-performance printable organic crystal transistors (invited), J. Takeya: 7th Japanese-German Frontiers of Science Symposium.

[4]Three-dimensional organic field-effect transistors using solution-processed thin films of benzothieno-benzothiophene derivatives (poster), W. Li, M. Uno, Y. Hirose, T. Uemura, K. Takimiya, and J. Takeya: Korea-Japan Forum 2010.

[5]Solution-crystallized organic transistors (oral), J. Takeya: International Conference on Science and Technology of Synthetic Metals 2010.

[6]High-density carrier accumulation and anomalous field effect in rubrene single crystal transistors (poster), Y. Okada, Y. Takatsuki, M. Yamagishi, J. Soeda, T. Nishikawa, K. Miwa, M. Uno and J. Takaya: International Conference on Science and Technology of Synthetic Metals 2010.

[7]Hall effect in polycrystalline organic thin-film transistors (oral), T. Uemura, M. Yamagishi, Y. Okada, J. Soeda, Y. Takatsuki and J. Takeya: International Conference on Science and Technology of Synthetic Metals 2010.

[8]A method of measuring anisotropic conductivity in organic semiconductors with improved precision (oral), M. Uno, K. Miwa, M. Yamagishi, T. Uemura, and J. Takeya: International Conference on Science and Technology of Synthetic Metals 2010.

[9]Three-Dimensional Organic Field-Effect Transistors (invited), M.Uno, Y. Hirose, K. Nakayama, T. Uemura, J. Takeya: AM-FPD'10.

[10]Solution-crystalized organic TFTs (invited), J. Takeya: The 37th International Symposium on Compound Semiconductors.

[11]Monolithic complementary inverters based on intrinsic semiconductor properties of organic single crystals (oral), T. Uemura, M. Yamagishi, Y. Okada, M. Nakayama, M. Yoshizumi, M.Uno, J. Takeya: The 37th International Symposium on Compound Semiconductors.

[12]A method of measuring anisotropic conductivity in organic semiconductors with improved precision (poster), M. Uno, K. Miwa, M. Yamagishi, T. Uemura, and J. Takeya: International Symposium on Organic Transistors and Functional Interfaces (OFET2010).

[13]Monolithic complementary inverters based on organic single crystals (poster), T. Uemura, M. Yamagishi, Y. Okada, K. Nakayama, M. Yoshizumi, M Uno, and J. Takeya: International Symposium on Organic Transistors and Functional Interfaces (OFET2010).

[14]Hall effect in high-mobility solution-processed organic thin-film transistors (poster), T. Uemuraa, M. Yamagishi, Y. Okada, Y. Takatsuki, J. Soeda, Y. Nakazawa, S. Shinamura, K. Takimiya, and J. Takeya: International Symposium on Organic Transistors and Functional Interfaces (OFET2010).

[15]Hall effect and charge transport in various OFETs (invited), J. Takeya: International Symposium on Organic Transistors and Functional Interfaces (OFET2010).

[16]Structure Analysis of Solution-crystallized 2,7-Dioctylbenzothieno [3,2-b]Benzothiophene Thin Films for Very Highmobility Transistors. (poster), Junshi Soeda, Masakazu Yamagishi, Yuri Hirose, Takafumi Uemura, Akiko Nakao, Shoji Shinamura, Kazuo Takimiya and Jun Takeya: 2010 MRS Spring Meeting.

[17]Monolithic complementary inverters based on intrinsic semiconductors of organic single crystals. (oral), Takafumi Uemura and Jun Takeya: 2010 MRS Spring Meeting.

[18]High-power organic field-effect transistors using a three-dimensional structure. (oral), M. Uno, Y. Hirose, K. Nakayama, T. Uemura and Jun Takeya: 2010 MRS Spring Meeting.

[19]Electric field-effect in solution-crystallized organic semiconductors. (invited), Jun Takeya: 2010 MRS Spring Meeting.

[20]Polymer thin-film transistors with improved mobility and air stability. (poster), Kengo Nakayama, Mayumi Uno and Jun Takeya: 2010 MRS Spring Meeting.

[21]Hall effect of solution-crystallized and vapor-deposited 2,7-dioctylbenzothieno[3,2-b]benzothiophene field-effect transistors. (poster), Masakazu Yamagishi, Yuichi Takatsuki, Junshi Soeda, Yugo Okada, Yuri Hirose, Takafumi Uemura, Shoji Shinamura, Kazuo Takimiya and Jun Takeya: 2010 MRS Spring Meeting.

[22]Organic-inorganic hybrids: a route to ferromagnetic semiconductors. (poster), Anne H. Arkenbout, Takafumi Uemura, Jun Takeya, Auke Meetsma and Thomas Palstra: 2010 MRS Spring Meeting.

**Patents**

[1]Fabrication process of organic semiconductor films and film arrays J. Takeya, T. Uemura, PCT/JP2010/064488

**Contributions to International Conferences and Journals**

| | |
|---|---|
| J. Takeya | International Symposium on Organic Transistors and Functional Interfaces (OFET2010) (Organaizing Committtee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Physical Society od Japan Meeting | 2 papers |
| Society of Applied Physics Meeting | 5 papers |
| Science Summer Scool in Iitsuna | 1 paper |
| Electronic Materials Symposium | 1 paper |
| Printed Electronics Workshop | 1 paper |
| Seminar for Private Companies on Printed Electronics | 1 paper |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| J. Takeya | Functions and physics of organic single-crystal interfaces | ¥24,960,000 |
| J. Takeya | Charge dynamics at organic semiconductor interfaces | ¥1,170,000 |
| J. Takeya | Three-dimensional organic transistors | ¥2,210,000 |
| K. Sudoh | Dynamics at silicon surfaces | ¥1,950,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| J. Takeya | JST | Creating high-performance nanoscale interfaces with heterojunctions of organic single-crystal sheets | ¥6,000,000 |
| J. Takeya | JST | Elucidating electronic properties of polymers and organic crystals | ¥4,500,000 |
| J. Takeya | JST | Development of AM-TFTs and flexible displays based on printed new and high-performance polymer semiconductors | ¥20,000,000 |
| J. Takeya | NEDO | Innovative high-performance organic transistors and active matrices for thin display panels | ¥40,000,000 |

**Contribution to Research**

| | | |
|---|---|---|
| J. Takeya | STARC | ¥2,000,000 |
| J. Takeya | KOEI Chemical Co. | ¥500,000 |

**Cooperative Research**

| | | |
|---|---|---|
| J. Takeya | CRIEPI | ¥1,000,000 |
| J. Takeya | Chisso | ¥900,000 |
| J. Takeya | STARC | ¥6,500,000 |

## Department of Intelligent Media

**Original Papers**

[1]Clothing-invariant gait identification using part-based clothing categorization and adaptive weight control, Md. Altab Hossain, Yasushi Makihara, Junqiu Wang, and Yasushi Yagi: Pattern Recognition, 43 (6) (2010) 2281-2291.

[2]High Speed 3D Reconstruction Method from Dense Grid Pattern Using de Bruijn Sequence and Line Detection Technique Based on Belief-Propagation, Yuya OHTA, Toshihiro KAWASAKI, Ryusuke SAGAWA, Ryo FURUKAWA, Hiroshi KAWASAKI, Yasushi YAGI, and Naoyuki ASADA: The IEICE transactions on information and systems, J93-D (8) (2010) 1544-1554.

[3]Endoscopic Image Matching for Reconstructing the 3-D Structure of the Intestines, HIRAI Katsuhiro, KANAZAWA Yasushi, SAGAWA Ryusuke, and YAGI Yasushi: Medical Imaging Technology, 29 (1) (2011) 36-47.

**International Conferences**

[1]Visual tracking and segmentation using appearance and spatial information of patches, Junqiu Wang, *Yasushi Yagi: Proc. 2010 IEEE International Conference on Robotics and Automation, (2010) 4553-4558.

[2]Analysis of Light Transport in Scattering Media, *Y.Mukaigawa, Y.Yagi, R.Raskar: Proc. the 23rd IEEE Conference on Computer Vision and Pattern Recognition, (2010) .

[3]Silhouette Transformation based on Walking Speed for Gait Identification, Akira Tsuji, *Yasushi Makihara, Yasushi Yagi: Proc. the 23rd IEEE Conference on Computer Vision and Pattern Recognition, (2010) .

[4]Color Analysis for Segmenting Digestive Organs in VCE, *Hai Vu, Tomio Echigo, Keiko Yagi, Masatsugu Shiba, Kazuhide Higuchi, Tetsuo Arakawa, Yasushi Yagi: Proc. of the 20th Int. Conf. on Pattern Recognition, (2010) 2468-2471.

[5]How to Control Acceptance Threshold for Biometric Signatures with Different Confidence Values?, *Y. Makihara, M.A. Hossain, Y. Yagi: Proc. of the 20th Int. Conf. on Pattern Recognition, (2010) 1208-1211.

[6]Cluster-Pairwise Discriminant Analysis, *Y. Makihara, Y. Yagi: Proc. of the 20th Int. Conf. on Pattern Recognition, (2010) 577-580.

[7]Gait Recognition using Period-based Phase Synchronization for Low Frame-rate Videos, A. Mori, *Y. Makihara, Y. Yagi: Proc. of the 20th Int. Conf. on Pattern Recognition, (2010) 2194-2197.

[8]Performance Evaluation of Vision-based Gait Recognition using a Very Large-scale Gait Database, *M.Okumura, H.Iwama, Y.Makihara, Y.Yagi: Proc. of IEEE Fourth International Conference on Biometrics: Theory, Applications and Systems, (2010) .

[9]Descattering Transmission via Angular Filtering, *J.Kim, D.Lanman, Y.Mukaigawa, R.Raskar: Proc. of the 11th European Conf. on Computer Vision, 1 (2010) 86-99.

[10]Hemispherical Confocal Imaging using Turtleback Reflector, *Y.Mukaigawa, S.Tagawa, J.Kim, R.Raskar, Y.Matsushita, Y.Yagi: Proc. of the 10th Asian Conf. on Computer Vision, (2010) 331-344.

[11]Linear solution for oneshot active 3D reconstruction using two projectors, *Hiroshi Kawasaki, Ryo Furukawa, Ryusuke Sagawa, Yuya Ohta, Kazuhiro Sakashita, Ryota Zushi, Yasushi Yagi, Naoki Asada: Proc. Fifth International Symposium on 3D Data Processing, Visualization and Transmission, (2010) .

[12]Temporal Super Resolution from a Single Quasi-Periodic Image Sequence Based on Phase Registration, *Y. Makihara, A. Mori, Y. Yagi: Proc. of the 10th Asian Conf. on Computer Vision, (2010) 107-120.

[13]Gait Analysis of Gender and Age using a Large-scale Multi-view Gait Database, *Y. Makihara, H.

Mannami, Y. Yagi: Proc. of the 10th Asian Conf. on Computer Vision, (2010) 975-986.

[14]Phase Registration of a Single Quasi-Periodic Signal Using Self Dynamic Time Warping, *Y. Makihara, N.T. Trung, H. Nagahara, R. Sagawa, Y. Mukaigawa, Y. Yagi: Proc. of the 10th Asian Conf. on Computer Vision, (2010) 1965-1975.

[15]Earth Mover's Morphing: Topology-Free Shape Morphing Using Cluster-Based EMD Flows, *Y. Makihara, Y. Yagi: Proc. of the 10th Asian Conf. on Computer Vision, (2010) 2302-2315.

[16]Foreground and Shadow Segmentation Based on a Homography-Correspondence Pair, *H. Iwama, Y. Makihara, Y. Yagi: Proc. of the 10th Asian Conf. on Computer Vision, (2010) 2790-2802.

[17]The Optimal Camera Arrangement by a Performance Model for Gait Recognition, *N. Akae, Y. Makihara, and Y. Yagi: Proc. the 9th IEEE Conf. on Automatic Face and Gesture Recognition, (2011) .

[18]Privacy-Protected Camera for the Sensing Web, *Ikuhisa Mitsugami, Masayuki Mukunoki, Yasutomo Kawanishi, Hironori Hattori, Michihiko Minoh: Proc. International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems, (2010) .

[19]Shape Prior Embedded Geodesic Distance Transform For Image Segmentation, Junqiu Wang, *Yasushi Yagi: Proc. Workshop on Application of Computer Vision for Mixed and Augmented Reality 2010, WS5-P8 (2010) 1-10.

**Review Papers**
Computer Vision and Image Media, Y. Yagi, Manufacturing and Technology, Association of Manufacturing and Technology, 63[2] (2010), .

Scene Adaptation of HOG-Based Human Detection for Fixed Camera, Ikuhisa Mitsugami, Hironori Hattori, Masayuki Mukunoki, Michihiko Minoh, IMAGE LAB, JAPAN INDUSTRIAL PUBLISHING, 21[12] (2010), 1-8.

A Proposal of Innovative Entertainment System ``Dive Into the Movie", Shigeo Morishima, Yasushi Yagi, Satoshi Nakamura, Shiro Ise, Yasuhiro Mukaigawa, Yasushi Makihara, Tomohiro Mashita, Kazuaki Kondo, Seigo Enomoto, Shinichi Kawamoto, Tatsuo Yotsukura, Yusuke Ikeda, Akinobu Maejima, Hiroyuki Kubo, The journal of the institude of electronics, information and communication engineers, The institute of electronics, information and communication engineers, 94[3] (2011), 250-268.

**Books**
[1]Switching Local and Covariance Matching for Efficient Object Tracking(Hanna Goszczynska) Junqiu Wang, Yasushi Yagi, “Object Tracking”, InTech, (119-136) 2011.

**Patents**
[1]Moving Object Detection Device Y. Yagi, Y. Makihara, C. Hua, JP2010-143213

**Contributions to International Conferences and Journals**

| | |
|---|---|
| Y. Yagi | The 20th Int. Conf. on Pattern Recognition (ICPR2010) (Technical Programm Committee) |
| Y. Yagi | 2010 IEEE International Conference on Robotics and Automation (ICRA2010) (Programm Committee) |
| Y. Yagi | 14th International Workshop on Combinatorial Image Analysis (IWCIA2011) (Programm Committee) |
| Y. Yagi | The 10th Workshop on Omnidirectional Vision, Camera Networks and Non-classical Cameras (OMNIVIS2010) (Programm Committee) |
| Y. Yagi | International Journal of Automation and Computing (Editorial Board) |

| | |
|---|---|
| Y. Yagi | The Tenth Asian Conference on Computer Vision (ACCV2010) (Stearing Committee) |
| Y. Yagi | 2010 IEEE International Conference on Robotics and Biomimetics (ROBIO2010) (Programm Committee) |
| Y. Yagi | The Open Artificial Intelligence Journal (Editorial Board) |
| Y. Yagi | 2011 IEEE International Conference on Robotics and Automation (ICRA2011) (Editorial Board) |
| Y. Yagi | The 24th IEEE Conference on Computer Vision and Pattern Recognition (CVPR2011) (Review Committee) |
| Y. Yagi | The 24th IEEE Conference on Computer Vision and Pattern Recognition (CVPR2011) (Program Committee) |
| Y. Yagi | The 23rd IEEE Conference on Computer Vision and Pattern Recognition (CVPR2010) (Program Committee) |
| Y. Yagi | Panamedia 2011 Workshop (Stearing Chair) |
| Y. Yagi | IEEE MMTC (Stearing Committee) |
| Y. Yagi | IPSJ Trans. Computer Vision and Application (Assoc. Editor-in-Chief) |
| Y. Yagi | Asian Federation of Computer vision societies (Financial Chair) |
| Y. Yagi | Asian Conference on Pattern recognition 2011 (Program co-chair) |
| Y. Yagi | IEEE Communication Society Multimedia Communications Technical Committee (Voting Member) |
| Y. Yagi | The 11th European Conference on Computer Vision (ECCV 2010) (Programm Committee) |
| Y. Yagi | The 13rd International Conference on Computer Vision (ICCV2011) (Programm Committee) |
| Y. Mukaigawa | The 12th International Conference on Computer Vision (ICCV2009) (Review Committee) |
| Y. Mukaigawa | The 23rd IEEE Conference on Computer Vision and Pattern Recognition (CVPR2010) (Review Committee) |
| Y. Mukaigawa | The 20th Int. Conf. on Pattern Recognition (ICPR2010) (Technical Programm Committee) |
| Y. Mukaigawa | The 11th European Conference on Computer Vision (ECCV 2010) (Programm Committee) |
| Y. Mukaigawa | Fourth Pacific-Rim Symposium on Image and Video Technology (PSIVT2010) (Area Chair) |
| Y. Mukaigawa | The Tenth Asian Conference on Computer Vision (ACCV2010) (Review Committee) |
| Y. Mukaigawa | The 24th IEEE Conference on Computer Vision and Pattern Recognition (CVPR2011) (Programm Committee) |
| Y. Mukaigawa | The 17th Scandinavian Conference on Image Analysis (SCIA2011) (Review Committee) |
| Y. Mukaigawa | The 13rd International Conference on Computer Vision (ICCV2011) (Programm Committee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| SIG-CVIM, Information Processing Society of Japan | 7 papers |
| The 13th Meeting on Image Recognition and Understanding | 16 papers |
| The 16th Symposium on Sensing via Image Information | 1 paper |
| Visual Computing autumn seminar, The Institude of Image Electronics Engineers of Japan | 1 paper |
| SIG-UC, Information Processing Society of Japan | 3 papers |
| The 49th Annual Conference of Japanese Society for Medical and Biological Engineering | 1 paper |
| TC-MI, the Institute of Electronics, Information, and Communication Engineers | 1 paper |

**Academic Degrees**

PhD Degree for Study for robot path teaching with machine vision

| | |
|---|---|
| Information Science<br>T. Anezaki | |
| Master Degree for Information Science<br>K. Sakashita | Simultaneous Measurement System of Texture and 3D Shape using Multi-band Camera and Near-IR Light Projector |
| Master Degree for Information Science<br>M. Okumura | Performance Evaluation of Person Identification and Age Estimation using a Large-scale Gait Database |
| Master Degree for Information Science<br>S. Kabashima | Proposal of Training Procedure and Content Production for Capsule Endoscope Reading |
| Master Degree for Information Science<br>A. Shiraishi | Gait Recognition using Arbitrary View Transformatiton Model based on 3D Gait Models |
| Master Degree for Information Science<br>Y. Baba | Proposal of Reflectance Model of Object in Scattering Media |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| Y. Yagi | Wearable ambient surveillance by lensless omnidirectional sensor and its application to schoolchild crime prevention | ¥41,340,000 |
| Y. Mukaigawa | Inverse rendering of translucent objects | ¥9,230,000 |
| Y. Mukaigawa | Measurement of 8-D reflectance field using a polyhedral mirror | ¥1,170,000 |
| Y. Makihara | Research on Gait Identification based on Multi-view Matching using an Omnidirectional Camera | ¥1,430,000 |
| Y. Mukaigawa | Safe visualization of 3D structure in human body by computational photography | ¥100,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| Y. Yagi | Japan Society for the Promotion of Science | Investigation on academic trend on perceptual information processing | ¥3,200,000 |
| Y. Yagi | Ministry of Education, Culture, Sports, Science and Technology | Human sensing system for criminal investigation | ¥26,808,000 |
| Y. Yagi | Japan Science and Technology Agency | Behavior Understanding based on Intention-Gait Model | ¥14,950,000 |

**Cooperative Research**

| | | |
|---|---|---|
| Y. Yagi | Honda R&D Co, Ltd. | ¥9,900,000 |
| Y. Yagi | Olympus Co, Ltd. | ¥1,650,000 |
| Y. Yagi | Fuji Film Co, Ltd. | ¥1,496,000 |

## Department of Reasoning for Intelligence

**Original Papers**

[1]A new particle filter for high-dimensional state-space models based on intensive and extensive proposal distribution, V. P. Nguyen, T. Washio, T. Higuchi: International Journal of Knowledge Engineering and Soft Data Paradigms, 2 (4) (2010) 284-311.

[2]Estimation of a structural vector autoregression model using nonGaussianity, A. Hyvarinen, K. Zhang, S. Shimizu, P. O. Hoyer: Journal of Machine Learning Research, 11 (2010) 1709-1731.

[3]Submodular fractional programming for balanced clustering, Y. Kawahara, K. Nagano, Y. Okamoto: Pattern Recognition Letters, 32 (2) (2011) 235-243.

[4]GTRACE: Mining Frequent Subsequences from Graph Sequences., A. Inokuchi, T. Washio: IEICE Transactions, ９３-D (10) (2010) 2792-2804.

**International Conferences**

[1]Mining Frequent Graph Sequence Patterns Induced by Vertices, *A. Inokuchi, T. Washio: SIAM Data Mining Conference 2010 (SDM2010), (2010) 466-477.

[2]GTRACE2: Improving Performance Using Labeled Union Graphs, *A. Inokuchi, T. Washio: The 14th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD2010), 2 (LNAI6119) (2010) 178-188.

[3]Learning nonlinear dynamical systems by alignment of local linear models, *M. Joko, Y. Kawahara, T. Yairi: Proceedings of the 20th International Conference on Pattern Recognition, (2010) 768-775.

[4]Minimum average cost clustering, *K. Nagano, Y. Kawahara, S. Iwata: Advances in Neural Information Processing Systems, 23 (2010) 1759-1767.

[5]Stationary subspace analysis as a generalized eigenvalue problem, *S. Hara, Y. Kawahara, T. Washio, P. Bunau: Lecture Note in Computer Science, 6443 (2010) 422-429.

[6]Estimation of Exposure Time and Purchase Probability for Supermarket Categories from RFID data (oral), *K. Takai, T. Washio, K. Yada, R. Kohli: 34th Annual Conference of the German Classification Society (GfKl),.

[7]A Classification Method Using DNA Sequence Alignment Algorithms for Path Data in Supermarket (oral), *K. Ichikawa, K. Yada, T. Washio: 34th Annual Conference of the German Classification Society (GfKl).

[8]Use of Prior Knowledge in a Non-Gaussian Method for Learning Linear Structural Equation Models (poster), *T. Inazumi, S. Shimizu, T. Washio: 9th International Conference on Latent Variable Analysis and Signal Separation.

[9]Assessing statistical reliability of LiNGAM via multiscale bootstrap (oral), *Y. Komatsu, S. Shimizu, H. Shimodaira: 20th International Conference on Artificial Neural Networks (ICANN2010), Thessaloniki, Greece, September 15-18, 2010.

[10]Discovery of exogenous variables in data with more variables than observations (oral), *Y. Sogawa, S. Shimizu, A. Hyvarinen, T. Washio, T. Shimamura, S. Imoto: 20th International Conference on Artificial Neural Networks (ICANN2010), Thessaloniki, Greece, September 15-18, 2010.

[11]An experimental comparison of linear non-Gaussian causal discovery methods and their variants (oral), *Y. Sogawa, S. Shimizu, Y. Kawahara, T. Washio: 2010 IEEE World Congress on Computational Intelligence (WCCI2010), Barcelona, Spain, July 18-23, 2010.

[12]Non-Gaussian methods for learning linear structural equation models (invited), *S. Shimizu, *Y. Kawahara: 26th Conference on Uncertainty in Artificial Intelligence (UAI2010), Catalina Island, California, U.S.A, July 8-11, 2010.

[13]Spacecraft telemetry data monitoring by dimensionality reduction techniques (oral), *T. Yairi, A. Yoshiki, M. Inui, Y. Kawahara: SICE Annual Conference 2010.

[14]Graph Classification Based on Optimizing Graph Spectra (oral), V. Nguyen, A. Inokuchi and T. Washio: The 13th International Conference on Discovery Science.

**Review Papers**

Relational Data Mining on Causal Relation Among Variables, T. Washio, IEICE Technical Report, The Institute of Electronics, Information and Communication Engineers (IEICE), 1 (2011), 5-5.

**Patents**

[1]A Method for Symboloic and Numerical Basket Analysis and an Instrument for Symboloic and Numerical Basket Analysis T. Washio, A. Fujimoto, H. Motoda, JP-PN4512832

**Contributions to International Conferences and Journals**

| | |
|---|---|
| T. WASHIO | SIAM Conference on Data Mining (SDM2011) (Program Committee Co-Chair) |
| T. WASHIO | the 10th IEEE International Conference on Data Mining (ICDM2010) (Program Committee Member) |
| T. WASHIO | International Journal of Knowledge and Web Intelligence (IJKWI) (Editorial Board) |
| T. WASHIO | 27th International Conference on Machine Learning (ICML10) (Program Committee Member) |
| T. WASHIO | 11th Pacific Rim International Conference on Artificial Intelligence (PRICAI 2010) (Special Session Chair) |
| T. WASHIO | 19th European Conference on Artificial Intelligence (ECAI 2010) (Program Committee Member) |
| T. WASHIO | The Thirteenth International Conference on Discovery Science (DS2010) (Program Committee Member) |
| T. WASHIO | Journal of Data Mining and Knowledge Discovery (DMKD) (Editorial Board) |
| T. WASHIO | Asian Conference on Machine Learning (ACML) (Steering Committee Member) |
| T. WASHIO | Pacific-Asia Conference on Knowledge Discovery and Data Mining. Future Conference (PAKDD) (Steering Committee Member) |
| A. INOKUCHI | 2010 Pacific-Asia Conference on Knowledge Discovery and Data Mining (Program Committee) |
| A. INOKUCHI | Special Section on Data Mining and Statistical Science, IEICE Transactions on Information and Systems, Special Section on Data Mining and Statistical Science (Guest Associate Editor) |
| A. INOKUCHI | 2010 IADIS European Conference on Data Mining (Program Committee) |
| A. INOKUCHI | 2010 Asian Conference on Machine Learning (Program Committee) |
| A. INOKUCHI | 2011 International Workshop on Data-Mining and Statistical Science (Program Committee) |
| A. INOKUCHI | 2011 Pacific-Asia Conference on Knowledge Discovery and Data Mining (Program Committee) |
| A. INOKUCHI | 2011 SIAM International Conference on Data Mining (Program Committee) |
| A. INOKUCHI | 2011 IADIS European Conference on Data Mining (Program Committee) |
| A. INOKUCHI | 2011 joint workshop of International Workshop on Data Oriented Constructive Mining and Multi-Agent Simulation and International Workshop on Massively Multi-Agent Systems: Models, Methods, and Tools (Program Committee) |
| A. INOKUCHI | 2012 International Conference on Pattern Recognition Applications and Methods (Program Committee) |
| A. INOKUCHI | 2012 International Conference on Social Eco-Informatics (Program Committee) |
| A. INOKUCHI | International Journal of Applied Evolutionary Computation (Editorial Review Board) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Information Based-Induction Sciences and Machine Learning, The Institute of Electronics, Information and Communication Engineers | 3 papers |
| The annual conference of The Japanese Society for Artificial Intelligence | 5 papers |
| Special Interesting Group on Knowledge base System, The Japanese Society for Artificial Intelligence | 2 papers |
| Annual Conference of Japan Society of Medical Electronics and Biological Engineering | 1 paper |
| Forum on Data Engineering and Information Management | 1 paper |
| Workshop on Information-Based Induction Sciences | 3 papers |
| Japanese Joint Statistical Meeting | 2 papers |

Meeting of the Iron and Steel Institute of Japan 1 paper

**Academic Degrees**

| | |
|---|---|
| Master Degree for Engineering<br>H. Ikuta | Study on Performance Improvement of Graph Sequence Mining based on the Reverse Search |
| Bachelor Degree for Engineering<br>T. Tashiro | Estimation of a non-Gaussian structural vector autoregressive moving average model and its application to causal inference |
| Bachelor Degree for Engineering<br>A. Yamaoka | Study on Enumerating Frequent Patterns from a Single Graph Sequence |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| T. Washio | Development of Statistical Estimation Principle for Extremely High Dimensional Data and Its Application to Large Scale Data Mining | ¥5,850,000 |
| T. Washio | Establishment of Knowledge Mining and Modeling Principles for Large Scale Dimensional Time Series and Its Application to Commercial Ubiquitous Data | ¥2,400,000 |
| T. Washio | Study on an estimation method for large PSD matrix from incomplete data and its application to quantum computation experiments | ¥1,700,000 |
| A. Inokuchi | A Development of Multidimensional Databases for Analyzing Time Interval Data in Heterogeneous Schemas | ¥4,550,000 |
| S. Shimizu | The development of a new method to discover reliable causal networks based on data with more variables than observations | ¥900,000 |
| Y. Kawahara | Data analysis method for super high dimensional data analysis using discrete structure | ¥2,210,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| Y. Kawahara | Japan Science and Technology Agency | Knowledge discovery from super-high dimensional data based on combinatorial computation | ¥9,100,000 |
| A. Inokuchi | Japan Science and Technology Agency | Development of Knowledge Organization and Understanding Support of Massive Graph Sequence Data | ¥18,070,000 |

**Contribution to Research**

| | | |
|---|---|---|
| T. Washio | FUJITSU LABORATORIES LIMITED | ¥1,000,000 |

**Cooperative Research**

| | | |
|---|---|---|
| T. Washio | Japan Science and Technology Agency | ¥1,245,000 |
| Y. Kawahara | NEC Corporation | ¥525,000 |

## Department of Knowledge Systems

**Original Papers**

[1]An Extension of the Environment for Building/Using Ontologies "Hozo" toward Practical Ontology Engineering - Focused on Theoretical Issues, Mamoru Ohta, Kouji Kozaki, Riichiro Mizoguchi: Transactions of the Japanese Society for Artificial Intelligence, 26 (2) (2011) 387-402.

[2]An Extension of the Environment for Building/Using Ontologies "Hozo" toward Practical Ontology Engineering - Focused on Practical Issues, Mamoru Ohta, Kouji Kozaki, Riichiro Mizoguchi: Transactions of the Japanese Society for Artificial Intelligence, 26 (2) (2011) 403-418.

[3]A Time and Situation Dependent Semantics for Ontological Property Classification, Ken Kaneiwa, Riichiro Mizoguchi: IEICE Transactions on Information and Systems, 94-D (3) (2011) 639-647.

[4]The RIKEN integrated database of mammals, Masuya H., Makita Y., Kobayashi N., Nishikata K., Yoshida Y., Mochizuki Y., Doi K., Takatsuki T., Waki K., Tanaka N., Ishii M., Matsushima A., Takahashi S., Hijikata A., Kozaki K., Furuichi T., Kawaji H., Wakana S., Nakamura Y., Yoshiki A., Murata T., Fukami-Kobayashi K., Mohan S., Ohara O., Hayashizaki Y., Mizoguchi R., Obata Y., Toyoda T.: Nucleic Acids Research, 39 (2010) D861-870.

[5]A Consideration of Quality-Attribute-Property for Interoperability of Quality Data - A Case Study of Quality Description in Nanomaterial Domain, Shinya Tarumi, Kouji Kozaki, Yoshinobu Kitamura, Riichiro Mizoguchi: Transactions of the Japanese Society for Artificial Intelligence, 25 (5) (2010) 579-592.

[6]The foundations of a theory-aware authoring tool for CSCL design, Seiji Isotani, Riichiro Mizoguchi, Akiko Inaba and Mitsuru Ikeda: International Journal of Computers and Education, 54 (4) (2010) 809-834.

**International Conferences**

[1]The Counting Problem in the Light of Role Kinds, Claudio Masolo, Laure Vieu, Yoshinobu Kitamura, Kouji Kozaki and Riichiro Mizoguchi: KProc. of Tenth International Symposium on Logical Formalizations of Commonsense Reasoning (Commonsense 2011), (2011) .

[2]An Extension of an Environment for Building/Using Ontologies "HOZO" Toward Practical Ontology Engineering, Mamoru Ohtai, Kouji Kozaki, and Riichiro Mizoguchi: Proc. of 10th IASTED International Conference Software Engineering and Applications (SEA2010), (2010) 725-066.

[3]Practical Considerations on Identity for Instance Management in Ontological Investigation, Kouji Kozaki, Satoshi Endo, Riichiro Mizoguchi: KProc. of the 17th International Conference on Knowledge Engineering and Knowledge Management (EKAW2010), LNAI6317, (2010) 16-30.

[4]Task-Oriented User Modeling Method and its Application to Service Navigation on the Web, Munehiko Sasajima, Yoshinobu Kitamura, Riichiro Mizoguchi: DASFAA 2010 International Workshop(SNSMW2010):Reviced Selected Papers, LNCS 6193, (2010) 240-251.

[5]Ontological Modeling for Reflective Instruc-tional Design: A Case Study on Modeling a Lesson Plan, Yusuke Hayashi, Toshinobu Kasai, Riichiro Mizoguchi: Proc. of 18th International Conference on Computers in Education (ICCE2010), (2010) 25-32.

[6]An Authoring Tool to Support the Design and Use of Theory-Based Collaborative Learning Activities, ISeiji Isotani, Riichiro Mizoguchi, Sadao Isotani, Olimpio M. Capeli, Naoko Isotani and Antonio R. P. L. de Albuquerque: Proc. of 10th International Conference on Intelligent Tutoring Systems (ITS2010), (2010) 92-102.

[7]Characterizing Functions based on Ontological Models from an Engineering Point of View, IYoshinobu Kitamura, Riichiro Mizoguchi: Proc. of the Sixth International Conference on Formal Ontology in Information Systems (FOIS 2010), (2010) 301-314.

[8]A Quality Assurance Framework for Ontology Construction and Refinement, Mamoru Ohtai, Kouji Kozaki, Riichiro Mizoguchi: Proc. of 7th Atlantic Web Intelligence Conference (AWIC2011), (2011) 207-216.

[9]A method of structuring communication data for in-vehicle information service, K Okamoto; M Sasajima; N P Chandrasiri; K Nawa; R Mizoguchi: Proc. of 2010 IEEE Vehicular Networking Conference (VNC2010), (2010) 144-151.

[10]Development of Fundamental Technologies for Better Understanding of Clinical Medical Ontologies (oral), Hiroko Kou, Mamoru Ohta, Jun Zhou, Kouji Kozaki, Riichiro Mizoguchi, Takeshi Imai, Kazuhiko Ohe: International Conference on Knowledge Engineering and Ontology Development (KEOD 2010), Valencia, Spain, October 25-28, 2010.

[11]A New Framework of Metacognition with Abstraction/Instantiation Operations (poster), Michiko Kayashima, Riichiro Mizoguchi: 10th International Conference on Intelligent Tutoring Systems (ITS2010), Pittsburgh, USA, June 14-17, 2010.

[12]A New Perspective for Metacognition-Driven Learning (oral), Michiko Kayashima, Riichiro Mizoguchi: 18th International Conference on Computers in Education (ICCE2010), Putrajaya, Malaysia, Nov. 29-Dec. 3, 2010.

[13]Building an Ontology-Based System Which Supports the Instructional Design Process (oral), Toshinobu Kasai, Kazuo Nagao, Riichiro Mizoguchi: 18th International Conference on Computers in Education (ICCE2010), Putrajaya, Malaysia, Nov. 29-Dec. 3, 2010.

**Review Papers**

Modeling and Applications of Artifact Functions and Mobile-User Actions based on Common Ontological Foundation for Goal-Oriented Processes, Yoshinobu Kitamura, Munehiko Sasajima, Riichiro Mizoguchi, Journal of the Japanese Society for Artificial Intelligence, Ohmsha, 25[4] (2010), 526-536.

Classification and Trend Analysis of Utilization of Ontology, Kouji Kozaki, Journal of the Japanese Society for Artificial Intelligence, Ohmsha, 25[4] (2010), 475-484.

**Books**

[1]Ontology-Based Formal Modeling of the Pedagogical World: Tutor Modeling(Roger Nkambou、Riichiro Mizoguchi and Jacqueline Bourdeau) Riichiro Mizoguchi, Yusuke Hayashi, Jacqueline Bourdeau, “Advances in Intelligent Tutoring Systems (Studies in Computational Intelligence 308)”, OSpringer-Verlag, (229-247) 2010.

[2]Structuring the Cultural Domain with an Upper Ontology of Culture(Emmanuel Blanchard and Allard Daniele) Emmanuel Blanchard, Riichiro Mizoguchi, Susanne P. Lajoie, “Handbook of Research on Culturally Aware Information Technology: Perspectives and Models”, IGI Global, (179-212) 2010.

[3]Addressing Cross-Linguistic Influence and Related Cultural Factors Using Computer-Assisted Language Learning(Emmanuel Blanchard and Allard Daniele) Allard Daniele, Riichiro Mizoguchi, Jacqueline Bourdeau, “Handbook of Research on Culturally Aware Information Technology: Perspectives and Models”, IGI Global, (582-598) 2010.

**Contributions to International Conferences and Journals**

R. MIZOGUCHI Semantic Web Science Association (Vice-president)
R. MIZOGUCHI International Journal of Web Semantics (Editors-in-Chief)
R. MIZOGUCHI International Artificial Intelligence in Education Society (Executive Committee)
R. MIZOGUCHI Asia-Pacific Society for Computers in Education(APSCE) (Board member)
R. MIZOGUCHI IEEE Transactions on Learning Technologies (Associate editor)
R. MIZOGUCHI International Journal of Applied Ontology (Editorial board)
R. MIZOGUCHI Research and Practice in Technology Enhanced Learning (Editorial board)
R. MIZOGUCHI International Journal of Artificial Intelligence in Education (Editorial board)
R. MIZOGUCHI Frontiers in AI and Application (Editorial board)
R. MIZOGUCHI International Journal of Web Engineering and Technology (Editorial board)
R. MIZOGUCHI Journal of Educational Technology & Society (Editorial board)
R. MIZOGUCHI Asian Semantic Web Conference (Steering committee chair)
R. MIZOGUCHI The 10th International Conference on Intelligent Tutoring System (ITS2010) (Senior

| | |
|---|---|
| | PC member) |
| R. MIZOGUCHI | The 18th International Conference on Computers in Education (ICCE2010) Conf. on AIED/ITS & Adaptive Learning (Poster Coordination Chair) |
| R. MIZOGUCHI | The 18th International Conference on Computers in Education (ICCE2010) Conf. on AIED/ITS & Adaptive Learning (PC member) |
| R. MIZOGUCHI | EKAW 2010 - Knowledge Engineering and Knowledge Management by the Masses (PC member) |
| R. MIZOGUCHI | 6th International Conference on Formal Ontology in Information Systems (FOIS 2010) (Program Co-Chair) |
| R. MIZOGUCHI | International Conference on Industrial, Engineering & Other Applications of Applied Intelligent Systems:IEA-AIE 2010 (PC member) |
| R. MIZOGUCHI | The Ninth International Semantic Web Conference: ISWC 2010 (PC member) |
| R. MIZOGUCHI | Multi-Agent Systems for Education and Interactive Entertainment: Design, Use and Experience:MEIE-10 (PC member) |
| Y. KITAMURA | The 19th International World Wide Web Conference (WWW 2010) (PC member) |
| Y. KITAMURA | The 17th International Conference on Concurrent Engineering (CE 2010) (PC member) |
| Y. KITAMURA | International Journal of Advanced Engineering Informatics (Editorial board) |
| Y. KITAMURA | ASME Journal of Computing and Information Science in Engineering (Associate editor) |
| Y. HAYASHI | The 18th International Conference on Computers in Education (ICCE2010) Conf. on AIED/ITS & Adaptive Learning (PC member) |
| Y. HAYASHI | The 18th International Conference on Computers in Education (ICCE2010) Conf. on Advanced Learning Technologies, Open Contents, & Standards (PC member) |
| Y. HAYASHI | The 10th International Conference on Intelligent Tutoring System (ITS2010) (PC member) |
| M. SASAJIMA | The 5th International Conference on Autonomic and Autonomous Systems(ICAS 2010) (PC member) |
| M. SASAJIMA | International conference on Internet and Multimedia Systems and Applications (IMSA 2010) (PC member) |
| M. SASAJIMA | The 1st Workshop on Social Networks and Social Media Mining on the Web (SNSMW2011) (PC member) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japanese Society for Artificial Intelligence | 13 papers |
| The Japan Society of Mechanical Engineers | 2 papers |
| Japanese Society for Information and Systems in Education | 2 papers |
| Japan Society for Educational Technology | 2 papers |
| The Institute of Electronics, Information and communication Engineers | 2 papers |

**Academic Degrees**

| | |
|---|---|
| Master Degree in Engineering<br>J. Nakayamada | An Investigation on Advertising Recommendation Method based on User Task |
| Doctor Degree in Engineering<br>S.Tarumi | Development of a Design Supporting System for Materials based on a Theory of Function-Quality |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| R. MIZOGUCHI | Development of the next-generation knowledge systems using ontological engineering | ¥8,580,000 |
| Y. KITAMURA | Development of a reference ontology of function and knowledge sharing systems based on an interdisciplinary approach | ¥4,550,000 |
| K. KOZAKI | Application Platform for Multi-Dimension Knowledge Structuring based on Ontological Engineering | ¥4,160,000 |
| Y. HAYASHI | Development of an authoring tool to bring diversity of lessons | ¥812,000 |

and to facilitate meta-cognition of teachers

**Entrusted Research**

| | | | |
|---|---|---|---|
| R. MIZOGUCHI | The University of Tokyo | Research on development of a medical knowledge database for medical information systems; Design of a semantic relational model | ¥15,015,000 |
| R. MIZOGUCHI | The University of Tokyo | Biofuel Use Strategies for Sustainable Development; Restructuring problems of biofuel use by using Ontology and developing policy-making supporting tools. | ¥1,935,000 |
| R. MIZOGUCHI | The University of Tokyo | Development of Ontology-based Knowledge Processing Mechanism | ¥9,000,000 |

**Contribution to Research**

| | | |
|---|---|---|
| R. MIZOGUCHI | Oki Data Corporation | ¥750,000 |
| Y. KITAMURA | Niigata Machine Techno co., Ltd. | ¥450,000 |
| Y. KITAMURA | Niigata Mechatronics co., Ltd. | ¥300,000 |

**Cooperative Research**

| | | |
|---|---|---|
| R. MIZOGUCHI | TOYOTA Info Technology Center Co., Ltd. | ¥6,000,000 |

## Department of Architecture for Intelligence

**Original Papers**

[1]Construction of Autonomous Traffic Light Offset Control System using Multi Agent System, T. Shirai, J. Yano, S. Nishimura, K. Kagawa, T. Morita, M. Numao, and S. Kurihara: Transactions of Japanese Society for Artificial Intelligence, 26 (2) (2011) 324-329.

[2]Extraction of Essential Events Using SOM and KeyGraph: Application to Damage Analysis on of Fuel Cells, T. Kitagawa, K. Fukui, K. Sato, J. Mizusaki, and M. Numao: Transactions on Mathematical Modeling and its Applications, 4 (2) (2011) 1-12.

[3]Fluctuated peer selection policy and its performance in large-scale multi-agent systems, T. Sugawara, K. Fukuda, T. Hirotsu, S. Sato, O. Akashi, and S. Kurihara: Web Intelligence and Agent Systems, 8 (3) (2010) 255-268.

**International Conferences**

[1]Three-Subagent Adapting Architecture for Fighting Videogames, S. Ortiz, *K. Moriyama, K. Fukui, S. Kurihara, and M. Numao: , LNAI 6230 (2010) 649-654.

[2]Kullback-Leibler Divergence Based Kernel SOM for Visualization of Damage Process on Fuel Cells, *K. Fukui, K. Sato, J. Mizusaki, and M. Numao: , 1 (2010) 233-240.

[3]Combining SOM and KeyGraph for Extraction of Essential Events: Application to Damage Evaluation of Fuel Cells, *T. Kitagawa, K. Fukui, K. Sato, J. Mizusaki, and M. Numao: , (2010) 24-33.

[4]Effect of Probabilistic Task Allocation Based on Statistical Analysis of Bid Values, *T. Sugawara, K. Fukuda, T. Hirotsu, and S. Kurihara: , (2010) .

[5]Sensor Network Topology Estimation using Time-Series Data from infrared Human Presence Sensors, *Y. Watanabe, S. Kurihara, and T. Sugawara: , (2010) .

[6]Desktop Searches based on Context Visualization using File Operation Logs, *M. Matsumoto, S.

Okanao, T. Morita, M. Numao, and S. Kurihara: , (2011) .

[7]New Relation between Human and The Real Environment based on Human Behavior Mining (invited), *S. Kurihara: The First International Workshop on Human Behavior Sensing (HBS2010), Kassel, Germany, Jun. 15, 2010.

[8]Does Profit Mean Happiness? - A way to create an emotional agent (invited), *K. Moriyama: 2nd Osaka University – De La Salle University Workshop on Empathic Computing, Phillippine, Sep. 27-28, 2010.

[9]Comparing Effectiveness of Different Physiological Sensors for Music Segmentation (poster), *R. Cabredo, R. Legaspi, and M. Numao: The 14th SANKEN International Symposium & The 9th SANKEN Nanotechnology Symposium, Japan, Jan. 25-26, 2011.

[10]Mining Frequent Sequences with Flexible Time Intervals (oral), K. Maruo, *D. Sodkomkham, K. Fukui, K. Moriyama, S. Kurihara, and M. Numao: The 5th International Workshop on Data-Mining and Statistical Science (DMSS2011), Japan, Mar. 29-30, 2011.

[11]Predicting Student's Appraisal of Feedback in an ITS Using Previous Affective States and Continuous Affect Labels from EEG Data (oral), *P.S. Inventado, M. Suarez, R. Legaspi, and T.D. Bui: 18th International Conference on Computers in Education (ICCE 2010), Malaysia, Nov. 29 - Dec. 3, 2010.

[12]The TALA Empathic Space: Integrating Affect and Activity Recognition into a Smart Space (oral), *J. Cu, R. Cabredo, G. Cu, P.S. Inventado, R. Trogo, M.T. Suarez, and R. Legaspi: 3rd International Conference on Human-Centric Computing, Phillippines, Aug. 11-13, 2010.

[13]Identifying Student Appraisal of Feedback provided by an ITS Using System Logs and Brainwave Data (oral), *P.S. Inventado, M. Suarez, and R. Legaspi: 15th Joint Academic Rsearch Symposium of De La Salle University and Osaka University, Phillippines, Sep. 29-30, 2010.

[14]Automatic Detection of Posture Congruence in Dyadic Interactions to Predict Rapport (oral), *J.L. Hagad, R. Legaspi, R. Cabredo, M. Suarez, and M. Numao: 15th Joint Academic Rsearch Symposium of De La Salle University and Osaka University, Phillippines, Sep. 29-30, 2010.

**Review Papers**

Mining Real World Information from the Web, K. Kazama and S. Kurihara, Information Processing, Information Processing Society of Japan, 51[9] (2010), 1171-1180.

The Trend from Imitation to Creation in Complex Network Simulations, T. Ishikawa, H. Sawai, and S. Kurihara, Computer Software, Japan Society for Software Science and Technology, 28[1] (2011), 21-25.

**Books**

[1]Tracking and Visualizing the Cluster Dynamics by Sequence-based SOM(George K. Matsopoulos) K. Fukui, K. Saito, M. Kimura, and M. Numao, “Self-Organizing Maps”, InTech, (97-112) 2010.

[2]Adaptive Sensor-Network Topology Estimating Algorithm based on the Ant Colony Optimization(Avi Ostfeld) S. Kurihara, H. Tamaki, K. Fukui, and M. Numao, “Ant Colony Optimization: Methods and Applications”, InTech, (101-112) 2011.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| M. Numao | New Generation Computing (Area Editor) |
| M. Numao | The 1st International Workshop on Empathic Computing (Workshop Co-chair) |
| M. Numao | The Thirteenth International Conference on Discovery Science (DS'10) (Program Committee) |

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|---|---|
| M. Numao | Pacific Rim Knowledge Acquisition Workshop (PKAW'10) (Program Committee) |
| M. Numao | Workshop on Web Personalization and Recommender Systems (WebPRES'10) (Program Committee) |
| S. Kurihara | International Journal of Knowledge and Web Intelligence (Editorial board member) |
| K. Moriyama | International Journal of Organizational and Collective Intelligence (International Editorial Review Board Member) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Annual Conference of The Japanese Society for Artificial Intelligence (JSAI) | 3 papers |
| SIG-EIN, Japan Society for Software Science and Technology | 1 paper |
| SIG-MPS, Information Processing Society of Japan | 3 papers |
| Joint Agent Workshops and Symposium | 1 paper |
| SIG-ICS, Information Processing Society of Japan | 1 paper |
| SIG-KBS, The Japanese Society of Artificial Intelligence (JSAI) | 2 papers |
| SIG-MUS, Information Processing Society of Japan | 1 paper |
| SIG-AI, The Institute of Electronics, Information and Communication Engineers | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Information Science<br>K. Iwao | Recommendation Based on Users' Similar Habits of Mobile Applications |
| Master Degree for Information Science<br>A. Ueda | Automatic Composition System considering Music Structure including Melody |
| Master Degree for Information Science<br>A. Ninomiya | Extraction of Keywords and Images with Geographic Information from Weblogs |
| Master Degree for Information Science<br>K. Maruo | Mining Frequent Sequences with Flexible Time Intervals |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| S. Kurihara | Proposal of top-down controllable multi-agent coordination algorithm | ¥1,300,000 |
| K. Fukui | A Study on Mechanical Property Evaluation of a Solid-type Electric Battery Based on Multidisciplinary Data Mining | ¥1,000,000 |

**Entrusted Research**

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|---|---|---|---|
| S. Kurihara | Japan Science and Technology Agency | Overlay-network Search Oriented for Information about Town Events | ¥1,500,000 |

**Cooperative Research**

| | | |
|---|---|---|
| S. Kurihara | Sumitomo Electric Industries, ltd. | ¥1,950,000 |

## Department of Quantum Information Optics (Alliance Laboratory of ISIR. Osaka Univ. and RIES Hokkaido Univ.)

**Original Papers**

[1]Analysis of experimental error sources in a linear-optics quantum gate, T.Nagata, R.Okamoto, H F. Hofmann, and S.Takeuchi: New Journal of Physics, 12 (2010) 43053-1-43053-17.

[2]Simple scheme for expanding photonic cluster states for quantum information, P.Kalasuwan, G.Mendoza, A.Laing, T.Nagata, J.Coggins, M.Callaway, S.Takeuchi, A.Stefanov, and J.L.O'Brien: Journal of the Optical Society of America B, 27 (6) (2010) A181-A184.

[3]Fiber-microsphere system at cryogenic temperatures toward cavity QED using diamond NV centers, H.Takashima, T.Asai, K.Toubaru, M.Fujiwara, K.Sasaki and S.Takeuchi: OPTICS EXPRESS(OSA), 18 (14) (2010) 15169-15173.

[4]Phase shift spectra of a fiber-microsphere system at the single photon level, A.Tanaka, T.Asai, K.Toubaru, H.Takashima, M.Fujiwara, R.Okamoto, S.Takeuchi: OPTICS EXPRESS, 19 (3) (2011) 2278-2285.

[5]Quantum lithography under imperfect conditions: effects of loss and dephasing on two-photon interference fringes, H.Fujiwara, Y.Kawabe, R.Okamoto, S.Takeuchi, and K.Sasaki: Journal of the Optical Society of America B, 28 (3) (2011) 422-431.

**International Conferences**

[1]Quantum Process Tomography of Microsphere Cavity-Coupled Tapered Fiber System. (poster), *A.Tanaka, K.Toubaru, M.Fujiwara, R.Okamoto and S.Takeuchi: CREST 2010 International Symposium on Physics of Quantum Technology, Tokyo, Japan, April 6-9,2010.

[2]Photonic quantum circuits and its application (invited), S.Takeuchi: Quantum2010 5th Workshop and memoriam of Carlo Novero Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons / 3rd Italian Quantum information Science Conference IQIS 2010, Torino, Italy, May 23-29, 2010.

[3]Photonic quantum circuits and its application (invited), S.Takeuchi: SONDERSEMINAR, München, Germany,May 28, 2010.

[4]How can we minimize errors in a linear-optics quantum gate? (invited), T.Nagata, R.Okamoto, M.Tanida, H.F.Hofmann, and * S.Takeuchi: SPIE Optics+Photonics 2010, San Diedo, USA, August 1-5, 2010.

[5]Linear optics quantum circuits (invited), *R.Okamoto, J.L.Obrien, H.F.Hofmann, T.Nagata, and S.Takeuchi: International Conference on Coherent and Nonlinear Optics/Lasers, Applications, and Technologies 2010, Kazan, Russia, August, 23-27, 2010.

[6]Coherent Phase Shift Sperctra of Fiber-Microsphere System at the Single Photon Level (poster), *A.Tanaka, K.Toubaru, H.Takashima,M.Fujiwara,R.Okamoto,and S.Takeuchi: Updating Quantum Cryptography and Communications 2010, Tokyo, Japan, October18-20, 2010.

[7]Fiber-copuled Microsphere at Cryogenic Temperatures for Cavity QED Experiemtns Using Single Diamondo NV Centers (poster), *M.Fujiwara, K.Toubaru, A.Tanaka, H.Q.Zhao, H.Takashima, K.Sasaki, and S.Takeuchi: Updating Quantum Cryptography and Communications 2010, Tokyo, Japan, October18-20, 2010.

[8]Investigation of NV centers in diamond nano-crystals by laser Scanning Confocal microscopy (invited), *H.Q.Zhao,M.Fujiwara,S.Takeuchi: Updating Quantum Cryptography and Communications 2010, Tokyo, Japan, October18-20, 2010.

[9]Optical quantum circuit combining tailored optical nonlinearities (invited), *S.Takeuchi, R.Okamoto, M.Fujiwara, H.Q.Zhao, H.Takashima, A.Tanaka, H.F.Hofmann, J.L.O'Brien: SPIE Photonics west 2011, San Francisco, USA, January22-27, 2011.

[10]Polarization-purity spectra of a tapered-fiber-coupled microsphere cavity system at cryogenic temperatures (oral), *M.Fujiwara, A.Tanaka, K.Toubaru, H.Q.Zhao, H.Takashima and S.Takeuchi: SPIE Photonics west 2011, San Francisco, USA, January22-27, 2011.

[11]Generation of broadband spontaneous parametric fluorescence and its application to quantum optical coherence tomography (poster), *M.Okano, R.Okamoto, A.Tanaka, S.Subashchandran, N.Nishizawa, and S.Takeuchi: The 14th SANKEN international Symposium 2011,The 9th SANKEN Nanotechnology

Symposium, Siga, Japan, January25-26, 2011.

[12]Cryogenic Spectrum Investigation on NV-Centers in Nano-Diamond Crystals (poster), *Hong-Quan Zhao, Masazumi Fujiwara, Shieki Takeuchi: The 14th SANKEN international Symposium 2011,The 9th SANKEN Nanotechnology Symposium, Siga, Japan, January25-26, 2011.

[13]Superconducting Nanowire Single Photon Detector System: Quantum Efficiency Measurement using Correlated Photons (poster), *S.Subashchandran, Ryo Okamoto, Labao Zhang, Akira Tanaka, Masayuki Okano, Lin Kang, Jian Chen, Peiheng Wu and Shigeki Takeuchi: The 14th SANKEN international Symposium 2011,The 9th SANKEN Nanotechnology Symposium, Siga, Japan, January25-26, 2011.

[14]Superconducting Nanowire Single Photon Detector System: Evaluation and Applications with Entangled Photon Pairs (invited), *S.Shanthi, R.Okamoto, A.Tanaka, M.Okano, L.Zhang, L.Kang, J.Chen, P.H.Wu, and S.Takeuchi: International Workshop on Advanced Functional Nanomaterials, Chennai, India, Febrary21-24, 2011.

**Books**

[1]Study on highly efficient solid state quantum phase gates for quantum info-communication S.Takeuchi, “Frontiers in quantum dot electronics”, NTS, (331-339) 2011.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| S. TAKEUCHI | SPIE Photonics+Optics, Quantum communications and Quantum Imaging (Program Committee Member) |
| S. TAKEUCHI | Nonlinear optics Quantum optics (Organizing Committee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Symposium of Science Council of Japan, "Prospects for Advanced Photonics" | 1 paper |
| The 22nd Quantum Information Technology Symposium | 3 papers |
| The 1th Summer Meeting of Quantum Information Processing Project | 1 paper |
| The 71th Autum Meeting 2010 ; JSAP | 1 paper |
| JPS 2011 Autumn Meeting | 2 papers |
| Core Research and Engineering of Advanced Materials-Interdisciplinary Education Center for Materials Science Fall School | 2 papers |
| Workshop at Tokushima University Center for Frontier Research of Engineering | 1 paper |
| Symposium on Mathematics and Complex Systems and Their Applications: Management Expenses Grants for National Universities Corporations from MEXT | 1 paper |
| Osaka University's Institute of Scientific and Industrial Research 67th Academic Lecture Meeting | 1 paper |
| FIRST Project Meeting 2010 | 4 papers |
| Young Researcher's Workshop for Carotenoids | 1 paper |
| Progress in Nanophotonics and Nanoelectronics for Quantum Information Science | 2 papers |
| H22 RIES Kenkyu-Kouryu-Kai | 4 papers |
| 31st Annual Meeting of Laser Conference | 1 paper |
| Interdisciplinary Workshop "Quantum Optics in Various Physical Systems, Atom-Photon Strong Interaction" | 1 paper |
| 58th Annual Meeting of JSAP | 2 papers |
| 66th Annual Meeting of JPS | 5 papers |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science | Towards innovation of quantum nonlinear optics: the realization of ultra-broadband entangled photon pair source and the quantum state estimation of output photons |
| A. Tanaka | from fiber-coupled microsphere resonator |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| S. Takeuchi | Realization and application of spatio-temporally single mode single photon source using group velocity engineering. | ¥10,200,000 |
| S. Takeuchi | Realization of quantum cybernetics using photonic quantum circuits | ¥27,300,000 |

| | | |
|---|---|---|
| R. Okamoto | Demonstration of a quantum shutter | ¥600,000 |
| M. Fujiwara | Ultrahigh-sensitive single molecular detection of photosynthetic light-harvesting complexes by using microsphere resonator | ¥940,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| S. Takeuchi | Japan Science and Technology Agency (JST) | Toward the realization of monocycle entangled photons for novel nonlinear quantum optics | ¥41,150,000 |
| S. Takeuchi | The Ministry of Internal Affairs and Communications (MIC) | Researches on the realization of Highly efficient solid state quantum phase gate for photons | ¥13,327,000 |
| S. Takeuchi | Japan Society for the Promotion of Science | Realization of entanglement microscope and supersensitive phase measurement | ¥11,200,000 |
| S. Takeuchi | Mitsubishi Electric Corporation | | ¥1,820,000 |

## Department of Quantum Functional Materials

**Original Papers**

[1]Spin-orbit coupling and anomalous angular-dependent magnetoresistance in the quantum transport regime of PbS, Kazuma Eto, A. Taskin, Kouji Segawa, and Yoichi Ando: Physical Review B, 81 (16) (2010) 161202/1-4.

[2]Zero-doping state and electron-hole asymmetry in an ambipolar cuprate, Kouji Segawa, M. Kofu, S-H. Lee, I. Tsukada, H. Hiraka, M. Fujita, S. Chang, K. Yamada, and Yoichi Ando: nature physics, 6 (8) (2010) 579-583.

[3]Oscillatory angular dependence of the magnetoresistance in a topological insulator Bi1-xSbx, A. A. Taskin, Kouji Segawa, and Yoichi Ando: Physical Review B, 82 (12) (2010) 121302/1-4.

[4]Large bulk resistivity and surface quantum oscillations in the topological insulator Bi2Te2Se, Zhi Ren, A. A. Taskin, Satoshi Sasaki, Kouji Segawa, and Yoichi Ando: Physical Review B, 82 (24) (2010) 241306/1-4.

[5]Bulk Superconducting Phase with a Full Energy Gap in the Doped Topological Insulator CuxBi2Se3, M. Kriener, Kouji Segawa, Zhi Ren, Satoshi Sasaki, and Yoichi Ando: Physical Review Letters, 106 (12) (2011) 127004/1-4.

[6]Doping Dependence of the (pi, pi) shadow band in La-based cuprates studied by angle-resolved photoemission spectroscopy, R-H. He, X J Zhou, M. Hashimoto, T. Yoshida, K. Tanaka, S-K. Mo, T. Sasagawa, N. Mannella, W. Meevasana, H. Yao, M. Fujita, T. Adachi, S. Komiya, S. Uchida, Y. Ando, F. Zhou, Z. X. Zhao, A. Fujimor, Y. Koike, K. Yamada, Z. Hussain and Z-X. Shen: New Journal of Physics, 13 (2011) 13031/1-14.

[7]Electronic structure of doped lanthanum cuprates studied with resonant inelastic e-ray scattering, D. S. Ellis, Jungho Kim, Harry Zhang, J. P. Hill, Genda Gu, Seiki Komiya, Yoichi Ando, D. Casa, T. Gog, and Young-June Kim: Physical Review B, 83 (7) (2011) 075120/1-9.

[8]Electron interactions and charge ordering in CuO2 compounds, B. Muschler, W. Prestel, L. Tassini, R. Hackl, M. Lambacher, A. Erb, Seiki Komiya, Yoichi Ando, D. C. Peets, W. N. Hardy, R. Liang and D. A. Bonn: The European Physical Journal Special Topics, 188 (1) (2010) 131-152.

[9]Quantitative comparison of single- and two-particle properties in the cuprates, W. Prestel, F. Venturini, B. Muschler, I. Tutto, R. Hackl, M. Lambacher, A. Erb, Seiki Komiya, Shimpei Ono, Yoichi Ando, D. Inosov, V. B. Zabolotnyy and S. V. Borisenko: The European Physical Journal Special Topics, 188 (1)

(2010) 163-171.

[10]Breakdown of the universal Josephson relation in spin-ordered cuprate superconductors, A. A. Schafgans, C. C. Homes, G. D. Gu, Seiki Komiya, Yoichi Ando, and D. N. Basov: Physical Review B, 82 (10) (2010) 100505/1-4.

[11]Direct Evidence for the Dirac-Cone Topological Surface States in the Ternary Chalcogenide TlBiSe2, Takafumi Sato, Kouji Segawa, Hua Guo, Katsuaki Sugawara, Seigo Souma, Takashi Takahashi, and Yoichi Ando: , 105 (13) (2010) 136802/1-4.

[12]An Electron-boson glue function derived from electronic Raman scattering, B. Muschler, W. prestel, E. Schachinger, J. P. Carbotte, R. Hackl, Shimpei Ono, and Yoichi Ando: Journal of Physics: Condensed Matter, 22 (37) (2010) 375702/1-7.

[13]High-Temperature Optical Spectral Weight and Fermi-liquid Renormalization in Bi-Based Cuprate Superconductors, D. Nicoletti, O. Limag, P. Calvani, G. Rohringer, A. Toschi, G. Sangiovanni, M. Capone, K. Held, S. Ono, Yoichi Ando, and S. Lupi: Physical Review Letters, 105 (7) (2010) 077002/1-4.

[14]Stability of exfoliated Bi2Sr2DyxCa1-xCu2O8+delta studied by Raman microscopy, L. J. Sandilands, J. X. Shen, G. M. Chugunov, S. Y. F. Zhao, Shimpei Ono, Yoichi Ando, K. S. Burch: Physical Review B, 82 (6) (2010) 064503/1-5.

[15]Spin-polarized surface bands of a three-dimensional topological insulator studied by high-resolution spin- and angle-resolved photoemission spectroscopy, Akinori Nishide, Yasuo Takeichi, Taichi Okuda, Alexey A Taskin, Tory Hirahara, Kan Nakatsuji, Fumio Komori, Akito Kakizaki, Yoichi Ando, and Iwao Matusda: New Journal of Physics, 12 (2010) 065011/1-14.

[16]Chemical potential jump between the hole-doped and electron-doped sides of ambipolar high-Tc cuprate superconductors, M. Ikeda, M. Takizawa, T. Yoshida, A. Fujimori, Kouji Segawa, and Yoichi Ando: Physical Review B, 82 (2) (2010) 020503/1-4.

[17]Angular-dependent oscillations of the magnetoresistance in Bi2Se3 due to the three-demensional bulk Fermi surface, Kazuma Eto, Zhi Ren, A. A. Taskin, Kouji Segawa, and Yoichi Ando: Physical Review B, 81 (19) (2010) 195309/1-5.

[18]Homogeneous Dispersion of Gallium Nitride Nanoparticles in a Boron Nitride Matrix by Nitridation with Urea, Takafumi Kusunose, Tohru Sekino, Ando Yoichi: Journal of Nanoscience and Nanotechnology, 10 (7) (2010) 4312-4316.

[19]Towards a Two-Dimensional Superconducting State of La2-xSrxCuO4 in a Moderate External Magnetic Field, A. A. Schafgans, A. D. LaForge, S. V. Dordevic, M. M. Qazilbash, W. J. Padilla, K. S. Burch, Z. Q. Li, Seiki Komiya, Yoichi Ando, and D. N. Basov: Physical Review Letters, 104 (15) (2010) 157002/1-4.

**International Conferences**

[1]Unusual Quantum Magnetotrnasport in a Topological Insulator Bi1-xSbx (invited), : The 19th International Conference on the Application of High Magnetic Fields in Semiconductor Physics and Nanotechnology (HMF19), Fukuoka convention center.

[2]Novel transport properties of Bi-Sb and other topological insulators (invited), : Workshop on Topological Inslators& Superconductors, Princeton University.

[3]Materials Studies of Topolgical Insulators and Superconductors (invited), : International Meeting on High-Accuracy, Hierarchical and Many-Body Schemes for Materials Simulations, Faculty of Engineering

the University of Tokyo.

[4]Magnetotransport studies of new topological insulators: Bi2Te2Se and others (invited), : APS March Meeting 2011, Dallas.

[5]Magneto-Optics in the search for the topological insulating state (oral), : APS March Meeting 2011, Dallas.

**Review Papers**
Experimental Study of Topological Insulators, Y. Ando, SOLID STATE PHYSICS, ©AGNE GIJUTSU CENTER, 45[11] (2010), 103-116.

**Contributions to International Conferences and Journals**

| | | |
|---|---|---|
| Y.Ando | EPL (Europhysics Letters) (co-editor) | |

**Publications in Domestic Meetings**

| | |
|---|---|
| Symposium in Yukawa Institute for Theoretical Physics of Kyoto University | 1 paper |
| The Physical Society of Japan | 12 papers |
| The Japanese Society for Synchrotron Radiation Research | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science<br>D. Hama | Development of Methods to Detect the Spin-polarized Charge Current on Topological Insulators |
| Master Degree for Science<br>T. Minami | Crystal Growth and Physical Properties of Tl-based Topological Insulators |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| Y.Ando | Mott Insulator and Spin Hall Insulator: Elucidating the Physics of Nontrivial Insulators | ¥24,830,000 |
| Y.Ando | Creation of Innovative Devices Based on Topological Insulators | ¥4,755,000 |
| K. Segawa | Study on the Mott insulator and electron-doped region in an ambipolar high-Tc cuprate | ¥2,080,000 |

**Other Research Fund**

| | | |
|---|---|---|
| Y.Ando | US AFRL Asian Office of Aerospace Research and Development, Special Grant | ¥4,484,000 |

## Department of Semiconductor Materials and Processes

**Original Papers**
[1]Fabrication of low reflectivity poly-crystalline Si surfaces by structure transfer method, T. Fukushima, A. Ohnaka, M. Takahashi, H. Kobayashi: Electrochem. Solid-State Lett., 14 (2011) B13-15.

[2]Ultra-low power TFT with gate oxide fabricated by nitric acid oxidation method, T. Matsumoto, Y. Kubota, M. Yamada, H. Tsuji, T. Shimatani, Y. Hirayama, S. Terakawa, S. Imai, H. Kobayashi: IEEE Electron Device Lett., 31 (2010) 821-823.

[3]Fabrication of $Al_2O_3$/Al structure by nitric acid oxidation at room temperature, T. Iwata, M. Matsumoto, S. Terakawa, H. Kobayashi: Cent. Eur. J. Phys., 8 (2010) 1015-1020.

[4]On ultra-thin oxide/Si and very-thin oxide/Si structures prepared by wet chemical process, E. Pincik, H. Kobayashi, J. Rusnak, W. B. Kim, R. Brunner, L. Malinovsky, T. Matsumoto, K. Imamura, M. Jergel, M. Takahashi, Y. Higashi, M. Kucera, M. Mikula: Appl. Surf. Sci., 256 (2010) 5757-5764.

[5]On photoluminescence properties of a-Si:H-based structures, R. Brunner, E. Pincik, H. Kobayashi, M. Kucera, M. Takahashi, J. Rusnak: Appl. Surf. Sci., 256 (2010) 5596-5601.

[6]On the influence of the surface roughness onto the ultrathin $SiO_2$/Si structure properties, S. Jurecka, H. Kobayashi, M. Takahashi, T. Masumoto, M. Jureckova, F. Chovanec, E. Pincik: Appl. Surf. Sci., 256 (2010) 5623-5628.

[7]Low temperature fabrication of 5~10 nm $SiO_2$/Si structure using advanced nitric acid oxidation of silicon (NAOS) method, Y. Fukaya, T. Yanase, Y. Kubota, S. Imai, T. Matsumoto, H. Kobayashi,: Appl. Surf. Sci., 256 (2010) 5610-5613.

[8]Analysis of A-DLTS spectra of MOS structures with thin NAOS $SiO_2$, P. Hockicko, P. Bury, P. Sidor, H. Kobayashi, M. Takahashi, T. Yanase: Cent. Eur. J. Phys., 8 (2010) 242-249.

[9]$SiO_2$/Si structure having low leakage current fabricated by nitric acid oxidation method with Si source, T. Yanase, M. Matsumoto, H. Kobayashi: Electrochem. Solid-State Lett., 13 (2010) H253-256.

[10]Enhanced leakage current properties of Ni-doped $Ba_{0.6}Sr_{0.4}TiO_3$ thin films driven by modified band edge state, H. Seo, Y.-B. Kim, G. Lucovsky, I.-D. Kim, K.-B. Chung, H. Kobayashi, D.-K. Choi: J. Appl. Phys., 107 (2010) 024109/1-7.

**International Conferences**

[1]Application of nitric acid oxidation of Si (NAOS) method to fabricate of thin film transistors (invited), S. Imai, K. Imamura, T. Matsumoto, H. Kobayashi: 7th Solid State Surfaces and Interfaces.

[2]Characterization of ultra-low power thin film transistors (TFTs) with $SiO_2$ layer formed by the nitric acid oxidation of Si (NAOS) method (invited), T. Matsumoto, M. Yamada, H. Tsuji, K. Taniguchi, Y. Kubota, S. Imai, S. Terakawa, H. Kobayashi: $7^{th}$ Solid State Surfaces and Interfaces.

[3]Improvement of Si solar cell performance by new chemical methods: surface passivation, defect elimination, metal removal, and surface structure transfer (invited), H. Kobayashi, W.-B. Kim: 7th Solid State Surfaces and Interfaces.

[4]New chemical methods improvement of Si solar cell performance (invited), H. Kobayashi, M. Takahashi, T. Matsumoto, W.-B. Kim: The 5th Meeting of the Saudi Physical Society.

[5]Studies on formation of functional materials assisted by understanding their chemical states (invited), M. Takahashi: International conference on DV-Xα method.

[6]Ultra-low power TFTs with 10 nm stacked gate insulator fabricated by the nitric acid oxidation of Si (NAOS) method (oral), T. Matsumoto, M. Yamada, H. Tsuji, K. Taniguchi, Y. Kubota, S. Imai, S. Terakawa, H. Kobayashi: 2010 International Electron Devices Meeting.

[7]On properties of MOS structures with ultra-thin and very-thin oxides prepared on Si and 6H-SiC substrates as observed by charge version of DLTS (oral), E. Pinčík, H. Kobayashi, J. Rusnák, T. Matsumoto, M. Takahashi, R. Brunner, M. Jerger: $7^{th}$ Solid State Surfaces and Interfaces.

[8]New chemical method for improvement of Si solar cell efficiency (oral), H. Kobayashi: Nanofair 2010-Workshop.

[9]New chemical methods for improving Si solar cell characteristics (poster), H. Kobayashi, T. Matsumoto, W.-B. Kim, M. Takahashi: Nanofair 2010-8th International Nanotechnology Symposium.

[10]Ultralow power thin film transistors (TFTs) with stacked gate oxide formed by the nitric acid oxidation of Si (NAOS) method (poster), T. Matsumoto M. Yamada, H. Tsuji, Y. Kubota, S. Imai, S. Terakawa, H. Kobayashi: International Conference on Core Research and Engineering Science of Advanced Materials.

[11]Improvement of Si-based Solar Cell Conversion Efficiency by the Use of New Chemical Methods (poster), C.-H. Kim, K. Wang, W.-B. Kim, M. Takahashi, H. Kobayashi: 14th SANKEN International Symposium 2011.

[12]Ultra-low Power TFTs with Low Operation Voltage and Leakage Current Achieved by Direct Oxidation of Poly-Si Surface in Nitric Acid Solution (poster), T. Matsumoto, M. Yamada, H. Tsuji, K. Taniguchi, Y. Kubota, S. Imai, S. Terakawa, H. Kobayashi: 14th SANKEN International Symposium 2011.

**Review Papers**

New method for clleaning semiconductor materials with use of HCN, H. kobayashi, Chemistry, KAGAKUDOJIN, 65[8] (2010), 77.

**Books**

[1]Formation of oxide layer for SiC power devices T. Matsumoto, H. Kobayashi, "New technologies for SiC power devices", Science & Technology, (138-158) 2010.

**Patents**

[1]Methods of formation of insulating films, methods of semiconductor apparatuses, and eqipments for manufacturing semiconductor apparatuses H. Kobayashi, Japanese Application Patent No.2010-140069

[2]Solar cells and methods for fabricating solar cells H. Kobayashi, Japanese Application Patent No.2010-186803

[3]Semiconductor apparatuses and methods of fabricating semiconductor appratuses H. Kobayashi, Japanese Application Patent No.2010-196672

[4]Solar cells, methods of fabriccating solar cells and eqipments for fabricating solar cells H. Kobayashi, PCT/JP2010/062420

[5]Solar cells, methods of fabriccating solar cells and eqipments for fabricating solar cells H. Kobayashi, PCT/JP2010/062788

[6]Eqipments for manufacturing semiconductor apparatuses and methods of semiconductor apparatuses H. Kobayashi, PCT/JP2010/064217

[7]Methods of semiconductor apparatuses, eqipments for manufacturing semiconductor apparatuses, and materials for molds H. Kobayashi, PCT/JP2010/071966

**Contributions to International Conferences and Journals**

| | |
|---|---|
| H. Kobayashi | Applied Surface Science (Chief Editor) |
| H. Kobayashi | 7th Solid State Surfaces and Interfaces (Organaizing Committtee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics Annual Meeting | 6 papers |
| The Physical Society of Japan Annual Meeting | 3 papers |
| The Surface Science Society of Japan Annual Meeting | 5 papers |
| Conference on SiC and Related Wide Bandgap Semiconductors | 1 paper |
| 13th Conference on XAFS Spectroscopy | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science<br>M. Ikawa | Reaction of Al and Si: Application to back surface electrode of solar cells |
| Master Degree for Science<br>H.-S. Joe | Low temperature formation of $SiO_2$/4H-SiC structure by the nitric acid vapor oxidation method |

| | | |
|---|---|---|
| Master Degree for Science<br>Y. Fukaya | Low temperature formation of $SiO_2$/Si structure by the novel nitric acid oxidation method: Application to semiconductor devices | |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| H. Kobayashi | Low temperature formation of $SiO_2$/Si structure by nitric acid oxidation with using surface nano-pores | ¥17,810,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| H. Kobayashi | Japan Science and Technology Agency | Low temperature formation of TFT gate oxide layers and lower power consumption by the nitric acid oxidation method | ¥81,834,000 |
| H. Kobayashi | New Energy and Industrial Technology Development Organization | Development of high-speed and low-cost production method of SiC and SiC solar cells | ¥4,945,000 |

## Department of Metallic Materials Process

**Original Papers**

[1]Strain-Rate Dependence of Anisotropic Compression Behavior in Porous Iron with Unidirectional Pores, M. Tane, T. Kawashima, H. Yamada, K. Horikawa, H. Kobayashi, H. Nakajima: J. Mater. Res., 25 (6) (2010) 1179-1190.

[2]Fabrication of Al-3.7%Si-0.18%Mg Foam Strengthened by AlN Particle Dispersion and its Compressive Properties, Y.H. Song, M. Tane, T. Ide, Y. Seimiya, B.Y. Hur, H. Nakajima: Metal. Mater. Trans. A, 40 (8) (2010) 2104-2111.

[3]Fabrication of Lotus-type Porous Carbon Steel Slabs by Continuous Casting Technique in Nitrogen Atmosphere, M. Kashihara, S. Suzuki, Y. Kawamura, S.Y. Kim, H. Yonetani, H. Nakajima: Metal. Mater. Trans. A, 41 (9) (2010) 2377-2382.

[4]Pore Closure in Multi-Pass Cold Rolling of Lotus-type Porous Copper, H. Utsunomiya, T. Yukimoto, T. Sakai, S. Suzuki H. Nakajima: Steel Res. Int., 81 (9) (2010) 158-161.

[5]Effect of pass route and pass number of ECAE on structure and strength of lotus-type porous copper, S. Suzuki, J. Lobos, H. Utunomiya, H. Nakajima: Steel Res. Int., 81 (9) (2010) 482-485.

[6]Fabrication, properties, and applications of porous metals with directional pores, H. Nakajima: Proc. Jpn. Acad. Ser. B, 86 (9) (2010) 884-899.

[7]Tensile Deformation of Anisotropic Porous Copper with Directional Pores, M. Tane, R. Okamoto, H. Nakajima: J. Mater. Res., 25 (10) (2010) 1975-1982.

[8]Pore Morphology of Porous Al-Ti Alloys Fabricated by Continuous Casting in Hydrogen Atmosphere, T.B. Kim, M. Tane, S. Suzuki and H. Nakajima: Mater. Trans., 51 (10) (2010) 1871-1877.

[9]Fabrication of Porous High-Purity Iron with Directional Pores by Continuous Zone Melting Technique, S.K. Hyun, M. Uchikoshi, K. Miura, M. Isshiki, H. Nakajima: Mater. Trans., 51 (11) (2010) 2076-2079.

[10]Low Young's Modulus of Ti-Nb-Ta-Zr Alloys Caused by Softening in Shear Moduli c' and $c_{44}$ near Lower Limit of Body-centered Cubic Phase Stability, M. Tane, S. Akita, T. Nakano, K. Hagihara, Y. Umakoshi, M. Niinomi, H. Mori, H. Nakajima: Acta Mater., 58 (20) (2010) 6970-6978.

[11]Nanovoid Formation through the Annealing of Amorphous $Al_2O_3$ and $WO_3$ Films, R. Nakamura, T. Shudo, A. Hirata, M. Ishimaru, H. Nakajima: Scr. Mater., 64 (2) (2011) 197-200.

[12]Strength and Pore Morphology of Porous Aluminum and Porous Copper with Directional Pores Deformed by Equal Channel Angular Extrusion, T.B. Kim, M. Tane, S. Suzuki, H. Utsunomiya, T. Ide, H. Nakajima: Mater. Sci. Eng. A, 528 (6) (2011) 2363-2369.

[13]Fabrication of Porous Metals with Directional Pores through Unidirectional Solidification of Gas-Dissolved Melt, H. Nakajima: Mater. Sci. Forum, 654-656 (2010) 1452-1455.

[14]Effect of Foaming Temperature on Pore Morphology of Al/AlN Composite Foam Fabricated by Melt Foaming Method, Y.H. Song, M. Tane, T. Ide, Y. Seimiya, H. Nakajima: Mater. Sci. Forum, 658 (2010) 189-192.

[15]Dynamic Compression Behavior of Lotus-type Porous Iron, M. Tane, T. Kawashima, K. Horikawa, H. Kobayashi, H. Nakajima: Mater. Sci. Forum, 658 (2010) 193-196.

[16]Formation of Hollow and Porous Nanostructures of Iron Oxides via Oxidation of Iron Nanoparticles and Nanowires, R. Nakamura, H. Nakajima: Mater. Sci. Forum, 658 (2010) 197-200.

[17]Fabrication of Lotus-type Porous Magnesium with Anisotropic Directional Pores by Mold Casting Technique, K. Sugihara, S. Suzuki, H. Nakajima: Mater. Sci. Forum, 658 (2010) 201-206.

[18]Fabrication of Lotus-type Porous Al-Ti Alloys using the Continuous Casting Technique, T.B. Kim, S. Suzuki, H. Nakajima: Mater. Sci. Forum, 658 (2010) 207-211.

[19]Effect of Transfer Velocity on Porosity of Lotus-Type Porous Aluminum Fabricated by Continuous Casting Technique, Y. Iio, T. Ide, H. Nakajima: Mater. Sci. Forum, 658 (2010) 211-214.

[20]Effect of Addition of NiO Powder on Pore Formation in Lotus-type Porous Carbon Steel Fabricated by Continuous Casting, M. Kashihara, H. Yonetani, S. Suzuki, H. Nakajima: Mater. Sci. Forum, 658 (2010) 215-219.

[21]Effect of Pore Diameter Distribution on Heat Transfer Capacity of Lotus-Type Porous Copper Heat Sink for Air Cooling, H. Chiba, T. Ogushi, S. Ueno, H. Nakajima: Mater. Sci. Forum, 658 (2010) 220-223.

[22]Formation of Oxide Nanotubes and Bamboo-like Structures via Oxidation of Cu, Fe and Ni Nanowires, G. Matsubayashi, R. Nakamura, H. Tsuchiya, S. Fujimoto, H. Nakajima: Mater. Sci. Forum, 658 (2010) 232-235.

[23]Fabrication of Lotus-Type Porous Iron by Thermal Decomposition Method, T. Ide, T. Wada, H. Nakajima: Mater. Sci. Forum, 658 (2010) 240-243.

[24]Deformation of Lotus-tyoe Porous Copper in Rolling, H. Utsunomiya, T. Yukimoto, T .Sakai, S. Suzuki, H. Nakajima: Mater. Sci. Forum, 658 (2010) 328-331.

[25]Elastic and Plastic Deformation Behaviors of Lotus-type Porous Metals, M. Tane, H. Nakajima: Mater. Sci. Forum, 658 (2010) 332-335.

[26]Analysis of Deformation Behavior of Lotus-type Porous Copper by Acoustic Emission Method, R. Okamoto, M. Tane, H. Nakajima: J. Jpn. Res. Inst. Adv. Copper-base Mater. Tech., 49 (1) (2010) 190-193.

[27]Deformation and Improvement of Mechanical Properties of Lotus-type Porous Copper through ECAE, S. Suzuki, J. Lobos, H. Utunomiya, H. Nakajima: J. Jpn. Res. Inst. Adv. Copper-base Mater. Tech., 49 (1) (2010) 244-248.

[28]Heat Transfer Capacity of Lotus-type Porous Copper Heat Sink for Air Cooling, H. Chiba, T. Ogushi, H. Nakajima: Journal of Thermal Science and Technology, 5 (2) (2010) 222-237.

[29]Application of Lotus-type Porous Metals to Heat Sink for Air Cooling, H. Nakajima: Proceedings of the International Cellular Materials (CELLMAT2010), (2010) 143-147.

[30]Fabrication of Lotus-type Porous Aluminum by Continuous Casting Technique, T. Ide, Y. Iio, H. Nakajima: Proceedings of the 12th International Conferrence on Aluminium Alloys, (2010) 1639-1644.

[31]Development of Heat Sinks for Air Cooling and Water Cooling Using Lotus-type Porous Metals, H. Chiba, T. Ogushi, H. Nakajima: Proceedings of the ASME/JSME 2011 8th Thermal Engineering Joint Conference, (2011) 1-9.

[32]Effect of Conditions of Unidirectional Solidification on Microstructure and Pore Morphology of Al-Mg-Si Alloys, T.B. Kim, S. Suzuki, H. Nakajima: Mater. Trans., 51 (3) (2010) 496-502.

[33]Fabrication of Hollow Nano Particles of Metallic Oxides Through Oxidation Process, H. Nakajima, R. Nakamura: Mater. Sci. Forum, 638-642 (2010) 67-72.

[34]Investigation of The Mechanical Properties of Lotus-Type Porous Carbon Steel Made by Continuous Zone Melting Technique, T. Kujime, H. Nakajima: Mater. Sci. Forum, 638-642 (2010) 1866-1871.

[35]Appearance of a Plateau Stress Region during Dynamic Compressive Deformation of Porous Carbon Steel with Directional Pores, Y.H. Song, M. Tane, H. Nakajima: Scr. Mater., 64 (2011) 797-800.

**International Conferences**

[1]Fabrication of Porous Metals with Directional Pores through Unidirectional Solidification of Gas-Dissolved Melt (oral), H. Nakajima: The 7th Pacific Rim International Conference on Advanced Materials and Processing(PRICM7).

[2]Fabrication of Lotus-type Porous Aluminum by Continuous Casting Technique (oral), T. Ide, Y. Iio, H. Nakajima: The 12th International Conferrence on Aluminium Alloys.

[3]Effect of Pass Route and Pass Number of Equal-Channel Angular Extrusion on Structure and Strength of Lotus-type Porous Copper (oral), S. Suzuki, J. Lobos, H. Utsunomiya, H. Nakajima: The 13th International Conference on Metal Forming （Metal Forming 2010）.

[4]Pore Closure in Multi-pass Cold Rolling of Lotus-type Porous Copper (oral), H. Utsunomiya, T. Yukimoto, T. Sakai, S. Suzuki, H. Nakajima: The 13th International Conference on Metal Forming （Metal Forming 2010）.

[5]Application of Lotus-type Porous Metals to Heat Sink for Air Cooling (invited), H. Nakajima, H. Chiba, T. Ide, T. Ogushi: Cellular Materials (CELLMAT2010).

[6]TEM Analysis on Nanovoid Formation in Annealed Amorphous Oxides (oral), R. Nakamura, T. Shudo, A. Hirata, M. Ishimaru, H. Nakajima: The 12th the International Symposium on Eco-materials Processing and Design (ISEPD2011).

[7]Tensile Deformation of Lotus-type Porous Copper (oral), M. Tane, R. Okamoto, H. Nakajima: The 12th the International Symposium on Eco-materials Processing and Design (ISEPD2011).

[8]Improvement of Strength of Lotus-type Porous Aluminium through ECAE process (poster), T. B. Kim, M. Tane, S. Suzuki, T. Ide, H. Utsunomiya, H. Nakajima: The 12th the International Symposium on

Eco-materials Processing and Design (ISEPD2011).

[9]Formation of Nanoporous Structures through Annealing of Amorphous Oxide Films (poster), R. Nakamura, T. Shudo, M. Ishimaru, A. Hirata, H. Nakajima: 14th Sanken International Symposium 2011/9th Sanken Nanotechnology Symposium.

[10]Development of Heat Sinks for Air Cooling and Water Cooling Using Lotus-Type Porous Metals (oral), H. Nakajima, H. Chiba, T. Ogushi: The 8th ASME-JSME Thermal Engineering Joint Conference (AJTEC2011).

**Review Papers**

Fabrication of hollow oxide nanoparticles and nanotubes through oxidation reaction, R. Nakamura, H. Nakajima, Kinzoku, AGNE GIJUTSU CENTER, 80[9] (2010), 757-762.

Fabrication of lotus-type porous metals by thermal decomposition method, T. Ide, H. Nakajima, Kinzoku, AGNE GIJUTSU CENTER, 80[10] (2010), 823-828.

Deformation of Lotus-type Porous Metals, M. Tane, H. Nakajima, Kinzoku, AGNE GIJUTSU CENTER, 80[10] (2010), 837-843.

Plastic Deformation Processes of Lotus-type Porous Metals, S. Suzuki, J. L.obos Martin, H. Utsunomiya, H. Nakajima, Journal of the Japan Society for Technology of Plasticity, The Japan Society for Technology of Plasticity, 52[601] (2011), 206-201.

Properties of Lotus-type Porous Metals, H. Nakajima, S. Suzuki, Encyclopedia of Materials: Science and Technology, Elsevier, (2010), 1-5.

Fabrication of Lotus-type Porous Metals, H. Nakajima, M. Tane, Encyclopedia of Materials: Science and Technology, Elsevier, (2010), 6-10.

**Patents**

[1]Heat sink H. Chiba, T. Ogushi, H. Nakajima, Japan Patent Number 4458872

[2]Heat sink and method of producing the same H. Chiba, T. Ogushi, H. Nakajima, China641709

[3]Manufacturing method of porous metal bodies H. Nakajima, S.K. Hyun, Japan Patent Number 4621938

[4]Metal bodies with deformed sections and its manufacturing methods H. Utsunomiya, H. Tsuruoka, S. Suzuki, H. Nakajima, JP2011-62677

**Contributions to International Conferences and Journals**

| | |
|---|---|
| H. Nakajima | 7th International Conference on Porous Metals and Metallic Foams (MetFoam2011) (Organizing Committee) |
| H. Nakajima | High Temperature Materials and Progress (Editorial Board Member) |
| H. Nakajima | Diffusion and Defect Data (Editorial Board Member) |
| H. Nakajima | Materials Science Foundations (Editorial Board Member) |
| H. Nakajima | International Conference on New Frontiers of Process Science and Engineering in Advanced Materials (Organizing Committee Member) |
| H. Nakajima | 7th International Conference on Diffusion in Solids and Liquids (Organizing Committee Member) |
| H. Nakajima | International Conference on Eco-Materials Processing and Design 2012 (Organizing Committee Member) |
| H. Nakajima | 4th International Symposium on Cellular Metals for Structural and Functional |

| | | |
|---|---|---|
| | Applications (Program Committee) | |
| H. Nakajima | International Conference on Advanced Structure and Functional Materials Design (Organizing Committee Member) | |
| H. Nakajima | Metals (Editional Board) | |
| H. Nakajima | International Symposium on Eco-materials and Eco-innovation for Global Sustainability (Organizing Committtee) | |
| R. Nakamura | 8th International Conference on Diffusion in Materials (DIMAT2011) (International Committee) | |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Institute of Metals | 15 papers |
| The Japan Institute of Light Metals | 3 papers |
| The Japan Copper and Copper Alloys Research Association | 2 papers |
| Japan Heat Transfer Symposium | 2 papers |

**Academic Degrees**

| | |
|---|---|
| Doctor Degree for Engineering<br>T.B. Kim | Fabrication of Porous Aluminum Alloys with Directional Pores and Improvement of Strength through ECAE Process |
| Master Degree for Engineering<br>Y. Iio | Fabrication of Lotus-type Porous Aluminum by Continuous Casting Technique |
| Master Degree for Engineering<br>T. Shudo | Formation Mechanism of Nanoporous Oxides via Annealing of Amorphous Oxides' Films |
| Master Degree for Engineering<br>S. Nakano | Nanovoid Formation by Change in Amorphous Structure through the Annealing of Amorphous Al2O3 Thin Films |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| H. Nakajima | Development of porous implants anchored with bone structure fabricated by micromachining | ¥30,810,000 |
| H. Nakajima | Development of unidirectionally porous metals using metal-gas compounds and application for electronic and medical materials | ¥900,000 |
| M. Tane | Development of beta-phase titanium alloys with low Young's modulus | ¥910,000 |
| R. Nakamura | Formation of nanoporous structures through crystallization of amorphous oxides | ¥1,300,000 |
| T. Ide | Fabrication of lotus-type porous metal through thermal decomposition of gas compound by continuous casting technique | ¥1,300,000 |

**Contribution to Research**

| | | |
|---|---|---|
| H. Nakajima | The Japan Institute of Light Metals | ¥250,000 |
| H. Nakajima | Nagaki Seiki Co., Ltd. | ¥1,000,000 |
| H. Nakajima | Lotus Alloy Co., Ltd. | ¥68,000 |
| H. Nakajima | Fukuda Hiroshi Co., Ltd. | ¥500,000 |
| H. Nakajima | Japan Light Metals Co., Ltd. | ¥1,000,000 |

**Cooperative Research**

| | | |
|---|---|---|
| H. Nakajima | Toyota Motor Corporation | ¥9,372,000 |

**Other Research Fund**

| | | |
|---|---|---|
| H. Nakajima | JSPS Bilateral Joint Projects | ¥1,200,000 |
| M. Tane | Grants-in-Aid for Young Scientists in Global COE Program (Center of Excellent for Advanced Structural and Functional Materials Design) | ¥1,000,000 |
| R. Nakamura | Grants-in-Aid for Young Scientists in Global COE Program (Center of Excellent for Advanced Structural and Functional Materials Design) | ¥1,100,000 |
| T. Ide | Grants-in-Aid for Young Scientists in Global COE Program | ¥1,300,000 |

(Center of Excellent for Advanced Structural and Functional Materials Design)

## Department of Advanced Interconnection Materials

### Original Papers

[1]Sn-Ag-Cu Soldering Reliability as Influenced by Process Atmosphere, A. Baated, J. Jiang, K.-S Kim, K. Suganuma, S.Huang, B. Jurcik, S. Nozawa, and M.Ueshima.: IEEE Transactions on Electronics Packaging Manufacturing, 33 (1) (2010) 38-43.

[2]Effects of reflow atmosphere and flux on Sn whisker Growth of Sn-Ag-Cu solders, A. Baated, K-S. Kim, K. Suganuma, S. Huang, B. Jurcik, S. Nozawa, and M. Ueshima: Journal of Material Science : Materials in Electronics, 21 (10) (2010) 1066-1075.

[3]Whisker Growth from an Electroplated Zinc Coating, A. Baated, K-S. Kim, K. Suganuma: Journal of Material Research, 25 (11) (2010) 2175-2182.

[4]Effects of Zn-Bearing Flux on Joint Reliability and Microstructure of Sn-3.5Ag Soldering on Electroless Ni-Au Surface Finish, H. Sakurai, Y. Kukimoto, S. Kim, A. Baated, K. Lee, K-S. Kim, S. Kumamoto, and K.Suganuma.: Japan. Mater. Trans., 51 (10) (2010) 1727-1734.

[5]Effects of Zn-containing Flux on Sn-3.5Ag Soldering with an Electroless Ni-P/Au Surface Finish: Microstructure and Wettability, H. Sakurai, S. Kim, A. Baated, K. Lee, K-S. Kim, Y.i Kukimoto, S. Kumamoto and K.Suganuma: Journal of Electronic Materials, 39 (12) (2010) 2598-2604.

[6]Die bonding for a nitride light-emitting diode by low-temperature sintering of micrometer size silver particles, M. Kuramoto, S. Ogawa, M. Niwa, K.S. Kim, K. Suganuma: IEEE T. Compon. Pack. T., 33 (4) (2010) 801-808.

[7]Ag nanoparticles paste synthesis for room temperature bonding, D. Wakuda, K.S. Kim, K. Suganuma: IEEE T. Compon. Pack. T., 33 (2) (2010) 437-442.

[8]Electro-migration Phenomenon in Flip-chip Packages(KOR), K. Lee, K-S. Kim, and K. Suganuma: Journal of the Microelectronics & Packaging Society, 17 (4) (2010) .

[9]Synthesis of silver nanorods and application for die attach materials in devices, J. Jiu, K. Murai, K-S. Kim,and K. Suganuma: J. Mater. Sci.: Mater Electron, (21) (2010) 713.

[10]Effect of substrate materials on Sn whisker growth, K-S.Kim, K. Suganuma.Y.Yorikado ,K.Lee, A. Baated M. Tsujimoto: Copper and copper alloy, (49) (2010) 122-115.

[11]Low-temperature wiring with Ag nanoinks, K. Suganuma, D. Wakuda, M. Hatamura, M. Nogi: IEEE Nanotechnology Magazine, 4 (3) (2010) 20-23.

[12]Transmission electron microscopy study on microstructure of Ag-based conductive adhesives, N. Kawamoto, Y. Murakami, D. Shindo, Y. Hayasaka, T. Kan, K. Suganuma: Mater.Trans., 51 (10) (2010) 1773-1778.

[13]Electrical Resistance and Microstructural Changes of Silver–Epoxy Isotropic Conductive Adhesive Joints Under High Humidity and Heat, S.-S. Kim, K.-S. Kim, K. Lee, S. Kim, K. Suganuma, H. Tanaka: J.Electron. Mater., 40 (2) (2011) 232-238.

[14]Ultra heat-shock resistant die-attachment for silicon carbide with pure zinc, K. Suganuma, S. Kim: IEEE Electron Device Letters, 31 (12) (2010) 1467-1469.

[15]Die-Bonding for a Nitride Light-Emitting Diode by Low-Temperature Sintering of Micrometer Size Silver Particles, M. Kuramoto, S. Ogawa, M. Niwa, K.-S. Kim, K. Suganuma: IEEE Trans.CPMT, 33 (4) (2010) 801-808.

[16]Stretchable fine fiber with high conductivity fabricated by injection forming, D. Wakuda, K. Suganuma: Appl. Phys. Letters, (98) 073304.

[17]Development of a cryogenic-stage for an ion-milling instrument, M. Terauchi, F. Satou, H. Sugizaki, K. Suganuma: Microscopy, 60 (1) (2011) 25-27.

[18]Effects of the crystallographic orientation of Sn on the electromigration of Cu/Sn-Ag-Cu/Cu ball joints, K. Lee, K.-S. Kim, K. Suganuma, Y. Tsukada, K. Yamanaka, S. Kuritani, M.Ueshima: J.Mater.Res., 26 (3) (2011) 467-474.

[19]Formation mechanism of nanostructured Ag films from Ag2O particles using a sonoprocess, M. Inoue, Y. Hayashi, H. Takizawa, K. Suganuma: Colloid and Polymer Science, 288 (2010) 1061-1069.

[20]Optimization of the Mechanical Performance of Bacterial Cellulose/Poly(L-lactic) Acid Composites, F. Quero, M. Nogi, H. Yano, K. Abdulsalami, S. M. Holmes, B. H. Sakakini, and S. J. Eichhorn: ACS Applied Materials & Interfaces, (2) (2010) 321-330.

[21]Microstructure and mechanical properties of bacterial cellulose/chitosan porous scaffold, T. T. Nge, M. Nogi, H. Yano, J. Sugiyama: Cellulose, (17) (2010) 349-363.

[22]Fibrillation of dried chitin into 10-20 nm nanofibers by a simple grinding method under acidic conditions, S. Ifuku, M. Nogi, M. Yoshioka, M. Morimoto, H. Yano, H. Saimoto: Carbohydrate Polymers, (81) (2010) 134-139.

[23]Preparation of nanofibrillar carbon from chitin nanofibers, M. Nogi, F. Kurosaki, H. Yano, M. Takano: Carbohydrate Polymers, (81) (2010) 919-924.

**International Conferences**

[1]Super Stretchable and Flexible Conductive Elastomer (oral), T. Araki, N. Nogi, K. Suganuma: .

[2]Mechanism for Spontaneous Zinc Whisker Growth from an Electroplated Zinc Coating, (oral), Alongheng Baated, Keun-Soo Kim, and Katsuaki Suganuma: .

[3]Super Stretchable and Flexible Conductive Elastomer (oral), T. Araki, N. Nogi, K. Suganuma: The 2010 International Conference on Flexible and Printed Electronics in Hsinchu, Taiwan, on October 28, 2010.

[4]Mechanism for Spontaneous Zinc Whisker Growth from an Electroplated Zinc Coating, (oral), Alongheng Baated, Keun-Soo Kim, and Katsuaki Suganuma: Proceedings of the 24th JIEP Annual Meeting.

[5]Intermetallic Growth Rate Effects on Spontaneous Whisker Growth from Tin Coating on Copper (oral), Alongheng Baated, Keun-Soo Kim, and Katsuaki Suganuma: International Conference on Electronics Packaging.

[6]Low Temperature Nano-Ag Wiring on Textiles by Ink-jet print (oral), J. Jiu, K. Suganuma, C. Kim, D. Wakuda, M. Nogi, Y. Linm P. Chen: Proceedings of ICFPE 2010.

[7]Effect of Zn-Containing Flux on the Joint Strength and Microstructure of Sn-3.5Ag Soldering on an Electroless Ni-Au Surface Finish (oral), H. Sakurai, Y. Kukimoto, K. Suganuma: 2010 TMS Annual

Meeting & Exhibition.

[8]Effects of crystallographic orientation of Sn on electromigration behavior (oral), K. Lee, K.S. Kim, K. Yamanaka, Y. Tsukada, S. Kuritani, M. Ueshima, K. Suganuma: IMAPS 2010.

[9]Effects of the crystallographic orientation of Sn grain during electromigration test (oral), K. Lee, K. S. Kim, K. Yamanaka, Y. Tsukada, S. Kuritani, M. Ueshima, K. Suganuma: IEEE CPMT Symposium Japan.

[10]The effect of microvia-in-pads design on SMT defects in ultra-small component assembly (oral), Y.W. Lee, K.S. Kim, K. Suganuma: 2010 International Conference on Electronic Packaging Technology & High Density Packaging.

[11]Intermetallic growth rate effects on spontaneous whisker growth from Tin coating on copper (oral), A. Baated, K.S. Kim, K. Suganuma: International Conference on Electronics Packaging (ICEP 2010).

[12]Prevention technologies of whisker growth for reliable electronic (invited), K.Suganuma: 11th JIC meeting (Jisso International Council)　May, 26th -28th 2010 , Kyoto.

[13]Tin Whisker Mitigation Project of JEITA (oral), K. Suganuma: 4th International Symposium on Tin Whiskers, June 23-24, Maryland,2010.

[14]Evaluation of Conformal Coating for Mitigation of Tin Whisker Growth (Part II) (oral), T. Nakagawa, T. Yamada, N. Nemoto, K. Suganuma: 4th International Symposium on Tin Whiskers, June 23-24, Maryland, (2010).

[15]Tin Whisker Evaluation Status for Space Application (oral), N. Nemoto, T. Nakagawa, T. Yamada, K. Suganuma: 4th International Symposium on Tin Whiskers, June 23-24, Maryland, (2010).

[16]High temperature lead-free solders(Plenary) (oral), K. Suganuma: The Discussion Meeting on Thermodynamics of Alloys (TOFA 2010), Sep.12-16, 2010, Porto, Portugal.

[17]Low temperature wiring with silver nano-inks (oral), K.Suganuma: US-Japan Nanotechnology Overview and Young Researchers Exchange Program on Nanomanufacuturing　: Univ Illinois Urbana-Champaign, Oct.3-4, (2010).

[18]Low Temperature Wiring Technology for Printed Electronics (invited), K. Suganuma, M. Nogi, M. Hatamura, T. Araki, J. Jiu: The 17th International Display Workshops(IDW10), Fukuoka, Japan, Dec. 1–3, 2010.

[19]Effects of Cu-bearing Flux on Sn-3.5Ag Soldering with Electroless Ni-P/Au Surface Finish: Microstructure and Joint Reliability (oral), H. Sakurai, K-S. Kim, Y. Kukimoto, K. Suganuma: 2011 TMS Annual Meeting & Exhibition, San Diego, CA, USA, Feb.27-Mar.3, 2011.

[20]Whisker Growth Behavior in a High Vacuum with Thermal Cycling (oral), K-S. Kim, J. Jo, K. Lee, A. Baated, K. Suganuma, N. Nemoto, T. Nakagawa, T. Yamada: 2011 TMS Annual Meeting & Exhibition.

[21]Electromigration Behavior of Sn-In Lead-Free Solder Alloy Under High Current Stress (poster), K. Lee, K-S. Kim, K. Suganuma: TMS, 140th Annual Meeting & Exhibition February 27 - March 3, 2011San Diego Convention Center, California USA.

[22]Optically transparent substrates from plants nanofibers for printed electronics (oral), M. Nogi, K.Suganuma, and H. Yano: Proceedings of LOPE-C 2010.

[23]Aging effects on electrical and thermal conductivities of electrically conductive adhesives composed

with a heat-resistant epoxy binder (oral), M. Inoue, H. Muta, S. Yamanaka, J. Liu: International Conference on Electronics Packaging 2010 (ICEP2010), Sapporo, Japan, May 12-14, 2010.

[24]Thermal conductivity in the vertical direction of heat-resistant epoxy based conductive adhesives with multimodal filler size distributions (oral), M. Inoue, H. Muta, S. Yamanaka, J. Liu: Electronics System Integration Technologies Conference 2010 (ESTC2010), Berlin, Germany, Sep. 13-16, 2010.

**Review Papers**
Domestic and global trends in printed electronics, K.Suganuma, M.Nogi, , (34(6)), 2010.

Low-Temperature Wiring with Ag Nanoinks, K. Suganuma, D. Wakuda, M. Hatamura, M. Nogi, IEEE Nanotechnology Magazine, (4(3)), 2010.

Control of tin whiskers, K-S. Kim, K. Suganuma, (62(3)), 2010.

R&D of metallic nano-ink for printed electronics, K.Suganuma, D. Wakuda .M. Nogi, Techno Times Co., Ltd, (16(5)), 2010.

Technologies and materials for printed electronics, K.Suganuma, M.Nogi, , (J93-C(11)), 2010.

Review: current international research into cellulose nanofibers and nanocomposites, S. J. Eichhorn, A. Dufresne, M. Aranguren, N. E. Marcovich, J. R. Capadona, S. J. Rowan, C. Weder, W. Thielemans, M. Roman, S. Renneckar, W. Gindl, S. Veigel, J. Keckes, H. Yano, K. Abe, M. Nogi, A. N. Nakagaito, A. Mangalam, J. Simonsen, A. S. Benight, A. Bismarck, L. A. Berglund, T. Peijs, K, J. Mater. Sci., (45), 2010.

Displays from transparent films of natural nanofibers, A. N. Nakagaito, M. Nogi, H. Yano, MRS Bulletin, (25(1)), 2010.

Importances of scientific supports, K.Suganuma, IPEA Journal、vol.22、No.8(2010),pp.3.（Aug ）.

Mechanims of conductive pastes, K.Suganuma, Parity、Vol.25、No.10(2010)、pp.46-51.（Oct） .

Present technologies in printed electronics, K.Suganuma, M.Nogi, , 46 (2010), 358-363.

Electrical and thermal conductivities of electrically conductive adhesives, M. Inoue, Journal of the Adhesion Society of Japan, The Adhesion Society of Japan, 47[1] (2011), 23-34.

Novel concept for electrically conductive adhesives with high thermal conductivity, M. Inoue, Materials Science and Technology, The Materials Science Society of Japan, 48[1] (2011), 2-6.

Synthesis of metal nanoparticles using the liquid-solid sonochemical reaction, Y. Hayashi, M. Inoue, Ultrasonic Technologies, Japan Industrial Publishing, 2011-1,2 (2011), 56-63.

**Books**
[1]Trends in printed electronics K.Suganuma, “cmc”, 2010 .

[2]Improvements of relasbilities in conductive pastes K.Suganuma, “Science＆Technology”, 51 .

[3]Lead-free and advance interconnection materials for electronics K.Suganuma, “Mater. Trans.,”, .

[4]Thermal conductivity of electrically conductive adhesives(Y. Takezawa) M. Inoue, “Advanced composites having high thermal conductivities”, CMC Publishing, (215-223) 2011.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| K.Suganuma | Technical committee (TC) for Emerging Technologies(The 11th International Conference on Electronic Packaging Technology & High Density Package, ICEPT-HDP 2010 (Technical committee) |
| K.Suganuma | IEEE Nanotechnology Council's Nanopackaging Technical Committee (Technical committee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| 20th Micro- Electronic Symposium | 3 papers |
| 25th JIEP Annual Meeting | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science<br>N.Cho | Fabrication of conductive lines using silver nanoparticles inks |
| Doctor Degree for Engineering<br>A. Baated | Influnces of Interface Intermetallic Compound Growth and Oxidation on Growth of Sn and Zn Whiskers |
| Doctor Degree for Engineering<br>K.Kuramoto | Die Bonding for a Nitride Light-Emitting Diode by Low-Temperature Sintering of Micrometer Size Silver Particles. |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| K.Suganuma | Mechanism elucidation and prevention of Sn whisker growth for aerospace electronics | ¥12,090,000 |
| M. Nogi | Conductive pastes for electronics devices using bio-nanofibers | ¥4,940,000 |
| M. Nogi | Bio-nanofiber substrates using printed electronics | ¥1,700,000 |
| M. Nogi | Printed electronics with bio-nanofibers | ¥43,000,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| K.Suganuma | Reliability Center for Electronic Components of Japan | Standardization of conductive adhesive testing methods | ¥1,417,000 |
| K.Suganuma | NEC Co.Ltd. | Development of interconnecting technology using conductive Adhesives | ¥525,000 |

**Contribution to Research**

| | | |
|---|---|---|
| K.Suganuma | DaiselChemical Industries,Ltd | ¥500,000 |
| K.Suganuma | C.Uyemura & Co.,Ltd | ¥1,000,000 |
| K.Suganuma | Bando Chemical Industries , Ltd | ¥500,000 |
| K.Suganuma | Showa Denko K.K. | ¥2,000,000 |
| K.Suganuma | NGK Spark Plug Co., Ltd. | ¥400,000 |

**Cooperative Research**

| | | |
|---|---|---|
| K.Suganuma | Mitsubishi Electric Corp. | ¥2,000,000 |
| K.Suganuma | Toppan Forms Co., Ltd. | ¥3,000,000 |
| K.Suganuma | FUJITSU TEN LIMITED | ¥3,105,000 |
| K.Suganuma | The Yokohama Rubber Company, Limited | ¥1,001,000 |
| K.Suganuma | C. Uyemura & Co., Ltd. | ¥420,000 |
| K.Suganuma | Mitsubishi Chemical Corp. | ¥2,100,000 |
| K.Suganuma | Kishu Giken Kogyo Co., Ltd. | ¥5,000,000 |
| K.Suganuma | NGK Spark Plug Co., Ltd. | ¥1,000,000 |
| K.Suganuma | NOF CORPORATION | ¥3,500,000 |
| K.Suganuma | Nippon Avionics Co.,Ltd. | ¥1,100,000 |

## Department of Excited Solid-State Dynamics

**Original Papers**

[1]The effect of van der Waals interactions on the properties of intrinsic defects in graphite, G.Teobaldi,,

H. Ohnishic, K. Tanimura, and A. L. Shluger: Carbon, 48 (2010) 4145-4161.

[2]The structure and properties of surface and sub-surface defects in graphite accounting for van der Waals and spin-polarization effects, G. Teobaldi, K. Tanimura, and A. L. Shluger: Phys. Rev. B, 82 (2010) 82, 174104-1-14.

**Review Papers**
Ultrafast Time-resolved electron diffraction based on photocathode RF gun generating MeV electron pulses, N. Naruse, Y. Murooka, J. Yang, and K. Tanimura, Journal of Particle Accelerator Society of Japan, Particle Accelerator Society of Japan, 7(4) (2010), 261-270.

Nano-scale sp2-sp3 conversion by visible lights irradiation and photoinduced phase transitions, （T.Naito）, Molecular electronic and related materials-Control and probe with light, Transworld Research Network, Kerala, India, (2010), 281-303.

Ultrafast carrier dynamics on Si surfaces by time-resolved two-photon photoemission spectroscopy, Manufacturing and Technology, , 63 (2011), 64-66.

## Department of Accelerator Science

**Original Papers**
[1]Short-Range Longitudinal Wake Field and Its Effect on the Energy Spectrum in a Linear Accelerator, Tetsuya Igo, Ryukou Kato, Shigeru Kashiwagi, and Goro Isoyama: Jpn. J. Appl. Phys., 49 (2010) 06301.

[2]Effect of humidity and temperature on polymer electrolyte membrane (Nafion 117) studied by positron annihilation spectroscopy, Y. Shibahara, H.S. Sodaye, Y. Akiyama, S. Nishijima, Y. Honda, G. Isoyama, S. Tagawa: J. Power Sources, 195 (2010) 5934-5937.

[3]Proton inelastic scattering to the dilute -cluster condensed 0+2 state at Ex=7.654 MeV in 12C, A. Okamoto, T. Yamagata, H. Akimune, M. Fujiwara, K. Fushimi, M. B. Greenfield, K. Hara, K. Y. Hara, H. Hashimoto, R. Hayami, K. Kawase, M. Kinoshita, K. Nakanishi, S. Nakayama, M. Tanaka, H. Utsunomiya, N. Warashina, and M. Yosoi: Phys. Rev. C, 81 (2010) 54604.

[4]Metrology of Wide Field of View Nano-Thickness Foils' Homogeneity by Conventional and Phase Contrast Soft X-ray Imaging, A. Faenov, T. Pikuz, Y. Fukuda, M. Kando, H. Kotaki, T. Homma, K. Kawase, I. Skovelev, S. Gasilov, T. Kawachi, H. Daido, T. Tajima, Y. Kato, and S. Bulanov: Jpn. J. Appl. Phys., 49 (2010) 06GK03.

[5]Intense and Reproducible K¥alpha Emissions from Micron-Size Kr Cluster Target Irradiated with Intense Femtosecond Laser Pulses, Y. Hayashi, Y. Fukuda, A. Ya. Faenov, M. Kando, K. Kawase, T. A. Pikuz, T. Homma, H. Daido, and S. V. Bulanov: Jpn. J. Appl. Phys., 49 (2010) 126041.

[6]Manipulation and electron-oscillation-measurement of laser accelerated electron beams, H. Kotaki, Y. Hayashi, K. Kawase, M. Mori, M. Kando, T. Homma, J.K. Koga, H. Daido, and S.V. Bulanov: Plasma Phys. Control. Fusion, 54 (2010) 014009.

[7]Observation and modeling of high resolution spectral features of the inner-shell X-ray emission produced by 10^{-10} contrast femtosecond-pulse laser irradiation of argon clusters, J. Colgan, J. Abdallah Jr., A. Ya. Faenov, T.A. Pikuz, I. Yu. Skobelev, Y. Fukuda, Y. Hayashi, A. Pirozhkov, K. Kawase, T. Shimomura, H. Kiriyama, Y. Kato, S.V. Bulanov, M. Kando: High Energy Density Physics, 7 (2011) 77.

**International Conferences**
[1]High power operation of the THz FEL at ISIR, Osaka University (poster), R. Kato, S. Kashiwagi, Y.

Morio, K. Furuhashi, Y. Terasawa, N. Sugimoto, G. Isoyama, S. Yamamoto, K. Tsuchiya: AIP Conference Proceedings 1214.

[2]Development of an L-band RF electron gun for SASE in the infrared region (poster), S. Kashiwagi, R. Kato, G. Isoyama, H. Hayano, J. Urakawa: AIP Conference Proceedings 1214.

[3]Development of a Photocathode RF Gun for the L-band Linac at ISIR, Osaka University (poster), S. Kashiwagi, K. Furuhashi, G. Isoyama, R. Kato, M. Morio, N. Sugimoto, Y. Terasawa, H. Hayano, H. Sugiyama, Y. Takahashi, T. Takatomi, J. Urakawa, H. Iijima, M. Kuriki: The 1st International Particle Accelerator Conference (IPAC'10), Kyoto, Japan, May 23-28, 2010.

[4]High Power Terahertz FEL at ISIR, Osaka University (poster), R. Kato, S. Kashiwagi, Y. Morio, K. Furuhashi, Y. Terasawa, N. Sugimoto, S. Suemine, G. Isoyama, K. Tsuchiya, S. Yamamoto: The 1st International Particle Accelerator Conference (IPAC'10), Kyoto, Japan, May 23-28, 2010.

[5]Elimination of Hall Probe Orientation Error in Measured Magnetic Field of the Edge-focusing Wiggler (poster), S. Kashiwagi, R. Kato, G. Isoyama, K. Tsuchiya, S. Yamamoto: The 1st International Particle Accelerator Conference (IPAC'10), Kyoto, Japan, May 23-28, 2010.

[6]Performance of the L-Band Electron Linac for Advanced Beam Sciences at Osaka University (poster), G. Isoyama, R. Kato, S. Kashiwagi, Y. Morio, Y. Terasawa, K. Furuhashi, N. Sugimoto, J. Shen, S. Hirata, M. Fujimoto, S. Suemine: The 1st International Particle Accelerator Conference (IPAC'10), Kyoto, Japan, May 23-28, 2010.

[7]Development of a High Average Power Laser Generating Electron Beam in ILC Format for KEK-STF (poster), M. Kuriki, H. Iijima, H. Hayano, Y. Honda, H. Sugiyama, J. Urakawa, G. Isoyama, S. Kashiwagi, R. Kato, E. Katin, E. Khazanov, V. Lozhkarev, G. Luchinin, A. Poteomkin, G. Shirkov, G. Trubnikov: The 1st International Particle Accelerator Conference (IPAC'10), Kyoto, Japan, May 23-28, 2010.

[8]Development of a Thermionic Electron Gun of the L-band Linac for FEL Operation (poster), N.Sugimoto, G. Isoyama, R. Kato, S. Suemine, A. Tokuchi, S. Kashiwagi: The 25th International Linear Accelerator Conference (LINAC10), Tsukuba, Japan, 12-17 September 2010.

[9]Development of an L-band RF Gun for High-duty-cycle Operation (poster), G. Isoyama, R. Kato, N. Sugimoto, M. Kuriki, H. Hayano, H. Sugiyama, T. Takatomi, J. Urakawa, S. Kashiwagi: The 25th International Linear Accelerator Conference (LINAC10), Tsukuba, Japan, 12-17 September 2010.

[10]Electronic States of One-dimensional Ca1-xNaxCo2O4 Probed by IR-THz Spectroscopy (poster), Akinori Irizawa, M. Isobe, R. Kato, G. Isoyama: International Conference on Infrared, Millimeter, and Teraherz Waves (IRMMW-THz 2010), Rome, Italy, September 5-10, 2010.

[11]IR-THz Spectroscopy on Solids utilizing High-Intensity FEL at ISIR (poster), A. Irizawa, R. Kato, K. Kawase, N. Sugimoto, Y. Terasawa, M. Fujimoto, J. Shen, S. Hirata, and G. Isoyama: The 14th SANKEN International Symposium 2011, Otsu, Japan, January 25-26, 2011.

[12]Development of the edge-focus wiggler for FEL and SASE (invited), Goro Isoyama: China-Korea-Japan Joint Workshop on electron/photon sources and applications, Shanghai Institute of Applied Physics (SINAP), Shanghai, China, December 2-3, 2010.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| R. KATO | The 1st International Particle Accelerator Conference (IPAC'10), Kyoto, Japan, May 23-28, 2010 (Local Organaizing Committtee, Executive Board) |
| G. ISOYAMA | The 25th International Linear Accelerator Conference (LINAC10), Tsukuba, Japan, 12-17 September 2010 (Local Organaizing Committtee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Particle Accelerator Society of Japan | 4 papers |
| The Physics Society of Japan | 3 papers |
| Topical Meeting for FEL & High Power Radiation | 3 papers |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science<br>N. Sugimoto | Development of Thermionic Electron Gun using High-Repetition Grid Pulser |
| Master Degree for Science<br>Y. Terasawa | Research and Development of Short-Pulse Grid Pulser for L-band Linac Electron Gun |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| R. Kato | Development of a high resolution slice emittance measurement metyhod | ¥1,040,000 |
| A. Irizawa | Upgrading of spectromicroscopy under multi-extreme conditions and the study of strongly-correlated electron systems | ¥2,340,000 |
| K. Kawase | Development of the two focal points laser oscillator for the intense Compton backscattered gamma-ray source | ¥2,340,000 |

## Department of Beam Materials Science

**Original Papers**

[1]Evidence of formation of adenine dimer cation radical in DNA The Importance of Adenine Cation Base Stacking, Kazuo Kobayashi: J. Phys. Chem. B, 114 (2010) 5600-5604.

[2]Catalysis and Oxygen Binding of EcDOS, a Heme-based Oxygen sensor Enzyme from Escherichia coli, Kazuo Kobayashi, Asunari Tanaka, Hiroto Takahashi, Jotaro Igarashi, Yukako Ishituka, and Toru Shimizu: J. Biochem., 148 (6) (2010) 693-703.

[3]Important Roles of Tyr43 at the Putative Heme Distal Side in Oxygen Recognition and Stability of the Fe(II)-O2 Complex of YddV, a Globin-Coupled Heme-Oxygen Sensor Diguanylate Cyclase, Kenichi Kitanishi, Kazuo Kobayashi, Yuroko Kawamura, Takashi Ogura, Kyosuke Nakajima, Jotaro Igarashi, Atsunari Tanaka, and Toru Shimizu: Biochemistry, 49 (2010) 10381-10393.

[4]A hydrogen-bonding network formed by the B10-E7-E11 residues of a truncated hemoglobin from Tetrahymena pyriformis is critical for stability of bound oxygen and nitric oxide detoxification, Jotaro Igarashi, Kazuo Kobayashi, and Ariki Matsuoka: J. Biol. Inorg. Chem., 16 (2011) 599-609.

**Review Papers**

Nanoscale charge dynamics and nanostructure formation in polymers, A. Saeki, Shu Seki, K. Kobayashi, S. Tagawa, Charged Particle and Photon Interactions with Matter: Recent Advances, Applications, and Interfaces., CRC press, (2010), 671-710.

**Publications in Domestic Meetings**

| | |
|---|---|
| Japanese Society of Radiation Chemistry | 3 papers |
| Annual Meeting of the Japan RadiationResearch Society | 1 paper |
| Japanese Biochemical Society Meeting | 2 papers |

## Department of Molecular Excitation Chemistry

**Original Papers**

[1]Photocatalytic Formation of I–I Bonds Using DNA Which Enables Detection of Single Nucleotide Polymorphisms, K. Kawai, H. Kodera, and T. Majima: J. Am. Chem. Soc., 132 (40) (2010) 14216–14220.

[2]Guanidinium-Enhanced Production of Hydrogen on Nafion-Coated Dye/$TiO_2$ under Visible Light, J. Park, J. Yi, T. Tachikawa, T. Majima, and W. Choi: J. Phys. Chem. Lett., 1 (9) (2010) 1351-13552010.

[3]Electron Transfer from Oligothiophenes in the Higher Triplet Excited States, M. Fujitsuka, T. Nakatani, M. Sakamoto, A. Sugimoto, and T. Majima: J. Phys. Chem. A, 114 (40) (2010) 10789-10794.

[4]Charge Separation and Photosensitized Damage in DNA Mediated by Naphthalimide, Naphthaldiimide, and Anthraquinone, K. Kawai, Y. Osakada, E. Matsutani, and T. Majima: J. Phys. Chem. B, 114 (31) (2010) 10195-10199.

[5]Sequence Dependence of Excess Electron Transfer in DNA, K. Tainaka, M. Fujitsuka, T. Takada, K, Kawai, and T. Majima: J. Phys. Chem. B, 114 (45) (2010) 14657–14663.

[6]Europium-Based Metal-Organic Framework as a Photocatalyst for One-Electron Oxidation of Organic Compounds, J. R. Choi, T. Tachikawa, M. Fujitsuka, and T. Majima: Langmuir (Lett.), 26 (13) (2010) 10437-10443.

[7]Site-Selective Bimodal Absorption and Emission of Distonic Radical Cation, S. Tojo, M. Fujitsuka, and T. Majima: J. Org. Chem., 75 (11) (2010) 3618-3625.

[8]Photocatalytic Oxidation Mechanism of As(III) on $TiO_2$: Unique Role of As(III) as a Charge Recombinant Species, W. Choi, J. Yeo, J. Ryu, T. Tachikawa, and T. Majima: Environ. Sci. Technol., 44 (23) (2010) 9099-9104.

[9]Design of a Highly Sensitive Fluorescent Probe for Interfacial Electron Transfer on a $TiO_2$ Surface, T. Tachikawa, N. Wang, S. Yamashita, S.-C. Cui, and T. Majima: Angew. Chem. Int. Ed., 49 (46) (2010) 8593-8597.

[10]8-Oxo-7,8-dihydro-2'-deoxyguanosine produces a long-lived charge-separated state during the photosensitized one-electron oxidation of DNA resulting in efficient and exclusive degradation, K. Kawai, E. Matsutani, and T. Majima: Chem. Commun., 46 (19) (2010) 3277-3279.

[11]Photophysical properties of Zn-substituted Cytochrome c investigated by single-molecule and ensemble-aveaged spectroscopy, J. Choi, T. Tachikawa, Y. Kim, M. Fujitsuka, H. Ihee, and T. Majima: Chem. Commun., 46 (48) (2010) 9155-9157.

[12]Tin-porphyrin sensitized $TiO_2$ for the production of H2 under visible light, W. Kim, T. Tachikawa, T. Majima, S. H. Kim, H.-J. Kim, and W. Choi: Energy Environ. Sci., 3 (11) (2010) 1789-1795.

[13]Synthesis and properties of fullerene (C70) complexes of 2,6-bis(porphyrin)-substituted pyrazine derivatives bound to a Pd(II) ion, Y. Eda, K. Itoh, Y. N. Ito, M. Fujitsuka, T. Majima, and T. Kawato: Supramol. Chem., 22 (9) (2010) 517-523.

[14]2,1,3-Benzothiadiazole Dimers: Preparation, Structure, and Transanular Electronic Interactions of syn- and anti-[2.2](4,7)Benzothiadiazolophanes, M. Watanabe, K. Goto, M. Fujitsuka, S. Tojo, T. Majima, T. Shinmyozu: Bull. Chem. Soc. Jpn., 83 (10) (2010) 1155-1161.

[15]Delocalization of Positive Charge in pi-Stacked Multi-Benzene Rings in Multi-Layered Cyclophanes, M. Fujitsuka, S. Tojo, M. Shibahara, M. Watanabe, T. Shinmyozu, and T. Majima: J. Phys. Chem. A, 115 (5) (2011) 741–746.

[16]Photoinduced Electron Transfer in a Quantum Dot-Cucurbituril Supramolecular Complex, S.-C. Cui, T. Tachikawa, M. Fujitsuka, and T. Majima: J. Phys. Chem. C, 115 (5) (2011) 1824–1830.

[17]Response to Comment on “Photocatalytic Oxidation Mechanism of As(III) on TiO2: Unique Role of As(III) as a Charge Recombinant Species”, D. Monllor-Satoca, T. Tachikawa, T. Majima, and W. Choi:

Environ. Sci. Technol., 45 (5) (2011) 2030-2031.

[18]Unfolding dynamics of cytochrome c revealed by single-molecule and ensemble-averaged spectroscopy, J. Choi, S. Kim, T, Tachikawa, M. Fujitsuka, and T. Majima: Phys. Chem. Chem. Phys., 13 (13) (2011) 5651-5658.

[19]Reorganization energy of supramolecular donor-acceptor dyad of octaethylporphyrin isomers: Experimental and computational study, M. Fujitsuka, H. Shimakoshi, Y. Hisaeda, and T. Majima: J. Photochem. Photobiol. A., 217 (1) (2011) 242-248.

[20]$^{13}$C-selective infrared multiple photon dissociation of beta-propiolactone by a free electron laser, Y. Miyamoto, T. Majima, S. Arai, K. Katsumata, H. Akagi, A. Maeda, H. Hata, K. Kuramochi, Y. Kato, and K. Tsukiyama: Nucl. Instrum. Meth. Phys. Res. B: Beam Interact. Mater. Atoms, 269 (2) (2011) 180-184.

[21]Single-molecule, single-particle observation of size-dependent photocatalytic activity in Au/$TiO_2$ nanocomposites, Nan Wang, Takashi Tachikawa and Tetsuro Majima: Chem. Sci., 2 (5) (2011) 891-900.

**International Conferences**

[1]DNA Charge Transport (invited), T. Majima: CIfAR Nanoelectronics Spring Program Meeting, USA, May 11, 2010.

[2]One-electron Oxidation of DNA (invited), T. Majima: 11th Int.Workshop on Radiation Damage to DNA, USA, May 16, 2010.

[3]Interfacial Electron Transfer in Quantum Dot Modified with Pyromellitimide (invited), T. Majima: NRF Global Symposium, Koresa, June 12, 2010.

[4]Charge Transfer in DNA (invited), T. Majima: EUCHEM Conference on Organic Free Radicals, Italy, July 2, 2010.

[5]Electron Transfer in Supramolecular Donor-Acceptor Dyads of Porphyrin Isomers (oral), *M. Fujitsuka and T. Majima: IUPAC Photochemistry, Italy, July 14, 2010.

[6]Inter and Intramolecular EnergyTransfer from Higher Triplet State toward Molecular Devices (poster), M. Fujitsuka and *T. Majima: IUPAC Photochemistry, Italy, July 14, 2010.

[7]Charge Transfer in DNA (invited), T. Majima: Conference of Korean Society of Photoscience, Korea, Aug. 31, 2010.

[8]Interfacial Electron Transfer in Quantum Dot Modified with Pyromellitimide (invited), T. Majima: 2nd International Green Technology Forum, Korea, Oct. 14, 2010.

[9]Interfacial Electron Transfer in Quantum Dot Modified with Pyromellitimide (invited), T. Majima: 106th Korean Chemical Society Annual Meeeting, Korea, Oct. 15, 2010.

[10]Electron Transfer in Supramolecular Donor-Acceptor Dyads of Porphyrin Isomers (invited), *M. Fujitsuka, Hisashi Shimakoshi, Yoshio Hisaeda, and Tetsuro Majima: 2010 KJFP, Korea, Oct. 26, 2010.

[11]Probing Photocatalytic Active Sites on a Single Titanosilicate Zeolite with a Redox-Responsive Fluorescent Dye (invited), T. Majima: 2010 KJFP, Korea, Oct. 26, 2010.

[12]Photochemistry for the Synthesis of Noble Metal Nanoparticles (invited), *M. Sakamato and Tetsuro Majima: 2010 KJFP, Korea, Oct. 26, 2010.

[13]Inter and Intramolecular Energy Transfer from Higher Triplet State of Oligothiophene (poster), M. Fujitsuka and *Tetsuro Majima: 2010 KJFP, Korea, Oct. 26, 2010.

[14]Electron Transfer from Oligothiophenes in the Higher Triplet Excited States (poster), *M. Fujitsuka and Tetsuro Majima: 2010 KJFP, Korea, Oct. 26, 2010.

[15]Kinetic studies of photosensitized one electron oxidation of DNA (oral), *K. Kawai, Y. Osakada, and T. Majima: The 37th Internatinal Symposium on Nucleic Acids Chemistry 2010, Japan, Nov. 10, 2010.

[16]Photoinduced Charge-Transfer Processes on Metal-Organic Framework (invited), T. Majima: 6th Asian Photochemistry Conference, New Zeeland, Nov. 18, 2010.

[17]Efficient Photo-electronic Devices by Supramolecular Chemistry (invited), M. Fujitsuka and *T. Majima: 2010 International Chemical Congress of Pacific Basin Societies, USA, Dec. 16, 2010.

[18]Intramolecular Dimer Radical Cation and Anion of [3n]Cyclophanes (invited), M. Fujitsuka and *T. Majima: 2010 International Chemical Congress of Pacific Basin Societies, USA, Dec. 16, 2010.

[19]Rapid long-range charge transfer through DNA (invited), *K. Kawa and T. Majima: 2010 International Chemical Congress of Pacific Basin Societies, USA, Dec. 18, 2010.

[20]Single-Molecule Fluorescence Imaging of $TiO_2$ Photocatalytic Reactions (oral), *T. Tachikawa and T. Majima: 2010 International Chemical Congress of Pacific Basin Societies, USA, Dec. 20, 2010.

[21]Charge separation in DNA and photosensitized DNA damage (poster), *K. Kawai and T. Majima: 2010 International Chemical Congress of Pacific Basin Societies, USA, Dec. 18, 2010.

[22]Spatial Distribution and Transport Behavior of Charge Carriers in a Single Titania Nanowire (poster), *T. Tachikawa and T. Majima: 2010 International Chemical Congress of Pacific Basin Societies, USA, Dec. 16, 2010.

[23]Photophysical and Photochemical Properties of Nanosized Metal-Organic Frameworks (poster), *T. Tachikawa and T. Majima: 2010 International Chemical Congress of Pacific Basin Societies, USA, Dec. 17, 2010.

[24]Tetsuro Majima, DNA Charge Transfer (invited), T. Majima: 2010 International Forum on Photoenergy Future (IFPEF 2010), USA, Dec. 21, 2010.

[25]Interfacial Electron Transfer from Excited Quantum Dot to Electron Acceptors (poster), S-C Cui, T. Tachikawa, M. Fujitsuka, and T. Majima: SANKEN International Symposium, Japan, Jan. 25, 2011.

[26]Photochemistry for Noble Metal Nanoparticles (invited), T. Majima: 2011 Spring Symposium of Photochemistry Association in Taiwan, Taiwan, Feb. 15, 2011.

**Review Papers**

Photochemistry for the Synthesis of Noble Metal Nanoparticles, M. Sakamoto and T. Majima, Bull. Chem. Soc. Jpn., The Chemical Society of Japan, 83[10] (2010), 1133-1154.

Single-molecule, single-particle fluorescence imaging of $TiO_2$-based photocatalytic reactions, T. Tachikawa and T. Majima, Chem. Soc. Rev., The Royal Society of Chemistry, 39[12] (2010), 4802-4819.

Conformational Change Dynamics of DNA and Protein Studied by Single-Molecule Fluorescence Spectroscopy, J. Choi, T. Majima, Polymer Science, The Society of Polymer Science, Japan, 60[2] (2011), 70-73.

**Books**

[1]G-C content independent long-range charge transfer through DNA(Ron Naaman) K. Kawai and T. Majima, “Electronic and Magnetic Properties of Chiral Molecules and Supramolecular Architectures for Topics in Current Chemistry”, Springer-Verlag, Inc., Berlin, 298 (129-142) 2010.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| T. MAJIMA | 2010 Korea-Japan Symposium on Frontier Photoscience (Organaizing Chair) |
| T. MAJIMA | 2010 International Chemical Congress of Pacific Basin Societies, session of "Molecular Photonics” (Organaizer) |
| T. MAJIMA | 2010 International Chemical Congress of Pacific Basin Societies, session of "DNA Photonics” (Organaizer) |
| T. MAJIMA | 2010 International Forum on Photoenergy Future (Organaizing Committtee) |
| T. MAJIMA | 2010 IUPAC Photochemistry (Organaizing Committtee) |
| T. MAJIMA | Langmuir (Senior Editor) |
| T. MAJIMA | ACS Applied Materials and Interfaces (Editorial Bord) |

**Publications in Domestic Meetings**

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|---|---|
| The 20th Annual Meeting of the Japan Photodynamic Association | 1 paper |
| The 34th Annual Meeting of Organic Electron Transfer | 1 paper |
| The 31th Japan Photobiology and Photomedicine Meeting | 1 paper |
| Photochemistry Meeting 2010 | 3 papers |
| The 53th Radiation Chemistry Meeting | 1 paper |
| The 25rd symposium on Biofunctional Chemistry | 1 paper |
| The 90th Japan Chemical Society Meeting | 4 papers |

**Academic Degrees**

| | |
|---|---|
| Doctor Degree for Science<br>J. R. Choi | Studies on the Photoinduced Charge-Transfer Processes on Metal-Organic Framework Nanoparticles and Their Composites |
| Doctor Degree for Science<br>S.-C. Cui | Studies on Interfacial Electron Transfer on Nanoparticles by Single-Molecule Fluorescence Spectroscopy |
| Master Degree for Science<br>E. Matsutani | Photo-induced Charge Separation and Recombination in DNA by Fluorescence Correlation Spectroscopy |
| Master Degree for Science<br>S. Yamashita | Crystal-Face-Dependence of $TiO_2$ Photocatalytic Reactions by Single-Molecule Fluorescence Spectroscopy |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| T. Majima | Photochemistry of higher excited states and its application to molecular devices, environmental problems, and nano- and biotechnology | ¥20,930,000 |
| M. Fujitsuka | Development of Molecular Devices Triggered by the Formation of the Higher Excited States | ¥4,160,000 |
| M. Fujitsuka | Study on Charge and Excitation Energy Delocalization Process in Polymeric Materials | ¥2,000,000 |
| K. Kawai | Reading out the DNA sequence information by measuring the charge separation lifetime | ¥2,080,000 |
| T. Tachikawa | Mechanistic study on the $TiO_2$ photocatalytic reactions by single-particle kinetic analysis and applications of | ¥910,000 |
| S.-C. Cui | Application of quantum dot nanocomplex to the photoelectric conversion device based on single molecule | ¥800,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| T. Majima | Japan Science and Technology Agency | Studies on unstable species of CPP delivatives | ¥15,600,000 |

**Cooperative Research**

| | | |
|---|---|---|
| T. Majima | Panasonic Ecology Systems Co. | ¥1,964,000 |

## Department of Synthetic Organic Chemistry

### Original Papers

[1]An Enantioselective Organocatalyzed Aza-MBH Domino Process: Application to the Facile Synthesis of Tetrahydropyridines, S. Takizawa, N. Inoue, H. Sasai: Tetrahedron Lett., 52 (3) (2011) 377-380.

[2]Acid-Base Organocatalysts for the Aza-Morita-Baylis-Hillman Reaction of Nitroalkenes, S. Takizawa, A. Horii, H. Sasai: Tetrahedron: Asymmetry, 21 (8) (2010) 891-894.

[3]Enantioselective Synthesis of Isoindolines: Organocatalyzed Domino Process Based on the Aza-Morita-Baylis-Hillman (Aza-MBH) Reaction, S. Takizawa, N. Inoue, S. Hirata, H. Sasai: Angew. Chem. Int. Ed., 49 (50) (2010) 9725-9729.

[4]Asymmetric Synthesis of Chiral Spiro Bis(isoxazoline) and Spiro (Isoxazole-Isoxazoline) Ligands, K. Takenaka, T. Nagano, S. Takizawa, H. Sasai: Tetrahedron: Asymmetry, 21 (4) (2010) 379-391.

[5]Enantioselective 6-Endo-Trig Wacker-Type Cyclization of 2-Geranylphenols: Application to a Facile Synthesis of (-)-Cordiachromene, K. Takenaka, Y. Tanigaki, M. L. Patil, C. V. L. Rao, S. Takizawa, T. Suzuki, H. Sasai: Tetrahedron: Asymmetry, 21 (7) (2010) 767-770.

[6]Enantioselective Wacker-Type Cyclization of 2-Alkenyl-1,3-diketones Promoted by Pd-SPRIX Catalyst, K. Takenaka, S. C. Mohanta, M. L. Patil, C. V. L. Rao, S. Takizawa, T. Suzuki, H. Sasai: Org. Lett., 12 (15) (2010) 3480-3483.

[7]Pd-Catalyzed 5-Endo-Trig-Type Cyclization of β,γ-Unsaturated Carbonyl Compounds: An Efficient Ring Closing Reaction to Give g-Butenolides and 3-Pyrrolin-2-ones, G. B. Bajracharya, P. S. Koranne, R. N. Nadaf, R. K. M. Gabr, K. Takenaka, S. Takizawa, H. Sasai: Chem. Commun., 46 (47) (2010) 9064-9066.

[8]Pd(II)-SPRIX Catalyzed Enantioselective Construction of Pyrrolizines/Pyrroloindoles Employing Molecular Oxygen As the Sole Oxidant, C. Ramalingan, K. Takenaka, H. Sasai: Tetrahedron, 67 (16) (2011) 2889-2894.

[9]Formal Total Synthesis of Ottelione Using Iridium-Catalyzed Oxidative Desymmetrization, T. Suzuki, K. Ghozati, D.-Y. Zhou, T. Katoh, H. Sasai: Tetrahedron, 66 (38) (2010) 7562-7568.

### International Conferences

[1]Enantioselective Domino Reactions Promoted by Acid-Base Organocatalysts (oral), S. Takizawa, N. Inoue, S. Hirata, H. Sasai: 22nd International Symposium on Chirality (ISCD-22).

[2]Enantioselective Oxidative Coupling of 2-Naphthols Using Dinuclear Vanadium Complex (oral), S. Takizawa, T. Katayama, D. Rajesh, H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[3]Enantioselective Aza-Morita-Baylis-Hillman (Aza-MBH) Domino Reactions Promoted by Acid-Base Organocatalyst (poster), N. Inoue, S. Takizawa, S. Hirata, T. M.-N. Nguyen, H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[4]Bifunctional Organocatalyst Bearing (S)-1,1'-Spirobiindane As Chiral Backbone (poster), K. Kiriyama, S. Takizawa, H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[5]Development of Bifunctional Organocatalysts for Enantioselective Morita-Baylis-Hillman Reaction (poster), S. Murakami, S. Takizawa, H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[6]Enantioselective Organocatalyzed Aza-MBH Domino Process: Application to the Facile Synthesis of Tetrahydropyridines and Isoindolines (oral), S. Takizawa, N. Inoue, S. Hirata, H. Sasai: 241st ACS National Meeting.

[7]Novel Asymmetric Domino Reactions Promoted by Acid-Base Organocatalysts (oral), H. Sasai: 3rd Aachen-Osaka Joint Symposium.

[8]Novel Catalytic Enantioselective Reactions Promoted by a Pd-SPRIX Complex (oral), H. Sasai: Japan-Korea Symposium on Organometallic Chemistry.

[9]Novel Oxidative Asymmetric Cyclizations Promoted by Pd-SPRIX Catalyst (invited), H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[10]Development of Chiral Bifunctional Organocatalysts (invited), H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[11]One-Pot Preparation of Chiral Dinuclear Vanadium(V) Complex (invited), S. Takizawa, D. Rajesh, T. Katayama, H. Sasai: 7th International Symposium on Chemistry and Biological Chemistry of Vanadium.

[12]Enantioselective Pd(II)/Pd(IV) Catalysis Using Spiro Bis(isoxazoline) Ligand (oral), K. Takenaka, T. Tsujihara, K. Onitsuka, M. Hatanaka, H. Sasai: The 6th Tokyo Conference on Advanced Catalytic Science and Technology & The 5th Asia Pacific Congress on Catalysis (TOCAT6/APCAT5).

[13]Enantioselective Synthesis of γ-Lactones via Intramolecular Wacker-Type Cyclization Catalyzed by Pd-SPRIX (poster), M. Akita, Y. Tanigaki, K. Takenaka, S. Takizawa, H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[14]DFT Study on 5-Endo-Trig Type Cyclization of β,γ-Unsaturated Carboxylic Acids Using Pd-SPRIX Catalyst (poster), R. K. M. Gabr, G. B. Bajracharya, X. Lin, K. Takenaka, S. Takizawa, Y. Okada, T. Hatakeyama, M. Nakamura, H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

[15]Oxidative Desymmetrization of Diols by Iridium Catalyst (oral), T. Suzuki, K. Ghozati, S. Takatani, Y. Ishizaka, D.-Y. Zhou, K. Asano, T. Katoh, H. Sasai: 14th SANKEN International Symposium 2011.

[16]Oxidative Desymmetrization of Diols by Iridium Catalyst (oral), T. Suzuki, K. Ghozati, T. Shuhei, T. Katoh, H. Sasai: The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010).

**Review Papers**

Development of Novel Domino Reaction Promoted by Chiral Organocatalysts with Dual Activation Mechanism, H. Sasai, S. Takizawa, Catalysts & Catalysis, Catalysis Society of Japan, 52[7] (2010), 484-489.

**Books**

[1]Asymmetric Aza-Morita-Baylis-Hillman Reaction(K. Maruoka, K. Nozaki, Y. Ishii, J. Otera, K. Tomioka) S. Takizawa, H. Sasai, “Practical Handbook of Useful Organic Transformations”, Kagakudojin, (224-225) .

[2]Asymmetric Coupling of 2-Naphthols(K. Maruoka, K. Nozaki, Y. Ishii, J. Otera, K. Tomioka) S. Takizawa, H. Sasai, “Practical Handbook of Useful Organic Transformations”, Kagakudojin, (262-263) .

[3]Asymmetric Oxidative Cyclization of Enynes(K. Maruoka, K. Nozaki, Y. Ishii, J. Otera, K. Tomioka) K. Takenaka, H. Sasai, “Practical Handbook of Useful Organic Transformations”, Kagakudojin, (280-281) .

[4]Asymmetric Intramolecular Cyclization of Alkenylureas(K. Maruoka, K. Nozaki, Y. Ishii, J. Otera, K. Tomioka) K. Takenaka, H. Sasai, “Practical Handbook of Useful Organic Transformations”, Kagakudojin, (360-361) .

**Patents**

[1]Chiral Spiro Bis(triazole) Compounds: Synthesis and Application H. Sasai, S. Takizawa, Y. Yosida, JP2011-05342

**Contributions to International Conferences and Journals**

| | |
|---|---|
| H. Sasai | The International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010), “Metal Catalysis for Asymmetric Synthesis” (Organizer) |
| H. Sasai | Japan-Korea Symposium on Organometallic Chemistry (Organizer) |
| H. Sasai | 7th International Symposium on Chemistry and Biological Chemistry of Vanadium (Organizing Committtee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Annual Meeting of The Chemical Society of Japan | 8 papers |
| Symposium on Organic Reaction | 4 papers |
| Symposium on Progress in Organic Reactions and Syntheses | 2 papers |
| The Japanese Society for Process Chemistry | 2 papers |
| Symposium on Organometallic Chemistry | 1 paper |
| Symposium on Molecular Chirality | 1 paper |

**Academic Degrees**

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|---|---|
| Doctor Degree for Science<br>S. C. Mohanta | Enantioselective Oxidative Cyclization Using Palladium-Spiro Bis(isoxazoline) Complex |
| Master Degree for Science<br>M. Akita | Enantioselective Synthesis of γ-Lactones via an Oxidative 5-Exo-Trig type Cyclization Promoted by Pd-SPRIX Catalyst |
| Master Degree for Science<br>S. Takatani | Development of Novel Chiral Spiro Ligands Bearing Sulfur Donor |
| Master Degree for Science<br>S. Murakami | Development and Application of Acid-Base Organocatalyst |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| H. Sasai | Development of Catalytic Skeletal Constructing Reactions Utilizing Spiro-type Ligands | ¥9,880,000 |
| H. Sasai | Development of Domino Reactions Based on Novel Organocatalysts | ¥3,510,000 |
| S. Takizawa | Development of Nanozyme As a Highly Active Asymmetric Catalyst | ¥3,120,000 |

**Cooperative Research**

| | | |
|---|---|---|
| H. Sasai | Shizuoka Institute of Science and Technology | ¥200,000 |

**Other Research Fund**

| | | |
|---|---|---|
| S. Takizawa | The Naito Foundation | ¥3,000,000 |

## Department of Regulatory Bioorganic Chemistry

**Original Papers**

[1]Ligand Inducible Assembly of a DNA Tetrahedron, Dohno, C.; Atsumi, H.; Nakatani, K.: Chem. Commun., 47 (2011) 3499-3501.

[2]Antisense-Induced Guanine Quadruplexes Inhibit Reverse Transcription by HIV-1 Reverse Transcriptase, Hagihara, M.; Yamauchi, L.; Seo, A.; Yoneda, K.; Senda, M.; Nakatani, K.: J. Am. Chem. Soc., 132 (2010) 11171-11178.

[3]Discrimination of N6-methyl adenine in a specific DNA sequence, Dohno, C.; Shibata, T.; Nakatani, K.: Chem. Commun., 46 (2010) 5530-5532.

**International Conferences**

[1]Novel Fluorescent Detection of Virus Using Cytosine Bulge Hairpin Primers for PCR (invited), *Fumie Takei: Virus and Infections-2010, Busan, Korea.

[2]Photoswitchable molecular glue for DNA nanotechnology (invited), *Chikara Dohno, Shin-nosuke Uno, Kazuhiko Nakatani: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules (ISSMA2011), 2011.1.24-26, Kyoto, Japan.

[3]Toward the Discovery of Small Molecules Affecting miRNA Function (invited), *Kazuhiko Nakatani: Asian 3 Roundtable on Nucleic Acids (A3RONA) 2010, 2010.10.29-31, Osaka, Japan.

[4]Antisense-induced guanine quadruplexes interfere with reverse transcription by HIV-1 reverse transcriptase (poster), *Masaki Hagihara, Lisa Yamauchi, Akiko Seo, Keisuke Yoneda, Mayo Senda, Kazuhiko Nakatani: The 37th International symposium on Nucleic acids chemistry, 2010.11.10-12, Yokohama, Japan.

[5]Binding of ligand to the d(CGG)n in the hairpin loop (oral), *Changfeng Hong, Masaki Hagihara, Kazuhiko Nakatani: The 37th International symposium on Nucleic acids chemistry, 2010.11.10-12, Yokohama, Japan.

[6]Adenine methylation-sensitive cross-link formation (poster), *Tomonori Shibata, Chikara Dohno, Kazuhiko Nakatani: The 37th International symposium on Nucleic acids chemistry, 2010.11.10-12, Yokohama, Japan.

[7]Binding of tetrameric naphthyridine derivatives to DNA containing a GG-mismatch (poster), *Izumi Kohyama, Chikara Dohno, Changfeng Hong, Kazuhiko Nakatani: The 37th International symposium on Nucleic acids chemistry, 2010.11.10-12, Yokohama, Japan.

**Contributions to International Conferences and Journals**

K. NAKATANI Asian 3 Roundtable on Nucleic Acids (A3RONA) 2010 (Organaizing Committtee)

**Publications in Domestic Meetings**

| | |
|---|---|
| 5th Annual Meeting of Japanese Society for Chemical Biology | 5 papers |
| 49th Annual Meeting of the Society of Electron Spin Science and Technology | 1 paper |
| 91th annual meeting of chemical society of Japan | 13 papers |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science<br>K. Yoneda | Studies on creating a fluorescent RNA using GFP chromophores |
| Master Degree for Science<br>H. Nakagawa | Studies on DNA nanostructures based on DNA-origami technique, and fluorescent properties of novel triethynylethane derivatives. |
| Master Degree for Science<br>T. Mizunashi | Studies on RNA aptamers for Schiff base formation |

| | |
|---|---|
| Master Degree for Science<br>S. Matsunaga | Synthesis of DNA bulge binding fluorescent dyes |
| Master Degree for Science<br>S. Im | Development of fluorescent indicators for RNA-ligand interactions |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| K. Nakatani | Regulation of DNA Structure and Function Based on the Stabilization of DNA Duplex | ¥4,700,000 |
| F. Takei | Development of SNP detection method with modified PCR primers | ¥1,000,000 |
| M. Hagihara | In vivo screening of novel ribozyme | ¥1,600,000 |
| C. Dohno | Discrimination of methylated nucleobases by a novel modified DNA forming Schiff base | ¥2,340,000 |
| C. Dohno | Photoresponsive RNA-binding ligands for regulation of RNA functions | ¥10,790,000 |
| S. Umemoto | Developing a new method to search RNA binding ligands and its application | ¥700,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| C. Dohno | Japan Science and Technology Agency, PREST | Biochemical functions emerging from DNA containing hydrophobic regions | ¥7,020,000 |
| K. Nakatani | National Institute of Biomedical Innovation | Development of Research Basis for accelerating the Drug Discovery targeting Functional ncRNA | ¥59,518,000 |

**Cooperative Research**

| | | |
|---|---|---|
| K. Nakatani | Nitto Kasei Co., LTD. | ¥806,000 |
| K. Nakatani | Takeda Pharmaceutical company | ¥909,000 |

**Other Research Fund**

| | | |
|---|---|---|
| M. Hagihara | The International Human Frontier Science Program | ¥8,319,000 |
| F. Takei | Cooperation program for the Internationalized Education and Research | ¥700,000 |

## Department of Organic Fine Chemicals

**Original Papers**

[1]Cotylenin A inhibits cell proliferation and induces apoptosis and PAX6 mRNA transcripts in retinoblastoma cell lines, Y. Kashiwagi, N. Kato, T. Sassa, K. Nishitsuka, T. Yamamoto, H. Takamura, H. Yamashita: Molecular Vision, 16 (2010) 970-982.

[2]Bivalent inhibitors for disrupting protein surface-substrate interactions and for dual inhibition of protein prenyltransferases, S. Machida, N. Kato, K. Harada, J. Ohkanda: Journal of the American Chemical Society, 133 (4) (2011) 958-963.

[3]Dioxygenases, key enzymes to determine the aglycon structures of fusicoccin and brassicicene, diterpene compounds produced by fungi, Y. Ono, A. Minami, M. Noike, Y. Higuchi, T. Toyomasu, T. Sassa, N. Kato, T. Dairi: Journal of the American Chemical Society, 133 (8) (2011) 2548-2555.

**International Conferences**

[1]Combating Drug-resistant Influenza Viruses with Novel Green Tea Catechin Derivatives (poster), K. Kaihatsu, H. Matsumura, S. Mori, C. Kawakami, H. Kurata, N. Kato: The 23rd International Conference on Antiviral Research, San Francisco, USA, April 25-27, 2010.

[2]Iinhibition of Influenza Virus Infection by Novel Tea Catechin Derivatives (invited), K. Kaihatsu: BIT's 1st Annual Conference of Medichem-2010, Beijing, China, May 18-20, 2010.

[3]Module assembly for disruption and detection of protein-protein interactions (invited), J. Ohkanda*: Gordon Research Conference, Bioorganic Chemistry, New Hampshire, USA, June 13-18, 2010.

[4]Isoform selective and partner dependent fluorescent labeling of 14-3-3 zeta by fusicoccins (poster), J. Ohkanda*, A. Kawamura, N. Kato, I. Hamachi, M. Takahashi.: Gordon Research Conference, Bioorganic Chemistry, New Hampshire, USA, June 13-18, 2010.

[5]Preparation of Anti-influenza and Antibacterial by Lipase-Catalyzed Transesterification of Epigallocatechin-3-O-gallate (oral), K. Kaihatsu: The 9th International Bioexpo, Tokyo, Japan, June 30-July 2, 2010.

[6]Inhibition of influenza virus infection by epigallocatechin-3-O-gallate (EGCG) fatty acid monoesters. (invited), K. Kaihatsu: The 4th International Conference on O-CHA(Tea) Culture and Science, Shizuoka, Japan, October 26-28, 2010.

[7]Studies on the Biosynthetic Pathways of Fusicoccnae Diterpenoids (poster), T. Toyomasu, T. Sassa, T. Dairi, N. Kato: The 5th International Conference on Cutting-Edge Organic Chemistry in Asia, Hsinchu, Taiwan ,November 7-11, 2010.

[8]Inhibition of influenza A virus genomic RNA reverse transcription by peptide nucleic acids (poster), K. Kaihatsu, T. Takahashi, S. Sawada, S. Nakamaura. N. Goto, T. Yasunaga, T. Nakaya, K. Kato: The 37th International Symposium on Nucleic Acids Chemistry 2010, Yokohama, Japan, November 10-12, 2010.

[9]Module assembly for disrupting protein-protein interactions and dual inhibition of prenyltransferases (oral), J. Ohkanda*, S. Machida, C. Oura, K. Harada, N. Kato: Pacifichem2010, Honolulu, USA, December 15-20.

[10]Combination use of a cotylenin-analog and interferon-α induces p53 down regulation besides apoptotic tumor suppression (poster), Y. Haranosono, T. Inoue, H. Nitta, J. Ohkanda, N. Kato: Pacifichem2010, Honolulu, USA, December 15-20.

[11]Design, synthesis and evaluation of the first non-peptide-based 14-3-3 inhibitor (poster), Y. Higuchi, C. Ottmann, H. Nitta, J. Ohkanda, N. Kato: Pacifichem2010, Honolulu, USA, December 15-20.

[12]Structure and anti-influenza virus activity relationship of catechin derivatives (oral), K. Kaihatsu, N. Kato: Pacifichem2010, Honolulu, USA, December 15-20.

[13]Application of peptide nucleic acid for the inhibition and detection of influenza viruses (oral), K. Kaihatsu, S. Sawada, N. Kato: Pacifichem2010, Honolulu, USA, December 15-20.

[14]Regulation of cellular uptake and duplex DNA strand discplacement by visible sensitive bis-peptide nucleic acid (poster), S. Sawada, N. Kato, K. Kaihatsu: Pacifichem2010, Honolulu, USA, December 15-20.

[15]Synthesis of neuraminic acid modified DNA as an inhibitor of influenza hemagglutinin (oral), Y. Ebara, K. Kaihatsu, N. Kato: Pacifichem2010, Honolulu, USA, December 15-20.

[16]Isoform selective and phosphopeptide-dependent 14-3-3 zeta labeling by fusicoccins (poster), J. Ohkanda*, M. Takahashi, A. Kawamura, I. Hamachi, T. Nishi, N. Kato: The 14th SANKEN International Symposium & The 9th SANKEN Nanotechnology Symposium, Otsu, January 25-26, 2011.

[17]Regulation of cellular uptake and duplex DNA strand displacement by visible light sensitive peptide analogue (poster), S. Sawada, K. Kaihatsu, N. Kato.: The 14th SANKEN International Symposium & The 9th SANKEN Nanotechnology Symposium, Otsu, January 25-26, 2011.

[18]Diagnosis of Influenza Virus by Hairpin-Type Peptide Nucleic Acid, (poster), K. Kaihatsu, S. Sawada, N. Kato: The 14th SANKEN International Symposium & The 9th SANKEN Nanotechnology Symposium, Otsu, January 25-26, 2011.

[19]Fusicoccane derivatives have potential as anoikis inducers (poster), Y. Haranosono, H. Nitta, Y. Honma, T. Sassa, N. Kato: The 14th SANKEN International Symposium & The 9th SANKEN Nanotechnology Symposium, Otsu, January 25-26, 2011.

**Review Papers**

Influenza virus pathogenesis based on viral tropism and apoptosis induction and anti-viral therapies., T. Daidoji, K. Kaihatsu, T. Nakaya., Current Chemical Biology, Bentham Science Publishers, 4 (2010), 208-218.

**Patents**

[1]Diagnosis method of influenza virus strain by azobenzene bridged peptide nucleic acid K. Kaihatsu, S. Sawada, S. Nakamura, N. Goto, T. Yasunaga, T. Nakaya, N. Kato, JP2010-222951

[2]Antibacterial agent K. Kaihatsu, Y. Matsumoto, PCT/JP2010/062952

[3]Identification and characterization of fusicoccin biosynthetic gene clusters T. Dairi, M. Noike, Y. Ono, N. Kato, Y. Higuchi, US Prov. 61/446,685

**Contributions to International Conferences and Journals**

| | |
|---|---|
| K. Kaihatsu | Journal of Antivirals & Antiretrovirals (Editor) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Japan Chemical Society Meeting | 5 papers |
| Annual Meeting of JSBBA 2011 | 4 papers |
| 13rd Biomolecular Chemistry Symposium | 1 paper |
| 43rd Forum of Peptide Chemistry for Young Scientists | 1 paper |
| Japan Society of Chemotherapy | 3 papers |
| Protein Socience Society of Japan | 1 paper |
| Biooptics Conference | 1 paper |
| The Japanese Society for Virology | 1 paper |
| Bio-related Science Joint Symposium | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Doctor Degree for Science<br>Y. Higuchi | Transformation of fusicoccins to create biological tools toward chemical bilogy and its applications |
| Master Degree for Science<br>T. Ohzawa | Physicochemical properties of peptide nucleic acids containing new thiouracyl derivatives |
| Master Degree for Science<br>Y. Yamaguchi | Synthesis and functional evaluation fo bipyridine-metal complexes for protein surface recognition |
| Master Degree for Science<br>T. Watanabe | Practical synthesis of 12-deoxyfusicoccin from natural fusicoccins |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| J. Ohkanda | Design and functional evaluation of organic agents for disrupting protein-protein interactions | ¥14,300,000 |
| J. Ohkanda | Protein labeling of 14-3-3 by fusicoccin analogs | ¥2,100,000 |

| | | | |
|---|---|---|---|
| K. Kaihatsu | Establishement of method for regulation of transcription by light-sensitive hairpin peptide nucleic acid | | ¥1,560,000 |
| Y. Higuchi | Chemical biology for understanding the functions of 14-3-3 protein | | ¥600,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| N. Kato | National Institute of Biomedical Inovation | Development of New Anti-cancer Agents Based on the Differentiation-inducing Diterpene Glycoside | ¥10,000,000 |
| N. Kato | Biomedical Kansai | Drug Development for Myelodysplastic Syndrome | ¥15,000,000 |
| K. Kaihatsu | New Energy and Industrial Tecnology Development Organization | Development of anti-RNA virus agent using novel green tea catechin derivatives | ¥16,250,000 |
| K. Kaihatsu | National Institute of Biomedical Innovation | Rapid diagnosis of influenza virus strain by triplex forming peptide nucleic acid | ¥17,000,000 |

**Contribution to Research**

| | | |
|---|---|---|
| N. Kato | MBR Co., Ltd. | ¥500,000 |
| J. Ohkanda | Eisai Co., Ltd. | ¥1,200,000 |
| K. Kaihatsu | All Japan Coffee Association | ¥1,500,000 |

**Cooperative Research**

| | | |
|---|---|---|
| K. Kato | TMRC Co., Ltd. | ¥2,000,000 |
| N. Kato | Japan BCG Laboratory | ¥2,000,000 |

**Other Research Fund**

| | | |
|---|---|---|
| Y. Higuchi | Japan Society for the Promotion of Science | ¥700,000 |

## Department of Structural Molecular Biology

**Original Papers**

[1]LIM domains regulate protein kinase C activity: A novel molecular function, A. D. Maturana, N. Nakagawa, N. Yoshimoto, K. Tatematsu, M. Hoshijima, K. Tanizawa and S. Kuroda: Cell. Signal., 23 (5) (2011) 928-934.

[2]Detection of the reaction intermediates catalyzed by a copper amine oxidase, M. Kataoka, H. Oya, A. Tominaga, M. Otsu, T. Okajima, K. Tanizawa and H. Yamaguchi: J. Synchrotron Radiat., 18 (1) (2011) 58-61.

[3]Nanocapsules incorporating IgG Fc-binding domain derived from *Staphylococcus aureus* protein A for displaying IgGs on immunosensor chips, M. Iijima, H. Kadoya, S. Hatahira, S. Hiramatsu, G. Jung, A. Martin, J. Quinn, J. Jung, S. Y. Jeong, E. K. Choi, T. Arakawa, F. Hinako, M. Kusunoki, N. Yoshimoto, T. Niimi, K. Tanizawa and S. Kuroda: Biomaterials, 32 (6) (2011) 1455-1464.

[4]X-ray crystal structure of the DNA-binding domain of response regulator WalR essential to the cell viability of staphylococcus aureus and interaction with target DNA, A. Doi, T. Okajima, Y. Gotoh, K. Tanizawa and R. Utsumi: Biosci. Biotechnol. Biochem., 74 (9) (2010) 1901-1907.

[5]Hepatoma-targeted gene delivery using a tumor cell-specific gene regulation system combined with a human liver cell-specific bionanocapsule, J. H. Kang, J. Oishi, J. H. Kim, M. Ijuin, R. Toita, B. Jun, D. Asai, T. Mori, T. Niidome, K. Tanizawa, S. Kuroda, Y. Katayama: Nanomedicine, 6 (4) (2010) 583-589.

[6]A gene-delivery system specific for hepatoma cells and an intracellular kinase signal based on human liver-specific bionanocapsules and signal-responsive artificial polymer, J. Oishi, J. Jung, A. Tsuchiya, R. Toita, J. H. Kang, T. Mori, T. Niidome, K. Tanizawa, S. Kuroda, Y. Katayama: Int. J. Pharm., 396 (1-2)

(2010) 174-178.

**International Conferences**

[1]X-ray crystal structure analysis of reaction intermediates of copper amine oxidase from *Arthrobacter globiformis* (poster), M. Kataoka, H. Oya, A. Tominaga, M. Ohtsu, T. Okajima, K. Tanizawa and H. Yamaguchi: 3rd International Symposium on Diffraction Structural Biology (ISDSB2010).

[2]Catalytic Mechanism of Copper Amine Oxidase: X-Ray Crystal Structure of the Intermediates Formed in the Oxidative-Half Reaction (poster), Toshihide OKAJIMA, Shougo KIKUKAWA, Akio HAMAGUCHI, Tadashi NAKAI, and Katsuyuki TANIZAWA: The 14th SANKEN International Symposium / The 9th SANKEN Nanotechnology Symposium.

**Review Papers**

Production of $H_2S$ by 3-mercaptopyruvate sulphurtransferase, K. Tanizawa, J. Biochem., 149 [4] (2011), 357-359.

Kenji Soda—researching enzymes with the spirit of an alpinist, T. Yoshimura, H. Mihara, T. Ohshima and K. Tanizawa, J. Biochem., 148 [4] (2010), 371-379.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| K. TANIZAWA | Journal of Biochemistry (Chief Editor) |
| K. TANIZAWA | Journal of Nutritional Science and Vitaminology (Editorial Board) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Joint Annual Meeting of Biochemistry and Molecular Biology (BMB2010) | 6 papers |
| Annual Meeting of Japan Society for Bioscience, Biotechnology, and Agrochemistry | 4 papers |
| Annual Meeting of Society of Nano Science and Technology | 1 paper |
| Meeting of Enzyme and Coenzyme Researchs | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science<br>S. Ishii | Analysis of inter-domain interactions of signal transduction proteins involved in biofilm formation |
| Master Degree for Science<br>N. Mizuno | Development of antibody-binding carrier for nucleic acid delivery to inflammatory cardiomyocytes |
| Master Degree for Frontier Biosciences<br>S. Tsuchida | Identification and biochemical analysis of novel membrane fusion motif in surface antigen L protein of hepatitis B virus |
| Master Degree for Frontier Biosciences<br>Y. Kato | Analysis of biochemical function of heme-binding subunit of quinohemoprotein amine dehydrogenase |
| Master Degree for Frontier Biosciences<br>S. Kikukawa | Structural analysis of mechanism of oxidative half-reaction catalyzed by copper amine oxidase |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| K. Tanizawa | Development of highly efficient protein delivery system utilizing import mechanism of peroxisome | ¥2,200,000 |
| T. Matsuzaki | Elucidation of Infection Mechanism of Hepatitis B Virus Using Bionanocapsule | ¥1,690,000 |
| T. Okajima | Structural Basis for Activation of Glutamate-gated Chloride Channel by Binding Macrocyclic Lactones | ¥1,690,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| K. Tanizawa | Bio-oriented Technology | Construction of improved | ¥3,190,000 |

| | | | |
|---|---|---|---|
| | Research Advancement Institution (BRAIN) | bionanocapsule and establishment of its mass production method | |
| T. Okajima | Bio-oriented Technology Research Advancement Institution (BRAIN) | Development of Drugs Inhibiting Bacterial Signal Transduction Based on X-ray Crystal Structures | ¥6,090,000 |
| T. Okajima | Adaptable and Seamless Technology transfer Program through target-driven R&D | Development of novel antibiotics effective on multidrug-resistant bacteria | ¥1,510,000 |

**Contribution to Research**

| | | |
|---|---|---|
| K. Tanizawa | Japan Foundation for Applied Enzymology | ¥500,000 |
| K. Tanizawa | Vitamin B Research Committee | ¥150,000 |

## Department of Cell Membrane Biology

**Original Papers**

[1]Regulation of AcrAB multidrug efflux pump in Salmonella enterica serovar Typhimurium in response to indole and paraquat, E. Nikaido, I. Shirosaka, A. Yamaguchi, K. Nishino: Microbiology, 157 (2011) 648-655.

[2]Effect of overexpression of small non-coding DsrA RNA on multidrug efflux in Escherichia coli, K. Nishino, S. Yamasaki, M. Hayashi-Nishino, A. Yamaguchi: J Antimicrob Chemother., 66 (2011) 291-296.

[3]Roles of Salmonella multidrug efflux pumps in tigecycline resistance, T. Horiyama, E. Nikaido, A. Yamaguchi, K. Nishino: J Antimicrob Chemother., 66 (2011) 105-110.

[4]The sphingosine 1-phosphate transporter, SPNS2, functions as a transporter of the phosphorylated form of the immunomodulating agent FTY720, Y. Hisano, N. Kobayashi, A. Kawahara, A. Yamaguchi, T. Nishi: J. Biol. Chem., 286 (2011) 1758-1766.

[5]Indole enhances acid resistance in Escherichia coli, H. Hirakawa, M. Hayashi-Nishino, A. Yamaguchi, K. Nishino: Microb. Pathog., 49 (2010) 90-94.

[6]TolC dependency of multidrug efflux systems in Salmonella enterica serovar Typhimurium, T. Horiyama, A. Yamaguchi, K. Nishino: J. Antimicrob. Chemother., 65 (2010) 1372-1376.

[7]Macrophage ABCA5 deficiency influences cellular cholesterol efflux and increases susceptibility to atherosclerosis in female LDLr knockout mice, D. Ye, I. Meurs, M. Ohigashi, L. Calpe-Berdiel, KL. Habets, Y. Zhao, Y. Kubo, A. Yamaguchi, TJ. Van Berkel, T. Nishi, M. Van Eck: Biochem. Biophys. Res. Commun., 395 (2010) 387-394.

[8]Effect of NlpE overproduction on multidrug resistance in Escherichia coli, K. Nishino, S. Yamasaki, M. Hayashi-Nishino, A. Yamaguchi: Antimicrob. Agents Chemother., 54 (2010) 2239-2243.

[9]Impact of RNA chaperone Hfq on multidrug resistance in Escherichia coli, J. Yamada, S. Yamasaki, H. Hirakawa, M. Hayashi-Nishino, A. Yamaguchi, K. Nishino: J. Antimicrob. Chemother., 65 (2010) 853-858.

**International Conferences**

[1]Development of novel therapeutic strategies to tackle multidrug-resistant pathogens (poster), *K. Nishino, S. Yamasaki, M. Hayashi-Nishino, A. Yamaguchi: The American Association for the Advancement of Science (AAAS) 2011 Annual Meeting, Washington, DC, U.S.A., Feb. 20-22, 2011.

[2]Function of mammalian sphingosin 1-phosphate transporter (poster), *T. Nishi, Y. Hisano, S. Kawasaki-Nishi, A. Yamaguchi: The 14th SANKEN International Symposium / The 9th SANKEN

Nanotechnology Symposium -Advanced Design toward Low-Carbon Science and Industry-, Shiga, Japan, Jan. 25-26, 2011.

[3]Functional network of multi-component drug efflux systems in Salmonella enterica serovar typhimurium (poster), S. Yamasaki, S. Nagasawa, M. Hayashi-Nishino, A. Yamaguchi, *K. Nishino: The 14th SANKEN International Symposium / The 9th SANKEN Nanotechnology Symposium -Advanced Design toward Low-Carbon Science and Industry-, Shiga, Japan, Jan. 25-26, 2011.

[4]Regulation mechanism of Salmonella AcrAB multidrug efflux pump in response to extracellular signals (including details of microarray data to identify RamA regulon) (oral), *E. Nikaido, K. Sakurai, R. Nakashima, A. Yamaguchi, K. Nishino: INRA-JSPS project meeting, Nouzilly, France, Oct, 12-13, 2010.

[5]Physiological roles of multidrug efflux pumps in Escherichia coli (enterobactin export) (oral), *T. Horiyama, A, Yamaguchi, K. Nishino: INRA-JSPS project meeting, Nouzilly, France, Oct, 12-13, 2010.

[6]Crystal structure of the substrate binding form of multidrug exporter AcrB (oral), *R. Nakashima, K. Sakurai, S. Yamasaki, K. Nishino, A. Yamaguchi: INRA-JSPS project meeting, Nouzilly, France, Oct, 12-13, 2010.

[7]Role of the RNA chaperon Hfq in multidrug resistance of Escherichia coli (poster), *K. Nishino, S. Yamasaki, M. Hayashi-Nishino, A. Yamaguchi: Joint meeting of the NZ Microbiological Society and NZ Society for Biochemistry & Molecular Biology, The Univ. Auckland, New Zealand, Nov. 30 - Dec. 3, 2011.

[8]Enhanced Antimicrobial Activity of New Acylated Derivatives of Epigallocatechin Gallate (EGCG) (poster), *Y. Matsumoto, K. Kaihatsu, N. Kato, A. Yamaguchi: 50th International Conference on Antimicrobial Agents and Chemotherapy, Boston, U.S.A., Sep. 12-15, 2010.

[9]Impact of Hfq on multidrug resistance in Escherichia coli (poster), *S. Yamasaki, J. Yamada, H. Hirakawa, M. Hayashi-Nishino, A. Yamaguchi, K. Nishino: The 10th Awaji International Forum on Infection and Immunity, Hyogo, Japan, Sep. 7-9, 2010.

[10]TolC dependency of multidrug efflux systems in Salmonella enterica serovar Typhimurium (poster), *T. Horiyama, A. Yamaguchi, K. Nishino: The 10th Awaji International Forum on Infection and Immunity, Hyogo, Japan, Sep. 7-9, 2010.

[11]The analysis of sphingosine 1-phosphate secretion from cells expressing Spns2. (poster), *Y. Hisano, A. Yamaguchi, T. Nish: “51st International Conference on the Bioscience of Lipids (ICBL)” and 7th International Conference on Lipid Binding Proteins, Bilbao, Spain, Sep. 7-11, 2010.

[12]Structural basis of multidrug recognition (invited), *A. Yamaguchi: Nanofair 2010 - 8th International Nanotechnology Symposium, International Congress Center, Dresden, Germany, July 6 - 7, 2010.

[13]Electron Tomography Revealed the Endoplasmic Reticulum as a Source of Autophagosomal Membranes (poster), *M. Hayashi-Nishino, N. Fujita, T. Noda, A. Yamaguchi, K. Nishino, T. Yoshimori, A. Yamamoto: ASM American Society for Microbiology 110th General Meeting, San Diego, U.S.A., May 23-27, 2010.

[14]Overexpressed Lipoprotein Increases Multidrug Resistance by Induction of Multidrug Transporters in E. coli (poster), *S. Yamasaki, M. Hayashi-Nishino, A. Yamaguchi, K. Nishino: ASM American Society for Microbiology 110th General Meeting, San Diego, U.S.A., May 23-27, 2010.

[15]Streptococcus pneumoniae Evades Neutrophil phagocytosis Through its Surface Protein PfbA (poster), *M. Yamaguchi, Y. Terao, K. Nishino, A. Yamaguchi, S. Hamada, S. Kawabata: ASM American

Society for Microbiology 110th General Meeting, San Diego, U.S.A., May 23-27, 2010.

**Review Papers**

Small RNA-mediated bacterial multidrug resistance, Nishino K, Yamasaki S, Nishino-Hayashi M, Yamaguchi A, Japanese Journal of Chemotherapy, Japanese Society of Chemotherapy, 59 (2011), 1-7.

**Publications in Domestic Meetings**

| | |
|---|---|
| The 45th Annual Meeting of the Paeudomonas Aeruginosa Infection Society | 1 paper |
| Symposium on Regulation of Oral Conditions | 1 paper |
| Joint Meeting of PRESTO 'Metabolism and Cellular Function' and 'RNA and Biofunctions' | 1 paper |
| The 83rd Annual Meeting of the Japanese Biochemical Society | 5 papers |
| Nano-Macro Materials, Devices and System Research Alliance | 1 paper |
| The 32nd Symposium on Biomembrane-Drug Interaction | 1 paper |
| Annual Meeting 2010 and General Assembly of the Crystallographic Society of Japan | 1 paper |
| The 36th Annual Meeting of Japan Bioenergetics Group | 1 paper |
| The 10th Awaji International Forum on Infection and Immunity | 2 papers |
| The 47th Annual Meeting of the Biophysical Society of Japan | 2 papers |
| The 22nd Symposium on Microbial Science | 2 papers |
| Nano-Macro Materials, Devices and System Research Alliance, Kickoff Meeting | 1 paper |
| The 27th Naito Conference | 3 papers |
| The 10th Annual Meeting of the Protein Society of Japan | 1 paper |
| The 52th Japanese Conference on the Biochemistry of Lipids | 1 paper |
| The 58th Annual Meeting of the Japanese Society of Chemotherapy | 2 papers |
| Transient Macromolrcular Complexes | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Bachelor Degree for Pharmaceutical Science<br>S. Nagasawa | Functional analysis of bacterial xenobiotic transporters |
| Bachelor Degree for Pharmaceutical Science<br>M. Mashita | Construction of stable transfectant of hSpns family proteins |
| Master Degree for Pharmaceutical Sciences<br>E. Ogawa | Identification of amino acid residues essential for sphingosine 1-phosphate transport activity of hSpns2 protein |
| Master Degree for Pharmaceutical Sciences<br>M. Ojima | Regulation and physiological functions of Salmonella xenobiotic transporters |
| Master Degree for Pharmaceutical Sciences<br>S. Hamanaka | Expression specificity and cellular localization of mSpns2 |
| Master Degree for Pharmaceutical Sciences<br>T. Horiyama | Roles of xenobiotic transporters in bacterial drug resistance and virulence |
| Master Degree for Pharmaceutical Sciences | Identification of sphingosine 1-phosphate transporter using yeast cells |

| | | |
|---|---|---|
| Y. Yoshimoto<br>Doctor Degree for Pharmaceutical Sciences<br>E. Nikaido | Regulatory network of the AcrAB xenobiotic transporter in Salmonella enterica | |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| A. Yamaguchi | Structures, functions, regulations and physiological roles of xenobiotic exporters | ¥21,580,000 |
| T. Nishi | Identification of the sphingosine 1-phosphate transporters and its diverse physiological roles | ¥1,170,000 |
| T. Nishi | Comprehensive analysis of the export mechanism of bioactive lipids from the cells and identification of the universal mechanism of the bioactive lipid transporters | ¥9,490,000 |
| S. Nishi | Elucidation of control mechanisms of proton pump activity responding to environmental signals | ¥1,000,000 |
| E. Nikaido | Regulatory network of multidrug transporters reveals their physiological role in Salmonella virulence | ¥600,000 |
| M.Yamaguchi | Molecular analysis of the interaction between Streptococcus pneumoniae and erythrocytes | ¥1,000,000 |
| M.Sasaki | Physiological roles of proton signals in immune cells | ¥1,000,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| A. Yamaguchi | National Institute of Biomedical Innovation | Development of novel inhibitors that counteract infectious diseases by drug resistant bacteria | ¥76,000,000 |

**Contribution to Research**

| | | |
|---|---|---|
| T.Nishi | Takeda Science Foundation | ¥3,000,000 |
| T.Nishi | SANPLATEC Corp. | ¥70,000 |
| Y.Hisano | The Naito Foundation | ¥500,000 |

**Cooperative Research**

| | | |
|---|---|---|
| A.Yamaguchi | Fine Co., Ltd | ¥5,000,000 |

## Department of Biomolecular Energetics

**Original Papers**

[1]Simple dark-field microscopy with nanometer spatial precision and microsecond temporal resolution., Ueno H, Nishikawa S, Iino R, Tabata KV, Sakakihara S, Yanagida T, Noji H.: Biophys. J., 98 (2010) 2014-2023.

[2]Fluctuation theorem applied to F1-ATPase., Hayashi K, Ueno H, Iino R, and Noji H.: Phys. Rev. Lett., 104 (2010) 218103-1-218103-4.

[3]Phosphate-release in F1-ATPase catalytic cycle follows ADP release., Watanabe R, Iino R, Noji H: Nat. Chem. Biol., 6 (2010) 814–820.

[4]Stiffness of γ subunit of F1-ATPase., Okuno D, Iino R, and Noji H: Eur. Biophys. J., 39 (2010) 1589-1596.

[5]A single-molecule enzymatic assay in a directly accessible femtoliter droplet array., Sakakihara S, Araki S, Iino R, Noji H: Lab Chip., 10 (2010) 3355-3362.

[6]Vacuolar-type proton pump ATPases: roles of subunit isoforms in physiology and pathology., Sun-Wada, G.H., and Y. Wada.: Histol Histopathol., 25 (12) (2010) 1611-1620.

[7]Optic nerve compression and retinal degeneration in Tcirg1 mutant mice lacking the vacuolar-type H+-ATPase a3 subunit., Kawamura, N., H. Tabata, G.H. Sun-Wada, and Y. Wada.: PloS One, 5 (8) (2010)

e12086.

[8]The (pro)renin receptor/ATP6AP2 is essential for vacuolar H+-ATPase assembly in murine cardiomyocytes, Kinouchi, K., A. Ichihara, M. Sano, G.H. Sun-Wada, Y. Wada, A. Kurauchi-Mito, K. Bokuda, T. Narita, Y. Oshima, M. Sakoda, Y. Tamai, H. Sato, K. Fukuda, and H. Itoh.: Circ Res., 107 (1) (2010) 30-34.

**International Conferences**
[1]Femtoliter Chamber Array for Single Molecular Bioassay. (invited), Hiroyuki Noji: ISMM2010.

[2]Mechanochemistry of F1-ATPase Moter Protein (invited), Hiroyuki Noji: ISMSC2010.

[3]Direct observation of steps in c-ring rotation of Escherichia coli FoF1-ATP synthase (oral), Ryota Iino, Khek-Chian Tham, Kazuhito V. Tabata, Hiroshi Ueno, Hiroyuki Noji: 16th European Bioenergetics Conference.

[4]Visualization of cargo dynamics in COPII vesicle formation on artificial planar lipid membrane (poster), Kazuhito V. Tabata, Ken Sato,, Toru Ide, Takayuki Nishizaka, Akihiko Nakano, Hiroyuki Noji: 16th European Bioenergetics Conference.

[5]Chemomechanical coupling of Pi release on F1-ATPase (poster), Rikiya Watanabe, Ryota Iino, Hiroyuki Noji: 16th European Bioenergetics Conference.

[6]Robustness of torque-transmission between β and γ of F1-ATPase (poster), Mizue Tanigawara, Kazuhito V. Tabata, Hiroyuki Noji: 16th European Bioenergetics Conference.

[7]Culture, detection, and recovery of the antibiotic-tolerant persister bacteria in the directly accessible microchamber array (poster), Iino R., Hayama K., Sakakihara S., and Noji H: 14th International Conference on Miniaturized Systems for Chemistry and Life Sciences (μTAS2010).

[8]Single-molecule studies on the fluctuation and function of a rotary motor protein ATP synthase (invited), Ryota Iino: The 4th International Symposium "Molecular Science of Fluctuations toward Biological Functions".

[9]Subunit rotation in a single FoF1-ATP synthase in a living bacterium monitored by FRET. (oral), Seyfert K., Oosaka T., Yaginuma H., Ernst S.,, Noji H., Iino R., Börsch M.: SPIE Photonics West 2011.

[10]STRUCTURAL FLUCTUATION AND CATALYTIC FUNCTION OF F1-ATPASE. (poster), Rikiya Watanabe, Kumiko Hayashi, Hiroshi Ueno,Hiroyuki Noji: Biophysical Society 55th Annual Meeting.

[11]Femto-liter Reactor Array for Single-molecule Bioanalysis (invited), Hiroyuki Noji: PITTCON 2011.

[12]Spatial restriction of BMP signalling in mouse gastrula by the endocytic pathway (oral), Wada Y.: CSHL Meeting on Vertebrate Organogenesis.

[13]Delivery of endosomes to lysosomes via microautophagy in the visceral endoderm of mouse embryo (poster), Wada Y., Sun-Wada, G. H.: Delivery of endosomes to lysosomes via microautophagy in the visceral endoderm of mouse embryo.

[14]Late endocytic pathway in mouse embryos: implication in spatiotemporal signaling during gastrulation. (poster), Sun-Wada, G. H., Wada Y.: The 16th International Conference of the International Society of Differentiation.

[15]ATP6ATP2(pro)renin receptor is essential for the function of organella in murine cardiomycytes

(oral), K. Kinouchi, A. Ichihara, M. Sano, G.H. Sun-Wada, Y. Wada, A. Kurauchi-Mito, K. Bokuda, T. Narita, Y. Oshima, M. Sakoda, Y. Tama, H. Sato, K. Fukuda, H. Itoh: 30es Journées de l'Hypertension Artérielle and 4th International Meeting of the French Society of Hypertension.

**Review Papers**

Measurement of the conformational state of F1-ATPase by single-molecule rotation., Okuno D, Ikeguchi M, Noji H., Methods in Enzymology, Academic Press, 475 (2010), 279-296.

**Publications in Domestic Meetings**

Biophysical Society of Japan 7 papers

**Academic Degrees**

| | |
|---|---|
| Master Degree for Engineering<br>T. Araki | Development of microdroplet array for single-molecule enzymatic assay and its application to digital counting method |
| Master Degree for Engineering<br>K. Tomiyama | Quantification of ATP concentration in living single bacterium. |
| Master Degree for Engineering<br>T. Oosaka | Single molecule rotation visualization of FoF1-ATP synthase in living E.coli. |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| H. Noji | Innovative nanoscience of supermolecular motor proteins working in biomembranes | ¥11,000,000 |
| H. Noji | Rotational mechanism of FoF1-ATP synthase | ¥34,400,000 |
| R. Iino | Visualization of the rotary motion of the ATP synthase by single-molecule techniques and microdevices. | ¥1,690,000 |
| R. Iino | Development of an ultra-high speed optical microscope for the investigation of correlation between the conformational fluctuation and the performance of motor proteins | ¥3,640,000 |
| R. Iino | Single-molecule FRET measurement of rotary motor protein dynamics in living cells | ¥2,000,000 |
| K. Tabata | Development of hole genome exchange method of bacteria. | ¥1,300,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| H. Noji | Japan Science and Technology Agency | Single-molecular Mechanochemistry of Artificial molecules | ¥6,500,000 |
| R. Iino | Japan Society for the Promotion of Science | Single-molecule measurement of rotation speed of ATP synthase working in living cells | ¥2,500,000 |

## Specially Appointed Laboratory

**Original Papers**

[1]Single Molecule Identification via Electric Current Noise, M. Tsutsui, M. Taniguchi and T. Kawai: Nature Communications, 1 (2010) 138(1-5).

[2]Dopant Homogeneity and Transport Properties of Impurity-doped Oxide Nanowires, A. Klamchuen, T. Yanagida, M. Kanai, K. Nagashima, K. Oka, S. Seki, M. Suzuki, Y. Hidaka, S. Kai and T. Kawai: Applied Physics Letters, 98 (2011) 053107(1-3).

[3]Atomically controlled fabrications of subnanometer scale electrode gaps, M. Tsutsui, T. Ohshiro, K. Matsubara, M. Furuhashi, M. Taniguchi and T. Kawai: Journal of Applied Physics, 108 (6) (2010) 064312(1-4).

[4]A behavioral model of unipolar resistive RAMs and its application to HSPICE integration, N. Akou, T.

Asai, T. Yanagida, T. Kawai and Y. Amemiya: IEICE Electronics Express, 7 (19) (2010) 1467-1473.

[5]Photocurable Silsesquioxane-Based Formulations as Versatile Resins for Nanoimprint Lithography, B. K. Lee, N.-G. Cha, L.-Y. Hong, D.-P. Kim, Hide. Tanaka, H. Y. Lee and T. Kawai: Langmuir, 26 (18) (2010) 14915-14922.

[6]Role of surrounding oxygen on oxide nanowire growth, A. Klamchuen, T. Yanagida, M. Kanai, K. Nagashima, K. Oka, T. Kawai, M. Suzuki, Y. Hidaka and S. Kai: Applied Physics Letters, 97 (7) (2010) 073114(1-3).

[7]Numerical study on the difference in mechanism between vapor-solid and vapor-liquid-solid solidification processes, M. Suzuki, Y. Hidaka, T. Yanagida, M. Kanai, T. Kawai and S. Kai: Physical review E, 82 (1) (2010) 011605(1-7).

[8]Nanochannels' fabrication using Kirkendall effect, A. Marcu, T. Yanagida and T. Kawai: Solid State Sciences, 12 (6) (2010) 978-981.

[9]Investigation of structural and magnetic properties of polycrystalline Ni0.50Zn0.50-xMgxFe2O4 spinel ferrites, A.K.M.A. Hossain, T.S.Biswas, T. Yanagida, Hide. Tanaka, H. Tabata, T. Kawai: Materials Chemistry and Physics, 120 (2-3) (2010) 461-467.

[10]A facile method towards cyclic assembly of gold nanoparticles using DNA template alone., Ohshiro T, Zako T, Watanabe-Tamaki R, Tanaka T, Maeda M: Chemical Commnunication, 46 (33) (2010) 6132-6134.

[11]Single-molecule imaging of DNA duplexes immobilized on surfaces with a scanning tunneling microscope., Ohshiro T, Maeda M: Chemical Commnunication, 46 (15) (2010) 2581-2583.

[12]STM Observation of Interference Patterns near the End Cap and Its Application to the Chiral Vector Determination of Carbon Nanotubes, T. Komeda, F. Masayuki: J. M. Marulanda, Electronic Properties of Carbon Nanotubes (Electronic Properties of Carbon Nanotubes) (2011) Intech.

[13]Synthesis and characterization of small circular double-stranded RNAs., Abe N, Abe H, Ohshiro T, Nakashima Y, Maeda M, Ito: Chemical Commnunication, 47 (7) (2011) 2125-2127.

**International Conferences**

[1]The Development and prospect of Nano-scale Devices and its Future: ReRAM and Nano-pore (invited), *T. Kawai: 125th Anniversary YONSEI International Symposium (The Development and Prospect of Nano-Scale Devices) Korea, 2010.05.12-13.

[2]Self-assembled metal oxide Nanowires: Synthesis, Properties and Non-voltile Memory Applciations (plenary), *T. Kawai: 3rd International Conference on Nanostructures (SElf-Assembly) French, 2010.06.28-07.02.

[3]Scientific challenges for the future of nanotechnology (invited), *T. Kawai: US-Japan-Korea-Taiwan Workshop on "Long-term Impacts and Future Opportunities for echnology" Japan, 2010.07.26-27.

[4]Green Nanotechnology for Low Power Consumption Devices using Metal Oxide Nanowires (plenary), *T. Kawai: IUMRS-ICEM2010 (International Union of Materials Research Societies - International Conference on Electronic Materials 2010) Korea, 2010.08.22-27.

[5]Crucial Role of Impurity Doping Dynamics on Transport , *A. Klamchuen: 17th International Workshop on Oxide Electronics(WOE 17) Japan, 2010.09.19-22.

[6]Giant Magnetoresistance in Nanostructured Metal (invited), *T. Kawai: International Conference on Nanoscale Magnetism (ICNM-2010) Turkey, 2010.09.28-10.02.

[7]Toward 1000 Dollars Single Molecular DNA Sequencing: STM and Gating Nanopore (invited), *T. Kawai: 바이오융합구본부 해외석학 초빙세미나 Korea, 2010.10.21.

[8]Green Nanotechnology for the Low Power Consumption Devices using Metal Oxide Nanowires (plenary), *T. Kawai: The 5th International Workshop on ADVANCED MATERIALS SCIENCE AND NANOTECHNOLOGY (IWAMSN 2010) Vietnam, 2010.11.09-12.

[9]Self-assembled metal oxide nanowires: synthesis, properties and non-volatile memory applications (invited), *T. Kawai: The 9th JapanFrance Workshop on Nanomaterials France, 2010.11.24-26.

[10]Single biomolecule spectroscopy and conductance measurement by Nanoelectrodes systems (poster), *M. Tsutsui: The 9th JapanFrance Workshop on Nanomaterials France, 2010.11.24-26.

[11]Metal oxide nanowires:synthesis, properties, and non-volatile memory applications (oral), *T. Yanagida: 2010 International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010) USA, 2010.12.15-20.

[12]Growth and mechanisms of VLS grown oxide nanowires (poster), *M. Kanai, T. Yanagida, A. Klamchuen, K. Nagashima, K. Oka, T. Kawai, M. Suzuki, Y. Hidaka, S. Kai: 2010 International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010) USA, 2010.12.15-20.

[13]Role of impurity doping on transport properties and microstructures of oxide nanowires (poster), *A. Klamchuen, T. Yanagida, M. Kanai, K. Nagashima, K. Oka, T. Kawai, M. Suzuki, Y. Hidaka, S. Kai: 2010 International Chemical Congress of Pacific Basin Societies (PACIFICHEM 2010) USA, 2010.12.15-20.

[14]Toward 1000 dollars Single Molecular DNA Sequencing ---- STM and Gating Nanopore--- (invited), *T. Kawai: 2011 Japan-Taiwan Join Workshop on Bioelectronics Taiwan, 2011.01.20-21.

[15]Development of Gating Nanopores for Single-Molecule Electrical Sequencing (invited), *M. Taniguchi: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[16]Fabrication of electrode-embedded in-plane nanopore detectors (invited), *M. Tsutsui: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[17]Fabrication of Nanogap Electrodes Using Self-Breaking Technique for Single-Molecule Identification (poster), *K. Matsubara, , M. Furuhashi, T. Ohshiro, M.Tsutusi, M. Taniguchi and T. Kawai: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[18]Identification of RNA Bases by Tunneling Gurrent (poster), *M. Furuhashi, T. Ohshiro, M. Tsutsui, K. Matsubara, M. Taniguchi and T. Kawai: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[19]Single-molecule Electrical Sequencing of DNA Codon (poster), *T. Ohshiro, K. Matsubara, M.Tsutsui, M. Furuhashi, M. Taniguchi and T. Kawai: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[20]Metal oxide nanowires: Fabrication, properties and device applications (invited), *T. Kawai:

Workshop on Nanomaterials Innovation and Nanotechnology The Kingdom of Thailand, 2011.02.25-26.

[21]Fabrication od Nanogap Electrodes Using Self-Breaking Technique for Single-Molecule Identification (poster), *K. Matsubara, M. Furuhashi, T. Ohshiro, M.Tsutsui, M. Taniguchi and T. Kawai: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[22]Identification of RNA Bases by Tunneling Gurrent (poster), *M. Furuhashi, T. Ohshiro, K. Matsubara, M.Tsutsui, M. Taniguchi and T. Kawai: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[23]Fabrication of electrode-embedded in-plane nanopore detectors (invited), *M.Tsutsui, M. Taniguchi and T. Kawai: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011) Japan, 2011.01.24-26.

[24]Single-molecule Imaging of DNA Duplex Immobilized on Surfaces with Scanning Tunneling Microscope (poster), *Takahito Ohshiro, Mizuo Maeda: Pachifichem2010.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| T. KAWAI | 12th International Ceramics Congress (CIMTEC 2010) (International Advisory Board) |
| T. KAWAI | International Conference on Superlattices, Nanostructures and Nanodevices (ICSNN-2010) (International Advisory Committee) |
| T. KAWAI | International Symposium on Surface Science -Towards Nano-, Bio-, and Green, Innovation- (ISSS-6) (International Program Advisary Board) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Applied Physics Society Conference 72 | 5 papers |
| Physical Society of Japan 2010 Fall Meeting | 4 papers |
| 90th Annual Meeting of The Chemical Society of Japan | 2 papers |
| 58th Meeting of The Japan Society of Applied Physics and Related Societies | 6 papers |
| 61th SPSJ Annual Meetiing: | 1 paper |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| T. Kawai | Emergence in Chemistry | ¥14,690,000 |
| T. Kawai | Programmed emergence phenomena in oxide nanostructures | ¥19,760,000 |
| T. Kawai | Development of Nanochannel structures For Single-Biomolecule Anaysis | ¥18,200,000 |
| M. Tsutsui | Development of Electrostatic Drived Single-MoleculeSwitch | ¥2,500,000 |
| T. Ohshiro | Development of Mesurement Methodogy for Electron Transfer through a DNA duplex by using Single-Molecule STM Imaging. | ¥2,200,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| T. Kawai | MEXT(The Ministry of Education, Culture, Sports, Science and Technology) | Handai Multi-Functional Nanofoundry | ¥108,000,000 |
| T. Kawai | MEXT(The Ministry of Education, Culture, Sports, Science and Technology) | 「Network Building Program of Research Centers for Reduction of Carbon-dioxide Emmision」 「Research Center for Organic/ Oxide Green Nano Device」 | ¥813,120,000 |
| T. Kawai | Funding Program for World-Leading Innovative R&D on Science and Technology | Research and Development of Innovative Nanobiodevices Based on Single-Molecule Analysis -Ultra-fast Single-Molecule-DNA Sequencing, | ¥915,600,000 |

Ultra-Low-Concentration Virus
Detection, and Ultra-Sensitive
Biomolecule Monitoring-

## Laboratory of Microbiology and Infectious Diseases

### Original Papers

[1]Impact of the RNA chaperone Hfq on multidrug resistance in Escherichia coli, Yamada J, Yamasaki S, Hirakawa H, Hayashi-Nishino M, Yamaguchi A, Nishino K: J Antimicrob Chemother, 65 (5) (2010) 853-858.

[2]Effect of NlpE overproduction on multidrug resistance in Escherichia coli, Nishino K, Yamasaki S, Hayashi-Nishino M, Yamaguchi A: Antimicrob Agents Chemother, 54 (5) (2010) 2239-2243.

[3]TolC dependency of multidrug efflux systems in Salmonella enterica serovar Typhimurium, Horiyama T, Yamaguchi A, Nishino K: J Antimicrob Chemother, 65 (7) (2010) 1372-1376.

[4]Indole enhances acid resistance in Escherichia coli, Hirakawa H, Hayashi-Nishino M, Yamaguchi A, Nishino K: Microb Pathog, 49 (3) (2010) 90-94.

[5]Roles of Salmonella multidrug efflux pumps in tigecycline resistance, Horiyama T, Nikaido E, Yamaguchi A, Nishino K: J Antimicrob Chemother, 66 (1) (2011) 105-110.

[6]Effect of overexpression of small non-coding DsrA RNA on multidrug efflux in Escherichia coli, Nishino K, Yamasaki S, Hayashi-Nishino M, Yamaguchi A: J Antimicrob Chemother, 66 (2) (2011) 291-296.

[7]Regulation of the AcrAB multidrug efflux pump in Salmonella enterica serovar Typhimurium in response to indole and paraquat, Nikaido E, Shirosaka I, Yamaguchi A, Nishino K: Microbiology, 157 (3) (2011) 648-655.

### International Conferences

[1]Drug resistance and virulence roles of multidrug efflux systems (invited), *K. Nishino: Einladung zum Kolloquium at Martin-Luther-Universitat Halle-Wittenberg.

[2]Virulence and drug resistance roles of multidrug efflux systems in Salmonella enterica (invited), *K. Nishino: ASM American Society for Microbiology 110th General Meeting.

[3]Development of novel therapeutic strategies to tackle multidrug-resistant pathogens (poster), *Nishino, K., S. Yamasaki, M. Hayashi-Nishino, and A. Yamaguchi: The American Association for the Advancement of Science (AAAS) 2011 Annual Meeting.

[4]Functional network of multi-component drug efflux systems in Salmonella enterica serovar typhimurium (poster), Yamasaki, S., S. Nagasawa, M. Hayashi-Nishino, A. Yamaguchi, and *K. Nishino: The 14th SANKEN International Symposium & The SANKEN Nanotechnology Symposium.

[5]Role of the RNA chaperon Hfq in multidrug resistance of Escherichia coli (poster), *Nishino, K., S. Yamasaki, M. Hayashi-Nishino, and A. Yamaguchi: New Zealand Microbiological Society and New Zealand Society for Biocheistry & Molecular Biology Joint Meeting 2010.

[6]Impact of Hfq on multidrug resistance in Escherichia coli (poster), *Yamasaki, S., J. Yamada, H. Hirakawa, M. Hayashi-Nishino, A. Yamaguchi, and K. Nishino: The Awaji International Forum on Infection and Immunity.

[7]TolC dependency of multidrug efflux systems in Salmonella enterica serovar Typhimurium (poster),

*Horiyama, T., A. Yamaguchi, and K. Nishino: The Awaji International Forum on Infection and Immunity.

[8]Overexpressed lipoprotein increases multidrug resistance by induction of multidrug transporters in E. coli (poster), *Yamasaki, S., M. Nishino-Hayashi, A. Yamaguchi, and K. Nishino: ASM American Society for Microbiology 110th General Meeting.

[9]Electron tomography revealed the endoplasmic reticulum as a source of autophagosomal membranes (poster), *Nishino-Hayashi, M., N. Fujita, T. Noda, A. Yamaguchi, K. Nishino, T. Yoshimori, and A. Yamamoto: ASM American Society for Microbiology 110th General Meeting.

[10]Streptococcus pneumoniae evades neutrophil phagocytosis through its surface protein PfbA (poster), *Yamaguchi, M., Y. Terao, K. Nishino, A. Yamaguchi, S. Hamada, and S. Kawabata: ASM American Society for Microbiology 110th General Meeting.

[11]Summary of INRA-JSPS project and microarray analysis (oral), *K. Nishino: INRA-JSPS project meeting.

[12]Regulation mechanism of Salmonella AcrAB multidrug efflux pump in response to extracellular signals (oral), *E. Nikaido, K. Sakurai, R. Nakashima, A. Yamaguchi, K. Nishino: INRA-JSPS project meeting.

[13]Physiological roles of multidrug efflux pumps in Escherichia coli (oral), *T. Horiyama, A, Yamaguchi, K. Nishino: INRA-JSPS project meeting.

[14]Recent study on crystal structures of the AcrB efflux pump (oral), *R. Nakashima, K. Sakurai, S. Yamasaki, K. Nishino, A. Yamaguchi: INRA-JSPS project meeting.

**Review Papers**

Epigenetics and regulation of bacterial multidrug resistance, Nishino K, Reviews and Topics on Surface Science & Technology Avant-grade, Koshinsya, 48 (2010), 365-374.

Small RNA-mediated bacterial multidrug resistance, Nishino K, Yamasaki S, Nishino-Hayashi M, Yamaguchi A, Japanese Journal of Chemotherapy, Japanese Society of Chemotherapy, 59 (2011), 1-7.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| K. Nishino | Frontiers in Antimicrobials, Resistance and Chemotherapy (Review Editorial Board) |
| K. Nishino | FEBS Letters (Ad-Hoc reviewer) |
| K. Nishino | Molecular Microbiology (Ad-Hoc reviewer) |
| K. Nishino | Biological and Pharmaceutical Bulletin (Ad-Hoc reviewer) |
| K. Nishino | Microbiology and Immunology (Ad-Hoc reviewer) |
| K. Nishino | Cell & Bioscience (Ad-Hoc reviewer) |
| K. Nishino | Microbiology (Ad-Hoc reviewer) |
| K. Nishino | Antimicrobial Agents and Chemotherapy (Ad-Hoc reviewer) |
| K. Nishino | External examinar, Medical Faculty, the University of Hong Kong (External examinar) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Protein Science Society of Japan | 1 paper |
| Microbiology Symposium | 2 papers |
| The Biophysical Society of Japan | 1 paper |
| Symposium on bacterial drug resistance | 1 paper |
| Annual Meeting of ISIR, Osaka Univ. | 1 paper |
| The Crystallographic Society of Japan | 1 paper |
| BMB2010 | 4 papers |

| | |
|---|---|
| Symposium on Regulation of Oral Conditions | 1 paper |
| Annual Meeting of the Psedomonas aeruginosa Infection Society | 1 paper |
| The Pharmaceutical Society of Japan | 2 papers |
| Life Phenomena and Measurement Analysis | 1 paper |
| Chembiomolecular Science: at the Frontier of Chemistry and Biology | 1 paper |
| Japanese Society of Chemotherapy | 1 paper |
| Science and Technology Festa | 1 paper |
| Alliance Kickoff Meeting | 1 paper |
| Meeting of CREST 'Basic Technologies for Controlling Cell Functions Based on Metabolic Regulation Mechanism Analysis' | 1 paper |
| Joint Meeting of PRESTO 'Metabolism and Cellular Function' and 'RNA and Biofunctions' | 2 papers |
| Senri-no-Kai | 1 paper |
| Matrix of Infection Phenomena | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Doctoral Degree for Pharmaceutical Science<br>E. Nikaido | Regulatory network of the AcrAB xenobiotic transporter in Salmonella enterica |
| Master Degree for Pharmaceutical Science<br>M, Ojima | Regulation and physiological functions of Salmonella xenobiotic transporters |
| Master Degree for Pharmaceutical Science<br>T. Horiyama | Roles of xenobiotic transporters in bacterial drug resistance and virulence |
| Bachelor Degree for Pharmaceutical Science<br>S. Nagasawa | Functional analysis of bacterial xenobiotic transporters |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| K. Nishino | Roles of orphan transporters in multidrug-resistant bacteria and development of therapeutic strategies to control infectious diseases | ¥11,700,000 |
| K. Nishino | Strategies of immune evasion utilized by bacteria | ¥3,800,000 |
| K. Nishino | Functional complexes of bacterial multidrug efflux systems | ¥5,590,000 |
| K. Nishino | Identification of intrinsic and environmental regulations of the Ram locus involved in the multidrug resistance of Salmonella | ¥2,500,000 |
| K. Nishino | Regulation of bacterial multidrug resistance and virulence modulated by drug efflux pumps and development novel therapeutics to control infectious diseases | ¥130,000 |
| M. Nishino | Study on defence mechanisms of bacteria and host cells in infection | ¥1,261,000 |

**Cooperative Research**

| | | |
|---|---|---|
| K. Nishino | Axel Cloeckaert (INRA, France) | ¥2,500,000 |
| K. Nishino | Aixin Yan (University of Hong Kong) | ¥200,000 |
| K. Nishino | Daiichi-Sankyo | ¥0,000 |
| K. Nishino | Fine | ¥5,000,000 |

**Other Research Fund**

| | | |
|---|---|---|
| K. Nishino | The Uehara Memorial Foundation | ¥3,000,000 |
| K. Nishino | The program HISHO the Top Thirty Young Researchers of | ¥3,360,000 |

Osaka University

## Laboratory of Atomic Scale Materials Processing

### Original Papers

[1]Resistive-Switching Memory Effects of NiO Nanowire/Metal Junctions, T. Yanagida, K. Nagashima, T. Kawai: J. Am. Chem. Soc., 132 (2010) 6634-6635.

[2]Role of surrounding oxygen on oxide nanowire growth, T. Yanagida, M. Kanai, K. Nagashima, T. Kawai: Appl. Phys. Lett., 97 (2010) 073114.

[3]Impurity induced periodic mesostructures in Sb-doped SnO2 Nanowires, T. Yanagida, M. Kanai, K. Nagashima, T. Kawai: J. Cryst. Growth, 312 (2010) 3251-3256.

[4]Dopant homogeneity and transport properties of impurity-doped oxide nanowires, T. Yanagida, M. Kanai, K. Nagashima, T. Kawai: Appl. Phys. Lett., 98 (2011) 053107.

[5]Size Control of Magnetite Nanoparticles by Organic Solvent-Free Chemical Coprecipitation at Room Temperature, T. Yanagida, T. Kawai: J. Exp. Nanosci., 5 (2010) 251-262.

[6]Numerical Study on the Difference in Mechanism between Vapor-Solid and Vapor-Liquid-Solid Solidification Processes, T. Yanagida, M. Kanai, T. Kawai: Phys. Rev. E, 82 (2010) 011605.

[7]A Behavioral Model of Unipolar Resistive RAM and its Application to HSPICE Integration, T. Yanagida, T. Kawai: IEICE Electronics Express, 7 (2010) 1467-1473.

[8]Direct Transformation from Goethite to Magnetite Nanoparticles by Mechanochemical Reduction, T. Yanagida, T. Kawai: J. Alloys and Comp., 509 (2011) L34-L37.

### International Conferences

[1]Non-volatile Resistive Switching in NiO Heterostructured Nanowire (poster), T. Yanagida, K. Nagashima, T. Kawai: HANDAI Global COE&ICNDR International Conference on Core Research and Engineering Science of Advanced Material.

[2]Redox Based Non-volatile Resistive Switching in MgO/Cobalt OxideHeterostructured Nanowires (poster), K. Nagashima, T. Yanagida, M.Taniguchi, T. Kawai: HANDAI Global COE&ICNDR International Conference on Core Research and Engineering Science of Advanced Materials.

[3]Resistive Switching Memory Effects of a Single Oxide Nanowire (oral), T. Yanagida, K. Nagashima, M. Kanai, T. Kawai: 17th International Workshop on Oxide Electronics.

[4]Crucial Role of Redox Events on Non-volatile Resistive Switching in Cobalt Oxide Nanostructures (poster), K. Nagashima, T. Yanagida, M. Kanai, T. Kawai: 17th International Workshop on Oxide Electronics.

[5]Resistive Switching Phenomena in Limited Nanospace of a Single NiO Heterostructured Nanowire (poster), T. Yanagida, K. Nagashima, M. Kanai, T. Kawai: 17th International Workshop on Oxide Electronics.

[6]Importance of Oxygen Atmosphere as a Controlling Factor of Oxide-Nanowire Growth (poster), M. Kanai, T. Yanagida, K. Nagashima, T. Kawai: 17th International Workshop on Oxide Electronics.

[7]Crucial Role of Impurity Doping Dynamics on Transport Properties and Microstructures of VLS Grown SnO2 Nanowires (poster), T. Yanagida, M. Kanai, K. Nagashima, T. Kawai: 17th International Workshop on Oxide Electronics.

[8]Numerical Study on VLS Oxide Nanowire Growth (poster), T. Yanagida, M. Kanai, T. Kawai: 17th International Workshop on Oxide Electronics.

[9]A Behavioral Model of Unipolar Resistive RAMs and its Application to HSPICE Integration (poster), T. Yanagida, T. Kawai: 17th International Workshop on Oxide Electronics.

[10]A ReRAM-based analog synaptic device having spike-timing-dependent plasticity (poster), T. Yanagida, T. Kawai: Nanoelectronics Days 2010.

[11]Resistive Switching Non-volatile Memory in a Single Oxide Nanowire (invited), T. Yanagida: JFFOE.

[12]Resistive Switching in a Single Oxide Nanowire (oral), T. Yanagida, K. Nagashima, M. Kanai, T. Kawai: Material Research Society Fall Meeting.

[13]Non-volatile Memory Effects in Heterostructured Oxide Nanowires (poster), T. Yanagida, K. Nagashima, M. Kanai, T. Kawai: Material Research Society Fall Meeting.

[14]PLD/VLS ZnO Nanowire Growing on Vicinal Surfaces (poster), T. Yanagida, T. Kawai: Material Research Society Fall Meeting.

[15]Resistive Switching Effect in Limited Nanospace of a Single NiO Heterostructured Nanowire (poster), T. Yanagida, K. Nagashima, T. Kawai: Material Research Society Fall Meeting.

[16]Metal Oxide Nanowires: Synthesis, Properties and Non-volatile Memory Applications (invited), T. Yanagida: PACIFICHEM2010.

[17]Growth and Mechanisms of VLS Grown Oxide Nanowires (poster), M. Kanai, T. Yanagida, K. Nagashima, T. Kawai: PACIFICHEM2010.

[18]Role of Impurity Doping on Transport Properties and Microstructures of Oxide Nanowires (poster), T. Yanagida, M. Kanai, K. Nagashima, T. Kawai: PACIFICHEM2010.

**Patents**

[1]Fabrication Method of Non-volatile Resistive Switching Memory Device T. Yanagida, T. Kawai, K. Nagashima, K. Oka, JP2011-023651

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics | 5 papers |
| The Society of Chemical Engineers, Japan | 2 papers |
| Society of Nano Science and Technology | 1 paper |
| Workshop on Semiconductor Electronics | 1 paper |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| T. Yanagida | The Development of fabrication process in oxide one-dimensional nanostructures toward structural and functional monodispersion | ¥4,680,000 |
| T. Yanagida | The Synthesis of thermoelectric device using self-assembled oxide nanostructures | ¥700,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| T. Yanagida | SCOPE | Study on Nonvolatile memory using network structures of inorganic/organic heterostructures | ¥12,394,000 |
| T. Yanagida | JST | Fabrication of nonvolatile memory | ¥17,160,000 |

by oxide nanowires

**Other Research Fund**

| | | |
|---|---|---|
| T. Yanagida | Hosokawa Powder Technology Foundation | ¥700,000 |

## Beam Application Frontier Research Laboratory

**Original Papers**

[1]Effect of Inhomogeneous Acid Distribution on Line Edge Roughness- Relationship to Line Edge Roughness Originating from Chemical Gradient, T. Kozawa, H. Yamamoto, and S. Tagawa: J. Photopolym. Sci. Technol., 23 (2010) 625-630.

[2]Formation and Decay of Fluorobenzene Radical Anions Affected by Their Isomeric Structures and the Number of Fluorine Atoms, S. Higashino, A. Saeki, K. Okamoto, S. Tagawa, and T. Kozawa: Journal of Physical Chemistry A, 114 (2010) 8069–8074.

[3]Relationship between Normalized Image Log Slope and Chemical Gradient in Chemically Amplified Extreme Ultraviolet Resists, T. Kozawa and S. Tagawa: Japanese Journal of Applied Physics, 49 (2010) 06GF02/1-06GF02/5.

[4]Relationship between Line Edge Roughness and Fluctuation of Acid Concentration in Chemically Amplified Resist, T. Kozawa, H. Yamamoto, and S. Tagawa: Japanese Journal of Applied Physics, 49 (2010) 096506-096507.

[5]Radiation Chemistry of Fluoronaphthalene as a Candidate for Absorption Enhancement Component of Chemically Amplified Extreme Ultraviolet Resists, S. Ikeda, K. Okamoto, H. Yamamoto, A. Saeki, S. Tagawa, and T. Kozawa: Japanese Journal of Applied Physics, 49 (2010) 096504-096505.

[6]Dynamics of Radical Cation of Poly(4-hydroxystyrene)-Based Chemically Amplified Resists for Extreme-Ultraviolet and Electon Beam Lithographies, K. Okamoto, M. Tanaka, T. Kozawa, and S. Tagawa: Japanese Journal of Applied Physics, 49 (2010) 106501-1-106501-6.

[7]Optimum Dissolution Point of Chemically Amplified Resists in Terms of Trade-Off Relationships between Resolution, Line Edge Roughness, and Sensitivity, T. Kozawa, H. Yamamoto, and S. Tagawa: Japanese Journal of Applied Physics, 50 (2010) 026502-1-026502-5.

[8]Relationship of Electron Diffusion Length to Line Edge Roughness in Chemically Amplified Extreme Ultraviolet Resists, T. Kozawa and S. Tagawa: Japanese Journal of Applied Physics, 50 (2010) 036505-1-036505-5.

[9]Electron-Beam-Induced Chromism Combined with Photo- or Thermal Reverse Reaction for Color Imaging, K. Enomoto, Y. Maekawa, S. Kono, M. Iwasaki and T. Narita: J. Photopolym. Sci. Technol., 23 (2) (2010) 285-287.

**International Conferences**

[1]Advances in EUV lithography (invited), S. Tagawa: 2010 Gordon Research Conference on Radiation Chemistry.

[2]Radiation Chemistry of EUV and EB Non-chemically and Chemically Amplified Resists for EUV and EB Lithography (invited), H.Yamamoto, K. Okamoto, T. Kozawa, and S. Tagawa: 3rd Asia Pacific Symposium on Radiation Chemistry and DAE-BRNS 10th Biennial Trombay symposium on Radiation & Photochemistry.

[3]Short-Lived Intermediates of Fluorinated Benzene Derivatives Generated upon Exposure to Ionizing Radiation (invited), S. Higashino, K. Okamoto, A. Saeki, T. Kozawa and S. Tagawa: 36th International Conference on Micro&Nano Engineering.

[4]Trade-off Problems among Resolution, LWR and Sensitivity of EUV Resists (invited), S. Tagawa: IEUVI Resist Technical Working Group meeting.

[5]Radiation Chemistry of EUV Resists: Science and Technology (invited), S. Tagawa,, H. Yamamoto, K. Okamoto, T. Kozawa: 9th Meeting of the Ionizing Radiation and Polymers Symposium.

[6]Recent progress in resist materials and processes for extreme ultraviolet (EUV) and electron beam (EB) lithography (invited), S. Tagawa: Pacifichem 2010.

[7]Radiation Chemistry of EUV and EB Resists (oral), S. Tagawa: 2010 International Workshop on EUV Lithography.

[8]Effect of Inhomogeneous Acid Distribution on Line Edge Roughness -Relationship to Line Edge Roughness Originating from Chemical Gradient (oral), T. Kozawa, H. Yamamoto, and S. Tagawa: The Conference of Photopolymer Science and Technology.

[9]Positive-Negative Inversion of Resist Materials Induced by High LET Radiation (oral), T. G. Oyama, A. Oshima, H. Yamamoto, S. Tagawa, M. Washio: Ionizing Radiation and Polymers Symposium (IRaP-2010).

[10]XPS Study on Chemical Structure of PTFE after Ar+ irradiation (oral), T. Tatsumi, H. Tsubokura, H. Yamamoto, M. Ito, T. G. Oyama, A. Oshima, S. Tagawa, and M. Washio: Ionizing Radiation and Polymers Symposium (IRaP-2010).

[11]Fundamental Study on Resist Processes of Extreme Ultraviolet Lithography (oral), T. Kozawa, H. Yamamoto, and S. Tagawa: International EUV Resist Symposium.

[12]Reactivity Calculation of Photoacid Generators for EUV Resist (oral), M. Endo, S. Tagawa: International EUV Resist Symposium.

[13]Acid Proliferation to Improve the Sensitivity of EUV Resists: A Pulse Radiolysis Study (oral), K. Enomoto, K. Arimitsu, A. Yoshizawa, H. Yamamoto, A. Oshima, T. Kozawa and S. Tagawa: International EUV Resist Symposium.

[14]Sensitization Processes in Chemically Amplified EUV resist (oral), H. Yamamoto, Takahiro Kozawa, and Seiichi Tagawa: International EUV Resist Symposium.

[15]Extendibility of EUV resists in the exposure wavelength from 13.5 down to 3.1 nm for next generation lithography (invited), T. G. Oyama, T. Takahashi, A. Oshima, M. Washio, S. Tagawa: SPIE Advanced Lithography 2011.

[16]Investigation of reactivity of photoacid generators for EUV exposure (poster), M. Endo, S. Tagawa: 2010 International Symposium on Extreme Ultraviolet Lithography.

[17]Theoretical Study of Photoacid Generators for EUV Resist (poster), M. Endo, S. Tagawa: 23rd International Microprocesses and Nanotechnology Conference.

[18]Theoretical study of radiation reactivity on photoacid generators for EUV lithography (poster), M. Endo, S. Tagawa, H. Yamamoto, K. Enomoto: 2010 International Chemical Congress of Pacific Basin Societies (USA, 12/15-20, 2010).

[19]Calculated reactivity analysis of photoacid generators for EUV resist (poster), M. Endo, S. Tagawa: SPIE Advanced Lithography 2010.

[20]Electron-Beam-Induced Chromism Combined with Photo- or Thermal Reverse Reaction for Color Imaging (oral), K. Enomoto, Y. Maekawa, S. Kono, M. Iwasaki, T. Narita: The Conference of Photopolymer Science and Technology.

[21]Synthesis and Reaction Mechanism of Graft Type Electrolysis Membrane by Radiation Graft Polymerization of Cycloalkyl Polyimide (oral), J. Park, K. Enomoto, T. Yamashita, and Y. Maekawa: The Conference of Photopolymer Science and Technology.

[22]Acid Proliferation Reaction in EUV Resists (poster), K. Enomoto, K. Arimitsu, H. Yamamoto, A. Oshima, T. Kozawa, and S. Tagawa: 2010 International Symposium on Extreme Ultraviolet Lithography.

[23]Enhancement of Sensitivity by Acid Proliferation Reaction in EB and EUV Resists (poster), K. Enomoto, K. Arimitsu, H. Yamamoto, A. Oshima, T. Kozawa, and S. Tagawa: 23rd International Microprocesses and Nanotechnology Conference.

[24]Acid Proliferation Reaction for Sensitivity Enhancement of EUV Resists (poster), K. Enomoto, K. Arimitsu, A. Yoshizawa, H. Yamamoto, A. Oshima, T. Kozawa, and S. Tagawa: SPIE　Advanced Lithography 2011.

[25]Acid Generation Processes in Halogenated Aromatic Polymer films for Electron Beam and Extreme Ultraviolet Lithography (poster), H. Yamamoto, T. Kozawa, A. Saeki and S. Tagawa: 2010 Gordon Research Conference on Radiation Chemistry.

[26]Theoretical Study on Optimum Dissolution Point of Chemically Amplified Resist (poster), T. Kozawa, H. Yamamoto and S. Tagawa: 36th International Conference on Micro&Nano Engineering.

[27]Study on Ionization Process of Chemically Amplified Resist using Ultraviolet Photoelectron Spectroscopy (UPS) (poster), H. Yamamoto, T. Kozawa and S. Tagawa: 2010 International Symposium on Extreme Ultraviolet Lithography.

[28]Ionization Potential of Chemically Amplified Extreme Ultraviolet Resists Studied by Ultraviolet Photoelectron Spectroscopy (UPS) (poster), H. Yamamoto, T. Kozawa and S. Tagawa: 23rd International Microprocesses and Nanotechnology Conference.

[29]Dynamics of radical cation of poly(styrene-acrylate)-based chemically amplified resist for EUV and electron beam lithography (poster), Y. Tajima, K. Okamoto, T. Kozawa, S. Tagawa, R. Fujiyoshi, and T. Sumiyoshi: 23rd International Microprocesses and Nanotechnology Conference.

[30]Study on depth profile of acid generator distribution in poly(4-hydroxystyrene) films using X-ray photoemission spectroscopy(XPS) (poster), H. Yamamoto, T. Kozawa and S. Tagawa: 2010 International Chemical Congress of Pacific Basin Societies (USA, 12/15-20, 2010).

[31]Acid Proliferation Reaction　for Sensitivity Enhancement of EUV Resists (poster), K. Enomoto, H. Yamamoto, A. Oshima, T. Kozawa, S. Tagawa: 2010 International Chemical Congress of Pacific Basin Societies (USA, 12/15-20, 2010).

[32]Deprotonation mechanism of poly(styrene-acrylate)-based chemically amplified resist (poster), Y. Tajima, K. Okamoto, T. Kozawa, S. Tagawa, R. Fujiyoshi, and T. Sumiyoshi: SPIE　Advanced Lithography 2011.

[33]Characteristics of main chain decomposable STAR polymer for EUV resist (poster), J. Iwashita, T. Hirayama, K. Matsuzawa, K. Suzuki, S. Yoshizawa, K. Kono, M. Yahagi, K. Sato, S. Tagawa, K. Enomoto, and A. Oshima: SPIE　Advanced Lithography 2011.

[34]Development of plant-based resist materials in electron beam lithography (poster), S. Takei, A. Oshima, N. Yanamori, A. Sekiguchi, T. Kozawa, and S. Tagawa: SPIE Advanced Lithography 2011.

[35]Characterization of EUV irradiation effects on Polystyrene Derivatives Studied by X-ray (poster), H. Yamamoto, T. Kozawa and S. Tagawa: SPIE Advanced Lithography 2011.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| S. TAGAWA | 22nd International Microprocesses and Nanotechnology Conference (Organizing Committee member) |
| M. Endo | 28th International Conference of Photopolymer Science and Technology (Organizing Committee member) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics | 4 papers |
| The Society of Polymer Science, Japan | 2 papers |
| Japanese Society of Radiation Chemistry | 1 paper |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| K. Enomoto | Synthesis of Conducting Graft Polymers with a Hydrogen-Bond Network and Applications to Anhydrous Fuel Cell Membranes | ¥1,170,000 |
| H. Yamamoto | Elucidation and control of Nano-topography mechanism in ulatrafine fabrication | ¥1,560,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| S. Tagawa | JST CREST | Research on resist for ultrafine fabrication and development of process simulator | ¥148,850,000 |
| S. Tagawa | SELETE | Proposal of reaction mechanism and resist design for next generation EUV resist | ¥3,000,000 |

## Department of Disease Glycomics

**Original Papers**

[1]Hypoxic regulation of glycosylation via the *N*-acetylglucosamine cycle., K. Shirato, K. Nakajima, H. Korekane, S. Takamatsu, C. Gao, T. Angata, K. Ohtsubo and N. Taniguchi: J. Clin. Biochem. Nutr., 48 (1) (2011) 20-25.

[2]Brain endothelial cells produce amyloid β from amyloid precursor protein 770 and preferentially secrete the *O*-glycosylated form., S. Kitazume, Y. Tachida, M. Kato, Y. Yamaguchi, T. Honda, Y. Hashimoto, Y. Wada, T. Saito, N. Iwata, T. Saido and N. Taniguchi: J. Biol. Chem., 285 (51) (2010) 40097-40103.

[3]Palmitoylated Ras proteins traffic through recycling endosomes to the plasma membrane during exocytosis., R. Misaki, M. Morimatsu, T. Uemura, S. Waguri, E. Miyoshi, N. Taniguchi, M. Matsuda and T. Taguchi: J. Cell Biol., 191 (1) (2010) 23-29.

[4]Involvement of ST6Gal I in the biosynthesis of a unique human colon cancer biomarker candidate, alpha2,6-sialylated blood group type 2H (ST2H) antigen., H. Korekane, A. Matsumoto, F. Ota, T. Hasegawa, Y. Misonou, K. Shida, Y. Miyamoto and N. Taniguchi: J. Biochem., 148 (3) (2010) 359-370.

[5]Simultaneous determination of nucleotide sugars with ion-pair reversed-phase HPLC., K. Nakajima, S. Kitazume, T. Angata, R. Fujinawa, K. Ohtsubo, E. Miyoshi and N. Taniguchi: Glycobiology, 20 (7) (2010) 865-871.

**International Conferences**

[1]Simultaneous analysis of nucleotide sugars with ion-pair reverse-phase HPLC and LC-MS on glycan

cycle. (oral), K. Nakajima, S. Kitazume, T. Angata, R. Fujinawa, K. Ohtsubo, E. Miyoshi, N. Taniguchi: International Symposium on Organelle Network: Interface among Infection-immunity, Cell biology and Glycobiology. Osaka, Japan, Apr. 12-13, 2010.

[2]HIF-1α protein and laminin-332 subunit mRNA are upregulated by wound healing in airway epithelial cells. (poster), K. Shirato, T. Betsuyaku, K. Ohtsubo, S. Takamatsu, C. Gao, R. Takamiya, T. Angata, N. Taniguchi: 2010 American Thoracic Society International Conference. New Orleans, U.S.A. May 14-19, 2010.

[3]Roles of *N*-Glycan Branchings in Disease (invited), N. Taniguchi: The 28th Naito Conference "Glycan Expression and Regulation [I]: Functions and disease mechanisms. Hayama, Japan, July 27-30, 2010.

[4]Pancreatic β Cell-Targeted Overexpression of *N*-acetylglucosaminyl-transferase-IVa Ameliorates High-Fat Diet Induced Diabetic Phenotypes. (oral), K. Ohtsubo, S. Takamatsu, JD. Marth, N. Taniguchi: The 28th Naito Conference "Glycan Expression and Regulation [I]: Functions and disease mechanisms. Hayama, Japan, July 27-30, 2010.

[5]Increased susceptibility of Alpha 1,6 Fucosyltransferase (Fut8) heterozygous knockout mice to cigarette smoke- and elastase-induced emphysema. (poster), C. Gao, T. Maeno, T. Yoshida, F. Ota, A. Matsumoto, T. Betsuyaku, N. Taniguchi: The 28th Naito Conference "Glycan Expression and Regulation [I]: Functions and disease mechanisms. Hayama, Japan, July 27-30, 2010.

[6]Prevention of Diet-Induced Diabetes by Correction of Impaired Protein N-Glycosylation in Pancreatic β Cells. (poster), K. Ohtsubo, S. Takamatsu, JD. Marth, N. Taniguchi: 7th International Symposium on Glycosyltransferases (GlycoT 2010 Tokyo) July 30-31, 2010.

[7]Antibody-Lectin Enzyme Immunoassay for the Analysis of Fucosylation of α-Fetoprotein. (poster), H. Korekane, A. Matsumoto, T. Hasegawa, E. Miyoshi, N. Taniguchi: 7th International Symposium on Glycosyltransferases (GlycoT 2010 Tokyo) July 30-31, 2010.

[8]Novel Analytical Methods for nucleotide sugar metabolites. (poster), K. Nakajima, K. Ohtsubo, R. Takamiya, K. Shirato, S. Kitazume, T. Angata, N. Taniguchi: 7th International Symposium on Glycosyltransferases (GlycoT 2010 Tokyo) July 30-31, 2010.

[9]Hypoxia reduced β1,6-GlcNAc branching N-glycans via GlcNAc cycle. (poster), K. Shirato, K. Nakajima, H. Korekane, C. Gao, R. Takamiya, S. Takamatsu, T. Angata, K. Ohtsubo, N. Taniguchi: 7th International Symposium on Glycosyltransferases (GlycoT 2010 Tokyo) July 30-31, 2010.

[10]Physiological and Glycomic Characterization of N-acetylglucosaminyl- transferase-IVa and –IVb Double Deficient Mice. (poster), S. Takamatsu, A. antonopoulos, K. Ohtsubo, D. Ditto, Y. Chiba, DT. Le, HR. Norris, SM Haslam, A. Dell, JD. Marth, N. Taniguchi: 7th International Symposium on Glycosyltransferases (GlycoT 2010 Tokyo) July 30-31, 2010.

[11]Structure-Function Relationship of N-glycans of Scavenger Receptor Expressed by Endothelial Cells (SREC)-I. (poster), M. Sano, M. Asahi, H. Korekane, K. Ohtsubo, Y. Yamaguchi, M. Kato, H. Adachi, Y. Wada, N. Taniguchi: 7th International Symposium on Glycosyltransferases (GlycoT 2010 Tokyo) July 30-31, 2010.

[12]Significance of Nucleotide Sugar Metabolism for Understanding Functional Glycomics by Using Ion-Pair Reversed-Phase HPLC and LC-ESI-MS (invited), N. Taniguchi: HUPO 9th Annual World Congress. Sydney, Australia, Sep. 19-23, 2010.

[13]Novel Analytical Methods for nucleotide sugar metabolites. (oral), K. Nakajima, K. Ohtsubo, R.

Takamiya, K. Shirato, S. Kitazume, T. Angata, N. Taniguchi: 2010 RIKEN Chemical Biology International Symposium. Saitama, Japan, Oct. 26-28, 2010.

[14]Prevention of diet-induced diabetes by correction of disordered protein N- glycosylation in pancreatic beta Cells (oral), K. Ohtsubo: Asian Communications of Glycobiology and Glycotechnology, 2nd Conferance.

[15]Roles of *N*-Glycan Branchings in Diseases (invited), N. Taniguchi: BBRC Symposium 2010. Singapore, Oct. 29, 2010.

[16]Glyco-redox research: A link between redox research and glycobiology (invited), N. Taniguchi: FRCM 2011. Kyoto, Japan, Jan. 20-22, 2011.

[17]Role of *N*-glycans in disease. (invited), N. Taniguchi: Glyco-biomarker for Cancer: as targets for early diagnosis and therapeutics. Daejeon, Korea, Jan. 28, 2011.

[18]Role of "glycan cycles" for understanding the role of glycan in disease. (invited), N. Taniguchi: Ixth International Symposium on "Biochemical Roles of Eukaryotic Cell Surface Macromolecules". Kerala, India, Jan.30, 2011.

**Review Papers**

Glycan Functions in Pancraetic Beta Cells and the Disease Process of Type-2 Diabetes, K. Ohtsubo, Seitai no Kagaku, Igakushoin, 61 (2010), 142-147.

Glycan Functions in COPD, C. Gao, J. Gu, N. Taniguchi, Seitai no Kagaku, Igakushoin, 61 (2010), 128-134.

**Books**

[1]Capillary Electrophoresis and Capillary Electrophoresis-Mass Spectrometry for Structural Analysis of N-Glycans Derived from Glycoproteins.(N. Volpi) M. Nakano, K. Kakehi, N. Taniguchi, A. Kondo, “Capillary Electrophoresis of Carbohydrates”, Humana Press, (205-235) 2011.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| N. TANIGUCHI | The 28th NAITO Conference (Glycan Expression and Regulation {I}) (Organaizing Committtee Chair) |
| N. TANIGUCHI | Glyco T 2010 (7th International Symposium on Glycosyltransferases) (Organaizing Committtee Co-Chair) |
| N. TANIGUCHI | Journal of Biological Chemistry (Editorial Board Member) |
| N. TANIGUCHI | Antioxidant and Redox Signaling (Editorial Board Member) |
| N. TANIGUCHI | Cellular and Molecuar Life Sciences (Editorial Board Member) |
| N. TANIGUCHI | Clinical Proteomics (Editorial Board Member) |
| N. TANIGUCHI | Glycobiology (Editorial Board Member) |
| N. TANIGUCHI | IUBMB Life (Editorial Board Member) |
| N. TANIGUCHI | IUBMB Biochemistry and Molecular Education (Editorial Board Member) |
| N. TANIGUCHI | Nitric Oxide (Editorial Board Member) |
| N. TANIGUCHI | Protein Expression and Purification (Editorial Board Member) |
| N. TANIGUCHI | Biochemical and Biophysical Research Communications (Editor) |
| N. TANIGUCHI | Glycoconjugate Journal (Review Editor) |
| N. TANIGUCHI | International Journal of Oncology (Editor) |
| N. TANIGUCHI | Proteomics (Editor) |
| N. TANIGUCHI | Proteomics Clinical Applications (Editor) |

**Publications in Domestic Meetings**

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|---|---|
| 1st Chugoku/Shikoku Region Study for Hepatology Deseases | 1 paper |
| 19th Annual Meeting of the Japanese Association for Metastasis Research | 1 paper |

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|---|---|
| BMB2010 | 8 papers |
| 22nd Meeting of the JSPS 170th Committee on Redox Life Science | 1 paper |
| 13th Annual Conference on Transglutaminases | 1 paper |
| 8th Japan Human Proteome Organization conference/6th Annual Meeting of Japan Society for Clinical Proteomics Joint conference | 1 paper |
| 69th Annual Meeting of the Japanese Cancer Association | 2 papers |
| 4th Annual Meeting of the Tohoku Glyco | 1 paper |
| 8th JCGG Symposium | 1 paper |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| N. Taniguchi | Analyses of biological regulation for acetylglucosamine glycan cycle | ¥9,750,000 |
| A. Matsumoto | A Mechanism of aggregulation in amyotrophic lateral sclerosis | ¥1,560,000 |
| K. Shirato | The role of HIF-1α in wound healing of airway epithelial cells | ¥2,990,000 |
| K. Nakajima | Novel analytical method of nucleotide sugars for monitoring tumor microenviroments | ¥1,400,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| N. Taniguchi | National Institute of Biomedical Innovation | Validation of the treatment protocol using glycosaminoglycans for COPD exacerbation in vitro and Exploring biomarkers associating COPD exacerbation | ¥58,000,000 |

**Contribution to Research**

| | | |
|---|---|---|
| K. Ohtsubo | Osaka Cancer Society | ¥300,000,000 |
| K. Ohtsubo | Japan Foundation for Applied Enzymology | ¥1,000,000,000 |
| K. Ohtsubo | SUNTORY Institute for Bioorganic Research | ¥500,000,000 |
| C. Gao | The Naito Foundation | ¥500,000,000 |

**Cooperative Research**

| | | |
|---|---|---|
| N. Taniguchi | Research Association for Biotechnology | ¥3,150,000 |

## Department of Functional Nanomaterials and Nanodevices

**Original Papers**

[1]Noise-driven signal transmission using nonlinearity of VO2 thin films, T. Kanki, Y. Hotta, N. Asakwa, T. Kawai and H. Tanaka: Appl. Phys. Lett., 96 (2010) 242108(3).

[2]Giant Magnetoresistance Obseved in (Fe,Mn)3O4 Artificial Nanoconstricted Structures at Room Temperature, K. Goto, T. Kanki, T. Kawai and H. Tanaka: Nano Letters, 10 (2010) 2772-2776.

[3]Electronic Structure of W-Doped VO2 Thin Films with Giant Melat-Insulator Transition Investigated by Hard X-ray Core-Level Photoemission Spectroscopy, H. Takami, T. Kanki, S. Ueda, K. Kobayashi and H. Tanaka: Appl. Phys. Exp., 3 (2010) 63201(3).

[4]Direct fabrication of integrated 3D epitaxial functional transition metal oxide nanostructures using extremely small hollow nanopillar nano-imprint metal masks, N.-G. Cha, T. Kanki and H. Tanaka: Nanotechnology, 22 (2011) 185306(6).

[5]Preparation of ferroelectric field effect transistor based on sustainable strongly correlated (Fe,Zn)3O4 oxide semiconductor and their electrical transport properties, J. Takaobushi, T. Kanki, T. Kawai and H. Tanaka: Appl. Phys. Lett., 98 (2011) 102506(3).

[6]Enhancement of Spin Polarization in a Transition Metal Oxide Ferromagnetic Nanodot Diode, S. Yamanaka, T. Kanki, T. Kawai and H. Tanaka: Nano Letters, 11 (2010) 343-347.

[7]Photocurable Silsesquioxane-Based Formulations as Versatile Resins for Nanoimprint Lithography,

B.-K. Lee, N.-G. Cha, L.-Y. Hong, D.-P. Kim, H. Tanaka, H.-Y. Lee and T. Kawai: Langmuir, 26 (2010) 14915-14922.

[8]Investigation of structural and magnetic properties of polycrystalline Ni0.5Zn0.5-xMgxFe2O4 spinel ferrites, A.K.M.Akther Hossain, T. S. Biswas, T. Yanagida, H. Tanaka, H. Tabata and T. Kawai A.K.M.Akther Hossain, T. S. Biswas, T. Yanagida, H. Tanaka, H. Tabata and T. Kawai: Materials Chemistry and Physics, 120 (2010) 461-467.

[9]AFM Nanopatterning of Transition Metal Oxide Thin Films, L. Pellegrino, I. Pallecchi, E. Bellingeri, G. Canu, A. S. Siri, D. Marre, Y. Yanagisawa, M. Ishikawa, T. Matsumoto, Hide. Tanaka, and T. Kawai: J. Nanosci. Nanotechnol., 10 (2010) 4471-4476.

[10]Formation of wide and atomically flat graphene layers on ultraprecision-figured 4H-Si(0001) surfaces, A. N. Hattori, T. Okamoto, S. Sadakuni, J. Murata, K. Arima, Y. Sano, K. Hattori, H. Daimon, K. Endo, and K. Yamauchi: Surface Science, 605 (2011) 597-605.

[11]High-integrity finishing of 4H-SiC (0001) by plasma-assisted polishing, K. Yamamura, T. Takiguchi, M. Ueda, A. N. Hattori1, and N. Zettsu: Advanced Materials Research, 126-128 (2010) 423-428.

[12]Chemical etchant dependence of surface structure and morphology on GaN(0001) substrates, A. N. Hattori, F. Kawamura, M. Yoshimura, Y. Kitaoka, Y. Mori, K. Hattori, H. Daimon, and K. Endo: Surface Science, 604 (2010) 1247-1253.

[13]Spatial Redistribution of Oxygen Ions in Oxide Resistance Switching Device after Forming Process, Takeshi Yajima, Kohei Fujiwara, Aiko Nakao, Tomohiro Kobayashi, Toshiyuki Tanaka, Kei Sunouchi, Yoshiaki Suzuki, Mai Takeda, Kentaro Kojima, Yoshinobu Nakamura, Kouji Taniguchi, and Hidenori Takagi: Jpn. J. Appl. Phys., 49 (2010) 060215-1-3.

**International Conferences**

[1]Nano-structuring Functional Oxides for Advanced Spintronic Materials and Devices (invited), H. Tanaka: International Union of Materials Research Societies (IUMRS 2010).

[2]Enhancement of Spin Polarization in a Transition Metal Oxide Ferromagnetic Nano-Dot Diode (poster), H. Tanaka: 17th International Workshop on Oxide Electronics.

[3]Functional Oxide Nano Spintronics (invited), H. Tanaka, T. Kanki, K. Goto, S. Yamanaka, N.G. Cha, H. Takami, A. Hattori, T. Kawai: The 5th International Workshop on ADVANCED MATERIALS SCIENCE AND NANOTECHNOLOGY.

[4]Large Area Fabrication of Integrated Au and Oxide Nanobox Arrays by Sidewall Deposition with Controllable Heights and Thickness (poster), H. Tanaka, N.-G. Cha, A. Hattori, A. Ono: 2010 MRS Fall Meeting.

[5]Electronic Structure of W-Doped VO2 correlated oxide semiconductor and their nanoscopic physical property (invited), H. Tanaka: H22Japan-India Seminar/The 4th Indo-Japan Seminar.

[6]Noise-controlled signal transfer in VO2 thin films (poster), T. Kanki, Y. Hotta, N. Asakawa, T. Kawai and H. Tanaka: International Conference on Core Research and Engineering Science of Advanced Materials at Osaka University.

[7]Direct observation of metallic path formation in stochastic resonance devices using VO2 (poster), T. Kanki, Y. Hotta, N. Asakawa, T. Kawai and H. Tanaka: 17th International Workshop on Oxide Electronics.

[8]Observation of Metallic Phase Formation by a Bias Voltage in Correlated Insulator VO2 Thin Films (oral), T. Kanki, H. Takami and H. Tanaka: 2010 MRS Fall meeting.

[9]Noise-driven Signal Transmission Using Nonlinear Property of VO2 Thin Films (poster), T. Kanki, Y. Hotta, N. Asakawa, T. Kawai and H. Tanaka: 2010 MRS Fall meeting.

[10]New functional devices using nonlinear electric response of oxide materials (oral), T. Kanki: NSF-MEXT US/Japan Young Scientists Symposium on Nanomanufacturing at ISIR.

[11]Clean GaN(0001) substrate surface structures and their optical properties (poster), A. N. Hattori, N.-G. Cha, H. Tanaka: International Conference on Core Research and Engineering Science of Advanced Materials.

[12]Three dimensional patterned oxide substrates for the direct epitaxial growth of functional oxides (poster), A. N. Hattori, N.-G. Cha, H. Tanaka: 17th International Workshop on Oxide Electronics.

[13]Surface treatments toward obtaining clean GaN(0001) substrate surfaces (oral), A. N. Hattori, K. Hattori, H. Daimon, K. Endo: Asia Pacific Interfinish 2010.

[14]Investigation of Electronic Properties for V0.99W0.01O2 Thin Films Using Hard X-ray Photoemission Spectroscopy (poster), : International Conference on Core Research and Engineering Science of Advanced Materials.

[15]Modulation mechanism of metal-insulator transition temperature by doping W in VO2 thin films (poster), : 2nd Global COE Student Conference on Innovative Electronic Topic.

[16]W-doping effects on VO2 thin film with giant metal-insulator transition investigated by Hard X-ray Photoemission spectroscopy (poster), : 17th International Workshop on Oxide Electronics.

[17]Investigation of Electronic States in W-doped VO2 Thin Films by Hard X-ray Photoemission Spectroscopy (oral), : 2010 Materials Research Society Fall Meeting.

[18]Achievement of High Temperature-Coefficient of Resistance at Room Temperature in W-doped VO2 Thin Films (poster), : 2010 Materials Research Society Fall Meeting.

[19]Fabrication of ZnO nano structures by using sidewall growth technique (poster), : 2nd Globa COE Student Conference on Innovative Electronic Topics.

**Review Papers**

Establishment of processes for nanoscale functional oxides, H. Tanaka, T. Kanki, N.-G. Cha, A. Hattori, Nanotech Japan Bulletin, National Institute for Materials Science, 3 (2010), 12th.

Ultra-precision Figured 4H-SiC(0001) Surfaces, A.Hattori、T.Okamoto、S.Sadakuni、J.Murata、K.Arima、Y.Sano、M.Endo、K.Yamauchi, Journal of the surface science society of Japan, The surface science society of Japan, 31 (2010), 466-473.

**Patents**

[1]Electric- to spin-current converter K. Fujiwara, Y. Fukuma, J. Matsuno, Y. Otani, and H. Takagi, JP2010-191414

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics | 7 papers |
| The Surface Science Society of Japan | 1 paper |

**Academic Degrees**

| | | |
|---|---|---|
| Master Degree for Science | Control of Giant Metal-Insulator Transition to Room Temperature on Transition Metal Oxide W-Doped VO2 and Investigation of Their Control Mechanism | |
| H. Takami | | |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| H.Tanaka | Reserch for oxide nano-electronics with strongly correlated electron system | ¥15,600,000 |
| T. Kanki | Development of new functional electronic materials learnig from bio-functionality and their applications | ¥9,880,000 |
| T. Kanki | Creation of Photo-induced magnetic oxides and the spintronic applications | ¥650,000 |
| K. Fujiwara | Mechanism of electric-field induced resistance switching in binary transition metal oxides | ¥2,730,000 |

**Cooperative Research**

| | | |
|---|---|---|
| H.Tanaka | Naturatechnology Co.Ltd. | ¥350,000 |

**Other Research Fund**

| | | |
|---|---|---|
| H.Tanaka | New Energy and Industrial Technology Development Organization | ¥33,280,000 |
| T. Kanki | Osaka University "Hisho30"Fellows | ¥3,600,000 |

## Department of Advanced Nanofabrication

**Original Papers**

[1]Ultrafast pulse radiolysis, J. Yang, T. Kondoh, K. Kan, Y. Yoshida: Nucl. Instrum. Method A, 629 (1) (2011) 6　10.

[2]Femtosecond pulse radiolysis and femtosecond electron diffraction, J. Yang, K. Kan, T. Kondoh, Y. Yoshida, K. Tanimura, J. Urakawa: Nucl. Instrum. Method A, (2010) in press.

[3]Femtosecond pulse radiolysis study on geminate ion recombination in n-dodecane, T. Kondoh, J. Yang, K. Norizawa, K. Kan, Y. Yoshida: Radiat. Phys. Chem., 80 (2) (2011) 286-290.

[4]Simulation study of sub-femtosecond electron bunch generation using photocathode RF gun linac, K. Kan, J. Yang, T. Kondoh, K. Norizawa, A. Ogata, T. Kozawa, Y. Yoshida: Nucl. Instrum. Method A, 622 (1) (2010) 35-40.

[5]ImprovementofanS-bandRFgunwithaCs2Te photocathodefor the KEK-ATF, N. Terunuma, A. Murata, M. Fukuda, K. Hirano, Y. Kamiya, T. Kii, M. Kuriki, R. Kuroda, H. Ohgaki, K. Sakaue, M. Takano, T. Takatomi, J. Urakawa, M. Washio, Y. Yamazaki, J. Yang: Nucl. Instrum. Method A, 613 (1) (2010) 1－8.

[6]Decomposition of halophenols in room-temperature ionic liquids by ionizing radiation, A. Kimura, M. Taguchi, T. Kondoh, J. Yang, R. Nagaishi, Y. Yoshida, K. Hirota: Radiat. Phys. Chem., 79 (11) (2010) 1159-1164.

[7]Collective energy loss of attosecond electron bunches, A. Ogata, T. Kondoh, K. Norizawa, J. Yang, Y. Yoshida, S. Kashiwagi, T. Kaneko: Nucl. Instrum. Method A, (2010) in press.

[8]Relationship between Chemical Gradient and Line Edge Roughness of Chemically Amplified Extreme Ultraviolet Resist, T. Kozawa, H. Oizumi, T. Itani, and S. Tagawa,: Appl. Phys. Express, 3 (3) (2010) 036501.

[9]Diffusion Control Using Matrix Change during Chemical Reaction for Inducing Anisotropic Diffusion in Chemically Amplified Resists, T. Kozawa, H. Oizumi, T. Itani, and S. Tagawa,: Jpn. J. Appl. Phys., 49 (3) (2010) 036506.

[10]Relationship between Normalized Image Log Slope and Chemical Gradient in Chemically Amplified

Extreme Ultraviolet Resists, T. Kozawa and S. Tagawa: Jpn. J. Appl. Phys, 49 (6) (2010) 06GF02.

[11]Reconstruction of Latent Images from Dose-Pitch Matrices of Line Width and Edge Roughness of Chemically Amplified Resist for Extreme Ultraviolet Lithography, T. Kozawa, H. Oizumi, T. Itani, and S. Tagawa: Jpn. J. Appl. Phys., 49 (6) (2010) 066504.

[12]Effect of Inhomogeneous Acid Distribution on Line Edge Roughness- Relationship to Line Edge Roughness Originating from Chemical Gradient, T. Kozawa, H. Yamamoto, and S. Tagawa: J. Photopolym. Sci. Technol., 23 (2010) 625－630.

[13]Formation and Decay of Fluorobenzene Radical Anions Affected by Their Isomeric Structures and the Number of Fluorine Atoms, S. Higashino, A. Saeki, K. Okamoto, S. Tagawa, and T. Kozawa: J. Phys. Chem. A, 114 (2010) 8069－8074.

[14]Radiation Chemistry of Fluoronaphthalene as a Candidate for Absorption Enhancement Component of Chemically Amplified Extreme Ultraviolet Resists, S. Ikeda, K. Okamoto, H. Yamamoto, A.Saeki, S. Tagawa, and T. Kozawa: Jpn. J. Appl. Phys., 49 (9) (2010) 096504.

[15]Relationship between Line Edge Roughness and Fluctuation of Acid Concentration in Chemically Amplified Resist, T. Kozawa, H. Yamamoto, and S. Tagawa: Jpn. J. Appl. Phys., 49 (9) (2010) 096506.

[16]Dynamics of Radical Cation of Poly(4-hydroxystyrene)-Based Chemically Amplified Resists for Extreme-Ultraviolet and Electron Beam Lithographies, K. Okamoto, M. Tanaka, T. Kozawa, and S. Tagawa: Jpn. J. Appl. Phys., 49 (10) (2010) 106501.

[17]Resist Parameter Extraction from Line-and-Space Patterns of Chemically Amplified Resist for Extreme Ultraviolet Lithography, T. Kozawa, H. Oizumi, T. Itani, and S. Tagawa: Jpn. J. Appl. Phys., 49 (11) (2010) 116505.

[18]Backexposure Effect in Chemically Amplified Resist Process upon Exposure to Extreme Ultraviolet Radiation, T. Kozawa, S. Tagawa, R. Ohnishi, T. Endo, and R. Sakamoto,: Jpn. J. Appl. Phys., 50 (1) (2011) 016504.

[19]Feasibility Study of Chemically Amplified Resists for Short Wavelength Extreme Ultraviolet Lithography, T. Kozawa and A. Erdmann: Appl. Phys. Express, 4 (2) (2011) 026501.

[20]Optimum Dissolution Point of Chemically Amplified Resists in Terms of Trade-Off Relationships between Resolution, Line Edge Roughness, and Sensitivity, T. Kozawa, H. Yamamoto, and S. Tagawa: Jpn. J. Appl. Phys., 50 (2) (2011) 026502.

[21]Thermalization Distance of Electrons Generated in Poly(4-hydroxystyrene) Film Containing Acid Generator upon Exposure to Extreme Ultraviolet Radiation, T. Kozawa and S. Tagawa,: Jpn. J. Appl. Phys., 50 (2011) in press.

[22]Relationship of Electron Diffusion Length to Line Edge Roughness in Chemically Amplified Extreme Ultraviolet Resists, T. Kozawa and S. Tagawa: Jpn. J. Appl. Phys., 50 (2011) in press.

**International Conferences**

[1]Beam dynamics in femtosecond photocathode RF gun , K. Kan, J. Yang, T. Kondoh, K. Norizawa, A. Ogata, T. Kozawa, Y. Yoshida: The 1st International Particle Accelerator Conference, Kyoto, Japan/ May 23-28, 2010.

[2]Photocathode femtosecond beam applications: femtosecond pulse radiolysis and femtosecond electron diffraction , J. Yang, K. Kan, T. Kondoh, N. Naruse, Y. Murooka, K. Tanimura, Y. Yoshida, J. Urakawa:

The 1st International Particle Accelerator Conference, Kyoto, Japan/ May 23-28, 2010.

[3]Femtosecond pulse radiolysis study in radiation chemistry using a photocathode rf gun linac , T. Kondoh, J. Yang, K. Norizawa, K. Kan, T. Kozawa, A. Ogata, Y. Yoshida: The 1st International Particle Accelerator Conference, Kyoto, Japan/ May 23-28, 2010.

[4]Femtosecond electron bunch generation using photocathode RF gun , K. Kan, J. Yang, T. Kondoh, K. Norizawa, A. Ogata, T. Kozawa, Y. Yoshida,: 25th International Linear Accelerator Conference, Tsukuba, Japan, Septenber 12-17、2010.

[5]Photocathode femtosecond electron linac and its applications , J. Yang, K. Kan, T. Kondoh, N. Naruse, Y. Murooka, K. Tanimura, Y. Yoshida, J. Urakawa: 25th International Linear Accelerator Conference, Tsukuba, Japan, Septenber 12-17、2010.

[6]Femtosecond electron bunch generation using photocathode RF gun , K. Kan, J. Yang, T. Kondoh, K. Norizawa, A. Ogata, T. Kozawa, Y. Yoshida: 32nd Free Electron Laser Conference, Malmo, Sweden, August 23-27,2010.

[7]Primary Process of Radiation Chemistry Studied by Femtosecond Pulse Radiolysis (invited), Y. Yoshida: 9$^{th}$ Meeting of the Ionizing Radiation and Polymers Symposium, 25-29 October 2010, Maryland, USA.

[8]Femtosecond pulse radiolysis study of geminate ion recombination with aromatic scavenger in n-dodecane , T. Kondoh, J. Yang, K. Norizawa, K. Kan, T. Kozawa, A. Ogata, S. Tagawa, Yoichi Yoshida: 9$^{th}$ Meeting of the Ionizing Radiation and Polymers Symposium, 25-29 October 2010, Maryland, USA.

[9]THz source using photocathode RF gun , K. Kan, J. Yang, T. Kondoh, K. Norizawa, A. Ogata, T. Kozawa, Y. Yoshida: 14th SANKEN International Symposium, Otsu, Japan, January 25-26, 80-81, 2011.

[10]Femtosecond pulseradiolysis study of geminate ion recombination in biphenyl-dodecane solution , T. Kondoh, J. Yang, K. Norizawa, K. Kan, T. Kozawa, A. Ogata, Y. Yoshida: 14th SANKEN International Symposium, Otsu, Japan, January 25-26, 80-81, 2011.

[11]Femtosecond pulse radiolysis study on geminate ion recombination in solute/solvent system of n-dodecane , T. Kondoh, J. Yang, K. Norizawa, K. Kan, T. Kozawa, A. Ogata, Y. Yoshida: 3$^{rd}$ Asia Pacific Symposium on Radiation Chemistry September 14-17, 2010, Lonavala, India.

[12]Quantum Beam-Induced Phenomena in Attosecond and Femtosecond Regions , Y. Yoshida、J. Yang, T. Kondoh, K. Norizawa, K. Kan, T. Kozawa, A. Ogata: 3$^{rd}$ Asia Pacific Symposium on Radiation Chemistry September 14-17, 2010, Lonavala, India.

[13]Pulse radiolysis study of pre-solvated and solvated electron in water , K. Norizawa, T. Kondoh, K. Kan, J. Yang, Y. Yoshida: 3$^{rd}$ Asia Pacific Symposium on Radiation Chemistry September 14-17, 2010, Lonavala, India.

[14]Decomposition of Halophenols in Room Temperature Ionic Liquids by Ionizing Radiation , A. Kimura, T. Kondoh, J. Yang, R. Nagaishi, Y. Yoshida, and M. Taguchi: 3$^{rd}$ Asia Pacific Symposium on Radiation Chemistry September 14-17, 2010, Lonavala, India.

[15]Pulse Radiolysis Studies of Mixed Ionic Liquids Containing Thiocyanate Ion , R. Nagaishi, N. Aoyagi, M. Taguchi, T. Kondoh, J. Yang, and Y. Yoshida,: 3$^{rd}$ Asia Pacific Symposium on Radiation Chemistry September 14-17, 2010, Lonavala, India.

[16]Ultrafast MeV electron diffraction using photocathode RF gun (invited), J. Yang: 2$^{nd}$ Joint Asian

Accelerator Workshop on technologies and applications, Pohang, Korea, Nov. 29-30, 2010.

[17]Photocathode RF gun facilities at Osaka University (invited), J. Yang: China-Korea-Japan Joint Workshop on electron/photon sources and applications, Shanghai, China, Dec. 2-3, 2010.

[18]Radiation induced Nano Particle Formation in Mixture of Ionic Liquids and Water Solution , T. Kondoh, J. Yang, K. Norizawa, K. Kan, Y. Yoshida, R. Nagaishi, M. Taguchi, K. Takahashi, R. Katoh: International Conference on Core Research and Engineering Science of Advanced Materiasls, May 30-June 4,2010, Osaka, JAPAN.

[19]Femtosecond electron beam dynamics at photocathode RF gun , K. Kan, J. Yang, T. Kondoh, K. Norizawa, T. Kozawa, A. Ogata: International Conference on Core Research and Engineering Science of Advanced Materiasls, May 30-June 4,2010, Osaka, JAPAN.

[20]Primary Process of Radiation Chemistry Studied by Femtosecond Pulse Radiolysis , Y. Yoshida, J. Yang, T. Kozawa, T. Kondoh, K. Norizawa, K. Kan, A. Ogata: Gordon Research Conference on Radiation Chemistry, 18-23 July, 2010, Andover, New Hampshire, USA.

[21]Analysis of trade-off relationships in resist patterns delineated using SFET of Selete , T. Kozawa, H. Oizumi, T. Itani, and S. Tagawa: Proc. SPIE 7639 (2010) 76390B.

[22]Evaluation of hydroxyl derivatives for chemically amplified extreme ultraviolet resist , K. Furukawa, Y. Arai, H. Yamamoto, T. Kozawa, and S. Tagawa: Proc. SPIE 7639 (2010) 76391L.

[23]Dynamics of radical cation of poly(4-hydroxystyrene) generated in thin film upon exposure to electron beam , K. Natsuda, T. Kozawa, K. Okamoto, A. Saeki, and S. Tagawa: Proc. SPIE 7639 (2010) 76391K.

[24]Negative-tone chemically amplified molecular resist based on novel fullerene derivative for nanolithography , H. Yamamoto, T. Kozawa, S. Tagawa, T. Ando, K. Ohmori, M. Sato, and J. Onodera: Proc. SPIE 7639 (2010) 76390U.

[25]Femtoscond RF gun based MeV electron diffraction (invited), J. Yang, K. Kan, N. Naruse, Y. Murooka, Y. Yoshida, K. Tanimura: Particle Accelerator Conference 2011, 28 Mar. - 1Apr. 2011, New York, USA.

**Review Papers**

Electron solvation and geminate ion recombination in ionic liquids, Takafumi Kondoh, Jinfeng Yang, Yoichi Yoshida, Radiation Chemistry, Japanese society of radiation chemistry, 91 (2011), 33-38.

N. Naruse,Y. Murooka, J. Yang, K. Tanimura, Journal of the Particle Accelerator Society of Japan, Particle Accelerator Sosiety of Japan, 7 (2011), 261-269.

【JJAP Invited Review】Radiation Chemistry in Chemically Amplified Resists, T. Kozawa and S. Tagawa, Jpn. J. Appl. Phys., JSAP, 49 (2010), 030001.

Resist material design for next-generation lithography, Chemical Industry, 61, 2010, 577-582, T. Kozawa, Chemical Industry, , 61 (2010), 577-582.

Challenge for nanochemistry in high-volume production of semiconductor devices, Chemical education, 58, 2010, 364-365., T. Kozawa, Chemistry & Education, The Chemical Society of Japan, 58 (2010), 364-365.

Current status and prospect of resist materials used for extreme ultraviolet lithography, 29, 2010, 95-99. T.

Kozawa, Optronics, Optronics, 348 (2010), 95-99.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| J. Yang | The 1st International Particle Accelerator Conference, Kyoto, Japan/ May 23-28, 2010 (Local Organizing Committee) |
| T. Kozawa | 23rd International Microprocesses and Manotechnology Conference (Steering Committee) |
| T. Kozawa | 23rd International Microprocesses and Manotechnology Conference (Program Committee) |
| T. Kozawa | 2010 EUVL Symposium (Steering Committee) |
| T. Kozawa | 2010 EUVL Workshop (Steering Committee) |

**Publications in Domestic Meetings**

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|---|---|
| Annual Meeting of Particle Accelerator Society of Japan | 5 papers |
| Meeting of the Atomic Energy Society of Japan | 5 papers |
| Meeting of Japanese Society of Radiation Chemistry | 7 papers |
| Meeting of high blightness/rf electron gun | 2 papers |
| The 5th Takasaki Advanced Radiation Research Symposium | 1 paper |
| The 91st Annual Meeting of the Chemican Sosiety of Japan | 2 papers |
| Meeting of NIFS collabolation | 2 papers |
| The Physical Society of Japan 66th Annual Meeting | 2 papers |

**Grant-in-Aid for Scientific Research**

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|---|---|---|
| Y.Yoshida | Attosecond and femtosecond pulse radiolysis study | ¥52,000,000 |
| J. Yang | Study of femtosecond time-resolved electron microscopy | ¥17,810,000 |
| T. Kozawa | Study on nanoscale reaction and reaction field using multiple quantum beams | ¥14,690,000 |
| T. Kozawa | Study on the size of thermalized electron in condensed matter | ¥1,000,000 |

**Cooperative Research**

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|---|---|---|
| Y. Yoshida | Japan Atomic Energy Agengy, R. Nagaishi | ¥0,000 |
| Y. Yoshida | Japan Atomic Energy Agengy, M. Taguchi | ¥0,000 |
| T. Kozawa | Selete | ¥1,000,000 |
| T. Kozawa | Nissan Chemical Industry | ¥1,000,000 |

**Other Research Fund**

| | | |
|---|---|---|
| K. Kan | International Collaboration for High Energy Density Science (ICHEDS)" supported by Japan Society for the Promotion of Science ("JSPS") Core-to-Core Program | ¥320,000 |
| A. Ogata | NIFS collabolation | ¥25,000 |
| K. Kan | NIFS collabolation | ¥25,000 |

## Department of Nanocharacterization for Nanostructures and Functions

**Original Papers**

[1]Damage and microstructure evolution in GaN under Au ion irradiation, Y. Zhang, M. Ishimaru, J. Jagielski, W. Zhang, Z. Zhu, L. V. Saraf, W. Jiang, L. Thome, and W. J. Weber: J. Phys. D, 43 (2010) 085303(1)-085303(9).

[2]In situ Transmission Electron Microscopy Observation of the Graphitization of Silicon Carbide Nanowires Induced by Joule Heating, H. Kohno, Y. Mori, S. Takeda, Y. Ohno, I. Yonenaga, and S. Ichikawa: Appl. Phys. Express, 3 (2010) 055001(1)-055001(3).

[3]Radiation-induced metastable ordered phase in gallium nitride, M. Ishimaru: Appl. Phys. Lett., 96 (2010) 191908(1)-191908(3).

[4]Influence of Preparation Methods for Pt/CeO2 and Au/CeO2 Catalysts in CO Oxidation, S. Shimada, T.

Takei, T. Akita, S. Takeda, and M. Haruta: Stud. Surf. Sci. Catal., 175 (2010) 843-847.

[5]Direct observations of $Ge_2Sb_2Te_5$ recording marks in the phase-change disk, M. Naito, M. Ishimaru, Y. Hirotsu, R. Kojima, and N. Yamada: J. Appl. Phys., 107 (2010) 103507(1)-103507(5).

[6]An attempt to characterize phase Q: Noble gas, Raman spectroscopy and transmission electron microscopy in residues prepared from the Allende meteorite, J. Matsuda, K. Morishita, H. Tsukamoto, C. Miyakawa, M. Nara, S. Amari, T. Uchiyama, and S. Takeda: Geochim. Cosmochim. Acta, 74 (2010) 5398-5409.

[7]Electrical breakdown of individual Si nanochains and silicide nanochains, H. Kohno, T. Nogami, S. Takeda, Y. Ohno, I. Yonenaga, and S. Ichikawa: J. Nanosci. Nanotechnol., 10 (2010) 6655-6658.

[8]X-ray photoelectron spectroscopy analysis of TlInGaAsN semiconductor system and their annealing induced structural changes, K. M. Kim, W.-B. Kim, D. Krishnamurthy, M. Ishimaru, H. Kobayashi, S. Hasegawa, and H. Asahi: J. Appl. Phys., 108 (2010) 123524(1)-123524(4).

[9]Nanovoid formation through the annealing of amorphous $Al_2O_3$ and $WO_3$ films, R. Nakamura, T. Shudo, A. Hirata, M. Ishimaru, and H. Nakajima: Scr. Mater., 64 (2011) 197-200.

[10]Influence of Si-doping on the characteristics of InGaGdN/GaN MQWs grown by MBE, S. N. M. Twail, D. Krishnamurthy, R. Kakimi, M. Ishimaru, S. Emura, S. Hasegawa, and H. Asahi: phys. stat. solidi (c), 8 (2011) 491-493.

[11]Investigations on the properties of intermittently Gd-doped InGaN structures grown by molecular-beam epitaxy, D. Krishnamurthy, S. N. M. Tawil, R. Kakimi, M. Ishimaru, S. Emura, S. Hasegawa, and H. Asahi: phys. stat. solidi (c), 8 (2011) 497-499.

[12]Experimental evidence of homonuclear bonds in amorphous GaN, M. Ishimaru, Y. Zhang, X. Wang, W.-K. Chu, and W. J. Weber: J. Appl. Phys., 109 (2011) 043512(1)-043512(4).

**International Conferences**

[1]High-resolution Environmental Transmission Electron Microscopy of Metal Nanoparticles in Gases (invited), S. Takeda, H. Yoshida, and S. Kujawa: In-situ TEM symposium at NNFC, Daejeon, Korea, June 22, 2010.

[2]Naturally-formed nanoscale phase separation in epitaxially-grown III-V semiconductor alloys (oral), M. Ishimaru, Y. Tanaka, S. Hasegawa, H. Asahi, K. Sato, and T. J. Konno: Microscopy & Microanalysis 2010, Portland, Oregon, USA、 August 1-5, 2010.

[3]Environmental Transmission Electron Microscopy Study on the Role of Impurities in Carbon Nanotube Growth (poster), Hideto Yoshida, Takuma Shimizu, Tetsuya Uchiyama, Hideo Kohno, and Seiji Takeda: Microscopy & Microanalysis 2010 Meeting, Portland, Oregon, USA, August 1-5, 2010.

[4]In Situ Observation of Au/TiO2 Catalysts in Reactant Gases by Environmental Transmission Electron Microscopy (oral), Y. Kuwauchi, H. Yoshida, T. Uchiyama, T. Akita, H. Kohno, S. Takeda: Microscopy & Microanalysis 2010 Meeting, Portland, Oregon, USA, August 1-5, 2010.

[5]Transmission electron microscopy study on radiation-induced structures in GaN (invited), M. Ishimaru: 21st International Conference on the Application of Accelerators in Research and Industry, Fort Worth, Texas, USA, August 8-13, 2010.

[6]Nanoscale phase separation in epitaxially-grown III-V alloys (invited), M. Ishimaru: 8th Japanese-Polish Joint Seminar on Micro and Nano Analysis, Uji, Kyoto, Japan, September 5-8, 2010.

[7]Observation of Electron-beam-induced Changes of Au/TiO2 Catalysts in Reactant Gases by Environmental Transmission Electron Microscopy (oral), Y. Kuwauchi, H. Yoshida, T. Uchiyama, T. Akita, H. Kohno, and S. Takeda: The 17th International Microscopy Congress (IMC17), Rio de Janeiro, Brazil, September 19-24, 2010.

[8]Recent Advancement of High Resolution Environmental TEM (invited), S. Takeda, H. Yoshida, and S. Kujawa: The 17th International Microscopy Congress (IMC17), Rio de Janeiro, Brazil, September 19-24, 2010.

[9]Environmental TEM Observation of Pt Nanoparticles Supported on CeO2 (oral), Hideto Yoshida and Seiji Takeda: The 17th International Microscopy Congress (IMC17), Rio de Janeiro, Brazil, September 19-24, 2010.

[10]In Situ Observation of Iron Catalyzed Carbon Nanotube Growth by Environmental TEM (oral), Hideto Yoshida Yoshikazu Homa, and Seiji Takeda: The 17th International Microscopy Congress (IMC17), Rio de Janeiro, Brazil, September 19-24, 2010.

[11]Radiation-induced amorphous structures in covalent materials (invited), M. Ishimaru: Materials Research Society 2010 Fall Meeting, Boston, Massachusetts, USA, November 29 - December 3, 2010.

[12]Environmental TEM Study of Pt Nanoparticles Supported on CeO2 in Reactant Gases (poster), H. Yoshida, K. Matsuura, Y. Kuwauchi, H. Kohno, S. Shimada, M. Haruta, and S. Takeda: The 14th SANKEN International Symposium.

**Review Papers**

A Cs-corrected Environmental Transmission Electron Microscope for Characterizing the Processes and Characteristics of Nanomaterials in Real Environments, Seiji Takeda, Hideto Yoshida , Yasufumi Kuwauchi and Stephan Kujawa, Microscopy, The Japanese Society of Microscopy, 46[1] (2011), 20-23.

**Books**

[1]Synthesis Methods of Silicon Nanowires and Nanochains(Nobuyoshi Koshida) Seiji Takeda, Hideo Kohno, “Dveloping Nanosilicon Technology and Device Application”, CMC Publishing, (236-245) 2010.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| M. Ishimaru | 8th Japanese-Polish Joint Seminar on Micro and Nano Analysis (Organaizing Committtee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics | 2 papers |
| Catalysis Society of Japan | 3 papers |
| The Japan Institute of Metals | 4 papers |
| The Japanese Society of Microscopy | 2 papers |
| The Physical Society of Japan | 2 papers |
| Analytical Electron Microscopy Meeting | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Engineering<br>T. Hattori | Structural Analysis of Ion-irradiated GaN by Transmission Electron Microscopy |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| S. Takeda | Atomistic and electronic structural analysis of the catalyst mechanism of metal nanoparticles in gases | ¥30,692,000 |
| M. Ishimaru | Spontaneous nano-scale phase separation and synthesis of low-dimensional nanomaterials | ¥2,730,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| M. Ishimaru | NEDO (Advance | Nano-structure Analysis for the | ¥2,625,000 |

| | |
|---|---|
| Materials Technology Utilizing Glassy Metals for Commercial Uses) | Evaluation of Mechanical Properties in Glassy Metals |

## Department of Theoretical Nanotechnology

### Original Papers

[1]Magnetic State in Iron Hydride Under Pressure Studied by X-ray Magnetic Circular Dichroism at the Fe K-edge, N. Ishimatsu, Y. Matsushima, H. Maruyama, T. Tsumuraya, T. Oguchi, N. Kawamura, M. Mizumaki, T. Matsuoka, K. Takemura: Mater. Res. Soc. Symp. Proc., 1262 (2010) W04-02/1-6.

[2]Angle-resolved photoemission observation of the superconducting-gap minimum and its relation to the nesting vector in the phonon-mediated superconductor YNi2B2C, T. Baba, T. Yokoya, S. Tsuda, T. Watanabe, M. Nohara, H. Takagi, T. Oguchi, S. Shin: Phys. Rev. B, 81 (2010) 180509/1-4.

[3]Spin-Polarized AM05 Functional for 3d-Transition Metals, M. Kodera, T. Shishidou, T. Oguchi: J. Phys. Soc. Jpn., 79 (2010) 074713/1-4.

[4]Theoretical Investigation of the Crystal Structure and Electronic and Dielectric Properties of the Potential Multiferroic (C2H5NH3)2FeCl4, P. Baettig, T. Oguchi: Jpn. J. Appl. Phys., 49 (2010) 080206/1-3.

[5]Large out-of-plane spin polarization in a spin-splitting one-dimensional metallic surface state on Si(557)-Au, T. Okuda, K. Miyamaoto, Y. Takeichi, H. Miyahara, M. Ogawa, A. Harasawa, A. Kimura, I. Matsuda, A. Kakizaki, T. Shishidou, T. Oguchi: Phys. Rev. B, 82 (2010) 161410/1-4.

[6]Evaluation of the coupling parameters of many-body interactions in Fe(110), X. Y. Cui, K. Shimada, Y. Sakisaka, H. Kato, M. Hoesch, T. Oguchi, Y. Aiura, H. Namatame, M. Taniguchi: Phys. Rev. B, 82 (2010) 195132/1-9.

[7]Stress Formulation in the All-Electron Full-Potential Linearlized Augmented Plane Wave Method, N. Nagasako, T. Oguchi: J. Phys. Soc. Jpn., 80 (2011) 024701/1-13.

[8]Doping Variation of Optical Properties in ZrNCl Superconductors, T. Takano, Y. Kasahara, T. Oguchi, I. Hase, Y. Taguchi, Y. Iwasa: J. Phys. Soc. Jpn., 80 (2011) 023702/1-4.

[9]Multiple phosphorous chemical sites in heavily phosphorous-doped diamond, H. Okazaki, R. Yoshida, T. Muro, T. Nakamura, T. Wakita, Y. Muraoka, M. Hirai, H. Kato, S. Yamasaki, Y. Takano, S. Ishii, T. Oguchi, T. Yokoya: Appl. Phys. Lett., 98 (2011) 082107/1-3.

[10]Fermi Surface and Metallic Propertie of Graphite at Hith Pressures, N. Nakae, J. Ishisada, K. Shirai, A. Yanase: J. Phys. Chem. Solids, 71 (2010) 418-422.

[11]Theoretical Investigation on Synthesizing BC5 Crystal, N. Nakae, J. Ishisada, H. Dekura, and K. Shirai: J. Phys.: Conf. Ser., 215 (2010) 012116-012122.

[12]Metallicity of Boron Carbides at High Pressure, H. Dekura, K. Shirai and A. Yanase: J. Phys.: Conf. Ser., 215 (2010) 012117-012122.

[13]Electronic Structures and Its Mechanical Properties of Boron and Boron-rich Crystals (Part I), K. Shirai: J. Superhard Materials, 32 (2010) 205-225.

[14]Electronic Structures and Its Mechanical Properties of Boron and Boron-rich Crystals (Part II), : J. Superhard Materials, 32 (2010) 336 -345.

[15]Raman Scattering and Isotopic Phonon Effects in Dodecaborides, : J. Phys.: Condens. Matter, 23 (2011) 065403-065428.

[16]Bandstructure and Fermi Surfaces of CeRh3B2, K. Yamauchi, A. Yanase, H. Harima: J. Phys. Soc. Jpn., 79 (2010) 044717.

[17]Magnetically induced ferroelectricity in Cu2MnSnS4 and Cu2MnSnSe4, T. Fukushima, K. Yamauchi, S. Picozzi: Phys. Rev. B, 82 (2010) 014102.

[18]Interplay between Charge Order, Ferroelectricity, and Ferroelasticity: Tungsten Bronze Structures as a Playground for Multiferroicity, K. Yamauchi, S. Picozzi: Phys. Rev. Lett., 105 (2010) 107202.

[19]Ab initio Investigations of Fe2+/Fe3+ Bond Dimerization and Ferroelectricity Induced by Intermediate Site/Bond-Centered Charge Ordering in Magnetite, T. Fukushima, K. Yamauchi, S. Picozzi: J. Phys. Soc. Jpn., 80 (2011) 014709.

[20]Ferroelectricity due to Orbital Ordering in E-Type Undoped Rare-Earth Manganites, P. Barone, K. Yamauchi, S. Picozzi: Phys. Rev. Lett., 106 (2011) 077201.

**International Conferences**
[1]Peculiar electronic properties driven by broken inversion symmetry (invited), T. Oguchi: Psi-k Conference 2010, Germany, September 12-16, 2010.

[2]Electron Theory of Surface Rashba Effect (invited), T. Oguchi: International Conference of Asian Union of Magnetics Societies, Korea, December 5-8, 2010.

[3]First-Principles Study of Light-Element Complex Hydrides for Hydrogen Storage (oral), T. Oguchi: The 14th SANKEN International Symposium 2011 — Advanced Design toward Low-Carbon Science and Industry, Otsu, January 25-26, 2011.

[4]Structural, Electronic and Magnetic Properties of Iron Hydride: A First-Principles Study (oral), T. Tsumuraya, T. Shishidou, T. Oguchi: Workshop on Computational Materials Science on Hydrogen Storage, Sendai, December 12-13, 2010.

[5]First-Principles Study of Ammonia Borane and Alkali-Metal Amidoboranes for Hydrogen Storage (poster), H.B. Huang, T. Tsumuraya, T. Shishidou, T. Oguchi: MRS Fall Meeting, USA, November 29-December 3, 2010.

[6]First-Principles Study of Ammonia Borane and Alkali-Metal Amidoboranes for Hydrogen Storage (oral), H.B. Huang, T. Tsumuraya, T. Shishidou, T. Oguchi: Workshop on Computational Materials Science on Hydrogen Storage, Sendai, December 12-13, 2010.

[7]First-Principles Calculations of Cobalt Hydride (oral), Y. Matsuura, T. Shishidou, T. Oguchi: Workshop on Computational Materials Science on Hydrogen Storage, Sendai, December 12-13, 2010.

[8]First-Principles Study of Nickel Hydrides (oral), T. Shishidou, T. Oguchi: Workshop on Computational Materials Science on Hydrogen Storage, Sendai, December 12-13, 2010.

[9]First-Principles Study of Ammonia Borane and Alkali-Metal Amidoboranes for Hydrogen Storage (poster), H.B. Huang, T. Tsumuraya, T. Shishidou, T. Oguchi: The 14th SANKEN International Symposium 2011 — Advanced Design toward Low-Carbon Science and Industry, Otsu, January 25-26, 2011.

[10]First-Principles Study of Cobalt Hydrides under Pressure (poster), Y. Matsuura, T. Shishidou, T.

Oguchi: The 14th SANKEN International Symposium 2011 — Advanced Design toward Low-Carbon Science and Industry, Otsu, January 25-26, 2011.

[11]First-principles study of noncentrosymmetric superconductors Li2Pt3B and Li2Pd3B (oral), T. Shishidou, T. Oguchi: APS March Meeting, USA, March 21-25, 2011.

[12]First-principles calculation of Ca2RuO4 at high pressure (oral), N. Miyawaki, T. Shishidou, T. Oguchi: APS March Meeting, USA, March 21-25, 2012.

[13]Structural Stability and Electronic Properties of Cobalt Hydrides (oral), Y. Matsuura, T. Shishidou, T. Oguchi: APS March Meeting, USA, March 21-25, 2013.

[14]First-principles calculations for XAS of infinite-layer iron oxides (oral), M. Kodera, T. Shishidou, T. Oguchi: APS March Meeting, USA, March 21-25, 2014.

[15]Dynamical Stability of α-boron Doped with Li (poster), H. Dekura, I. Hamada, A. Yanase, and K. Shirai: 13th International Conference Phonon in Condensed Matter PHONONS 2010, Aoruk 18-23m 2010 The National Taiwan University, Taiwan, China.

[16]Superconductivity Research on Semiconducting Boron Solids (poster), K. Shirai, H. Dekura, and A. Yanase: International Conference on Core Research and Engineering Science of Advanced Materials (Global COE Program) & Third International Conference on Nanospintronics Design and Realization, 3rd-ICNDR, May 30 to June 5, 2010 at Osaka University Convention Center.

[17]Metallic Properties of Graphite at High Pressures (poster), K. Shirai, N. Nakae, and A. Yanase: 30th International Conference on the Physics of Semidoncuctors ICPS 2010, July25-30,2010 COEX, Seoul, Korea.

[18]Beta NMR measurement of $^{58}$Cu in Si (poster), M. Mihara, T. Izumikawa, H. Ueno, K. Matsuta, D. Nishimura, T.Nagatomo, T. Moriguchi, Y. Ito, D. Nagae, M. Fukuda, A. Yoshimi, K. Yamada, M. Takechi, Y. Ichikawa, S. Momota, Y. Hirayama, T. Ohtsubo, S. Suzuki, T. Kubo, Y. Namiki, A. Ozawa, Y. Ishibashi, H. Oishi, K. Suzuki, I. Hachiuma, K. Namihira, D. Horikawa, T. Minamisono, T. Yamaguchi, T. Kuboki, T. Suzuki, K. Sato, Y. Kobayashi, K. Asahi, K. Matsukawa, K. Shirai: 3rd Joint International Conference on Hyperfine Interactions and International Symposium on Nuclear Quadrupole Interactions, CERN, Swuitzerland September 14, 2010.

[19]Dynamics of Reorientation of Single Lattice Vacancy in Silicon (poster), K. Shirai and J. Ishisada: The 6th Forum on The Science and Technology of Silicon Materials, Okayama Unkverity 50th Anniversary Hall, November 16, 2010.

[20]Superconductiviry Research on Semiconducting Boron (invited), K. Shirai and H. Dekura: 14th International Conference on High Pressure Semiconductor Physics High Pressure Semiconductor Physics HPSP14, August 1-4, 2010, Jilin Univerity, Changchun, China.

[21]DFT+U study of charge-ordering driven multiferroicity (poster), K. Yamauchi, S. Picozzi: International Conference on Core Research and Engineering Science of Advanced Materials (Global COE Program) & Third International Conference on Nanospintronics Design and Realization, 3rd-ICNDR, May 30 to June 5, 2010 at Osaka University Convention Center.

[22]Exploring multiferroicity in charge-ordered iron-based compounds (oral), K. Yamauchi, S. Picozzi: Psi-k Conference 2010, Germany, September 12-16, 2010.

[23]First Principles Studies on Charge-Order Induced Ferroelectricity and Magnetoelectric Effects (invited), K. Yamauchi, S. Picozzi: The 3rd APCTP workshop on multiferroics RIKEN Workshop on

Multiferroics and Cross-correlated Materials 17-19 January 2011, Waseda University, Tokyo, Japan.

**Books**

[1]Modern Thermodynamics K. Shirai, “Modern Thermodynamics”, Kyoritu-publication co., (1-309) 2011.

[2]Handbook of Rare-metals(G. Adachi) K. Shirai, Maruzen, 2011.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| T. OGUCHI | The 13th Asia Workshop on First-principles Electronic Structure Calculations (International Organizing Committee) |
| T. OGUCHI | Journal of Physics: Condensed Matter (Advisory Board) |
| K. SHIRAI | Silicon Forum (Organizing Committee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Physical Society of Japan | 7 papers |
| Physical Society of Japan | 7 papers |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| T. Oguchi | Strategic state-of-the-art solid state chemistry for new functional materials: Exploring for new multi-functional materials | ¥13,248,000 |
| K. Shirai | Superconductivity research on icosahedron-based | ¥1,200,000 |
| K. Shirai | Many-electron theory of first-principles excited states and materials design for high-Tc superconductivity | ¥910,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| T. Oguchi | New Energy and Industrial Technology Development Organization | Computational study on the properties and microscopic kinetics of hydrogen storage materials | ¥17,455,000 |

**Contribution to Research**

| | | |
|---|---|---|
| K. Shirai | Institute for Higher Education Research and Practice, Osaka University | ¥200,000 |

**Cooperative Research**

| | | |
|---|---|---|
| K. Shirai | Fujitsu Lab. | ¥1,000,000 |

## Department of Soft Nanomaterials

**Original Papers**

[1]Solution-processed n-type organic field-effect transistors based on electronegative oligothiophenes having fully oxo-substituted terthiophenes, Y. Ie, M. Nitani, H. Tada, Y. Aso: Org. Electron, 11 (11) (2010) 1740-1745.

[2]N-channel organic field-effect transistors containing carbonyl-bridged bithiazole derivative fabricated using polyfluorene derivatives as solution-processed buffer layers, H. Kajii, Y. Ie, M. Nitani, Y. Hirose, Y. Aso, Y. Ohmori: Org. Electron, 11 (12) (2010) 1886-1890.

[3]Synthesis of tripodal-anchor units having pyridine or amine functional groups and their adsorption behavior on metal electrodes, H. Hirose, Y. Ie, Y. Aso: Chem. Lett., 40 (2) (2011) 204-205.

[4]Convenient Synthesis of dibenzo[a,h]anthracenes and picenes via C-H arylation of acetophenones with arenediboronates, K. Kitazawa, T. Kochi, M. Nitani, Y. Ie, Y. Aso, F. Kakiuchi: Chem. Lett., 40 (3) (2011) 300-302.

[5]Nature of electron transport by pyridine-based tripodal anchors: potential for robust and conductive single-molecule junctions with gold electrodes, Y. Ie, T. Hirose, M. Kiguchi, N. Takagi, M. Kawai, H. Nakamura, Y. Aso,: J. Am. Chem. Soc., 113 (9) (2011) 3014-3022.

[6]Branched polythiophene as a new amorphous semiconducting polymer for an organic field-effect transistor, M. Karakawa, Y. Ie, Y. Aso: Semicond. Sci. Technol, 26 (2011) 034004-1-9.

[7]Air-stable n-type organic field-effect transistors based on solution-processable, electronegative oligomers containing dicyanomethylene-substituted cyclopenta[b]thiophene, Y. Ie, K. Nishida, M. Karakawa, H. Tada, A. Asano, A. Saeki, S. Seki, Y. Aso: Chem. Eur. J, 17 (17) (2011) 4750-4758.

**International Conferences**

[1]Dendritic Oligothiophenes Bearing Perylene Bis(dicarboximide) Groups as Active Materials for Photovoltaic Device , Y. Ie, T. Uto, A. Saeki, S. Seki, S. Tagawa, Y. Aso: 9th International Symposium on Functional p-Electron Systems (Fp9), Atlanta, USA, May 23-28, 2010.

[2]Air-stable N-Type Organic Field-Effect Transistors Based on Carbonyl Bridged Bithiazole Compound , Y. Ie, M. Nitani, M. Karakawa, Y. Aso: 9th International Symposium on Functional p-Electron Systems (Fp9), Atlanta, USA, May 23-28, 2010.

[3]Development of Oligomers Containing Carbonyl-bridged Bithiazole as Solution-Processible n-Type Organic Field-Effect Transistor Materials , M. Nitani, Y. Ie, Y. Aso: 9th International Symposium on Functional p-Electron Systems (Fp9), Atlanta, USA, May 23-28, 2010.

[4]Branched Oligothiophenes: Synthesis, Properties and Electronic Applications (invited), Y. Aso: International Conference on Science and Technology of Synthetic Metals 2010 (ICSM 2010), Kyoto, Japan, July 4-9, 2010.

[5]Synthesis, Properties, and n-Type Performances of π-Conjugated Systems Containing Carbonyl-Bridged Bithiazole , Y. Ie, M. Nitani, M. Karakawa, Y. Aso: International Conference on Science and Technology of Synthetic Metals 2010 (ICSM 2010), Kyoto, Japan, July 4-9, 2010.

[6]Twisted Polythiophenes as a New Organic Memory Materials , M. Karakawa, Y. Ie, Y. Aso: International Conference on Science and Technology of Synthetic Metals 2010 (ICSM 2010), Kyoto, Japan, July 4-9, 2010.

[7]Development of Electronegative pi-Conjugated Systems towards n-Type Organic Field-effect Transistor Materials (oral), Y. Ie, Y. Aso: Pacifichem 2010, Hawaii, USA, December 14-22, 2010.

[8]Development of Conjugated Oligomers Based on Carbonyl-Bridged Bithiazole for Solution-processable n-Type OFET Materials , M. Nitani, Y. Ie, Y. Aso: Pacifichem 2010, Hawaii, USA, December 14-22, 2010.

[9]Synthesis, Properties, and OFET Performances of Conjugated Oligomers Having Bis(dicyanomethylene)difluorocyclopentene-annelated Thiophenes , K. Nishida, Y. Ie, Y. Aso: Pacifichem 2010, Hawaii, USA, December 14-22, 2010.

[10]Air-stable and Solution-processable FET Materials Based Electronegative Oligomers Having Dicyanomethylene Cyclopentene-annelated Thiophene , Y. Ie, K. Nishida, Y. Aso: The 14th SANKEN International Symposium 2011, Shiga, Japan, January 25-26, 2011.

[11]Synthesis and Properties of Twisted Polythiophenes for Organic Electronics Materials , M. Karakawa, Y. Ie, Y. Aso: The 14th SANKEN International Symposium 2011, Shiga, Japan, January 25-26, 2011.

[12]Electronegative pi-Conjugated Oligomers for n-Channel OFET Materials (invited), Y. Aso: Symposium on Organic and Polymer Electronics, Singapore, December 10, 2010.

**Review Papers**

Development of New π-cojugated Compounds for Organic Electronic and Molecular Electronics, Y. Ie, Y. Aso, Expected materials for the future, NTS Co., Ltd, 10 (2010), 32-39.

**Books**

[1]Organic semiconducting materials for printed electronics(K. Suganuma) Y. Ie, Y. Aso, "Advanced Printed Electronics", CMC Publishing Co.,Ltd, (51-56) 2010.

[2]Development of functional oligothiophenes and their application to organic field-effect transistors(Y. Chujo) Y. Ie, Y. Aso, "New Functional Materials Based on Characteristics of Hetero-Elements", CMC Publishing Co.,Ltd, (228-237) 2010.

**Patents**

[1]Insulated Hteroaromatic Compounds Y. Aso, Y. Ie, A. Han, JP4505568

[2]Fused-Ring Compounds, Organic Thin Films, and Organic Thin-Film Devices Y. Ie, M. Nitani, Y. Aso, M. Ueda, JP2010-169526

[3]Conjugated Compounds, Their Organic Thin Films, and Their Organic Thin-Film Devices Y. Ie, K. Nishida, Y. Aso, M. Ueda, JP2010-261465

[4]Nitrogen-containing Fused-Ring Compounds, Nitrogen-containing Fused-Ring Polymers, and Organic Thin Films and Organic Thin-Film Devices Y. Ie, M. Ueta, Y. Aso, M. Ueda, JP2010-261575

[5]Development of Electronegative conjugated system and their application to devices Y. Ie, T. Sakurai, Y. Aso, M. Ueda, JP2011-032205

[6]Conjugated Compounds, Their Organic Thin Films, and Their Organic Thin-Film Devices Y. Ie, K. Nishida, Y. Aso, M. Ueda, JP2011-033737

[7]Nitrogen-containing Fused-Ring Compounds, Nitrogen-containing Fused-Ring Polymers, and Organic Thin Films and Organic Thin-Film Devices Y. Ie, M. Ueta, Y. Aso, M. Ueda, JP2011-045515

[8]Delopment of Polymer and Their Application to Devices Y. Ie, M. Kou, M. Karakawa, Y. Aso, M. Ueda, JP2011-046563

[9]Nitrogen-containing Fused-Ring Compounds, Nitrogen-containing Fused-Ring Polymers, and Organic Thin Films and Organic Thin-Film Devices Y. Ie, M. Ueta, Y. Aso, M. Ueda, PCT–JP2011–054924

**Contributions to International Conferences and Journals**

| | |
|---|---|
| Y. Aso | The Tenth International Conference on Heteroatom Chemistry (ICHAC-10) (Organaizing Committtee) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Chemical Society of Japan | 7 papers |
| Symposium on Main Element Chemistry | 3 papers |
| Symposium on Fundamental Organic Chemistry | 3 papers |
| The Japan Society of Applied Physics | 3 papers |
| Symposium on Organic pi-Systems | 2 papers |
| The Society of Polymer Science | 1 paper |
| Symposium on Fluorine Chemistry | 1 paper |

**Academic Degrees**

| | |
|---|---|
| DoctorDegree for Engineering<br>T. Hirose | Studies on Development of Tripodal Anchor Units toward Molecular Electronics and Characterization of Their Monolayers on Electrodes |
| Master Degree for | Development of Pendant Polymers for Memory Devices and Three-Dimensional |

| | |
|---|---|
| Engineering<br>T. Sakurai | Compounds for Photoboltaic Devices |
| Master Degree for Engineering<br>K. Nishida | Development of Cyclopentene-annelated Thiophenes Having Dicyanomethylene Group and Application to Organic Field-Effect Transistor Materials |
| Bachelor of Engineering<br>K. Tanaka | Development of Fullerene-Oligothiophene-Linked Molecules for Single Molecular Organic Solar Cell |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| Y. Aso, M. Karakawa | Functions of Highly Elaborated π-Space Based on the Synthesis of Extended π-Electron Systems and Application to Electronics | ¥4,500,000 |
| Y. Ie | Development of electronegative three-dimensional conjugated systems | ¥1,400,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| Y. Ie | Japan Science and Technology | Development of n-type organic semiconductor materials towards bulk heterojunction solar cells | ¥14,600,000 |
| Y. Ie | New Energy and Industrial Technology Sevelopment Organization | Development of New π-cojugated Compounds for Organic Electronic and Molecular Electronics | ¥3,700,000 |
| Y. Aso, M. Karakawa | Osaka Science & Technology Center | Development ofNovel n-Type Organic Semiconductor Materials for Oganic Thin-Film Solar Cells | ¥1,998,000 |

**Cooperative Research**

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|---|---|---|
| Y. Aso, Y. Ie | Sumitomo Chemical | ¥1,012,000 |
| Y. Aso, Y, Ie, M. Karakawa | Daikin Industries, Ltd. | ¥2,750,000 |

## Department of Bio-Nanotechnology

**Original Papers**

[1]Molecule-Electrode Bonding Design for High Single-Molecule Conductance, K. Yokota, M. Taniguchi, M. Tsutsui and T. Kawai: J. Am. Chem. Soc., 132 (9) (2010) 17364-17365.

[2]Mechanically-controllable single molecule switch based on configuration specific electrical conductivity of metal-molecule-metal junctions, M. Taniguchi, M. Tsutsui, K. Yokota and T. Kawai: Chemical Science, 1 (2) (2010) 247-253.

[3]Identifying single nucleotides by tunnelling current, M. Tsutsui, M. Taniguchi, K. Yokota and T. Kawai: Nature Nanotechnology, 4 (4) (2010) 286-290.

[4]Nano-scale Resistivity Reduction in Single-Grain of Lead Phthalocyanine, Satomi Tabuchi, Yoichi Otsuka, Masaki Kanai, Hitoshi Tabata, Takuya Matsumoto, Tomoji Kawai: Organic Electronics, 11 (5) (2010) 916-924.

[5]AFM Nanopatterning of Transition Metal Oxide Thin Films, L. Pellegrino, I. Pallecchi, E. Bellingeri, G. Canu, A. S. Siri, D. Marré, Y. Yanagisawa, M. Ishikawa, T. Matsumoto, Hide. Tanaka, T. Kawai: J. Nanosci. Nanotechnol., 10 (7) (2010) 4471-4476.

[6]Nanoparticle Arrangement by DNA-programmed Self-assembly for Catalyst Applications, Y. Maeda, T. Akita, M. Daté, A. Takagi, T. Matsumoto, T. Fujitani, M. Kohyama: J. Appl. Phys, 108 (9) (2010) 094326 (4pp).

[7]DNA Observation with Scanning Tunneling Microscope Using a Solution, Hiroshi Matsuura, Hitomi

Hokonohara, Tomoe Sugita, Akihiko Takagi, Kohji Suzuki, Takuya Matsumoto, Tomoji Kawai: J. Appl. Phys, 109 (3) (2011) 034701(5pp).

[8]A proposal for a new porphine substitution motif aimed at advanced materials: introduction of 4-alkoxy-3,5-diisopropylphenyl groups on porphine, K..Yamashita, Y. Akita, M. S. Asano, H. Tanaka, T. Kawai and K. Sugiura: Journal of Porphyrins and Phthalocyanines, 14 (12) (2010) 1040.

**International Conferences**

[1]Mechanically Controllable Configuration Single-Molecule Switch , M. Taniguchi: International Conference on Science and Technology of Synthetic Metals 2010 (ICSM 2010).

[2]DEVELOPMENT OF 3G DNA SEQUENCER USING GATING NANOPORE DEVICES , M. Taniguchi: 2ND JAPANESE-RUSSIAN YOUNG SCIENTISTS CONFERENCE ON NANO-MATERIALS AND NANO-TECHNOLOGY.

[3]Development of Gating Nanopores for Single-Molecule Electrical Sequencing , M. Taniguchi: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011).

[4]Fabrication Method of Plastic Micropores for Artificial Lipid Bilayer Formation , Hiro. Tanaka: International Symposium: Advanced Science and Technology for Single Molecular Analysis of DNA and Related Molecules(ISSMA 2011).

[5]Stochastic resonance emerging on Coulomb blockade network induced by redox-active biomolecular arrays (invited), T. Matsumoto: The 6th International Symposium on Organic Molecular Electronics (ISOME2010).

[6]Noise-induced entrainment and stochastic resonance for a device based on cytochrome c and DNA nanonetwork (oral), T. Matsumoto, Y. Segawa, Y. Miyake, Y. Hirano, T. Kawai: 5th International Meeting on Molecular Electronics [ElecMol'10].

[7]Current Path Imaging of Soft Nanomaterials (poster), T. Matsumotoa, Y. Otsukaa, H. Tanakab, T. Ogawab, R. Tsunashimac, T. Akutagawac, T. Nakamurac, T. Kawaia: 5th International Meeting on Molecular Electronics [ElecMol'10].

[8]Control of Network Formation of DNA Origami and λ-DNA:Emergent One-pot Processes Utilizing Binary Solvent (poster), T. Matsumoto, Y. Hirano, Y. Miyake, Y. Segawa, T. Kawai: 5th International Meeting on Molecular Electronics [ElecMol'10].

[9]Noise-induced entrainment and stochastic resonance based on the device of cytochrome c and lambda DNA binary system (oral), Y. Hirano; Y. Miyake; Y. Segawa; T. Matsumoto; T. Kawai: The 2010 International Chemical Congress of Pacific Basin Societies.

[10]Incorporation of gold nano particle into cytochrome c / DNA network for biomolecular device (poster), Y. Miyake; Y. Hirano; Y. Segawa; T. Matsumoto; T. Kawai: The 2010 International Chemical Congress of Pacific Basin Societies.

[11]Stochastic resonance emerging on coulomb blockade network induced on self-assembled redox-active biomolecular arrays (poster), T. Matsumoto; Y. Segawa; Y. Miyake; Y. Hirano; T. Kawai: The 2010 International Chemical Congress of Pacific Basin Societies.

[12]Noise-induced entrainment and stochastic resonance for a device based on cytochrome c and DNA nanonetwork (poster), T. Matsumoto; Y. Segawa; Y. Miyake; Y. Hirano; T. Kawai: International Symposium on Engineering Neo-Biomimetics II – Soft Nanomaterials and Soft Robotics.

[13]Noise-induced entrainment and stochastic resonance for a neuro-device based on cytochrome c and DNA nanonetwork (oral), T. Matsumoto, Yoshiaki Hirano, Y. Segawa, Y. Miyake, T. Kawai: Sixth international conference on Molecular Electronics and Bioelectronics (M&BE6).

[14]Molecule Recognition Imaging by Frequency Shift Detection in Liquid (oral), T. Matsumoto, T. Kawahara, T. Kawai: Pittcon 2011.

[15]Stochastic Resonance Emerging on Coulomb Blockade Network Induced on Self-Assembled Redox-Active Biomolecular Arrays (oral), T. Matsumoto, Y. Segawa, Y. Miyake, Y. Hirano, T. Kawai: 13th International Conference on Organized Molecular Films (LB13).

[16]Control of Network Formation of DNA Origami and l-DNA Utilizing (poster), T. Matsumoto, Y. Segawa, Y. Miyake, Y. Hirano, T. Kawai: 13th International Conference on Organized Molecular Films (LB13).

[17]Control of Network Formation of DNA Origami and l-DNA Utilizing Binary Solvent (poster), Y. Hirano, Y. Miyake, Y. Segawa, T. Matsumoto, T. Kawai: 13$^{th}$ International Conference on Organized Molecular Films (LB13).

[18]Sequencing of a single DNA molecule with a scanning tunnelling microscope (invited), H. Tanaka, T.Kawai: Functionalized Nanomterials Conference, Santa Fe, New Mexico, USA, April 26-28, 2010.

[19]Real Time Observation of Kcsa Channel Gating with Mechanical Stimulus by AFM (poster), M. Kitta, M. Hirano, T. Yanagida, H. Tanaka, T. Ide, T. Kawai: the 13th International Conference on Non-Contact Atomic Force Microscopy. Kanazawa Japan, July 31- August 4, 2010.

[20]Real Time Observation of Kcsa Channel Gating with Mechanical Stimulus by AFM (oral), M. Kitta, M. Hirano, T. Yanagida, H. Tanaka, T. Ide, T. Kawai: 18th International Colloquium on Scanning Probe Microscopy, Atagawa, Shizuoka, Japan, 2010 Dec. 9-11.

**Patents**

[1]Probe apparatus for measuring an electron state on a sample surface Takuya Matsumoto, Tomoji Kawai, US 7,874,202 B2

[2]Peobe device and method of controlling the same Takuya Matsumoto, Tomoji Kawai, US 2,503,957

**Contributions to International Conferences and Journals**

| | |
|---|---|
| T. Matsumoto | International Symposium on Surface Science (ISSS-6) (Program/Pubication Committee) |
| T. Matsumoto | e-Journal of Surface Science and Nanotechnology (Editorial Board) |
| M. Taniguchi | Japanese Journal of Applied Physics (Associate Editor) |

**Publications in Domestic Meetings**

| | |
|---|---|
| The Japan Society of Applied Physics | 9 papers |
| Others | 2 papers |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| M. Taniguchi | Development of DNA Sequencing Technologies Using Gating Nanopores | ¥8,580,000 |
| T. Matsumoto | Emergence of self-organized molecular system with top-down nanoelectdes | ¥13,780,000 |
| T. Matsumoto | Analysis of molecular recognition in liquid by pulse-modulated attractive force microscopy | ¥3,380,000 |
| T. Matsumoto | Stochastic resonance devices by molecular neural network | ¥1,900,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| M. Tanikguchi | Japan Science and | Creation of Ultra-High Integrated | ¥5,460,000 |

| | | | |
|---|---|---|---|
| | Technology Agency | Molecular devices Using Self-Organized Interconnect Method | |
| Hiro. Tanaka | Japan Science and Technology Agency | Nanopore-based single-molecule DNA sequencing | ¥4,515,000 |

**Contribution to Research**

| | | |
|---|---|---|
| M. Taniguchi | The Murata Science Fundation | ¥1,700,000 |

**Cooperative Research**

| | | |
|---|---|---|
| T. Matsumoto | Hyogo University | ¥,000 |
| T. Matsumoto | Kyushu University | ¥,000 |
| T. Matsumoto | Hokkaido University | ¥,000 |
| T. Matsumoto | Hokkaido University | ¥,000 |
| T. Matsumoto | Osaka University | ¥,000 |
| T. Matsumoto | Osaka University | ¥,000 |
| T. Matsumoto | AIST | ¥,000 |
| T. Matsumoto | AIST | ¥,000 |
| T. Matsumoto | Riken | ¥,000 |

**Other Research Fund**

| | | |
|---|---|---|
| H. Tanaka | Program for World-Leading Innovative R&D on Science and Technology－Inovative NanoBiodevice based on Single Molecule Analysis | ¥1,000,000 |

## Department of Nanotechnology for Environmental and Energy Applications

**Original Papers**

[1]Spin-orbit coupling and anomalous angular-dependent magnetoresistance in the quantum transport regime of PbS, Kazuma Eto, A. Taskin, Kouji Segawa, and Yoichi Ando: Physical Review B, 81 (16) (2010) 161202/1-4.

[2]Zero-doping state and electron-hole asymmetry in an ambipolar cuprate, Kouji Segawa, M. Kofu, S-H. Lee, I. Tsukada, H. Hiraka, M. Fujita, S. Chang, K. Yamada, and Yoichi Ando: nature physics, 6 (8) (2010) 579-583.

[3]Oscillatory angular dependence of the magnetoresistance in a topological insulator Bi1-xSbx, A. A. Taskin, Kouji Segawa, and Yoichi Ando: Physical Review B, 82 (12) (2010) 121302/1-4.

[4]Large bulk resistivity and surface quantum oscillations in the topological insulator Bi2Te2Se, Zhi Ren, A. A. Taskin, Satoshi Sasaki, Kouji Segawa, and Yoichi Ando: Physical Review B, 82 (24) (2010) 241306/1-4.

[5]Bulk Superconducting Phase with a Full Energy Gap in the Doped Topological Insulator CuxBi2Se3, M. Kriener, Kouji Segawa, Zhi Ren, Satoshi Sasaki, and Yoichi Ando: Physical Review Letters, 106 (12) (2011) 127004/1-4.

[6]Doping Dependence of the (pi, pi) shadow band in La-based cuprates studied by angle-resolved photoemission spectroscopy, R-H. He, X J Zhou, M. Hashimoto, T. Yoshida, K. Tanaka, S-K. Mo, T. Sasagawa, N. Mannella, W. Meevasana, H. Yao, M. Fujita, T. Adachi, S. Komiya, S. Uchida, Y. Ando, F. Zhou, Z. X. Zhao, A. Fujimor, Y. Koike, K. Yamada, Z. Hussain and Z-X. Shen: New Journal of Physics, 13 (2011) 13031/1-14.

[7]Electronic structure of doped lanthanum cuprates studied with resonant inelastic e-ray scattering, D. S. Ellis, Jungho Kim, Harry Zhang, J. P. Hill, Genda Gu, Seiki Komiya, Yoichi Ando, D. Casa, T. Gog, and Young-June Kim: Physical Review B, 83 (7) (2011) 075120/1-9.

[8]Electron interactions and charge ordering in CuO2 compounds, B. Muschler, W. Prestel, L. Tassini, R.

Hackl, M. Lambacher, A. Erb, Seiki Komiya, Yoichi Ando, D. C. Peets, W. N. Hardy, R. Liang and D. A. Bonn: The European Physical Journal Special Topics, 188 (1) (2010) 131-152.

[9]Quantitative comparison of single- and two-particle properties in the cuprates, W. Prestel, F. Venturini, B. Muschler, I. Tutto, R. Hackl, M. Lambacher, A. Erb, Seiki Komiya, Shimpei Ono, Yoichi Ando, D. Inosov, V. B. Zabolotnyy and S. V. Borisenko: The European Physical Journal Special Topics, 188 (1) (2010) 163-171.

[10]Breakdown of the universal Josephson relation in spin-ordered cuprate superconductors, A. A. Schafgans, C. C. Homes, G. D. Gu, Seiki Komiya, Yoichi Ando, and D. N. Basov: Physical Review B, 82 (10) (2010) 100505/1-4.

[11]Direct Evidence for the Dirac-Cone Topological Surface States in the Ternary Chalcogenide TlBiSe2, Takafumi Sato, Kouji Segawa, Hua Guo, Katsuaki Sugawara, Seigo Souma, Takashi Takahashi, and Yoichi Ando: , 105 (13) (2010) 136802/1-4.

[12]An Electron-boson glue function derived from electronic Raman scattering, B. Muschler, W. prestel, E. Schachinger, J. P. Carbotte, R. Hackl, Shimpei Ono, and Yoichi Ando: Journal of Physics: Condensed Matter, 22 (37) (2010) 375702/1-7.

[13]High-Temperature Optical Spectral Weight and Fermi-liquid Renormalization in Bi-Based Cuprate Superconductors, D. Nicoletti, O. Limag, P. Calvani, G. Rohringer, A. Toschi, G. Sangiovanni, M. Capone, K. Held, S. Ono, Yoichi Ando, and S. Lupi: Physical Review Letters, 105 (7) (2010) 077002/1-4.

[14]Stability of exfoliated Bi2Sr2DyxCa1-xCu2O8+delta studied by Raman microscopy, L. J. Sandilands, J. X. Shen, G. M. Chugunov, S. Y. F. Zhao, Shimpei Ono, Yoichi Ando, K. S. Burch: Physical Review B, 82 (6) (2010) 064503/1-5.

[15]Spin-polarized surface bands of a three-dimensional topological insulator studied by high-resolution spin- and angle-resolved photoemission spectroscopy, Akinori Nishide, Yasuo Takeichi, Taichi Okuda, Alexey A Taskin, Tory Hirahara, Kan Nakatsuji, Fumio Komori, Akito Kakizaki, Yoichi Ando, and Iwao Matusda: New Journal of Physics, 12 (2010) 065011/1-14.

[16]Chemical potential jump between the hole-doped and electron-doped sides of ambipolar high-Tc cuprate superconductors, M. Ikeda, M. Takizawa, T. Yoshida, A. Fujimori, Kouji Segawa, and Yoichi Ando: Physical Review B, 82 (2) (2010) 020503/1-4.

[17]Angular-dependent oscillations of the magnetoresistance in Bi2Se3 due to the three-demensional bulk Fermi surface, Kazuma Eto, Zhi Ren, A. A. Taskin, Kouji Segawa, and Yoichi Ando: Physical Review B, 81 (19) (2010) 195309/1-5.

[18]Homogeneous Dispersion of Gallium Nitride Nanoparticles in a Boron Nitride Matrix by Nitridation with Urea, Takafumi Kusunose, Tohru Sekino, Ando Yoichi: Journal of Nanoscience and Nanotechnology, 10 (7) (2010) 4312-4316.

[19]Towards a Two-Dimensional Superconducting State of La2-xSrxCuO4 in a Moderate External Magnetic Field, A. A. Schafgans, A. D. LaForge, S. V. Dordevic, M. M. Qazilbash, W. J. Padilla, K. S. Burch, Z. Q. Li, Seiki Komiya, Yoichi Ando, and D. N. Basov: Physical Review Letters, 104 (15) (2010) 157002/1-4.

**International Conferences**

[1]Unusual Quantum Magnetotrnasport in a Topological Insulator Bi1-xSbx (invited), : The 19th International Conference on the Application of High Magnetic Fields in Semiconductor Physics and Nanotechnology (HMF19), Fukuoka convention center.

[2]Novel transport properties of Bi-Sb and other topological insulators (invited), : Workshop on Topological Inslators& Superconductors, Princeton University.

[3]Materials Studies of Topolgical Insulators and Superconductors (invited), : International Meeting on High-Accuracy, Hierarchical and Many-Body Schemes for Materials Simulations, Faculty of Engineering the University of Tokyo.

[4]Magnetotransport studies of new topological insulators: Bi2Te2Se and others (invited), : APS March Meeting 2011, Dallas.

[5]Magneto-Optics in the search for the topological insulating state (oral), : APS March Meeting 2011, Dallas.

**Review Papers**
Experimental Study of Topological Insulators, Y. Ando, SOLID STATE PHYSICS, ©AGNE GIJUTSU CENTER, 45[11] (2010), 103-116.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| Y.Ando | EPL (Europhysics Letters) (co-editor) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Symposium in Yukawa Institute for Theoretical Physics of Kyoto University | 1 paper |
| The Physical Society of Japan | 12 papers |
| The Japanese Society for Synchrotron Radiation Research | 1 paper |

**Academic Degrees**

| | |
|---|---|
| Master Degree for Science<br>D. Hama | Development of Methods to Detect the Spin-polarized Charge Current on Topological Insulators |
| Master Degree for Science<br>T. Minami | Crystal Growth and Physical Properties of Tl-based Topological Insulators |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| Y.Ando | Mott Insulator and Spin Hall Insulator: Elucidating the Physics of Nontrivial Insulators | ¥24,830,000 |
| Y.Ando | Creation of Innovative Devices Based on Topological Insulators | ¥4,755,000 |

**Other Research Fund**

| | | |
|---|---|---|
| Y.Ando | US AFRL Asian Office of Aerospace Research and Development, Special Grant | ¥4,484,000 |

## Department of Nano-Intelligent Systems

**Original Papers**
[1]A new particle filter for high-dimensional state-space models based on intensive and extensive proposal distribution, V. P. Nguyen, T. Washio, T. Higuchi: International Journal of Knowledge Engineering and Soft Data Paradigms, 2 (4) (2010) 284-311.

[2]GTRACE: Mining Frequent Subsequences from Graph Sequences., A. Inokuchi, T. Washio: IEICE Transactions, 93-D (10) (2010) 2792-2804.

**International Conferences**
[1]Mining Frequent Graph Sequence Patterns Induced by Vertices, *A. Inokuchi, T. Washio: SIAM Data Mining Conference 2010 (SDM2010) , Columbus, America, April 29-May 1, 2010, (2010) 466-477.

[2]GTRACE2: Improving Performance Using Labeled Union Graphs, *A. Inokuchi, T. Washio: The 14th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD2010), Hyderabad, India,

June 21-24, 2010, 2 (LNAI6119) (2010) 178-188.

[3]Estimation of Exposure Time and Purchase Probability for Supermarket Categories from RFID data (oral), *K. Takai, T. Washio, K. Yada, R. Kohli: 34th Annual Conference of the German Classification Society (GfKl), Larlsruhe, Germany, July 21-23, 2010.

[4]Discovery of exogenous variables in data with more variables than observations (oral), *Y. Sogawa, S. Shimizu, A. Hyvarinen, T. Washio, T. Shimamura, S. Imoto: 20th International Conference on Artificial Neural Networks (ICANN2010), Thessaloniki, Greece, September 15-18, 2010.

[5]An experimental comparison of linear non-Gaussian causal discovery methods and their variants (oral), *Y. Sogawa, S. Shimizu, Y. Kawahara, T. Washio: 2010 IEEE World Congress on Computational Intelligence (WCCI2010), Barcelona, Spain, July 18-23, 2010.

[6]Graph Classification Based on Optimizing Graph Spectra (oral), *V. Nguyen, A. Inokuchi, T. Washio: The 13th International Conference on Discovery Science, Canberra, Australia, October 6-8, 2010.

**Review Papers**

Relational Data Mining on Causal Relation Among Variables, T. Washio, IEICE Technical Report, The Institute of Electronics, Information and Communication Engineers (IEICE), 1 (2011), 5-5.

**Contributions to International Conferences and Journals**

| | |
|---|---|
| T. WASHIO | SIAM Conference on Data Mining (SDM2011) (Program Committee Co-Chair) |
| T. WASHIO | The 10th IEEE International Conference on Data Mining (ICDM2010) (Program Committee Member) |
| T. WASHIO | International Journal of Knowledge and Web Intelligence (IJKWI) (Editorial Board) |
| T. WASHIO | 27th International Conference on Machine Learning (ICML10) (Program Committee Member) |
| T. WASHIO | 11th Pacific Rim International Conference on Artificial Intelligence (PRICAI 2010) (Special Session Chair) |
| T. WASHIO | 19th European Conference on Artificial Intelligence (ECAI 2010) (Program Committee Member) |
| T. WASHIO | The Thirteenth International Conference on Discovery Science (DS2010) (Program Committee Member) |
| T. WASHIO | Journal of Data Mining and Knowledge Discovery (DMKD) (Editorial Board) |
| T. WASHIO | Asian Conference on Machine Learning (ACML) (Steering Committee Member) |
| T. WASHIO | Pacific-Asia Conference on Knowledge Discovery and Data Mining. Future Conference (PAKDD) (Steering Committee Member) |
| A. INOKUCHI | 2010 Pacific-Asia Conference on Knowledge Discovery and Data Mining (Program Committee) |
| A. INOKUCHI | Special Section on Data Mining and Statistical Science, IEICE Transactions on Information and Systems, Special Section on Data Mining and Statistical Science (Guest Associate Editor) |
| A. INOKUCHI | 2010 IADIS European Conference on Data Mining (Program Committee) |
| A. INOKUCHI | 2010 Asian Conference on Machine Learning (Program Committee) |
| A. INOKUCHI | 2011 International Workshop on Data-Mining and Statistical Science (Program Committee) |
| A. INOKUCHI | 2011 Pacific-Asia Conference on Knowledge Discovery and Data Mining (Program Committee) |
| A. INOKUCHI | 2011 SIAM International Conference on Data Mining (Program Committee) |
| A. INOKUCHI | 2011 IADIS European Conference on Data Mining (Program Committee) |
| A. INOKUCHI | 2011 Joint workshop of International Workshop on Data Oriented Constructive Mining and Multi-Agent Simulation and International Workshop on Massively Multi-Agent Systems: Models, Methods, and Tools (Program Committee) |

| | |
|---|---|
| A. INOKUCHI | 2012 International Conference on Pattern Recognition Applications and Methods (Program Committee) |
| A. INOKUCHI | 2012 International Conference on Social Eco-Informatics (Program Committee) |
| A. INOKUCHI | International Journal of Applied Evolutionary Computation (Editorial Review Board) |

**Publications in Domestic Meetings**

| | |
|---|---|
| Information Based-Induction Sciences and Machine Learning, The Institute of Electronics, Information and Communication Engineers | 1 paper |
| The annual conference of The Japanese Society for Artificial Intelligence | 2 papers |
| Annual Conference of Japan Society of Medical Electronics and Biological Engineering | 1 paper |
| Forum on Data Engineering and Information Management | 1 paper |
| Japanese Joint Statistical Meeting | 2 papers |

**Academic Degrees**

| | |
|---|---|
| Bachelor Degree for Engineering<br>T. Tashiro | Estimation of a non-Gaussian structural vector autoregressive moving average model and its application to causal inference |
| Bachelor Degree for Engineering<br>A. Yamaoka | Study on Enumerating Frequent Patterns from a Single Graph Sequence |

**Grant-in-Aid for Scientific Research**

| | | |
|---|---|---|
| T. Washio | Development of Statistical Estimation Principle for Extremely High Dimensional Data and Its Application to Large Scale Data Mining | ¥5,850,000 |
| T. Washio | Establishment of Knowledge Mining and Modeling Principles for Large Scale Dimensional Time Series and Its Application to Commercial Ubiquitous Data | ¥2,400,000 |
| T. Washio | Study on an estimation method for large PSD matrix from incomplete data and its application to quantum computation experiments | ¥1,700,000 |
| A. Inokuchi | A Development of Multidimensional Databases for Analyzing Time Interval Data in Heterogeneous Schemas | ¥4,550,000 |

**Entrusted Research**

| | | | |
|---|---|---|---|
| A. Inokuchi | Japan Science and Technology Agency | Development of Knowledge Organization and Understanding Support of Massive Graph Sequence Data | ¥18,070,000 |

## Handai Multi-Functional Nanofoundry

**Original Papers**

[1]Study on EB/UV Nanoimpront Lithography Using Nano / Micro-fabricated Crosslinked PTFE Mold, T. Takahashi, Y. Takasawa, T. Gowa, S. Okubo, T. Sasaki, T. Miura, A. Oshima, S. Tagawa, M. Washio: J. Photopolym. Sci. Tech., 23 (2010) 69-74.

[2]Study on Synchrotron Radiation Induced Photo Etching of Perfluorinated Polymers by K-edge Absorption of F-atom, A. Oshima, H. Nagai, T. Hyuga, N. Miyoshi, T. Urakawa, K. Murata, T. Katoh, E. Katoh, M. Washio: J. Photopolym. Sci. Tech., 23 (2010) 381-386.

[3]Study on functionally gradient proton exchange membrane fabricated by EB irradiation with heterogeneous energy deposition, H. Fujita, F. Shiraki, T. Yoshikawa, A. Oshima, M. Washio: J. Photopolym. Sci. Tech., 23 (2010) 387-392.

[4]Microfabrication of Biodegradable Polymers using Focused Ion Beam, S. Okubo, T. Takahashi, Y. Takasawa, T. Gowa, T. Sasaki, N. Nagasawa, M. Tamada, A. Oshima, S. Tagawa, M. Washio: J.

Photopolym. Sci. Tech., 23 (2010) 393-398.

[5]Ion Beam Irradiation Effects on Resist Materials, T. Gowa, T. Takahashi, T. Oka, T. Murakami, A. Oshima, S. Tagawa, M. Washio: J. Photopolym. Sci. Tech., 23 (2010) 399-404.

[6]Micro- and Nano-Scale Fabrication of Fluorinated Polymers by Direct Etching Using Focused Ion Beam, N. Fukutake, N. Miyoshi, Y. Takasawa, T. Urakawa, T. Gowa, K. Okamoto, A. Oshima, S. Tagawa, M. Washio: Jpn. J. App. Phys., 49 (2010) 065201-1-5.

[7]Appearance of a correlation between the Hall coefficient and resistivity upon dihydrogenation of yttrium, M. Sakai, D. Kodama, S. Ito, M. Ito, O. Nakamura, S. Hasegawa, A. Kitajima, A. Oshima: J. Appl. Phys, 108 (2010) 083719-1-7.

[8]Fabrication of PEFC Membrane based on Perfluorinated Polymer Using Quantum Beam Induced Grafting Technique, A. Oshima, Y. Sato, F. Shiraki, N. Mitani, K. Fujii, Y. Oshima, H. Fujita, M. Washio: Radiat. Phys. Chem., 80 (2011) 164-168.

[9]Surface Modification of Polymeric Materials Using Ultra Low Energy Electron Beam Irradiation, A. Oshima, F. Shiraki, H. Fujita, M. Washio: Radiat. Phys. Chem., 80 (2011) 196-200.

[10]The Effect of Water Uptake Gradient in Membrane Electrode Assembly on Fuel Cell Performance, H. Fujita, F. Shiraki, Y. Oshima, T. Tatsumi, T. Yoshikawa, T. Sasaki, A. Oshima, M. Washio: Radiat. Phys. Chem., 80 (2011) 201-206.

[11]Nano and Micro Fabrication of Perfluorinated Polymers Using Quantum Beam Technology, N. Miyoshi, A. Oshima, T. Urakawa, N. Fukutake, H. Nagai, T. Gowa, Y. Takasawa, T. Takahashi, Y. Numata, T. Katoh, E. Katoh, S. Tagawa, M. Washio: Radiat. Phys. Chem., 80 (2011) 230-235.

[12]Study on Resist Sensitivities for Nano-scale Imaging Using Water Window X-ray Microscopy, T. Gowa, T. Takahashi, A. Oshima, S. Tagawa, M. Washio: Radiat. Phys. Chem., 80 (2011) 248-252.

[13]Change of Surface Morphology for polytetrafluoroethylene by Reactive Ion Etching, T. Takahashi, Y. Hirano, Y. Takasawa, T. Gowa, N. Fukutake, A. Oshima, S. Tagawa, M. Washio: Radiat. Phys. Chem., 80 (2011) 253-256.

[14]Study on Depth Profile of Heavy Ion Irradiation Effects in Poly(tetrafluoroethylene-co-ethylene), T. Gowa, T. Shiotsu, T. Urakawa, T. Oka, T. Murakami, A. Oshima, Y. Hama, M. Washio: Radiat. Phys. Chem., 80 (2011) 264-267.

[15]Changes to the chemical structure of isotactic-polypropylene induced by ion-beam irradiation, T. Oka, A. Oshima, R. Motohashi, N. Seto, Y. Watanabe, R. Kobayashi, K. Saito, H. Kudo, T. Murakami, M. Washio, Y. Hama: Radiat. Phys. Chem., 80 (2011) 278-280.

**International Conferences**

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| The Japan Society of Applied Physics | 5 papers |
| The Society of Chemical Engineers | 1 paper |
| Japanese Society of Radiation Chemistry | 3 papers |
| Chemical Society of Japan | 4 papers |
| Japan Radioisotope Association | 2 papers |
| The Committee of Battery Technology | 1 paper |

**Grant-in-Aid for Scientific Research**

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| A. Oshima | Fabrication of high aspect multi-nanoarray electrodes using quantum beam | ¥11,310,000 |

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**Contribution to Research**

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| T. Suzuki | Nitto Kasei Co., Ltd. | ¥500,000 |

## Reserch Laboratory for Quantum Beam Science

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**Publications in Domestic Meetings**

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| Meeting of Atomic Energy Society of Japan | 1 paper |

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