



Research Institute for Electronic Science Hokkaido University

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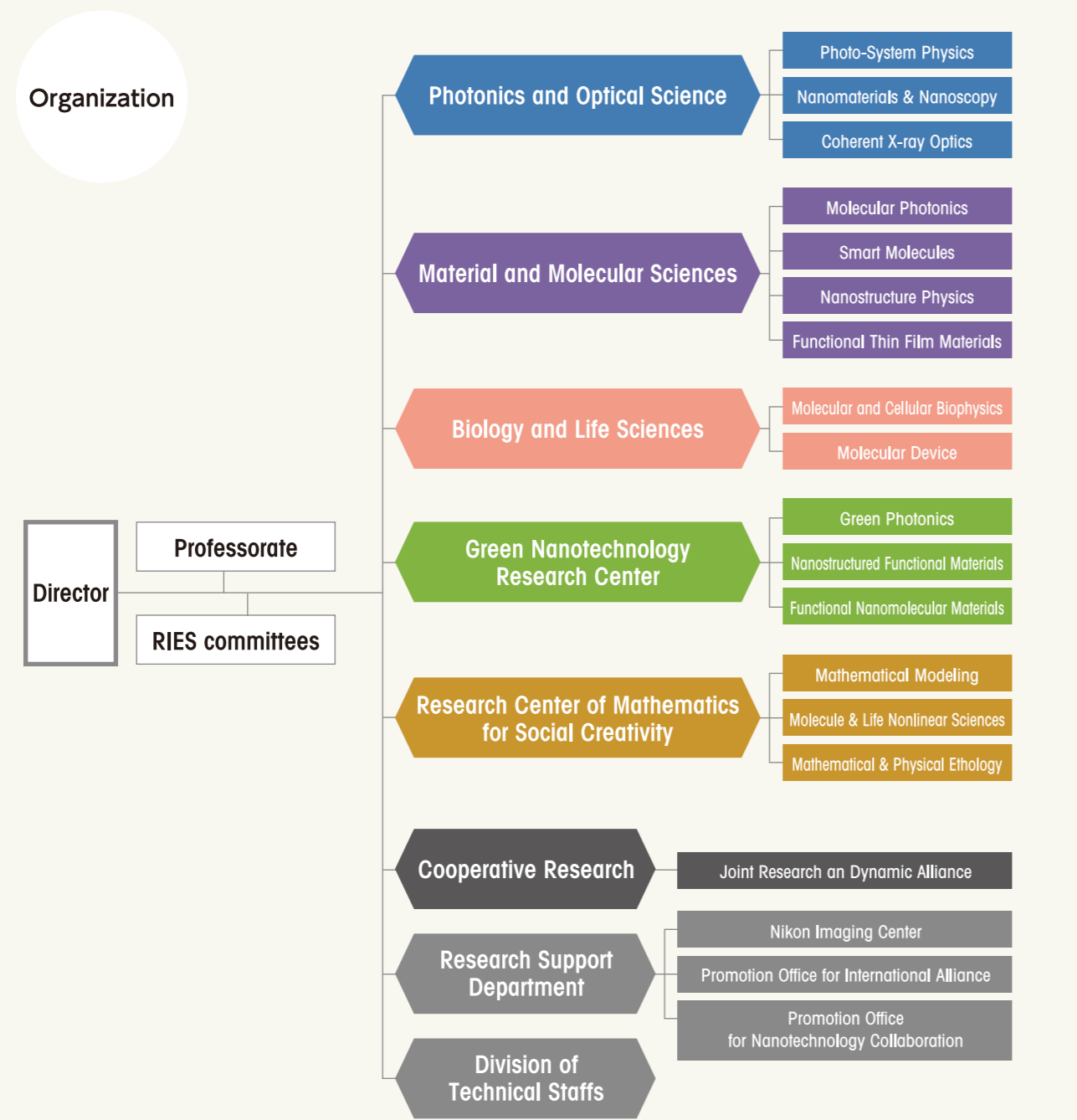
Research Institute for Electronic Science Hokkaido University

Cooperating 5 sections explore interdisciplinary fields

The Research Institute for Electronic Science has engaged in the history of more than 20 years, with the mission to explore new interdisciplinary fields. Moreover, from the former ultra-shortwave laboratory, more than 70 years have passed since the organization was established.

In 2015, we implemented a reorganization in

all areas and set 5 sections; "Optical Science", "Material Science" and "Life Science", and "Department of Green Nanotechnology Research Center", "Research Center of Mathematics for Social Creativity". We are working on the mission in full force with our 5 pillar structure.



SECTION OF PHOTONICS AND OPTICAL SCIENCE

LABORATORY OF PHOTO-SYSTEM PHYSICS

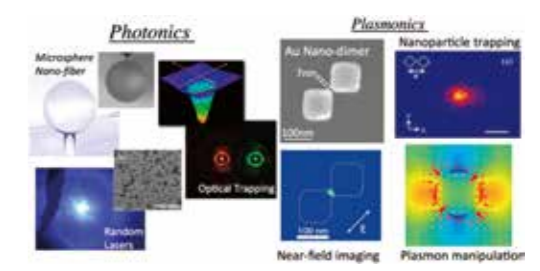
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PI: Prof. Keiji Sasaki, Assoc. Prof. Atsushi Taguchi, Assist. Prof. Christophe Pin, Assist. Prof. Kenji Setoura

Outline

Advanced optical technologies utilizing unique characteristics of light will play an important role in a future information-oriented society. To open the next generation optical science, we are aiming toward the ultimate of optical science and technology, such as the developments of photon control and optical measurement technologies based on a new concept of manipulating the quantum and wave natures of light.



Research highlights

- Trapping and Deposition of Dye-Molecule Nanoparticles in the Nanogap of a Plasmonic Antenna, *ACS Omega*, 2018, **3**, 4878.
- Nanofocusing of structured light for quadrupolar light-matter interactions, *Sci. Rep.*, 2018, **8**, 7746.
- Magnetic Response of Random Lasing Modes in a ZnO nanoparticle film deposited on a NiFe thin film, *Appl. Phys. Lett.*, 2018, **113**, 131108.

Education

Graduate School of Information Science and Technology, Division of Electronics for Informatics

SECTION OF PHOTONICS AND OPTICAL SCIENCE

LABORATORY OF NANOMATERIALS AND NANOSCOPY

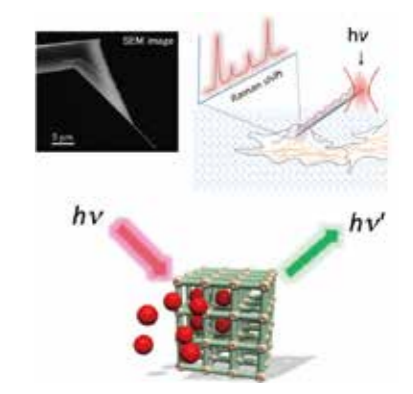
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PI: Prof. Hiroshi Uji-i, Assoc. Prof. Kenji Hirai, Assist. Prof. Tomoko Inose

Outline

We explore nano photonic materials and nanoscopy based on nano-materials for single cell interrogation and surface analysis. Main research topics are development of synthetic method of nano-materials, control of chemical reactions via strong/weak coupling, and single-molecule Raman/fluorescence super resolution microscopy/spectroscopy using nano-materials.



Research highlights

- Facilitating Tip-Enhanced Raman Scattering on Dielectric Substrates via Electrical Cutting of Silver Nanowire Probes, *J. Phys. Chem. Lett.*, 2018, **9**, 7117.
- In-situ synthesis of Au-shelled Ag nanoparticles on PDMS for flexible, long-life, and broad spectrum-sensitive SERS substrates, *Chem. Commun.*, 2017, **53**, 11298.
- Visualization of molecular-fluorescence point spread functions via remote excitation switching fluorescence microscopy, *Nat. Commun.*, 2015, **6**, 6287.

Education

Graduate School of Information Science and Technology, Division of Bioengineering and Bioinformatics

SECTION OF PHOTONICS AND OPTICAL SCIENCE

LABORATORY OF COHERENT X-RAY OPTICS

PI: Prof. Yoshinori Nishino, Assist. Prof. Akihiro Suzuki

Outline

Using state-of-the-art high-quality and high-intensity X-rays, X-ray free-electron lasers and synchrotron radiation, we are developing microscopic techniques to observe phenomena that no one has ever seen before, aiming at elucidating biological functions, reducing environmental problems, etc. In the research, we also utilize supercomputers and cutting-edge nanofabrication techniques.

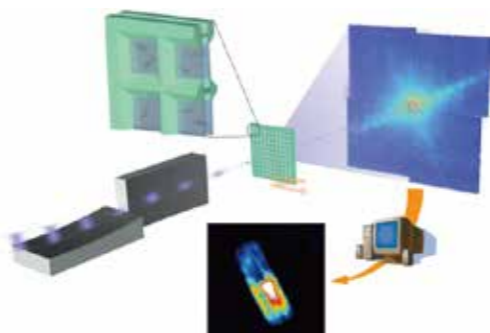
Research highlights

- Nearly diffraction-limited X-ray focusing with variable-numerical aperture focusing optical system based on four deformable mirrors, *Sci. Rep.*, 2016, **6**, 24801.
- Imaging live cell in micro-liquid enclosure by X-ray laser diffraction, *Nat. Commun.*, 2014, **5**, 3052.
- Human mitotic chromosomes consist predominantly of irregularly folded nucleosome fibres without a 30-nm chromatin structure, *EMBO J.*, 2012, **31**, 1644.

Education

Graduate School of Information Science and Technology, Division of Bioengineering and Bioinformatics

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SECTION OF MATERIAL AND MOLECULAR SCIENCES

LABORATORY OF SMART MOLECULES

PI: Prof. Nobuyuki TAMAOKI, Assoc. Prof. Yuna Kim
Assist. Prof. Yoshimitsu Sagara, Assist. Prof. Kazuya Matsuo

Outline

We explore advanced artificial molecular systems which can sense external stimuli, judge and execute informative functions.

Main research topic includes light-driven molecular machines: photoresponsive energy molecules and inhibitors for control of motor proteins, and photo-regulation of chiral liquid crystals for optical and mechanical functions.

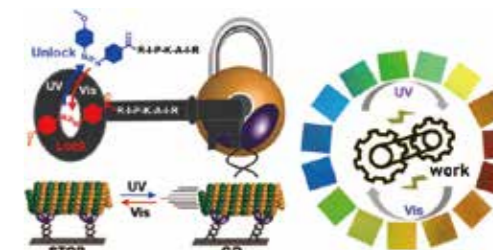
Research highlights

- Targeted Activation of Molecular Transportation by Visible Light, *ACS Nano*, 2017, **11**, 12292.
- Complete ON/OFF Photoswitching of the Motility of a Nanobiomolecular Machine, *ACS Nano*, 2014, **8**, 4157.
- Helical Naphthopyran Dopant for Photoresponsive Cholesteric Liquid Crystal, *Chem. Commun.*, 2017, **53**, 200.

Education

Graduate School of Life Science, Division of Life Science

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SECTION OF MATERIAL AND MOLECULAR SCIENCES

LABORATORY OF MOLECULAR PHOTONICS

PI: Prof. Vasudevan Pillai Biju, Assoc. Prof. Yuta Takano,
Assist. Prof. Ken-ichi Yuyama

Outline

We explore advanced molecular photonics based on semiconducting quantum dots, photofunctional organic molecules, and laser manipulation techniques. Main research topics are developments of photofunctional nanomaterials, single-molecular manipulation techniques, laser manipulation techniques, and photofunctional molecular tools.

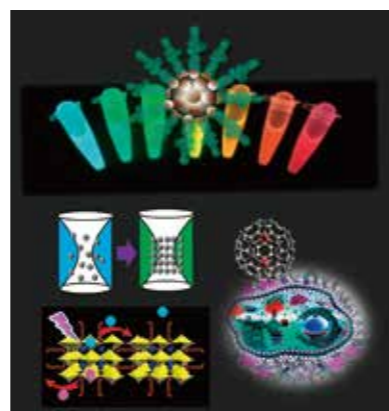
Research highlights

- Blinking Suppression in Highly-Excited CdSe/ZnS Quantum Dots by Electron Transfer under Large Positive Gibbs (Free) Energy Change, *ACS Nano*, 2018, **12**, 9060.
- Crystallization of Methylammonium Lead Halide Perovskites by Optical Trapping, *Angew. Chem. Int. Ed.*, 2018, **57**, 13424.
- Optical control of mitochondrial reductive reactions in living cells using an electron donor-acceptor linked molecule, *Nanoscale*, 2017, **9**, 18690.

Education

Graduate School of Environmental Science, Division of Environmental Materials Science

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SECTION OF MATERIAL AND MOLECULAR SCIENCES

LABORATORY OF NANOSTRUCTURE PHYSICS

PI: Prof. Akira Ishibashi, Assoc. Prof. Kenji Kondo

Outline

We explore advanced electronic devices and systems considering Atom•Bit•Energy/Environment (ABE²) space.

Main research topics are high efficiency solar cells, theory of novel spintronics devices, theory of topological matters, and advanced clean systems.

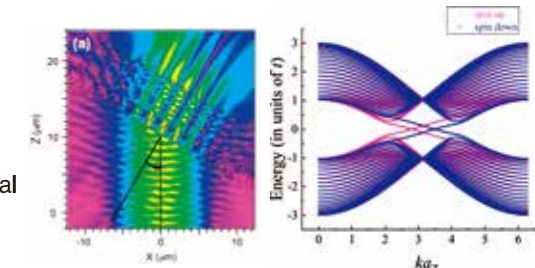
Research highlights

- Redirection Waveguide having Discrete Translational Symmetry for Photovoltaic Systems with Solar-Cell Units. Placed at the Periphery, *Energies*, 2018, **11** 3498.
- Optical simulation for multi-stripped orthogonal photon-photocarrier-propagation solar cell (MOP³SC) with redirection waveguide, *3D Res.*, 2016, **7** 33.
- Spin filter effects in an Aharonov-Bohm ring with double quantum dots under general Rashba spin-orbit interactions, *New J. Phys.*, 2016, **18** 013002.

Education

Faculty of Sci. Dept. of Condensed Matter Physics

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SECTION OF MATERIAL AND MOLECULAR SCIENCES

LABORATORY OF FUNCTIONAL THIN FILM MATERIALS

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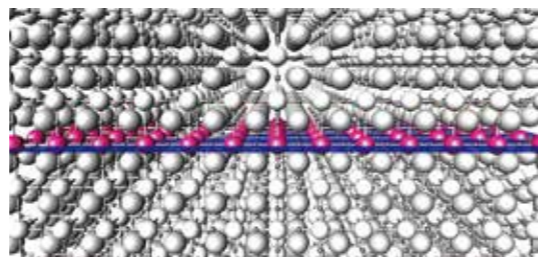
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PI: Prof. Hiromichi Ohta, Assoc. Prof. Michihiko Yamanouchi,
Assist. Prof. Hai Jun Cho

Outline

We fabricate high-quality thin film materials with the atomically flat surface to extract the intrinsic performance and develop novel devices. Especially, we develop thermoelectric materials, which can convert heat into electricity, and novel materials for advanced device applications.



Research highlights

- Double thermoelectric power factor of a 2D electron system, *Nat. Commun.*, 2018, **9**, 2224.
- Large thickness dependence of the carrier mobility in a transparent oxide semiconductor, *Appl. Phys. Lett.*, 2018, **112**, 232102.
- High thermoelectric power factor of high-mobility two-dimensional electron gas, *Adv. Sci.*, 2017, **4**, 1700696.

Education

Graduate School of Information Science and Technology, Division of Electronics for Informatics

SECTION OF LIFE SCIENCES

LABORATORY OF MOLECULAR AND CELLULAR BIOPHYSICS

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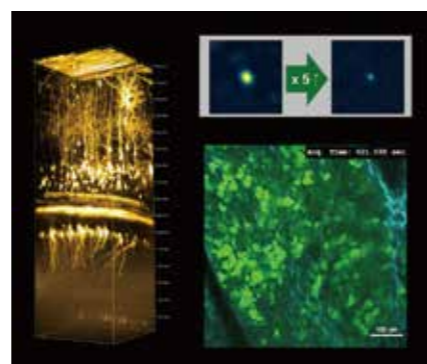
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PI: Prof. Tomomi Nemoto, Assoc. Prof. Ryosuke Enoki,
Assist. Prof. Kohei Otomo

Outline

We explore innovative bio-imaging methodologies and applications for life- and medical sciences by utilizing cutting-edge optical and material technologies. Main research topics are developments of invasive fast observations and manipulations in living bodies and super-resolution microscopy, and as well as studies on neural activities, exocytosis/secretion and biological rhythms.



Research highlights

- Ultradian calcium rhythms in the paraventricular nucleus and subparaventricular zone in the hypothalamus, *Proc. Natl. Acad. Sci. USA*, 2018, **115**, E9469.
- Advanced easy STED microscopy based on two-photon excitation by electrical modulations of light pulse wavefronts, *Biomed. Opt. Express*, 2018, **9**, 2476.
- Heterogeneous distribution of doublecortin-expressing cells surrounding the rostral migratory stream in the juvenile mouse, *J. Comp Neurol.*, 2018, **526**, 2631.

Education

Graduate School of Information Science and Technology, Division of Bioengineering and Bioinformatics

SECTION OF LIFE SCIENCES

LABORATORY OF MOLECULAR DEVICE

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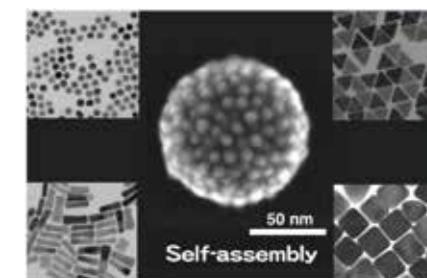
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PI: Prof. Kuniharu Ijiro, Assoc. Prof. Hideyuki Mitomol,
Assist. Prof. Yusuke Yonamine

Outline

Biomolecules autonomously assemble and show higher functionalities in the cell. By learning the nature system, our group is working on development of nanoparticle assemblies with controlled structures via self-assembly focusing on the surface properties and shape of the nanoparticles. As the metal nanoparticles show unique properties related to electronic, optical and biomedical applications, their assemblies are expected to be novel functional materials.



Research highlights

- Two-step Assembly of Thermoresponsive Gold Nanorods Coated with a Single Kind of Ligand, *Small*, 2018, **14**, 1704230.
- Shape-dependent adjuvanticity of nanoparticle-conjugated RNA adjuvants for intranasal inactivated influenza vaccines, *RSC Adv.*, 2018, **8**, 16527.
- Size-Defined Cracked Vesicle Formation via Self-Assembly of Gold Nanoparticles Covered with Carboxylic Acid-Terminated Surface Ligands, *Langmuir*, 2018, **34**, 12445.

Education

Graduate School of Life Science, Division of Soft Matter

GREEN NANOTECHNOLOGY RESEARCH CENTER

LABORATORY OF GREEN PHOTONICS

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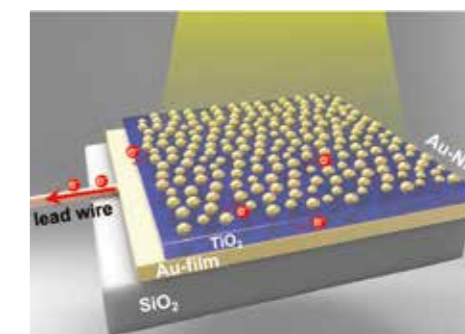
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PI: Prof. Hiroaki Misawa, Assist. Prof. Tomoya Oshikiri,
Assist. Prof. Quan Sun, Assist. Prof. Xu Shi (Specially Appointed),
Assist. Prof. Adithya Lakshumanna Yapamanu

Outline

We study on highly efficient optical antennae based on the strong coupling between a Fabry-Pérot nanocavity mode and a localized surface plasmon resonance of Au nanoparticles and its application for solar cells as well as artificial-photosynthesis systems which evolve oxygen and hydrogen as a result of a photolysis of water.



Research highlights

- Enhanced water splitting under modal strong coupling conditions, *Nat. Nanotechnol.*, 2018, **13**, 953.
- Manipulation of the dephasing time by strong coupling between localized and propagating surface plasmon modes, *Nat. Commun.*, 2018, **9**, 4858.
- Solid-State Plasmonic Solar Cells, *Chem. Rev.*, 2018, **118**, 2955.

Education

Graduate School of Information Science and Technology, Division of Bioengineering and Bioinformatics

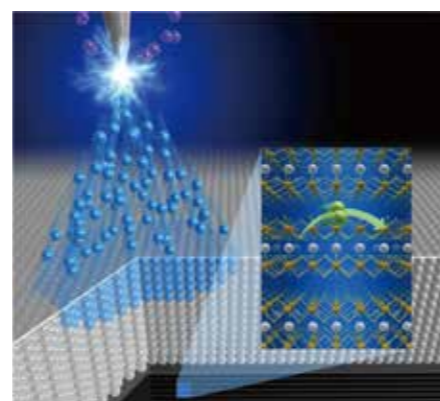
LABORATORY OF NANOSTRUCTURED FUNCTIONAL MATERIALS

PI: Prof. Junji Nishii, Assoc. Prof. Hideo Kaiju,
Assist. Prof. Masaya Fujioka

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Outline

We are conducting basic research with an aim to extract novel functions and features of inorganic and metallic materials in the form of bulk bodies by controlling the states of ions and electron spin in the materials.

In particular, we are developing a wide range of research on the novel synthesis methods using solid-state electrochemistry or high-pressure technique, and the observation of new quantum phenomena using nanostructures.

Research highlights

- Robustness of Voltage-induced Magnetocapacitance, *Sci. Rep.*, 2018, **8**, 14709.
- Dense proton injection into phosphate glasses using corona discharge treatment, *Appl. Surf. Sci.*, 2018, **428**, 718.
- Proton-Driven Intercalation and Ion Substitution Utilizing Solid-State Electrochemical Reaction, *J. Am. Chem. Soc.*, 2017, **139**, 17987.

Education

Department of Chemistry, Graduate School of Chemical Sciences and Engineering, Materials Chemistry and Engineering Course

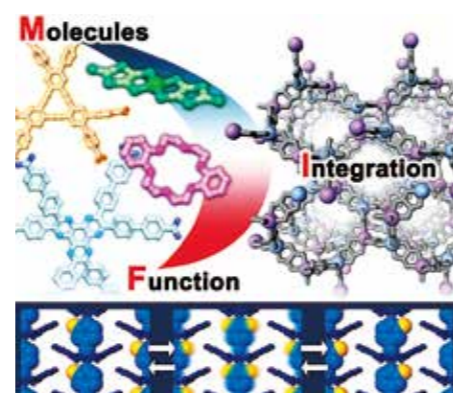
LABORATORY OF FUNCTIONAL NANO-MOLECULAR MATERIALS

PI: Prof. Takayoshi Nakamura, Assoc. Prof. Ichiro Hisaki,
Assist. Prof. Kiyonori Takahashi

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Outline

We construct the "Integrated Molecular Systems" through self-assembly processes of molecules. Based on the systems, we develop molecular devices for future electronics and high-performance porous materials.

Main research topics are developments of Multi-functionalized molecular-based conductors, magnets, and organic porous materials through supramolecular approach.

Research highlights

- Ferroelectricity and Polarity Control in Solid State Flip-Flop Supramolecular Rotators, *Nat. Mater.*, 2009, **8**, 342.
- Docking Strategy to Construct Thermostable, Single-Crystalline, Hydrogen-Bonded Organic Framework with High Surface Area, *Angew. Chem. Int. Ed.*, 2018, **57**, 12650.

Education

Graduate School of Environmental Science, Division of Environmental Materials Science

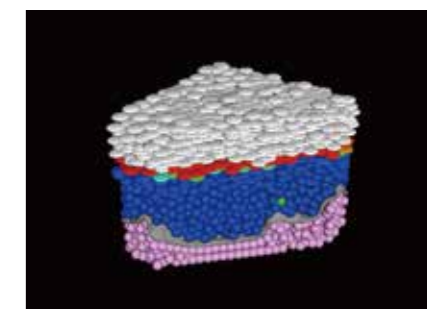
LABORATORY OF MATHEMATICAL MODELING

PI: Prof. Masaharu Nagayama,
Assist. Prof. Masakazu Akiyama

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Outline

With mathematical modeling, numerical computation, and mathematical analysis forming the foundation of our research, we aim to understand biological and other natural phenomena from the perspective of the mathematical sciences.

Main research topics are following:

Research highlights

- Interplay between epidermal stem cell dynamics and dermal deformation, *npj Comput. Mater.*, 2018, **4**, 45.
- Mathematical model for self-propelled droplets driven by interfacial tension, *J. Chem. Phys.*, 2016, **144**, 114707.
- A Mathematical model of collective cell migrations based on cell polarity. *Dev. Growth Differ.*, 2017, **59**(5), 471.

Education

Faculty of Science, Department of Mathematics

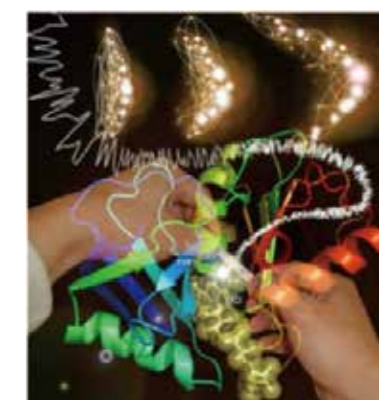
LABORATORY OF MOLECULE & LIFE NONLINEAR SCIENCES

PI: Prof. Tamiki Komatsuzaki, Assoc. Prof. Hiroshi Teramoto,
Assist. Prof. Goro Nishimura (Specially Appointed Assist.),
Prof. James Nick Taylor (Specially Appointed Assist.),
Prof. Koji Tabata

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Outline

The purpose of our laboratory is to understand the fundamental principles of chance and necessity of "change of states", and to construct new concepts and methodologies in terms of data-driven mathematical sciences, enabling us to unveil the mechanisms that bridge molecules and life across hierarchies in time and space.

Research highlights

- Deciphering hierarchical features in the energy landscape of adenylate kinase folding/unfolding, *J. Chem. Phys.*, 2018, **148**, 123325.
- Mechanism and Experimental Observability of Global Switching Between Reactive and Nonreactive Coordinates at High Total Energies", *Phys. Rev.Lett.*, 2015, **115**(093003).
- ATP hydrolysis assists phosphate release and promotes reaction ordering in F₁-ATPase *Nat. Commun.*, 2015, **6**(10223).

Education

Graduate School of Chemical Sciences and Engineering Materials Chemistry and Engineering Course, Graduate School of Science, Department of Mathematics

LABORATORY OF MATHEMATICAL AND PHYSICAL ETHOLOGY

PI: Prof. Toshiyuki Nakagaki, Assoc. Prof. Katsuhiko Sato, Yuzuru Sato,
Assist. Prof. Yukinori Nishigami

Outline

Soft matter physics that deals with soft and largely deformable materials is a necessary tool for mechanical understanding of motion, deformation and growth of biological systems such as cells, tissues and organisms. Based on these ideas, we are investigating characteristic and functional behaviors of various biological systems, by inventing unique experimental setup. We focus on unicellular organisms of amoebae and ciliates, and observe how they behave in complicated conditions and propose a mathematical model in terms of soft matter physics. Based on the model simulation and analysis, we seek for algorithm of how they process information and behavioral smartness.

Research highlights

- Experimental models for Murray's law *J. Phys. D: Appl. Phys.*, 2017, **50**, 024001.
- Left-right asymmetric cell intercalation drives directional collective cell movement in epithelial morphogenesis *Nat. Commun.*, 2015, **6**, 10074.
- Simple mechanosense and response of cilia motion reveal the intrinsic habits of ciliates *Proc. Natl. Acad. Sci. USA*, 2018, **115**, 3231.

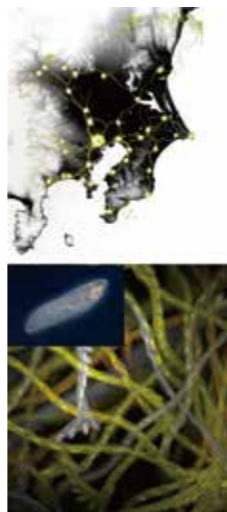
Education

Graduate School of Life Science, Division of Soft Matter; Department of Mathematics

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NIKON IMAGING CENTER

Leader: Prof. Tomomi Nemoto,
Prof. Yasutaka Matsuo, Assist. Prof. Kohei Otomo,
Sp. Appt. Assist. Prof. Motosuke Tsutsumi,
Tech. Staff Kentaro Kobayashi

Outline

Nikon Imaging Center provides cutting edge light microscopy instruments to researchers not only in Hokkaido University but also throughout Japan.

Our missions are: To enhance scientific research by providing of advanced microscopy and imaging equipment; To provide technical support for high quality imaging; To hold seminars on basic and advanced light microscopy techniques for users; To develop novel microscope systems and imaging techniques reflecting demands of users.

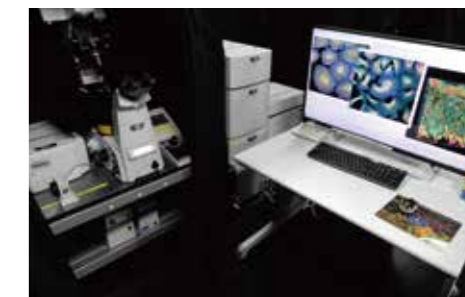
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Spectral Confocal Microscopy



Multi Point Scanning Two Photon Microscopy

LABORATORY OF JOINT RESEARCH AND DYNAMIC ALLIANCE (CORE LAB.)

PI: Assoc. Prof. Yoshihisa Oda (NIG), Res. Assoc. Takema Sasaki (NIG),
Assoc. Prof. Takashi Murata (NIBB)

Outline

In collaboration with Nemoto Lab and Nikon Imaging Center, we investigate the regulatory mechanisms of cytoskeletons in plant cells. By using the originally developed two-photon spinning disk microscope and cell/tissue culture systems, we reveal the dynamic behavior of microtubule structures during mitosis and xylem vessel cell differentiation.

Research highlights

- Multi-point scanning two-photon excitation microscopy by utilizing a highpeak-power 1042-nm laser, *Anal. Sci.*, 2015, **31**, 307.
- CORTICAL MICROTUBULE DISORDERING1 Is Required for Secondary Cell Wall Patterning in Xylem Vessels, *Plant Cell*, 2017, **29**, 3123.
- A Rho-based reaction-diffusion system governs cell wall patterning in metaxylem vessels, *Sci. Rep.*, 2018, **8**, 11542.

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PROMOTION OFFICE FOR NANOTECHNOLOGY COLLABORATION

Director: Prof. Yasutaka Matsuo

Outline

We support the research and development by nano/ micro fabrication techniques using EB lithography system, clean room environment and so on, and advanced characterization of nanomaterials using CsSTEM, FE-SEM, XPS. Technical consultation, equipment training and technical support will be carried out to other universities, public institutions, corporate users. We also actively accept collaborative research.

Research highlights

- Uphill water transport on a wettability patterned surface: Experimental and theoretical results *ACS Appl. Mater. Interfaces*, 2017, **9**, 15814.
- Crystallization of Methylammonium Lead Halide Perovskites by Optical Trapping Metal Phthalocyanine Derivative Nanocrystals: Color-controlled and Transparent Dispersions by a One-pot UV-assisted Synthetic Process, *Chem. Lett.*, 2017, **46**, 695.

Education

Graduate School of Chemical Sciences and Engineering, Materials Chemistry and Engineering Course Inorganic Materials Chemistry Unit

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DIVISION OF TECHNICAL STAFFS

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System/Equipment Development Team

Equipment Development/Machining Group designs, develops, and produces laboratory instruments using various machine tools. We receive orders from all departments on and off the campus through the Global Facility Center's Prototype Machining Solution Project. System Development/Data Analysis Group supports the institute's publicity, information and network, including running of the Web site of our research institute.

Leader (Coordinator); Masashi Takei

■ Equipment Development/Machining Group:

Masashi Takei (Chief), Mao Kusuzaki

■ System Development/Data Analysis Group:

Itsuko Imamura (Chief), Kentaro Kobayashi (additional post),
 Michiaki Endo (additional post)



Nanofabrication/Imaging Analysis Team

The Nanofabrication / Imaging Analysis Team provides technical supports for the clean Room, shared facilities for nano-fabrication and structural analysis, the Nikon Imaging Center as well. The management mentioned here includes maintenance, improvement, training on use etc. As a technical support staff of the Nanotech Platform, we are also receiving requests such as technical consultation, technical assistance, technical agency etc. off campus regardless of industry and academia through the Nanotechnology Collaboration Promotion Office.

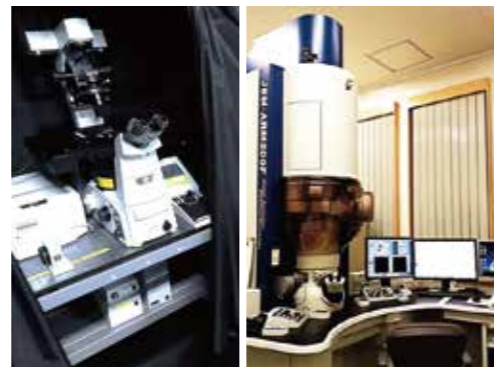
Leader (Coordinator); Kentaro Kobayashi

■ Nanofabrication Group:

Ko Onishi (Chief), Michiaki Endo, Wakako Nakano,
 Mao Kusuzaki (additional post)

■ Imaging Analysis Group:

Kentaro Kobayashi (Chief), Naomi Hirai



* Both teams also provide assistance related to the entire institute, such as institute's events/exhibitions and liquefied nitrogen training sessions.

Open Laboratory

Early summer, laboratory open is held every year. Exhibition of research mainly for elementary and junior high school students is famous as a great place to touch advanced science.



International Symposium

International Symposium is held every year by us for discussing common issues beyond national boundaries. Each theme of the year is expressed in one Japanese letter.



Internationality

We enroll many international students in the laboratories, and they research in a global atmosphere.



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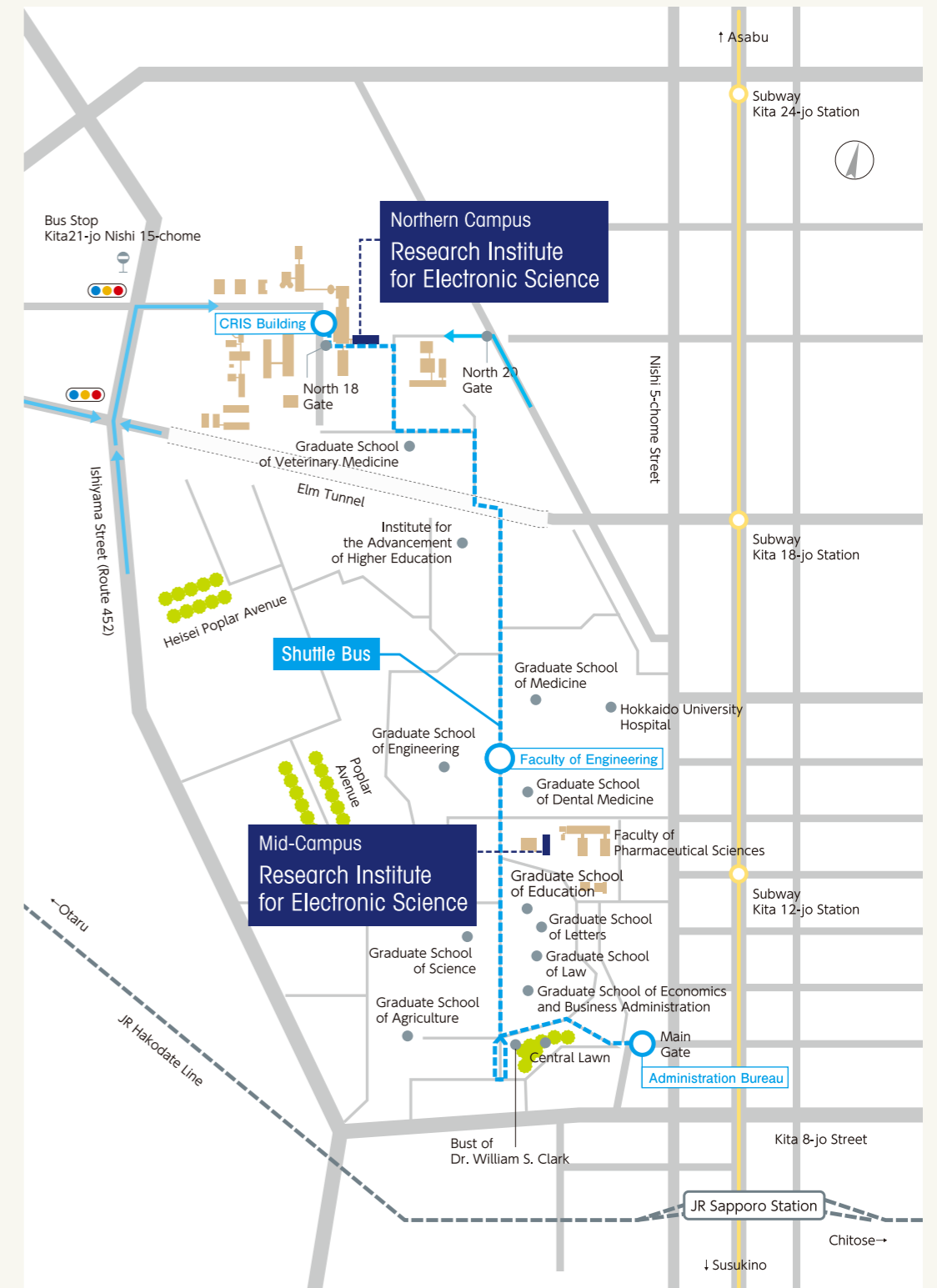


For Embassy recommended MEXT Scholarships, visit the homepage of Japanese embassy in your country, Gateway to study in Japan, etc.

<https://www.g-studyinJapan.jasso.go.jp>



HOKKAIDO
UNIVERSITY
SAPPORO
CAMPUS



A C C E S S

New Chitose Airport
→ Sapporo Sta.

- ◎Rapid Airport Train: approx. 40 min.
- ◎Bus: approx. 70 min.

Sapporo Sta. → RIES

- 【Northern Campus】**
- ◎Subway Nanboku Line (Get off at Kita 18-jo Station) + Walk: 15 min.
 - ◎Bus (Get off at Kita 21-jo Nishi 15-chome Bus Stop) + Walk: 5 min.
 - ◎Walk: 10 min (To the Main Gate of Hokkaido University)
+ Shuttle Bus (Get off in front of the RIES or the CRIS Building)

【Mid Campus】

- ◎Walk: 17min
- ◎Subway Nanboku Line (Get off at Kita 12-jo Station) + Walk: 3 min.