



ENGINEERING SCIENCE

ENGINEERING SCIENCE

Graduate School of Engineering Science
School of Engineering Science
Osaka University

2018



Welcome to the Graduate School of Engineering Science/ School of Engineering Science, Osaka University



Dean
Graduate School of
Engineering Science
School of Engineering Science,
Osaka University

Yutaka Hano

As we well know, science and engineering had developed tremendously during the 20th century, so that subsequently our lives have been changed and improved drastically. The extension and formalization of the fundamental disciplines and their applications to manufacturing played an important role of the developments. We believe that fusing together as well as developing the fundamental disciplines are necessary steps toward continuing to contribute to developments in the future. In addition, we incorporate the fruits from humanity and social science research with those from science and engineering in order to create true culture of the human being.

Since the foundation of the School of Engineering Science in 1961, we have continu-

ously created interdisciplinary research fields congruent with social needs and have made a great contribution to the academy and industry through research and education. Osaka University offers great and unique opportunities of education and research in the wide range of the fields of basic science, engineering science and manufacturing. In addition, our graduate school attempts to connect life science with the engineering science and further progress toward the integration of arts and science, which includes financial engineering and insurance, robotics and data science.

In the School of Engineering Science, which has ten courses, we have organized a characteristic curriculum for each course to provide a deep knowledge of basic subjects, such as mathematics, physics, chemis-



try, biology and informatics, as well as major important subjects related to the courses. Our education also develops wider viewpoints and flexibility. In the Graduate School, with eleven divisions, we provide higher-level professional education and perform fusion research with the different areas. We attempt to produce graduates who have a firm specialty and the potential to pursue research and development in areas beyond their acquired specialty.

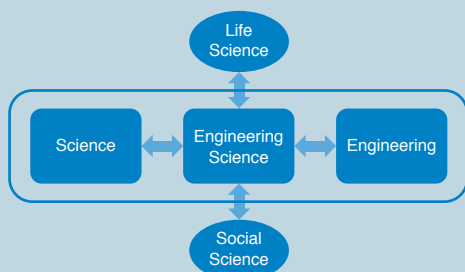


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ENGINEERING SCIENCE

The symbol for the Graduate School of Engineering Science/ School of Engineering Science Σ

Σ has the meaning of "summation". This symbol was selected because the ideal of the School of Engineering Science is represented by Σ (Science and Engineering), namely, the initial S for science (a Greek character), and the initial E of Engineering (E resembles the shape).

Graduate School of Engineering Science/School of Engineering Science

Graduate School of Engineering Science

In the modern world, progress in technology is founded on the achievements in science, and these advances must be supported by continually developing technology. Technology and science are thus tightly knit together. The necessity of reflecting on this situation in research and education, particularly at Osaka University which is located in a major industrial area, was emphasized by Dr. Kenjiro Shoda while he was president of the university. Plans were laid out by Dr. Shoda to establish a new school for this purpose, rather than to extend the School of Science and School of Engineering which had their own separate aims. Through his efforts and those of former university President Dr. Shiro Akabori, together with support from the industry in and outside of Osaka, the School of Engineering Science came into existence in April 1961, and the Graduate School of Engineering Science was opened in April 1964.

The School and Graduate School are unique in name and character in Japan. Their purpose is to develop scientists with a keen interest in practical technology and engineers with a firm grasp of the basic sciences, who may use their expertise to develop new technology.

In April 1997, the departments of the Graduate School of

Engineering Science were reorganized by restructuring the old departments into four departments: "Physical Science", "Chemical Science and Engineering", "Systems and Human Science", and "Informatics and Mathematical Science".

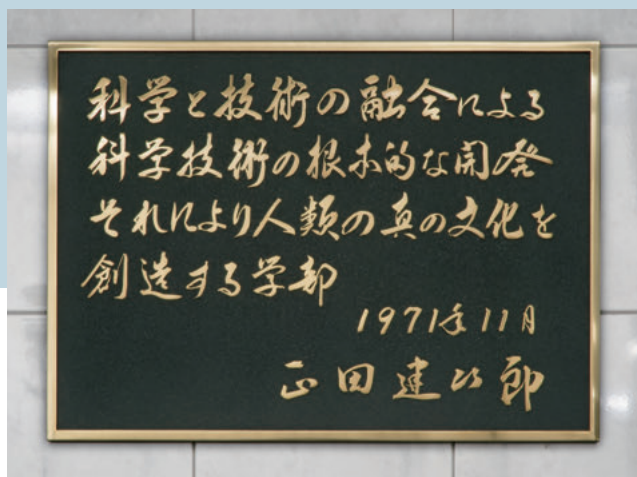
In April 2002, some groups in "Systems and Human Science" and "Informatics and Mathematical Science" moved to the newly founded graduate schools of Osaka University: Information Science and Technology, and Frontier Bioscience. They play important roles in education and research of these new areas.

In April 2003, Graduate School of Engineering Science was reorganized in order to create new research fields in the multi- and inter-disciplinary areas. The new Graduate School of Engineering Science has three departments: "Department of Materials Engineering Science" dealing with physical and chemical materials from a unified view point of materials science, "Department of Mechanical Science and Bioengineering" dealing with mechanical science and bioengineering from the view point of applied mechanics, and "Department of Systems Innovation" dealing with electronics, systems and mathematics from the view point of system creation.

School of Engineering Science

The School of Engineering Science was established in April 1961. In April 1997, the School of Engineering Science was reorganized to develop engineering science based on a new concept. The School of Engineering Science is characterized as an institution, which undertakes not only the exploration of novel aspects of engineering that directly reflect modern developments in basic sciences, but the cultivation of new types of engineers and scientists with a creative sense of technology.

There are four departments and each department has two or three courses: Electronics and Materials Physics (Division of Electronics, and Materials Physics), Chemical Science and Engineering (Division of Chemistry, and Chemical Engineering), Systems Science (Division of Mechanical Science, Systems Science and Applied Informatics, and Biophysical Engineering) and Information and Computer Sciences (Division of Computer Science, Software Science, and Mathematical Science).



The inscription shown left is a congratulatory address written by Dr. Shoda, the first dean of the Faculty of Engineering Science, in celebration of the tenth anniversary of the faculty. It reads :

Fundamentally developing scientific technology by a fusion of science and engineering will create the true culture of humanity.

November, 1971
Kenjiro SHODA



August 15, 1973

Historical Sketch

School/Graduate School of Engineering Science

Established in:

- 1961 — Department of Mechanical Engineering
Department of Chemistry
Department of Electrical Engineering
Common Chairs (Mathematical Science)
- 1962 — Department of Control Engineering
Department of Material Physics
- 1963 — Department of Chemical Engineering
- 1964 — Graduate School of Engineering Science
Mathematical Science Course
Physical Science Course
Chemical Science Course
- 1967 — Department of Biophysical Engineering
- 1970 — Department of Information and Computer Sciences
- 1992 — Department of Systems Engineering
(reorganized from Department of Control Engineering)
- 1996 — Department of Chemical Science and Engineering
(reorganized from Department of Chemistry and
Department of Chemical Engineering)
Department of Information and Computer Sciences
(reorganized from Department of Information and
Computer Science and Common Chairs (Mathematical Science))
Graduate School of Engineering Science was
reorganized as follows:

- Department of Chemical Science and Engineering
Department of Informatics and Mathematical Science
- 1997 — Department of Electronics and Materials Physics
(reorganized from Department of Electrical Engineering
and Department of Material Physics)
Department of Systems Science
(reorganized from Department of Mechanical Engineering,
Department of Systems Science and Department of
Biophysical Engineering)
Graduate School of Engineering Science was
reorganized as follows:
Department of Physical Science
Department of Systems and Human Science
- 2002 — Graduate School of Information Science and Technology
Graduate School of Frontier Bioscience
- 2003 — Graduate School was reorganized as follows
Department of Materials Engineering Science
Department of Mechanical Science and Bioengineering
Department of Systems Innovation
- 2014 — Center for Science and Technology
under Extreme Conditions
Center for Promotion of
Advanced Interdisciplinary Research
- 2016 — Center for Spintronics Research Network
- 2017 — Center for Industry-University Collaboration

Successive Deans

Shiro AKABORI (Apr. 1961 ~ Mar. 1962)
Kenjiro SHODA (Apr. 1962 ~ Mar. 1965)
Tokio UEMATSU (Apr. 1965 ~ Mar. 1969)
Junkichi ITOH (Apr. 1969 ~ Jul. 1969)
Yoshifumi SAKURAI (Jul. 1969 ~ Mar. 1972)
Takeo NAGAMIYA (Apr. 1972 ~ Mar. 1974)
Toshio MAKIMOTO (Apr. 1974 ~ Mar. 1978)
Shiichiro TERANISHI (Apr. 1978 ~ Mar. 1982)
Toshio FUJISAWA (Apr. 1982 ~ Mar. 1986)
Takashi KATAYAMA (Apr. 1986 ~ Mar. 1988)
Hidekazu FUKUOKA (Apr. 1988 ~ Mar. 1990)
Tadao KASAMI (Apr. 1990 ~ Mar. 1992)

Saburo TSUJI (Apr. 1992 ~ Mar. 1994)
Koichi HATADA (Apr. 1994 ~ Mar. 1996)
Takao YOSHIKAWA (Apr. 1996 ~ Mar. 1998)
Hideo MIYAHARA (Apr. 1998 ~ Mar. 2000)
Satoshi HIYAMIZU (Apr. 2000 ~ Mar. 2002)
Tadashi OKADA (Apr. 2002 ~ Mar. 2003)
Naoshi SUZUKI (Apr. 2003 ~ Sep. 2003)
Shogo NISHIDA (Oct. 2003 ~ Aug. 2007)
Yoshito TOBE (Aug. 2007 ~ Aug. 2011)
Yasuyuki OKAMURA (Aug. 2011 ~ Aug. 2013)
Genta KAWAHARA (Aug. 2013 ~ Mar. 2017)
Yutaka KANO (Apr. 2017 ~)

Graduate School of Engineering Science

Dept.	Division	Area
Materials Engineering Science	Materials Physics	Electron Correlation Physics
		Quantum Physics of Nanoscale Materials
	Chemistry	Synthetic Chemistry
		Molecular Organization Chemistry
	Chemical Engineering	Chemical Reaction Engineering
		Environment and Energy System
		Bioprocess Engineering
	Frontier Materials Science	Frontier Materials Dynamics of Nanoscale Materials
Mechanical Science and Bioengineering	Nonlinear Mechanics	Mechanics of Fluids and Thermo-fluids
		Mechanics of Solid Materials
	Mechanical Engineering	Propulsion Engineering
		Mechano-informatics
	Bioengineering	Biomechanical Engineering
		Biophysical Engineering Biomedical and Biophysical Measurements
Systems Innovation	Advanced Electronics and Optical Science	Solid State Electronics
		Advanced Quantum Devices and Electronics
		Optical Electronics
	Systems Science and Applied Informatics	System Theory
		Intelligent Systems
	Mathematical Science	Mathematical Modelling
		Statistical Science
	Mathematical Science for Social Systems	Mathematical and Statistical Finance Theoretical Systems Science

Facilities Attached to Schools and Research Institutes

Facilities Attached to Schools and Research Institutes	Division
Center for Science and Technology under Extreme Conditions	High-pressure Research Division
	Advanced Electronics Division
	International Collaboration Division
Center for Promotion of Advanced Interdisciplinary Research	Division of Quantum Optics
	Division of Emergent Materials and Functions
	Division of Collaborative Research with AIST
	Division of Collaborative Research with NICT
Center for Spintronics Research Network	Division of Spintronics Design and Development Research (Materials Design Facility)
	Division of Spintronics Research and Developments (Device Design Facility)
	Industry-University Exchange Promotion Division
Center for Industry-University Collaboration	Industry-University Collaborative Research Division
	Industry-University Collaborative Education Division

Multidisciplinary Research Laboratory System for Future Developments (ΣMRL)

Advisement office for International Students

School of Engineering Science

Dept.	Course
Electronics and Materials Physics	Electronics
	Materials Physics
Chemical Science and Engineering	Chemistry
	Chemical Engineering
Systems Science	Mechanical Science
	Intelligent Systems Science
	Biophysical Engineering
Information and Computer Sciences	Computer Science
	Software Science
	Mathematical Science

Related Facilities

Graduate School of Information Science and Technology

Graduate School of Frontier Bioscience

Research Center for Solar Energy Chemistry

Administration Staff

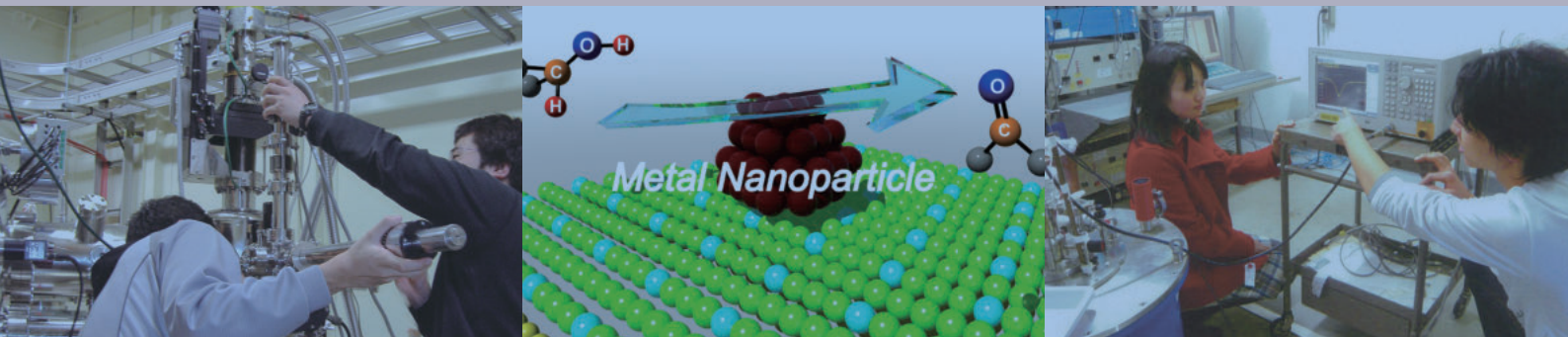
Head	Assistant Head	General Affairs Section
		Personnel Section
		Accounting Section
		Research Development Section
		Supplies Section
		Student Affairs Section
		Graduate Students Section
		Departmental Offices

Technical Staff

Technical Leader (Mechanical Electronic)	Technical Team (Mechanical)
	Technical Team (Electronics)
Technical Leader (Material Biophysical Chemical)	Technical Team (Materials and Biophysical)
	Technical Team (Chemical)

As of October 1st, 2017

Department of Materials Engineering Science



The Department of Materials Engineering Science aims at interdisciplinary researches and educations of skilled young scientists/engineers who can challenge new experimental and theoretical studies including developments and analyses of advanced new functional materials, new chemical processes, new technologies based on physics and chemistry. This department is composed of 4 divisions, namely, Divisions of Materials Physics, Chemistry, Chemical Engineering and Frontier Materials Science.

Division of Materials Physics

Division of Chemistry

Division of Chemical Engineering

Division of Frontier Materials Science

Collaboration Laboratories

Innovative quantum functions

Human Development and Environment

Division of Materials Physics

In this division, the cutting-edge studies of materials physics are performed in both experimental and theoretical fields. Along with the fundamental researches of the materials for advanced devices, studies of new materials and new phenomena, which are expected to contribute to the development of the frontier of physics, are widely carried out. The microscopic mechanisms of various interactions are investigated for a large class of materials in the bulk, surface, molecule, nanoscale and mesoscopic conditions, through new theoretical methods and models, and through the most advanced experimental methods such as synchrotron radiation spectroscopy and various probes under very low temperature. These results are also reflected in the development of new artificial materials of applicational interests. The characteristic feature of this area is the broad field of researches, which covers the creation of new materials and the development of new instruments and new methods, as well as the construction of new theories to clarify unknown phenomena and predict new observations. Furthermore, this feature is directly reflected on the education of new generations of researchers and engineers.

Area of Electron Correlation Physics

■ **Prof.** : Satoshi FUJIMOTO, Akira SEKIYAMA,
■ **Assoc.Prof.** : Takeshi MIZUSHIMA,
Takayuki KISS, Hidekazu MUKUDA
■ **Assis.Prof.** : Atsushi TSURUTA,
Hidenori FUJIWARA, Mitsuharu YASHIMA,

Theory Group for Strongly Correlated Systems: Basic research on materials science is developed putting emphasis on the strongly correlated electron systems of metallic compounds including f-, d- and p-electrons. In particular, by clarifying the mechanisms of unconventional behaviors of superconductivity and magnetism that those compounds exhibit, new physical concepts and mechanisms are tried to be found.

Experiment Group for Spectroscopy of Correlated Materials: In order to investigate detailed bulk electronic structures of strongly correlated electron systems, such studies as photoemission and soft-X ray absorption and their dichroisms, are performed. New techniques of cutting-edge bulk-sensitive photomission spectroscopy are also developed.

Experimental Research Group for Electron-correlated Matter Science: By means of microscopic NMR probe, the studies of correlated electrons matter and giant molecules are performed, focusing on the new phenomena such as high-temperature superconductivity, permanent magnetism, extremely slow dynamics in self-organized process of giant molecules and so on. Via these studies, a new approach is proposed for the synthesis of frontier materials.

Area of Quantum Physics of Nanoscale Materials

■ **Prof.** : Nobuyuki IMOTO, Yoshishige SUZUKI
■ **Assoc.Prof.** : Takashi YAMAMOTO,
Yusuke WAKABAYASHI, Shinji MIWA
■ **Assis.Prof.** : Rikizou IKUTA, Minori GOTO,
Hiromasa HANZAWA

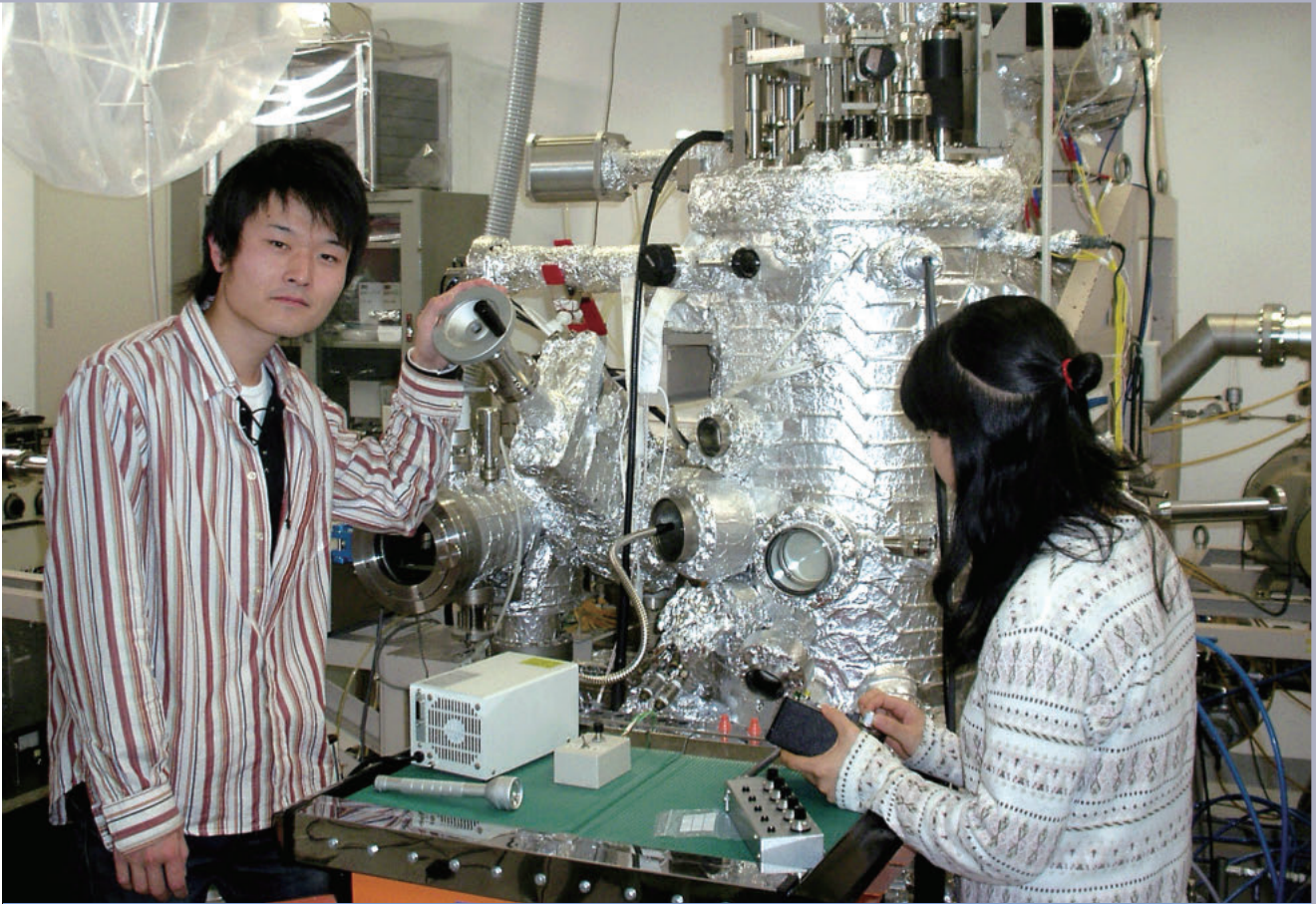
Quantum Information and Quantum Optics Group: Preparation, storage, processing, and transmission of quantum information are theoretically studied, which also leads to new proposals of quantum information processing. For this purpose, quantum optics is also investigated including light-matter interaction and entanglement control. Experimental demonstrations of such proposals are also performed.

Experimental Group for Exploration of Functional Materials: We investigate various electronic properties such as magnetism, electrical conductivity, lattice distortion, and dielectric property in correlated electron systems. By employing mutual interactions among the above-mentioned properties, we develop novel magnetoelectric functionality. For this purpose, we also perform materials design and synthesis.

Experiment Group for Nano-spintronics: Spin-transport and dynamics are investigated using nano-sized crystals, molecules and single spin-state in diamond. Based on fundamental understandings of nano-sized magnets, novel spintronics devices are created and characterized.

Collaborative Chairs/ Area of Quantum Materials Physics

■ **Prof.** : Kazuhiko MATSUMOTO (Add.),
Tamio OGUCHI (Add.)
■ **Assoc.Prof.** : Koichi INOUE (Add.),
Koun SHIRAI (Add.)
■ **Assis.Prof.** : Kunihiro YAMAUCHI (Add.),
Hiroyoshi MOMIDA (Add.), Yasushi KANAI (Add.),

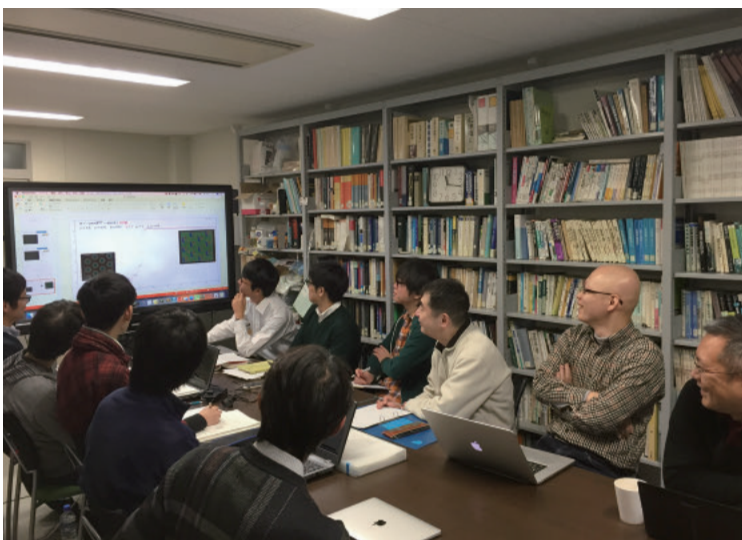


Students grow ultra-thin metallic films by molecular beam epitaxy.

Takao ONO(Add.)

Semiconductor Electronics Group: Semiconductor quantum structures including hetero-interfaces are fabricated, and their atomic and electronic structures are studied optically for applications to new devices based on quantum effects.

Condensed Matter Physics Group: First-Principles electronic structure calculations are carried out to predict the materials properties appearing in various condensed matter and surface systems. Developments of theoretical and computational approaches are also performed.



Condensed matter theory seminar

Study of ferroelectric materials in high-pressure and high-magnetic field conditions using superconducting magnet.

Division of Chemistry

Chemistry continues to be a fundamental field of science which is indispensable for the creation of materials with new functions and better performance, and is becoming more important with the advances of all fields of science and technology. Moreover, it will play a crucial role in the 21st century as a key technology to solve the important problems which confront contemporary life such as resources, environment, and energy. From these viewpoints, the Division of Chemistry is engaged in researches involving broad disciplines of chemical science and technology, including development of synthetic methods, creation of new materials with intelligent functions, and exploration of molecular organizations on surfaces as well as in biological systems in close collaboration with the Research Center for Solar Energy Chemistry. On the basis of the high level of research activities, the division is actively involved in graduate education with the focus on cultivating students' ability required not only in chemistry but also in the wide range of related fields.

Area of Synthetic Chemistry

Synthetic Organic Chemistry Group

- **Prof.** : Takeshi NAOTA
- **Assoc.Prof.** : Shuichi SUZUKI
- **Assis.Prof.** : Soichiro KAWAMORITA

This research group aims to provide a new chemistry for the synthesis and synthetic methodologies of the highly functionalized organic and organometallic molecules. The elucidation of selective organic transformations, studies on the chemical control of reactive intermediates, and creation of innovative organic functional materials are categories of our interests.

Physical Organic Chemistry Group

- **Prof.** : Ryo SHINTANI

Based on the development of new organic and catalytic reactions, our research group focuses on the synthesis and functionalization of novel organic and main group organometallic compounds that are difficult to access by existing methods. In particular, for the development of reactions, we aim to achieve precise controls through mechanistic studies. In addition to the synthesis of novel organic compounds, we also try to understand the relationship between molecular structures and their functions through detailed examination of their physical properties.

Synthetic Supramolecular Chemistry Group

- **Assoc.Prof.** : Keiji HIROSE

To create new functional organic materials of optic and electronic interest, we investigate the synthesis and functions of topologically novel π -electronic systems, giant π -systems of a nanometer size regime, and formation and function of two-dimensional patterns formed by self-assembly of π -conjugated molecules on surfaces based on molecular design. In addition, we study on the molecules which change their molecular information responding to the external impetus to develop molecular machines and switches.

Area of Molecular Organization Chemistry

Surface Chemistry Group

- **Prof.** : Ken-ichi FUKUI
- **Assoc.Prof.** : Akihito IMANISHI
- **Assis.Prof.** : Ichiro TANABE

Our research interests are focused on the functions of interfaces that convert and store the energy. The electric double layer (EDL) formed at electrolyte/electrode interfaces provides a field for electron transfer in batteries (electric energy) and reactions for catalysts (chemical energy). We aim to develop novel methodologies to obtain spatially and temporally resolved information of the EDL on the structure and the electronic states at the molecular scale to obtain the basic concepts which enable to develop efficient energy storage devices.

Biological Chemistry Group

- **Prof.** : Shigenori IWAI
- **Assoc.Prof.** : Junpei YAMAMOTO
- **Assis.Prof.** : Miyako SHIRAIISHI

To understand the underlying principles of life, we are studying recognition and catalytic reactions of biomolecules such as nucleic acids and proteins, from a chemical point of view. Our aim is the elucidation of substrate recognition and reaction mechanisms of enzymes using synthetic chemistry of nucleic acids, techniques in molecular biology, and analysis by spectroscopic measurements. One of our important targets is DNA damage (especially those formed by ultraviolet light or reactive oxygen species) and repair, and we hope to apply our basic research to medical science.

Collaborative Chairs/ Area of Solar Energy Chemistry

Research Center for Solar Energy Chemistry, Group of Solar Energy Conversion

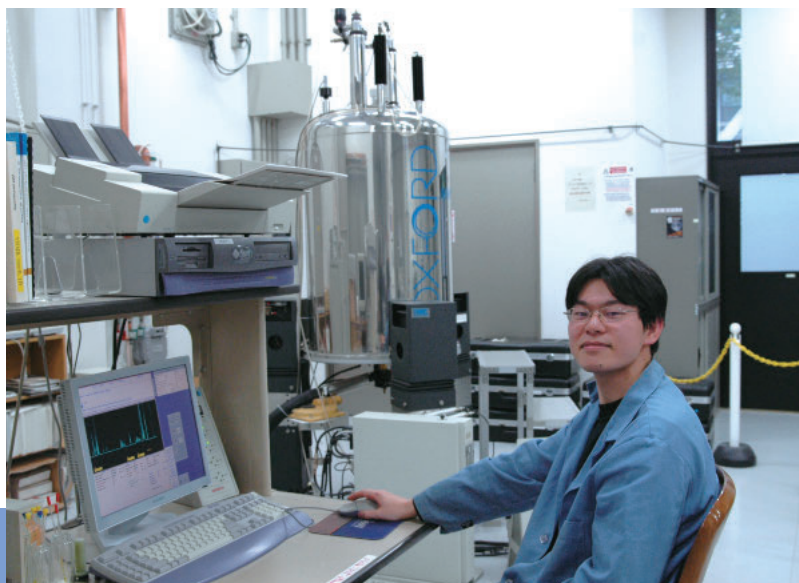
- **Prof.** : Shuji NAKANISHI (Add.)
- **Assis.Prof.** : Kazuhide KAMIYA (Add.)



Experiments in an organic chemistry laboratory

To resolve the global problem continuously dwindling energy resources and environmental problems, we are studying fundamentals and applications of materials and/or systems that will enable efficient utilization of solar energy, from the view point of electrochemistry, photochemistry, and catalytic material chemistry. Specifically, aiming to apply photoelectric conversion

devices and environmental photocatalysts, we are trying to develop novel photo-electrochemical energy conversion systems by the use of photo-functional materials and photosynthetic organisms.



Molecular structural study using a 500 MHz NMR spectrometer

Division of Chemical Engineering

The Division of Chemical Engineering covers the fundamental studies on elucidation of the phenomena in chemical conversion processes, which deal with material synthesis and separation, energy conversion and storage, and design and development of functional materials with high conversion efficiencies, as well as the application studies on the development of novel industrial processes including studies on solving energy and global environmental problems. The research projects are being conducted based on the latest information in chemistry, biochemistry, physics, mathematics, nanotechnology, biotechnology, computational science and quantum science, and the final results obtained are integrated as new knowledge and methodologies, targeting the development of a sustainable society with recycle and reuse system which is friendly to environment on Earth. As the core of the research group, Program for Leading Graduate Schools "Interactive Materials Science Cadet Program", intensive researches and high-level education are being conducted to bring up young scientists and/or engineers who pioneer a new era, while keeping in close collaborations with the Research Center for Solar Energy Chemistry.

Area of Chemical Reaction Engineering

■ **Prof.** : Norikazu NISHIYAMA,
Masayoshi NAKANO, Koichiro JITSUKAWA
■ **Assoc.Prof.** : Yoshiaki UCHIDA,
Yasutaka KITAGAWA, Tomoo MIZUGAKI
■ **Assis.Prof.** : Yuichiro HIROTA, Ryohei KISHI,
Zen MAENO

The **Nanoreaction Engineering Group** has the aim of developing new reaction and separation processes using nano-structured materials. This group focuses on (1) the synthesis of nanostructured materials such as nanoporous inorganic materials and liquid crystals via self-organization and self-assembly, (2) development of nano-scale reaction fields, and (3) development of membrane separation and adsorption processes, (4) development of molecular technology to design soft-matter, based on physical chemistry, reaction engineering and separation engineering. The **Quantum Chemical Engineering Group** has investigated quantum nonlinear optical and magnetic properties of molecular systems, quantum dynamics, and quantum transport phenomena of electrons and energy in supramolecular systems in view of their chemical structural dependence and interaction with environments by utilizing quantum chemistry and statistical physics. The group aims to construct novel concepts in theoretical chemistry and to develop guidelines for theoretical proactive design of quantum materials in the future electronics, photonics, spintronics, and biomaterials. The **High Performance Catalyst Group** designs nano-structured metal catalysts using inorganic crystal composites and structurally ordered organic polymers. The catalyst surface is characterized at the atomic level using the latest spectroscopic techniques. This group aims at the development of environmentally acceptable chemical reactions utilizing the above catalysts, which can provide clean and simple alternative methods to replace hazardous synthetic routes with low atom utilization.

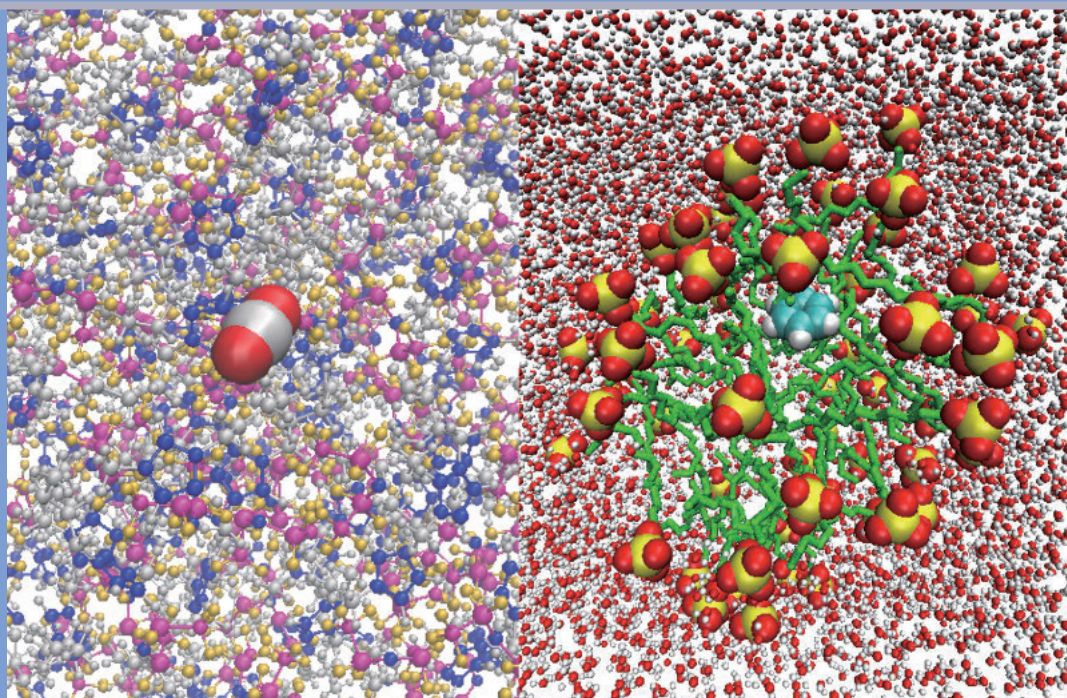
Area of Environment and Energy System

■ **Prof.** : Nobuyuki MATUBAYASI,
Yasunori OKANO
■ **Assoc.Prof.** : Kang KIM, Takato MITSUDOME
■ **Assoc.Prof.** : Takahiko BAN
■ **Assis.Prof.** : Ryosuke ISHIZUKA,
Atsushi SEKIMOTO, Takeshi SUGAHARA
The **Molecular-Aggregate Chemical Engineering Group** focuses on aggregates of molecules such as solution, micelle, lipid membrane, protein, and glass. Through development of statistical-mechanical theory of solutions and large-scale molecular simulation, analyses of intermolecular interactions and transport properties are conducted to reveal and apply the principle connecting the properties of individual molecules and the functions of the aggregates. The **Transport Phenomena Control Group** develops the smart control technology of transport phenomena encountered in various chemical engineering processes by using the external forces such as rotation, magnetic and electric fields. Furthermore, the phase interface phenomena related with the Marangoni convection along interface between different phases, the self-propelled liquid and the stress relaxation on solid-liquid interface are also investigated.

Area of Bioprocess Engineering

■ **Prof.** : Hiroshi UMAKOSHI, Masahito TAYA,
Shinji SAKAI
■ **Assoc.Prof.** : Yukihiro OKAMOTO
■ **Assis.Prof.** : Keishi SUGA, Yang LIU,
Masaki NAKAHATA
The **Bio-Inspired Chemical Engineering Group** aims to establish a new chemical engineering inspired by biological and bionic systems. This group focuses on the creation of a new separation engineering utilizing "molecular recognition" based on physical chemistry of "self-assembly system" (i.e. liposome membrane). This group exploits the self-assembly system as a "platform" to achieve the molecular recognition and is expanding it to the design and development of a variety of bio-inspired materials, such as artificial enzyme (nano-biomaterial), artificial organ (medical device), and nano-bioreactor (microfluidics). The **Bioreaction Engineering Group** has the aim of establishing a

Absorptions of carbon dioxide into ionic liquid and of hydrophobic solute into micelle



sophisticated bioreaction system, and it conducts research on such topics as understanding and control of microbial consortia and intracellular metabolisms for bio-production, reconstruction of three-dimensional tissues from individual cells, and design of biocidal materials and inactivation kinetics under heterogeneous systems.

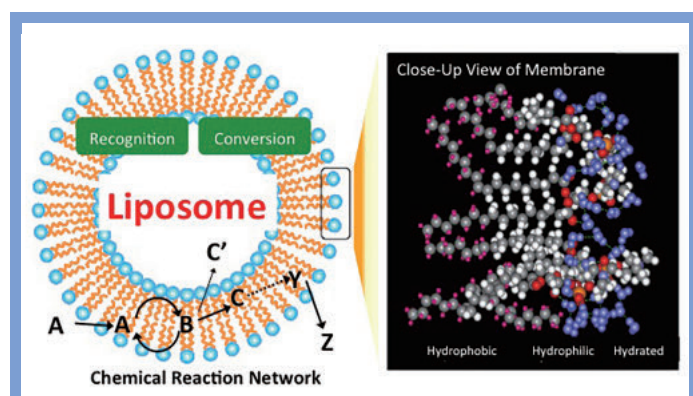
Collaborative Chairs/ Area of Solar Energy Chemistry

■ **Prof. :** Takayuki HIRAI (Add.)

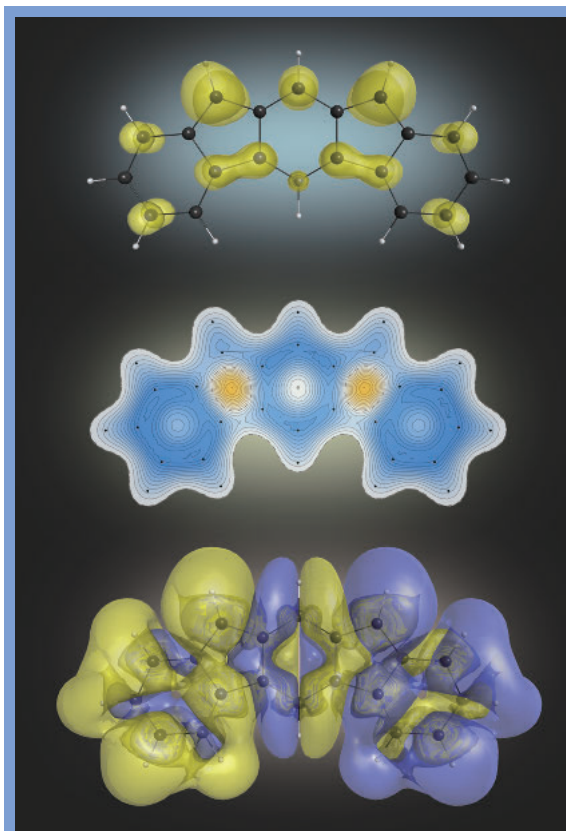
■ **Assoc.Prof. :** Yasuhiro SHIRAISHI (Add.)

The **Environmental Photochemical Engineering Group** has the aim of advancing the research that will resolve the problems concerning energy resources and environmental pollution through the use of solar energy. This group researches the revolutionary technologies that use photochemical and photocatalytic reactions towards the selective conversion of organic materials, development of fluorescent and colorimetric

chemosensors and probes for selective detection of hazardous ionic species and metal cations, as well as the development of novel nano-structured photofunctional materials.



Chemical Engineering Inspired by Bio-System.



Spatial Correlation of Open-Shell Character, Aromaticity, and Nonlinear Optical Property of Indeno[1,2,3-cd]fluorene

Division of Frontier Materials Science

In order to create the basic science and engineering in the twenty-first century, it is necessary to investigate the fabrication of frontier materials and their new functionality in combination with physics and chemistry, especially in the research field of nanoscale materials. In this Division, based on materials physics and molecular chemistry which have excellent theoretical and experimental frameworks, we not only investigate various kinds of electronic and optical properties of materials and their new phenomena but also fabricate new kinds of materials, thus providing active research and educational programs to graduate school students who will be able to open the frontier fields of multidisciplinary materials science and its applications as researchers and engineers of wide outlooks.

Area of Frontier Materials

■ **Prof.** : Hirokazu TADA, Kazushi MASHIMA, Hajime ISHIHARA

■ **Assoc.Prof.** : Ryo YAMADA, Hayato TSURUGI, Koichi KUSAKABE

■ **Assis.Prof.** : Tatsuhiko OHTO, Haruki NAGAE, Tomohiro YOKOYAMA

Molecular Electronics Research Group: We are studying electric properties of molecular-based and molecular-scale electronic devices. Our interest is focused on junction behavior at the interface between molecules and electrodes for better understanding of carrier injection and transport mechanisms in molecular systems. The well defined molecule-electrode interfaces are prepared and studied at molecular-level with newly designed equipments including scanning probe microscopes.

Organometallic Chemistry Group: Organometallic chemistry is transdisciplinary field between organic and inorganic chemistry. New organometallic compounds of transition metals have a rich chemistry due to their unique chemical aspects including chemical bonding, coordination modes, structure, and reactivity. Based on these fundamental works, we have developed chiral metal catalysts for synthesizing important building blocks of pharmaceutical compounds along with functional organic compounds, and multinuclear metal cluster catalysts showing unique chemoselectivity.

Theoretical Group for Materials Science: Developing methods and computational programs for first-principles electronic structure calculations, studies utilizing the numerical simulations are being made on the theoretical design of new materials and devices with new functions and also on the search for and understanding of new physical phenomena under extreme conditions. As results of the studies, we have performed the design of nano-spintronics materials based on transition metal compounds, design of molecular electronics materials based on carbon materials and organic molecules, and prediction and understanding of structural phase transition, superconducting transition, magnetic transition, etc. induced by high pressure.

Theoretical Group for Photophysics in Nanomaterials: The nature of solids is determined by constituent atoms and crystal structures. However, if the size of solid is on the order of nanometers, materials show peculiar size- and shape-dependence as "different materials." Our research subjects are to investigate such peculiar properties of nanomaterials with light and to realize novel properties of light and

optical devices with new functionalities by nanomaterials. Further, we develop schemes for mechanically manipulating nanomaterials by light, which would be a new utilization of light in condensed matter physics and photochemistry. Creation of nanoscale structures of nanomaterials by the optical manipulation is our important aim.

Area of Dynamics of Nanoscale Materials

■ **Prof.** : Masaaki ASHIDA, Hiroshi MIYASAKA

■ **Assoc.Prof.** : Masaya NAGAI, Syoji ITO

■ **Assis.Prof.** : Yosuke MINOWA, Hikaru SOTOME

Experimental Research Group for Coherence of Nanoscale Materials: In view of light-matter interaction, we experimentally investigate the dynamics and coherence of excited electrons, phonons and spins in nanoscale and low-dimensional materials of semiconductors, insulators and metals, strongly correlated electron systems, etc., by means of various kinds of spectroscopic methods. For example, time-resolved spectroscopy, nonlinear optical spectroscopy, coherent spectroscopy, single-particle spectroscopy, cathodoluminescence spectroscopy, THz time-domain spectroscopy, etc. have all been used. Based on the above investigation, we also fabricate new optical functional nanostructured materials.

Experimental Research Group for Fluctuation Dynamics in Condensed Phase: The focus of our research is the ultrafast and space-resolved spectroscopic studies of photophysical and photochemical processes in solution and glasses. To elucidate the dynamics of the solute-solvent interactions and fluctuation regulating the reaction profiles in chemical as well as biological processes, solvation dynamics, energy relaxation, electron transfer, photo-dissociation, photochromism and photoconductivity are under investigation.

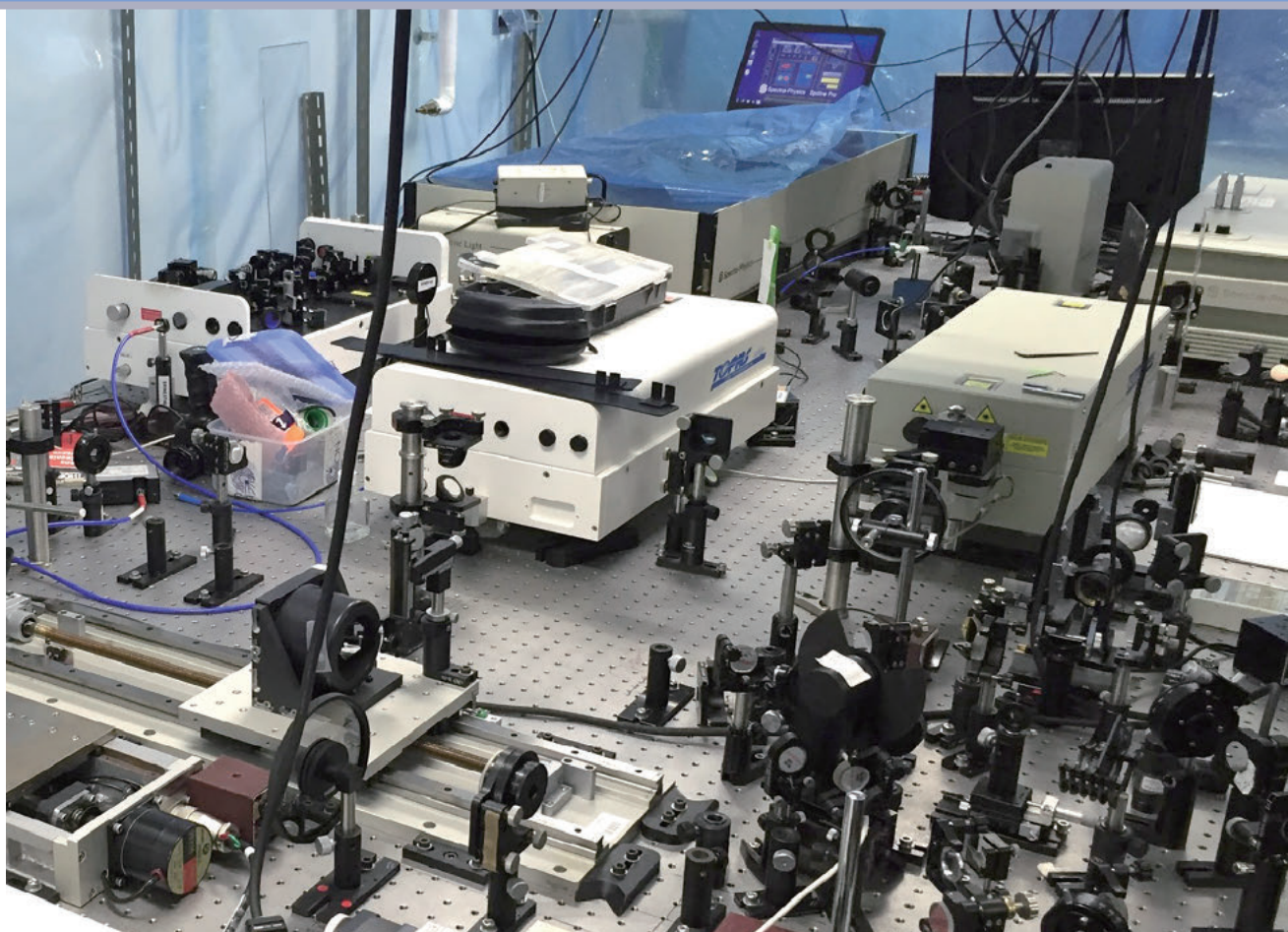
Area of Quantum Science in Extreme Conditions

■ **Prof.** : Katsuya SHIMIZU (Add.)

■ **Assoc.Prof.** : Tomoko KAGAYAMA (Add.)

■ **Assis.Prof.** : Yoshimi MITA (Add.)

Experimental Research Group for Material Science in Extreme Conditions: We performed the generation of combined extreme conditions (high pressure, low temperature, and strong magnetic field) and the measurements of physical-properties at these conditions. Educational research on the pressure-induced superconductivity under a low-temperature and high-pressure, the magnetic phase transi-



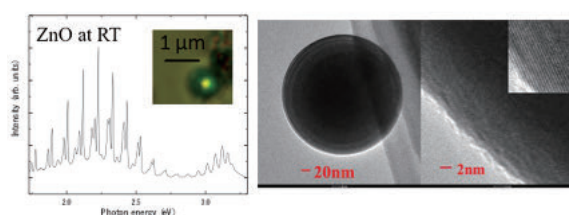
Femtosecond laser system with 15fs pulse duration

tion under a low-temperature and strong magnetic field, and the crystal structure analysis under high pressure are executed. There is a strong collaboration with the high-pressure division in the Center for Science and Technology under Extreme Conditions, which has succeeded the long tradition of synthesizing new materials and studying their properties by means of the apparatus producing pressures exceeding 1 Mbar.

Collaborative Chairs/ Area of Quantum Materials Engineering Science

■ **Prof.** : Hidekazu TANAKA (Add.)
 ■ **Assoc.Prof.** : Teruo KANKI (Add.)
 ■ **Assis.Prof.** : Azusa HATTORI (Add.),
 Mahito YAMAMOTO (Add.)

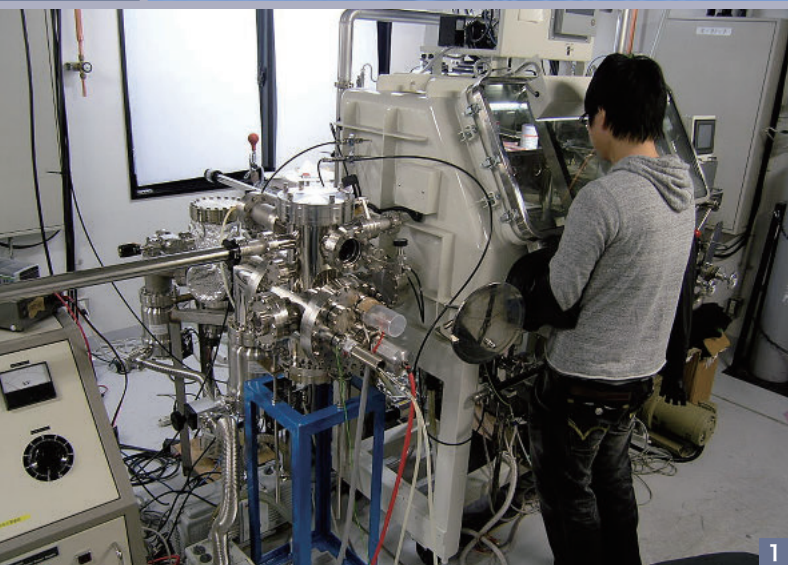
Experimental Research Group for Materials Engineering Science in Nano-structure: The purpose of this group is to create function harmonized nano-materials and nano-devices by using typical "Bottom-up Nanotechnology" of ultra thin film/artificial lattices, and "Top-down nanolithography" techniques toward new functional oxide nano-electronics based on strongly correlated oxides.



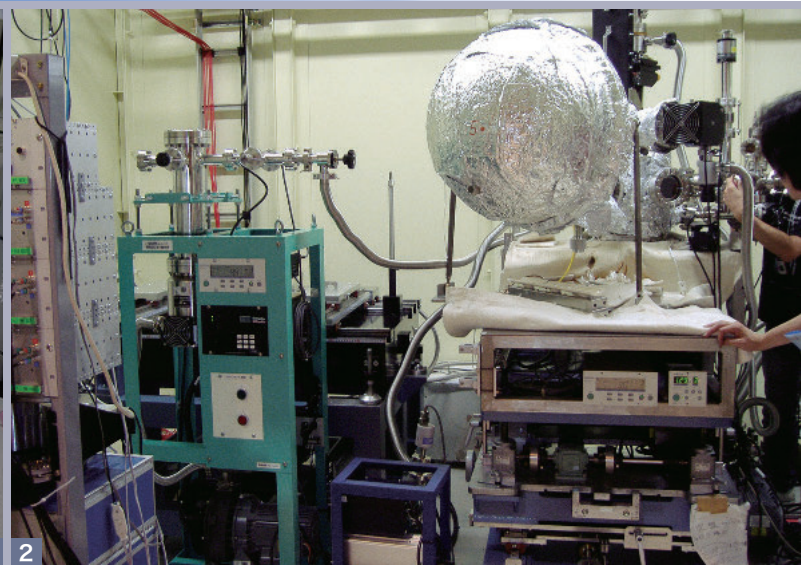
Fabrication of semiconductor single-crystalline microspheres with high sphericity by laser ablation in superfluid helium
 White light lasing and transmission electron microscope images with lattice fringes



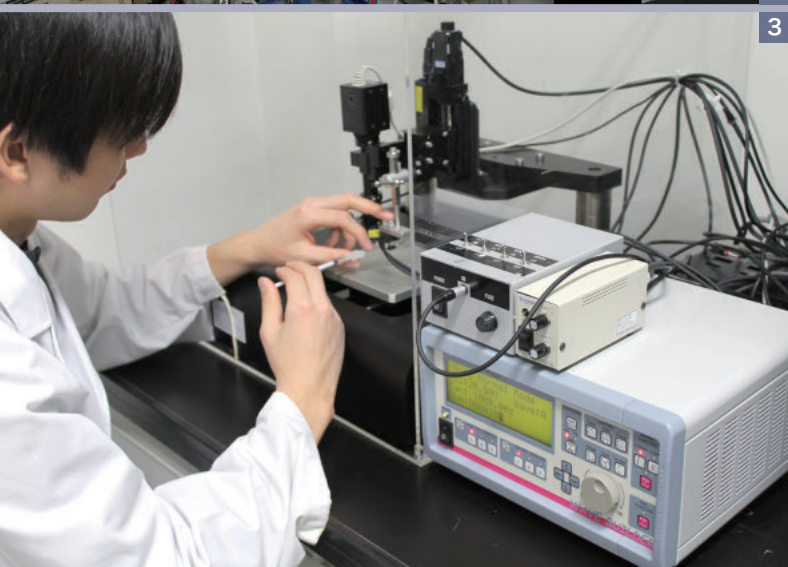
The glovebox to prepare organic devices



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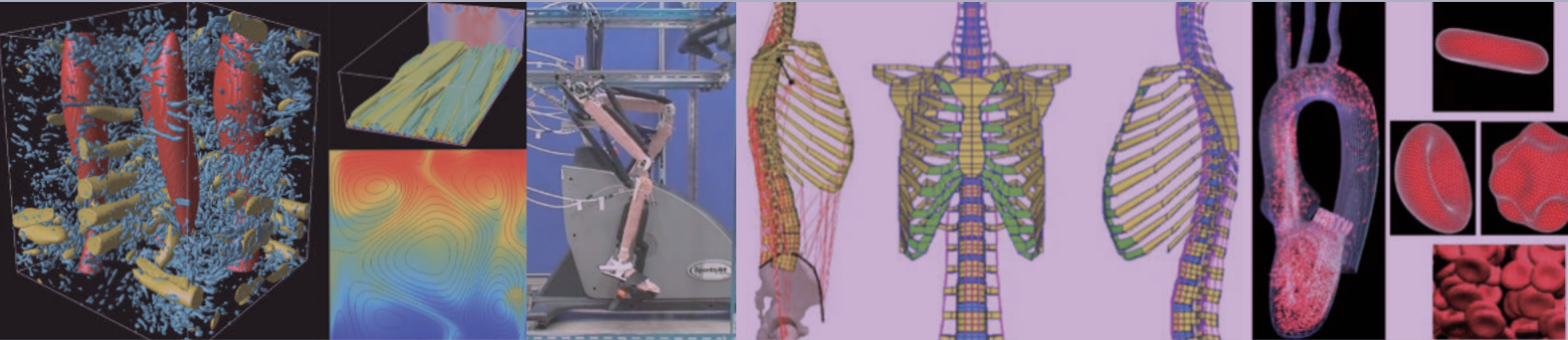
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4

- 1 Preparation of organic devices
- 2 Apparatus for high-resolution hard x-ray excited photoemission spectroscopy
- 3 Bio-printing system for fabricating 3D tissue constructs with human cells
- 4 A cluster simulator to analyze atomic structures in nano-meter space. Graphene functionalized by reactions at an oxide surface is displayed.

Department of Mechanical Science and Bioengineering



The Department of Mechanical Science and Bioengineering constitutes one department specializing a study of mechanical or dynamical "function" of man-made objects and/or nature including human bodies, along with the other two departments specializing "materials" and "systems." This Department organizes itself to endow students with various programs of education and research on mechanical science and bioengineering, and consists of three divisions: Division of Nonlinear Mechanics, Division of Mechanical Engineering and Division of Bioengineering. The programs at all three divisions emphasize the acquirement of fundamental knowledge and scientific skills with ethics. At the Division of Nonlinear Mechanics, discipline on various mechanics of fluids, solids, etc. is bestowed from a viewpoint of nonlinear mechanics. Environment/energy issues, functions of emerging materials, and mechanical behavior of structures are among the topics. At the Division of Mechanical Engineering, fundamental knowledge of mechanics are applied to developments of novel machines and reliable functions required for near-future space mission, robotics, intelligent material processing and manufacturing. At the Division of Bioengineering, biomechanical and biophysical studies are performed on the analyses of the structure and function of nano- to human-scaled living systems and their applications to biological and medical sciences, clinical medicine, assistive and rehabilitation technology, applied mechanics, photonics, and engineering.

Division of Nonlinear Mechanics

Division of Mechanical Engineering

Division of Bioengineering

Collaboration Laboratories

Design Bionics

Division of Nonlinear Mechanics

Research and education in the Division of Nonlinear Mechanics aim at establishing new fields of nonlinear mechanics from various mechanical phenomena and problems arising from man-made objects and/or nature, to create novel functions and machines, and at fostering students with such capabilities. Nonlinear mechanics uncover laws and principles underlying apparently complicated phenomena to describe the real world more precisely than the "linear mechanics." Specific examples range over chaos in turbulence, solitons in nonlinear waves, mesoscopic mechanics from micro- to nano-scales, localization of deformation, crack, fracture and so on. The Division consists of four groups specializing thermal engineering and science, fluid mechanics, fracture mechanics and solid mechanics with contributions to energy and environmental problems, new materials, and security against failure of mechanical systems.

Mechanics of Fluids and Thermo-fluids

Thermal Engineering and Science Group

■ **Prof.** : Genta KAWAHARA

■ **Assis.Prof.** : Hideshi ISHIDA, Masaki SHIMIZU

This group performs fundamental researches on thermo-fluid phenomena and their application to engineering problems. Research topics include elucidation and control of structures, dynamics and statistical properties of fully developed turbulent flows, prediction and control of subcritical transition to turbulence, elucidation of transfer mechanisms of heat and momentum in turbulent flows and its application to heat transfer enhancement and drag reduction, description and control of turbulence dynamics using unstable periodic motion, and chaotic behavior in natural convection fields.

Fluid Mechanics Group

■ **Prof.** : Susumu GOTO

■ **Assoc.Prof.** : Takao YOSHINAGA

■ **Assis.Prof.** : Yosuke WATANABE,

This group studies various nonlinear phenomena in fluid mechanics for their deep understanding and for their engineering applications by means of effective combination of mathematical analyses, laboratory experiments and numerical simulations. The current group studies the following specific topics: (1) transport and mixing in flows, (2) flows of complex fluids, (3) turbulent flows at high Reynolds numbers, (4) interfacial flows, (5) nonlinear waves and vibrations in fluid-structure systems, and so on.

Mechanics of Solid Materials

Strength of Structure and Materials Group

■ **Prof.** : Hidetoshi KOBAYASHI

■ **Assoc.Prof.** : Keitaro HORIKAWA

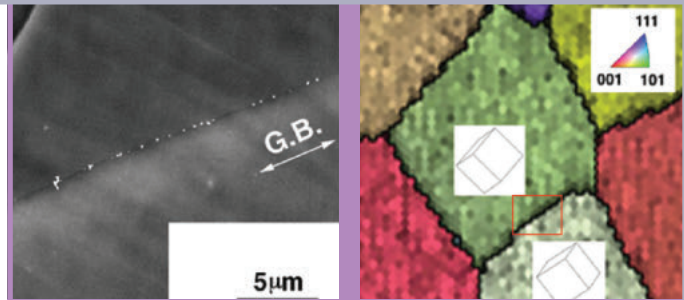
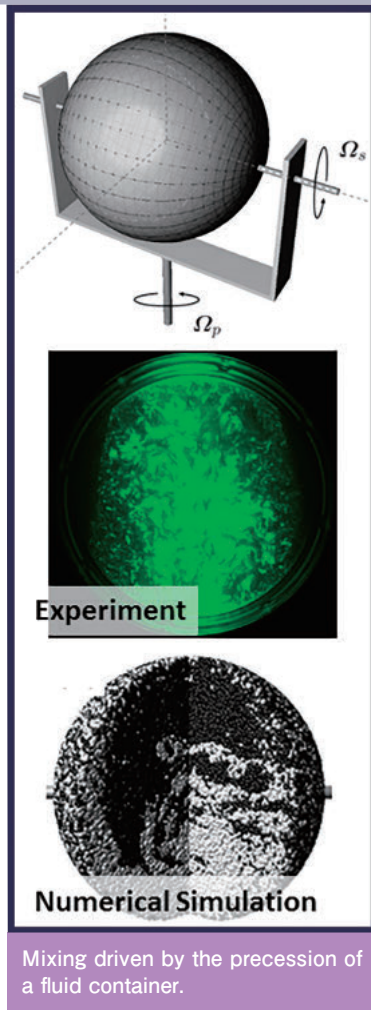
■ **Assis.Prof.** : Kenichi TANIGAKI

This group studies mechanical behavior of structure and structural materials focusing on the effects of impact loading and hydrogen. Specific topics are mechanical behavior of materials and light structure such as metal and polymer foams under impact loading, biomimetics for plant structure and materials, hydrogen embrittlement in aluminum alloys for high pressure hydrogen gas tank, elucidation of hydrogen diffusion in metallic materials by means of hydrogen microprint technique, development of hydrogen permeation membranes, electromagnetic phenomena of rocks during impact deformation and phenomena induced by high-speed penetration into granular medium and creation of new function in ordinary materials by using catastrophic impact.

Solid Mechanics Group

■ **Assis.Prof.** : Nobutomo NAKAMURA

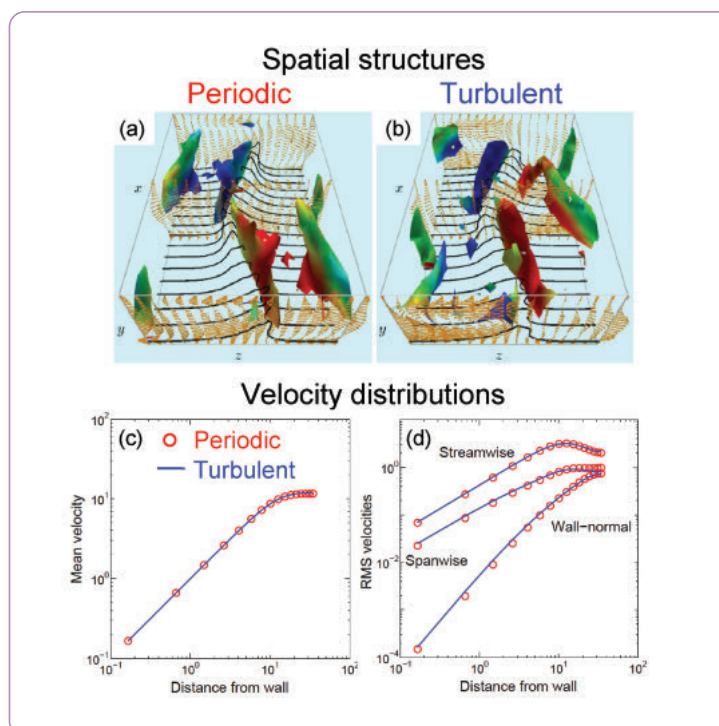
Resonance of sound and ultrasound is studied to evaluate functional and nano-scale materials, develop novel sensors using resonance of piezoelectric material, and investigate acoustical properties of glass. For example, we are working on development of the non-contacting sensor that detects the morphological change from discontinuous to continuous structure during film deposition and visualization of acoustic wave propagating in solid using a system consisting of micro glass beads. We are elucidating the physical acoustic phenomena for solids on the scale of 10^{-8} – 10^{-2} m from the mechanical viewpoint.



Visualization of hydrogen accumulation at the grain boundary in an aluminum alloy.



Originally developed tripod-needle transducers. A quartz specimen is measured.



Description of near-wall turbulence using unstable periodic motion.

Division of Mechanical Engineering

The goal of this area is to help progress "Engineering Science" by focusing on challenges requiring fundamental solutions, such as the highly reliable engine systems which play important roles in space development in the near future, the development of DNA devices for bionanotechnology, the intelligent information processing necessary for creating new artificial commodities, and the advanced material processing and manufacturing technologies.

Propulsion Engineering

Molecular Fluid Dynamics Group

- **Prof.** : Satoyuki KAWANO
- **Assoc.Prof.** : Kentaro DOI
- **Assis.Prof.** : Tetsuro TSUJI

Kawano laboratory carries out research on the motion of plasma flow, including electrons, ions and atoms. We are trying to develop the mathematical models and the computational scheme for advanced technology with industrial applications. We aim to make further scientific research and contribute directly to the industrial field through the developments of multi-scale/ multi-physics analysis of bio-nano fluid dynamics, numerical design for electronic devices and micro medical devices.

Fluids Engineering Research Group

- **Prof.** : Kazuyasu SUGIYAMA
- **Assoc.Prof.** : Hironori HORIGUCHI
- **Assis.Prof.** : Tomoaki WATAMURA

We are developing prediction and measurement methods for a variety of fluid flow problems associated with practical applications. We are experimentally, theoretically and numerically studying on the phenomena in view of the avoidance of the negative effect, the utilization of the passive/positive functions, and the optimized control. The research interests include the elucidation of multiphase/cavitating flow phenomena, the development of large-scale/multiscale analysis and data assimilation method, and the development of state-of-the-art fluid machineries.

Mechano-informatics

Robotics and Mechatronics Group

- **Prof.** : Fumio MIYAZAKI
- **Assoc.Prof.** : Hiroaki HIRAI
- **Assis.Prof.** : Mitsunori UEMURA

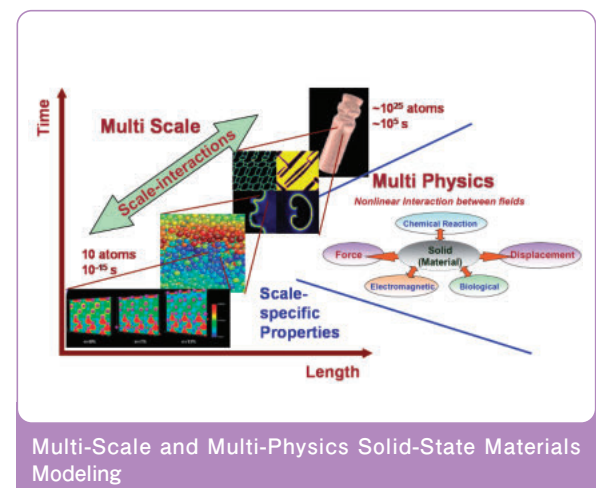
This group uses robots as a testbed for studying the functions of living organisms including humans with the ultimate aim of utilizing these functions in integrated systems. Research interests are on human-robot interface, analysis of human movements, hu-

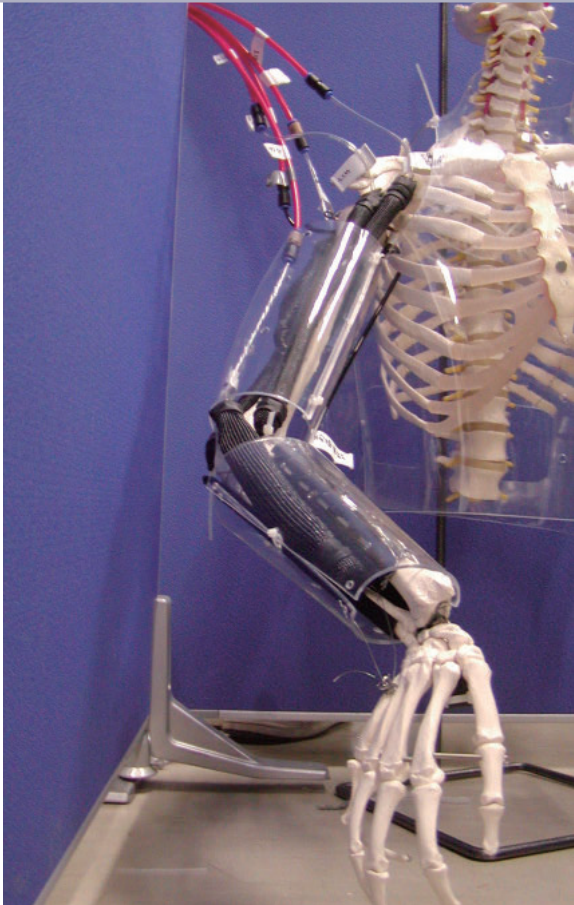
man-like musculoskeletal robots, human skills transfer to robots, robotic orthosis, assistance system for single-incision laparoscopic surgery.

Theoretical Solid Mechanics Group

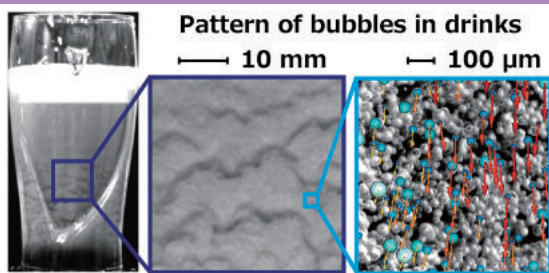
- **Prof.** : Shigenobu OGATA
- **Assoc.Prof.** : Hajime KIMIZUKA
- **Assis.Prof.** : Akio ISHII

We are developing predictive nonlinear multiscale and multiphysics theory and modeling for solid-state materials, which realizes fundamental understanding of materials behavior under various physical fields and predicting and designing new functional solid structures and materials. We are now focusing on 1) understanding physical, chemical, and mechanical properties of nano-scale devices using theoretical chemo-bio-electromechanics multiscale and multiphysics modeling, 2) predicting material properties under extreme pressure, speed and temperature conditions, 3) designing new functional nanocomposite polymers and bio-materials, and 4) controlling brittle materials processing.

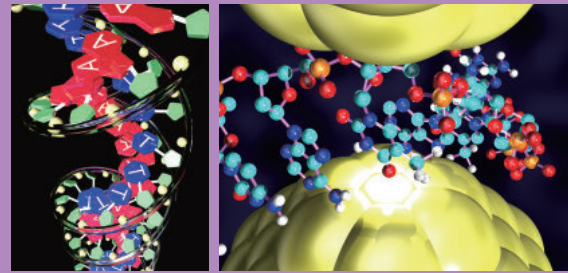




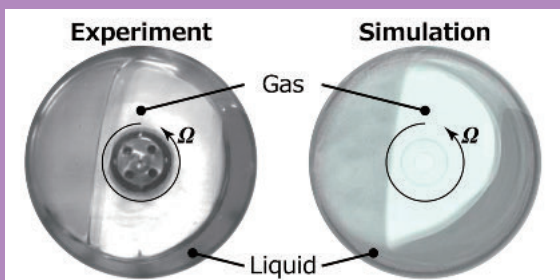
Musculoskeletal robots as a testbed for studying motor control by humans



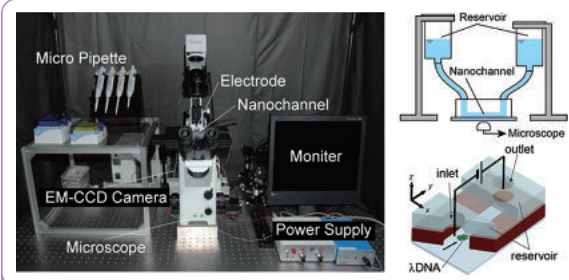
Flow pattern driven by bubbles in drinks and the transition mechanism



Schematic illustrations of double-stranded DNA (left) and base sequencing of single-stranded DNA by using nanogap electrodes (right).



Massively parallel computing of gas-liquid-solid three-phase flows



Experimental measurement system of molecular flow dynamics using micro/nano-channels (left) and schematics of the experiments (right).

Division of Bioengineering

We are mainly focusing on bioengineering analyses of the structure and function of living systems in nano- to macro-scopic multiple scales and their applications to biological and medical sciences, clinical medicine, applied mechanics, and engineering. Our major research and educational fields are as follows: structural analyses, biophysics, and biomechanics of biological materials and tissues; analyses of the principles and mechanisms of biological functions, and structure-function relationships in bio-machinary units; model analyses of living systems and systemic analyses of human body motion; biomedical and biophysical measurements, cellular and molecular bioengineering, and medical informatics; Big data analysis of medical and biological information, healthcare applications of wearable IoT devices; and developments of optimal design methods and techniques based on biomimetics.

Biomechanical Engineering

Biomechanics Group

■ **Prof.** : Shigeo WADA
■ **Assoc.Prof.** : Kenichiro KOSHIYAMA
■ **Assis.Prof.** : Naoki TAKEISHI

We are investigating the biomechanical structure and functions from cells to organisms by means of computational and experimental approaches. The current topics are: 1) Microbiomechanics of tissue and cells, 2) Multi-scale analysis of blood flow, 3) Rule-based simulation of vascular disease progression, 4) Advance in clinical diagnosis of lung and heart diseases by computational biomechanics.

Mechanical and Bioengineering Systems Group

■ **Prof.** : Masao TANAKA
■ **Assoc.Prof.** : Yo KOBAYASHI
■ **Assis.Prof.** : Tomohiro OTANI

The topics studied include: 1) Modeling and analysis for orthopedic and orthodontic biomechanics, 2) Coronary microcirculation and artificial red blood cells, 3) Human body motion analysis for design/evaluation of assistive rehabilitation devices, 4) Optimality analysis of bone tissue/structure and design optimization of adaptive structural system, 5) Assistant system for smart structure/mechanism design, and so on.

Human Mechano-Informatics Group

■ **Guest Prof.** : Yasukazu YOSHIDA

A study on the estimation of a stress state or a living state of a person by analyzing a long term record of a physiological response or the living behavior in everyday life is carried out. This study aims to enable the realization of a personal health care and a personal life support by detecting the change of individual living state in a daily life.

Biophysical Engineering

Bio-Dynamics Group

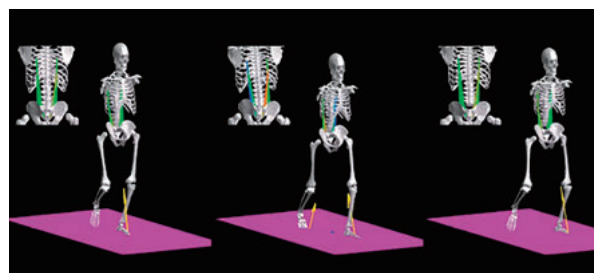
■ **Prof.** : Taishin NOMURA
■ **Assis.Prof.** : Yasuyuki SUZUKI,
Masanori SHIMONO, Hirohiko NIIOKA,
Seiichi TAGAWA

We aim at establishing a bridge between changes in state of living organisms and emergence of bio-functions. We focus on bio-dynamics associated with dynamic stability and their destabilization. Research topics include biosignal acquisition and analysis, mathematical modeling of bio-functions including human motor control (biped standing and locomotion), and development of an open-platform for physiome. Medical applications are also addressed.

Biophysics and Data Science Group

■ **Prof.** : Ken KIYONO

The main research focus of our group is to develop methods to analyze biosignal and clinical big data from the viewpoint of mathematical physics and data science. In addition, through the real-time integration of biosignal information measured by wearable IoT devices, clinical big data and environmental information, we are developing healthcare cyber-physical systems to achieve effective health and safety managements.



Measuring human biped gait for understanding functions of erector spinae muscles using multi-link rigid body modeling

Biomedical and Biophysical Measurements

Molecular BioMeasurement Group

■ **Prof.** : Shinji DEGUCHI

■ **Assoc.Prof.** : Tsubasa MATSUI

■ **Assis.Prof.** : Shuichiro FUKUSHIMA

The research topics that we are investigating are: 1) Molecular and biophysical mechanisms underlying the cellular response and adaptation to physical environment, 2) biophysical properties of individual cells and protein complexes, 3) experimental and image-based visualization of intracellular forces that individual cells or cell clusters generate, 4) development of high-throughput screening systems to identify genes/drugs that regulate cellular mechanobiological functions, and 5) biomechanics of animal vocalization.

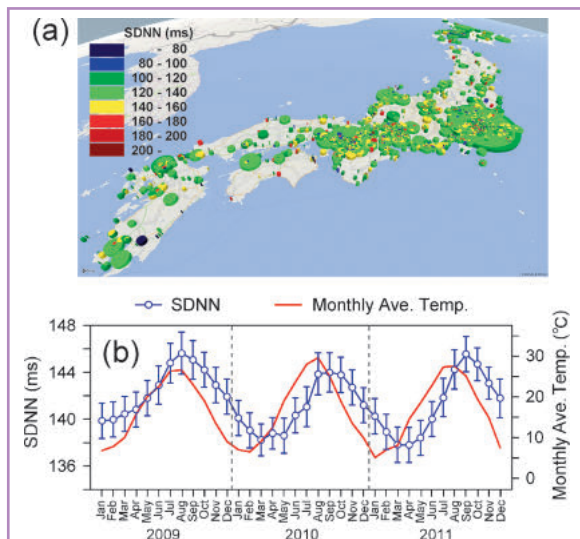
Bioimaging Group

■ **Prof.** : Osamu OSHIRO

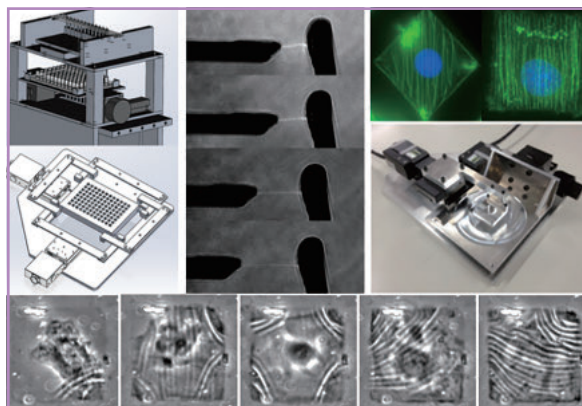
■ **Assoc.Prof.** : Yoshihiro KURODA

■ **Assis.Prof.** : Shunsuke YOSHIMOTO

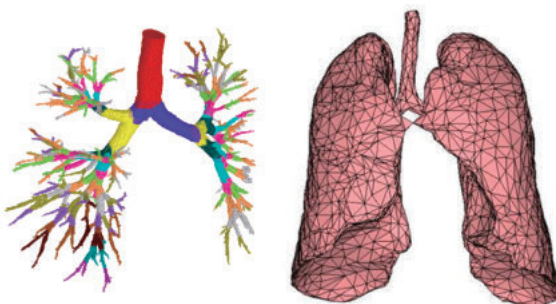
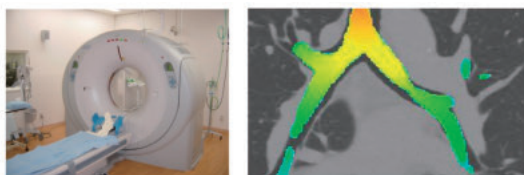
We will challenge to generate the transdisciplinary field based on biomedical engineering and ICT. The main researches focus on the active presentation of various biomedical organization, for example, DNA, protein, cell, tissue, organ and so on. Furthermore, we have been studying to construct the complex space with CG / VR technology, simulate biomedical phenomenon based on physical theory and share bioinformatics via Internet.



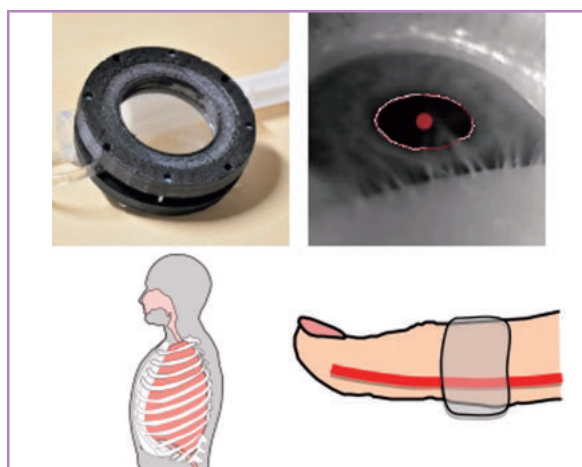
Large database analysis of heart rate variability and meteorological observation



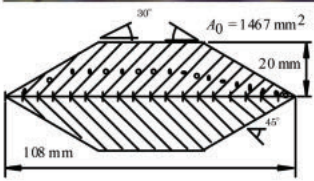
New technologies to measure molecular and biophysical properties of individual cells and protein complexes



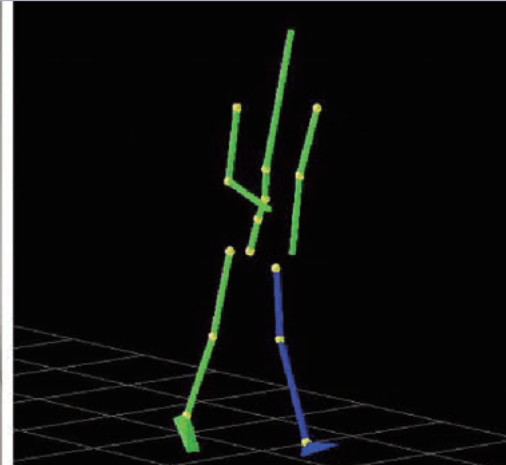
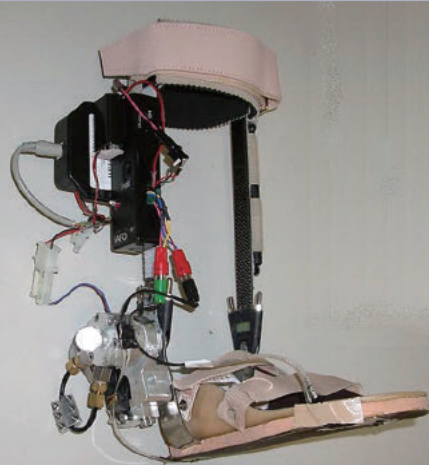
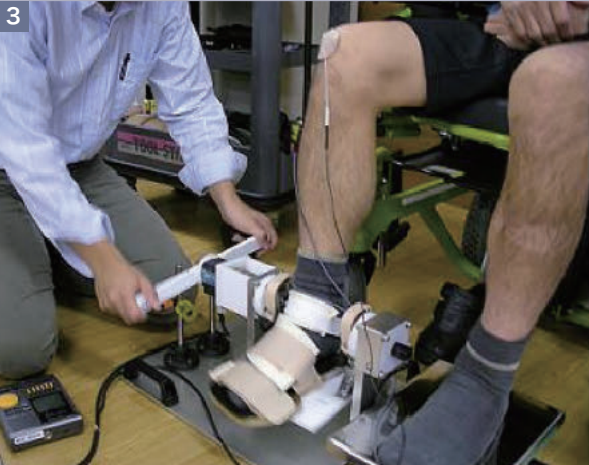
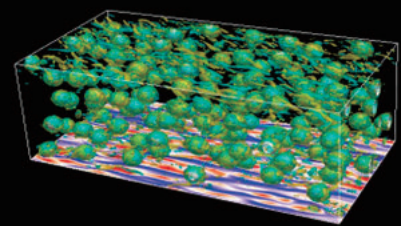
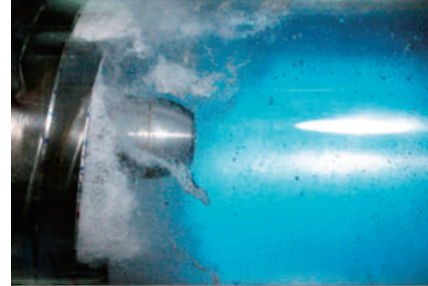
Computer aided-medicine of the lung respiration



Bioimaging



1 2



1 Evaluation of Mechanical Characteristics of Clever Structures in Plants

left-upper) Corrugated hornbeam leaf

left-lower) Paper model of a corrugated leaf

right-upper) Vein structure observed in Santa Cruz water lily leaf

right-lower) Santa Cruz water lily leaves covering water surface

2 Fluid flows including gas-liquid interface

upper) Experimental snapshot of cavitation in an inducer

lower) Simulated snapshot of bubbly turbulent flow in a channel

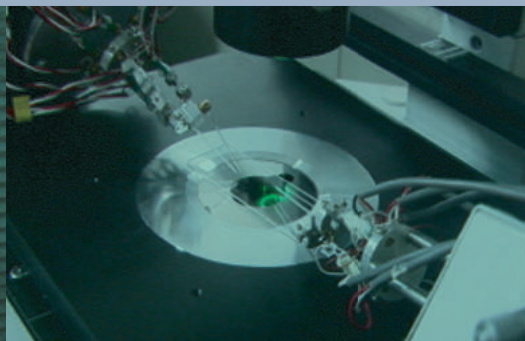
3 Rehabilitation engineering.

Left: Stiffness measurement of ankle joint.

Center: Prototype of iAFO (intelligent ankle foot orthosis).

Right: Walk model and simulation with prosthetic left limb.

Department of Systems Innovation



The Department of Systems Innovation aims at interdisciplinary education and research to train the skilled people who can play an important part in the progress of the current information society with the wide knowledge ranging from device engineering to systems integration. In this department, education and research covering a wide range from hardware technology to systems design and analysis, such as electronics, systems science and mathematical science, are carried out. This department is composed of the Division of Advanced Electronics and Optical Science, the Division of Systems Science and Applied Informatics, the Division of Mathematical Science, and the Division of Mathematical Sciences for Social Systems newly started as an interdisciplinary division.

The Division of Advanced Electronics and Optical Science is mainly devoted to develop novel electronics technology which serves as a base of the developing a high information society. In this division, education and research in advanced technology extending from nanoelectronics to eco-friendly electronics, such as novel solid state devices and processing, functional quantum devices and quantum information, optical and quantum electronics, are carried out.

The Division of Systems Science and Applied Informatics aims to obtain intelligence and high quality functions for rapidly growing and complicated systems. It focuses on the education and research of basic theories and their applications which offer tools for analysis and design of intelligent systems and complicated systems, where human beings play important roles, by integrating system theory, information processing, media, sensing, and robotics technologies.

The Division of Mathematical Science carries out training and research in order to understand practical phenomena which occur in the fields of natural science, social science, technology, medical science and so on. The methodologies are concocted by constructing mathematical models, analyzing them, diagnosing the models and reanalyzing them based on the recent development of computer hardware and software.

The Division of Mathematical Sciences for Social Systems is concerned mainly with research and education in advanced mathematical approaches to analyze and design complicated social systems, such as financial economics and networked society by integrating stochastic analysis, statistical inference and decision theory, systems theory, and operations research.

Division of Advanced Electronics and Optical Science

Division of Systems Science and Applied Informatics

Division of Mathematical Science

Division of Mathematical Science for Social Systems

Collaboration Laboratories

Advanced Sensor Electronics

Division of Advanced Electronics and Optical Science

The future prospects for society in the twenty first century are to construct a stable network of information and energy with high quality. This division is devoted firstly to the creation and innovation of new structures, new phenomena and new functions related to electronic and photonic devices, and the elucidation of physics of materials used in the devices. Next, advanced research and development of process technology and device design are being carried out widely. Moreover, the smart system, utilizing the developed devices, is created for the human interface. By education through these research, excellent researchers and technical experts supporting future science and civilization as well as fusion of science and technology are cultivated.

Area of Solid State Electronics

Nano-electronics Group

■ **Prof.** : Akira SAKAI

■ **Assoc.Prof.** : Tetsuya TOHEI

■ **Assis.Prof.** : Shotaro TAKEUCHI

The nanoelectronics group focuses on the research and education of science and technology associated with thin film and nano-structure growth of novel electronic and optoelectronic materials, atomic scale characterization of material properties, and nano-scale fabrication and substrate engineering for next generation wide-bandgap semiconductors.

Nanostructure Physics Group

■ **Prof.** : Yoshiaki NAKAMURA

■ **Assoc.Prof.** : Kiminori HATTORI

■ **Assis.Prof.** : Kentaro WATANABE,
Yasushi SOBAJIMA

The group designs and fabricates state-of-the-art nano-structural materials with novel physical properties using nanotechnology based on semiconductor physics, and quantum physics. For utilization and control of waste heat energy, the group focuses on thermoelectric power generation material research for green energy and nano-material development for thermal management. The group is also involved in leading-edge measurement method development.

Nano-physics Device Group

■ **Prof.** : Kohei HAMAYA

■ **Assoc.Prof.** : Takeshi KANASHIMA

■ **Assis.Prof.** : Shinya YAMADA

For developing ultra-low power consumption devices, we have studied spin-based electronics, i.e., spintronics. In particular, study of semiconductor spintronics is a main research target of our group. As recent research subjects, we focus on the technology based on crystal growth of spintronics-material thin films and on exploring novel functional physics based on the spintronics materials.

Area of Advanced Quantum Devices and Electronics

Advanced Quantum Device System Group

■ **Assoc.Prof.** : Hideo AKABA

■ **Assis.Prof.** : Yuji MIYATO

Research and development of quantum sensing technologies such as high sensitive magnetic sensing with superconducting quantum interference devices, material inspection with nuclear magnetic resonance or nuclear quadrupole resonance, and liquid scanning with near infrared absorption spectroscopy. (These technologies will be useful for various applications of non-destructive testing and stand-off sensing represented by baggage screening in security check.)

Advanced Quantum Information Device Group

■ **Prof.** : Masahiro KITAGAWA

■ **Assis.Prof.** : Akinori KAGAWA, Makoto NEGORO,
Naoki ICHIJO

The group is engaged in the pioneering research of quantum computers which may revolutionize information processing by taking full advantage of quantum mechanics. The group focuses on the research, development and education of quantum information devices for nuclear and/or electron spins in molecules and novel NMR / ESR methodology and devices.

Area of Optical Electronics

Microwave Photonics Group

■ **Prof.** : Atsushi SANADA

■ **Assoc.Prof.** : Hiroshi MURATA

■ **Assis.Prof.** : Hidehisa SHIOMI

The research group focuses on science and engineering of artificial metamaterials. Theory and applications for innovative materials with unusual properties that cannot be found in natural materials such as invisibility cloaks are explored in the microwave to optical frequency regions.

Information Photonics Group

■ **Prof.** : Tadao NAGATSUMA

■ **Assoc.Prof.** : Masayuki FUJITA

Microwaves and lightwaves have been widely used for mobile phones and optical fiber communications, respectively. The electromagnetic-wave regions located between these waves are referred to as millimeter waves and terahertz waves, which have remained undeveloped in this 21-st century. We aim at developing these new electromagnetic-wave regions by employing advanced electronics and photonics technologies to explore applications in future communications and sensing.

Quantum electronics Group

■ **Prof.** : Takashi MUKAIYAMA

■ **Assoc.Prof.** : Utako TANAKA

■ **Assis.Prof.** : Kenji TOYODA

The following subjects are studied in this group: (i) Trapping and laser cooling of ions, and high-resolution spectroscopy of trapped ions, with the aim of application to frequency standards of the next generation and quantum information processing. (ii) Development of light sources for laser cooling, especially those in the deep UV region.

Area of Advanced Electronics Under Extreme Conditions

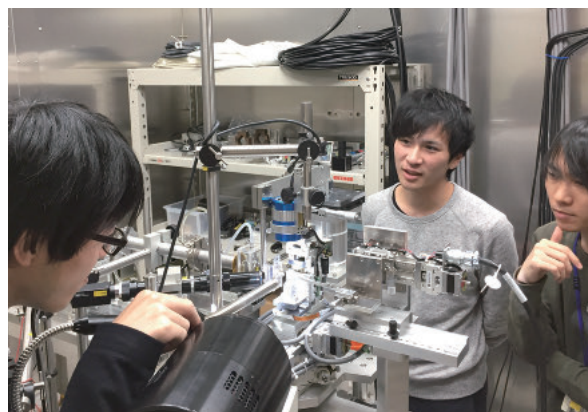
■ **Prof.** : Masayuki ABE (Add.)

■ **Assoc.Prof.** : Fujio WAKAYA (Add.)

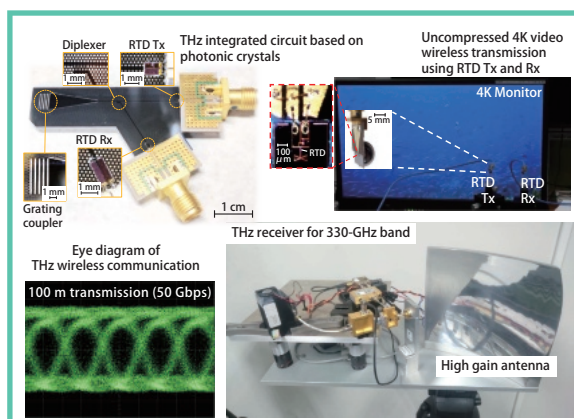
■ **Assis.Prof.** : Satoshi ABO (Add.),

Hayato YAMASHITA (Add.)

The group focuses on developing methods for observing nano-structure and single atoms using scanning probe, electron beam, ion beam, and laser beam. These methods are applied not only to material science but also to nano-biology field. The group aims at construction of new scientific principle in these fields.



Nanobeam X-ray diffraction experiment in SPring-8



Terahertz wireless communication systems and their integrated devices



triplet-DNP/NMR magnetic field cycling system.

Division of Systems Science and Applied Informatics

This division aims to obtain intelligence and high quality functions for rapidly grown and complicated systems. According to our educational policy, graduate students are qualified to obtain various aspects of knowledge on systems science and powerful computer literacy based on applied mathematics, technical English, a variety of liberal arts, and to master the abilities of developing unique ideas with their own observations, making persuasive presentation, and creating a new area of engineering science.

Area of System Theory

Systems science plays a fundamental role in modeling, analysis, design, control, optimization, and evaluation of large and complex systems that often arise in engineering and scientific problems. This area focuses on research and education on systems theory, control theory, and signal processing theory with applications to mechanical, electrical, electronic, or other systems to create flexible and intelligent systems based on a systems science approach.

Adaptive Robotics Group

- **Prof.** : Koh HOSODA
- **Assoc.Prof.** : Masahiro SHIMIZU
- **Assis.Prof.** : Shuhei IKEMOTO

This group studies adaptive behavior emerging from a bio-mimetic compliant body, on muscular-skeletal robots, bio-machine hybrid robots, and bio-inspired information processing. Concretely, it focuses robots with bio-mimetic muscular-skeleton system and reflexes, Bio-robot with living cells, and bio-inspired information processing utilizing noise.

Systems Analysis Group

- **Prof.** : Youji IIGUNI
- **Assoc.Prof.** : Arata KAWAMURA
- **Assis.Prof.** : Hiromi YOSHIDA

Our research group is interested in theory and practice of signals and systems, including smart signal processing algorithms with application to speech and image processing, and signal and image analysis with application to noise reduction, signal separation, image interpolation, image conversion and feature extraction.

Area of Intelligent Systems

The area focuses on research and education of sensing, pattern recognition, environment understanding, adaptive control, and coordinated motion to create intelligent systems like autonomous robots as well as human interface, communication, and media technologies to achieve the smooth interactions of human with another or a computer in both aspects of software and hardware.

Applied Robotics Group

- **Assoc.Prof.** : Yasushi MAE
- **Assis.Prof.** : Masaru KOJIMA

Novel mechanisms and intelligent controls for smart robots and their applications are studied to achieve "Human and Earth Friendly Society, including dependable robotics, micro robotics applied in bio fields, humanoid, arm & leg integrated robot, human robot interaction, mental safety robotics, etc.

Intelligent Robotics Group

- **Prof.** : Hiroshi ISHIGURO
- **Assoc.Prof.** : Yuichiro YOSHIKAWA
- **Assis.Prof.** : Yoshihiro NAKATA

This group studies intelligent robots, humanoids, androids, intelligent visual recognition and pattern recognition. Concretely, it focuses on tele-operated and autonomous androids that have very humanlike appearance, field experiments of robots using sensor networks, and intelligence and sociality of robots.

Robotic Manipulation Group

- **Prof.** : Kensuke HARADA
- **Assis.Prof.** : Ixchel RAMIREZ

This group studies the robotic manipulation where a robotic manipulator dexterously manipulates an object grasped by the hand. From both academic/practical points of view, our research interest includes but not limited to motion planning, motion analysis, motion understanding and machine learning.

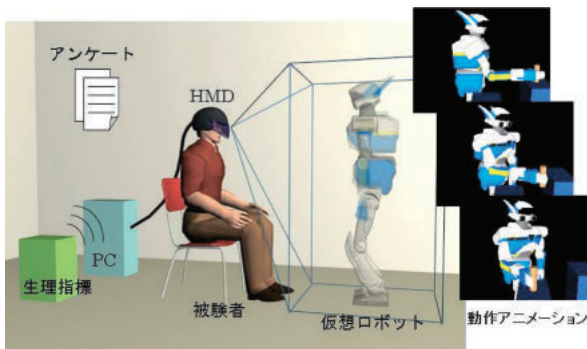
Pattern Measurement Group

■ **Prof.** : Kosuke SATO

■ **Assoc.Prof.** : Daisuke IWAI

■ **Assis.Prof.** : Haruka MATSUKURA

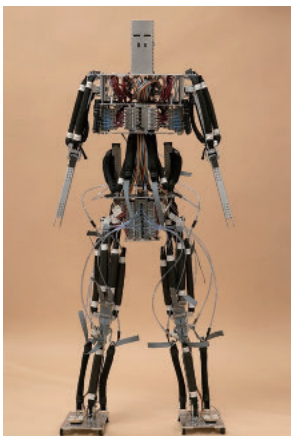
Research interests are intelligent sensing systems for pattern analysis and media/human understanding. Research activities include mixed and augmented reality, human-computer interaction, haptic interface, and 3D digital archives with 3D and human sensing.



Evaluation System of Human Sense of Security for Robots



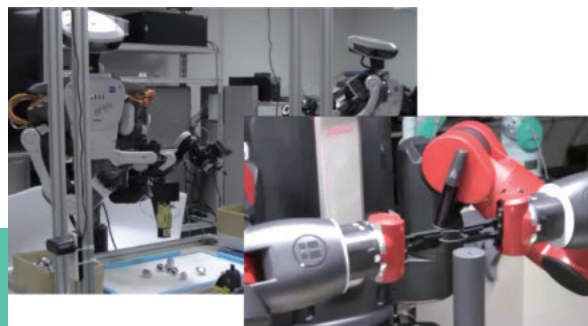
Integrated Limb Mechanism Robot ASTERISK.
The Integrated Limb Mechanism (ILM) concept deals with a dual arm-leg integrating the leg for locomotion and the arm for manipulation, while it enables a robot, for example, to operate flexibly in different work and situations, dual use requires that components are compact and mobile.



Humanoid Robot driven by Pneumatic Artificial Muscles



Interactive robots and androids



Grasp and manipulation of an object by dual-arm manipulators

Division of Mathematical Science

Mathematical Science is the science in which mathematical and statistical models are constructed, developed mathematically and diagnosed empirically in order to understand practical phenomena which occur in the fields of natural science, social science, technology, biology and so forth. For the purpose, one needs to utilize computers with advanced levels to make computer simulations, computer graphics and to develop algorithms, among others. This area consists of two large groups. One is a group of applied mathematics and the other a group of statistical science, each having two smaller subgroups. In this area, emphasis is placed on research and education of differential equations, mathematical physics, statistical analysis and data science.

Area of Mathematical Modelling

The Area of Mathematical Modelling comprised of the following two research groups is concerned with research and education of mathematical theory and applications on modelling phenomena occurred in several fields of natural science, social science and engineering.

Differential Equation Group

- **Prof.** : Takayuki KOBAYASHI
- **Assoc.Prof.** : Satoshi MASAKI
- **Assis.Prof.** : Hajime KOBAYASHI (Add.)

We study nonlinear partial differential equations appearing in the various fields of Mathematics. For example, we are focusing on the following topics:

- 1: Mathematical analysis on fluid dynamics and quantum mechanics.
- 2: Mathematical modeling of physical phenomena.

Applied Analysis Group

- **Assoc.Prof.** : Michinori ISHIWATA
- **Assis.Prof.** : Hajime KOBAYASHI (Add.)

This group is engaged in the following study and education.

1. Mathematical formulation of problems in natural science, engineering, economics, and medical science based on physical principle and phenomena.
2. Numerical simulation, numerical scheme, and mathematical analysis based on the theory of partial differential equations and nonlinear functional analysis.
3. Investigation of mathematical structure for self-interacting particles and biological functions such as the kinetic equation, system of chemotaxis, and tumour growth model.

Area of Statistical Science

The Area of Statistical Science comprised of the following two research groups is concerned with research and education on analyzing and modelling statistical data with errors, correlations and complex nonlinear structures.

Statistical Analysis Group

- **Prof.** : Joe SUZUKI
- **Assoc.Prof.** : Fuyuhiko TANAKA
- **Assis.Prof.** : Shinpei IMORI (Add.)

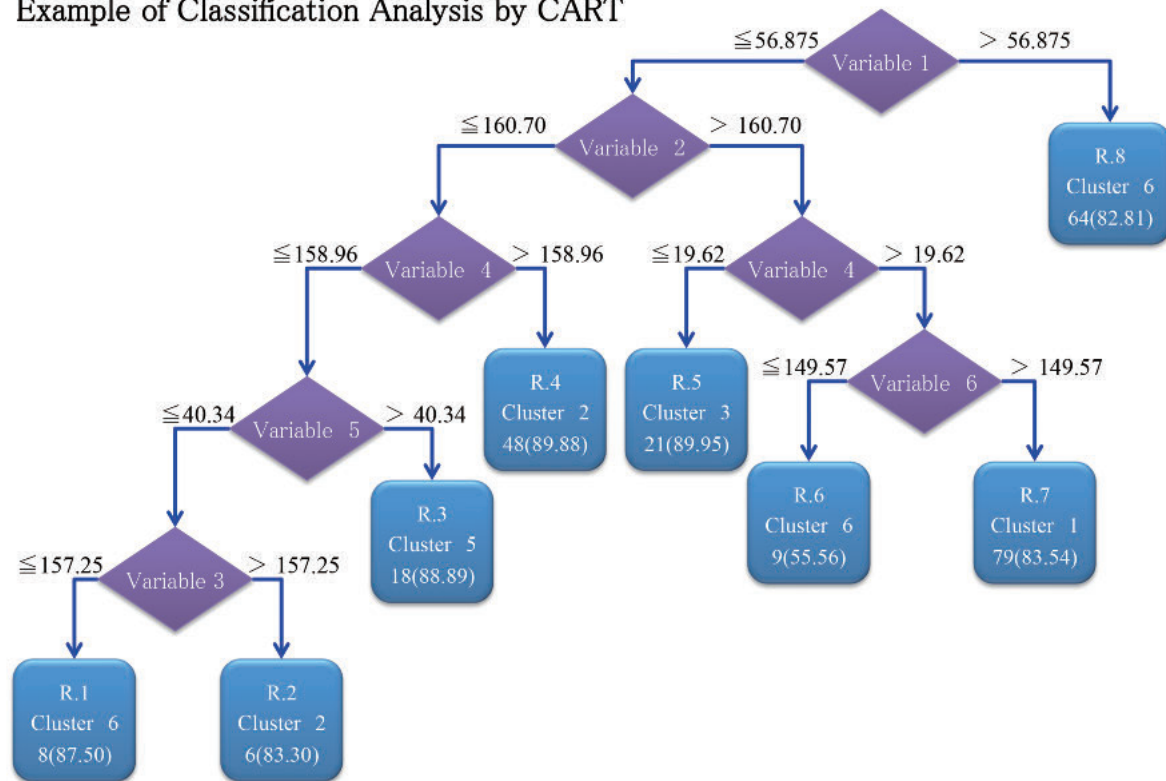
Statistical science, machine learning, and Bioinformatics are studied in this group. Statistical analysis of complex networks is also an important topic. You can easily find groups of good friends in social networks with one hundred people, but it is yet a big challenge to understand the structure of very big networks. We also work on statistical analysis of DNA sequences and gene expressions. For estimating the evolutionary tree of life from DNA sequences, in particular, a statistical method developed by our group has been used in labs worldwide.

Data Science Research Group

- **Prof.** : Yutaka KANO
- **Assoc.Prof.** : Etsuo HAMADA
- **Assis.Prof.** : Shinpei IMORI (Add.)

An important purpose of multivariate statistical analysis is to identify any relations among many variables based on statistical data. Multivariate analysis is often applied to analyze observational or correlational data, and gives a statistical basis for the analyses of high-dimensional data and big data, both of which have recently received considerable attention in many fields of empirical studies. In this research group, we apply mathematics and computers extensively to study structural equation modeling, graphical modeling, missing data analysis and statistical causal inference as well as model selection and statistical information. Our research includes methodological and application aspects.

Example of Classification Analysis by CART



Misclassification: 16.38%

An example of Data Analysis



Journal



Study Room of Graduate Students



Library

Division of Mathematical Science for Social Systems

The development of science and technology which cope with rationalization and internationalization of financial assets management could be done through research of financial engineering and mathematical finance. To analyze random and complex fluctuation according to time development and consider optimization under such random phenomena, we need the latest results of advanced mathematics concerning the theory of stochastic differential equations or statistical inference. Moreover, when we apply the theoretical results to actual technology for capital assets management, techniques of numerical analysis on a large scale at high speed are indispensable. On the other hand, due to the recent rapid technological advances in computer engineering, large scale networked systems and embedded systems with high quality functions have been developed. To analyze, design, and control such systems, extensions of the systems theory and optimization theory are required. Moreover, computational intelligence techniques are important for developing flexible intelligent systems. In an area of mathematical science for social systems, we achieve the education of competent persons who contribute to the development of such technology by means of advanced mathematical methods and also research development.

Area of Mathematical and Statistical Finance

We perform education and research on mathematical modelling of natural and social phenomena or nonlinear ones arising from financial economics and their analysis.

Research Group of Statistical Inference

- **Prof.** : Masayuki UCHIDA
- **Assoc. Prof.** : Kengo KAMATANI
- **Assis.Prof.** : Yoshikazu TERADA

In order to explicate the phenomena of economics and natural sciences, we study and educate the statistical inference and data analysis for stochastic differential equations and time series models by using the quasi-likelihood analysis from the viewpoint of both theory and practice. Monte Carlo statistical methods and statistical learning theory are also our main research topics.

Research Group of Mathematical Modeling in Finance

- **Prof.** : Jun SEKINE
- **Assoc.Prof.** : Hidehiro KAISE
- **Assis.Prof.** : Dai TAGUCHI

Researches and Education on stochastic models related with mathematical finance and stochastic control are main activities. Some keywords of our research activities are as follows: long-term optimal investment portfolio insurance, equilibrium processes, market liquidity, dynamic programming equations.

Research Group of Stochastic Analysis

- **Prof.** : Masaaki FUKASAWA
- **Assis.Prof.** : Nobuaki NAGANUMA

Stochastic Analysis is the calculus of random trajectories such as Brownian motions. It is an infinite dimensional analysis that includes the theory of differentiation and integration with respect to trajectories. Through studies of stochastic analysis and related fields, we develop frameworks for analyzing natural and social phenomena.

Area of Theoretical Systems Science

The Area of Theoretical Systems Science comprised of the following two research groups is concerned with research and education of systems theory and operations research, which offer key technology for analysis, design, and control of complicated systems interacting with human beings.

Research Group of Complex Systems

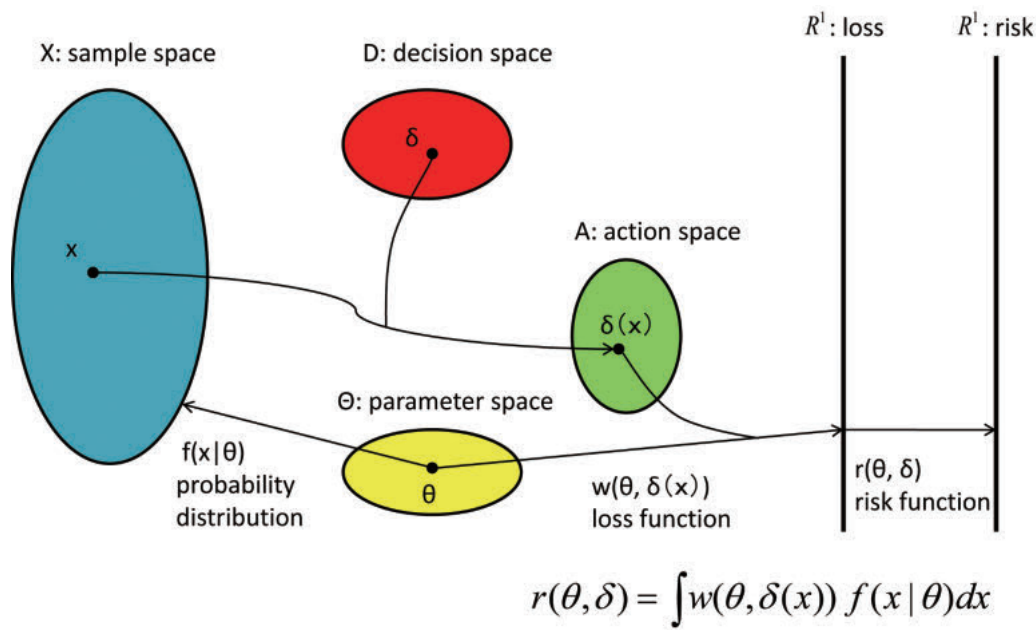
- **Prof.** : Toshimitsu USHIO
- **Assoc.Prof.** : Takafumi KANAZAWA
- **Assis.Prof.** : Takuya AZUMI

We carry out research on systems theory for complex systems and its applications. Our main research is concerned with analysis and control of hybrid/discrete event systems and nonlinear systems, application of machine learning to control engineering, control of multi-agent systems, control of selfish routing, and applications of evolutionary game theory in social systems.

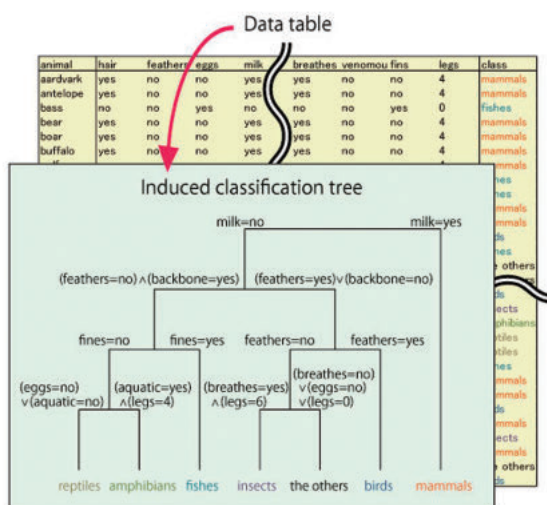
Research Group of Systems Optimization and Decision Making

- **Prof.** : Masahiro INUIGUCHI
- **Assoc.Prof.** : Tatsushi NISHI
- **Assis.Prof.** : Hirosato SEKI

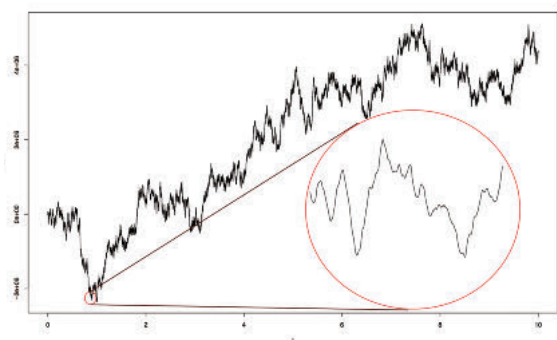
We carry out research on mathematical models and computational methods for systems optimization and decision making. Especially, we investigate the fundamental theories of decision making, games, mathematical programming, algorithms, scheduling theory, discrete optimization and soft computing (fuzzy systems, rough sets). Furthermore, we apply them to systems analysis, optimization, social systems, management of uncertainty and so on.



The relationship among the parameter space Θ , the sample space X , the action space A and the decision space D in statistical inference and decision problem.



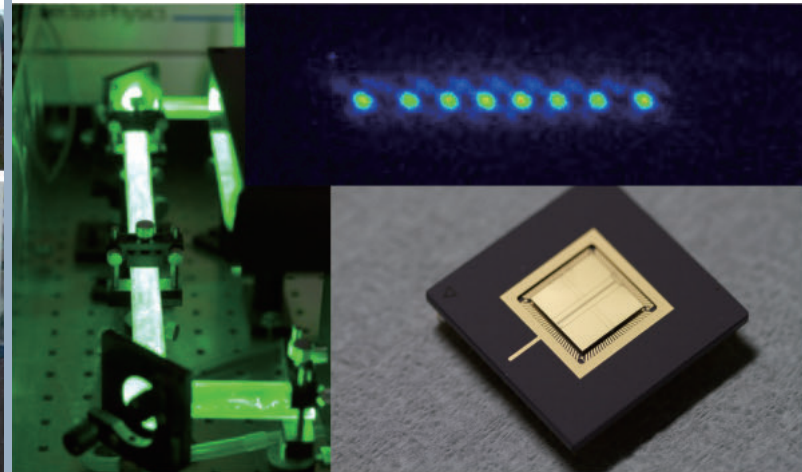
The result of clustering and rough set analysis of data table "zoo" obtained from UCI machine learning repository. The statements written on the right- and left-sides of the branch of the classification tree show the conditions of classifications.



Brownian dynamics approximating Langevin dynamics



1
3



2
4



- 1 Thin Film Silicon Solar Cell
- 2 Laser Cooling of Trapped Ions
- 3 3D Measurement of Step Pyramid, Saqqara, Egypt
- 4 A very human-like autonomous android robot

Center for Science and Technology under Extreme Conditions

The Center for Science and Technology under Extreme Conditions is creating extreme conditions by combining advanced science and engineering technologies, and aims, on the one hand, at exploring the properties of materials under such conditions, and on the other hand, at developing new materials using the results of the above-mentioned research. The Center is promoting the development of new materials science, while pioneering basic technology for the 21st century. The Center includes 3 divisions of “High-pressure Research” , “Advanced Electronics” , and “International Collaboration” . The High-pressure Research Division is trying to search for new phenomena and to clarify the mechanism by creating complex extreme conditions, i.e. ultra-high pressure, ultra-high magnetic fields, very low temperatures. The Advanced Electronics Division focuses on developing novel methods for observing nano-structure and single atoms using scanning probe, electron beam, ion beam, and laser beam. The International Collaboration division conducts the international collaborative research in above 2 divisions.

Director: Prof. Masahiro KITAGAWA (Add)

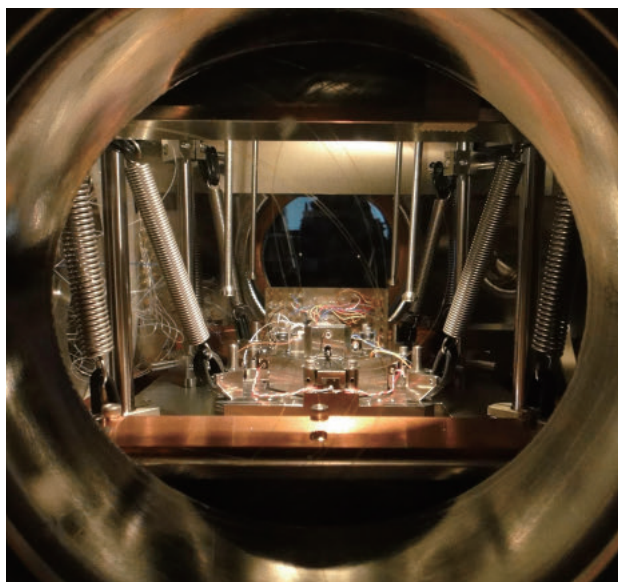
High-pressure Research Division

■ **Prof.** : Katsuya SHIMIZU
■ **Assoc. Prof.** : Tomoko KAGAYAMA,
Masafumi SAKATA
■ **Assis.Prof.** : Yoshimi MITA,
Takahiro ISHIKAWA, Mari EINAGA,
Gayan Prasad HETTIARACHCHI
■ **Technical Staff** : Yuki NAKAMOTO

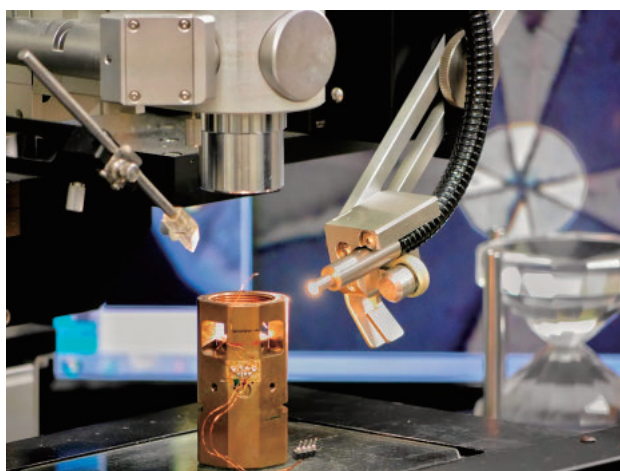
Advanced Electronics Division

■ **Prof.** : Masayuki ABE, Hiroshi TOKI
■ **Assoc. Prof.** : Fujio WAKAYA
■ **Assis.Prof.** : Satoshi ABO, Hayato YAMASHITA

International Collaboration Division



Head of noncontact atomic force microscope (NC-AFM)
developed in the Advanced Electronics Division.



Diamond anvil
cell (DAC)
generates very
high pressure
with two
diamonds.

Center for Promotion of Advanced Interdisciplinary Research

The Graduate School of Engineering Science has launched a new research center, called “Center for Promotion of Advanced Interdisciplinary Research (C-Pair)” in 2014, which aims to create innovative research areas through the promotion of collaborative research activities. C-Pair consists of 5 divisions as follows: Division of Quantum Optics, Division of Emergent Materials and Functions, Division of Collaborative Research with the large synchrotron radiation facility (SPRING-8) managed by RIKEN and the Japan Synchrotron Radiation Research Institute (JASRI), Division of Collaborative Research with National Institute of Advanced Industrial Science and Technology (AIST), and Division of Collaborative Research with National Institute of Information and Communications Technology (NICT).
Director: Prof. Hirokazu TADA (Add)

Division of Quantum Optics

■ **Prof.** : Hiroshi MIYASAKA (Add.),
Nobuyuki IMOTO (Add.)
■ **Assoc. Prof.** : Takashi YAMAMOTO (Add.),
Syoji ITO (Add.)
■ **Assis.Prof.** : Rikizou IKUTA (Add.)

Division of Emergent Materials and Functions

■ **Prof.** : Satoshi FUJIMOTO (Add.),
Fumio MIYAZAKI (Add.), Hirokazu TADA (Add.),
Norikazu NISHIYAMA (Add.),
Masaaki FUKASAWA (Add.), Takashi SUZUKI (Add.)
■ **Assoc. Prof.** : Tatsushi NISHI (Add.),
Hisekazu MUKUDA (Add.), Akihito IMANISHI (Add.)
■ **Assis.Prof.** : Masaru KOJIMA (Add.),
Keishi SUGA (Add.), Liu YANG (Add.),
Yuuji MIYATO (Add.), Tomohiro OTANI (Add.),
Shunpei NOBUSUE (Spec. Appt.),
PHAM Song Toan (Spec. Appt.)

Division of Collaborative Research with AIST

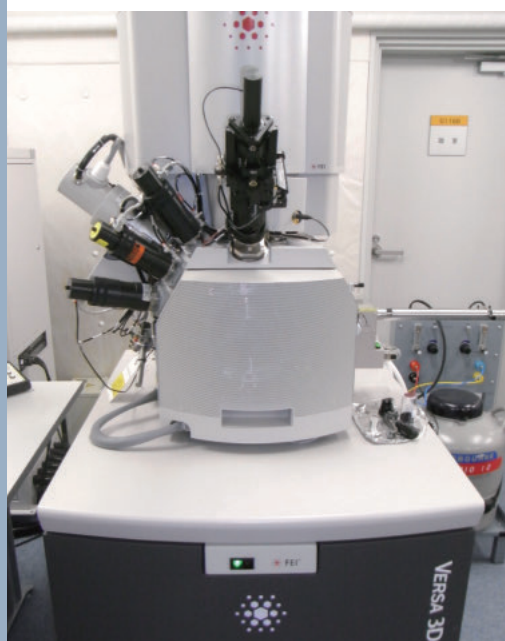
■ **Prof.** : Masayoshi NAKANO (Add.),
Yasukazu YOSHIDA (Guest Prof.),
Kensuke HARADA (Add.), Kazushi MASHIMA (Add.)
■ **Assoc. Prof.** : Keiji HIROSE (Add.)

Division of Collaborative Research with NICT

■ **Prof.** : Masaaki ASHIDA (Add.),
Tadao NAGATSUMA (Add.),
Iwao HOSAKO (Guest Prof.)
■ **Assoc. Prof.** : Masaya NAGAI (Add.),
Takashi YAMAMOTO (Add.), Utako TANAKA (Add.),
Kazuhiro HAYASAKA (Spec. Appt.),
Shukichi TANAKA (Guest Assoc.Prof)
■ **Assis. Prof.** : Kenji TOYODA (Add.)

Division of Collaborative Research with SPRING-8

■ **Prof.** : Akira SEKIYAMA (Add.),
Koichiro JITSUKAWA (Add.),
Kenji TAMASAKU (Guest Prof.),
Toyohiko KINOSHITA (Guest Prof.)
■ **Assoc. Prof.** : Takayuki KISS (Add.),
Yusuke WAKABAYASHI (Add.),
Kenichi KATO (Guest Assoc.Prof)



Focused Ion Beam (FIB) System is used for nanoscale fabrication of various materials with a 30 kV Ga⁺ ions beam.



Electron Beam (EB) Lithography System is used for lithography with a dimension of 5-10 nm with an electron beam accelerated up to 100 kV.

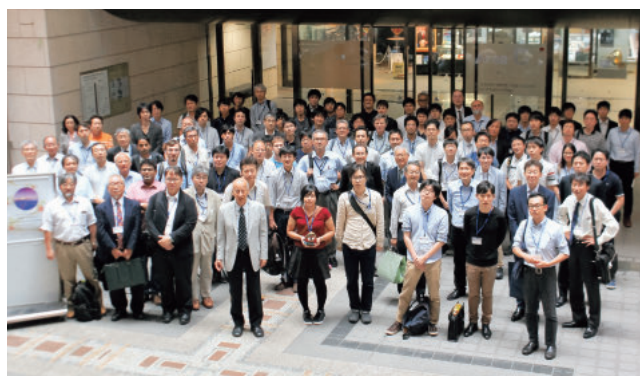
Center for Spintronics Research Network (CSRN)

Center for Spintronics Research Network (CSRN) in the Graduate School of Engineering Science of Osaka University was established in 2016, based on the acceptance of the proposal of the “Large-scale Scientific Research Projects–Roadmap 2014” in 2014 by Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. During this project, we established a CSRN in each of four base universities: The University of Tokyo, Tohoku University, Osaka University, and Keio University. These have allowed us to form a nationwide network connecting various research institutions in Japan. Through this network, we aim to promote collaborations among research groups and institutions, strengthen competitive power in research and industry for the development of technological innovations, and cultivate the next generation of young researchers and engineers. The four base universities have the following general responsibilities: The University of Tokyo focuses on spintronics materials and devices; Tohoku University focuses on spintronics devices and integration; Osaka University focuses on design of spintronics materials and devices; and Keio University focuses on quantum spintronics. CSRN in Osaka University have 10 Departments under the 2 Divisions of Division of Spintronics Design and Development Research (Materials Design Facility) and Division of Spintronics Research and Developments (Device Design Facility).

Director: Prof. Yoshishige Suzuki

Division of Spintronics Design and Development Research (Materials Design Facility)

■ **Prof. :** Tamio OGUCHI (Add.),
Yoshitada MORIKAWA (Add.), Tatsuki ODA (Guest Prof.),
Noriaki HAMADA (Specially Appointed Professor (Part time))
■ **Assoc. Prof. :** Kazunori SATO (Add.),
Teruo KANKI (Add.),
Koji NAKAMURA (Guest Assoc. Prof.),
Yoshio MIURA (Guest Assoc. Prof.),
Akira MASAGO (Specially Appointed Associate Professor (Full time))
■ **Assis.Prof. :** Hidetoshi KIZAKI (Add.),
Haruki KIYAMA (Add.)



Yamada Science Foundation
Junjiro Kanamori Memorial Inter-
national Symposium
– New Horizon of Magnetism –
September 27 - 29, 2017
Koshiba Hall, The University of
Tokyo, Tokyo, Japan

Kick-off Symposium for the Spintronics Research network of Japan (Spin-RNJ) and the Center for Spintronics Research network (CSRN) at the University of Tokyo, 2016.

Division of Spintronics Research and Developments (Device Design Facility)

■ **Prof. :** Kohei HAMAYA (Add.),
Kensuke KOBAYASHI (Add.),
Tsuyoshi KIMURA (Guest Prof.),
Masayoshi NAKANO (Add.), Hirokazu TADA (Add.),
Yoshishige SUZUKI,
Katsuhiro KITAGAWA (Add.),
Teruo ONO (Guest Prof.),
Norikazu MIZUOCHI (Guest Prof.),
Masashi SHIRAISHI (Guest Prof.)
■ **Assoc. Prof. :** Yusuke WAKABAYASHI (Add.),
Yasutaka KITAGAWA (Add.), Ryo YAMADA (Add.),
Kiminori HATSUTORI (Add.),
Yasuhiro NIIMI (Add.), Shinji MIWA,
Ikutaro HAMADA (Add.)
■ **Assis.Prof. :** Shinya YAMADA (Add.),
Tomonori ARAKAWA (Add.), Tatsuhiko KIDA (Add.),
Minori GOTO, Akinori KAGAWA (Add.),
Makoto NEGORO (Add.)



Center for Industry-University Collaboration

At the Graduate School of Engineering Science, in April 2003, we established an Industry-University Collaborative Office to promote the industry-university collaboration in order to revitalize the industry and contribute to the society by utilizing our research results and knowledge. Since then, we have actively carried out various industry-university collaborative activities, such as patenting support for research results of faculty members, practical application support by transferring research results/knowledge, implementation of research/technical consultation, promotion of human interactions through our industry-university exchange meetings, promotion of collaborative research and industry-university cooperative projects, and so on. Since April 2017, we have expanded this collaborative framework into the “Center for Industry-University Collaboration”. This center consists of: Industry-University Exchange Promotion Division, Industry-University Collaborative Research Division, and Industry-University Collaborative Education Division.

Director, Prof. Shigeo WADA (Add.)

Industry-University Exchange Promotion Division

■ **Prof. :** Akira SAKAI (Add.),
Hiroshi YAMACHIKA (Specially Appointed Prof.),
Shinzo UDA (Specially Appointed Prof.),
Kenji ARIMA (Guest Prof.)

Industry-University Collaborative Research Division

Frontier Intelligent System Collaborative Laboratory

■ **Specially Appointed Assoc. Prof. :**
Itaru KURAMOTO
■ **Visiting Researcher :** Jun BABA
■ **Collaborator :** Hiroshi ISHIGURO (Prof.)

Impulse Science Collaborative Laboratory

■ **Specially Appointed Assoc. Prof. :**
Naoto OKUYAMA
■ **Guest Prof. :** Akihisa TAKABE
■ **Visiting Researcher :** Toru KITAGUCHI,
Yuto MAKINO
■ **Collaborator :** Hidetoshi KOBAYASHI (Prof.),
Shigeo WADA (Prof.), Hiroshi UMAKOSHI (Prof.),
Katsuya SHIMIZU (Prof.), Masaaki ASHIDA (Prof.),
Koichi KUSAKABE (Assoc. Prof.),
Tomoko KAGAYAMA (Assoc. Prof.),
Kenichiro KOSHIYAMA (Assoc. Prof.),
Kenichi TANIGAKI (Assis.Prof.)

Biomedical Engineering & Health Informatics Laboratory

■ **Specially Appointed Prof. :**
Toru NAKAMURA
■ **Specially Appointed Researcher :** Li Li
■ **Guest Prof. :** Yoshiharu YAMAMOTO
■ **Collaborator :** Taishin NOMURA (Prof.)

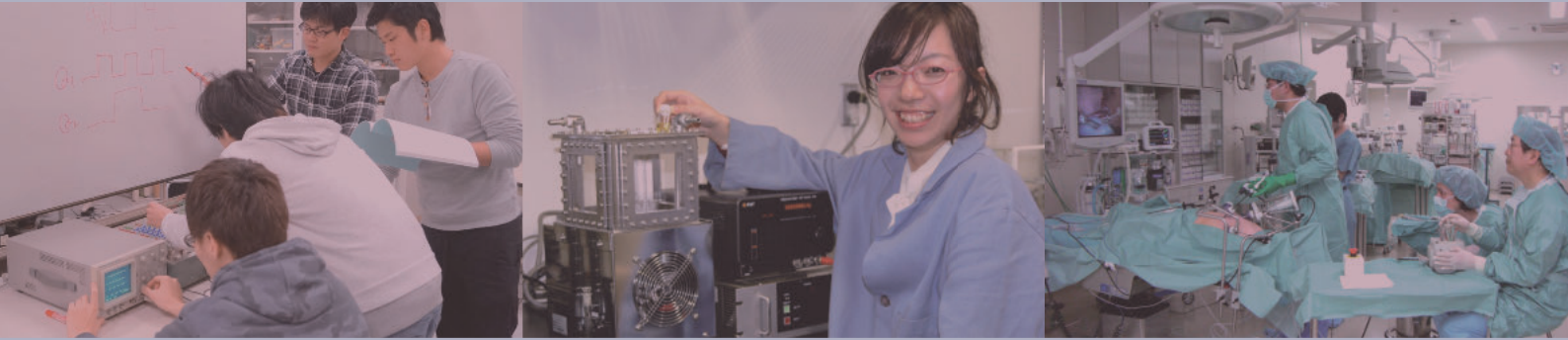
Industry-University Collaborative Education Division

■ **Prof. :** Koichiro JITSUKAWA (Add.),
Tadao NAGATSUMA (Add.),
Akira SEKIYAMA(Add.), Kenichi FUKUI (Add.),
Masaaki ASHIDA(Add.), Takashi SUZUKI (Add.)



Industry-University Exchange Meeting :
For the purpose of industrial application and information dissemination of our research results at the Graduate School of Engineering Science and promotion of exchanges with the industry and researchers, we hold industry-university exchange meetings about once a year.

School of Engineering Science



Department of Electronics and Materials Physics

Department of Chemical Science and Engineering

Department of Systems Science

Department of Information and Computer Sciences

Department of Electronics and Materials Physics

We are living in a resource-saving and intellectual information-oriented society with the basic respect for human life and dignity. In order to further develop such a society capable of efficiently controlling and co-owning a great deal of information, it becomes important to actualize the efficient production, storage, transmission and control of information and energy, and to supply, with severe selection, the material resources to maintain the society. These requirements would be effectively fulfilled by the advanced science and technology of electrons and light. It will become more and more necessary to investigate the new properties and useful functions of electrons and light, and to promote their materials development and the applications for devices and systems.

From the viewpoints mentioned above, we have combined "electrical engineering" and "materials physics" taking into account the human factors, and have organized the "Department of Electronics and Materials Physics", which covers a vast area from basic research to application. As for the education of students, a new curriculum has been organized to comply with the needs of the future society, with the aim of developing wider viewpoints and flexibility, as well as providing deeper knowledge. The freshmen all complete general classes for their basic major subjects, and the sophomores are divided into two sets of courses, i.e., the Division of Electronics and Division of Materials Physics.

Electronics Course

The Division of Electronics offers a curriculum which provides students with a firm foundation for more advanced study as well as for entering the professional field after graduation. Subjects are systematically and carefully selected in close collaboration with the material science course, and cover fundamentals of electrical and electronic circuits, electromagnetic field theory, material science for electronics, laser science and technology, and semiconductor electronics. Students also carry out a year length research project, joining each specialized laboratory in the electronics course.

■ **Prof.** : Akira SAKAI, Hiroaki OKAMOTO, Kohei HAMAYA, Yoshiaki NAKAMURA, Masahiro KITAGAWA, Atsushi SANADA, Tadao NAGATSUMA, Masatuki ABE

■ **Assoc.Prof.** : Kiminori HATTORI, Takeshi KANASHIMA, Hideo AKABA, Hiroshi MURATA, Masayuki FUJITA, Fujio WAKAYA

■ **Assoc.Prof.** : Utako TANAKA

■ **Assis.Prof.** : Shotaro TAKEUCHI, Kentaro WATANABE, Yasushi SOBAJIMA, Shinya YAMADA, Yuji MIYATO, Akinori KAGAWA, Makoto NEGORO, Kenji TOYODA, Hidehisa SHIOMI, Satoshi ABO, Hayato YAMASHITA

Materials Physics Course

In the field of materials physics, the experimental and theoretical studies are performed on the search for new phenomena, the creation of new materials and the development of new instruments and methods, in order to get a better understanding of nature and to contribute to the forefront of science and technology. In this Division, the educational program provides the students with comprehensive subjects including basics of materials physics and their

technological applications. The principles of modern physics on electricity, magnetism, light, heat, force and motion are learned in the first and second periods of the course. Experiments and exercises are included to get a deeper understanding of these subjects. Then such main subjects in modern physics as quantum mechanics, statistical physics, and condensed-matter physics are studied. In the next stage, subjects of applied materials physics, such as semiconductor physics, laser spectroscopy, magnetism, superconductivity and nano-science, are presented. In the final period, various cutting-edge problems on electrons, photons and their various mutual interactions will be studied as graduation subjects. In this way, the Division provides many young researchers and engineers of materials physics through the well-considered educational programs conducted by the world first-class researchers.

■ **Prof.** : Masaaki ASHIDA, Nobuyuki IMOTO, Hajime ISHIHARA, Yoshishige SUZUKI, Akira SEKIYAMA, Hirokazu TADA, Satoshi FUJIMOTO, Katsuya SHIMIZU, Tamio OGUCHI, Hidekazu TANAKA, Kazuhiko MATSUMOTO

■ **Assoc.Prof.** : Takayuki KISS, Koichi KUSAKABE, Masaya NAGAI, Shinji MIWA, Takeshi MIZUSHIMA, Hidekazu MUKUDA, Ryo YAMADA, Takashi YAMAMOTO, Yusuke WAKABAYASHI, Tomoko KAGAYAMA

■ **Assis.Prof.** : Rikizou IKUTA, Tatsuhiko OHTO, Atsushi TSURUTA, Hiromasa HANZAWA, Hidenori FUJIWARA, Yoshimi MITA, Yosuke MINOWA, Minori GOTO, Mitsuharu YASHIMA, Tomohiro YOKOYAMA

Department of Chemical Science and Engineering

Chemistry has been playing a key role in all fields of science and technology to create materials with new functions or enhanced performance and to solve such important problems as those concerning environment, resources, and energy. The Department of Chemical Science and Engineering is organized to cover the most important and rapidly growing fields in science and technology related to chemistry and chemical engineering, such as design and synthesis of new materials and construction and assessment of the systems for chemical conversion of materials and energy, in a variety of areas ranging from the molecular level to the living and global systems. In the first year, all students who take subjects for general education extend their knowledge of natural science and social science including foreign languages. After successfully completing the first year, students choose to proceed to the Course of Chemistry or the Course of Chemical Engineering. The second and third years provide essential grounding in chemical principles and chemical engineering principles. Formal lecture courses are supported by tutorial (exercise) work and laboratory work which are carried out in small groups. In the final year, all students must complete a thesis (research project), which is carried out under direct contact with academic and research staff.

Course of Chemistry

Chemistry continues to be a fundamental field of science, which is indispensable to create materials with new functions or better performance, and is getting more and more important with the advances in all fields of science and technology. Moreover, its role in the 21st century will be tremendous as a key technology to solve such important problems as those concerning environment, resources, and energy. The research in the Course of Chemistry includes important topics of fundamental and applied chemistry, such as the development of environmentally benign chemical reactions, the creation and development of functions of intelligent materials based on organic molecules, polymers, organometallic compounds and nano-particles that sustain the bottom-up approach of nanotechnology, and the elucidation and application of the biological functions of key molecules involved in heredity and photosynthesis. Moreover, in close collaboration with the Research Center for Solar Energy Chemistry, investigations on chemical utilization of solar energy are keenly conducted. Accordingly, the education in this course is mainly focused on the basics of chemical bonding and chemical reactions, but also on the related area in physics and biology, to promote self-established graduates who are capable of developing new fields of chemistry and its interdisciplinary area.

■**Prof.** : Takeshi NAOTA, Ryo SHINTANI,
Ken-ichi FUKUI, Shigenori IWAI,
Kazushi MASHIMA, Hiroshi MIYASAKA,
Shuji NAKANISHI

■**Assoc.Prof.** : Shuichi SUZUKI, Keiji HIROSE,
Akihito IMANISHI, Hayato TSURUGI, Syoji ITO

■**Assoc.Prof.** : Junpei YAMAMOTO

■**Assis.Prof.** : Soichiro KAWAMORITA,
Ichiro TANABE, Miyako SHIRAISHI,
Haruki NAGAE, Hikaru SOTOME,

Kazuhide KAMIYA, Takafumi NISHIURA

■**Assis.** : Noriko WADA

Course of Chemical Engineering

Research and education on fundamental engineering sciences and advanced technologies for material and energy conversion systems are indispensable for developing an environmentally friendly and sustainable society with recycling systems on Earth. The research section of the Course of Chemical Engineering covers not only fundamental studies on elucidation of the phenomena in chemical conversion processes, which deal with material synthesis and separation, energy conversion and storage, and design and development of functional materials with high conversion efficiencies, but also application studies on development of novel industrial processes including studies on solving energy and global environmental problems. The research projects are being conducted based on the latest information in chemistry, biochemistry, physics, mathematics, nanotechnology, biotechnology, computational science and quantum science, and the final results obtained are integrated as new knowledge and methodologies into chemical engineering education. In modern technological society, chemical engineers play an essential role in the analysis, design, and development of material and energy conversion systems in various industrial and environmental processes. A high-level education is being conducted in our undergraduate course so that each student grows to be a self-established researcher and/or engineer in the field of chemical engineering. Our activity closely collaborates with the Research Center for Solar Energy Chemistry.

<http://www.cheng.es.osaka-u.ac.jp>

■**Prof.** : Norikazu NISHIYAMA, Masayoshi NAKANO,
Koichiro JITSUKAWA, Nobuyuki MATUBAYASI,
Yasunori OKANO, Hiroshi UMAKOSHI,
Masahito TAYA, Shinji SAKAI, Takayuki HIRAI

■**Assoc.Prof.** : Yoshiaki UCHIDA,
Yasutaka KITAGAWA, Tomoo MIZUGAKI,
Kang KIM, Takato MITSUDOME,
Yukihiro OKAMOTO, Yasuhiro SHIRAISHI

■**Assoc.Prof.** : Takahiko BAN

■**Assis.Prof.** : Yuichiro HIROTA, Ryohei KISHI,
Zen MAENO, Ryosuke ISHIZUKA, Atsushi SEKIMOTO,
Takeshi SUGAHARA, Keishi SUGA, Yang LIU,
Masaki NAKAHATA

Department of Systems Science

In the Department of Systems Science, education and research on 'system', including humans, are undertaken to uncover/establish the symbiotic relations in which the harmony between technology and humans is based.

The word 'system' is used to mean a thing that is composed of many machines and electronic components, like aircraft, automobiles, chemical plants, etc., and brings about more advanced function through the organic cooperation among its components. For this, the human who operates and utilizes these systems is also included. While taking Liberal Arts and Sciences programs, students receive more specialized training in one of the three major courses, namely, Mechanical Science, Intelligent Systems Science, and Biophysical Engineering, a year after entering the program. Although the fields of study undertaken in these three courses have developed from different original backgrounds, they have many common or mutually related research areas from the viewpoint of "systems science". While each course continues to advance their respective fields independently, an interdisciplinary cooperation on the study of "system including human" exists and this new field for the future is exploited.

After graduation, most students enter graduate studies in any department in the Graduate School of Engineering Science, the Graduate School of Information Science, as well as the Graduate School of Frontier Biosciences, to further deepen their knowledge of their major field. (Some of the teachers in the Graduate School of Frontier Biosciences take charge of the education in the Biophysical Engineering Course.)

Mechanical Science Course

The education in the Mechanical Science Course covers a broad area covering particles and rigid body mechanics, solid mechanics, fluid mechanics, thermodynamics, machine dynamics, and acoustics and extending to material processing and manufacturing, control of systems, measurements, mechatronics, robotics, and human engineering. The education in these areas provides useful knowledge and methodology to develop cutting-edge areas such as new materials and space developments, mechatronics, computer aided engineering, and bioengineering, and to solve the urgent problems of environment and energy. Most of the graduates proceed to graduate school and finally obtain jobs in a wide variety of the fields such as heavy industries, electronics, automobiles, metals, energy, chemistry, as well as information processing, communication, computers, medical applications, aeronautics and astronautical industries, finance, trading and social services. The classes are offered by the faculty members in the three divisions (Division of Nonlinear Mechanics, Division of Mechanical Engineering, and Division of Bioengineering) of the Department of Mechanical Science and Bioengineering in Graduate School.

■**Prof.** : Genta KAWAHARA, Susumu GOTO, Hidetoshi KOBAYASHI, Satoyuki KAWANO, Kazuyasu SUGIYAMA, Fumio MIYAZAKI, Shigenobu OGATA, Shigeo WADA, Masao TANAKA, Shinji DEGUCHI

■**Assoc.Prof.** : Takao YOSHINAGA, Keitaro HORIKAWA, Kentaro DOI, Hironori HORIGUCHI, Hiroaki HIRAI, Hajime KIMIZUKA, Yo KOBAYASHI

■**Assoc.Prof.** : Kenichiro KOSHIYAMA, Tsubasa MATSUI

■**Assis.Prof.** : Hideshi ISHIDA, Masaki SHIMIZU, Yosuke WATANABE, Kenichi TANIGAKI, Nobutomo NAKAMURA, Tetsuro TSUJI, Tomoaki WATAMURA, Mitsunori UEMURA, Akio ISHII, Naoki TAKEISHI, Tomohiro OTANI, Shuichiro FUKUSHIMA

Intelligent Systems Science Course

Systems Science plays a central role in analyzing behavior in order to understand specified functions of complex systems involving human operations, which include mathematical, physical and computer systems. This division is, therefore, interdisciplinary and related to electrical, control, mechanical engineering and computer science. The curriculum is generally divided into three categories that students are required to pursue in parallel. The first consists of a series of lectures covering modern theories of

optimization, control systems and signal processing. The second covers measurement and instrumentation, including experimental practices. And the third covers various aspects of computer science ranging from signal processing architecture to artificial intelligence. Research activities in this division are combinatorics and optimization, system and control theory, human-machine systems analysis, robotics, artificial intelligence, pattern recognition, and signal processing and sensing. Most graduates continue their education in graduate degree programs, or step directly into career positions in computer science and electric engineering with in the industry or government.

■**Prof.** : Youji IIGUNI, Hiroshi ISHIGURO, Kosuke SATO, Toshimitsu USHIO, Masahiro INUIGUCHI, Koh HOSODA, Kensuke HARADA

■**Assoc.Prof.** : Arata KAWAMURA, Yasushi MAE, Yuichiro YOSHIKAWA, Daisuke IWAI, Tatsushi NISHI, Masahiro SHIMIZU, Takafumi KANAZAWA

■**Assis.Prof.** : Hiromi YOSHIDA, Yoshihiro NAKATA, Masaru KOJIMA, Takuya AZUMI, Shuhei IKEMOTO, Hirosato SEKI, Ixchel RAMIREZ, Haruka MATSUKURA

Biophysical Engineering Course

The Biophysical Engineering Course aims to foster students who can explore the mechanisms of various biological phenomena and apply the findings to develop new engineering and technologies by combining broad spectra of research fields such as brain science, biophysics, biochemistry, cell biology, genetic engineering, physics, mathematics, computer science, and information and systems engineering. Since studies in biophysical engineering require interdisciplinary knowledge, students are encouraged to construct their own curriculum according to their study aims. Approximately 80% of the graduates proceed to the master course, and 20% get jobs in companies.

■**Prof.** : Taishin NOMURA, Osamu OSHIRO, Ichiro FUJITA, Izumi OHZAWA, Nobuhiko YAMAMOTO, Akihiko ISHIJIMA, Takeshi YAGI, Ken KIYONO

■**Assoc.Prof.** : Hiroshi TAMURA, Yasushi KOBAYASHI, Ryuichi SHIRASAKI, Yoshihiro KURODA, Hajime FUKUOKA, Takashi KITSUKAWA

■**Assis.Prof.** : Hiroaki KOBAYASHI, Noriyuki SUGO, Kota SASAKI, Yasuyuki SUZUKI, Hirohiko NIIOKA, Shunsuke YOSHIMOTO, Seiichi TAGAWA, Mikio INAGAKI, Masanori SHIMONO, Yong-Suk CHE

Department of Information and Computer Sciences

The Department of Information and Computer Sciences aims at educating undergraduate students to acquire basic scientific ability and technological mastery in the fields of informatics and mathematical science. After one year of general education including basic courses in computer science, students are required to enter one of the three courses offered by Divisions of Computer Science, Software Science, and Mathematical Science. Almost ninety percent of the students proceed to the graduate program, after completion of 4 years of the undergraduate program or 3 years of high achievement. Many other students go to electronic, computer, communication, or software industries after graduation. The Divisions of Computer Science and Software Science share the education program aiming at fundamental training in computer science and software science. The Division of Mathematical Science includes both applied mathematics and statistical sciences.

Computer Science Course

The Division of Computer Science is concerned mainly with research and education in basic theory of computer science such as the theory of computation and information theory, and in areas of design and development of information systems such as the design of digital systems, computer architecture, bio-informatics, computer networks and multimedia information systems.

■**Prof.** : Toru FUJIWARA, Tatsuhiro TSUCHIYA, Teruo HIGASHINO, Masanori HASHIMOTO, Masayuki MURATA, Hideo MATSUDA, Haruo TAKEMURA

■**Assoc.Prof.** : Hiroyuki NAKAGAWA, Hirozumi YAMAGUCHI, Yoshinori TAKEUCHI, Shinichi ARAKAWA, Yuki URANISHI, Tomohiro MASHITA

■**Assoc.Prof.** : Manabu HIGASHIDA

■**Assis.Prof.** : Naoto YANAI, Hideharu KOJIMA, Akira UCHIYAMA, YU Jaehoon, Yuichi OHSHITA, Shigeto SENOO, PHOTCHARA RATSAMEE

Software Science Course

The Division of Software Science is concerned mainly with research and education in basic theory of software science such as the program theory and algorithms, and in design methodologies and application techniques of software systems including programming languages, database systems, operating systems, software development methodologies, human interface, and intelligent information processing.

■**Prof.** : Naoki WAKAMIYA, Shinji KUSUMOTO, Fumihiko INO, Katsuro INOUE, Morito MATSUOKA, Toshimitsu MASUZAWA, Toru HASEGAWA, Yasushi YAGI,

■**Assoc.Prof.** : Junnosuke TERAMAE, Yoshiki HIGO, Go HASEGAWA, Makoto MATSUSHITA, Hirotugu KAKUGAWA, Yasushi MAKIHARA, Daigo MURAMATSU

■**Assis.Prof.** : Masafumi HASHIMOTO, Shinsuke MATSUMOTO, Masao OKITA, Yuya TARUTANI, Yuichi SUDO, Yuki KOIZUMI, Fumio OKURA

Mathematical Science Course

This course consists of three research areas, namely, mathematical models, statistical science, and mathematical and statistical finance. Mathematical science aims at understanding practical phenomena by constructing and analyzing mathematical models. For the purpose, we extensively utilize advanced mathematics and computers such as computer simulations, computer graphics, and developing several algorithms. In this course, emphasis is placed on research and education of differential equations, applied analysis, statistical analysis, data sciences, statistical inference, probabilistic modelling, and stochastics and mathematical finance.

■**Prof.** : Takayuki KOBAYASHI, Joe SUZUKI, Yutaka KANO, Masayuki UCHIDA, Jun SEKINE, Masaaki FUKASAWA

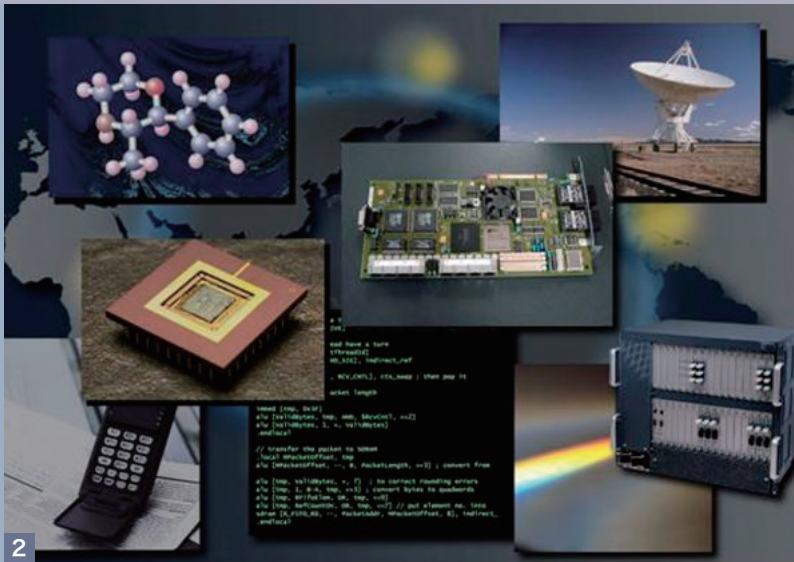
■**Assoc.Prof.** : Satoshi MASAKI, Michinori ISHIWATA, Fuyuhiko TANAKA, Etsuo HAMADA, Hidehiro KAISE

■**Assoc.Prof.** : Kengo KAMATANI

■**Assis.Prof.** : Hajime KOBAYASHI, Shinpei IMORI, Yoshikazu TERADA, Nobuaki NAGANUMA, Dai TAGUCHI



1 2
3 4



- 1 Virtual 3D ground navigation interface
(international collaboration with Telecom ParisTech, France)
- 2 Network Technologies for Supporting Advanced Information Communication
- 3 Geminoid: A tele-operated android robot that has similar appearance of original person
- 4 Medical Sensor Node for In-Body Biomonitoring

Facts and Figures



■ Organization

Number of Staff

As of October 1st, 2017

Division	Prof.	Assoc. Prof.	Assis. Prof.	Assis.	Sub Total	Admin. Staff	Technical Staff	Total
Materials Physics	3	5	5	0	13	—	—	13
Chemistry	4	4	4	1	13	—	—	13
Chemical Engineering	8	7	9	0	24	—	—	24
Frontier Materials Science	5	5	5	0	15	—	—	15
Nonlinear Mechanics	2	2	5	0	9	—	—	9
Mechanical Engineering	4	4	4	0	12	—	—	12
Bioengineering	6	4	8	0	18	—	—	18
Advanced Electronics and Optical Science	7	7	10	0	24	—	—	24
Systems Science and Applied Informatics	5	5	6	0	16	—	—	16
Mathematical Science	3	4	3	0	10	—	—	10
Mathematical Science for Social Systems	5	4	4	0	13	—	—	13
Center for Science and Technology under Extreme Conditions	2	2	3	0	7	—	—	7
Center for Spintronics Research Network	1	1	1	—	3	—	—	3
Educational Planning and Promotion	—	—	1	—	1	—	—	1
Public Information and Promotion	—	—	1	—	1	—	—	1
Technical	—	—	—	—	—	—	4	4
Administration	—	—	—	—	—	45	—	45
Total	55	54	69	1	179	45	4	228

	Specially Appointed Prof.	Specially Appointed Assoc.Prof.	Specially Appointed Assis.Prof.	Total
Temporary Staff	2	9	11	22

Number of Students As of October 1st, 2017

Year	Admission Capacity	Number of Students (International Student)
School of Engineering Science		
1st	435	446 (4)
2nd	435	448 (7)
3rd	435	461 (8)
4th	435	575 (3)
Total	1,740	1,930 (22)
Master's Course, Graduate School of Engineering Science		
1st	267	283 (22)
2nd	267	296 (18)
Total	534	579 (40)
Doctoral Course, Graduate School of Engineering Science		
1st	70	51 (15)
2nd	70	51 (15)
3rd	70	50 (13)
Total	210	152 (41)

■ Financial Statement FY2016

Item	Amount (1,000JPY)
Management Expenses Grant	644,785
Contract Research Budgets	527,281
Contract Enterprise Budgets	38,323
Joint Research Budgets	119,643
Donations for Research	80,656
Grants-in-Aid for Scientific Research	868,408
Grants for Creating Research and Education Bases etc.	62,112
Indirect Research Budgets	246,935
Total	2,588,143

※The Management Expenses Grant is one which is initially allocated, excluding the budget for the special project, i.e. the Project for Establishing Spintronics Research Infrastructure and Network.

※The amounts of money which are filled in fields of Contract Research Budget, Contract Enterprise Budget, Joint Research Budget, and Grants-in-Aid for Scientific Research, are the amounts of direct research budget which have been received within this fiscal year.

※Indirect Research Budgets include those of Research Center for Solar Energy Chemistry, Institute for NanoScience Design, and Center for Mathematical Modeling and Data Science.

■ Acceptance of Research Grants from outside the University FY2016

Contract Research

Number	Amount (1,000JPY)
48	672,791

Contract Enterprise

Number	Amount (1,000JPY)
4	42,555

Joint Research

Number	Amount (1,000JPY)
85	146,402

Donations for Research

Number	Amount (1,000JPY)
77	80,656

Grants-in Aid for Scientific Research

Research Categories	Number	Amount (1,000JPY)
Specially Promoted Research	1	142,869
Scientific Research on Innovative Areas	42	294,890
Scientific Research (S)	5	34,886
Scientific Research (A)	21	157,119
Scientific Research (B)	52	187,386
Scientific Research (C)	35	33,504
Scientific Research (B)(C)Generative Research Fields	4	6,370
Research Activity Start-up	6	7,280
Young Scientists(A)	12	63,733
Young Scientists(B)	18	25,883
Challenging Exploratory Research	52	74,766
Fund for the Promotion of Joint International Research	7	50,895
JSPS Fellows	41	45,969
Foreigner JSPS Fellows	3	3,380

※The received amount includes the budgets for indirect, management, industry-academia collaboration etc.

※Grants-in Aid for Scientific Research includes the budgets for Co-Investigators of Graduate School of Engineering Science.

※Grants-in Aid for Scientific Research does not include the budgets for Co-Investigators in other research institutes.

■ Number of Foreign Researchers FY2016

Region	Number	Proportion (%)
Asia	37	45.1
Middle East	4	4.9
Africa	0	0
Oceania	1	1.2
North America	5	6.1
Latin America	3	3.7
Europe	32	39.0
Total	82	100

■ Number of International Students As of October 1st, 2017

Region	Number	Proportion (%)
Asia	112	76.1
Middle East	4	2.7
North America	6	4.1
Central & South America	6	4.1
Oceania	2	1.4
Europe	15	10.2
Africa	2	1.4
Total	147	100

■ Special Program of “Engineering Science 21st Century” for Master's and Doctoral Courses in English

The Graduate School of Engineering Science provides interdisciplinary courses in English to students whose Japanese language is not fluent. We have a large variety of lectures (69 classes, including 8 compulsory subjects in each of the 11 Divisions and common 61 subjects), instruction, seminars, and research-related supervision, so that successful students can gain both Master's and Doctoral degrees in English from Osaka University. This means that graduate students in this Special Program will not only experience cutting-edge research topics in the world leading laboratories, but also study highly advanced engineering science, all through this training program under supervision of eminent teachers and advisors. We have eleven Divisions associated with three Departments of the Graduate School, therefore, students are firstly required to choose one Division of those, based on their backgrounds and interests.

Degree programs offered are

Materials Physics,
Chemistry,
Chemical Engineering,
Frontier Materials Science,
Mechanical Science and Bioengineering,
Advanced Electronics and Optical Science,
Systems Science and Applied Informatics,
Mathematical Science,
Mathematical Science for Social Systems

and the degree awarded are Ph.D. in Engineering, Ph.D. in Science or MS in Engineering.

New students are welcome to join us in exploring science and technology in the 21st century.

Inter-Faculty International Academic Exchange Agreement

As of Oct. 1, 2017.

France

Universities (School/Faculty/College)	Since
Institut National Polytechnique de Toulouse École Nationale Supérieure des Ingénieurs en Arts Chimiques et Technologiques	Feb 2012
LABORATOIRE DE PHYSIQUE THEORIQUE (LPT) INSTITUT DE MATHÉMATIQUES DE TOULOUSE (IMT) Université Paul Sabatier & CNRS	Sep 2012
École Normale Supérieure de Cachan	Apr 2016

Belgium

Universities (School/Faculty/College)	Since
KU Leuven (Faculty of Science)	Mar 2014

Italy

Universities (School/Faculty/College)	Since
Pisa University (Faculty of Engineering, Civil and Industrial Engineering Department)	Sep 2009

Sweden

Universities (School/Faculty/College)	Since
KTH Royal Institute of Technology (School of Engineering Sciences)	Jun 2012
Linköping University (The Institute of Technology)	Jul 2013

Poland

Universities (School/Faculty/College)	Since
Warsaw University of Technology	Sep 2017

Netherlands

Universities (School/Faculty/College)	Since
Eindhoven University of Technology (Department of Biomedical Engineering)	Jul 2015

Germany

Universities (School/Faculty/College)	Since
Technische Universität Berlin (Faculty II, Mathematics and Natural Sciences)	Jun 2009
RWTH Aachen University (Faculty of Mathematics, Computer Science and Natural Sciences)	Aug 2009
Justus Liebig University Giessen (Faculty of Mathematics and Computer Science, Physics, Geography)	Jan 2011 * Double Degree Agreement (May 2017)
Frankfurt University of Applied Sciences	Nov 2016
Eberhard Karls University Tübingen (Faculty of Sciences)	Nov 2016

Canada

Universities (School/Faculty/College)	Since
University of Ontario Institute of Technology (UOITS)	Oct 2012
University of Saskatchewan (College of Arts and Science)	Jul 2013
University of Toronto (Faculty of Applied Science and Engineering)	Apr 2013

U.S.A.

Universities (School/Faculty/College)	Since
Worcester Polytechnic Institute (WPI) (the Computer Science Department, the Interdisciplinary and Global Studies Division)	Mar 2010
The University of Arizona (College of Optical Sciences)	Sep 2015

Colombia

Universities (School/Faculty/College)	Since
Universidad Nacional de Colombia (School of Mines)	Aug 2013

Brazil

Universities (School/Faculty/College)	Since
Escola Politécnica da Universidade de São Paulo	Sep 2017

New Zealand

Universities (School/Faculty/College)	Since
The University of Canterbury (The College of engineering and Forestry)	Aug 2013

Korea

Universities (School/Faculty/College)	Since
Inha University (graduate School of Department of Physics, College of Natural Science)	Dec 2009
Korea University (College of Science and Technology)	Mar 2014

China

Universities (School/Faculty/College)	Since
Hong Kong University of Science and Technology (School of Science)	Aug 2005
Dalian University of Technology (School of Chemical Engineering)	Dec 2012
Huazhong University of Science and Technology (School of Automation)	Jan 2016

India

Universities (School/Faculty/College)	Since
Indian Institute of Technology Hyderabad	Oct 2012

Thailand

Universities (School/Faculty/College)	Since
Thai-Nichi Institute of Technology	Apr 2010
Chulalongkorn University (Faculty of Engineering)	Mar 2017

Vietnam

Universities (School/Faculty/College)	Since
Vietnamese Academy of Science and Technology (Institute of Materials Science)	Dec 2001
Vietnam National University- Ho Chi Minh City (University of Sciences)	Mar 2003
KISOKO-HANOI OFFICE FOR ACADEMIC EXCHANGE	Dec 2012

Singapore

Universities (School/Faculty/College)	Since
National University of Singapore (Faculty of Engineering)	Jan 2008

Malaysia

Universities (School/Faculty/College)	Since
Universiti Teknologi Malaysia	Nov 2008

■ Advisement Office for International Student in the Department of Engineering Science

This office was established in 1994 for international students mainly. We provide information about campus life, daily life, and studies guide. Meeting space, computers, traditional Japanese games and goods are available in our office. We hold several parties and Bus Trip for international students in order to communicate each other. Not only the international students but also the overseas researchers, their families and Japanese students are welcomed. We hope that you would take advantage of our office to let your campus life more comfortable.

Open: 11 a.m. to 5 p.m. on weekdays

Place: Building A 3rd floor (A325)

Office Chief: Professor Hiroshi Umakoshi (Division of Chemical Engineering)

Office Manager: Associate Professor Kengo Kamatani (Division of Mathematical Science for Social Systems)

Staff member: Ms.Emiko Tasaka



■ Support Office for International Students and Scholars

The Support office offers assistance and provides information for international students, scholars and their families, on such matters as visa procedures, the search for accommodations, and other necessary procedures, focusing its service on prior to and soon after arrival in Japan.

The primary goal of the Support Office is to create good links with the international students, scholars and the faculty staff at Osaka University, and also to help make their lives easier and more comfortable, so that they can concentrate fully on their academic activities throughout the duration of their stay in Japan.

<Address> IC Hall 2F, 1-1 Yamadaoka, Suita, Osaka 565-0871,
JAPAN

Support Office for International Students and Scholars, Osaka University

<e-mail> supportoffice@office.osaka-u.ac.jp

<URL> <http://iss-intl.osaka-u.ac.jp/supportoffice/>

■ Program for Leading Graduate Schools

Interactive Materials Science Cadet Program

(Prof. Yutaka Kano and Prof. Masaaki Ashida)



'Materials Science Cadets' is a program launched as an integrated five-year doctoral course in materials science, and is promoted in an integrated manner by the graduate schools of engineering science, science, and engineering, Osaka University.

The departments of materials engineering science and systems innovation also contribute to the program. The program aims to educate talented graduate students by cultivating 'Materials Science Cadets' with the skills to occupy senior research positions in the materials science and production sectors, with the full support of faculty members of Osaka University from a wide range of materials science fields including physics and chemistry. The program is also designed to apply the synergistic benefits of dialogic and interactive approaches to various facets of materials science education and research. In particular, the key concept of interactivity is applied to:

(i) Materials: Interactions and correlations within and between materials

(ii) Research: Interactive research approaches between different research fields and research methods

(iii) Training: Interactive learning by way of dialog among students and instructors, among instructors, and between students and outside researchers and engineers.

The multi-faceted curriculum organically links together various interactive ideas and approaches by combining a range of components including mentor systems, laboratory rotation, liberal arts subjects, career guidance, private sector internships and overseas study opportunities. In this way, the curriculum is designed for the training of well-rounded Materials Science Cadets.

Cross-Boundary Innovation Program

(Prof. Masahito Taya, Prof. Prof. Hidetoshi Kobayashi and Prof. Kosuke Sato)



Knowledge is fundamental to a society that has achieved great progress through advances in science and technology. However, at the same time, due to the rapid explosion of knowledge, areas of expertise have become significantly compartmentalized, hindering efforts by even specialists and professionals to alleviate problems facing society.

Rising to this challenge and recognizing the urgency to go beyond just turning out graduates with specialized knowledge and a single set of skills, Osaka University including Graduate School of Engineering Science has established the Cross-Boundary Innovation Program (CBI), a program that will cultivate individuals with the creative and strategic skills needed to deal with diverse challenges. CBI graduates will be able to go beyond the traditional framework - they will possess the ability to achieve what is "only possible by crossing boundaries."

The development of the CBI Program is supported under the "Programs for Leading Graduate Schools" of the Japanese government's Ministry of Education, Culture, Sports, Science and Technology. Osaka University's challenge is now to implement the program by including scholars from a wide range of areas, emphasizing comprehensive skills, building a heterogeneous learning environment, and establishing collaborative endeavors with leading professionals from the public and private sectors.

Humanware Innovation Program

(Prof. Takao Onoye and Prof. Hiroshi Shimizu /Prof. Hiroshi Ishiguro)



"Humanware Innovation Program" is a five-years doctoral program launched in 2012 under "Program for Leading Graduate Schools - Multidisciplinary type (Information)" of Ministry of Education, Culture, Sports, Science and Technology, Japan. This program is designed to spearhead the development of "humanware" through collaboration between the Graduate School of Information Science and Technology, the Graduate School of Frontier Biosciences, and the Graduate School of Engineering Science of Osaka University. Its aim is to foster leaders in integrative informatics who can change the direction

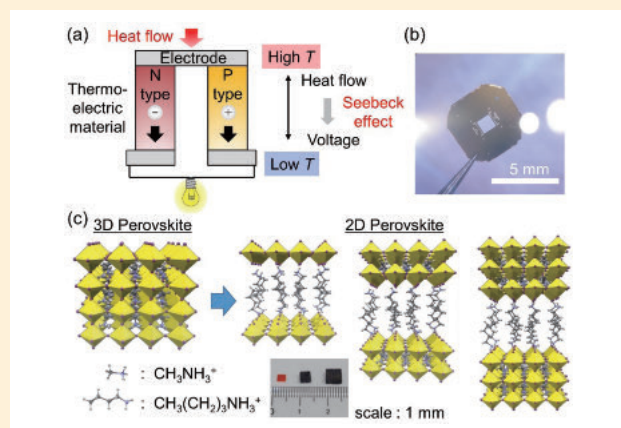
of innovation and construct flexible, robust, and sustainable systems by bridging information science, life science, and cognitive/brain science and cultivating new arenas of research. To this end, curricular aims are put into practice under a principle known in Japanese as Seido Jukugi—students from different disciplines work together to conduct intensive interdisciplinary studies. Students also undergo seminars from various corporations and industries about practical issues including project planning, research and development strategies, and innovation in interdisciplinary fields. To cultivate skills of practical design, communication, and management and become a global leader, students are given research opportunities in international research institutes outside the university, including internships, summer camp, and research caravan. Graduates of this program are "networking doctors" play a central role in industry, academia, and government with an integrated understanding of interdisciplinary areas.

■ Multidisciplinary Research Laboratory System for Future Developments (“MIRAI” Lab, Σ MRL)

With its rich experience in developing newly emerging interdisciplinary fields, the Graduate School of Engineering Science established in 2002 a unique system called the Multidisciplinary Research Laboratory System for Future Developments (MIRAI LAB) which supports and incubates various research projects aimed at the future development of creative research fields as well as the education of young researchers and engineers with global standards of knowledge and expertise in these fields, in cooperation with conventional basic engineering science.

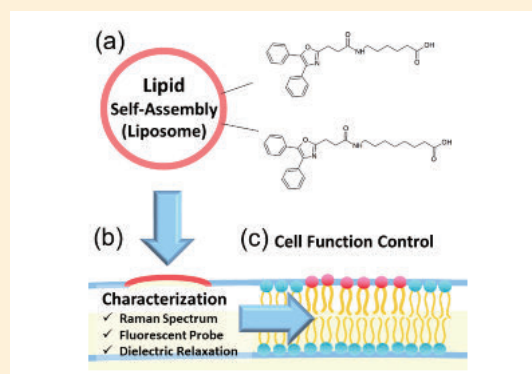
Research projects in 2017 are:

- (1) Behavior of metal ions at interface of ionic liquid and its application to new devices and materials (Akihito IMANISHI)
- (2) High frequency data analysis for single molecule measurement (Masaaki FUKASAWA)
- (3) Search for new superconducting mechanism, materials, and charge Kondo effect derived from atomic valence skipping phenomenon (Hidekazu MUKUDA)
- (4) Lipid insertion can alter the membrane properties and induce cell death (Keishi SUGA)
- (5) Systematic investigation of organic-inorganic hybrid materials toward improvement of thermoelectric performance (Shunpei NOBUSUE)
- (6) Personalized blood flow analysis in human left atrium with using cartesian-grid computational fluid dynamics (Tomohito OTANI)
- (7) Search for high- T_c superconducting hydrides by integration of computational and data sciences (Takahiro ISHIKAWA)
- (8) Construction of innovative mechano-biomaterials based on macromolecules with dynamically-tunable mechanical properties (Masaki NAKAHATA)
- (9) Development of surface plasmon resonance sensors utilizing far-ultraviolet region (Ichio TANABE)
- (10) Multi-scale optimization of flow fields and application toward material engineering (Takashi NAKAZAWA)
- (11) Molecular beam epitaxial growth of spin-gapless Heusler-alloy films for spintronic applications (Shinya YAMADA)



Systematic investigation of organic-inorganic hybrid materials toward improvement of thermoelectric performance.

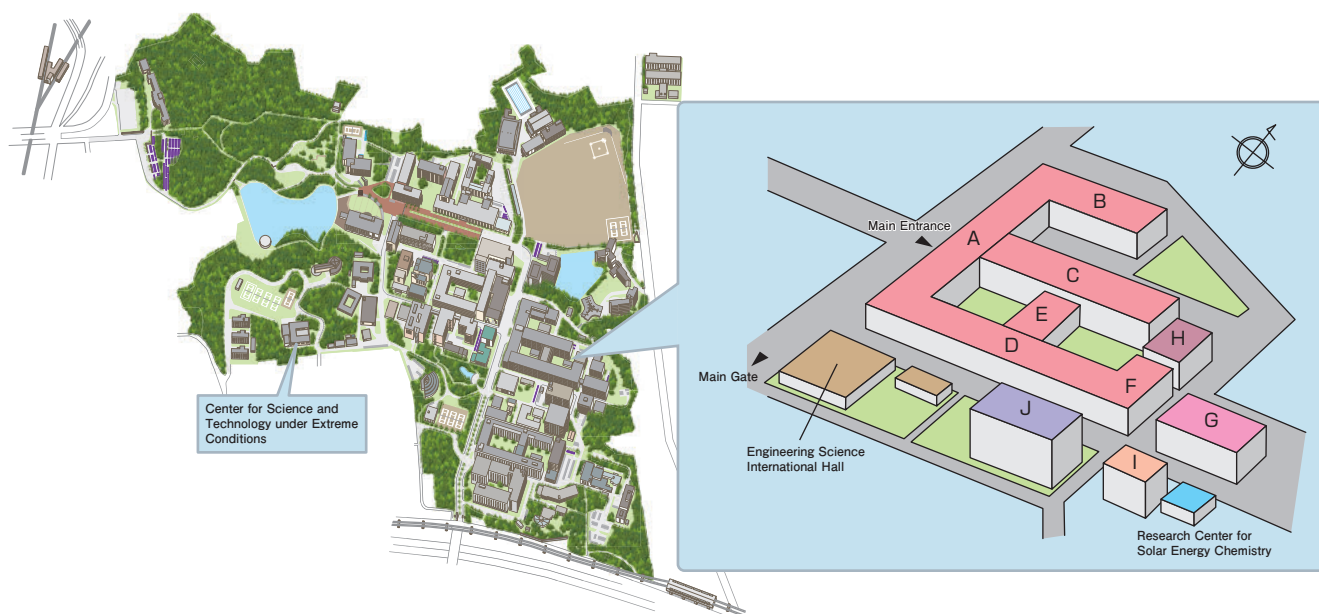
- (a) Schematics of thermoelectric conversion system
 (b) Substrate for the measurement of thermal conductivity
 (c) Structural control of organic-inorganic hybrid perovskites (S.Nobusue)



Insertion of self-assembled lipid molecules into cell membranes alter the physicochemical membrane properties, and control cell function.

- (a) Designed lipids form self-assembly, which can be inserted into membrane.
 (b) Alteration in membrane properties is characterized using spectroscopic methods.
 (c) Control of cell function: e.g. induced cell death. (K. Suga)

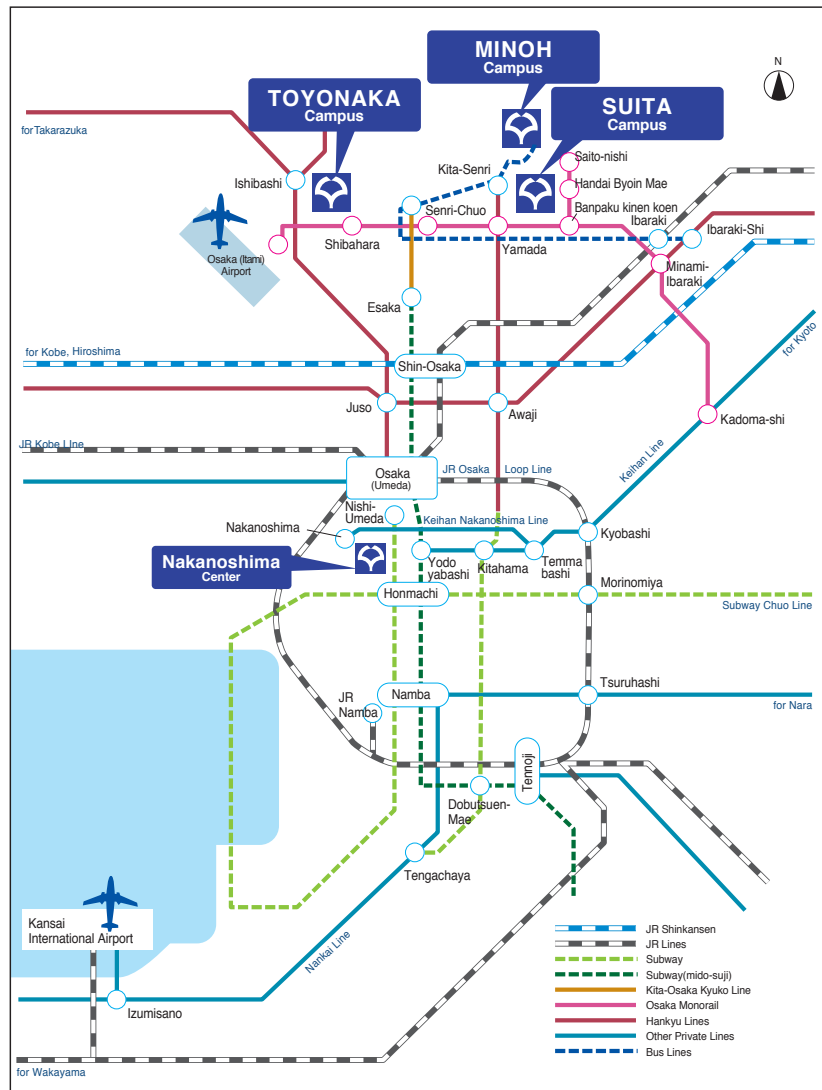
Campus Map



Building	Major Dept.	m ²
A	Mechanical Science and Bioengineering Administration Offices	29,133
B	Class Rooms	
C	Materials Engineering Science	
D	Materials Engineering Science	
E	Systems Innovation	
F	Systems Innovation	
G	Joint-Use Space etc.	3,468
H	Laboratories	1,201
I	Joint-Use Space etc.	1,951
J	Mechanical Science and Bioengineering Systems Innovation Graduate School of Frontier Biosciences	6,376
Others	Engineering Science International Hall etc.	4,952
Total		47,081



Location and Transportation



Toyonaka Campus

Access from the nearest station

By Train

15-25 min. east on foot from **Ishibashi** on Hankyu Takarazuka Line.

By Monorail

10-15 min. west on foot from **Shibahara**.

From Shin-Osaka Station

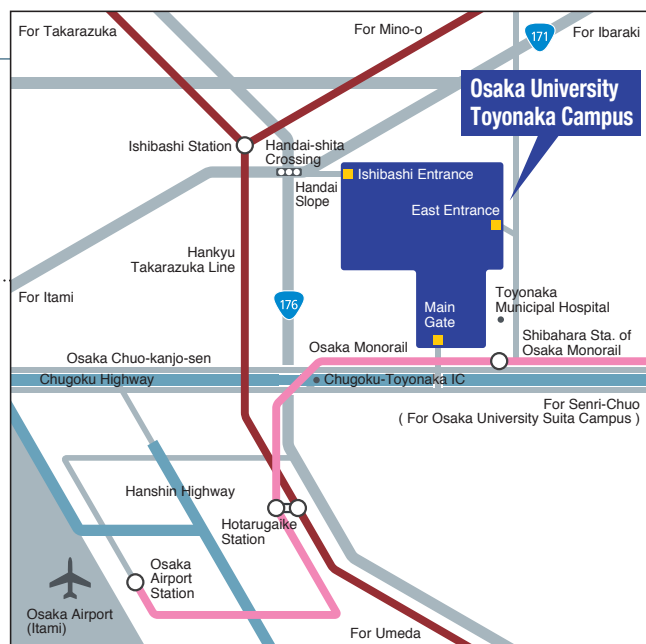
Take the subway Midosuji Line to **Senri-Chuo**, transfer to Osaka Monorail and exit at **Shibahara**. (about 1 hour)

From Osaka Airport (Itami)

Take Osaka Monorail to **Shibahara**. (about 30 min.)

From Kansai International Airport

- Take JR line to **Osaka**, transfer to the subway Midosuji Line, exit at **Senri-Chuo**, change to Osaka Monorail and exit at **Shibahara**. (about 2 hours)
- Take Nankai Line to **Namba**, transfer the subway Midosuji Line to **Senri-Chuo**, and take Osaka Monorail to **Shibahara**. (about 2 hours)
- Take Airport Bus to **Osaka Airport**, transfer to Osaka Monorail to **Shibahara**. (about 2.5 hours)



Osaka University Overseas Centers

European Center for Academic Initiatives

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Tel: +31-50-363-8865
email: info@osaka-u-groningen.org web: www.groningen.overseas.osaka-u.ac.jp

North American Center for Academic Initiatives

44 Montgomery St., Suite 1404, San Francisco, CA 94104 USA
Tel: +1-415-296-8561 Fax: +1-415-296-8676
email: info.sf@overseas.osaka-u.ac.jp web: www.sf.overseas.osaka-u.ac.jp

East Asian Center for Academic Initiatives

Room 817, Tongji Building Block A, No. 1,
Zhang Wu Road, Shanghai City 200092, China
Tel: +86-21-6598-5665 Fax: +86-21-6598-5535
email: shanghai-ina@ml.office.osaka-u.ac.jp
web: www.shanghai.overseas.osaka-u.ac.jp

ASEAN Center for Academic Initiatives

Room C, T.W.Y. Office Center, 10th Fl., Serm-Mit Tower, 159 Sukhumvit 21 Rd.,
Klongtoey-Nua, Wattana, Bangkok, 10110 Thailand
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