RESEARCH OUTLINE 2020-2021

TOYOHASHI
UNIVERSITY OF TECHNOLOGY

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2020-2021

Laboratory list

Department of Mechanical Engineering

Department of Electrical and Electronic Information Engineering

Department of Computer Science and Engineering

Department of Applied Chemistry and Life Science

Department of Architecture and Civil Engineering

Faculty members

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Key word index 126

Department of Mechanical Engineering

- Mechanical Systems Design
- Materials and Mnufacturing
- System Control and Robotics
- Environment and Energy

Materials and Structural Mechanics Laboratory

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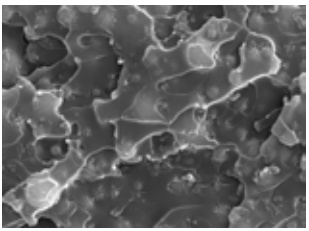
	• Associate Professor	**Takeichi, Yoshinori**	(E-mail：takeichi@tut.jp)
	• Assistant Professor	**Ishii, Yosuke**	(E-mail：ishii@me.tut.ac.jp)
Laboratory URL	http://solid.me.tut.ac.jp/		
Key words	Material mechanics, material engineering, tribology, structural mechanics, surface engineering, impact engineering, friction, wear, biomechanics, mechanical properties of materials, ultrasonics		

The Materials and Structural Mechanics Laboratory studies, develops and designs materials and structures with functions appropriate for various purposes from the perspectives of material mechanics, material engineering and tribology through experimental and theoretical methods as well as numerical simulation. The study targets polymeric material, metallic material, ceramic material and their composite materials ranging from nano/micro-size to the large structures. The lab also designs and produces new measuring devices and develops software.

Theme 1 ▶ Mechanical properties of polymeric materials and polymeric composite materials

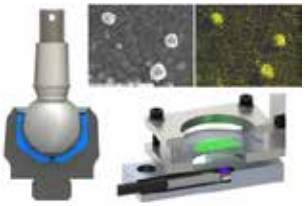
Polymeric materials and polymeric composite materials, which are lightweight and have excellent mechanical properties, are used in many machine structures and machine components. This study conducts mechanical assessments of polymeric material and polymeric composite material aiming at using them in machine structure. The laboratory also designs and develops materials to acquire more excellent mechanical properties. Specifically, the lab conducts the study on submicron/nano-sized particles as the reinforcing materials that affect mechanical properties, the influence of fiber distribution along with temperature dependence and time dependence, including impacts, of mechanical properties.



Fracture surface of an epoxy composite filled with nano silica particles

Theme 2 ▶ Tribology (Solid lubricants)

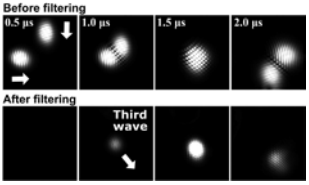
Oil or grease is generally used as a lubricant to reduce friction and wear of the sliding parts of machinery, but oil lubricators cannot be used to the parts that are utilized under harsh conditions of pressure, temperature and the like. In relation to this theme, this laboratory performs the study on the solid lubricants that are used under such conditions. Specifically, aiming at improving lubrication properties of various solid lubricants and reducing wear of the materials, the lab seeks to improve the lubrication properties of metallic composite oxide under high temperatures and understand the mechanism; clarifies the sliding mechanism of polymeric materials; and conducts experimental work on reduction of wear, etc.



Research on the lubrication mechanism of various applications

Theme 3 ▶ Nondestructive evaluation of plate structures by non-collinear mixing of Lamb waves

When two ultrasonic beams intersect each other, the third wave is generated due to the nonlinear interaction. This phenomenon is called the non-collinear mixing and has recently attracted much attention in the field of non-destructive testing for more sensitive evaluation of material soundness than the conventional testing techniques using the linear wave propagation behavior, such as the wave velocity and attenuation. The lab is trying to elucidate the non-collinear mixing of Lamb waves in plate structures by using the theoretical and numerical analysis as well as experiments in order to establish a new ultrasonic nondestructive testing which can sensitively detect the damage in plate structures including fatigue and plastic strain in its early stage.



FEM simulation of non-collinear mixing of Lamb waves

Machine Dynamics Laboratory

Staff	• Professor **Kawamura, Shozo** (E-mail：kawamura.shozo.qk@tut.jp) • Assistant Professor **Matsubara, Masami** (E-mail：matsubara.masami.od@tut.jp)
Laboratory URL	http://dynaweb.me.tut.ac.jp/
Key words	Vibration engineering, Dynamic analysis, Modeling, Structural health monitoring, Sports engineering, Human dynamics

The Machine Dynamics Laboratory conducts the study on modeling, analysis and design of artifacts, such as machinery/structures/equipments and human body movements based on vibration engineering.

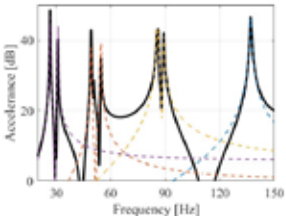
Evaluation of SHM
(three-layer structure)

Theme 1 ▶ Study on modeling, evaluation and diagnosis of machines and structures

This laboratory researches the modeling of bolted joints, the effect of shape machining on the modal parameters and the structural health monitoring (SHM) using strain data. Moreover, as the inverse analysis, the studies on identification of external force acting on the structures and random force of ground motion.

Theme 2 ▶ Study on dynamical design and experimental modal analysis

This laboratory designs the isolation equipment against the long period earthquake and wheel chair to get over the step stably. And this laboratory develops the new experimental modal analysis method which is called linear fit method, and the grouping method of similar vibration modes and the extraction method of vibration modes which behave like dynamic damper.



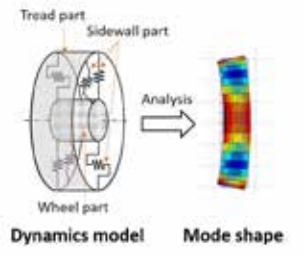
Comparison of the FRF based on modal analysis and representative mode analysis

Theme 3 ▶ Study on modeling of tires

Tire dynamics are of crucial importance for the dynamic behavior of the road vehicle. This laboratory researches modeling of cornering and vibration characteristics of tire. In particular, we are developing analytical method using three-dimensional elastic ring model. Furthermore, we are working on development of a measurement system for deformation of the tire tread block.

Theme 4 ▶ Study on damping material

T It is known that damping characteristics are improved by complexing fine particles in a viscoelastic material, but the relevant mechanism is unknown. In this study, to investigate the filler / matrix interface, an X-ray computer tomography image was obtained with a tensile load applied to the test piece, and the interface state was observed through image processing.



Three-dimensional elastic ring model for tire

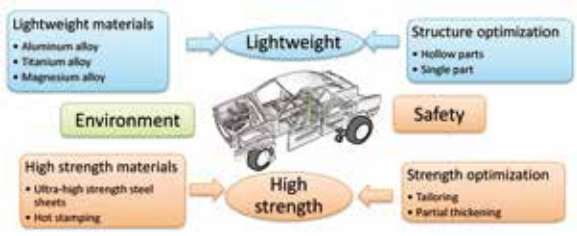
Theme 5 ▶ Study on sports engineering and human dynamics

This laboratory engages in analysis and design of sports equipment; identification of dynamic characteristics of sports surface, and running state analysis of human body considering sports surface. In addition, the lab carries out the study of inverse analysis of running motion and the study of effect of supports surface on running motion. And measuring techniques by using the wireless motion sensors are also developed.

Analysis of human body in running

Frontier Forming System Laboratory

Staff	• Project Professor **Mori, Ken-ichiro** (E-mail：mori@plast.me.tut.ac.jp) • Associate Professor **Abe, Yohei** (E-mail：abe@plast.me.tut.ac.jp)
Laboratory URL	http:// plast.me.tut.ac.jp/index.eng.html
Key words	Production processes, forming process, high strength steel sheets, cold stamping, hot stamping, forging, joining by plastic deformation



Aiming at safe and environmentally friendly automobiles, the Frontier Forming System Laboratory develops the production processes for forming and joining of lightweight structural parts made of lightweight materials, including high-strength steel, magnesium alloys, aluminum alloys and titanium alloys, as well as hollow parts, and optimizes the processes. This laboratory contributes to environment and safety through the production of lightweight automobiles.

Theme 1 ▶ Forming process of lightweight materials

(1) Hot stamping and die quenching of ultra-high strength steel parts; (2) Hot and warm shearing of ultra-high strength steel parts; (3) Cold stamping of ultra-high strength steel sheets; (4) Cold punching of hot-stamped sheet and evaluation of qualities of sheared edge; (5) Seizure prevention in ironing of stainless and high strength steel sheets

Hot stamping of ultra-high strength steel part

Theme 2 ▶ Joining of lightweight sheets

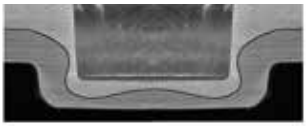
(1) Mechanical clinching and self-pierce riveting of high strength steel and aluminum alloy sheets; (2) Mechanical clinching of high strength steel sheets; (3) Hemming for joining of high strength steel sheets and assembling of hollow part; (4) Joining of nut with hot-stamped sheet by punching; (5) Joining of bolt with hot-stamped sheet by punching

Cold stamping of ultra-high strength steel sheet

Theme 3 ▶ Forming of lightweight structural parts

(1) Stamping of sheet metals using plastic tools made with 3D printer; (2) Plate forging of tailored blanks having partial thickening; (3) Lubricant containing nanoparticles for ironing; (4) Enhancement of stiffness and fatigue strength of products by local thickening; (5) Increase in formability by local work-hardening of blanks

Hemming for joining of high strength steel sheets and assembling of hollow part



Mechanical clinching of high strength steel and aluminum alloy sheets

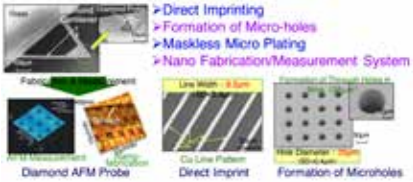
MEMS/NEMS Processing Laboratory

Staff	• Professor **Shibata, Takayuki** (E-mail：shibata@me.tut.ac.jp) • Associate Professor **Nagai, Moeto** (E-mail：nagai@me.tut.ac.jp)
Laboratory URL	http:// mems.me.tut.ac.jp/
Key words	Micro/nano fabrication, MEMS/NEMS, BioMEMS, Cell Processing, Bioactuator

In MEMS/NEMS Processing Laboratory, we study the basics and applications of Micro Electro Mechanical Systems (MEMS) that are produced by micro/nano fabrication. Our consistent concept is to “investigate MEMS technologies and create a bridge between MEMS and nano and biology.” We strive to develop the next-generation “basic technology for interdisciplinary fabrication” in micro/nano scale. The fundamental policies are free from process principles, processing targets, and parts. Application fields are the development of the MEMS devices/systems to support innovation in medicine and life science. Currently, our group focuses on the three projects.

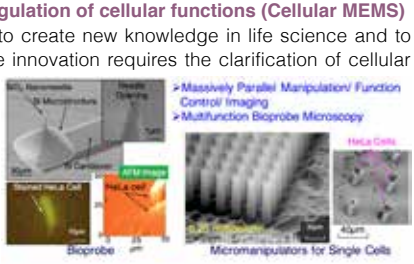
Theme 1 ▶ Micro/Nano-structure fabrication technologies

Novel and interdisciplinary fabrication technologies of micro/nano-structures are essential to create MEMS devices having innovative functions. Our group studies the development of original and advanced micro/nano-process technologies through creation of special tools based on the MEMS technologies. Especially, our research aim at the establishment of mass production technologies based on mask-less and vacuum-less methods, which are different from semiconductor manufacturing technologies.



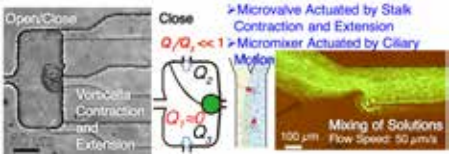
Theme 2 ▶ Lab-on-a-chip platforms for analysis and regulation of cellular functions (Cellular MEMS)

For the realization of a safe and secure life, it is critical to create new knowledge in life science and to facilitate the innovation in life science and medicine. Life innovation requires the clarification of cellular functions, where a cell is the basic unit of living organisms. We are developing various MEMS devices to perform massively parallel manipulation of single cells and analysis/control of cellular functions at the single cell-level. One example is a bioprobe consisting of a hollow nanoneedle and cantilever, which can be used for measuring multiple cellular functions.



Theme 3 ▶ Microorganism-based MEMS (Actuation technologies)

Microorganisms are sophisticated machines and expected to work in microsystems. We create microorganism-actuated MEMS by integrating the microstructure produced by microfabrication and microorganism actuators. Microorganisms work autonomously and do not require either an external power supply or a control circuit. These actuators are suitable for further downsizing and information processing of microsystems because they are small and work autonomously. We study the fabrication of useful microdevices using environment-responsive microorganisms, such as Vorticella, Volvox, and Euglena.



Materials Function Control Laboratory

Staff	• Professor **Todaka, Yoshikazu** (E-mail：todaka@me.tut.ac.jp) • Assistant Professor **Adachi, Nozomu** (E-mail：n-adachi@me.tut.ac.jp)
Laboratory URL	http://martens.me.tut.ac.jp/
Key words	micro-/nano- structure control, lattice defect, severe plastic deformation, alloy design, steel, metal

Through multi-scale microstructure control using deformation process and alloy design, we are studying for “properties and function improvement”, and “development of novel metallic materials”. In order to expand newly developed material to industrial world, we are also developing new process and improving conventional techniques.

Theme 1 ▶ Micro-/nano- structure control of steels

Steels are used most widely because it is possible to extensively create their properties through micro-/nano- structure control and alloy design. We investigate to high-functionalize steels by controlling heat/deformation history (optimizing phase transformation, precipitation behavior, etc.).

Theme 2 ▶ Creation of bulk nanostructured metals with high-density lattice defects by severe plastic deformation

Plastic deformation forms lattice defects, such as vacancy, dislocation and grain boundary, in metallic materials. Severe plastic deformation can endlessly introduce strains, and it is possible to prepare bulk nanostructured metals with high-density lattice defects. Bulk nanostructured metals show high-strength and high-ductility, as shown in Fig.1. We investigate to clarify the mechanism of high mechanical properties in the bulk nanostructured metals.

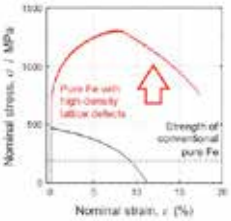


Fig.1 Mechanical property improvement in pure Fe via introduction of high-density lattice defects by severe plastic deformation (high-pressure torsion straining).

Concrete objectives:

(1) To achieve mechanically high-functionalization of general metallic materials through clarifying the role of high-density lattice defects for high-strength and high-ductility.
(2) To understand destruction phenomenon through clarifying the deformation mechanism of metallic glass (amorphous metals).
(3) To understand high-pressure phase stabilization behavior by means of lattice defect control.

Theme 3 ▶ Creation of surface nanostructured metals by severe plastic deformation

Physical and chemical properties of metallic materials largely depend on surface properties. Grain refining to nano-scale is effective to enhance the properties. We have succeeded to create high-grade surface nanostructured metals, as shown in Fig.2. We investigate to clarify the mechanism of excellent properties in the surface nanostructured metals. Moreover, we investigate to clarify the mechanism for formation of nanostructure by severe plastic deformation aiming at developing new processes.

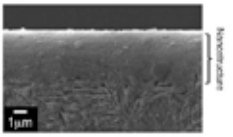


Fig.2 High-grade surface nanostructured SUJ2 bearing steel produced by severe plastic deformation (surface-nanostructured wearing).

Concrete objectives:

(1) To achieve friction coefficient control by using high reactivity of surface nanostructure (Fig.3).
(2) To achieve excellent rolling fatigue properties through clarifying the role of surface nanostructure.

Theme 4 ▶ Creation of thermoelectric materials

Thermoelectric materials, which can directly convert thermal energy into electrical energy (Seebeck effect), can be effectively used for the development of a clean and environmentally compatible power-generation technology. We seek highly efficient thermoelectric materials without toxic and/or expensive elements. Recently, we have successfully synthesized a new thermoelectric material, CaMgSi, by combining mechanical ball-milling and pulse current sintering processes.

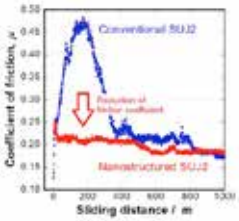


Fig.3 Stable tribological behavior with low friction coefficient during ball-on-disk test under Poly-α-Olefin oil in surface nanostructured SUJ2 steel disk.

Development and Evaluation of High Strength Materials Laboratory

Staff	• Professor	**Miura, Hiromi**	(E-mail：miura@me.tut.ac.jp)
	• Associate Professor	**Kobayashi, Masakazu**	(E-mail：m-kobayashi@me.tut.ac.jp)
Laboratory URL	http://str.me.tut.ac.jp/		
Key words	Severe plastic deformation, high strength, microstructure control, dynamic recrystallization, high-temperature processing, biomaterial, bulk nanostructured metals		

Focusing on non-ferrous metal materials, the “Development and Evaluation of High Strength Materials Laboratory” develops materials with high strength and superior formability through thermomechanical treatments, etc., along with the techniques to evaluate deformation/fracture mechanisms and reliability.

Theme 1 ▶ Study on high-temperature processing and the issues relevant to light weight materials

Magnesium alloys are expected as the next-generation lightweight structural materials to replace aluminum alloys. However, because of low actual strength, their application to the structure members of automobiles, etc., has not been advanced yet. This laboratory seeks to strengthen and functionalize magnesium alloys by employing multi-directional forging, which is one of severe plastic deformation methods.

Fig. 1 Magnesium alloy parts (Theme 1)

Theme 2 ▶ Study on microstructure control and material-quality improvement through thermomechanical processing

For the purpose of improving the balance between higher strength and superior workability of metal-based mechanical materials, this laboratory works on microstructure control using “dynamic recrystallization”, which is a phenomenon taking place during the high-temperature processing. This causes significant improvements of processing productivity at high temperatures and balance between strength and formability at room temperature.

Theme 3 ▶ Study on the material evaluation using synchrotron radiation

This laboratory works on the development of the techniques necessary to evaluate three-dimensional deformation/fracture mechanisms of materials using synchrotron radiation at SPring-8, which is the world’s largest facility to generate synchrotron radiation. We have started this project using aluminum alloys.

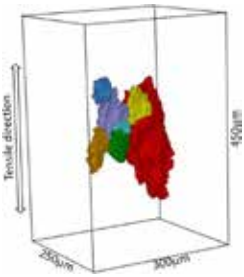


Fig. 2 3D grains obtained by synchrotron CT (Theme 3)

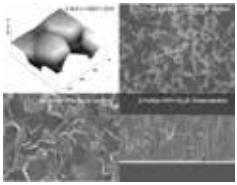
Thin Film Laboratory

Staff	• Professor **Izaki, Masanobu** (E-mail：m-izaki@me.tut.ac.jp) • Associate Professor **Yokoyama, Seiji** (E-mail：yokoyama@me.tut.ac.jp) • Assistant Professor **Sasano, Junji** (E-mail：sasano@me.tut.ac.jp)
Laboratory URL	http://tf.me.tut.ac.jp/index_e.html
Key words	Electrochemistry, oxide, organic, semiconductor, nano-structure, photovoltaic, electrochromic materials, waste treatment, composite materials

Thin Film Laboratory conducts the study and education concerning the science and technology to use effectively the energy and to reduce the carbon dioxide emission in material processing and to generate the sustainable energy by inorganic and organic photovoltaic devices. The lab also carries out the environment-related study, including recycling and reuse of wastes. Following research themes are carried out in Thin Film Laboratory.

Theme 1 ▶ Thermodynamic design of chemical solution process for smart oxide preparation

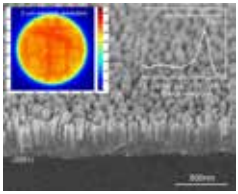
The electrochemical and chemical processes for preparing smart oxide layers with semiconducting and ferromagnetic characteristics have been developed based on thermodynamics and is an energy effective and environmentally friendly process. The process using hydroxide and proton generation reactions in aqueous solutions have been proposed for the direct preparation, and the preparation of semiconducting oxide layers of zinc oxide, indium oxide, cerium dioxide, titanium dioxide, tungsten oxide, tin dioxide, cupric oxide, and cuprous oxide, and ferromagnetic oxide layers of magnetite and Zn-ferrite have been demonstrated to approve the ability and applicability. (Image 1)



(Image 1)
ZnO, Cu_2O, and Ag_2O layers prepared by electrochemical reactions

Theme 2 ▶ Crystal growth and design for oxide and organic nanostructure fabrication

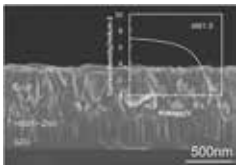
The nanostructure and quality of oxide semiconductor layers have been controlled by using the electrochemical heteroepitaxial growth. The <0001>-oriented ZnO vertical nanowire with a room temperature strong ultraviolet-light-emission has been prepared by the heteroepitaxial growth and has been operated as a high spatial resolution scintillator for industrial and medical applications. (Image 2) And, highly-oriented organic semiconductor layer has been prepared on inorganic single crystal substrate with gas-phase deposition technique.



(Image 2)
<0001>-oriented ZnO vertical nanowires and the resolution image of the scintillator

Theme 3 ▶ Sustainable energy generation by oxide photovoltaic devices from sunlight

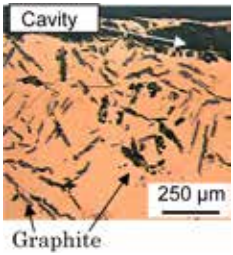
The next generation oxide photovoltaic device composed of n-zinc oxide and p-copper oxide of 2.1-eV-Cu_2O and 1.3-eV-CuO has been prepared by electrochemical process and realized world-class photovoltaic performance. (Image 3) The science and technology to enhance the performance for generating electricity from sunlight have been studied to realize high performance oxide photovoltaic device available to apply on earth based on solid state physics.



(Image 3)
Electrochemically constructed Cu_2O/ZnO photovoltaic device and the performance

Theme 4 ▶ Waste treatment and physical chemistry of materials

Slag and dust are generated from the smelting process of steel. They contain valuables as well as environmentally regulated substances. Collecting valuables from these substances makes it possible to use and reuse them as resources. This laboratory performs the fundamental study on their elution into a solution and applicability of slag to mortar. In addition, this laboratory performs preparation of graphite dispersed copper composite based on chemical thermodynamic study of copper – graphite system.(Image 4) This composite is expected to be used as a sliding contact. Furthermore, this laboratory performs the fundamental study of strengthening of iron by nitrogen.



(Image 4)
Graphite particles precipitated from carbon saturated molten copper.

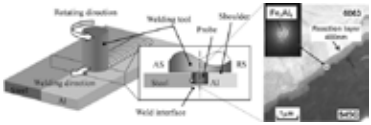
Interface and Surface Fabrication Laboratory

Staff	• Associate Professor **Yasui, Toshiaki** (E-mail：yasui@tut.jp) • Assistant Professor **Yamada, Motohiro** (E-mail：yamada@me.tut.ac.jp)
Laboratory URL	http:// isf.me.tut.ac.jp/
Key words	Dissimilar materials joining, Surface Modification, Friction Stir Welding (FSW), Cold Spray, Suspension Plasma Spray (SPS), Microwave Spraying, Plasma Electrolytic Oxidation (PEO)

Development of advanced joining process is the main objective of the laboratory research. It involves both advanced joining processes based on friction stir welding (FSW) for the bulk materials and advanced surface modification technologies, such as cold spray (CS), suspension plasma spray (SPS), microwave plasma spray, and plasma electrolytic oxidation (PEO).

Theme 1 ▶ Welding between dissimilar materials by friction stirring

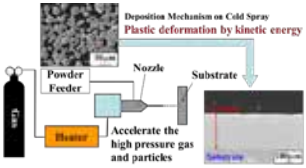
Friction stir welding (FSW) is non melting plastic flowing process instead of normal fusion welding should give a remarkable benefit and an infinite possibility to joining in dissimilar materials. The laboratory established the principle for FSW between aluminum and steel with high weld strength. This is attributed to the suppression of reaction layer growth in the weld interface by low heat input during welding. The laboratory aspires to expand the range of application as three-dimensional structure joints and dissimilar materials welding (aluminum/plastics, aluminum/ceramics) through clarifying the welding mechanism.



Dissimilar welding by FSW.

Theme 2 ▶ Cold spray

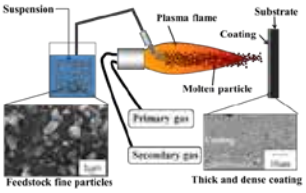
Cold spray is a solid particle deposition and thick and dense coating process. This process can avoid the thermal oxidation and phase transformation due to relatively lower heat input to the feedstock powder material. It realizes to fabricate high quality metallic coatings under atmospheric ambient. This laboratory mainly focuses on the fabrication of functional ceramic coatings by cold spray process and investigates the bonding mechanism of solid ceramic particles to the substrate.



Cold spray

Theme 3 ▶ Suspension spray process for functional coatings

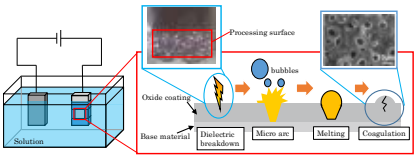
Conventional thermal spray coatings include pores and defects because of relatively larger size of particle deposition. In order to improve the density of the coatings, suspension spray process has an advantage. This process uses liquid feedstock which consists of sub-micrometric- or several micrometers of particles dispersed in a solvent. This laboratory investigates the influence of spray conditions to the coating microstructure and the properties.



Schematic images of suspension spray process.

Theme 4 ▶ Plasma electrolytic oxidation

Plasma electrolytic oxidation (PEO) is a kind of anodizing process with generation of small and minute spark discharge (micro-arc) on the anode. The coating gives excellent corrosion and wear protection properties to light metal. The laboratory investigate the coating formation mechanism by PEO and the control method by laser irradiation.



Plasma Electrolytic Oxidation (PEO)

Robotics and Mechatronics Laboratory

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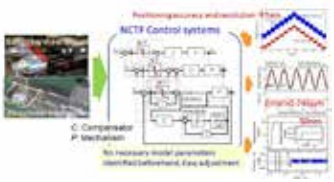
Laboratory URL	http://www.rm.me.tut.ac.jp/
Key words	Precision motion control, Manipulator, Precision robot, Learning, Actuator

Our research group aims to achieve practical and excellent mechatronics systems which have high operability, maintainability and high motion performance such as high precision and high-speed motion, for a wide variety of application fields and contribution to the convenience of the society.

Theme 1 ▶ Practical and Intuitive Controller Design for Precision Motion Systems

In order to provide high performance control systems independent of their nonlinear characteristics easily, practical control system design procedures for precision positioning and precision motion control have been proposed and evaluated experimentally. The proposed design procedures can be used without special knowledge of control theory, the information of the detailed characteristics and the model parameters prepared beforehand.



Practical control system design and its performance

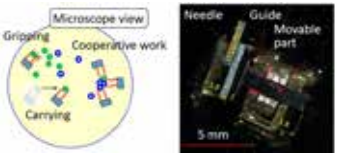
Theme 2 ▶ Precision robot for long-term stable operation

For making sustainable society amid the downward trend in the labor force population, robots are required to maintain and improve themselves, and they need to be useful over a long time without any problems. In addition, the robots need to provide high precision motion for fine and precise works. Our group has studied the precision robots and their element technologies in order to satisfy the above requirements.

Overview of testing robot

Theme 3 ▶ Micro-Manipulator with Wireless Actuators Using Lasers and Thermo-Sensitive Magnetic Material for Operating Microparts and Cells

Actuators comprising thermo-sensitive magnetic material (TSMM) parts and permanent magnets (PMs) and using laser beams, have simple structures and are free from wiring problems. These features are suitable for downsizing. Our research group studies their micro-actuators and a micro-manipulator system with them.



Works using micro-manipulator systems and a prototype of gripper unit

Theme 4 ▶ The design of the practical robot system and its control design.

Recently, the demand of the practical robots is increasing and they are studied actively at various places. This laboratory develops the human-operated and autonomous robot. In particular, the operational support control for the human-operated mobile robot and the localization and tracking control for the autonomous mobile robot.

Ionic polymer metal composite

Theme 5 ▶ Modeling and control of polymer actuators and the development of robot using polymer actuator.

As new actuator, the polymer actuators is focused. We study on the modeling and the control system of them. In particular, We aim at the realization of the self-sensing actuator by IPMC(Ionic Polymer Metal Composite) and the development the systems using the IPMC actuator.

Instrumentation Systems Laboratory

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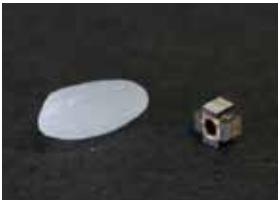
Key words	Signal processing, image processing, intellectual diagnosis, behavior measurement/ modeling, safe driving support, abnormality diagnosis, human interface

Theme 1 ▶ Micro Piezoelectric Sensors and Actuators

Piezoelectric ultrasonic actuators have two significant advantages, namely their high energy density and their simple structure, which both contribute to their miniaturization. We have proposed a micro ultrasonic actuator using a stator with a volume of approximately one cubic millimeter. This novel motor is now the smallest micro ultrasonic motor that has been developed with a practical torque in the world.There are diverse applications ranging from consumer products such as mobile phones and smart watches to medical products such as endovascular medicines and biological manipulations.



Micro ultrasonic actuator using a stator with a side length of 1 mm.

Theme 2 ▶ Minimally-invasive Medical Diagnosis Applications

The micro piezoelectric sensor and actuator technologies aim to be applied for minimally-invasive medical diagnosis and treatment devices. For example, micro actuators can control the orientation of the endoscopic camera with auto-focus and zoom mechanisms and the miniature robot arm driven by micro ultrasonic motors cut a tissue inside our body. We are developing the medical diagnosis devices using our original micromechanisms. Besides, we are starting a collaboration with medical devices companies for the practical applications.

Future medical endoscopic robot.

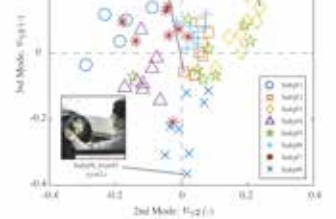
Theme 3 ▶ Soft Sensor for Measuring and Monitoring Driver State

Soft sensors are a method for estimating the response of state variables based on multivariable signals and machine learning technics. We are developing algorithms for measuring and monitoring the driver's state, such as driver's fatigue and drowsiness, which are difficult to measure directly, based on the soft sensor approach. Our approach also aims to detect and analyze for distracted driving behaviors by combining physiological and behavioral signals.

Overview of our safety driving system

Theme 4 ▶ Feature Extraction for Personal Identification

Human body movement in activities such as car driving, sport, and daily living includes components of both style and characteristics: style is defined as a common component to all subjects and characteristics is defined as a set of differences component to each subject. The goal of our research is to present a method of extracting these components features in human motions from sensor data for analyzing and evaluating human skills.



An example of feature space for classifying driver's individuality based on driving behavior

Systems Engineering Laboratory

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Key words	Design, control and motion planning of industrial machines, Optimization, Production system, Scheduling, Supply chain management		

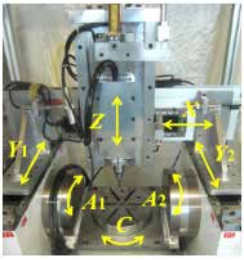
The Systems Engineering Laboratory deals with theoretical development of optimization, control, motion planning, and scheduling methods for industrial systems, and their application to industrial machinery and production systems. Current studies include the following themes:

Theme 1 ▶ Design and motion generation of industrial machinery and robotic systems based on optimization methods.

(1) Generation of energy-saving motion for machine tools/industrial robots (Figure 1);
(2) Precision control of industrial machinery using a two-dimensional pico-order sensor;
(3) Inspection system using a four-rotor helicopter (Figure 2);
(4) Conveyance robotic system by throwing and catching objects (Figure 3); and
(5) Design and control of mobile robots (wheel-type/walking-type) for industrial applications (Figure 4).

Theme 2 ▶ Study on support systems for decision-making in design/planning on manufacturing activities

(1) Multi-agent based simulation for supply chain optimization;
(2) Process planning, manufacturing execution systems;
(3) Integration of operation planning and scheduling (Figure 5);
(4) Production scheduling; and
(5) Planning support systems for nursing home



Energy-saving control for 5-axis machining (Fig. 1)


Multicopter for inspection of a wall surface (Fig. 2)


Robotic manipulator for catching a falling object (raw egg) (Fig. 3)


Robotic lawn mower (Fig. 4)


Optimization of cutting layout (Fig. 5)

Energy Conversion Engineering Laboratory

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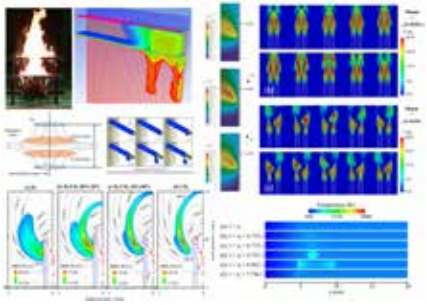
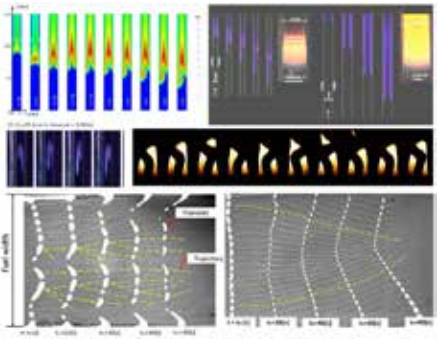
Key words	Combustion, Numerical modeling, Scale modeling, Fire safety, Reacting flow, Space		

Even today, combustion plays an important role in the world's energy systems and its control is of great importance from the two perspectives: one is to improve of energy conversion systems (e.g., engines of automobile, air plane, rocket etc.) and the other is to prevent natural disaster (fire). In terms of environmental hazard, it is noteworthy that the wildland fire causes enormous CO2 so that its prevention (control) provides huge impact to the global warming issue. The Energy Conversion Engineering Laboratory cultivates a deep insight into complicated combustion/fire phenomena to control the combustion/fire well then help to renovate/upgrade an environmental-friendly, yet secured and safe society. To cover the wide range of scale (time and space) featured in reactive-flow system, introducing the "scale modeling concept" is one of key ad unique strategies in our lab. Here are example research topics supervised in our lab.

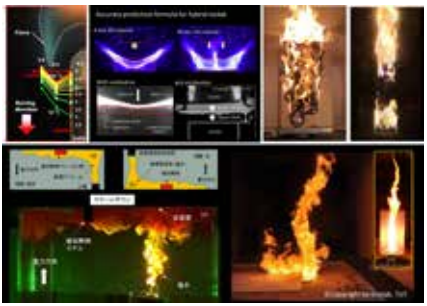
Theme 1 ▶ Numerical modeling



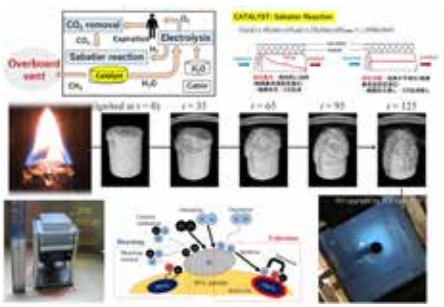
Theme 2 ▶ Combustion instability



Theme 3 ▶ Fire safety (Scale modeling researches)



Theme 4 ▶ Visualization / Novel measurement technique



Thermo-Fluid Engineering Laboratory

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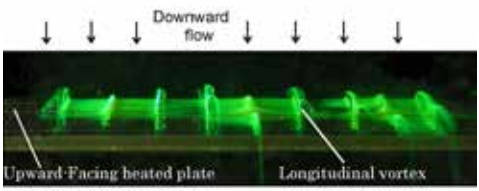
Key words	Convective heat transfer, visualization of flow and temperature fields, heat transfer performance, liquid atomization, spray characteristics, thermo-fluid analysis, computational fluid dynamics

The Thermo-Fluid-Engineering Laboratory implements the research and development of heat transfer equipment and fluid devices that enable environment-friendly and high-efficiency energy conversion and transport. To tackle a variety of thermo-fluid problems that encountered in environment and industrial equipment, we first investigate the mechanisms of heat and fluid transport through measurements and computations, and, then, clarify the parameters that govern the transportation of heat and fluid.

Theme 1 ▶ Development of visualization techniques of flow and temperature fields and evaluation of heat transfer performance

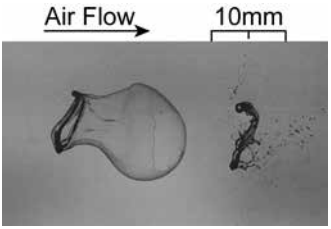
This laboratory develops various techniques to visualize flow and temperature fields encountered in heat transfer equipment and devices. The techniques differ from fluid to fluid and also depend on the objective of visualization. In light of the visualization, we subsequently assess the heat transfer performance.



Longitudinal vortices over heated plate

Theme 2 ▶ Investigation of liquid atomization process and measurement of spray characteristics

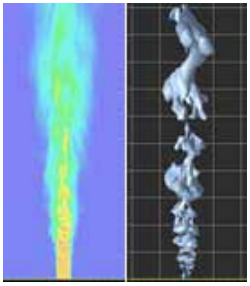
The laboratory investigates the mechanism of liquid atomization through visualizing basic atomization processes, such as droplet breakup and liquid column breakup, with use of high-speed video camera and flash photography. The lab develops the measuring system of spray characteristics and evaluates the performances of pressure-type atomizer, twin-fluid atomizer, rotary atomization device, etc.



Deformation and breakup of droplets in air-flow

Theme 3 ▶ Development and application of numerical computations for various problems concerned with heat and momentum transfer

The laboratory develops numerical models to simulate the flow/temperature fields encountered in various industrial equipment and devices. The effort is also paid to develop techniques that enable fast and efficient numerical computations applicable to the specific thermos-fluid problems.



Numerical analysis on mixing process of jet flow

Natural Energy Conversion Science Laboratory

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Laboratory URL	http://aero.me.tut.ac.jp (Iida group) http://wind.me.tut.ac.jp (Sekishita group)		
Key words	Aerodynamics, Turbulent flow, Aeroacoustics, Diffusion, Control of flow, Wind tunnel experiment, Fluid measurement, Computational fluid dynamics, Wind turbines, Musical instruments, Fluid-acoustic interactions, Automobile		

Most of the flows in the natural world and industrial products are turbulent flows. Therefore, it is necessary to clarify the characteristics of turbulent flows and examine the control method in order to develop efficient fluid machine and to predict and control pollutant diffusion. The Natural Energy Conversion Science Laboratory seeks to clarify the turbulent flow phenomenon and conducts the study on its control.

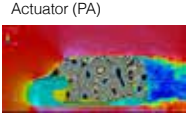
Theme 1 ▶ Technology for aeroacoustic analysis
With the aim of clarifying the generation mechanism of aerodynamic noise, which is an issue associated with fluid-related machines and high-speed vehicles, this laboratory carries out the development of measurement technologies of flows and noise as well as the study on the reduction of aerodynamic noise through controlling flows. These include hot-wire anemometer, PSP, PIV, and smoke-wire visualization. The control methods include Plasma Actuators and blowing jets.


Experimental setup of Pressure Sensitive Paint (PSP)

Theme 2 ▶ Large-scale computational technique for aerodynamic analysis
The laboratory performs coupled analysis of flows, noise, heat and vibration using the large-scale computational analysis technique. This analysis clarifies the microscopic fluid structures or characteristics of flows under special conditions, which cannot be easily observed by experiments, and seeks to develop a new technology based on that knowledge.


Flow control by Plasma Actuator (PA)

Theme 3 ▶ Natural energy-related study
This laboratory implements the study on natural energy/waste heat recovery relating to wind power generation system, thermoacoustic refrigeration system, etc.


Predicted results of interior noise of automobile

Theme 4 ▶ Study on micro-/bio fluid
The laboratory conducts the study on measurement and engineering applications of flows in the natural environment, such as flying of insects and swimming of fish.

Theme 5 ▶ Wind tunnel experiment on thermal/substance diffusion in large-scale turbulent flows
This laboratory conducts the wind tunnel experiment on diffusion of heat/substance emitted from chimneys, thermal/wind environment in the cities and blown sand on sand dunes, etc.

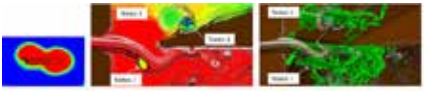

Predicted flow fields around wind turbine

Theme 6 ▶ Wind tunnel experiment on aerodynamics of racing bicycles
This laboratory conducts various experiments on wireless helicopters in addition to the product development focusing on resistance phenomenon of bicycles.

Theme 7 ▶ Musical instruments
To clarify the mechanism of acoustic radiation and propagation around musical instruments such as air-reed instruments and reed instruments, direct simulations of flow and acoustic fields and experiments by using PIV are performed.


Flow visualization of heated and unheated


Large-scale turbulent flow generator


Predicted flow and acoustic fields in musical instrument

Energy Conservation Engineering Laboratory

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Laboratory URL	http://ec.me.tut.ac.jp/index_en.html		
Key words	Liquid Purification, Resource Saving, Electrohydrodynamics, Fluid Power, Rotating Fluid Machinery, Acoustic Energy, Thermoacoustic Phenomena, Two-phase Heat Transfer		

The Energy Conservation Engineering Laboratory performs the study on energy saving and resource saving including environmental load reduction by reusing lubricating oil, enhancement of performance for fluid machinery with low noise and thermoacoustic device and development of heat transport devices using capillary force.

Theme 1 ▶ Development of high-performance lubricating oil purification system

The laboratory carries out the development of a high-speed electrostatic filter with the aim of removing minute contaminants from lubricating oils, which cause machine failure.

Theme 2 ▶ Basics and applications of electrohydrodynamics (EHD) flow

This laboratory seeks to clarify the fundamental principle of EHD flow and develops efficient pumps without impeller, actuators and heat control equipment.

Theme 3 ▶ Friction characteristics of fluid power actuators

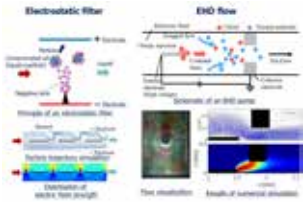
The laboratory proposes a new mathematical model allowing for the dynamic characteristics of lubricating film and seeks to improve prediction accuracy of fluid power actuator motions.

Theme 4 ▶ Phenomena related with fluid, sound and energy

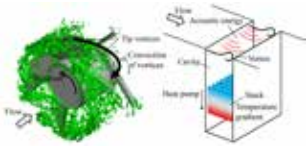
To achieve both the high performance and noise reduction for fluid machinery and high-speed transport vehicles, flow and acoustic fields need to be clarified. To do this, wind tunnel experiments and large-scale computations are performed for the flow around an axial-flow fan and cavity flow. The flow control such as a plasma actuator is also conducted for reduction of energy loss and aerodynamic noise. Also, to utilize the acoustic energy, thermoacoustic phenomena including conversion between heat and sound energy are also researched.

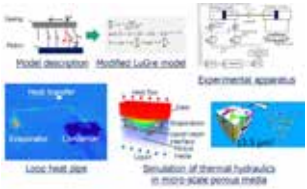
Theme 5 ▶ Clarification of liquid-vapor phase-change phenomenon within porous media in loop heat pipe evaporator

This laboratory performs three-dimensional simulation and visualization experiments with a view to clarifying the heat transfer mechanism and unstable phenomenon in loop heat pipes that can transfer heat over a long distance without electric power.



Study on lubricating oil purification and EHD


Predicted vortices around fan (left) and thermoacoustic heat pump in cavity flow (right)



Study on dynamic behavior of friction and loop heat pipes

Department of Electrical and Electronic Information Engineering

- Electronic Materials
- Electrical Systems
- Integrated Electronics
- Information and Communication Systems

Advanced Materials Science Laboratory

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Key words	Sol-Gel, Mechanical Milling, Anodization, Fuel Cells, All-Solid-State Lithium Ion Batteries, Metal-Air Batteries, Solar Cells, Superhydrophilic/Superhydrophobic, Photocatalyst, Plasmonic Nanoparticles, Multiferroic nanocomposite

We undertake research on manufacture of and applications for functional materials. The materials are prepared by means of sol-gel, ball milling, layer-by-layer assembly, liquid phase shaking, electrophoretic deposition, anodization, etc.

Fig. 1 Photo of electrolyte for fuel cell

Theme 1 ▶ New Generation Fuel Cells

We have developed novel electrolyte composed of phosphoric acid doped polybenzimidazole and inorganic solid acid complex for fuel cells. The inorganic solid acid complex is prepared by ball milling method and the composite electrolyte thus obtained exhibits high thermal stability and high proton conductivity at 100 °C and up. The electrolyte is also mechanically strong and flexible as seen in Fig. 1. The maximum power density at 160 °C and under anhydrous condition is 400 mW cm-2.

Theme 2 ▶ All-Solid-State Li Ion Secondary Battery

We have developed novel synthetic method for a precursor of Li3PS4 solid electrolyte for Li ion secondary battery. The precursor was composed of Li3PS4 and ethyl acetate in a molar ratio of 1 : 2, as determined by thermogravimetric-differential thermal analyses (TG-DTA). Upon drying at 160 °C, the precursor decomposed to form crystalline Li3PS4 with a high ionic conductivity of 3.3 × 10−4 S cm−1 and low activation energy of about 31 kJ mol−1. Fig. 2 shows a scanning electron microscope (SEM) image of Li3PS4 solid electrolyte which is derived from the newly developed precursor.

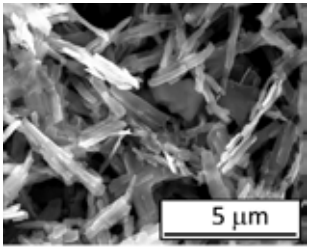

Fig. 2 SEM image of Li3PS4 solid electrolyte derived from the newly developed precursor for Li ion battery

Theme 3 ▶ Plasmonic Nanostructures for Photocatalyst and Solar Cells

We have synthesized several kinds of plasmonic nanostructures composed of noble metal nanoparticles and nano/meso-porous metal oxides prepared by sol-gel, anodization, etc. Fig. 3 shows transmission electron microscope (TEM) images of Au deposited mesoporous SiO2-TiO2. Au was deposited with selected shapes of sphere and rod. These materials show high performance of photocatalysis under sunlight because they absorb the photons very efficiently. Ag-nanoparticle-doped TiO2 was used as photoanode of dye-sensitized solar cells to enhance their power conversion efficiency.

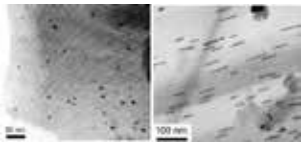

Fig. 3 TEM images of Au nanosphere (left) and Au nanorod (right) deposited mesoporous SiO2-TiO2 photocatalysts

Theme 4 ▶ Multiferroic Nanocomposites for Novel Devices

We have synthesized BaTiO3 (BTO) nanotube arrays by anodization followed by hydrothermal treatment. Figs. 4A and 4B show the top and cross-sectional SEM images of BTO nanotube arrays. The pores of the tubes are filled with CoFe2O4 (CFO) through electro-magneto-phoretic deposition, sol-gel, etc. to obtain multiferroic nanocomposites as shown in Fig. 4C.

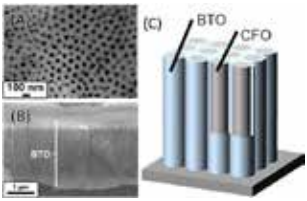

Fig. 2 (A and B) SEM images of BTO nanotube arrays. (C) Illustration of one of the ideal structures of multiferroic nanocomposite.

Spin Electronics Group

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Laboratory URL	http://www.spin.ee.tut.ac.jp/		
Key words	Magnetic material, spin, artificial magnetic lattice, magneto-optical effect, magnetophotonic crystal, photonics, spintronics, magnonics, spin caloritronics, advanced measurement system		

Spin is the origin of ferromagnetism and plays an important role in electrical and electronic information engineering. By controlling the orientation and extent of this spin, it can control various physical quantities such as light, high-frequency electromagnetic waves or ultrasonic, offering attractive functions. We investigate new magnetic materials and devices having specific micro or nano structures called artificial magnetic lattices.

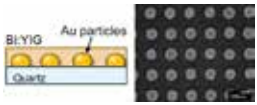
Theme 1 ▶ Spin functional material

We develop magnetophotonic crystals (original to our group) that show enhancement of magneto-optical effects. We also develop new materials with spin functions such as magnetic holograms, multiferroic materials, magnetic domain materials, etc. using sputtering, PLD (Pulsed Laser Deposition), MBE (Molecular Beam Epitaxy), MOD (Metal Organic Decomposition methods.

Magnetophotonic crystals

Theme 2 ▶ Magneto-optical plasmonic structure

In magnetic garnet composite structure with Au particles, which is one of the artificial magnetic lattices, Faraday rotation is enhanced at a wavelength where surface plasmon resonance is excited. Finite-difference time-domain (FDTD) simulation is used to understand phenomena.



Magneto-optical plasmonic structure

Theme 3 ▶ Magnetic hologram memory

A large-capacity holographic data storage system called the collinear system is recognized as a world-first international standard from our research. Currently, we are working to develop high-density holographic data storage systems (multi-volume recording) using optical phase information and rewritable recording systems using polycrystalline spin materials with nanoscale particle size.

Hologram memory system and recorded magnetic information

Theme 4 ▶ Magneto optic special light modulator and 3D display

We develop magneto optic spatial light modulator (MOSLM) using magneto-optical effect with fast switching speed of approximately 10ns per pixel. As an application of the MOSLM, a 3D display can show stereoscopic image having a viewing angle of about 30 degrees in case of the MOSLM with pixel size of 1 μm.

MOSLM and 3D display

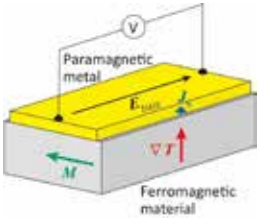
Theme 5 ▶ Spin wave devices

Using magnonic crystal that manipulates spin wave, we develop a new magnonic device for magnetic field sensing with ultra-high sensitivity at room temperature. Furthermore, we develop a new logic device that utilizes spin wave interference in magnetic oxide material.

Magnonic device using spin wave

Theme 6 ▶ Spin caloritronics application

Realizing thermoelectric power generation, in addition to exploring raising the performance of thermoelectric materials such as Ca3Co4O9 (Co349), we develop a thermoelectric conversion module. Using the recently discovered spin Seebeck effect, we develop a spin control device based on heat and new thermoelectric power generation module.



Spin Seebeck effect

Theme 7 ▶ Advanced measurement technology

We develop new advanced measurement technologies: optical and magneto-optical confocal microscopy, computer tomography, scanning near field microscopy, etc. for the magnetic, optical, electrical and structural properties,

Processing and Instrumental Mechanics Laboratory

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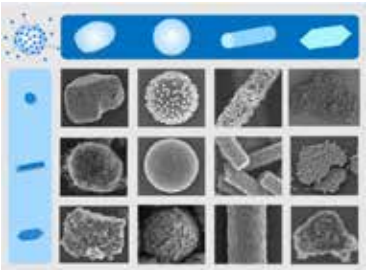
Laboratory URL	http://ion.ee.tut.ac.jp/
Key words	Nano-composite, functional / structural ceramics, composite particles, discrete element method, finite element method, nano-indentation, superplastic deformation

To further advance various electronic devices, it is essential to develop materials with properties that surpass existing ones. Up to now, as a method to both improve the properties and to innovate new ones, our laboratory has proposed a novel nanocomposites fabrication technique that can be used to obtain optimal microstructural design using attractive electrostatic force, and the properties improvement of the nanocomposite in mechanical, heat and electrical properties have been investigated. Additionally, as it is imperative to establish technologies that can universally and scientifically perform evaluative analysis of the newly-developed materials' properties, establishment of evaluation technology is also carried out.

Theme 1 ▶ Nanostructure controlled functional ceramic composite materials

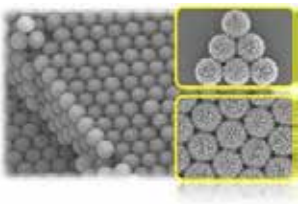
By controlling the microstructural morphology, the mechanical and functional properties of composite materials, such as strength and fracture toughness, etc., can be enhanced. However, by using conventional mechanical powder mixing method, desired properties could not be achieved due to the inhomogeneous mixing. In this study, various types of functional composites fabrication are investigated and developed using novel nano-assembly technique.



Composite materials via proposed technique

Theme 2 ▶ Development of functional composite particles

In this study, novel preparation of functional composite particles via electrostatic adsorption technique is investigated. Various types of composite particles with varying shape can be obtained using nano-sized materials such as adsorption of carbon nanotube onto a particle matrix. This technique would be useful for application in electrochemistry, high efficiency catalysts as well as optoelectronic devices.

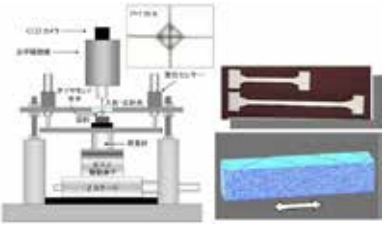


Ordered structure of functional composite particles

Theme 3 ▶ Deformation and flow of advanced materials

This project focus on the investigation of deformation and flow of polycrystalline materials (commonly ceramics) at not only room temperature but also high temperatures. A novel testing procedure and theoretical analysis which includes computer simulation are proposed in this study.

a. Mechanical property analysis of thin films by nano-indentation technique.
b. Surface mechanical property evaluation by scratch test
c. Superplastic deformation of nanostructured materials



Evaluation techniques in our laboratory

Electroanalytical Chemistry Laboratory

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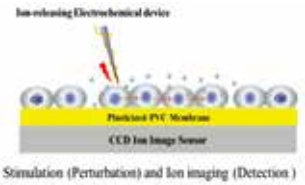
Laboratory URL	http://www.electroanal.ee.tut.ac.jp/
Key words	Ion sensor, ion imaging, electrochemical device, chemical stimulation, polyelectrolyte, chemical observation, living cells and tissue, bio-friendly system

Our laboratory researches micro electrochemical devices and array type ion image sensors, and investigates the application of polyelectrolytes for electrochemical devices. The aim and concept is to fabricate a bio-friendly system for chemical observation of cells and tissues.

Theme 1 ▶ Development of Micro Electrochemical Devices to Release Ions

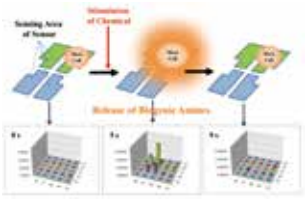
Living action of cells and tissues is due to a conversion and/or a transfer of chemical substances. In order to analyze the action of a tissues, controlled techniques is required; only a cell is stimulated in local, and then the change of chemical substances by the stimulation transfer is monitored. We are developing micro ion-release electrochemical devices to the chemical stimuli. The electrochemical ion-release device is an important tool to stimulate a cell chemically without other effects.



bio-friendly system
An electrochemical system observes living cells by a chemical stimulation.

Theme 2 ▶ Development of Electrochemical Ion Image Sensor

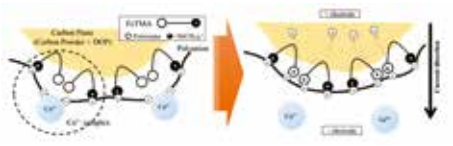
Ion selective electrodes (ISE) and semiconductor ion sensors (ISFET/CCD ion sensor) can measure a specific ion immediately. We have developed ISEs for polyelectrolytes and non-ionic chemicals that had been regarded as difficulty of its detection from Nernst equation. Recently, using a CCD-type ion image sensor that was developed by Professor Sawada in TUT, we are developing chemical imaging of several metal ions and biologically-important organic ions. The image sensors can monitor living cells and tissues non-invasively.



mast cell stimulation
The ion image sensor monitors the concentration change of biogenic amines released from mast cells by a chemical stimulation. 3D images show each sensor response around a mast cell stimulated.

Theme 3 ▶ Application of polyelectrolytes

Polyelectrolytes act as substances with unique functions. We had developed analytical methods for various synthetic and natural polyelectrolytes (chitosan, heparin, chondroitin sulfate, and polyhexanide hydrochloride, etc.) using titration, electrochemical analysis (voltammetry and potentiometry), and capillary electrophoresis. In addition the reaction of polyelectrolyte with proteins has been analyzed. Now, we develop electrochemical devices using polyelectrolytes.



polyelectrolyte ternary complex
A polyelectrolyte ternary complex releases calcium ion by electrolysis.

Clean Energy Conversion Laboratory

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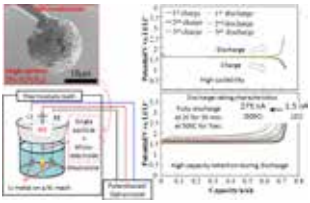
Laboratory URL	http://www.cec.ee.tut.ac.jp/
Key words	Lithium-ion batteries, Multivalent ion batteries, All-solid-state batteries, Battery materials, measurement

In order to provide integrated solutions to resource energy and environmental issues and meet societal demands such as for diversification, low environmental impact and decentralization of power sources in the desired ubiquitous network clean energy society, long life secondary batteries and high efficiency fuel cells with low environmental load and high energy density are essential. R&D on new materials, processes and evaluation technologies that will be the foundation of these power sources will become more and more important in the future. This laboratory is broadly deploying R&D that contributes to high safety, low cost, high performance and high reliability of electrochemical energy conversion devices, while looking to their use in clean vehicles such as electric and fuel cell vehicles and the renewable energy generation field.

Theme 1 ▶ Research for next-generation high-performance secondary batteries

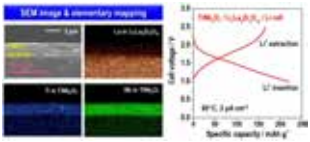
We are putting our attention on environmentally friendly, low cost electrode materials, making clear the material physico-chemical properties, battery operating conditions and various reaction process correlations that occur within batteries such as charge transfers, mass transfers and side reactions. We are also conducting research to improve the performance of lithium-ion batteries by clarifying battery reaction mechanisms. We are also working on research for new battery types such as multivalent ion batteries.



Charge-discharge property of new battery material using single particle measurement system.

Theme 2 ▶ Research for oxide-based all-solid-state battery

All-solid-state lithium-ion batteries, using nonflammable inorganic solid Li-ion conductor as an electrolyte, is expected as one of the next generation energy storage devices, because its safety and reliability are much superior to present lithium ion batteries with flammable organic carbonate liquid electrolyte. However, development of solid electrolytes with both high ionic conductivity and minimizing interfacial resistance between solid electrolyte and electrodes are critical issues to be solved. In our laboratory, oxide solid electrolyte with high ionic conductivity and chemical stability against electrode materials are developed. In addition, aerosol deposition (AD) method, which is polycrystalline ceramic film formation process under room temperature, is applied for novel fabrication process of all-solid-state batteries.



Film electrode formed on oxide solid electrolyte by AD (left) and its charge and discharge property (right).

Theme 3 ▶ Research of new measurement technologies for batteries

There is a trend for lithium-ion batteries to be used in more large scale applications, but fires or explosions may occur if a fault occurs due to the high energy density, and together with recent large-scale recalls, the battery safety has become an issue for society. In this research, we develop battery measurement technologies to detect problems in the production and use of batteries in advance and that can non-destructively identify battery degradation causes.

Plasma Energy System Laboratory

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Laboratory URL	http:// www.pes.ee.tut.ac.jp
Key words	Vacuum plasma, atmospheric-pressure plasma, diamond-like carbon, eco-energy, nanocarbon, energy devices

Theme 1 ▶ Effective utilization of renewable energy and eco-energy

Securing sufficient energy and protection of the global environment are important issues for human. In order to deal with these issues, we are working on research to effectively utilize clean energy (solar energy and wind energy) from the Sun that is the enormous plasma and eco-energy (cogeneration) from energy recovery system such as exhaust heat utilization.

(1) Eco-energy system design and its high-efficiency operation
(2) Utilization and application of weather measurements and solar panel systems
(3) Energy environment control on the cultivation of plants

Solar panels of TUT

Theme 2 ▶ Development of apparatus using generation and control of plasma and its applications for industrial use

We have investigated generation and control technologies of vacuum arc plasma that generates high-energy ions and atmospheric-pressure plasma that generates chemical active radicals. Especially, we have developed apparatuses and processes aimed at industrial use.

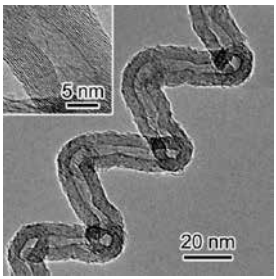
(1) High-performance filtered arc deposition apparatus based on electromagnetic field control and its process development
(2) Composition control and quality analysis of diamond-like carbon (DLC) film
(3) Development of vacuum and atmospheric-pressure plasma apparatuses, and its application to surface treatment by physical vapor deposition and chemical vapor deposition (PVD/CVD) processes
(4) Development of forming, shaping and removing processes for functional protective films

Apparatus for generating high-purity carbon plasma beam

Theme 3 ▶ Nanocarbon synthesis and its application development

We have synthesized nanocarbons using a thermal chemical vapor deposition (CVD) method. We have developed nanocarbons for applications such as energy devices for eco-energy systems, electronic devices, and hydrogen generation system.

(1) Synthesis of helical carbon nanofibers using a catalytic CVD method
(2) Development of direct methanol fuel cells using nanocarbons
(3) Development of super capacitors using nanocarbons
(4) Development of field electron emission sources using fibrous nanocarbons
(5) Development of solar cells using nanocarbons



Transmission electron micrograph of carbon nano-coil

Dielectrics and Electrical Insulation System Laboratory

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	• Assistant Professor	**Kawashima, Tomohiro**	(E-mail：kawashima@ee.tut.ac.jp)
Laboratory URL	http://icceed.tut.ac.jp/hozumi/ http://dei.ee.tut.ac.jp/		
Key words	High voltage, insulation diagnosis, ageing, functional insulating material, Ultrasonic microscope, biological tissue, acoustic impedance		

To ensure safety and reliability of power equipment and electronic devices, it is important to select the dielectric and insulating materials suitable for the equipment. In addition, it is also necessary to clarify the cause of failure or to estimate the replacement timing of the equipment. We are developing new measurement and diagnosis techniques based on electrical engineering and clarify the high electric field phenomenon of the dielectric and insulating material. In addition, we apply the developed techniques to fields for medicine, environmental technique, automobile, steel, food, and material.

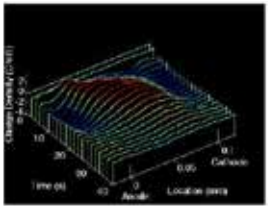
Theme 1 ▶ Diagnosis techniques for industrial use

Replacement timing of deteriorated electrical equipment is important. If it is too early, the replacement cost will increase. On the contrary, if it is too late, it will lead to accident. To prevent the accidents, we develop new techniques for detecting minute signals emitted with degradation. The main research are as follows.

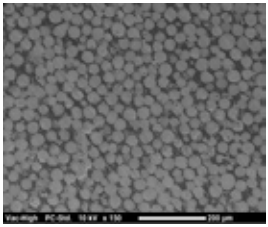
① An electrification in materials is significantly distorts the internal electric field and it may lead to dielectric breakdown. By using ultrasonic technique, the internal charge density distribution can be measured by applying a very high voltage. The technique is highly appreciated in the field of high voltage power transmission.

② Partial discharge (PD) may occur due to the electric field concentration in the electrical insulation parts of power equipment and continuous PD occurrence may lead to dielectric degradation and finally breakdown. PD detection using an antenna method has often advantage. We clarify the relationship between PD phenomena and radiation electromagnetic waves.

③ It is big issue that continuous PD occurs locally in solid dielectric material. Local dendritic path grows and branch into hollow channels (Electrical Tree) may arise. The electric tree is also one of the causes of degradation. We clarify the occurrence and propagation mechanism for the electrical tree.



Charge movement in polymer



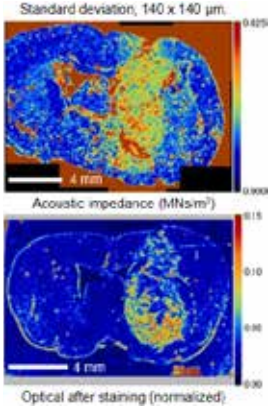
Composite insulation materials

Theme 2 ▶ Development of functional composite insulation materials

The thermal conductive plate in devices like power module for an automobile requires materials with higher thermal conductivity and acceptable electric breakdown strength. By using electrostatic adsorption method, it can design optimal microstructures of filler and matrix polymer. We are developing thermal conductive composite insulating materials with a good balance of acceptable breakdown strength and higher thermal conductivity.

Theme 3 ▶ Ultrasonic techniques for medical use

We are developing an ultrasonic microscope that can image local acoustic impedance of a biological tissue. It can observe without introducing any contamination to the tissue, and without staining the tissue. At this moment we can observe live cultured cells as well as cross section of tissue. Its resolution is as good as several micrometers.



Ultrasonic techniques for medical use

Integrated Biosensor and MEMS Group

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Laboratory URL	http://int.ee.tut.ac.jp/bio/
Key words	Smart sensors, CMOS, silicon devices, MEMS/NEMS, RF devices, nanodevices, agricultural sensors, biosensors, gas sensors

Our group studies sensors and micro/nano devices based on LSI and MEMS technologies. The application of the devices covers various fields that include life science, environment, healthcare, etc. We work on creating world's first novel devices from scratch —from design to evaluation— by fully utilizing the LSI/MEMS fabrication facility to contribute to solving issues in such fields.

Theme 1 ▶ Intelligent biosensors

We are researching creative biosensor devices that combine integrated-circuit technology (CMOS and CCD image sensor technology), MEMS and bio-chemical technology. In particular, we are researching and developing image sensors (Fig.1) that can detect various ions from DNA and biological substances and visualize their 2-dimensional distribution and concentration. Further, based on this technology combined with enzymatic reaction, we are developing biomolecule sensors that can detect only specific substances (glucose, etc.). We are also researching on multimodal sensors that can detect various biomolecules, fluorescence, and force at the same time as pH.

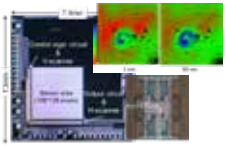

Fig.1

Theme 2 ▶ Filter-free fluorescence image sensor

We develop novel Si-based fluorescence image sensors aiming for the applications including point of care testing (POCT) and micro-total analysis systems (μ-TAS) (Fig. 2). The devices do not require any optical filters, which enable a miniature and simple detection system compared with conventional fluorescence microscopy. Further, they realize simultaneous detection of more than two fluorescence with different wave lengths. We both design and fabricate the devices for further improvement in their performance.

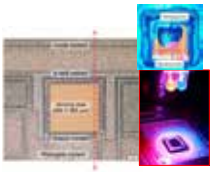

Fig.2

Theme 3 ▶ Ion and force image sensors

Ion and force image sensors can record the change of ion concentration and force distribution in solution (Fig. 3). The sensor consists of CMOS integrated readout circuits and arrayed pairs of an Ion-sensitive FET (ISFET) and a piezoelectric oxide semiconductor FET (POSFET). The recorded images by the sensor will be able to provide a comprehensive analysis of extracellular metabolisms, such as cell immigration and biochemical communications.

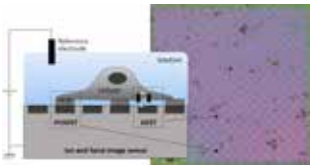

Fig.3

Theme 4 ▶ Intelligent Bio-MEMS devices

We develop sensors that can detect biomarkers that are the diagnostic indices of various diseases quickly and accurately from one drop of blood or urine, aiming to realize rapid onsite diagnosis for simple examination and first aid of illnesses in the home. We are reducing the size and adding multiple elements to sensors that fuse optical MEMS (microelectromechanical systems) and integrated circuit technology, aiming for exhaustive disease diagnosis by the detection of multiple biomarkers (Fig. 4).

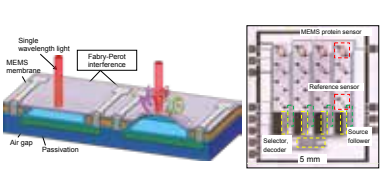

Fig.4

Theme 5 ▶ Variable plasmonic metamaterials

We fabricate metal periodic nanostructures at the same dimensions as light wavelengths, and develop artificial optical materials and plasmonic metamaterials with optical properties that do not exist in the natural world. We embed nanostructures in polymer thin films, aiming to create display elements and electronic skins that can be pasted on that to freely change their coloring using micro-actuator technology (Fig. 5).

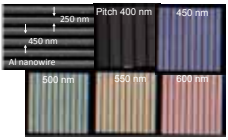

Fig.5

Integrated Photonic Device Group

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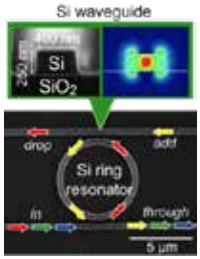
Laboratory URL	http://int.ee.tut.ac.jp/photon
Key words	Silicon Photonics, Photonic Devices, Integration, Optical Communications/ Interconnects, Germanium, Epitaxial Growth, Optical Waveguides, Multiplexers/ Demultiplexers, Photodetectors, Optical Modulators, Lasers

Si photonics is a technology to fabricate and integrate ultrasmall photonic devices on a Si chip using LSI processes. Such integrated photonic devices are strongly required for low-power and high-capacity information transmission. Based on the state-of-the-art SiGe epitaxial growth technology, high-performance active photonic devices operating at the near-infrared communication wavelengths (1.3–1.6 μm) are integrated on a Si chip with passive photonic devices such as optical waveguides and optical filters.

Theme 1 ▶ Si-based Waveguides

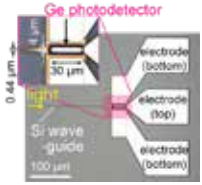
Si/Si nitride waveguides enable light propagation on a Si chip for high-capacity optical communications (wavelength: 1.3 - 1.6 μm) as well as optical interconnections in high-performance LSIs such as AI chips. SOI (Si-on-insulator) wafers have been used, while a technology has to be developed using standard bulk Si wafers toward mass productions.



Si optical waveguides and ring resonators

Theme 2 ▶ Ge-on-Si Photodetectors

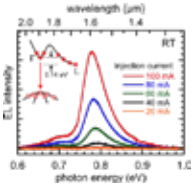
Photodetectors are inevitably necessary to convert optical signals to electrical ones for the processing with LSIs. Ge, a group-IV semiconductor similar to Si, has a good compatibility with Si processing technology. Integrated photodetectors of high-quality Ge epitaxial layer have been realized, while higher-frequency operation remains as an important issue.



Ge photodetector integrated with Si optical waveguides

Theme 3 ▶ Novel Ge-on-Si Devices

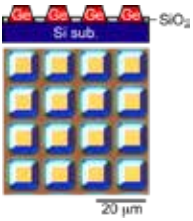
Ge is an indirect bandgap semiconductor, while theoretical investigations have shown that excellent optical properties, similar to direct semiconductors, can be obtained applying the band engineering. Novel photonic devices are under investigations such as optical intensity/phase modulators and light emitters (particularly, lasers).



Electroluminescence from Ge

Theme 4 ▶ Near-infrared Imaging

Near-infrared Ge detectors are applicable to image sensors in addition to optical communications. Near-infrared light tends to penetrate into materials as well as human bodies, indicating applications to see-through image sensors.



Arrayed Ge mesa structure selectively grown on Si

Opto-Electronic Group

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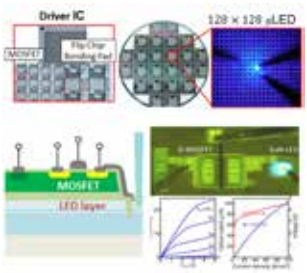
Laboratory URL	http://www.int.ee.tut.ac.jp
Key words	Micro-Display, Solar Cell, Thermal Stable LD, Crystal Growth (III-V-N on Si, GaN), OEIC

Theme 1 ▶ Development of Monolithic Opto-Electronic Integrated Circuit

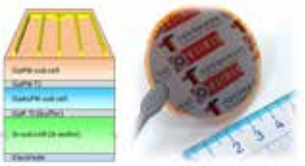
In the last decade, the significance of heterogeneous integration devices/systems has been progressively increasing because of the anticipated limit on further miniaturization of Si-based LSIs, and GaN-based materials are understandably one of the candidates for that component. In Particular, the heterogeneous integration technique on the Si-CMOS platform is an important topic for a breakthrough to POST-CMOS technology. In this subject, a monolithic integration process of Si-MOSFET and GaN-μLED using Si/SiO2/GaN-LED wafer has been developed. The n-channel MOSFETs (nMOSFETs) and μLED are successfully fabricated as a top-Si layer and GaN-LED layer respectively using a CMOS process line.



Opto-Electronic Integrated Circuit using GaN-LED and Si-LSI

Theme 2 ▶ Development of Monolithic III-V-N/Si Multi-Junction Solar Cell

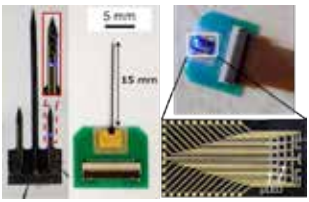
Integration of high-quality III-V compounds on Si substrates are of importance for a wide variety of light emitting/absorbing device applications while it allows significant saving of substrates. The monolithic integration approach using lattice-matched III-V/Si hetero-epitaxy enables a simple fabrication process of dislocation-free device structures on entire Si substrates. In this subject, we propose a GaPN/ GaAsPN/Si multi-junction structure in which lattice constants for all layers are matched to a Si bottom cell for highly efficient and cost effective solar cells.



Monolithic III-V-N/Si Multi-Junction Solar Cell

Theme 3 ▶ Development of micro-LED neural probe for optogenetic stimulation

Optogenetics, in which neural activity can be selectively manipulated by light, is a new technology that has attracted in neuroscience in recent years. Although optical fibers are generally used for optical stimulation, they restrict the free moving of experimental animals because they are connected to the animals. A MicroLED device is one of candidates for achieving optical stimulation under free movement because it can be controlled by wireless. Furthermore, multipoint stimulation can be achieved by arranging a plurality of micro LEDs in one probe, which can clarify how neural network works. In this subject, we have been developed a novel MicroLEDs tool for Optogenetics to understand brain function.



MicroLED tool for bioscience

Kawano Research Group

Staff	• Associate Professor **Kawano, Takeshi**
Laboratory URL	http://www.int.ee.tut.ac.jp/icg/member/~takekawano
Key words	microscale device, nanoscale device MOSFET, MEMS, flexible device, stretchable device, neural recording/stimulation, neuron/cell, brain

Theme 1 ▶ Microneedle-electrode array device

"The brain is an extremely complex system." Microfabricated silicon needle-electrode devices were expected to be an innovation that records and analyzes the electrical activities of the microscale neuronal circuits in the brain. We have developed the world's smallest 5-μm-diameter low-invasive needle electrodes for the brain. Their electrode device reduces the total invasiveness to brain tissue in vivo and realizes stable neural recordings, thus enhancing opportunities for needle-electrode device technology in neurophysiology.

Recent papers:

Sawahata, H. et al. Single 5 μm diameter needle electrode block modules for unit recordings in vivo. Sci. Rep. 6, 35806 (2016).
Fujishiro, A., et al. In vivo neuronal action potential recordings via three-dimensional microscale needle-electrode arrays. Sci. Rep. 4, 4868 (2014).

Theme 2 ▶ Nanoneedle-electrode array device

For acquiring a large amplitude and a high quality of neuronal signals, intracellular recording is a powerful methodology compared to extracellular recording to measure the voltage or current across the cell membranes. We have developed an intracellular recording device, which has >100-μm-long three-dimensional nanoscale-tipped microneedle-electrodes. The nanoelectrode, whose size is longer than the conventional intracellular nanoelectrode (< 10-μm long), has the potential to be used in cells that are deep within a tissue, such as cells in brain slices or brain in vivo, thus accelerating the understanding of the brain.

Recent papers:

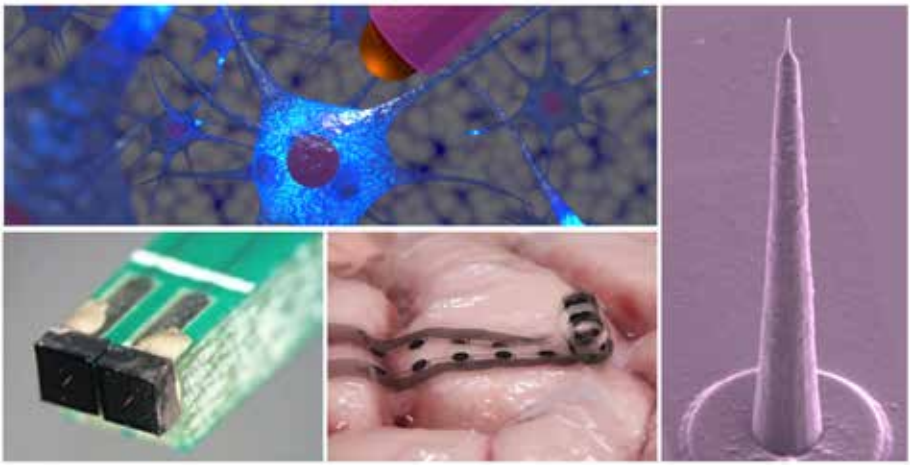
Kubota, Y. et al. Long nanoneedle-electrode devices for extracellular and intracellular recording in vivo. Sensors Actuators B. Chem. in press.
Kubota, Y. et al. Nanoscale-tipped high-aspect-ratio vertical microneedle electrodes for intracellular recordings. Small 12, 2846–2853 (2016).

Theme 3 ▶ Flexible, stretchable, and deformable device

Electrocorticographic (ECoG) recordings are a low invasive way to record the neuronal activities from cortical surfaces and are used in medical applications such as diagnostics of diseases. Common issue of state-of-the-art flexible ECoG devices that are thin and a large area, is addressing difficulties during device placement. We have proposed a way to overcome this by facilitating an actuating film based on a curled film. However, the curled film is flattened when the film comes in contact with a brain surface due to the surface tension between the film and the brain-surface.

Recent paper:

Yamagiwa, S., Ishida, M. & Kawano, T. Self-curling and -sticking flexible substrate for ECoG electrode array. Proc. IEEE Int. Conf. Micro Electro Mech. Syst. 480–483 (2013).



Developed neuronal recording micro/nanodevices: extracellular micro-scale needle-electrode (lower left), flexible ECoG microelectrode (lower center) and intracellular nano-scale needle electrode (right).

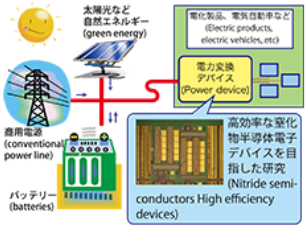
Applied Physical Properties and Process Laboratory

Staff	• Professor **Okada, Hiroshi** (E-mail : okada@las.tut.ac.jp)
Laboratory URL	http://www.int.ee.tut.ac.jp/oeg
Key words	Electron device, compound semiconductor, GaN, harsh environment electronics, power electronics, nano materials

Our interest is a development of novel electron devices beyond the present microelectronics by using compound semiconductors such as gallium nitride (GaN). Towards integrated device/system for power electronics and harsh environment electronics, device fabrication technologies are also investigated using clean room facility.

Theme 1 ▶ High performance electron device based-on nitride semiconductors

So far, semiconductor devices are regarded as components for "low power electronics." However, recent advances in technology for GaN-related materials open up a new field of “heavy electronics” or “power electronics,” where high voltages beyond 100 V are controlled in higher temperature environments. These advances are promising for compact and high efficiency systems which are indispensable for hybrid vehicles and electric vehicles. Realization of high tolerance devices for use in harsh environments is also expected. In this laboratory, we focus on power electronics and electronics for harsh environments, and investigations are made to develop advanced semiconductor devices based on nitride semiconductors and nano materials.



Power electronics for daily life.

Theme 2 ▶ Investigation of novel electron device by heterogeneous integration

Nitride semiconductors possess relatively wide band gap energy and chemically stable nature. These properties are suitable for operations of electron devices made with nitride semiconductors in tough environment such as in high temperatures nearby the engine in vehicles, irradiation environment in space, and so on. Novel sensors and electronic devices can be expected by hybriding nitride semiconductors and other characteristic materials or nano structures including well developed silicon circuits. These unique integrated devices are expected to enhance the field of engineering since these are useful to detect physical information in harsh environment.

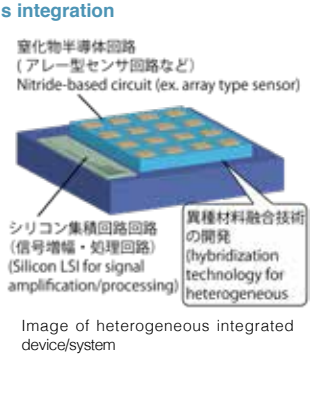


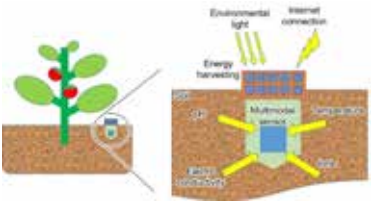
Image of heterogeneous integrated device/system

Integrated Sensing System Laboratory

Staff	• Associate Professor **Noda, Toshihiko** (E-mail：info-bio@int.ee.tut.ac.jp)
Laboratory URL	http://int.ee.tut.ac.jp/bio/en/
Key words	CMOS, MEMS, Multimodal sensing, Intelligent sensors, Agricultural sensors, Packaging technology

Our research interests are focused on smart sensing systems based on CMOS/MEMS technology. Multimodal sensing systems integrated with different kind of sensors such as physical sensors, chemical sensors, and biosensors, attract attention as a key element of new generation society based on IoT and big data analysis. This concept is proposed in the 5th Science and Technology Basic Plan of Japan as “Society 5.0”. In our laboratory, design and fabrication technologies of the multi-modal sensors are studied. Novel application of sensors in the harsh environment that can be realized using robust packaging technology is also investigated.

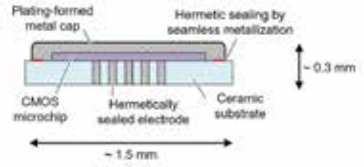
Theme 1 ▶ Agricultural sensors



Agricultural multimodal sensor

Multi-modal sensing become an important technology in the field of smart agriculture typified as the plant factory. In the case of hydroponics, feed-back control of components of nutrient solution is necessary based on multi-element detection of nutrients. The temperature of nutrient solution and the amount of dissolved oxygen also have a big influence on the growth of fruit and vegetables. Similarly in the soil cultivation, there are many items related to growth, which are nutrients, moisture content, pH, and temperature in the soil. In recent years, there are attempts to measure these items to optimally control the growth of plants and maximize the productivity of crops. Since each item is not independent but mutually related, it is necessary to comprehensively measure a plurality of items simultaneously and perform big data analysis in order to optimize growth conditions. In this laboratory, we are studying sensing devices and systems that measure and visualize the important items, which are nutrients, moisture content, and distribution of various ions for example, by a multimodal measurement. This makes it possible to accurately grasp the information of the rhizosphere, which plays an important role in plant growth, and contributes to an increase in yield.

Theme 2 ▶ Packaging technology



Miniaturized packaging technology for harsh environment

In social implementing the multimodal sensors and expanding its application range, it is necessary to operate the sensor stably for a long time even in harsh environments. For example, in the case of sensors for agriculture, sensors are used in the water and soil. Therefore it is required to withstand external stress such as water infiltration, water absorption, electrode corrosion, and mechanical force. In the case of biomedical applications, it is also required to be minimally invasive, non-toxic, and flexible. Unless these requirements are satisfied, even a sensor having excellent measurement capability cannot be put into practical use. Our laboratory is working on development of a packaging technology concurrently with the sensor development. In accordance with various requirements of each application, we are working on the development of element technologies for realizing ultra-small packages as well as optimum shapes and materials of the packages. As an alternative to a conventional packaging technology which was based on the assembly of individual parts, we are working on a chip level package by introducing thick-film forming technologies such as a plating technology used in the CMOS/MEMS technology. Sophisticated packages that are compact and flexible and can operate stably for a long time even under the harsh environments can be achieved by a combination of these technologies.

Wave Engineering Laboratory

Staff	• Professor **Ohira, Takashi** (E-mail：ohira@tut.jp) • Research Assistant **Abe, Shinji** (E-mail：abe@ee.tut.ac.jp)
Laboratory URL	http:// www.comm.ee.tut.ac.jp
Key words	Electrified road electric cars, underwater wireless power transmission, communication for high-frequency filters, battery-less sensor systems, non-linear device measuring instruments, DOA finders, wireless secret key sharing, wireless power transfer, drone

The wireless technology makes us free from the confines due to wires. In addition to the current information transmission systems for broadcasting and communication, prospective applications are emerging if we can exploit the wireless technology for energy transfer. Our laboratory is engaged in research and education covering a wide scope from creating basic theories to pragmatic system development. Graduated students are expected to be a professional engineer who contributes to the global society by the sophisticated wireless technology.

Theme 1 ▶ Electrified roadway, Future vehicle city

We propose a new concept of electric motor vehicle named EVER, which can continuously run on electrified roadways without consuming charged onboard energy. This technology simultaneously overcomes four major problems: weight, cost, charging time, and cruising range of battery-based EVs. To develop this technology, we focus on the wheels of the vehicle to pick up high-frequency energy from a feeder line buried under the road surface. The line is excited with high frequency while the EV is running, the energy propagates on the line, goes through the wheel, and finally reaches the motor. This technology will contribute to mass deployment of EVs replacing fossil-fuel engines, and to the ecological world with minimum CO2 emission.

Custom Computing Systems Laboratory

Staff	• Professor **Ichikawa, Shuichi** (E-mail : ichikawa@tut.jp)
Laboratory URL	http://www.ccs.ee.tut.ac.jp/ich/index.html.en.latin1
Key words	Special-purpose Computing Circuits, FPGA Applications, Computer Security, Parallel Processing, High-performance Computing, Embedded Systems

Our laboratory deals with a wide range of research from software to hardware based around “high-speed processing.” We explore the methods to improve performance using dedicated circuits (in hardware themes), and using parallel and distributed processing (in software themes). We are also promoting research on information security and computer security, whose importance has been increasing in recent years.

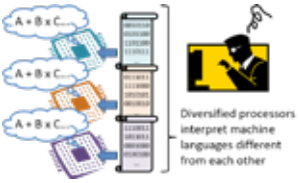
Theme 1 ▶ Reconfigurable logic circuits and special-purpose computation circuits

Field Programmable Gate Array (FPGA) is a kind of reconfigurable logic devices in which the internal logic circuit can be arbitrarily rewritten. We design, implement, and evaluate dedicated circuits for various applications, which range from academic to practical. We design the dedicated circuits in Hardware Description Language (HDL), implement circuits using CAD software, and evaluate their performance on FPGA boards. For an example, we have implemented hard-wired sequence control circuits by translating PLC (Programmable Logic Controller) software into HDL description. One of the proposed circuits achieved 8,050 times higher performance than the equivalent software implementation on a PLC. In addition, we are working on data-dependent hardware that makes circuits smaller and faster by fixing a part of input as constant. This idea corresponds to “partial evaluation” or “specialization” in software.

A demonstration version of control machinery using FPGA.

Theme 2 ▶ Information security and computer security

We utilize FPGAs to implement and evaluate components for secure systems such as encryption circuits and random number generation circuits. We are also studying secure processors which incorporate the features to protect software. One of our research on secure processors is based on diversification. The reason why a computer virus spreads and infects many computers is that their processors interpret the same machine language. If they interpret different machine languages, malicious software for a specific processor will no longer affect the other processors. The concept of such diversified processors can be compared to the myth of the Tower of Babel. FPGA technologies are well suited to this diversification technology. We apply our idea to the soft processors written in HDL to demonstrate the practicality of diversified processors.



The concept of diversified processors

Theme 3 ▶ Parallel processing technology

In recent parallel processing, the performance of each processing element may differ widely. For a simple example, different kinds of personal computers may be used in a PC cluster. We are studying the load balancing techniques for such heterogeneous systems to derive their maximal performance automatically. We are also working on optimized application software mainly for embedded systems. The target applications include, for example, scientific computation, image processing, and positioning systems.

Load balancing on a heterogeneous cluster system.

Wireless Networks Laboratory

Staff	• Professor **Uehara, Hideyuki** (E-mail：uehara@tut.jp) • Assistant Professor **Miyaji, Yuichi** (E-mail：miyaji@ee.tut.ac.jp)
Laboratory URL	http://www.comm.ee.tut.ac.jp/
Key words	Wireless access controls, wireless multi-hop communications, sensor and ad-hoc networks, array signal processing

Wireless systems hide limitless possibilities that can enrich our lives, as said by the father of wireless communications, Guglielmo Marconi, “It is dangerous to put limits on wireless.” We are aiming to realize new communication networks through wireless access and multi-hop communications, based on communications theory, network architecture and signal processing. Specifically, we undertake research on access control for effectively sharing limited radio resources, network control for cooperative connections and signal processing for high quality communications, for distributed autonomous systems such as sensor and ad hoc networks.

Theme 1 ▶ Wireless Networks

In wireless networks, especially distributed autonomous networks such as sensor and ad hoc networks, it is crucial to keep connectivity high for delivering more data with low latency, and also to save energy for longer time operation. We are aiming to design and build medium access control and topology control protocols so as to utilize and manage wireless resources efficiently for the use of the emerging IoT or trillion sensors universe.

Cluster formation for wireless sensor networks.

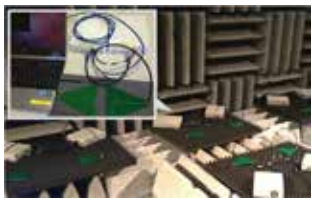
Theme 2 ▶ Sensing Systems

A sensor which converts physical quantities to electrical signals can be a sensing system and create new services when a lot of sensors are assembling together and connecting each other, besides having processing and communication functions. We are aiming to develop new sensing systems exploiting radio wave propagation characteristics such as localization for mobile objects including sensors and persons, and also for resonator’s location estimation in wireless multi-hop power transfer systems.

Location estimation for wireless multi-hop power transfer systems.

Theme 3 ▶ Full Duplex Multi-hop Communications

Communication traffic is rapidly growing as widely spreading wireless tools and sensors, which causes wireless resources a critical shortage. In-band full duplex communications can double the capacity in principle than half duplex communications used in current wireless LAN etc., however it must suppress self-interference. In addition, no protocols have been designed for multi-hop communications. We are aiming to develop a self-interference canceler and access protocol for in-band full duplex multi-hop communication systems that can efficiently utilize wireless resources by spatial-temporal control.



Wireless multi-hop communication testbed using two directional transceivers.

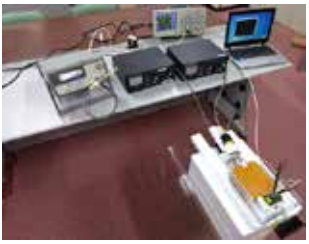
Electromagnetic Wave Engineering Laboratory

Staff	• Associate Professor **Tamura, Masaya** (E-mail：tamura@ee.tut.ac.jp)
Laboratory URL	http://www.comm.ee.tut.ac.jp/em/index.html
Key words	Microwave circuit, RF circuit, wireless power transfer, underwater wireless power transfer, high-frequency filters for communication, battery-less sensor systems, wireless harness

Our daily lives are surrounded by electromagnetic wave. It includes not only radio wave utilized in the data transmission but also heat radiation from our body and sunlight. We are widely conducting basic & applied researches with the aim of social contribution using the electromagnetic field.

Theme 1 ▶ Underwater wireless power transfer

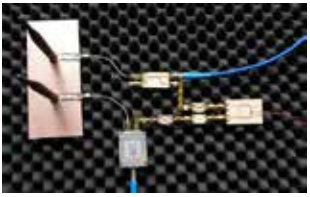
Autonomous underwater vehicles are desired to charge battery and communicate information under water in order to improve operation efficiency. We have an ambitious goal of developing the wireless power and data transfer system for operation underwater, focusing on the capacitive coupling with a simple structure and low leakage of field. So as to require a high power charging in this case, we are also investigating an elucidation of high-frequency property in fresh water and seawater.



Underwater wireless power and data transfer systems.

Theme 2 ▶ Next-Generation Wireless RF Circuits

Various methods in order to achieve high-speed and large-capacity wireless communications are developed such as Massive-MIMO, In-band full-duplex, and OAM. We aim to develop the RF circuits that are key technologies to realize these methods. As we image the application to a wide target range from portable devices to base station in small cell, we are developing value-added solutions such as high tunability and high power capability corresponding to the targets.



RF front-end circuit for in-band full duplex.

Theme 3 ▶ Wireless Harness

Numerous sensors are installed in various facilities and equipment for the purpose to support safe and secure life. In particular, power supply by wireless power transfer is expected for the sensors in dangerous places such as infrastructures in factory and power plant. We are developing a unique system with the pseudo-shielded space, which makes it possible to confine the electromagnetic field in the space and communicate with the sensors outside the space.

Cavity resonance enabled wireless power transfer systems.

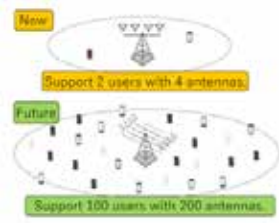
Communications and Signal Processing Laboratory

Staff	• Associate Professor **Takeuchi, Keigo** (E-mail：takeuchi@ee.tut.ac.jp)
Laboratory URL	http://comm.ee.tut.ac.jp/csp/en/
Key words	Massive MIMO, compressed sensing, belief propagation, spatial modulation, energy efficiency, multiuser decoding, spatial coupling

For future wireless communications, groundbreaking schemes are needed to satisfy high performance requirements. In order to realize such a paradigm shift in the field of communications, an interdisciplinary point of view is important in our research. One sometimes recognizes that a problem is essentially the same as a problem that has been already solved in another research field, while there is no superficial relationship between the two problems. Our goal is to realize novel communication schemes by applying such achievements from other fields to the field of communications. Also, we are aiming to deliver our achievements on communications to different research fields in order to contribute to academic and industrial progress in a wide range of fields including communications.

Theme 1 ▶ Massive MIMO

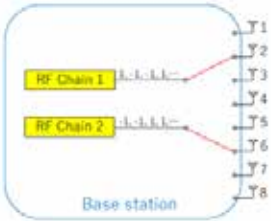
Multiple-input multiple-output (MIMO) systems are wireless communication systems that use multiple transmit and receive antennas for information transmission. In massive MIMO systems, base stations equip a large number of antennas to support many users simultaneously. Conventional receivers cannot be used to process all user signals jointly and efficiently. In our laboratory, we are aiming to construct efficient reception schemes for massive MIMO on the basis of an iterative method called belief propagation and of its modification proposed in the field of compressed sensing.



Massive MIMO

Theme 2 ▶ Spatial Modulation

The signals 1, -1, or 0 (no transmission) are transmitted in spatial modulation, while 1 or -1 is sent in conventional modulation. Since information is conveyed by signal 0 (no transmission), spatial modulation is an energy-efficient transmission scheme. A problem is an efficient blind estimation of the positions at which signals 0 have been sent. In our laboratory, we utilize a similarity between the problem and that considered in the field of compressed sensing to construct efficient reception schemes.



Spatial modulation

Theme 3 ▶ Multiuser Decoding

Decoding and multiuser detection have been separately developed in coding theory and communication theory, respectively. In multiuser decoding, on the basis of a combination of the two fields, joint detection and decoding are performed to realize a significant improvement in decoding performance. In our laboratory, we are aiming at improving the performance of multiuser decoding by applying spatial coupling, which was an idea to improve the performance of belief-propagation-based decoding up to the optimal performance.

Department of Computer Science and Engineering

Computer and Mathematical Sciences | Data Informatics

Human and Brain Informatics | Media Informatics and Robotics

Systems Ai Laboratory

Staff	• Professor **Ishida, Yoshiteru** (E-mail：ishida@cs.tut.ac.jp) • Assistant Professor **Harada, Koji** (E-mail：harada@cs.tut.ac.jp)
Laboratory URL	http://sys.cs.tut.ac.jp
Key words	design, architecture and integration of AIs, networked AIs, teacher-student AIs, IoA, modular AI, self-action network, resilient AI, artificial big data, immunity-based AI, brain-based AI, artificial consciousness

Many AIs emerge with the innovation of AI technology involving Big Data. We first study a design and architecture to integrate these AIs aiming the strong AI capable of flexible problem solving. We also study modularity and functionality of these AI components that allow them to mutually teach and learn with each other. Further IoA (Internet of AIs) is also our recent interest where AIs are connected by IoT network.

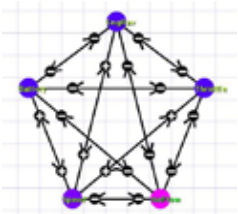
Theme 1 ▶ (Fundamental research) IoA (Internet of AIs)

To deploy AIs to the Internet and IoT, we need to study a network model where each node is AI. We have been studying such a network model called self-action network. So far, we have already studied a self-recognition network, a self-repair network and a self-rewire network.

An architecture to integrate self-recognition/repair/rewire AIs

Theme 2 ▶ (Industrial Application) Integration of Sensor-based AIs

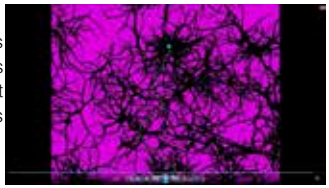
In the era of IoT, AIs must be connected to many types of AIs. One such AI is the sensor-based AI. With the self-recognition network, we develop a sensor-based AI that are connected to many physical sensors and virtual sensors.



Self-recognition of sensor-based AIs for automobile engine

Theme 3 ▶ (Industrial Application) Modular Searching AI

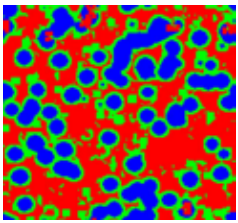
To integrate a strong AI, we need many AIs as modular components for several functions required for thinking. One such component is a searching AI. We developed a searching AI that can be tuned not only for path finding but for discovery of regularity when the data is arranged in a specific way.



Digital staining of neural pathways by path finding AI

Theme 4 ▶ (Fundamental research) A Mechanism Design of Symbiotic AIs

For the emergence of symbiotic AIs, we must first design a mechanism that motivates cooperating AIs to be protected from defecting AIs. We study such mechanisms involving recent game theory and matching theory.



Membrane formation to protect cooperative AIs from defective ones (Blue: cooperative AI cluster; Red: defective one; Green: Membrane)

Information Security Laboratory

Staff	• Professor **Suzuki, Koutarou** (E-mail：suzuki@cs.tut.ac.jp) • Assistant Professor **Takahashi, Chako** (E-mail：chako@cs.tut.ac.jp)
Laboratory URL	https://www.sec.cs.tut.ac.jp/
Key words	Cryptographic Protocol, Key Exchange, Functional Encryption, Elliptic Curve, Pairing, 2-party / Multi-party Computation

We are engaged in research and development on information security and cryptographic technologies that are required for secure communication and information processing on the Internet. Modern cryptographic technology is designed to be provably secure based on computational hard problems such as prime factorization problem and discrete logarithm problem, so theoretical analysis to prove its security is required. On the other hand, cryptographic technology is actually used in the Internet, so efficiency and practicality are also important. Based on these theoretical and practical viewpoints, we do research and development on information security, especially public key cryptography and cryptographic protocols, with the following research topics.

Theme 1 ▶ Cryptographic Protocol

We do research and development on cryptographic protocols, which realize advanced functions using cryptographic primitives, e.g., key exchange protocol TLS widely used in the Internet, and distributed ledger technology block chain used in Bitcoin etc. We design and implement secure and efficient cryptographic protocols.

Theme 2 ▶ Functional Encryption

We do research and development on functional encryption and other highly functional cryptographic primitives, e.g., ID-based encryption, and anonymous signature etc. We also study and implement efficient algorithms for elliptic curve and pairing, which is the basis of the functional encryption and highly functional cryptographic primitives.

Elliptic Curve

Theme 3 ▶ 2-party / Multi-party Computation

We do research and development on 2-party / multi-party computation, which is the key technology to utilize sensitive information, e.g., personal information and medical information, effectively, while keeping privacy. 2-party / multi-party computation is a "universal" cryptographic protocol that can compute arbitrary function on inputs of the parties, without revealing the inputs.

Discrete Optimization Laboratory

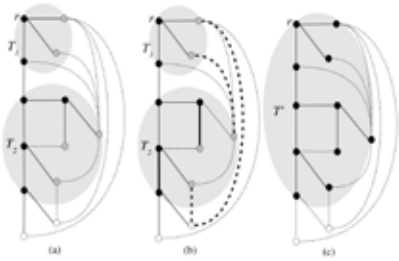
Staff	• Professor **Fujito, Toshihiro** (E-mail : fujito@cs.tut.ac.jp) • Assistant Professor **Wasa, Kunihiro** (E-mail : kunihiro.wasa@gmail.com)
Laboratory URL	http://www.algo.cs.tut.ac.jp/
Key words	algorithm, combinatorial optimization, mathematical programming, constraint satisfaction problem

A wide range of computational tasks are in great demand in modern society and industries. Dealing with them without algorithmic ingenuity, however, often causes an exponential explosion in processing time, or otherwise, results in poor outputs. It is thus said that most crucial and essential portion of software development in such cases consists of algorithm design. Therefore, we aim to develop highly efficient and accurate algorithms for various problems by making use of discrete structure analysis, algorithm theory, computational complexity theory, mathematical programming, among others.

Theme 1 ▶ Design and development of new algorithms and models

Mainly focusing on important combinatorial optimization problems (and typically abstracting them into problems of graphs, networks, and sets) appearing in the areas of production/delivery planning, scheduling, VLSI design, optimal routing, and others, we devise and design new algorithms and mathematical models for them. Various types of algorithms are of our interest such as approximation, distributed/parallel, online/streaming, etc.

In order to verify the validity and effectiveness of the algorithms and models thus designed, their performance will be evaluated by theoretical analysis and/or computational experiments.



An example run of the algorithm for Tree Cover problem

Theme 2 ▶ New ways of designing optimization algorithms

Studied here are principles and mechanism of optimization that can serve as driving forces for algorithms solving combinatorial optimization problems. Compared to Theme 1, such study requires consideration from a more meta viewpoint. Examples under this theme include design techniques based on the duality theorem and complementary slackness conditions from the area of linear programming.

Theme 3 ▶ Study on the constraint satisfaction problem (CSP)

CSP is recognized as one of the most fundamental problems in computer science with applications in diverse fields such as artificial intelligence, operations research, and otheres. Recently, it is shown that CSP with a finite domain has the dichotomy property. We study the complexity of variants of CSP.

Theme 4 ▶ Online/Stream optimization

Online algorithms process input data given in sequence along the time-series (implying that input coming in the future is unpredictable). It has applications in a wide range of areas such as power-saving control, logistics, and financial engineering. In the large-scale data processing of present days, it is also crucial to to process input sequence data without (or with strictly restricted) need for data storage, using streaming algorithms.

Computers and Education Laboratory

Staff	• Associate Professor **Kawai, Kazuhisa** (E-mail : kawai@tut.jp)
Laboratory URL	http://www.ita.cs.tut.ac.jp/
Key words	Information Education, Computers and Education, E-Learning, HCI, Language Education

In the Course of Study for high school that went into effect in 2003, the new subject "Information" was added as a compulsory subject. It made all high school students receive information education. In addition, the "Information and Computer" unit of technology and home economics in junior high school became compulsory. Elementary schools have classes and information education using computers at "Period for Integrated Studies" and classes for other subjects. The importance of information education is commonly recognized in school education at every level. Educational efforts to develop the ability to utilize information, which is the target of information education, have been made beyond the framework of subjects. I am among those who are making such effort. I work with teachers of local elementary, junior high and high schools and conduct practical research on how the new way of information education should be. Main research themes include the following.

Theme 1 ▶ Information education at primary and secondary education

The figure 1 shows the book educational support system for the school library. Part of this system has been introduced in all elementary and junior high schools in Toyohashi city.

Figure 1: Book Educational Support System

Theme 2 ▶ Computer use in language education

Theme 3 ▶ Science cafe for lifelong education in community

I believe the most important thing for students is to have them decide the theme for their graduate research and master's thesis themselves when I provide students guidance. Choosing a research theme is the hardest yet most interesting thing. It is the best part of the research. As an educator, I bear in mind not make the idiotic mistake of assigning research themes to students.

Figure 2: EST Vocabulary Learning Application

Quantum and Computational Biology Laboratory

Staff	• Associate professor **Kurita, Noriyuki** (E-mail : kurita@cs.tut.ac.jp)
Laboratory URL	http://www.klab.cs.tut.ac.jp
Key words	In silico drug design, medication for Alzheimer's disease, tuberculosis drug, cancer metastasis inhibitor, transcription of genetic information, molecular simulation, quantum chemistry, molecular orbital calculation, DNA, protein

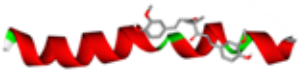
We have been studying on the electronic properties of biological macromolecules such as DNA, proteins and ligand using ab initio molecular simulations, in order to propose novel potent medicines for treating globally feared diseases such as Alzheimer's disease, tuberculosis and cancer. In addition, to elucidate the transcription mechanism of genetic information from DNA to RNA, which is controlled efficiently by some transcriptional regulation proteins, we investigate the specific interactions between DNA and these proteins by the ab initio molecular simulations. Some of the key research themes of our laboratory are shown below.

Theme 1 ▶ Elucidation of aggregation mechanism of amyloid-beta (Aβ) proteins

Onset of Alzheimer's disease is shown to be deeply associated with the formation of amyloid plaque in a patient's brain. However, the formation mechanism of the plaque from Aβ proteins is not clarified yet. We are in an attempt to elucidate the mechanism, in order to propose novel compounds for preventing the formation of the plaque. These compounds might be potent inhibitors against Alzheimer's disease.

Theme 2 ▶ Proposal for potent medicines against Alzheimer's disease

We investigated the specific interactions between Aβ protein and many kinds of compounds and proposed novel inhibitors against the aggregation of Aβs. These inhibitors are the derivatives of curcumin, which is included in natural product turmeric. Our collaborators in Ukraine are attempting to synthesize these derivatives, and they are expected to be potent medicines for Alzheimer's diseases.



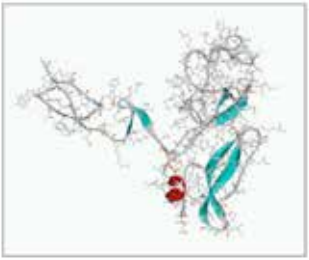
Structure of our proposed compound strongly bound to Aβ monomer

Theme 3 ▶ Proposal for potent medicines against tuberculosis

Tuberculosis (TB) is one of the most widespread infection diseases in the world, and many types of anti-TB drugs were developed. However, since Mycobacterium tuberculosis (Mtb) can easily get drug resistance, it is necessary to develop novel effective anti-TB drugs targeting the most conservative proteins. We employed the filamental temperature-sensitive Z (FtsZ) as the target protein and investigated the binding properties between FtsZ and many types of compounds using ab initio molecular simulations. Based on the results simulated, we proposed some novel compound inhibiting the polymerization of FtsZ proteins, which causes the cell division of Mtb.

Theme 4 ▶ Proposal for potent inhibitors against cancer metastasis

To develop more potent inhibitors against the cancer metastasis, we investigated the binding properties of amino acid peptides with a protein, which is considered to be a trigger for the onset of cancer metastasis. Based on the results simulated, some novel peptides having large binding affinity to the protein were proposed as potent inhibitors. Our proposed new peptides are expected to be new inhibitors against cancer metastasis.



Structure of our proposed new medicine against cancer metastasis obtained by our simulation

Theme 5 ▶ Elucidation of the transcription mechanism controlled by regulatory proteins

The transcription mechanism of gene information from DNA to RNA is efficiently controlled by various regulatory proteins as well as ligand molecules. The catabolite activator protein (CAP) is one of the regulatory proteins, and the complex of CAP with cyclic AMP (cAMP) plays an efficient role in the transcription mechanism. We investigated the effect of cAMP-binding to CAP on the interactions between DNA and CAP using ab initio molecular simulations, in order to elucidate the transcription mechanism controlled by CAP and cAMP. The results will be helpful for proposing novel compounds controlling the transcription mechanism.

Structure of the complex with DNA, CAP and cAMP obtained by our simulation

Computer Systems and Performance Engineering Laboratory

Staff	• Associate Professor **Sato, Yukinori** (E-mail：yukinori@cs.tut.ac.jp)
Laboratory URL	http://www.perf.cs.tut.ac.jp
Key words	Computer Architecture, Computer Systems, Software Performance Engineering

The Computer Systems Performance Engineering Laboratory studies performance of any platforms of computers from ultra high-speed supercomputers to extreme low-power mobile devices based on scientific and engineering approaches. Currently, many deep learning programs, which become a typical component for AI-based applications, has struggled with lack of performance even if it is implemented on the state-of-the-art CPUs or GPUs. Therefore, techniques that realize high-performance and high-efficiency computer systems are expected to be an enabler of emerging new AI applications such as self-driving cars and autonomous intelligent robots. In the context of system performance matter, we highlight specialization for inherent memory access locality which will be a clue to its solution.

Theme 1 ▶ Memory-centric customization toward FPGA accelerators

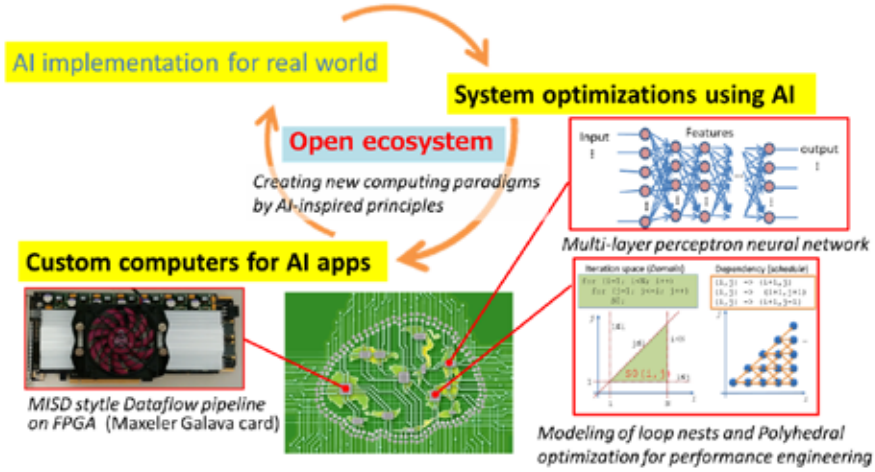
For realizing a human-centered super smart society called Society 5.0, it is very important to attain high-performance and high-efficiency computing through custom computing systems specialized for particular application domains. On the other hand, customization of systems incurs challenges in productivity and costs for the hardware and software development process. To overcome these difficulty, we investigate the ways to detect locality of processing inherent in application programs and develop high-level optimization frameworks that automatically map it to FPGA accelerators.

Theme 2 ▶ Scientific modeling of system performance and quality of the performance

We investigate the ways to profile, analyze and predict behaviors of program execution to understand the software execution performance. Here, we develop profilers, performance models, and simulators of hierarchical memories.

Theme 3 ▶ Automation of customization and co-design driven by mathematical optimization and machine learning techniques

We investigate the ways to automate co-design processes for domain-specific customization. These are implemented upon the current software stack such as compilers, code translators, and optimizers. These are also strongly tackled with mathematical optimization, machine learning, and deep learning techniques.



The overview of computer systems and performance engineering lab.

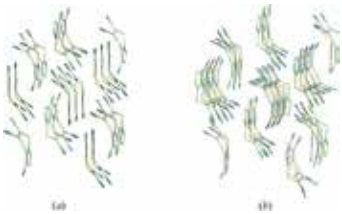
Computational Chemistry Laboratory

Staff	• Professor **Goto, Hitoshi** (E-mail：gotoh@tut.jp)
Laboratory URL	http://www.cch.cs.tut.ac.jp/
Key words	High-Performance Computing, Deep Learning, Crystal Structure Prediction, Docking Simulation, Conformation Search, Molecular Design, Material Informatics

My laboratory develops new methodologies and software applications on computational chemistry and chemoinformatics using the latest computational science and information technologies, such as high-performance parallel distributed programing, data assimilation using computer simulation and database, and machine learning with deep neural net technology. The main research themes are introduced as follows.

Theme 1 ▶ Exploring Molecular Conformation and Crystal Structure Polymorphism

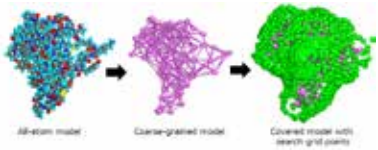
Many of drug molecules and organic molecular materials are used as solid crystals, and their medicinal effects and material properties are determined by their stable crystal structure. However, in these molecular crystals, it is possible that a molecule in crystal may form different 3D structures (conformations) or different crystal structures (polymorphisms). Therefore, prediction of some stable crystal structures in advance is important information for designing pharmaceutical molecules and organic materials. Our computational chemistry application CONFLEX that can be exploring molecular conformations and crystal structure polymorphisms, is developed as a supporting tool for advanced molecular design.



Comparison with the experimental crystal structure with predicted structures of (a) DFT-D and (b) CONFLEX methods.

Theme 2 ▶ Protein-Ligand Docking Simulation by using Coarse-Grained Potentials

A drug molecule binds to a target protein and forms a complex structure. As a result, information transmission in vivo is activated or inhibited, and the function expression of the protein is controlled. In order to elucidate essential biomolecular behaviors and biological phenomena in the fields of drug discovery, we are developing a new docking simulation method so that can efficiently search some plausible ligand binding sites by a coarse-grinded model and rapidly produce highly accurate all-atom model by data assimilation with conformation database.



Preparation of our coarse-grained docking simulation

Theme 3 ▶ Molecular Activity and Material Property Prediction by using Deep Neural Nets

Machine learning technology using deep neural nets has made amazing results in the field of speech recognition and image analysis. Furthermore, it is expected that paradigm shift will occur in structural activity correlation of drug molecules and prediction of physical-chemical properties for electronic device materials. Our laboratory formulates new molecular descriptors in terms of structures, energies, and electronic states based on computational chemistry simulation, and develops a next generation system on molecular activity and property prediction by using some deep learning platforms.

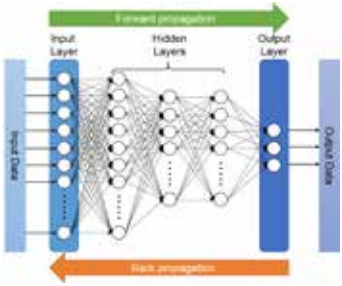


Illustration of a deep neural networks with three hidden layers

Knowledge Data Engineering Laboratory

Staff	• Professor **Aono, Masaki** (E-mail：aono@tut.jp) • Assistant Professor **Asakawa, Tetsuya** (E-mail：asakawa@kde.cs.tut.ac.jp)
Laboratory URL	https://www.kde.cs.tut.ac.jp
Key words	Data science, multimedia information retrieval, text mining, data mining, feature extraction, 3D shape retrieval, image captioning, deep learning, time series data mining

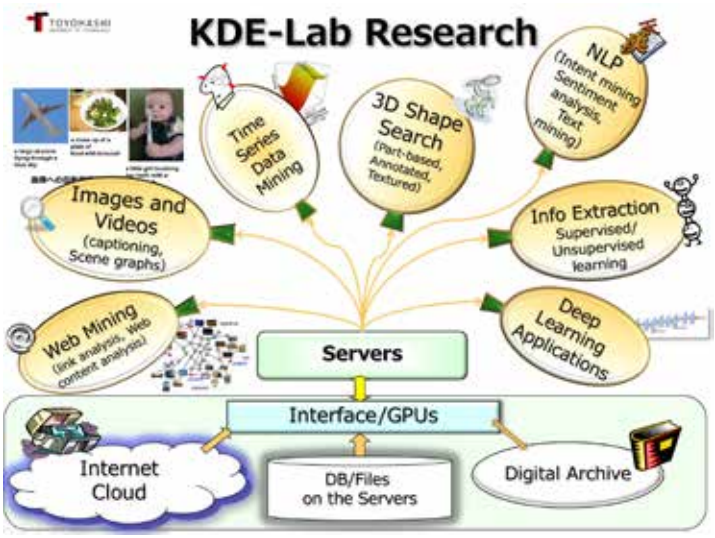
We have conducted research on massive multimedia datasets including texts, images, videos, and 3D shape modes, and extract valuable pieces of information. Main focus of our research has been on feature extraction, information retrieval, clustering, classification, segmentation, and automatic annotation or tagging to multimedia.

Theme 1 ▶ Research on Multimedia Retrieval, Classification, and Automatic Annotation using Fine-grained Feature Extraction with Deep Learning

In this research, we use three-dimensional shape models, images, videos, and annotated texts, in order to investigate fine-grained accurate search, including partial-matching and classification. The basic idea is to extract salient features that represent an object robustly and invariantly under translation, rotation, scaling, and other similar operations. We boast of the world-top-level search performance for 3D shape models, proven by SHREC international contests. We also boast of the world-top-level classification for plane identification among massive datasets, proven by PlantCLEF international contests. To keep our research up to the state-of-the-art we are currently embarking on various applications on deep learning.

Theme 2 ▶ Web Mining, Data Mining, Text Mining, and More

Web is considered a rich resource including a billion of stones and a handful of gems. Web mining is an emerging research field, attempting to find “gems” on the Web. Our research on Web mining includes Web content mining (such as SNS data mining), Web spam detection, Web link analysis, and Web usability monitoring. In addition we are conducting research on times series data mining, blog/microblog analysis, sentiment analysis, personalized information extraction, and prediction of trends not easily observed by ordinary users’ perspectives. We have also started research on intent mining and diversification, focusing on “what’s new” (novelty) to disambiguate multiply interpreted queries.



Caption: KDE Laboratory Research Outlook

Data Informatics

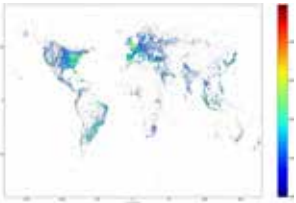
Applied Mathematics and Network Laboratory

Staff	• Professor **Umemura, Kyoji** (E-mail : umemura@tut.jp) • Assistant Professor **Yoshida, Mitsuo** (E-mail : yoshida@cs.tut.ac.jp)
Laboratory URL	http://www.ss.cs.tut.ac.jp/
Key words	Applied Statistics, Information Retrieval, Natural Language Processing, Data Mining, Computational Social Science, Social Media, E-learning

We are applying statistical methodology to make the best use of computer networks and the data in the works as follows.

Theme 1 ▶ Handling Large Scale Data from Social Media

We have been operating data collecting systems, especially from social media (Twitter), where various information is posted. As the result, we can handle almost all tweets with location information and Japanese/English retweets, and large scale social graphs. We are conducting researches to make the most of these data. One example of these researches is estimating the location of tweets and users without location information. Moreover, we are analyzing the differences between the real world and the internet world regarding human/user relations for computational social science.



Distribution of tweets in the world.

Theme 2 ▶ Natural Language Processing for Information Retrieval

It is crucial for information retrieval systems to decide whether each term is important for retrieval. We have developed a method to extract important terms from documents using statistical analysis. Unlike commonly used approaches, this method does not require dictionaries, but collections of data. This method is the result of joint research with a company, and used in commercial products. You can get more details on the following page.
http://www.sei-info.co.jp/quicksolution/technology/birth-story2.html

Theme 3 ▶ E-learning System in Network Era

We believe that computer technology can provide more effective contents for E-learning than simple video. One of our results is an image processing method to remove the image of the lecturer and to provide a clear image of the black board. This kind of content makes note taking easier because the lecturer tends to cover the characters on the white board.

Lecture video image by our approach.

Spoken Language Processing Laboratory

Staff	• Professor **Kitaoka, Norihide** (E-mail：kitaoka@tut.jp)
Laboratory URL	https://sites.google.com/site/a5gistokushimau/
Key words	Speech recognition, acoustic model, language model Spoken dialog system Multimodal interface, autonomous vehicle

Almost all the humans use spoken dialog, which is the most natural communication method. If we can recognize/manage/ synthesize speech in computers, this speech can be not only the best method of communication but can also be used as data storage media. I am engaged in technologies on spoken language.

Theme 1 ▶ Speech recognition

Making transcriptions of monologues such as lectures is a very promising research area. We improve acoustic modeling of the human voice using models such as the Hidden Markov Model (HMM)and Deep Neural Network (DNN), and statistical language modeling (N-gram) . We also improve the decoding algorithm.

Theme 2 ▶ Friendly spoken dialog system

The first impression of a spoken dialog system for novice users is that it is unnatural, because the time-lag between a human utterance and the system reply is too long and as such the user cannot distinguish whether or not the system works. This is one of the reasons why users do not feel that spoken dialog systems can be used in a comfortable, frendly manner. Thus, we focus on prosodic features like timing and pitch change in a dialog. Our dialog system has begun to speak with appropriate prosodic features considering previous user utterances. When the dialog gets lively, the pitch of the system utterances chase the user's pitch. On the other hand, we also study a semantic dialog strategy. We are now developing a robust and natural response generation method in a system that considers its own misunderstandings.

Theme 3 ▶ Multimodal interface

Human often uses gestures such as finger pointing and gaze to transmit his/her intention. We are trying to realize such interaction between human and machine.
Consider the operation of an autonomous vehicle. How do you let it know where you want to go and where you want to turn? It is useful if you can use finger pointing and gaze. We are developing an autonomous vehicle with such interface!

Multimodal interface system for autonomous vehicle

Natural Language Processing Laboratory

Staff	• Associate Professor **Akiba, Tomoyosi** (E-mail：akiba@cs.tut.ac.jp)
Laboratory URL	http://www.nlp.cs.tut.ac.jp
Key words	Natural language processing, spoken language processing, information retrieval, information access, machine translation, speech interface, spoken document processing

Natural language is indispensable for inter-human communication. Likewise, if an artifact has a good command of language, that would enhance human-machine communication. Our research group is developing computer programs that can deal with natural language for helping various human activities, including information retrieval, machine translation, and speech interface. We are also studying intersectional area of the above-mentioned research topics, including spoken document retrieval, cross-language information retrieval, and spoken language translation.

Theme 1 ▶ Information retrieval

Development of intellectual activity support technology to discover the necessary information from large-scale data. In particular, we are studying technologies that make use of spoken language for information retrieval. Firstly, we are studying spoken document retrieval, in which the target documents are not textual but speech data. Secondly, we are studying speech-driven retrieval, in which user's information needs are expressed by using spontaneous speech. For these tasks, we have been organizing the evaluation task called SpokenDoc and SpokenQuery&Doc at the NTCIR project (http://research.nii.ac.jp/ntcir/index-en.html) to promote the research activities on those research topics.

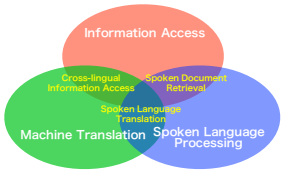
Theme 2 ▶ Machine translation

Development of technology that supports communication between cultural regions that use different languages. Out of various methods proposed for machine translation, we are studying statistical machine translation that learns probabilistic models from parallel translation corpus that have the same content corresponding between languages. We also develop cross-language question answering that finds the answer from information sources written in other languages using machine translation.

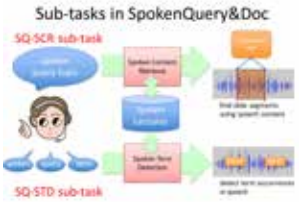
Theme 3 ▶ Speech interface

Development of technology to have a dialog with artifacts using human spoken language. We research language models that capture the characteristics of words used for various applications such as question answering and machine translation. We are also studying para-linguistic event detection, including laughter and interest detection from speech. Recently, we are also challenging medical diagnosis code retrieval from doctor-patient conversation.

Our Research Areas

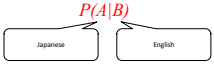


Our research areas



NTCIR SpokenQuery&Doc task

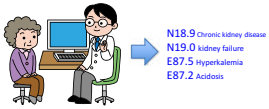
Statistical Machine Translation



Statistical machine translation

Goal

• Developing a system that automatically estimates ICD-10 codes from Doctor-Patient conversation



ICD-10 code retrieval from doctor-patient conversation

Learning and Inference Systems Laboratory

Staff	• Associate Professor **Watanabe, Kazuho** (E-mail : wkazuho@cs.tut.ac.jp)
Laboratory URL	http://www.lisl.cs.tut.ac.jp/
Key words	Bayesian inference, learning algorithm, rate-distortion theory, data visualization

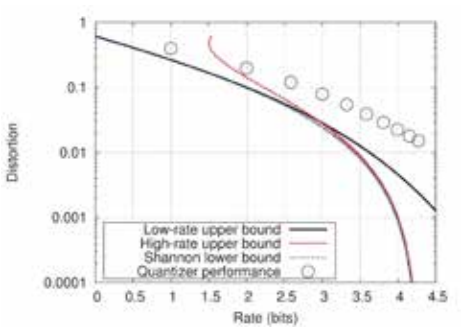
Machine learning techniques are widely used for various applications such as pattern recognition and robot control. We study fundamental theories of machine learning based on statistical and information theoretic methods, and apply them to data analysis problems.

Theme 1 ▶ Analysis and development of statistical learning methods

Bayesian inference provides a framework for solving learning and inference problems. We aim at analyzing and devising learning and inference methods, and apply them to problems such as data analysis and visualization.

Theme 2 ▶ Lossy data compression and rate-distortion theory

The rate-distortion function shows the minimum code length required for reconstructing compressed data under allowed distortion levels. We aim at evaluating rate-distortion functions of distortion measures used in practical learning algorithms and information sources modelling real data generation processes.



Analysis of the rate-distortion function

Applied Information System Laboratory

Staff	• Associate Professor **Tsuchiya, Masatoshi** (E-mail : tsuchiya@imc.tut.ac.jp)
Laboratory URL	http://is.cs.tut.ac.jp/
Key words	Natural Language Processing, High Performance Computing, Applied Information System

We are interested in two research areas: natural language processing and applied information system. The first research interest is natural language processing to assist human intellectual activities and to enhance human intellectual ability. Our second research interest is how to design large-scale applied information systems such as the university educational computer system and the campus network and how to operate them. In the latter area, our advantage is that we can access the real systems and networks which are used in our university campus (the photograph of this page shows a part of the systems).

Theme 1 ▶ Automatic summarization and organization of lecture slides and lecture speeches

There is increasing interest against e-Learning contents, in order to provide flexible supports to students who are diverse in their understanding ability. Therefore, many educational organizations work at gathering lecture slides and recording lecture speeches to construct e-Learning contents. However, such e-Learning contents have a crucial problem: if a lecture speech has neither index nor cues, its skip listening is too difficult for e-Learning users to study the lecture efficiently.
We are tackling automatic summarization and organization of lecture slides and lecture speeches, in order to resolve the above problem.

Theme 2 ▶ Information visualization to compose multiple information sources considering user intent

The internet is a treasury of consumer generated contents, but it is quite difficult to distinguish practical, useful, accurate content among impractical, useless, inaccurate, noisy content. In order to resolve this problem, we focus into methods to improve information reliability. The first one is textual entailment, which is a task to determine whether the meaning of the hypothesis sentence can be inferred from the meaning of the premise sentence. The second one is text reuse detection, which is a task to determine whether a given text is original or not and to discover its origin when it contains reused part. The final one is visualization of relationship between texts which are collected by the above two methods.

Theme 3 ▶ Improvement of availability of large-scale applied information systems and networks

The modern society widely depends on information systems and networks which run 24/7. However, it is quite difficult to realize high-available large-scale complex information systems and networks because their complexity frequently bring oversights of their designers which cause unexpected outage. In order to resolve this problem, we are investigating a method to improve automatic monitoring of information systems and networks and to prevent outages.

The high performance computer system of TUT

Visual Psychophysics Laboratory

Staff	• Professor **Kitazaki, Michiteru** (E-mail：mich@cs.tut.ac.jp) • Assistant Professor **Ueda, Sachiyo** (E-mail：ueda@cs.tut.ac.jp)
Laboratory URL	http://real.cs.tut.ac.jp/
Key words	Psychophysics, Ensemble Perception, Virtual Reality, Cognitive Neuroscience, Perception and Action, Empathy, Implicit perception, Embodied perception

We aim to understand how humans perceive the environments and ourselves, behave in the natural environments, and communicate with others scientifically with psychophysical and cognitive neuroscience methods. Embodied perception is a main perspective in our research. Our perceptual process and communication are crucially connected to our body physically and psychologically. We are investigating three research themes based on this perspective.

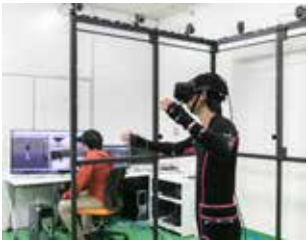
Theme 1 ▶ Science for Mobile Observer

To understand perception for mobile observers, we are investigating self-motion perception, 3-D objects, scene and human-body recognition across viewpoints with psychophysical experiments. To know interaction of perception and action, we are measuring motor behavior and perception during action such as walking and driving a car. Parts of driving study are cooperative studies with motor companies. We are developing a system to experience tele-presence of walking using virtual reality.

Driving simulator with optic flow

Theme 2 ▶ Science for Embodied Reality

To know what is realty, we are focusing on body perception, ownership and self-agency. Perceptual reality must be based on our body and its perception. We are investigating material perception, perceptual aesthetics, lightness perception, self-motion perception, human-body perception, and augmented body in virtual-reality environments. Cross-modal studies such as vision-vestibular interaction on postural control and face-voice interaction on emotions are included in the theme. We are modifying human body appearance and function using virtual reality to see how human mind and behavior change in such modified bodies.



Virtual reality system for augmented body

Theme 3 ▶ Science for Implicit Social Cognition

We interact with others naturally, and perceive the world and others based on social communications. The crucial factor for implicit social cognition is our body. We are investigating body perception, neurophysiology of empathy, equity, and moral. We found that the preverbal infants show sympathy for others in distress and that humans can empathize with humanoid robots.

Empathy with a robot

Visual Perception and Cognition Laboratory

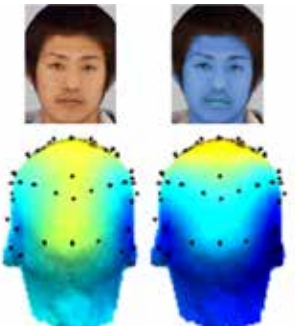
Staff	• Professor **Nakauchi, Shigeki** (E-mail：nakauchi@tut.jp) • Assistant Professor **Hine, Kyoko** (E-mail：hine@vpac.cs.tut.ac.jp)
Laboratory URL	http://www.vpac.cs.tut.ac.jp/en/
Key words	material perception, color vision, visual attention, face recognition, brain decoding, color universal design, spectral imaging

We can see and recognize things, and act without feeling any difficulties. Our mission is to explore visual function and the mechanisms of the brain which allow us to do so, and to develop new technology, including color universal design, spectral imaging, for visual information processing based on the fundamental vision research.

Theme 1 ▶ Vision Science - why is it seen as it is? -

Vision is far skillful rather than we imagine. Visual perception results from "interpretations" of the retinal images. The visual system has many important features including adaptation to the visual environments, integration of various visual clues to estimate 3D information, etc. Understanding these functions may make present media technology remarkable progress. Moreover, although we are almost always subjected to a barrage of different source of visual information, our visual system does not process all the information. Rather, by so-called visual attention, the visual system selectively processes some extent of the input image. To explore the fundamental functions of the vision, we are doing psychophysical experiment, EEG measurement and analysis, and constructing mathematical models of the vision.

We are now tackling various topics as: Color vision; motion-color interaction; surface quality perception; ERP studies on face processing, visual naturalness, awareness; brain--computer interface.

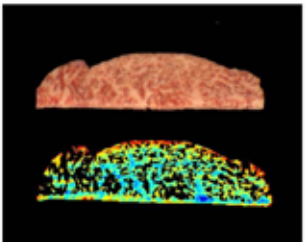


Activity of face-sensitive ERP component for natural and unnatural (bluish) face color stimuli

Theme 2 ▶ Vision Technology - Media technology like human vision or beyond it -

Our life has surely become convenient since image media such as a digital camera has developed and spread rapidly. It is true, however, that capability of such image media is nothing like as good as that of the human vision because it is far easy for our vision to capture image information, code the information, and recognize it. The purpose in this project is to crystallize as "technology" the knowledge acquired by the fundamental research of vision science.

We are now tackling various topics as: Color blind experience filter; visualization of invisible information using spectral imaging.



Visualisation of fat and fatty acid distribution in beef by near-infrared spectral imaging

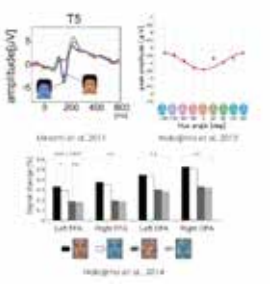
Cognitive Neurotechnology Unit (CNt)

Staff	• Professor **Minami, Tetsuto** (E-mail：minami@tut.jp)
Laboratory URL	https://sites.google.com/site/nantetsu/
Key words	cognitive neuroscience, psychology, EEG, BCI, pupillometry, face processing, emotion, insight

Our approach is to use non-invasive method for measuring brain such as EEG, to clarify our cognition and behavior and apply these results to brain-machine interface (BCI) and neuromarketing.

Theme 1 ▶ Face processing

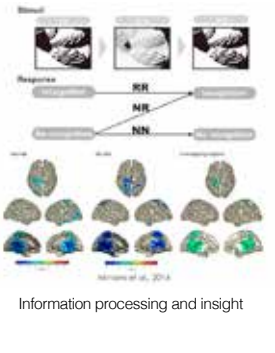
Facial color is important information for our social communication, because it provides important clues to recognize someone's emotion and health condition. Our previous EEG study shows that face sensitive ERP component (N170) is modulated by facial color, which suggests that face color is important for face detection (Minami et al. 2011). Moreover, facial color sensitivity of N170 was found at the left occipito-temporal site (Nakajima et al. submitted). Although the EEG study suggests that N170 at the left occipito-temporal site is related to facial color processing, it has been controversial issue which brain region is involved in facial color processing, because EEG measurement has low spatial resolution. Therefore, the present study will examine the brain regions related to facial color processing by using functional magnetic resonance imaging (fMRI) with higher spatial resolution.



Facial color affects brain activities.

Theme 2 ▶ Information processing and Insight

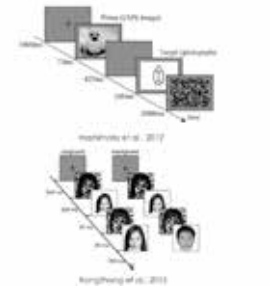
For user-kindly information technology, information should be controlled and selected depending on our brain states. For this purpose, we must know users' understanding of information. Our previous study is to estimate whether a subject recognized an object or not through a single-trial analysis of EEG, ambiguous or clear state. Six subjects (mean age was 22 years) participated in the experiments. A pool of 120 paired pictures was used for the experimental task. One is an original color image (CI) and the other is the binarized picture (BI). A classification result revealed a good discrimination with the accuracy greater than 90% (Noritake, Minami and Nakauchi, 2009). In the next, I intend to investigate the dynamics of brainstorm: the transition process from ambiguous to clear state. In addition, we will develop applied system enabling real-time estimation of the level of understanding.



Information processing and insight

Theme 3 ▶ Neurocommunication

The affect misattribution procedure (AMP) was proposed as a technique to measure an implicit attitude to a prime image. In the AMP, neutral symbols (e.g., a Chinese pictograph, called the target) are presented, following an emotional stimulus (known as the prime). Participants often misattribute the positive or negative affect of the priming images to the targets in spite of receiving an instruction to ignore the primes. The AMP effect has been investigated using behavioral measures; however, it is difficult to identify when the AMP effect occurs in emotional processing?whether the effect may occur in the earlier attention allocation stage or in the later evaluation stage. In this study, we will examine the neural correlates of affect misattribution, using event-related potential (ERP) dividing the participants into two groups based on their tendency toward affect misattribution.



Affective processing

Biological Motor Control System Laboratory

Staff	• Associate Professor **Fukumura, Naohiro** (E-mail：fukumura@cs.tut.ac.jp)
Laboratory URL	http://www.bmcs.cs.tut.ac.jp
Key words	Human voluntary movement control, sensory-motor integration, motor learning

Humans can perform various complex and dexterous movements. Even simple motions we do mindlessly in daily life are realized by excellent ability of information processing that extracts required information for the motions from complex external information obtained through various sensory organs, and control their limbs properly to establish the task. Our focus is on perception by the integration of sensory information (e.g. object recognition), motion (e.g. reach and grasp movement and handling of object) and learning function. We aim to elucidate those excellent information processing mechanisms for cognition and motor control of the central nervous system that achieves humans' skillful movements from the viewpoint of computational neuroscience.

Theme 1 ▶ Computational studies of the voluntary movement of the human limb

The hand and arm trajectory of various movements such as the reach and grasp movements, handwriting movements, drawing line or figure and sports movement under a various conditions is measured by a three-dimensional motion capture system, and at the same time, other biological signals such as eye movements or electromyography signals are also measured. With the measurements, we analyze the achieved motion trajectory, change in trajectory accompanied by motor learning and cognitive information. Based on the results, we work to elucidate the principles of motion planning, motor control system and learning function by developing mathematical models of the information processing of motion control using neural models that can reproduce the measured human movements with computer simulation.

Experiment of eye-hand coordination when tracing a line

Theme 2 ▶ Applied research of the model for motor control

We apply the features and measurement technology of human movement obtained by motion analysis to develop a user-friendly man-machine interface, welfare technology, and robotics. For example, we investigate the sign-language translation system using the feature of human arm movements and the back-parking assist system using the motor learning theory. These applied researches also aim to confirm the validity of the model of information processing regarding motor control or learning that we constructed.

Experiment of back-parking assist system using driving simultor

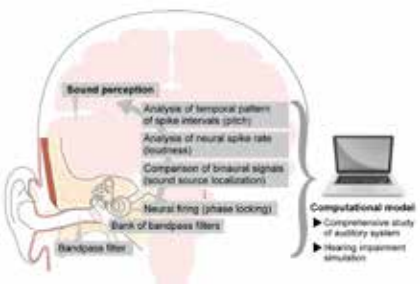
Auditory Psychophysics Laboratory

Staff	• Associate Professor **Matsui, Toshie** (E-mail：tmatsui@cs.tut.ac.jp)
Laboratory URL	http://www.aplab.cs.tut.ac.jp/
Key words	psychology of hearing, computational model of auditory peripheral, hearing impairment simulation, music perception and cognition, diversity of musicians' sensory processing

We address the issues related to auditory perception and cognition using various psychological experiment paradigms, mainly psychophysical methods. Our research scope covers various themes from computational modeling of the early stage of hearing to cognition of music. We aim to reveal the full function of hearing by approaching from both low-level processing and that of higher function.

Theme 1 ▶ Computational model of auditory system

In the auditory system there still remains some unexplained functions; the auditory path from the outer-ear to the auditory area of cerebral cortex is too deep inside to observe from the outside and the path is complicated due to lots of nuclei relays. To understand such hearing has been recently facilitated by computational models that express the processing at each stage of hearing by signal processing. We measure the fundamental functions of hearing such as encoding frequency components, period of waveform, and dynamic range of sounds by psychophysical experimental methods, and reflect the results in a computational model called dynamic compressive gammachirp filterbank model which has been developed in collaborative research projects. By following the prediction of perceptual phenomena by the computational model and its experimental validation, we contribute to the understanding of the human auditory system.



A schematic model of the auditory system and our computational model approach

Theme 2 ▶ Hearing impairment simulation and its application

Japan is experiencing a "super-aging" society nowadays. It is predicted that age-related hearing loss will increase with the increase in the population of elderly people. Although it is necessary to avoid disconnection of communication due to hearing loss, it is so hard to imagine how hearing loss changes the perception of sound. The computational model of the auditory system can output not only an expression of auditory function, but also sounds deteriorated by modules causing hearing loss. It allows users "to listen as a person with hearing loss". We are planning to apply this hearing impairment simulation to an educational course for speech therapists, and disperse broadly to the general public to learn about hearing. This simulation will also allow us to evaluate sounds with specific hearing loss, and obtain cues to synthesize clear sounds for all of us.

GUI of the hearing impaired simulation system (right) in a practical class for speech therapists (left)

Theme 3 ▶ Changes in perception and cognition by long-term training of music

The questions of how we perceive music as an object with recognizable temporal structure, receive various emotions from it, and enjoy it are still research themes stimulating many researchers. We will study how music changes human audio-visual information processing with the cooperation of professional musicians intensely trained since childhood. We are also investigating the diversity of musicians who have often been treated as a single group.

Human and Brain Informatics

Computational Intelligence Laboratory

Staff	• Associate Professor **Murakoshi, Kazushi** (E-mail：mura@tut.jp)
Laboratory URL	http://www.ci.cs.tut.ac.jp
Key words	Intelligence information processing, neural network model, soft computing, sensory information processing model

Although humans and animals have great information processing functions, many of such features are yet to be elucidated. Thus, we are studying ways to elucidate the information processing process of those functions and consider a breakthrough based on what we learned from biological information processing when we face an obstacle or difficult problem in artificial information processing. A wide range of academic disciplines must be taken into consideration to examine the information processing mechanism of humans and animals. Therefore, we thoroughly examine physiological and psychological knowledge and proceed with our studies from a multidisciplinary view while taking an information scientific approach. The ultimate goal is to create an artifact with functions superior to that of humans and animals.

Theme 1 ▶ Intelligent information processing

We aim to realize the intelligent information processing that humans can perform well and suggest soft computing techniques of neural circuit models, flexible reinforcement learning and self-organizing maps etc.

Theme 2 ▶ Sensory information processing model

We explore the mechanism of perception information processing that humans can perform well by applying the modeled visual processing that humans can do well to image processing and modeling the visual process with consideration to the mechanism of processing illusions.

Three major approaches to research the brain.

Visual Neuroscience Laboratory

Staff	• Associate professor **Koida, Kowa** (E-mail : koida@eiiris.tut.ac.jp)
Laboratory URL	http://www.eiiris.tut.ac.jp/koida/
Key words	Vision, electrophysiology, unit recording, animal behavior, human psychophysics, electrode development, optical fiber imaging, color vision, color blindness

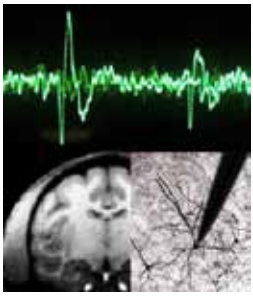
Our research interest lies in the field of systems neuroscience, particularly in the functional relationship between visual perception and neuron activity in the cerebral cortex. The goal of our research is understanding neuronal processes that mediate color perception and object recognition. We have been conducting behavioral and physiological experiments with trained monkeys to perform cognitive tasks. Human psychophysics is also carried out to support correlative evidence between animal behavior and human perception.

Theme 1 ▶ Understanding neural basis for visual sensation and cognition

Color is a premier model system for understanding how visual information is processed by neural circuits. Both the physical stimulus for color and the perceptual output experienced as color are quite well characterized, but the neural mechanisms that underlie the transformation from stimulus to perception are incompletely understood.

We are focusing on the inferior temporal cortex (ITC), where many neurons response to visual stimuli as highly selective and sophisticated manner. We found a patch organization of color selective cells in the ITC where clusters of neurons showed strong and fine color responses. To understand higher visual function taking place in the ITC such as effect of task demands, memory and utility, color response in the patch could become a useful target area for single unit recording and electrical microstimulation.

Human psychophysics is carried out to find out new phenomena, visual illusion and critical feature of visual stimuli. Psychophysical measurement is important to supports correlative evidence between animal behavior and human perception.



Neurons, spiking activities, and monkey's brain taken by MRI.

Theme 2 ▶ Establishing innovative method for neuroscience

EIIRIS have a strong advantage for the development of sensing device such as high density electrode with smart electrical circuits and optical devices. The electrode using Vapor-Liquid-Solid techniques (also known as Toyohashi-probe) is now in trial for effective physiological experiments. An optical imaging system using bundle fibers enable us to monitor functional architecture of deep brain. We debelop these techniques using animalas such as mice, rats, and monkeys.

Picture of a micro-imaging probe with a high density optical fibers.

Theme 3 ▶ Behavioral study for dichromatic macaque

Our research groug have found dichromatic macacues a deacade ago, and examined their color vision by genetics (Onishi, et al. 1999), electroretinography (Hanazawa, et al. 2000), and behavioral color discrimination perfromance (Koida, et al. 2013). Futher reseach such as physiological recording in the brain would be expected.

Pseudoisochromatic plates example used in the behavioral tests.

Interactions and Communication Design Laboratory

Staff	• Professor **Okada, Michio** (E-mail：okada@tut.jp) • Assistant Professor **Hasegawa, Komei** (E-mail：hasegawa@cs.tut.ac.jp)
Laboratory URL	http://www.icd.cs.tut.ac.jp/
Key words	Interaction Design, Social Robotics, Human-Robot Interaction, Cognitive science in communication, Learning science

We are conducting researches on underlying the mechanisms of embodied human-human communication and social interaction from multidisciplinary perspectives, such as social robotics, cognitive science and interaction design.

Theme 1 ▶ Social robotics and human-robot interaction studies

We use these ecological perspectives to recruit those/things around us to help and build robots with relational capabilities (social robots who use their imperfections as strength). From our research on proto communication, we have created robots such as

- Sociable Trash Box: This robot can't pick up trash on its own, but by cleverly drawing out help from children, the robot picks up trash.
- i-Bones: A robot that nervously draws out the kindness and help from people to give out tissues.
- Talking-Ally: Drawing out help from the listener, Talking-Ally starts conversations and needs the help of the listener to keep the conversation going.
- Muu: Making conversation without words, Muu is a robot who makes conversation with multiple people.

ICD-lab's Social Robots

Theme 2 ▶ Cognitive science in our everyday communications

Our true research focuses on trying to draw out help from those around us by ways of subtraction design and conversation through minimal spontaneous sounds. We hope that these points of research will lead to new communication methods. Furthermore, our lab looks to find a constructive approach to the aspect of human-human proto-communication. Here are several of our research focuses:

- Pursuing the involvement of participants in order to communicate and use minimal cues to bring about communication.
- Developing robots based on isomorphism in relation to the environment and human-robot proto-communication.
- Research on body-body communication through the use of Pelat; the unsteady wandering robot who walks alongside you by holding your hand.

Sociable Creature - Muu

Theme 3 ▶ Interaction Design and Social Implementation

By adding more capabilities and raising the functionality of systems, we become more passive and even arrogant at times towards the way we use robots or systems. Our lab in essence, is focused on creating and socially implementing an interactive design which excels in drawing out human kindness, schemes/strategy, and a new way to learn.

-Our research focuses on designing leaning environment for children that focus on the relational development theory.

- Another focus point is to construct the symbiosis theory through NAMIDA, a level 3 robotic (conditional automation) autonomous driving system. These little agents create a cooperative environment with the driver in which, both NAMIDA and the driver draw out each other's weakness, while building on those weaknesses to create a stronger bond.

Driving Agent NAMIDA

Visual AI Laboratory

Staff	• Professor **Kuriyama, Shigeru** (E-mail：sk@tut.jp)
Laboratory URL	http://www.val.cs.tut.ac.jp
Key words	Computer Graphics, Human motion synthesis and analysis, Image-based craftwork and optical control, Style informatics for visual media

We are developing novel technologies based on artificial intelligence (AI) such as machine learning and neural network, for smartly generating, editing, and analyzing visual contents. Also, mathematical models or applications are developed to create contents or values in a real world, such as digitally designed craftworks or lighting environments, from graphical or image representation.

Theme 1 ▶ Humanoid animations based on motion data learning

Classification, recognition, and conversion of human motion data has a big potential for developing digital human technologies in various fields: gestural or behavioral recognitions, simulations for physical trainings, and humanoid animations for video games and VR systems. This project introduces advanced numerical optimizations or machine learning techniques such as deep neural networks to motion data generation or recognition.

Geo-statistical motion interpolations.

Theme 2 ▶ Style-based graphics and image processing

Machine learning techniques are rapidly progressed in the research fields of graphics and image synthesis. We are interested in applying state-of-the-art deep learning algorithms to these fields, especially in style manipulation/conversion of graphical/image representations such as motion capture data and illustrative or cartoon-like images.

Style-based arrangement of illustrative images.

Theme 3 ▶ Image-based craftwork and optical control

This project develops the methodologies or novel applications based on artificial or illustrative images. Smart image processing such as conversion, sampling, style recognition, is developed to support the designs and creations of physical object, such as machine embroidery and smart controls of decorative illuminations, using state-of-the-art methods of machine learnings.

Smart optical controls of decorative illuminations.

Active Intelligent Systems Laboratory

Staff	• Professor **Miura, Jun** (E-mail：jun.miura@tut.jp) • Assistant Professor **Hayashi, Kotaro** (E-mail：hayashik@cs.tut.ac.jp)
Laboratory URL	http://www.aisl.cs.tut.ac.jp/
Key words	Intelligent robot, mobile robot, service robot, autonomous driving, robot vision, robot planning, robot teaching, human-robot interaction

We aim to develop intelligent systems, such as service robots and self-driving vehicles, which can operate autonomously and intelligently in complex real environments. A key to realize such systems is advanced information processing or AI, including scene recognition, context-aware planning, and human-machine interaction.

Theme 1 ▶ Attendant robot / Service robot

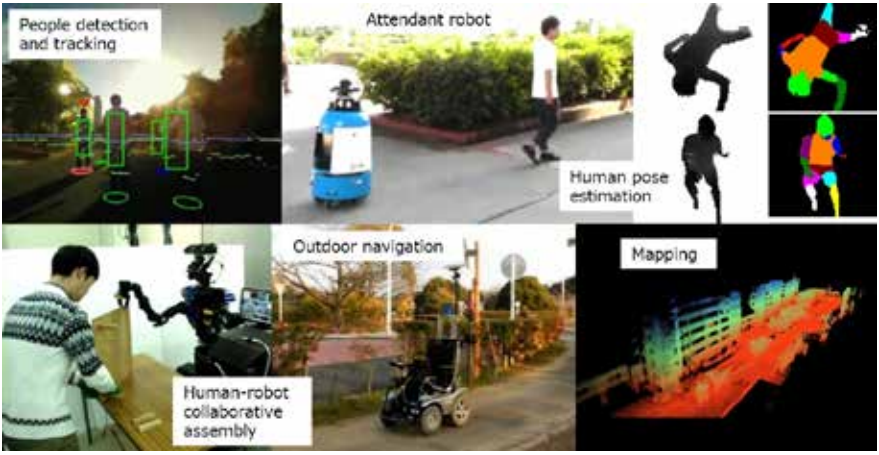
Autonomous service robots are expected to support our daily life in various scenarios, such as attending, guiding, errand, and search. We have been developing novel methods for such service robots, including robust scene recognition, human detection/tracking/identification and pose estimation, and task and action planning.

Theme 2 ▶ Outdoor navigation / Autonomous driving

Outdoor navigation is one of the necessary functions of service robots since outdoor environments are important parts of human activity. We have been developing novel methods for outdoor navigation such as multi-sensory road boundary tracking, view-based robust localization, and large-scale 3D mapping and localization. Many of these methods can be applied to autonomous driving.

Theme 3 ▶ Human-robot interaction

Human-robot collaboration is an effective way of achieving non-trivial tasks in complex real environments. We have been developing novel approaches in various collaborating scenarios such as human-robot collaborative assembly, collaborative remote object search, and robot-mediated task knowledge transfer.



Research projects at Active Intelligent Systems Laboratory

Ubiquitous Computing Systems Laboratory

Staff	• Associate Professor **Ohmura, Ren** （E-mail：ren@tut.jp）
Laboratory URL	http://www.usl.cs.tut.ac.jp
Key words	Ubiquitous Computing, Wearable Computing, Sensor-Actuator Network, Context-aware Systems, Activity Recognition, Smart Devices, IoT, Computer Network, Distributed Systems, Operating Systems

Our laboratory aims to a system that support our daily life using ubiquitous technologies. We study several techniques in wide range from devices to AI technologies, such as embedded systems, wearable computers, sensor networks, computer networks, distributed systems, system software, pattern recognition, visualization and so on.

Theme 1 ▶ Body (Wearable) Scale System

In recent days, wearable devices, such as a smart watch and a head mounted display, are getting common. Connecting these devices as a "body-area network", we study techniques to automatically understand what a user is doing now, so-called "activity recognition". Also, using the recognition results, we also develop systems to support human activities, such as training of certain action form, error detection of tasks. Figure 1 shows the example of cardio pulmonary resuscitation (CPR) support system using wrist-worn sensors that gives instruction of correct CPR on the site of emergency rescue.

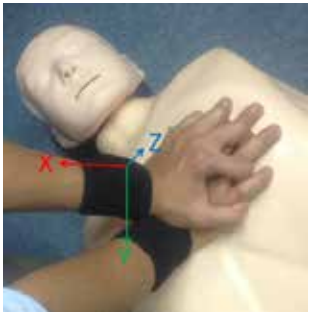


Figure 1. CPR support system with wrist-worn (wearable) sensors

Theme 2 ▶ House and Office Scales Systems

Now, appliances in a house and office, such as a TV, air conditioner, and a cleaning robot, have functions of information processing. Activity and situation recognition techniques described above can be extended to these environment, and we develop a system that support our daily life at our house and working environment, such as a system supporting efficient and safe medical care in hospitals. Figure 2 shows a research project using Terapio, a robot supporting medical rounding in a hospital, collaborating with Human-Robot Symbiosis Research Center at TUT. Also, we are developing an application execution and development environment of home network that enables ordinal people to build a program easily, by personifying appliances and integrating between-human and between-device communication. Moreover, we also develop novel sensor devices which works efficiently with energy-harvesting and wireless power transmission techniques.

Figure 2. Terapio, a robot supporting medical rounding in a hospital

Theme 3 ▶ Urban Scale Systems

Mobile phones and wearable computers accomplish the support of our activity even outside environment. In other words, these devices can contribute to design our city in the aspect of information, and our laboratory aims to a "smart city" where citizens can spend their happy, enjoyable, and safe life. One example of the systems we are developing is the one supporting emergency rescue enabling efficient information exchange among concerning organizations, such as fire department, ambulance, and hospitals. Also, Figure 3 shows another example, a navigation system of a city and theme park that reflects users' impression by detecting their emotion with wearable devices automatically.

Figure 3. A map with users' impressive location detected by wearable sensors

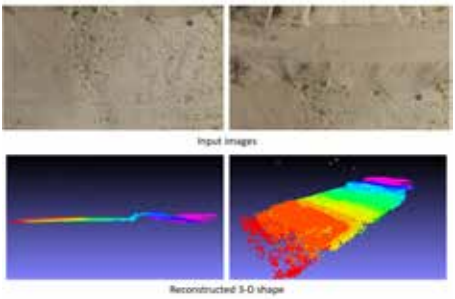
Computer Vision and Image Processing Laboratory

Staff	• Associate Professor **Kanazawa, Yasushi** (E-mail : kanazawa@cs.tut.ac.jp)
Laboratory URL	http://www.img.cs.tut.ac.jp/
Key words	computer vision, image processing, 3-D reconstruction, image matching, vulnerable road users

The aim of computer vision is to realize the functions of human vision on a computer and its applications are widely used for various fields: 3-D measurement, surveillance system, robot vision, medical image processing, and so on. In this laboratory, we focus on 3-D reconstruction from images and matching between images. We also study image processing for colorblind persons and a safety system for vulnerable road users like children and elderly persons using image processing.

Theme 1 ▶ Accurate image matching

Image matching is the first step for many computer vision applications like 3-D reconstruction and object recognition. The accuracy affects to that of reconstructed 3-D shape. We are studying robust and accurate image matching methods for various scenes.



3-D reconstruction of sands

Theme 2 ▶ 3-D reconstruction from images under special environments

Endoscope image sequence is one of difficult case for accurate 3-D reconstruction because of the special motion of the camera. Drone images of the sands or beach is also difficult to obtain accurate 3-D shape because the target is almost planar and its texture is almost the same. We are conducting the research of accurate 3-D reconstruction under such special environments.

Theme 3 ▶ Image enhancement for colorblind person

Colorblind person feels inconvenience in daily life because the color design of almost things is not adequate for them, e.g., traffic signs/signals, road/floor maps, even web pages. We have proposed image enhancing method by additive image noise for them. By our method, not only colorblind person can distinguish their indistinguishable colors but also normal person can recognize the original colors. We are conducting the improvement of our method.

Image enhancement for colorblind person

Image Information and Image Media Laboratory

Staff	• Associate Professor **Sugaya, Yasuyuki** (E-mail：sugaya@iim.cs.tut.ac.jp)
Laboratory URL	http://www.iim.cs.tut.ac.jp
Key words	Computer vision, 3-D shape reconstruction, mixed reality system, ellipse detection

We are studying geometric problems of computer vision including 3-D reconstruction, ellipse fitting, ellipse detection, and mixed reality system.

Theme 1 ▶ Mixed reality system using circular marker

We are studying ellipse detection from images and use this technique for detecting a circular marker of a mixed reality system. The advantage of using a circular marker is that we can estimate a camera position and pose from this marker if it is hidden by other objects.

Theme 2 ▶ Developing diminished reality system

We are developing a diminished reality system using circular markers and a 3-D shape of a background scene obtained from a RGB-D sensor like the Kinect. We are now focusing an alignment between the overlaid background and a captured image from a user camera.

Theme 3 ▶ Ellipse fitting and ellipse detection

We are studying a high-accuracy ellipse fitting technique and ellipse detection from images for applying mixed reality system and camera calibration.

Diminished reality. Left top: input image, left bottom: reconstructed background, right: output image.

Autonomous robot navigation system using ellipse detection.

Social Robot Laboratory

Staff	• Lecturer **Ohshima, Naoki** (E-mail：ohshima@eiiris.tut.ac.jp)
Laboratory URL	http://sarl.jp/
Key words	Human-robot interaction, human-agent interaction, multi-party conversation, verbal/non-verbal communication, behavior analysis of social interaction

Currently, we are developing several communication robots that can involve in conversation with people using verbal and non-verbal means of communication. Through our research, we intend to construct a suitable robot architecture for achieving human-like multi-party conversation among more than two robots. In this study, we are constructing and evaluating the social interactions of robots that can participate in human communications. Therefore, our research findings will help to understand the daily communication mechanisms of humans.

Research members are making novel social robots

Theme 1 ▶ Design of a Speech Eliciting Robot that Intervenes in Brainstorming Sessions to Ensure Collaborative Group Work

For brainstorming to work effectively, a cooperative atmosphere in which all participants can exchange their ideas in a collaborative manner is essential. On such occasions, situations in which the topic of discussion moves on without some participants being able to share their comments or ideas must be obviated. In this research, we developed a speech eliciting robot (Neut) that ensures a cooperative brainstorming environment. Neut creates an atmosphere that makes it easier for participants who are often overlooked to express their ideas, by promoting cooperation from the other participants. Neut is a small robot that moves freely on a table and approaches one or the other participant who has not yet had his/her speaking turn. After stopping in front of such a participant, it brings out a wireless microphone and prompts the participant to speak, while looking around restlessly to suggest to others that they give the participant a chance to speak.

Speech eliciting robot that intervenes in brainstorming sessions to ensure collaborative group work

Participants interacting with a communication enhance robot (Neut)

Theme 2 ▶ Bot-type Agents to Promote Conversations Between a Child and a Parent Who Live Far Away

Daily communication between a child and the parent living alone is important for maintaining parent-child relationships and verification of health. However, a parent and a child living away from one another will only contact each other when there is a special event or reason, and communication will gradually fade. The purpose of this study is to construct a system to promote parent-child remote communication. Therefore, based on a parent's cooking and chat activity of multiple agents, a communication support system that gives a parent and a child the opportunity to speak has been developed.

An example of parent-child communication promoted by chatbots system

Department of Applied Chemistry and Life Science

Molecular Design Chemistry

Molecular Functional Chemistry

Molecular Biological Chemistry

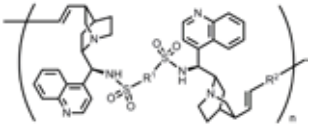
Functional Polymer Chemistry Laboratory

Staff	• Professor **Itsuno, Shinichi** (E-mail：itsuno@chem.tut.ac.jp) • Research Associate **Fujisawa, Ikuhide** (E-mail：ifujisawa@chem.tut.ac.jp)
Laboratory URL	https://chem.tut.ac.jp/chiral/
Key words	Asymmetric reaction, polymer-immobilized catalyst, chiral polymer synthesis, chiral organocatalyst, chiral transition metal catalyst, peptide folding, protein folding structure

We carry out research in several areas at the interface of organic chemistry and polymer chemistry and are especially concerned with asymmetric synthesis, reactive polymers, and new chiral polymer synthesis. We mainly focus on the development of new methods of asymmetric synthesis with the aid of polymer immobilized chiral catalysts. We are also considering statistical theory of protein (peptide) folding, which will provide a novel approach to design of new asymmetric catalyst system.

Theme 1 ▶ Chiral polymers as organocatalysts in asymmetric synthesis

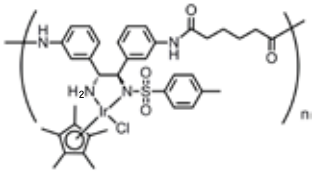
Various efficient asymmetric catalysts have been designed based on cinchona alkaloids, an important class of which are their sulfonamide derivatives. We have developed several syntheses of polymeric cinchona-based catalysts including quaternary ammonium salts, sulfonamides, and squaramide derivatives. These chiral polymers showed excellent catalytic activities with high level of stereoselectivities in various kinds of asymmetric reactions.



Cinchona sulfonamide polymer

Theme 2 ▶ Chiral polymer – transition metal complexes in asymmetric synthesis

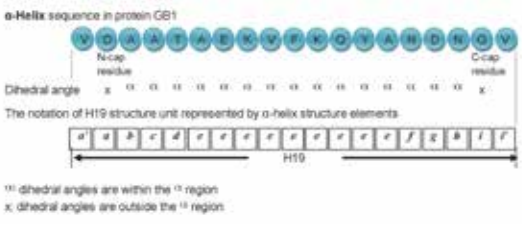
A chiral main-chain polyamide consisting of (*R*,*R*)-1,2-diphenylethylenediamine monotoluenesulfonamide (TsDPEN) repeating unit was prepared. Treatment of the main-chain polymer chiral ligand and transition metal complexes such as $[IrCl_2Cp^*]_2$, $[RhCl_2Cp^*]_2$, and $[RuCl_2(p\text{-cymene})]_2$ afforded the polymer chiral metal complexes. Asymmetric transfer hydrogenation of cyclic sulfonamide was efficiently catalyzed by the chiral TsDPEN polymer - metal complex to give the optically active cyclic sulfonylamine in quantitative conversion and high enantioselectivities.



Chiral polymer - transition metal complex

Theme 3 ▶ Protein folding structures based on probability theory

Decoding, rather than predicting, the initiation mechanism of protein folding from amino acid sequences is a stringent requirement for protein folding researchers. We proposed 44 kinds of folding elements, which covered all the amino acids in the protein chains, and defined all folding structure units. Folding structure formation based on probability theory is the general solution for the initiation mechanism of Anfinsen's tenet of protein folding.



Peptide folding

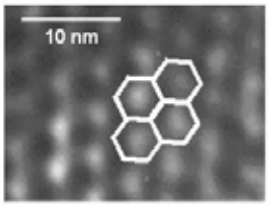
Functionalized Interface Science Laboratory

Staff	• Professor **Matsumoto, Akihiko** (E-mail：aki@chem.tut.ac.jp) • Assistant Professor **Ito, Hiromitsu** (E-mail：hiro_ito@chem.tut.ac.jp)
Laboratory URL	https://www.tut.ac.jp/university/faculty/chem/227.html
Key words	adsorption, adsorption microcalorimetry, energy of adsorption, fullerene, gas adsorption, mesoporous silica, nanoporous carbon, nanoporous material, zeolite, PCPs/MOFs

Our laboratory has been interested in adsorption of gases on micro/mesoporous materials. The research topics focus on development and characterization of pore structure of adsorbents and interaction between gas molecules and solid surfaces by aid of physicochemical techniques, such as adsorption microcalorimetry, adsorption measurement, and spectroscopic methods. Our researches also include development of novel porous materials by controlling surface chemical features and pore structures which are suitable for adsorption removal of target gas molecules. Based on these research results, we are undertaking application studies on adsorption removal of air pollutants and adsorption storage of hydrogen and methane.

Theme 1 ▶ Surface functionalization of porous materials and developing novel nanoporous materials

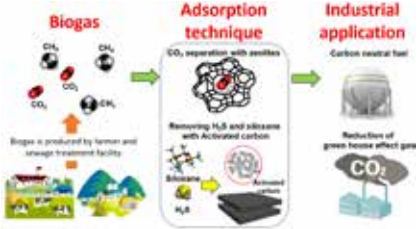
Adsorbed state of molecules on porous materials strongly depends on the chemical composition of the surface, the pore structure, and the chemical characteristics of adsorbate molecules. We study gas adsorption mechanisms and adsorption characteristics of molecules on porous materials such as zeolites, MOFs/PCPs, ordered mesoporous silica, and nanoporous carbon by the aid of various adsorption techniques such as adsorption isotherm measurements, adsorption microcalorimetry, and spectroscopic method (UV/VIS, FT-IR and Raman).



TEM image of hexagonal pore structure in ordered mesoporous silica

Theme 2 ▶ Selective separation of CO_2 and CH_4 purification from biogas by gas adsorption technique

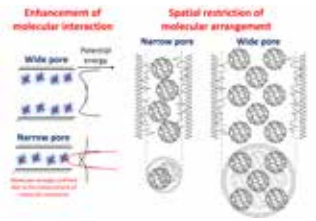
The biogas, which consisted by CH_4, CO_2 and misc. is one of carbon neutral energy sources produced by anaerobic fermentation of sewage sludge.
Our research focuses on purification of biogas by pressure swing adsorption (PSA). Especially we are interested in the separation of CO_2, H_2S, and siloxane gas by zeolites, MOFs/PCPs and surface modified activated carbons.



Biogas separation for the sustainable society by gas adsorption

Theme 3 ▶ Controlling molecular and atomic arrangements by using nanosapace in porous materials

When molecules and atoms are confined in nanospace or micropore in molecular dimension (ex; length < a few nm), features of the confined molecules such as crystal structure and electric properties are often dramatically changed from the bulk state due to enhancement of intermolecular interaction in the nanospace. These phenomena depend on both the size of the nanospace and the combination of the container and confined molecules. We challenge to create novel molecular arrangement in the nanospace of nanoporous materials.



Controlling molecular and atomic arrangements.

Microscale Separation Science Laboratory

Staff	• Professor **Saito, Yoshihiro** (E-mail : saito@tut.jp)

Key words	Molecular shape recognition, Chemically bonded phase, Liquid chromatography, Gas Chromatography, Microextraction techniques, Microcolumn separations, On-line coupling, Sample preparation, On-site sampling, Derivatization, Air analysis

Due to the recent requirements for stationary phases in chromatography such as higher selectivity, we have been developed various novel stationary phases by the systematic analysis of the retention behavior of sample solutes. One of the examples is the successful introduction of the synthetic fibers as the stationary phase in packed-capillary gas chromatography. The applications of the fibrous stationary phases as the novel extraction medium in sample preparation techniques are also studied in our group.
Miniaturization and automation of the whole separation instruments have been another important project in separation science, because of the increasing requirements for recent separation systems, such as selective/specific detection with high sensitivities, high throughput processing, as well as an environmentally-friendly feature of the systems. On the basis of the above concept, miniaturized sample preparation and separation techniques have been also studied along with the effective coupling of these techniques.

Theme 1 ▶ Development of Novel Stationary Phases in Chromatography.

Chromatography is regarded as one of the most effective and powerful techniques in separation science, and a wide variety of applications have been studied not only in the area of analytical chemistry but also in pharmaceutical, medical and environmental chemistry. In this topic, we have developed novel stationary phases in liquid chromatography and gas chromatography, including fine fibrous stationary phase.

Theme 2 ▶ Miniaturization of Sample Preparation Techniques.

To reduce the amount of organic solvent and chemicals in the analytical process, we have introduced miniaturized analytical system consisted of micro-extraction for sample preparation and microcolumn in chromatography for effective separation. Downsizing the whole analytical process could be realized with the effective on-line coupling of the sample preparation and chromatographic separation.

Theme 3 ▶ Needle Extraction Device for Effective Sample Pretreatment.

Introducing a novel needle-type sample preparation device for sampling and preconcentration of variety of volatile organic compounds in air samples, various applications especially a precise analysis of air environment have been demonstrated, including human breath analysis and fire investigation.

Supramolecular Chemistry Laboratory

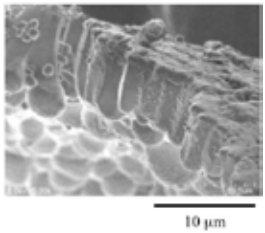
Staff	• Associate Professor **Yoshida, Eri** (E-mail : yoshida.eri.gu@tut.jp)

Key words	Artificial biomembrane models, Molecular self-assembly, Giant vesicles, Morphology control, Polymer surfactant, Amphiphilic block copolymer, Photo-controlled/living radical polymerization, Superhydrophobic surface, Supercritical carbon dioxide, Intelligent supramolecules

Our research group focuses on engineering new materials with high performance and functions by biomimetic approaches using synthetic polymers. We study the mechanisms of structure formation and function expression of biomolecules and tissues from a chemical aspect, and use nanotechnology to fabricate functional biomaterials. We also design intelligent supramolecules using polymers with the structure strictly controlled by the nitroxide-mediated controlled/living radical polymerization technique recently established in our lab.

Theme 1 ▶ Artificial Biomembrane Models Using Polymer Giant Vesicles

The polymer giant vesicles we created using amphiphilic diblock copolymers are regarded as possible artificial models of biomembranes for cells and organelles, such as erythrocytes, mitochondria, and chloroplasts based on the similarities in their size, structure, and behavior. The models involve an artificial cholesterol model formed with amphiphilic random copolymers. We investigate biological phenomena within the biomembrane from the viewpoint of chemistry based on the slow movement of the copolymers composing the vesicles and engineer the functions originating from the biomembrane on the vesicle membranes. These biomembrane models enable us to presume the shape and morphology of the vesicles through the hydrophobic free energy calculation found in our lab. We also focus on designing the diblock copolymers to control their critical packing shapes in the vesicles. The control of critical packing shapes of the copolymers allows us to fabricate artificial tissues of villus-like structure and to provide the vesicle membrane with the biomembrane phenomena and functions, such as morphological transformation, budding separation in endocytosis, and pore formation in membrane transport.



The FE-SEM image of the villus-like structure prepared by an amphiphilic diblock copolymer

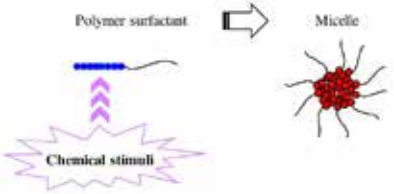
Theme 2 ▶ Fabrication of Superhydrophobic Surface

Our group explores new approaches to the superhydrophobic surface with self-cleansing ability by imitating the lotus leaf structure. The simple methods we have recently developed include coating with nanospheres prepared by dispersion polymerization of perfluoroalkyl methacrylate. The surface coated with the nanospheres has superamphiphobicity with the contact angles of 173° for water and 160° for diiodomethane. The synergistic effect of the spherical structure and the high concentration of fluorine on the top of the surface produces the superamphiphobicity. We also have fabricated superhydrophobic surface using micelle-like nanospheres prepared in supercritical carbon dioxide. The nanospheres are formed by self-assembly of CO_2-amphiphilic random copolymers and have the CO_2-philic shell of fluoroalkyl chains and CO_2-phobic cores. This highly safe method wherein no unreacted monomer and organic solvent remain inside the nanospheres is useful for creating wiperless vehicles.

The image of a water droplet on the surface coated with the nanospheres.

Theme 3 ▶ Design of Intelligent Supramolecules Using Controlled/Living Radical Polymerization

We design and develop a new type of intelligent supramolecules with the responsivity to chemical stimuli, such as electron transfer in oxidation and reduction, photolysis, photo-rearrangement in addition to physical stimuli of temperature, pH, and salt concentration. The supramolecular aggregates, like micelles, serve as nano-sized oxidizing and reducing agents, dyes, and adhesion-latent materials. For obtaining such intelligent supramolecules, we employ polymer surfactants with the structure precisely controlled by the nitroxide-mediated controlled/living radical polymerization.



The schematic image of designing intelligent supramolecules.

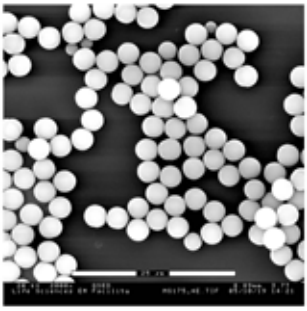
Functional Polymer Chemistry Laboratory

Staff	• Associate Professor **Haraguchi, Naoki** (E-mail：haraguchi@chem.tut.ac.jp)
Laboratory URL	https:// chem.tut.ac.jp/chiral/
Key words	Polymer microsphere, Polymeric catalyst, Functional polymer, Asymmetric reaction, Chiral Organocatalyst, One-pot reaction, Environmentally benign reaction

Our research group is focused on the molecular design and precise synthesis of functional polymers such as polymer microsphere, polymer-supported chiral catalyst and architectural polymer, and the development of their practical use. These functional polymers are applied as asymmetric catalysts for the synthesis of pharmaceuticals, agrochemicals and functional materials. We have further investigated the relationship between polymeric structure and its performance in detail. Through these studies, we are challenging the development of high performance polymeric catalyst and construction of new organic synthesis system.

Theme 1 ▶ Synthesis of functional polymer microsphere

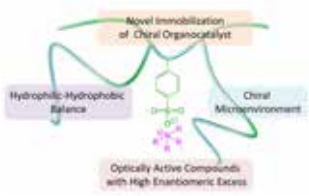
Polymer microspheres have been applied to paints, coatings, diagnostic drugs, cosmetics, precision machines, etc. Precise synthesis of well-defined monodispersed functional polymer microspheres, core-shell polymer microspheres, and hollow polymer microspheres has been developed by precipitation polymerization. Polymer microspheres functionalized with chiral catalyst have been used for a general asymmetric reaction, one-pot asymmetric reaction and an automated flow system for chiral compound synthesis.



Well-defined monodispersed functional polymer microspheres by precipitation polymerization

Theme 2 ▶ Polymer-supported chiral catalyst for asymmetric reaction

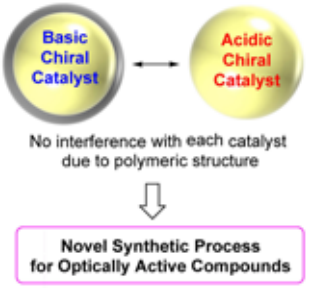
Polymer-supported chiral organocatalysts and polymer-supported chiral organometallic catalysts have been developed for the efficient synthesis of chiral product using asymmetric reaction. Immobilization of chiral catalyst onto polymer facilitates the separation of chiral product from reaction mixture. In addition, the recovered polymeric chiral catalyst can be reused. Recently, main-chain polymer of chiral organocatalyst, novel immobilization of chiral organocatalyst onto polymer by ionic bonding, and amphiphilic polymer-supported chiral catalyst for asymmetric reaction in water have been developed. These polymeric catalysts show high catalytic activity in a variety of asymmetric reaction.



Polymer-supported chiral organocatalyst

Theme 3 ▶ Development of novel organic synthesis process using polymeric catalyst

Polymeric catalyst can provide specific microenvironment that it is difficult to realize in a reaction using the corresponding molecular catalyst. We have focused on one-pot reaction by using combination of multiple catalysts (i.e. acid and base catalysts) which are difficult to use simultaneously. Automated synthesis using polymeric catalyst has also been investigated.



Novel synthetic process by using combination of multiple catalysts

Applied Sensing Technology Laboratory

Staff	• Professor **Tanaka, Saburo** (E-mail：tanakas@tut.jp)
Laboratory URL	https://chem.tut.ac.jp/squid/
Key words	Magnetics, Superconductor, SQUID, Magnetic sensor, Contaminant detector

Saburo Tanaka received his B.E. and M.E. from Toyohashi University of Technology in 1981, and 1983, respectively. He received his Doctoral Degree in engineering from Osaka University in 1991. Since 1987 he has been involved in the research of high-temperature superconductors at Sumitomo Electric Itami Research Lab. He was engaged in the development of multichannel high-Tc SQUID systems at the Superconducting Sensor Laboratory from 1991 to 1995. He was a visiting research associate at the Department of Physics, University of California at Berkeley from 1996 to 1997. Currently, he is a professor at faculty of Environmental and Life Sciences.

One of my main interests is in the applications of Superconducting Quantum Interference Devices (SQUIDs). The applications include the contaminant detection system in food and a Li-ion battery, and the magnetic nanoparticle imaging.

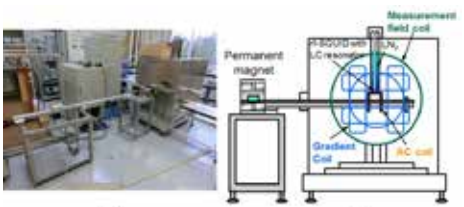
Theme 1 ▶ Ultra-sensitive Metallic contaminant detector for Li ion battery. And Food

The detection technique is based on recording the remnant magnetic field of a contaminant using SQUID sensors. SQUID is a high-sensitivity magnetic sensor based on the superconductivity phenomenon. The sensitivity for food inspection is 0.3 mm in diameter and for Li ion battery is 35 micron in diameter.

Metallic contaminant detection system using HTS-SQUID. Inset shows the appearance of the electromagnetic shield with SQUID electronics when the front door is open.

Theme 2 ▶ Ultra-Low Field NMR/MRI using SQUID

We have developed an ultra-low field (ULF) magnetic resonance imaging (MRI) system using a high-temperature superconducting quantum interference device (HTS-SQUID) for food inspection.



Ultra-low field magnetic resonance imaging system using HTS-SQUID.
(a) Appearance of the system. (b) Schematic diagram of the system.

Theme 3 ▶ Magnetic nano-particle imaging using SQUID.

We have developed a method to improve the detection sensitivity for the magnetization M of MNP (Magnetic Nano-Particle) and the imaging technique based on the detection of a second harmonic of the response. The advantage of the use of the second harmonic response is that the response can be taken for small AC magnetic field.

Magnetic Nanoparticle imaging Scanner using HTS-SQUID.

Applied Light Sensing Laboratory

Staff	• Associate Professor **Ariyoshi, Seiichiro** (E-mail：ariyoshi@tut.jp)
Laboratory URL	https://chem.tut.ac.jp/terahertz/
Key words	Terahertz Technology, Superconducting Devices

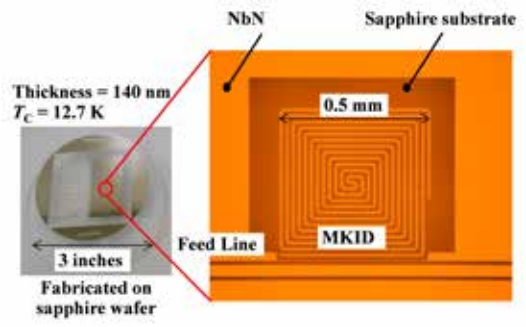
Terahertz-waves (0.1-10 THz, 3 mm-30 um), located in the gap between radio-waves and light-waves, are called as the frontier of light. Terahertz-waves show both properties of transparency in various materials that are visually opaque and invasive nature compared to X-ray and gamma-ray. This ability has opened a wide range of possibilities in various application fields such as security, medicine, biology, astronomy, material science and so on.
This laboratory is pushing ahead with the development on highly sensitive terahertz-wave detectors using superconductor, two-dimensional terahertz spectroscopy and their new applications.

Theme 1 ▶ Development of Superconducting Terahertz-wave Sensors

Two-dimensional terahertz spectroscopy offers potential opportunities in material science research into soft materials for example, and industrial application development. This laboratory have progressed the development of a Microwave Kinetic Inductance Detector (MKID, Fig.1) array operating at 3 K with a cryogen-free He-4 refrigerator, and exhibiting both superior detection sensitivity of greater than one digit or more compared to conventional semiconductor bolometers, and greater speed response. Such an array aims to realize the application of a 2D-Fourier transform terahertz spectrometer.

Theme 2 ▶ Terahertz Spectroscopy of General-purpose Plastics

Polymer properties such as hardness, fragility, workability, and thermal stability are determined not only by the chemical composition but also the higher-order structure related to the crystallinity, molecular chain length, and chain packing in the solid state. In conventional diagnostic methods employed for general-purpose plastics, destructive techniques to measure tensile and bending strengths and subjective observation of the degree of deterioration such as a change in color or transparency are commonly applied. New analysis techniques are currently being developed to allow nondestructive and objective inspection of plastics.



Left: Fabricated spiral-MKIDs on a sapphire substrate. Right: Microscopy image of a spiral-MKID. The NbN film thickness is 140 nm and its Tc is 12.7 K.

Synthetic Organic Chemistry Laboratory

Staff	• Professor **Iwasa, Seiji** (E-mail：iwasa@chem.tut.ac.jp)
Laboratory URL	http://www.siorgchem.chem.tut.ac.jp/index.html
Key words	asymmetric catalyst, ruthenium, carbene, diaozo compound, cyclopropanation, antibody, molecular sensor, computational chemical analysis

Our research group is engaged on several areas of organic molecular research such as development of new methodologies for catalytic asymmetric synthesis, highly sensitive immunoassay for pesticide residue and natural products chemistry.

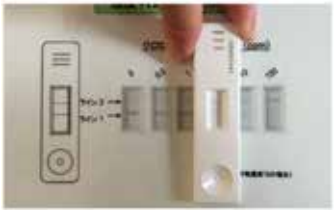
Theme 1 ▶ Development of Enantioselective Catalysts for Carbene Transfer and Various Bond Forming Reactions

Newly designed chiral ligands, a series of chiral bis (oxazolinyl) pyridine and phenyl oxazoline (Pheox) derivatives and their transition metal complexes can be used for synthesis of optically active organic molecules. Especially, Ru(II)-Pheox catalyst and its microporous polymer are found to be a powerful chiral catalyst for carbene transfer reactions to synthesize optically active cyclopropane derivatives. We are also pursuing application of the newly developed methods for the synthesis of biologically relevant molecules.

Ru(II)-Pheox catalyzed cyclopropantions

Theme 2 ▶ Development of A Monoclonal Antibody-based Immunoassay

We have developed an enzyme-linked immunosorbent assay (ELISA) system based on a monoclonal antibody (MoA) to detect small molecules such as pesticide residue in environment, combining with synthetic organic chemistry, molecular biology and antibody technology. The working range was 0.3ng/mL level. Recently, we developed novel immunochromatographic assay kits for analyzing pesticide residue in agricultural products.



Novel immunochromatographic assay kits

Theme 3 ▶ Natural Products Chemistry

Our research interests are extraction, isolation and purification of natural products from various plants cooperation with southern Asian countries and also total synthesis of natural products such as DCG-IV, Dysibetaine CPa, Strychnine.

Natural products from Melaleuca tree in VN

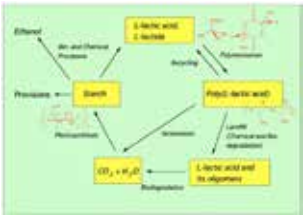
Polymer Materials Engineering Laboratory

Staff	• Professor **Tsuji, Hideto** (E-mail：tsuji@chem.tut.ac.jp) • Assistant Professor **Arakawa, Yuki** (E-mail：yarakawa@chem.tut.ac.jp)
Laboratory URL	https://chem.tut.ac.jp/BDPolym/
Key words	bio-based polymers, sustainable polymers, biodegradable polymers, poly(lactic acid), stereocomplex, liquid crystal, structure-property relationship

We carry out three research projects; (1) Development of bio-based, sustainable, and biodegradable polymers, (2) Stereocomplex formation between enantiomeric polymers, and (3) Synthesis of novel liquid crystalline molecules, and investigation of their phase structures and optical/electrical properties. Our publications have now gathered more than 12,000 citations (SCOPUS).

Theme 1 ▶ Development of Bio-based, Sustainable, and Biodegradable Polymers

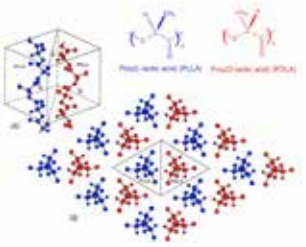
Bio-based, sustainable, and biodegradable polymers such as poly(lactic acid) (PLA), which is produced from renewable resources like corn starch and other plant-derived resources, have been extensively studied for various applications. We synthesize bio-based, sustainable, and biodegradable polymers with a wide variety of molecular and higher ordered structures via ring-opening-polymerization of aliphatic lactones (including lactide) or polycondensation of aliphatic hydroxycarboxylic acid utilizing various combination of monomer, comonomer and initiator and various treatments and investigate their crystallization behavior, physical properties, and biodegradation behavior, and are aiming to develop high performance or functional bio-based, sustainable, and biodegradable polymers.



Synthesis, recycling, and degradation of poly(lactic acid) (PLA).

Theme 2 ▶ Stereocomplex Formation between Enantiomeric Polymers

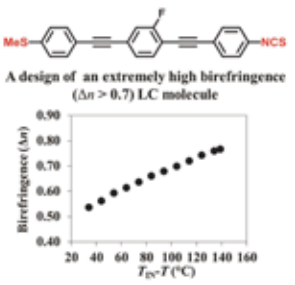
Stereocomplex (SC) formation or crystallization occurs between enantiomeric optically active polymers such as poly(L-lactic acid) and poly(D-lactic acid). Stereocomplexation elevates material mechanical properties and resistance to thermal/hydrolytic degradation. Of SCs, PLA SC is attracting much attention from polymer researchers in terms of their unique crystallization behavior and applicability for reinforcing material properties. We utilize PLA SC as a model SC and investigate the effects of a wide variety of molecular structures on SC crystallization and the effects of SC crystallization on physical properties and morphologies. We are also looking for the new pairs and combinations of enantiomeric polymers which can form SC and have found seven polymer pairs and combinations which can form SC.



Crystal structure of PLA SC.

Theme 3 ▶ Synthesis of novel liquid crystalline molecules, and investigation of their phase structures and optical/electrical properties.

Liquid crystals located between solid crystals and isotropic liquids have a unique property which is able to spontaneously orient along external forces including electromagnetic field and rubbing, and so on. Taking advantage of the alignment property, liquid crystalline (LC) materials are of great interest for various optical and electrical applications as well as scientific concern. In order to use them for various applications, synthesis of new LC molecules as well as evaluation of their optical and electrical properties is significantly important. Our study is aimed at revealing the relationships between molecular structures and optical/electrical properties such as refractive index, birefringence, dielectric constant, fluorescence and charge mobility, etc. Our approaches include design, synthesis, thermal and phase structural analysis, and optical/electrical measurements of novel LC molecules including low-molecular compounds as well as polymers.



Novel LC molecular structure and its temperature dependence of Δn at 550 nm.

Functional Catalytic System Engineering Laboratory

Staff			
	• Professor	**Mizushima, Takanori**	(E-mail：mizushima@chem.tut.ac.jp)
	• Assistant Professor	**Satoh, Hirohisa**	(E-mail：hsato@chem.tut.ac.jp)
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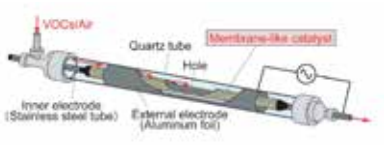
Key words	Solid catalyst, Plasma catalytic reaction, Steam reforming of ethanol, Synthesis of 1,3-butadiene, Crystal structure, Phase transition

Solid catalysts are essential substances for chemical industries and environmental protections. The main subject of our research group is to develop heterogeneous catalysts and catalytic reaction systems for environmentally-friendly synthesis of chemical materials and detoxifying of environmental pollutants. We also investigate crystal growth and structure of single crystals of rare earth manganites as new types of inorganic materials.

Theme 1 ▶ Plasma catalytic reaction system for oxidative decomposition of volatile organic compounds

Although non-thermal plasma (NTP) reactions are effective for decomposing volatile organic compounds (VOCs) in air, their energy efficiencies are relatively low because of very low concentration of VOCs. We have designed a tubular membrane-like catalyst for the NTP reactor by dielectric barrier discharge to improve the energy efficiency. In this approach, VOC molecules in air are condensed by selective adsorption onto the catalyst during the plasma-off period and then oxidatively decomposed by short-term NTP discharge. This has the potential to remarkably reduce electric consumption without significantly decreasing the reaction rate.



Membrane-like catalyst-equipped plasma reactor

Theme 2 ▶ Hydrogen production via low-temperature steam reforming of biomass ethanol

Hydrogen demand is expected to increase precipitously for fuel cells in the near future. Currently, hydrogen is mainly produced by steam reforming of fossil fuels such as natural gas and petroleum, but there are environmental concerns such as emission of CO_2 as a greenhouse gas, resource depletion, etc. Recently, biomass ethanol has attracted significant attention as an alternative resource for hydrogen production, because it is a renewable and environmentally- friendly fuel. Steam reforming of ethanol ($C_2H_5OH + 3H_2O \rightarrow 2CO_2 + 6H_2$) is the most promising method for converting biomass ethanol to hydrogen. We now investigate the catalytic performance of CeO_2-supported multi-metallic catalysts.

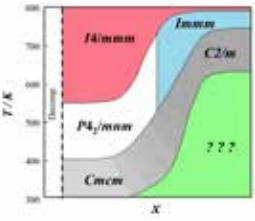
H_2 production from biomass ethanol

Theme 3 ▶ Synthesis of 1,3-butadiene via oxidative dehydrogenation of n-butane

1,3-butadiene as an important chemical raw material of synthetic rubbers is produced by catalytic cracking of naphtha. Because its demand is expected to increase with motorization in developing countries, other synthetic approach is required. We now develop modified bismuth-molybdenum oxide catalysts for 1,3-butadiene synthesis via oxidative dehydrogenation of n-butane.

Theme 4 ▶ Crystal growth and structure analysis of single crystal of rare earth manganites

Single crystal of $BaLn_2Mn_2O_7$ (Ln = rare earth) with layered perovskite structure can be grown by floating zone method. We have investigated the thermal property of the yielded single crystal using DSC and found the thermal anomalies which indicates the existences of several phases and transition paths. Single-crystal X-ray diffraction analysis for each phase heated under the specified condition revealed that the change to another path is caused by increment in oxygen nonstoichiometry.



Phase diagram of BaEu2Mn2O7+x

Chemical Kinetics and Energy Engineering Laboratory

Staff	• Associate Professor **Oguchi, Tatsuo** (E-mail : oguchi@tut.jp)
Laboratory URL	https://chem.tut.ac.jp/keel/
Key words	Combustion Chemistry, Chemical Kinetics, Reaction modeling, Combustion synthesis

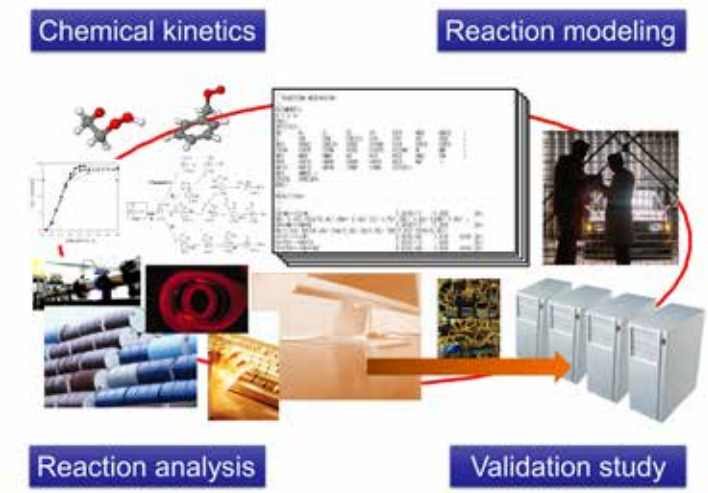
Although the global climate change due to the carbon dioxide emission from our modern life is serious problem, combustion technology is still very important in our life. We have to improve thermal efficiency and reduce unburned fuel on the internal combustion engines for motor vehicles. These days many people aware that the combustion chemistry is very important to understand the several phenomena in engines. Therefore, the information of detail chemical kinetic mechanism is highly recommended to develop new combustion system.

Now we try to reveal the complicated mechanism for the formation of polycyclic aromatic hydrocarbons (PAHs) from the combustion systems, auto-ignition mechanism for the reference fuels, behavior of the small amount of intermediates in the reactor, and elementally reactions by using our self-constructed experimental apparatuses. Also, the theoretical calculation is a strong tool. We use the quantum chemical calculations to obtain chemical and thermal properties of molecules as well as reaction paths. These results are used to estimate the reaction rate coefficients of the elementally reactions. Finally, reaction models are constructed and are compared with the experimental studies for verification.

Theme 1 ▶ Chemical kinetic analysis and modeling of combustion in engines.

Theme 2 ▶ Reaction mechanism of the formation of particulate matters from combustion.

Theme 3 ▶ Theoretical investigation of elementary reactions in combustion chemistry.



Schematic image of the research process for combustion chemistry.

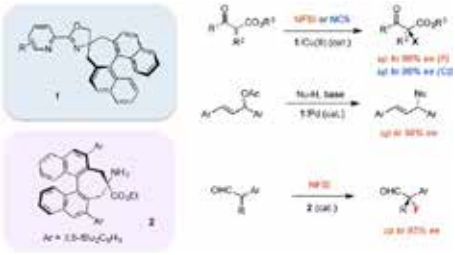
Recreation: a trip to somewhere with lab's members annually.

Organic Chemistry Laboratory

Staff	• Associate Professor **Shibatomi, Kazutaka** (E-mail：shiba@chem.tut.ac.jp)
Laboratory URL	https://chem.tut.ac.jp/orgchem/
Key words	Organic Chemistry, Pharmaceutical Chemistry, Fluorine Chemistry, Organocatalysis, Organometallic Chemistry, Asymmetric Synthesis

Theme 1 ▶ Development of novel chiral catalysts and their application to highly enantioselective reactions

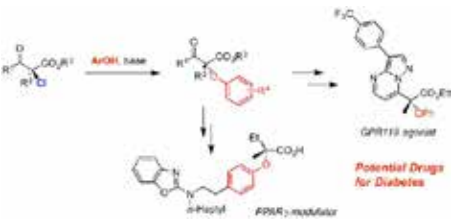
We have been studying the development of novel chiral transition-metal catalysts and organocatalysts. For example, we synthesized a new class of chiral oxazoline ligands 1 with a spiro structure and successfully applied them to various metal-catalyzed asymmetric transformations giving high enantioselectivity, such as Cu(II)-catalyzed enantioselective halogenation and Pd(0)-catalyzed C-C bond forming reactions. Recently, we also developed a new chiral primary amine catalyst 2 having an axial chiral binaphthyl backbone, which catalyzed the asymmetric fluorination of a-branched aldehydes with high enantioselectivity. These reactions could be utilized to the asymmetric synthesis of biologically active compounds.



Asymmetric Reactions with Newly Developed Chiral Catalysts

Theme 2 ▶ Asymmetric synthesis of chiral halogenated compounds and their derivatization via the stereospecific carbon-halogen bond cleavage

We achieved highly enantioselective halogenation reactions with the above-mentioned chiral catalysts, which have had difficulty in achieving high enantioselectivity so far. We also achieved the derivatization of the resulting halogenated compounds via stereospecific carbon-halogen bond cleavage. In particular, the SN2 substitution of α-chloro-β-keto esters proceeded smoothly despite the fact that the reaction occurred at a tertiary carbon center. Using this method, we demonstrated the synthesis of a potential treatment for type 2 diabetes.



Synthesis of Anti-diabetes Drug

Material Cycling Engineerling Laboratory

Staff	• Professor	**Daimon, Hiroyuki**	(E-mail：daimon@cir.ignite.tut.ac.jp)
	• Project Associate Professor	**Atsuta, Yoichi**	(E-mail：atsuta@water.chem.tut.ac.jp)
Laboratory URL	http://water.ens.tut.ac.jp		
Key words	Subcritical water, Rare metals, Hydrothermal reaction, Liquid feed, Amino acids, Organic recycling resource, Lipid biomarkers profile, Anaerobic digestion, Wastewater treatment, Microbial community		

We have been developing waste recycling and biomass utilization technologies to establish sound material-cycle society with high ecological homeostasis. Research projects are focused on development process and methodology by utilizing the high-temperature and high-pressure water and supercritical carbon dioxide technologies. These researches include intensive investigation of the whole process from production to disposal and from inorganic to organic matters. Our group is also involved in the development of "biomass town project" in several cities.

Theme 1 ▶ Construction of Research Center for Production and Utilization of Biomass

In general the utilization of biomass is an ongoing challenge shared by every region. This challenge, however, is a complex task that involves various sectors, including the local authorities, industries, agriculture, as well as the movements towards CO_2 emission. Based on the project "Development of Biomass, CO_2, Heat Utilization System" (2011-2016), our group proposes a new biomass utilization system that combines biomass utilization (energy and nutrients recovery) with biomass production. This new system is in response to the call of innovation in terms of social needs as well, as it can be the catalyst to create new opportunities, as well as enhance the present regional development. Our group aims to build up a research and development base that invites cooperation between different sectors to approach the biomass issues, by applying present or new concepts that well-suit to each case' conditions and needs.

Development from the Viewpoint of the Research Center for Production and Utilization of Biomass

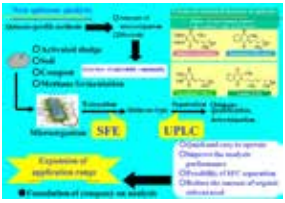
Theme 2 ▶ Environmental Assessment for Production and Utilization of Biomass

Biomass has been a basic resource that supporting human life since ancient times. Recent technological innovations by now allow us to convert various type of biomass into energy or industrial products. On the other hand, the expansion of biomass use, including for food consumption is having an impact on land use change and water pollution. We are looking for solutions to mitigate its environmental impact by analyzing the material and energy balance.

High-Temperature and High-Pressure Water Application

Theme 3 ▶ Development and Application of a Novel Method for Analysis of Microbial Community Structure

Supercritical fluid extraction using carbon dioxide as solvent is a green technology and offers numerous advantages, mainly rapidity and low organic solvent usage for analytical purpose. We have been developing a new application of supercritical carbon dioxide extraction on the determination of microbial community structure for environmental assessment. Four lipid biomarkers namely respiratory quinones (RQ), phospholipid fatty acids (PLFA), phospholipid ether lipids (PLEL), and polyhydroxyalkanoates (PHA) have been investigated. The studies showed potential application of supercritical carbon dioxide extraction as a suitable method for the routine comprehensive analysis of microbial community structures in environmental assessment using the lipid biomarkers profile.



New Quinone Analysis

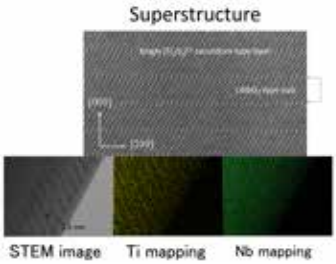
Inorganic Materials Laboratory

Staff	• Professor **Nakano, Hiromi** (E-mail：hiromi@crfc.tut.ac.jp)
Laboratory URL	http://www.crfc.tut.ac.jp/nakano/index.html
Key words	Phosphor, Crystal structure, TEM, XRD, Photoluminescence

We synthesize new inorganic materials and determine the relationship between property and crystal structure from macro- to atomic- scale.

Theme 1 ▶ "Synthesis of new oxide phosphors and clarification of mechanism for relationship between property and crystal structure"

1. Synthesis of new phosphors by solid-phase reaction and liquid-phase-reaction
2. Design and synthesis for new phosphor by controlling of composition and crystal structure
3. Application of red phosphor Li-Ta-Ti-O:Eu excited by 400 nm
4. Relationship between crystal structure and photoluminescence



TEM images of unique structure of LNT ceramic

Theme 2 ▶ "Anisotropic structure and property in oriented bulk ceramics"

In this work, as a first step toward application of the unique qualities of an electro-ceramic with an anisotropy structure, we prepared an oriented LNT balk ceramic by slip casting in a strong magnetic field of 12 T. The direction of the magnetic field was parallel to the casting direction. The obtained specimen was analyzed by X-ray diffraction, scanning electron microscope, and transmission electron microscope. Consequently, the c-axis of the LNT powders was aligned parallel to the magnetic field and a high orientation degree was achieved in a strong magnetic field of 12 T. This investigation is being pursued in collaboration with NIMS (Dr. Suzuki).


Meeting in Lab.

Theme 3 ▶ Microstructure and mechanical property of metallic materials controlled by metallographic-structure and -phases

We are investigating metallic films with a nano-lamellar structure or porous metals. TEM observations and simulations by molecular dynamics and first-principles analysis are used to study the mechanism of metallic materials' physical properties.
This investigation is being pursued in collaboration with Kyoto University (Prof. Mabuchi Lab.) and AIST JPN (Dr. Chino).

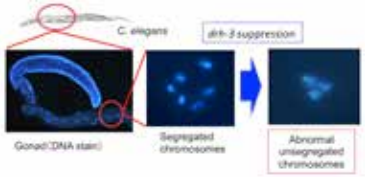
Molecular Genetics Laboratory

Staff	• Professor **Eki, Toshihiko** (E-mail：eki@chem.tut.ac.jp) • Assistant Professor **Hirose, Yuu** (E-mail：hirose@chem.tut.ac.jp)
Laboratory URL	https:// chem.tut.ac.jp/molgenetics/
Key words	*C. elegans*, soil nematode, yeast, RNAi, genome editing, cyanobacteria, Dicer-related helicase, DNA barcoding, next generation sequencer

A number of chemicals or wastes are continuously produced by our social activities and are accumulated in the environment. These substances may be potentially and unexpectedly changed into genotoxic agents, causing DNA damage to lead to dysfunctions of genetic information. Since it has been well known that excess DNA damage increase the risk of various cancers via genetic mutations, studies of "genome environment" are important for environmental and medical sciences. Therefore, first, we are studying molecular mechanism of maintenance of genome integrity via a novel Dicer-related helicase DRH-3 in nematode *C. elegans* and also developing novel yeast-based genotoxicity tests using reporter assay. Secondly, we are developing yeast-based chemical sensing method as well as genome editing technologies with CRISPR/Cas9. Thirdly, we analyze taxonomic structure of soil nematodes by DNA barcoding to assess soil environments. Finally, we are also interested in the light color sensing system of cyanobacteria. We explored new photosensing systems for application of optogenetics using the next generation sequencer.

Theme 1 ▶ Study of two *C. elegans* Dicer-related helicases DRH-1 and DRH-3

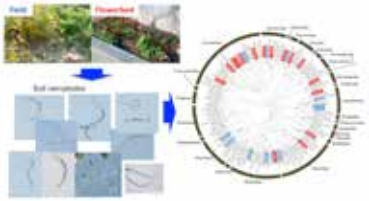
We identified a novel *C. elegans* gene *drh-3* that functions in both maintenance of chromosome integrity and RNA interference (RNAi). Since the relationship between RNAi and chromosome regulations has been largely unknown, we have focused on functional analyses of DRH-3 protein as well as the related DRH-1 that acts in antiviral function by biochemical approach.



DRH-3 is essential for chromosome segregation in *C. elegans*

Theme 2 ▶ Development of biosensing assay systems using genetically altered yeasts

It is important to detect genome toxicities of chemicals and waste products. We have developed the biosensing assays by recombinant reporter yeasts for detecting genotoxicity and/or oxidative toxicity. We also tried to develop recombinant yeasts that can detect a broad range of chemicals and editing technology of yeast genome using CRISPR/Cas9.



DNA barcode analysis of soil nematodes

Theme 3 ▶ DNA sequence analyses of soil nematodes and cyanobacteria

De novo sequencing of cyanobacteria is in progress to study genome structures and transcription profiles using the next generation sequencer. We are also performing DNA barcode analyses to clarify taxonomic structure of soil nematodes for assessment of soil environment.

Cyanobacteria and next generation sequencers

Theme 4 ▶ Characterization and application of cyanobacterial photoswitch

Cyanobacteria harbor photoswitch systems that sense various light colors. We utilize green and red light sensing CcaS/R system for regulating the gene expression in other organisms, contributing the development of sophisticated optogenetic tools.

Reactive Plasma Science Laboratory

Staff	• Professor	**Takashima, Kazunori**	(E-mail：takashima@chem.tut.ac.jp)
	• Assistant Professor	**Kurita, Hirofumi**	(E-mail：kurita@chem.tut.ac.jp)
Laboratory URL	https://chem.tut.ac.jp/plasma/		
Key words	Reactive Plasma, Plasma catalysis, Plasma medicine, Electrostatic precipitator, Single DNA manipulation, Water droplet based electroporation, Plasma sterilization / virus inactivation		

Our research interests include air and water pollution control using plasma catalysis, electrostatic precipitation, fundamental of interaction between plasma and biological objects, application of plasma to medical treatment and life science, development of single bio-molecule manipulation technique and its application to analysis of interaction between bio molecules.

Theme 1 ▶ Plasma catalysis for pollution control and material conversion

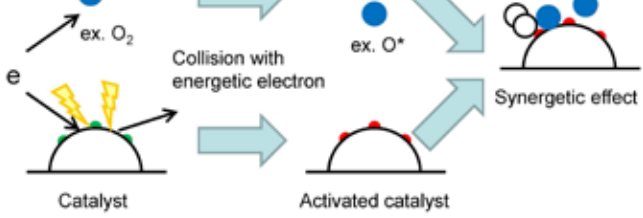
Discharge plasma has been studied as a tool to induce various chemical reactions at moderate conditions taking advantage that various active species are generated in gas and liquid phases by non-thermal plasma. To improve energy efficiency and reaction selectivity, we are working on plasma catalysis in many fields such as diesel NOx emission control, room air cleaning, liquid and gas fuel reforming, ammonia generation at moderate conditions, water treatment etc.

Theme 2 ▶ Non-thermal plasma and electrostatics in life science

Phenomenologically, irradiation of plasma is effective for sterilization, inactivation of virus and apoptosis induction, which are potential application in medical treatment but their mechanisms are yet to be studied. We are studying the mechanisms from multi-level analysis of the response of bio molecules, cells, tissues and individuals to plasma irradiation. Electroporation-based gene introduction using electrostatic manipulation of a water droplet in oil is also studied, which is very advantageous for small volume process.

Theme 3 ▶ Analysis of interaction between bio molecules based on single molecule observation and manipulation

Electrostatic force is exerted on very small objects because forces of gravity and inertia are negligible. Electrostatic manipulation and fluorescent labeling enable us to position and observe a single molecule DNA in liquid under the microscope. For example, DNA molecules can be stretched electrostatically like a thread. Such single molecule in-situ observation is advantageous for the analysis of interaction between bio molecules because not only statistic results but also reaction of individual molecule can be visualized in real time. We are working on the analysis of interaction between bio molecules such as DNA and proteins using newly developed single molecule observation methods.



Plasma catalysis

Laboratory of Genetic Engineering

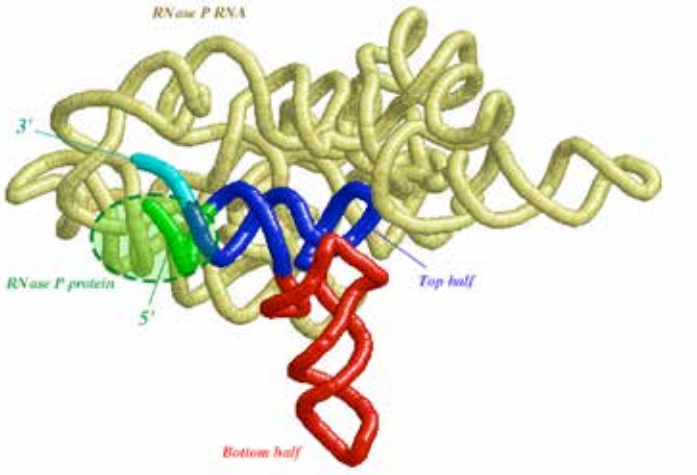
Staff	• Associate Professor **Tanaka, Terumichi** (E-mail：terumichi-tanaka@tut.jp)
Key words	protein engineering, recombinant DNA, tRNA, ribonuclease P, vector, β-lacatamase, evolution,

All lives on the Earth, including human species, use common biological system, and which are performed by nano-sized molecules genes and enzymes. In my laboratory, we analyze and reveal hidden mechanism of genes and enzymes, and we also apply recombinant DNA technique to design and obtain new functional enzymes.

Theme 1 ▶ Analysis on the mechanism of ribonuclease P.
This enzyme ubiquitous and essential enzyme and is made up of RNA and protein subunits. This enzyme catalyzes the 5'-maturating reaction of tRNA precursor. We have focused on the substrate recognition mechanism of this enzyme how this enzyme accepts the substrate to form the high energy Michaelis complex, and to release the catalyzed product from the enzyme.

Theme 2 ▶ Analysis and designing of new drug resistant gene.
Drug resistant genes are to be found everywhere and they sometimes prohibit curing from the disease caused by bacteria. We have focused on the substrate recognition mechanism of beta-lactamase, which hydrolyzes penicillin-related drugs, to obtain detailed information of the enzyme to design new effective drugs.

Theme 3 ▶ Development of biological species detection kit.
We have developed gene detection tool of various biological species including food animal and vegetables using the multiplex-PCR technique and PCR-RFLP technique.



Computer generated structure of E.coli ribonuclease P and tRNA. The RNA subunit of the enzyme (orange), the putative position of the protein subunit of the enzyme (green), the top-half part of tRNA (blue), the bottom-half part of tRNA (red), and the 3'-terminus of tRNA (cyan), are shown.

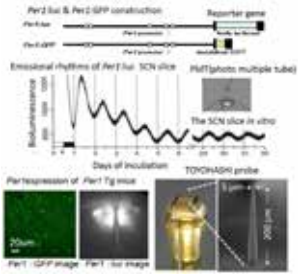
Regulatory Biofunction Laboratory

Staff	• Associate Professor **Numano, Rika** (E-mail：numano@tut.jp)
Laboratory URL	https://chem.tut.ac.jp/biofunction/
Key words	Circadian rhythms, *Period1*, Transgenic mice, TOYOHASHI probe, pacemaker neuron, LiGluR, azobenzene, MAG, a water-in-oil droplet electroporation, Transfection

We would like manipulate neural activity and physiological reaction by our original electrical probe, photo-switched nanomachines and transfection method both *in vitro* and *in vivo*. For example, the pacemaker neuron activity of circadian rhythms in the SCN can be manipulated by stimulating the SCN target circuit, which investigates the mechanism to control rhythms of the whole body, and shows how to maintain and administer the health life with normal rhythms.

Theme 1 ▶ Analysis of pacemaker neurons in mammalian circadian rhythms using Per1 Tg mice and TOYOHASHI probe

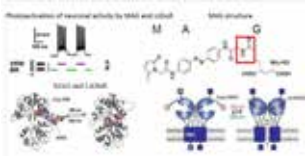
The biochemical, physiological and behavioral processes are under the control of internal clocks with the period of approximately 24 hr, circadian rhythms. The expression of mouse *Period1* (m*Per1*) gene oscillates autonomously in the suprachiasmatic nucleus (SCN). *Per1* is an indispensable member of the central clock system to maintain the autonomous oscillator. I constructed *Per1:luc* Tg mice and rats in which firefly luciferase was rhythmically expressed under the control of the mouse *Per1* promoter in order to monitor mammalian circadian rhythms by *Per1* rhythmic expression.
I performed functional analysis of circadian pacemaker neurons in the SCN by TOYOHASHI original electrophysiological probe with nano-size electrode other than *Per1* expressional rhythms.



Rhythmic emission from the cultured SCN slices of *Per1:luc* Tg mouse persisted for up to some months in vitro. Per1 expression could be observed in one cell level by the SCN slice of *Per1*:GFP Tg. Electric activity of the SCN pace maker neurons could be detected in one cell level by TOYOHASHI probe with nano-several micro meter diameter probe.

Theme 2 ▶ Manipulation of neural activity under optical control by bionanomachine.

I recognize intact biostructure ionotropic glutamate receptors (iGluR6) as machinery, which is normally expressed in synaptic neural processes in mammalian brain. To control any neural activity remotely and reversibly, photoswitchable nanomachine LiGluR were developed based on iGluR6 and operated using photoiosomerizable new chemicals, MAG. Two iGluR6 mutants could be photo-switched using a series of maleimde-azobenzene-glutamate (MAG) compounds, which dangled 2R,4R-allyi glutamate (G) from a linker containing the photoisomerizable azobenzene (A) that was attached to the introduced cysteines via maleimide (M). Three kinds of MAGs were examined at cysteine positions around the “mouth” of the ligand binding domain “clamshell” from geometry. LiGluR: opening in UV light and closing in visible light by all MAGs. In neural cells with LigluR, action potentials were optimally evoked and extinguished by UV and visible light, respectively. These photo-switched nanomachines could manipulate neural activity under optical control both *in vitro* and *in vivo*.



LiGluR is based on the reversible photoisomerization of maleimide-azobenzene-glutamate (MAG) between its *trans* configuration under 500 nm light and its *cis* configuration under 380 nm light. MAG is covalently attached by the maleimide moiety to a cysteine introduced into the ligand-binding domain (LBD) of the receptor. MAG binding under 380 nm light activates the receptor and opens its cation-selective channel, resulting in membrane depolarization.

Theme 3 ▶ Novel Parallelized Electroporation by Electrostatic Manipulation of a Water-in-oil Droplet as a Microreactor

Electroporation is the most widely used transfection method for delivery of cell-impermeable molecules into cells. We developed a novel gene transfection method, water-in-oil (W/O) droplet electroporation, using dielectric oil and an aqueous droplet containing mammalian cells and transgene DNA. When a liquid droplet suspended between a pair of electrodes in dielectric oil is exposed to a DC electric field, the droplet moves between the pair of electrodes periodically and droplet deformation occurs under the intense DC electric field. This method has several advantages over conventional transfection techniques, including co-transfection of multiple transgene DNAs into even as few as 1000 cells, transfection into differentiated neural cells, and the capable establishment of stable cell lines. This technique will lead to the development of cell transfection methods for novel regenerative medicine and gene therapy.

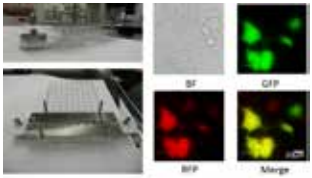


Image of the parallel W/O droplet electroporation electrode for the 8-well string of disposable 96-well plates and HEK293cells transfected fluorescent protein plasmid by W/O droplet electroporation. BF: Bright field image, GFP: Green Fluorescent Protein image RFP: Red Fluorescent Protein image, Merge: Merge image of GFP and RFP

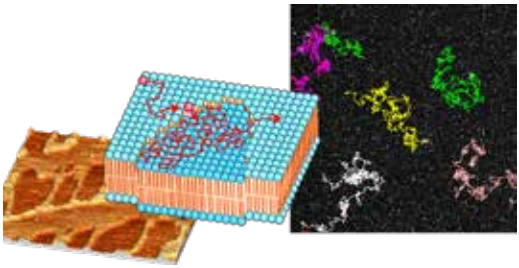
Interface Physical Chemistry Laboratory

Staff	• Associate Professor **Tero, Ryugo** (E-mail：tero@tut.jp)
Laboratory URL	https://chem.tut.ac.jp/interface/
Key words	Lipid bilayer, cell membrane, surface chemistry, atomic force microscopy, fluorescence microscopy, single molecule observation

Lipid bilayers are fundamental structures of cell membranes, and provide reaction fields to membrane proteins relating to the transportation of signal, materials and energy into and out of cells. Our research targets are fundamental processes in artificial cell membrane systems, (e.g. lipid diffusion, domain formation/dissipation, peptides and protein assemblies) during the activities of membrane proteins and functional peptides. We are also interested in applications of the artificial cell membrane systems to nanomaterials and plasma medicine.

Theme 1 ▶ Structure and dynamics in artificial cell membrane systems

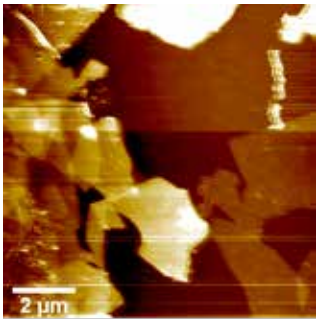
Lateral lipid diffusion and domain formation are important fundamental processes at biological reactions on cell membranes. We investigate lateral diffusion, domain formations and their relation with protein reactions using supported lipid bilayers as artificial cell membrane systems. Atomic force microscope and fluorescence microscope are complementary methods to observe structures in the supported bilayers on nano- to micrometer scales. We use fluorescence microscope-based techniques for the investigation of molecular diffusion, to evaluate diffusion coefficient and its spatiotemporal dependence quantitatively: fluorescence recovery after photobleaching and fluorescence single molecule tracking.



Theme 1: Domain formation and lateral diffusion in a supported lipid bilayer

Theme 2 ▶ Artificial lipid bilayer platform on graphene oxide

Graphene oxide is a single atomic sheet material, derived from graphene, sp2 carbon sheet. Graphene oxide is an amphiphilic 2D material consisting of hydrophobic pristine graphene region and that modified with oxygen functional groups, and shows a unique fluorescence quenching property. We are investigating the interaction between GO and lipid bilayer, and developing lipid bilayer platform on graphene oxide.



Theme 2: AFM topography of lipid bilayer on GO deposited on a SiO2/Si substrate.

Theme 3 ▶ Plasma on plasma membrane

Atmospheric pressure plasma is applied as a novel and valuable tool in the medical and biological fields. We apply artificial lipid bilayer systems to understand the mechanism how the plasma-induced active species (reactive oxygen/nitrogen species) affect and pass through cell membrane. We showed that irradiation of irradiation of atmospheric pressure plasma made nanopores on lipid bilayer membranes.

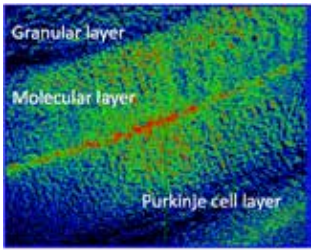
Physiological Bioscience Laboratory

Staff	• Lecturer **Yoshida, Sachiko** (E-mail：syoshida@tut.jp)
Laboratory URL	http://www.rodent.chem.tut.ac.jp
Key words	Cerebellar development, spatio-temporal visualization of neurotransmitter, developmental neurotoxicity, epigenetics, acoustic impedance microscopy, non-invasive cancer research, autism

We study neuronal development and organ research using animal models and cultured cells through the development of new visualizing device. Our devices could have visualized both the distribution of cancers cells in organs non-invasively, and the neurotransmitter release in living brain slices and neurospheres spatio-temporally. New research system gives us new views and new ideas about lives. We collaborate many engineers and develop something new for biological research.
First theme is visualization of neurotransmitter release in developing cerebellar cortex, and second theme is non-invasive cancer cell research. Newest third theme, which is autism and neuropsychological deficit induced chemicals or environmental conditions, is related epigenetics and evolution of our brain system.

Theme 1 ▶ Visualization of neurotransmitter release in developing cerebellar cortex.

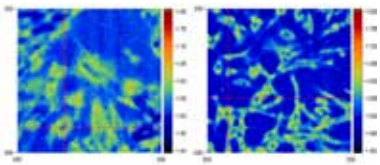
Neurotransmitters are known to play important roles as modulators in the survival and development of cerebellar neurons. We have developed an enzyme-linked real-time assay system of released glutamate, GABA and ATP, and observed their release spatio-temporally. Dynamical change through the development shows the progress of neuronal circuits.



GABA release in developing cerebellar cortex

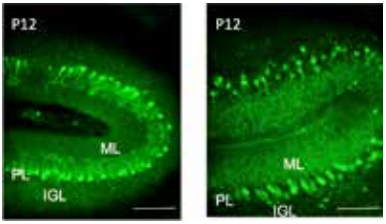
Theme 2 ▶ Non-invasive living cell observation using ultrasonic microscopy

Ultrasonic visualizing system is useful for non-invasive observation of organs, however, its spatial resolution was too poor to visualize cell-level structure and alteration. We have developed the acoustic impedance microscopy for observation of intracellular dynamic structure. This system becomes possible to identify cancer cells in living organs.


Cancer cell observation using acoustic impedance microscopy. Left: normal glial cells, right: cancer cells.

Theme 3 ▶ Autism and neuropsychological deficit induced Chemicals or environmental conditions

Some drugs or chemicals, and environmental stress conditions are known to induce autism of offsprings. We have developed the in vivo detection system for slow-onset neuropsychological deficit using animal models. In autistic animal models, neuronal cells were developed earlier and made irregular distribution. This system is applicable for detection of the chemicals to avoid, and development of recovery treatment from the deficit.



Cerebellar alteration in autistic animal model. Left: control rat cerebellar cortex, right: cerebellar cortex in autistic model animal. Both animals were postnatal day 12. PL: Purkinje cell layer, ML: molecular layer, IGL: internal granular layer.

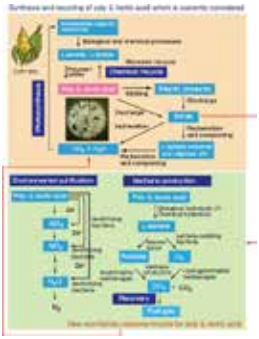
Hydrosphere Environmental Biotechnology Laboratory

Staff	• Lecturer **Yamada, Takeshi** (E-mail：tyamada@chem.tut.ac.jp)
Laboratory URL	https://chem.tut.ac.jp/microbes/
Key words	Poly(L-lactic acid), wastewater treatment, nitrogen removal, anaerobic digestion, methane, bulking, microbial measurement, microbial index

This laboratory conducts research on the following themes in the pursuit of a stable and efficient biological wastewater treatment system.

Theme 1 ▶ Microbiological technologies for environmental purification and methane production using poly(L-lactic acid)

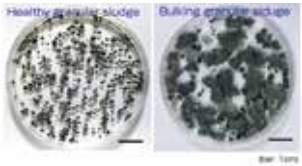
Poly(L-lactic acid) (PLLA) is superior to other biodegradable plastics owing to its mechanical, chemical, and physical properties. Various types of PLLA products such as packing and agricultural materials have expanded into further generic use. However, the disposal and re-use of this material is a serious problem because of the large amount of PLLA waste generated. Although “clean” PLLA wastes can be chemically recycled to lactic acid by thermal decomposition and hydrolysis, disposal of PLLA wastes that are unsuitable for such recycling has been handled by methods such as landfill deposition, incineration, and composting. Although no increase in global carbon emission has been reported owing to these methods, a more effective and earth-friendly PLLA waste management system should be established. We have been attempting to develop technologies that produce methane from PLLA waste in anaerobic digestion reactors. Additionally, we have been trying to develop a technology that would facilitate the functioning of PLLA as an electron donor and as a carrier for microorganisms in denitrification reactors.



Suggestion of a new resource recycling system for PLLA.

Theme 2 ▶ Elucidation and possible control strategies of the unknown phenomenon of "anaerobic bulking" observed during anaerobic wastewater treatment

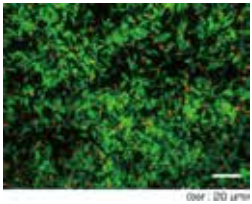
Anaerobic wastewater treatment processes have become part of the core treatment process for middle-strength and high-strength organic wastewater. However, several problems, unforeseen even by the manufacturer, have often occurred during the operation and startup of the reactor. Particularly serious problems include the sudden rise and consequent overflow of anaerobic sludge (anaerobic sludge bulking), which decreases the wastewater treatment efficiency and, subsequently, necessitates stoppage of the functioning of reactors. However, the mechanisms and microbes responsible for anaerobic sludge bulking remain unknown. We have been investigating the ecology, physiology, and genetics of causative microbes, and aim to develop technologies to prevent anaerobic sludge bulking and detect the causative microbes.



Healthy granular sludge and bulking sludge formed in anaerobic wastewater treatment reactor.

Theme 3 ▶ Development of rapid, simple, and on-site measurement techniques for microbes in wastewater treatment

Wastewater treatment reactors are controlled on the basis of water quality indices such as pH and loading rate, while microbes in the reactor are treated as a “black box.” Once effluent quality of the reactor deteriorates, the ensuing problems require laborious intervention. As a solution, we suggest the indexing of microbes that play an important role in the reactor and building mutually complementary management systems consisting of water quality and microbes. We have been developing rapid, simple, and on-site measurement technologies for microbes involved in wastewater treatment to contribute in the strengthening of wastewater treatment control methods.



A double-stained image by the 5-cyano-2,3-ditoryl tetrazolium chloride method and fluorescence in situ hybridization method using bacterial specific DNA probe.

Applied Symbiosis Laboratory

Staff	• Associate Professor **Nakabachi, Atsushi** (E-mail：nakabachi@eiiris.tut.ac.jp)
Laboratory URL	https://www.tut.ac.jp/english/schools/faculty/eiiris/701.html
Key words	insects, bacteria, intracellular symbiosis, aphids, psyllids, bacteriocytes, genomics, secondary metabolites, agricultural pests

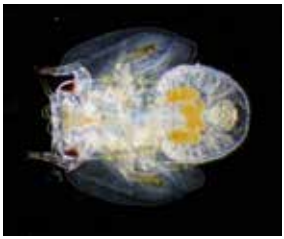
Our research interests focus on the molecular basis for the symbiosis between multicellular organisms and microbes, which has not only been playing key roles in the evolutionary history of life, but is also important for agricultural and medical biotechnologies.

Theme 1 ▶ Studies on intracellular symbioses of pest insects

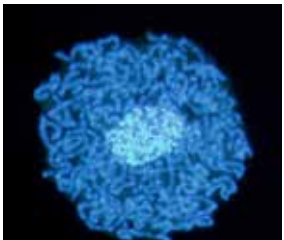
Many insect lineages including agricultural/medical pests have mutually indispensable associations with bacterial symbionts that are localized in specialized cells called bacteriocytes. We are trying to elucidate the molecular mechanisms for developing and maintaining this type of intimate symbioses.

Selected publications

- Dan H, Ikeda N, Fujikami M, Nakabachi A. (2017) Behavior of bacteriome symbionts during transovarial transmission and development of the Asian citrus psyllid. PLoS One 12(12): e0189779.
- Nakabachi A. (2015) Horizontal gene transfers in insects. Curr Opin Insect Sci 7: 24-29.
- Nakabachi A, Ishida K, Hongoh Y, Ohkuma M, Miyagishima SY. (2014) Aphid gene of bacterial origin encodes a protein transported to an obligate endosymbiont. Curr Biol 24(14): R640-R641.
- Sloan DB, Nakabachi A, Richards S, Qu J, Murali SC, Gibbs RA, Moran NA. (2014) Parallel histories of horizontal gene transfer facilitated extreme reduction of endosymbiont genomes in sap-feeding insects. Mol Biol Evol 31(4): 857-871.
- The International Aphid Genomics Consortium. (2010) Genome sequence of the pea aphid Acyrthosiphon pisum. PLoS Biol 8(2): e1000313.
- Nikoh N, McCutcheon JP, Kudo T, Miyagishima S, Moran NA, Nakabachi A. (2010) Bacterial genes in the aphid genome: Absence of functional gene transfer from Buchnera to its host. PLoS Genet 6(2): e1000827.
- Nakabachi A, Yamashita A, Toh H, Ishikawa H, Dunbar HE, Moran NA, Hattori M. (2006) The 160-kilobase genome of the bacterial endosymbiont Carsonella. Science 314 (5797): 267.
- Nakabachi A, Shigenobu S, Sakazume N, Shiraki T, Hayashizaki Y, Carninci P, Ishikawa H, Kudo T, Fukatsu T. (2005) Transcriptome analysis of the aphid bacteriocyte, the symbiotic host cell that harbors an endocellular mutualistic bacterium, Buchnera. Proc Natl Acad Sci USA 102(15): 5477-82.



A nymph of the Asian citrus psyllid, *Diaphorina citri*. The yellow and U-shaped structure is the symbiotic organ that harbors organelle-like intracellular bacteria.



A bacteriocyte of the hackberry petiole gall psyllid, *Pachypsylla venusta*. The cytoplasm is packed with tubular cells of the obligate symbiont, *Candidatus* Carsonella ruddii, surrounding a central nucleus.

Theme 2 ▶ Studies on symbiotic bacteria as genetic resources

Making use of omics technologies, we are also pursuing the possibility of utilizing symbiotic bacteria as genetic resources.

Selected publications

- Nakabachi A, Okamura K. (2019) Diaphorin, a polyketide produced by a bacterial symbiont of the Asian citrus psyllid, kills various human cancer cells. PLoS One 14(6):e0218190.
- Nakabachi A, Ueoka R, Oshima K, Teta R, Mangoni A, Gurgui M, Oldham NJ, van Echten-Deckert G, Okamura K, Yamamoto K, Inoue H, Ohkuma M, Hongoh Y, Miyagishima SY, Hattori M, Piel J, Fukatsu T. (2013) Defensive bacteriome symbiont with a drastically reduced genome. Curr Biol 23(15): 1478-84.
- Moran NA, McCutcheon JP, Nakabachi A. (2008) Genomics and evolution of heritable bacterial symbionts. Annu Rev Genet 42: 165-90.

Lab members working at the bench.

Theme 3 ▶ Studies on various agriculture-related symbioses

Agricultural plants have complicated symbiotic relationships with a wide variety of organisms including
microbes. We have started some research on this knotty issue.

Selected publications

- Yamada T, Hamada M, Floreancig P, Nakabachi A. (2019) Diaphorin, a polyketide synthesized by an intracellular symbiont of the Asian citrus psyllid, is potentially harmful for biological control agents. PLoS One 14(5):e0216319.
- Nakabachi A, Nikoh N, Oshima K, Inoue H, Ohkuma M, Hongoh Y, Miyagishima SY, Hattori M, Fukatsu T. (2013) Horizontal gene acquisition of Liberibacter plant pathogens from a bacteriome-confined endosymbiont of their psyllid vector. PLoS One 8(12): e82612.

Department of Architecture and Civil Engineering

Architecture and Urban Design **Urban and Regional Management**

Earthquake Disaster Engineering Research Laboratory

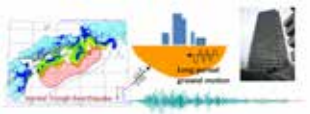
Staff	• Professor **Saito, Taiki** (E-mail：tsaito@ace.tut.ac.jp) • Assistant Professor **Hayashi, Kazuhiro** (E-mail：hayashi@ace.tut.ac.jp)
Laboratory URL	http://www.rc.ace.tut.ac.jp/saito/index.html
Key words	Long-period ground motion, high-rise buildings, response control techniques, earthquake response analysis, shaking table test, piles, health monitoring

Working toward the earthquake disaster mitigation of buildings and urban structures, and the promotion of international cooperation.

Faced with frequent earthquakes, everyone must have wondered at some point about whether the town and buildings in which they live are truly safe in regard to earthquakes and tsunami. In order to alleviate these concerns and reduce the impact of such disasters, there is a requirement for specialists such as ourselves to transmit accurate information out into society. Furthermore, enhancing the seismic safety of structures is extremely important work that demonstrably contributes to the saving of lives. This is true regardless of nation or race. The Earthquake Disaster Engineering Research Laboratory conducts research and development into the earthquake disaster mitigation of buildings and urban structures, and then relays these results out into society. We also promote international cooperation, aiming to conduct research that will aid in disaster mitigation both in Japan and around the world.

Theme 1 ▶ Seismic safety of high-rise buildings against long-period ground motions

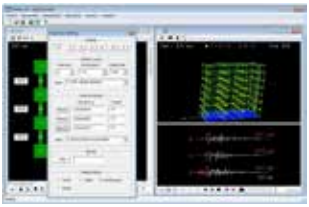
The Nankai Trough Earthquake is highly likely to occur by the middle of the 21st century, and threatens to cause extensive damage to those vital structures that perform core city functions. In particular, the high-rise buildings with long natural period have a quality to resonate with long-period ground motions. Therefore, the repeated shaking carries the risk of increased structural damage, movement & falling of interior furnishings, people becoming trapped in elevators, and ceiling panels falling. We are therefore conducting comprehensive investigations into the seismic safety of high-rise buildings against long-period ground motions.



The threat of long-period ground motion shaking high-rise buildings

Theme 2 ▶ Experiments and analysis concerning earthquake and tsunami safety of buildings

There is a requirement to enhance the seismic safety of cities and buildings in response to the threat of massive earthquakes or tsunami with an epicenter in the Nankai Trough. We are therefore conducting the experimental practice of structural engineering and the monitoring of strong earthquake observations of foundations and structures to clarify the actual phenomenon that occur. Moreover, we are using precise earthquake response analysis methods for the research to quantify the response and damage characteristics of buildings to large earthquakes and tsunami from the perspectives of safety, retention of function, and reparability.



Development of earthquake response analysis software

Theme 3 ▶ Development of post-earthquake health monitoring techniques for cast-in-place reinforced concrete piles

Any structure that experiences a major earthquake may still, at a glance, appear to be solid and sound, but could actually have suffered severe damage in locations that cannot be visually confirmed. In particular, the cast-in-place reinforced concrete piles used in the construction of large buildings have suffered severe damage in many cases, including crushing of the underground concrete, but current technology does not provide a way to evaluate their damage without excavating the surrounding ground and performing a direct visual inspection. We therefore focused our attention on the changes in the vibration characteristics of a building that accompany damage to its piles, and aim to exploit this to develop safety evaluation techniques that do not require any soil-foundation excavation.

A pile and foundations fracture experiment using a big shaking table

Structural Mechanics Laboratory

Staff	• Professor **Nakazawa, Shoji** (E-mail：nakazawa@ace.tut.ac.jp) • Assistant Professor **Takiuchi, Yuji** (E-mail：y-takiuchi@ace.tut.ac.jp)
Laboratory URL	http://www.st.ace.tut.ac.jp/~nakazawa/
Key words	Shell and spatial structure, steel structure, numerical analysis, vibration control, buckling, risk analysis

Spatial structures, such as the gyms for elementary and junior high schools, are often used as evacuation area or disaster prevention bases during a disaster, and so they have to be built to be resistant to seismic motions. These kinds of structure are easily accessed by the public, and needs to offer sufficient safety in regard to earthquakes, wind, and snow. The laboratory performs the following research themes; (1) analysis of seismic response characteristics of spatial structures subjected to severe seismic motion; (2) evaluation of seismic resistance capacity; (3) proposal of design methods with vibration control to reduce the damages; and recently (4) proposal of super light structures using low volume, recyclable materials and construction methods, and (5) a grid parallel computing system in order to provide effective analysis.

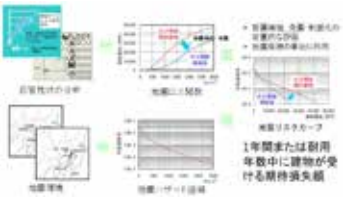
Theme 1 ▶ Evaluation of seismic performance of shell and spatial structures

As spatial structures vibrate in a different way from high-rise buildings, it is necessary to analyze the response characteristic and seismic capacity of spatial structures. We therefore perform the following researches; (1) analysis of seismic responses and collapse characteristics; (2) proposal of the equivalent static seismic load; (3) research of evaluation method of seismic performance based on the pushover analysis; (4) research of vibration control methods to reduce the responses for spatial structures (fig.1).

Shaking of a mid-story isolation dome during an earthquake (When seismic isolation is not used, the dome shakes severely, but the use of seismic isolation greatly reduces the response of the dome)

Theme 2 ▶ Evaluation of buckling strength of shell and spatial structures

Shell and spatial structures can be realized using a lightweight construction, making their composite materials narrow and thin. This means that investigations into overall buckling and buckling for parts are important. We perform the following researches; (1) development of analysis programs that take buckling and turning into plastic of parts into account; (2) development of buckling design methods for spatial structures; (3) performing collaborative research of a visualization system with other Universities.



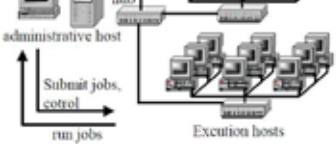
Outline of seismic risk analysis (allows for quantifiable evaluation of seismic retrofitting, base isolation and response control)

Theme 3 ▶ Development of seismic performance evaluation techniques based on seismic risk analysis

Seismic risk analysis is a stochastic method(fig.2). It is our aim to use seismic risk analysis to establish a method to quantifiably evaluate the seismic performance of a structure. Our research themes include; (1) a comparison of detached base isolation housing and seismic-resistant housing based on seismic risk analysis; (2) proposal of seismic retrofit method based on the minimum standard of lifecycle costs; (3) analysis of the capability to maintain functioning for school gyms and factories; (4) proposal of evaluation indexes for regional disaster prevention capabilities.

Theme 4 ▶ Development of structural design approach using a grid computer system

Advanced structural analysis of large structures and seismic risk analysis requires faster computers. In order to realize high speed operations, we have therefore adopted a parallel grid computing system (grid system) as the foundation technology for the numerical analysis(fig.3), and research into how this would be used in the fields of architecture and civil engineering.



Outline of grid computing (A grid system connects multiple computers across a network, allowing them to perform parallel computations and achieving high speed operations. Applied to structural engineering)

Earthquake Resistant Structures Laboratory

Staff	• Associate Professor **Matsui, Tomoya** (E-mail : matsui@ace.tut.ac.jp)
Laboratory URL	http://www.rc.ace.tut.ac.jp/matsui/index.html
Key words	Reinforced concrete structures, Steel concrete composite structures, Seismic performance evaluation, seismic retrofit

This laboratory conducts research into the reduction of damage caused to structures by earthquakes. Our principle goals are to increase the seismic resistance capacity of concrete structures (reinforced concrete structures, steel concrete composite structures) and establish methods for evaluating their seismic resistance capacity, and we are advancing our research from the approach of both experiments (static and dynamic testing) and analysis (earthquake response analysis and FEM analysis). Our research themes also branch out across a diverse range, including the development of new building structure systems, the seismic retrofitting of existing buildings, and methods for evaluating existing building's seismic resistance capacity.

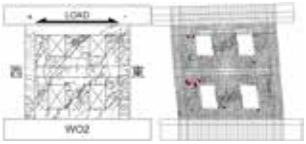
Theme 1 ▶ Development of composite concrete encased steel structural system

This research intends to develop a new structural system (CES structure), comprised of a steel frame and fiber reinforced concrete, offering excellent seismic resistance capacity. The current structural system of steel reinforced concrete is known for offering extremely good seismic resistance, but issues remain in terms of both construction and the length of time that construction takes due to the steel frame and rebar placing. In order to resolve these issues we are conducting ongoing research and development into a composite concrete encased steel structure that cuts out the rebar, with the ultimate aim of practical applications. As well as conducting parts testing in order to understand the structural capabilities of the CES structure, we also implement simulation analysis (FEM analysis), studying internal stresses that cannot be understood through just practical experiments.

Static loading test of CES beam-column joint

Theme 2 ▶ Structural performance of RC shear walls with multiple openings

This research intends to formulate a more logical structural performances evaluation method for reinforced concrete shear walls with multiple openings. Restrictions due to building plans etc. often result in shear walls having openings in them. Because those with openings display much more complex failure mechanism when compared to those with no openings, this makes them extremely hard to handle in regard to design. Therefore, in order to establish a more logical structural performances evaluation method we are implementing static loading test on RC shear walls with openings in different positions and of different sizes, investigating their structural performances. Alongside these tests we are also conducting numerical analysis, investigating the stress transfer mechanisms and numerical analysis models for RC shear walls with multiple openings.



FEM analysis of RC wall with multi openings : Crack situation (left ; experiment, right ; analysis)

Theme 3 ▶ Earthquake resistance seismic retrofitting via providing increased ductility to reinforced concrete walls using carbon fiber sheets

After the 2010 earthquake in Chile, much attention was drawn to the fact that concrete crushes due to bending and compression on multi-story shear walls without boundary columns in RC structures led to some buildings completely collapsing. Therefore, this research intends to develop a method for retrofitting these kinds of walls without columns against concrete flexural failure by using carbon fiber sheets. By conducting structural experiments on RC walls without boundary column retrofitted by being wrapped in carbon fiber sheets, we have confirmed a delay to the crush to the concrete at the bottom of the wall that occurs flexural failure, and an improvement in deformation capacity.

Static loading test of retrofitted wall using carbon fiber sheets

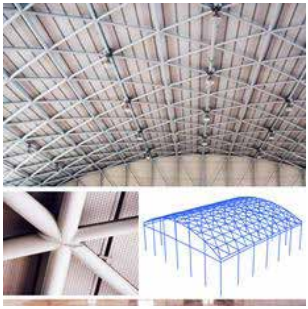
Structural Engineering Laboratory

Staff	• Associate Professor **Matsumoto, Yukihiro** (E-mail：y-matsum@ace.tut.ac.jp)
Laboratory URL	http://sel.ace.tut.ac.jp
Key words	Shell, Spatial structures, Seismic design, Buckling, FRP, Hybrid structures, FBG, SHM

Research topics are as follows:
1) Seismic and Buckling Design Methodology of Shell & Spatial Structures
2) Structural Design of FRP Structures
3) Reinforcement and Strengthening for Steel Members using CFRP
4) Structural Health Monitoring using Fiber Bragg Grating Sensor

Theme 1 ▶ Buckling and seismic response behavior of shell and spatial structures

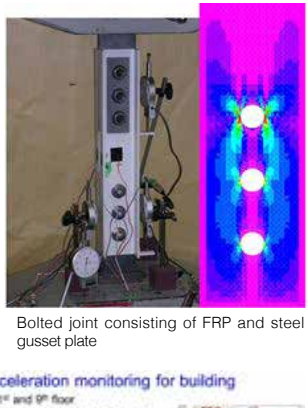
For the design of shell-like space frames located in seismic area, it is very important to give considerable attention to the dynamic and buckling behavior. However, for single layer latticed cylindrical roof structures, it has not been enough to make clear their dynamic responses during earthquake and to estimate the load carrying capacities. Also, it is well-known that metal shells and shell-like lattice frame structures have buckling behavior which is very sensitive to initial geometric imperfections. Our research interests are as follows.
1) Buckling behavior of thin-walled cylinders
2) Buckling behavior of latticed shell structures
3) Seismic response behavior of shell and spatial structures and its seismic design methodology



Single layer latticed cylindrical shell structure

Theme 2 ▶ Fundamental study on FRP material for building and civil structures

FRP material has good characteristics such as light-weight, high-strength and high-corrosion resistance. Light-weight structure possesses some advantages over the seismic load and rational constructing procedure. Our research interests are as follows.
1) Mechanical characteristics of bolted and adhesively bonded joint for FRP
2) Effects of reinforcement using CFRP
3) Design method of FRP structures
4) Long-term characteristics of FRP materials and FRP structures



Bolted joint consisting of FRP and steel gusset plate

Theme 3 ▶ Structural health monitoring

Structural health monitoring (SHM) is developed in order to detect the degradation of the structural mechanical performance.
We have been performing the vibration monitoring by using the recently developed fiber Bragg grating (FBG) sensors. Our research interests are as follows.
1) SHM using FBG accelerometers for buildings
2) SHM using FBG sensors for steel bridges
3) SHM using FBG sensor for adhesively bonded layer
4) SHM using wireless sensor system

SHM system using FBG accelerometer in Toyohashi Tech.

Building Environment Laboratory

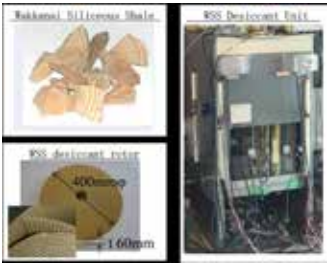
Staff	• Professor **Tsuzuki, Kazuyo** (E-mail : ktsuzuki@ace.tut.ac.jp) • Assistant Professor **Jihui, Yuan** (E-mail : yuan@ace.tut.ac.jp)

Key words	Indoor air quality, indoor climate, desiccant ventilation system (dehumidification), sleep, thermoregulation, thermal comfort, energy saving, productivity, foliage, renovation

We conduct research on methods to achieve healthy and comfortable residential environments with a minimum burden on the natural environment. Current research themes include (1) indoor air pollution and ventilation systems; (2) sleep and thermal environments; (3) thermal comfort and productivity; (4) housing renovation and healthy effects for elderly people.

Theme 1 ▶ Development of Desiccant Ventilation System Using Natural Mesoporous Material

A highly efficient air-conditioning system for residential use is necessary to develop because energy consumption is increasing more and more in both the residential and commercial sectors. In Asian countries, with high temperatures and humid climates, dehumidification requires a large amount of energy to sustain a satisfactory level of thermal comfort. The desiccant ventilation system is expected to reduce energy consumption for the dehumidification process. We are focusing on a natural mesoporous material called Wakkanai Siliceous Shale (WSS) as a desiccant material. Our research aims to develop a new desiccant system using WSS. Currently, in order to evaluate energy saving performance, a demonstration test of a prototype WSS desiccant unit has started.



Pictures of WSS desiccant rotor and ventilation unit

Theme 2 ▶ The Effects of Thermal Environment on Human Sleep and Thermoregulation

Sleep is one of the most important behaviors for human health in the indoor environment. In order to investigate sleep quality and thermoregulation in an actual living environment, field surveys are performed to reveal the sleep quality and subjective sensations of the occupants as along with the surrounding air temperature, humidity, and air velocity in the bedroom. In a climatic chamber we set environmental conditions and measure EEG, ECG, or thermoregulatory responses such as skin temperature and sweat loss of the human subjects in order to investigate the effects of environmental factors on the human body during the sleep period. We consider the correlations between thermal factors and human responses in order to research a thermally comfortable environment for sleeping people. Further researches on elderly sleep quality and seasonal environmental effects on sleep are studied in residential houses and nursing homes.

Theme 3 ▶ The Effect of Foliage on Physiological & Psychological Responses and Productivity

Foliage plants such as benjamin and pothos seem to have a variety of beneficial (“green amenity”) effects, including purification by removing chemical compounds from indoor air, recovery from fatigue, alleviation of stress, and an increase in productivity. The subject experiments were performed to investigate EEG, ECG, salivary amylase, subjective sensations, and productivity in a space including foliage plants in the experimental room. Moreover, further investigations were carried out to analyze office workers’ productivity in actual offices.

Experiment on the effect of foliage plants on the office workers’ productivity

Theme 4 ▶ The Housing Retrofit and its Health Effects on Human Occupants

Old houses without sufficient insulation material need to be renovated. We measured the blood pressure of the elderly occupants as well as thermal environments in the houses and compared them before and after renovation. The indoor air temperature increased with the addition of insulation material and improved air tightness in the older structures. Such an increase in indoor air temperature resulted in a good outcome by lowering the blood pressure of the elderly occupants.

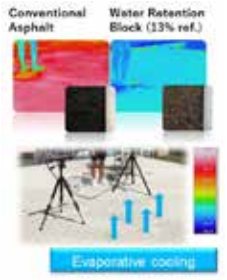
Building Environment Design Laboratory

Staff	• Associate Professor **Shimazaki, Yasuhiro** (E-mail : shimazaki@ace.tut.ac.jp)
Key words	Environmental Engineering, Ergonomics, Public Health, Thermo-physical property, Urban climate

Comfort or safety is an important concept in environment design. We are mainly investigating human thermal comfort or human-biometeorology under transient and un-uniform complex condition (space un-uniformity and human regional differences) and effect of environment components' thermal properties such as building materials and even clothing and bedding on heat transfer between human and environment with using field measurement and numerical simulation. Our research plans are to develop an accurate evaluation method for comfort issues to build both human and eco-friendly products and environments with engineering approach.

Theme 1 ▶ Evaluation for thermal comfort and environmental health

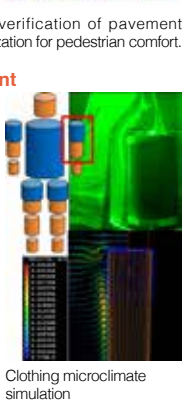
Traditional studies of thermal environments were performed indoors under uniform conditions. Because outdoor heat stresses people more severely than indoor heat, such extreme heat exposure is concerned about discomfort or risks of health. Since a thermal comfort index is a useful tool for understanding the experiencing environment, we proposed the human thermal load, which is a thermal comfort index based on the energy balance of the human body. In a steady state, and even in an unsteady state with its variations in weather and human factors, thermal comfort values can generally be obtained by using the overall human thermal load. The application for environmental planning is now examining with using human thermal load method. It has a lot of potentials by combining characteristics of material around living environment.



Field verification of pavement optimization for pedestrian comfort.

Theme 2 ▶ Measurement of material properties for comfortable living environment

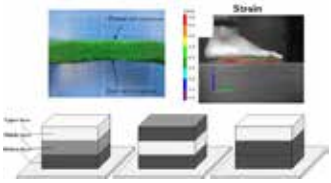
Our living environment is surrounded by various materials with various properties. They play an important role for formation of living environment and sense of user comfort. We are trying to assess the influences of materials properties around us on humans and the formation of the thermal environment. For example, covering the body such as clothing and footwear is a major contributor to the microclimate around the human body, which is the state of temperature formed by the combination of the environment, the human body, and materials. We are conducting measurements for the temperature, humidity and air behavior inside clothing microclimate contribute to the perception of thermal comfort, and commercial products have been developed based on the optimization of these parameters.



Clothing microclimate simulation

Theme 3 ▶ Ergonomics applications contributing to enhancing QOL (Quality Of Life)

Our research topics mainly include, but are not limited to thermal aspect of human comfort. Product designs have continued to advance in an effort to improve comfort and performance and reduce ergonomics risks. One of fundamental ergonomic principles is to reduce excessive force or stress. For example, we investigated the mechanical properties along with the viscoelastic behavior of laminated EVA foams and we provide a useful database for optimizing dynamic shock-absorption performance, which is applicable to footwear midsoles and paddings for preventing hip fractures.



Structure optimization for functionally-graded EVA foam

Architecture and Urban Design Laboratory

Staff	• Professor **Matsushima, Shiro** (E-mail：shirom@ace.tut.ac.jp)
Laboratory URL	http://mlab.ace.tut.ac.jp/
Key words	Design technology, design robotics, digital fabrication, town development, management

The Architecture and Urban Design Laboratory conducts a wide variety of research relating to building design and practical design activities.

Theme 1 ▶ Theory in architectural design

We are conducting research into theories of design relating to what kind of philosophies is behind the background to an architect's designs and what kind of processes are used in designing. By reflecting the results of this research into actual design, we aim for the creation of comfortable and safe architectural environments.

A robot arm

Theme 2 ▶ Design technology & robotics

We are conducting research into application of CAD/CAM technology to architectural design, including 3D printers, laser cutters and CNC (Computer Numerical Control) devices by using a leading-edge architectural manufacturing lab, from such perspectives as; 1) the creation of complex architectural models that would have been impossible with existing design methods; 2) development of methods for gaining a practical understanding and investigating spaces at the planning stages using physical models; (3) new architectural manufacturing that involved collaboration with other industries, starting with manufacturers. We have introduced industrial robots ahead of other domestic architecture universities, and are working alongside overseas universities, including Harvard University , while taking progressive approach to realize a revolution in architectural design.

CloudLeft: Cast model project

Theme 3 ▶ Community Development and project management

We have been actively involved in community development by doing renovating the façades of the shops aligned in Toyokawa-Inari, Shrine promenade in Aichi. In order to improve the streetscape of the most popular venue to the prayers and tourist in Toyokawa City, students under the supervision of professor collaborated with local residents and have already renovated 15 shops. Other community-related projects include the creation of communion bases in order to promote proactive village development in hilly and mountainous areas. Management together with advancement of technology is another topic to investigate the keys to success in complex modern architectural projects; unlike the old projects where architect should only handle client, the knowledge and skills to undertake the tasks and coordination not only of a large number of participants but also of information. Instructor has a long practice experience and by combining real world situation and pedagogical methodologies, empirical research and education is provided.

The townscape improvement in Toyokawa Inari Monzen

Architectural Design and Information Technology Laboratory

Staff	• Associate Professor **Mizutani, Akihiro** (E-mail：mizutani@ace.tut.ac.jp)
Key words	Architectural Design, Architectural Planning, Building Information System, Digital Design

I am working extensively in the research and the practice related to architecture and urban design and planning. In particular, I am focusing on the research and the practice on "digital design" which is noted as a new design method in the field of architectural design.
My current main themes are the following three. I am trying to organize architectural design informatics from historical analysis of computational designs. In addition, I focus on the research which explores its possibilities through the practice of design activities and development of digital design method.
On the other hand, I am working on the research on redesign mainly for public buildings and public spaces. In addition to theoretical research about existing public buildings and public spaces, I am doing practical projects which perform from implementation design to renovation with my students.

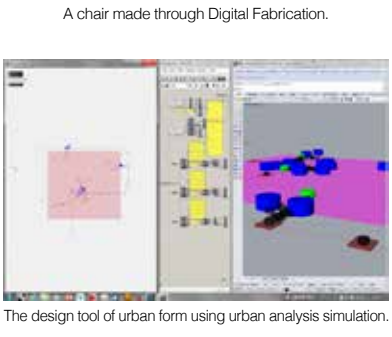
Theme 1 ▶ Study on "Architectural Design Informatics"

This research theme focuses on the arrangement of computer utilization projects which was introduced from the 1960s in the architectural design field. It also approaches to clarify its theoretical framework by analyzing it historically. Focusing especially on the philosophy of computer use in the early period, the research tackles to clarify the significance of its application today. By structuring them as "Architectural Design Informatics", we aim to make relativization of the development of computational design method that is becoming mainstream recently and to generalize it as an architectural design theory.

A chair made through Digital Fabrication.

Theme 2 ▶ Study on Computational Design

In this research theme, we mainly develop the following digital design method. (1) Design proposal / consensus forming building tool using VR head mounted display (2) Using digital fabrication tool for manufacturing, (3) Design tool which can utilize various simulations such as structural analysis and urban forming. In addition to the development of design tools of such a new approach, we analyzes how the design and the result of planning changed through the process using these tools and we are discussing what effect it has in design proposals and forming consensus.



The design tool of urban form using urban analysis simulation.

Theme 3 ▶ Study on Redesign of Public Space

In this research theme, we analyze and examine how to redesign existing public buildings and spaces against anticipated social changes including population declines. Through the development of method that is not only complementing imperfections of existing spaces such as maintenance and renovation of facilities, it tries to optimize the gap between existing space or situation and future vision. In addition to the theoretical research approaches such as surveys on actual situation of public space use and analysis of refurbishment methods, we also focuses on the research through practical projects which perform from design to construction.

Recent work of redesign (Startup Garage).

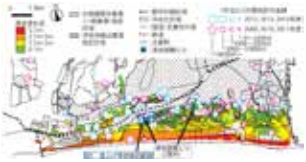
Urban Planning Laboratory

Staff	• Professor	**Asano, Junichiro**	(E-mail：asano@ace.tut.ac.jp)
	• Assistant Professor	**Karashima, Kazuki**	(E-mail：k-karashima@ace.tut.ac.jp)
	• Assistant Professor	**Liu, Yichen**	(E-mail：liu@ace.tut.ac.jp)
Laboratory URL	http://urbandesign.web.fc2.com/MOTHER-hp/STU-hp/index.html		
Key words	Land use planning, land use controls, urban design, history of modern urban planning, history of modern city making		

"Urban Planning Research Declaration: Our method shall be urban design, our mentality shall be the doctrine of provincial cities, and our attitude shall be a complete appreciation of cities and architecture!" This is a riff on the famous city creation declaration of "Our method shall be readjustment, our mentality shall be the doctrine of small cities, and our attitude shall be a complete appreciation of cities." I include it here because it perfectly describes my research style and goals.

Theme 1 ▶ Study on land use planning and land use controls in Japan

Entering an age of falling population and low economic growth, city planning needs to consider not only these factors but also effects upon the Earth's environment. In particular, provincial cities have a requirement to be compact and sustainable. One of the major factors that influences city planning is land use planning. This theme therefore focuses on suburban land use planning for provincial cities. While closely inspecting land use controls, including city planning areas, area division, the land development permission system, the district plan system and voluntary ordinances by local governments, we seek to highlight the issues between actual development and the systems & operations in place, and to inquire into issues relating to them. In the 2016-2017 academic years, it is our intention to advance our research into international comparative research into preventive measures for city shrinkage, research relating to formulation status of location optimization plans, etc.



Individual developments distribution in urbanization control area included of Tunami Hazard area : Hamamatsu City

Theme 2 ▶ Study on history of modern urban planning and city making in Japanese cities

Japanese research into the history of modern urban planning has been focused first and foremost on large cities and colonial cities from the world war period, but the development of domestic provincial cities has not yet been fully explained. This research targets major domestic provincial cities to which the old Urban Planning Act applied in a relatively early period, and seeks to make clear the ideals behind the planning and the planning techniques used in both the pre-war period and post-war reconstruction period. We also seek to make clear the meaning this history holds today, and how it is continued or discontinued in current urban planning. In the 2016-2017 academic year we intend to place our focus on the relationship between land use planning according to the war damage reconstruction plan, and land use planning in the period when the area division system was introduced.

Initial concept association diagram for the Gifu post-war reconstruction urban planning

Theme 3 ▶ Study on urban design methods

Some of the issues faced by urban design include three dimensional design, going beyond two dimensional land planning on a regional scale and allowing explorations of the form and design of buildings, processes that presume the participation of a variety of planning bodies, and the systems and income & expenditure management required in order to realize those plans, while research into urban design seeks to uncover new values and regional planning resources in order to create rich urban spaces. For the 2016-2017 academic year, we are placing our focus on the relationship between post-war reconstruction urban planning and modern downtown development policies.

Uncovering the riddle of the axis lines on the path leading to Zenkoji temple (left), A view of Ueda, as seen in the 1966 movie "The Inugami's family" (middle), The same location in the summer of 2002 (right)

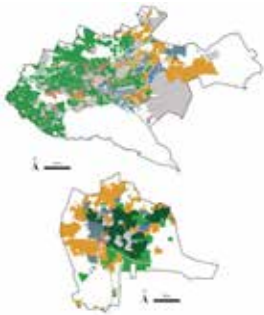
International Urban Planning Laboratory

Staff	• Lecturer **Ono, Haruka** (E-mail：ono.haruka@ace.tut.ac.jp)
Key words	Urban and Regional Planning, Territorial Design, Community Development, African Cities, Asian Cities

To realize sustainable cities, the mission of our laboratory is to explore the potential recommendations on what needs to change at policy, institutional and ground levels from a global perspective. Our research includes: international urban and regional planning; land tenure, planning and management; and territorial design. We encourage students to develop a sound theoretical knowledge as well as practical skills for enabling them to practice in all areas of urban planning and territorial design.

Theme 1 ▶ International urban and regional planning

In many of the rapidly growing cities, especially in Asian and African countries, modern urban planning and land management systems derived from western countries are not properly working. Urban development issues have become evident such as poverty, slums, environmental pollution and vulnerability to disaster. It is an urgent global issue to consider urban and regional planning based on the history and local resources of the city. Our work is to explore case studies on the process and actual situation of urbanization, as well as the institutional and political approaches, to develop sound theories for urban planning and regional development in developing countries.



Urban land use (Top: Nairobi, Bottom: Lusaka)

Theme 2 ▶ Land tenure, planning and management

Land issues gain increasing importance in view of accumulating problems related to vacant houses, little or unused land, utilization of public spaces faced by shrinking cities, housing shortages, squatters, environmental pollution faced by growing cities, and to issues relating to disaster reconstruction faced by both cities. Now it is essential to consider how to manage and make use of our land as a shared property for all humanity. Research is focused mainly in providing a highlight of the current situation regarding how land is owned, perceived, planned, used and managed in order to best contribute to the evolution of livable cities.

Before and after renewal of a parking lot in the Matsuyama city center

Theme 3 ▶ Territorial Design

Our laboratory explores ideal territorial design in the contexts of community, spatial and institutional design on multiple scales from neighborhood to regional. We develop both scientific research and practical territorial design work in the field with particular interests in proposing new design processes that lead to the creation of sustainable living environments.

Territorial design practice (Left: Community design, Right: Spatial design)

Japanese Literature and Culture Laboratory

Staff	• Professor **Nakamori, Yasuyuki** (E-mail：nakamori@las.tut.ac.jp)
Laboratory URL	http://las.tut.ac.jp/~nakamori/
Key words	W.M. Vories, Isaku Nishimura, Basho, Haikai, Shiko

The appeal of the buildings by W.M. Vories and Isaku Nishimura are revealed from a perspective of cultural history, taking into account such clues as their ideas, their life philosophies, their value.

Theme 1 ▶ William Merrell Vories : personality and philosophy of Architecture

William Merrell Vories was a layman of Christianity, educator, architect, and founder of the Omi Mission. The appeal of the buildings by W.M. Vories are revealed from a perspective of cultural history, taking into account such clues as their ideas, their life philosophies, their values, the backdrop of the times and their interpersonal relationships.

Suikyuso

Theme 2 ▶ Isaku Nishimura : Education and philosophy of Architecture

Isaku Nishimura was an educator, architect, ceramist, painter, and founder of the Bunkagakuin. The appeal of the buildings by Isaku Nishimura are revealed from a perspective of cultural history, taking into account such clues as their ideas, their life philosophies, their values, the backdrop of the times and their interpersonal relationships.

Nishimurakinenkan

Theme 3 ▶ Theme3 History of Haikai : Basho, Shiko, Minoha

Haikai is a cultural movement from the Edo period. We seek to make clear the essence of Shiko-hairon, the poetic doctrine of Shiko, that reached the most notably conclusion among the Haikai poets. Moreover, we also seek to make clear the essence of the Minoha-Densyo written by Mino-ha poets based on the doctrine of Shiko and the history of Haikai. We are currently advancing research into a restructuring of the history of Haikai and literature.

"Zyuronibensyo"

Shishian

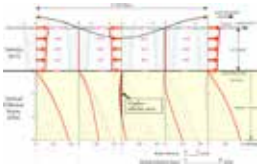
GeoMechanics Laboratory

Staff	• Professor **Miura, Kinya** (E-mail：k-miura@ace.tut.ac.jp) • Lecturer **Matsuda, Tatsuya** (E-mail：t.matsuda@ace.tut.ac.jp)
Laboratory URL	http://www.geomech.tutrp.tut.ac.jp/
Key words	Geotechnical engineering, seabed, structural foundations, stability analysis, seismic resistant design, wave resistant design

GeoMechanics Group Laboratory has studying the stability of soil structures and structural foundations, the disaster mitigation, and the geotechnical environment. The stability of structures that residential areas and public facilities such as roads, bridges and ports are important under severe external actions including earthquake, tsunami, heavy rain, and typhoon, is a pressing issue of civil structures for the safety and sustainability of residents lives. The geotechnical environment is also important for it, just as the atmosphere and the ocean. We are continue studying of geomechanics to resolve the issues related to these areas and propose new technologies.97

Theme 1 ▶ Scour mechanisms of seabed due to ocean waves and the stability of coastal structures

The study on the scour of seabed around coastal structure due to ocean wave has focusing on the tractive force by shear stress in surface seabed. On the other hand, the instability of seabed that is decreased of the vertical effective stress by acting the change of water pressure in the seabed during ocean wave is known. Our study clarify the mechanism of scour phenomenon with the synergy effect between the tractive force and a change in vertical effective stress due to ocean wave, and also is investigate for effect of stability of coastal structures.95



Investigation of scour phenomenon among interaction between tractive force and seepage force due to ocean wave by explicit solution

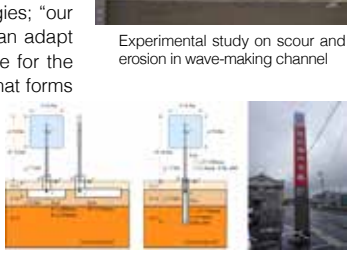
Theme 2 ▶ Design and construction method for economical pile foundations with short construction time for signs

The foundations for signs and traffic signs are almost all gravity type, using a large volume of concrete. However, not only does concrete require considerable time for strength development, but construction processes include excavation, form construction, reinforcement work and water replacement. The results will be a number of potential problems, such as a prolonged work period or lack of skilled personnel. In order to resolve these issues, our laboratory has developed a design and construction method for pile foundations. This research is supported by three technologies; “our uniquely developed deflection analysis technique for a pile that can adapt to layered ground,” “our uniquely developed compound structure for the support pillar and the pile” and “a construction method for a pile that forms a soil improvement.”125

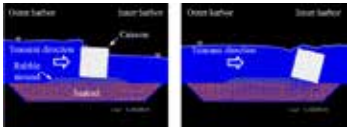
Experimental study on scour and erosion in wave-making channel

Theme 3 ▶ Stability of coastal structures against earthquake and tsunami

Coastal structures have occurred catastrophic damage from earthquakes and tsunami. However, the mechanism of the tsunami disaster for the coastal structure has not yet been completely revealed. Our laboratory is studying the seismic and tsunami disaster of coastal structure focusing to how the multi-scaling problems and multi-phase interactions among the soil and water affect structures, based on centrifuge tests and smoothed particle hydrodynamics simulations with external force-soil-structure interactions, and research the countermeasure and design methods based on the fracture control design.



Design-construction method for economical piled foundations with short-term construction for signs



Estimation of damage to caisson-type breakwater induced by tsunami with particle based method

Urban and Regional Management

Water Environment Conservation Laboratory

Staff	• Professor **Inoue, Takanobu** (E-mail：inoue@ace.tut.ac.jp)
Laboratory URL	http://www.wq.ace.tut.ac.jp/
Key words	Water environment, water quality, runoff loading, diffuse pollution, eutrophication, environment conservation

The main topics of this laboratory are quantification of pollution sources by monitoring and modelling, and development of approach for pollution control.

Theme 1 ▶ Development of the nutrients runoff model

The runoff of nutrients from drainage basins occurs not only from point sources such as factories and sewers, but also from plane sources such as forests and agricultural urban regions. There are a number of closed water areas, such as the Mikawa Bay, that have seen no improvement in water quality even with a reduction in runoff load from point sources, and therefore calculation of nutrient runoff load from plane sources is becoming more important. Based in actually observed data, we are working to create a model that can be used for high accuracy calculation of the nutrient runoff load in order to validate nutrient reduction effects etc.

Gold mining site

Theme 2 ▶ Survey on mercury contamination in the environment

In Indonesia and other regions in South-East Asia as well as Amazon basin, small-scale gold mining is common among the residents of the region. The mercury used for refining the gold is then released into the river without any processing. As a result of the biological concentration through the ecosystem of the river, the mercury contaminates the fish that the people living along the river eat, posing a threat to their health. In the regions where gold mining takes place actively, we are seeking to investigate the volumes of mercury contained in the river water and silt, and the effects this is having on fish and people to reveal the current state of mercury contamination.

Runoff from agricultural field

Theme 3 ▶ Development of measurement method for bio-available phosphorus and analysis of environmental fate

Phosphorus is a major cause of eutrophication, and a large volume of suspended phosphorus runs off in rainfall. This increases the ratio of suspended phosphorus, but as suspended phosphorus includes phosphorus derived from mineral, it is important to measure bio-available phosphorus. Along with the development of a method for testing a large number of samples in a short space of time, we will also make clear the runoff characteristics of bio-available phosphorus from a drainage basin.

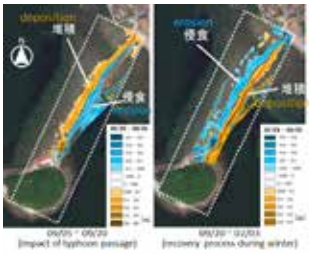
Theme 4 ▶ Runoff analysis of contaminants from agricultural fields

A large amount of nitrogen and phosphorus applied through fertilizer are transported from agricultural fields to lakes and basins during rain events. We are investigating the loading and fate of contaminants in aquatic systems as well as the strategies for reduction of the contaminant loading.

Coastal Engineering Laboratory

Staff	• Professor **Kato, Shigeru** (E-mail：s-kato@ace.tut.ac.jp)
Laboratory URL	http://www.umi.ace.tut.ac.jp
Key words	Sediment movement, Topographic/bathymetric change, Field observation and survey, Hydraulic experiment, UAV, Image analysis, Coastal erosion, Tsunami, Storm surge, Disaster mitigation

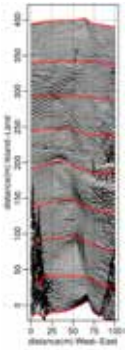
Researches on coastal environment and disaster mitigation are conducted from the viewpoint of Coastal Engineering which is a part of Civil Engineering. We are trying to solve problems and to make clear phenomena in coastal region using field observation, data analysis and numerical simulation. We hope to create useful results for our life and community.



Topographic change of tidal flat

Theme 1 ▶ Sediment Dynamics and Topographic Change in River-mouth and Coastal Region

Sediment transport in coastal zone has a great influence on coastal erosion, topographic changes and coastal environment. We are conducting the researches on the generation of the sediment transport in coastal region (sea and river mouths), their spatial and/or temporal characteristics, the relationship among coastal high waves and currents, volumes of the sediment transport and coastal topographic changes, to aim for the protection of coastal erosion and the preservation of coastal environment Various approaches, such as field observation, laboratory experiment and numerical simulation, are used for the elucidation of related phenomena and the investigation of countermeasures. This theme is the fundamental research for preservation and management of rich coastal environment.



Spatial distribution of cross-sectional profile of tidal flat

Theme 2 ▶ Measurement and Monitoring of Sediment Movement and Coastal Morphology

We are trying to develop and propose various measurement and monitoring methods to understand the characteristics of sediment movement and topographic/bathymetric changes in a coastal areas such as rivers, beaches and sea. For example, investigation of monitoring / measurement method for topographic changes in tidal flat area efficiently and in detail using UAV, development of new measurement method for sediment transport and its amount using ultrasonic waves, simple and easy method to obtain sand particle size information using image analysis.

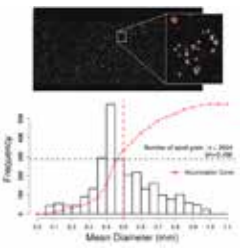
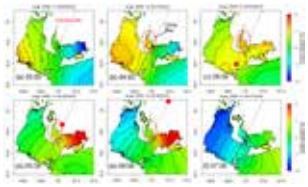


Image analysis for grain size distribution

Theme 3 ▶ Coastal Disaster Mitigation

For various disasters occurring in the coastal area, numerical simulation, field survey and their data analysis are conducted to clarify the cause of the occurrence and understand the phenomenon. For example, with regard to tsunamis generated by earthquake, storm surges and high waves caused by typhoon, we conduct the analysis of the mechanism of the disaster occurrence by numerical simulation and data analysis, consider measures for the spread of disasters into inland and urban areas, evacuation when disasters occur. In addition, we also analyze the occurrence mechanism of shoreline change and coastal erosion based on the field surveys on the Omotehama coast facing the Enshu-nada coast. Through these researches, we aim to contribute to regional disaster prevention.



Storm surge simulation caused by Typhoon 0918

Water Environment Engineering Laboratory

Staff	• Associate Professor **Yokota, Kuriko** (E-mail：yokota@ace.tut.ac.jp)
Laboratory URL	http://www.wq.ace.tut.ac.jp/
Key words	Water environment, diffuse pollution, nutrients, Mercury

The main topics of this laboratory are quantification of pollution sources by monitoring, and elucidation of runoff mechanism from forest stream to urban area rivers.

Theme 1 ▶ Runoff analysis of contaminations from agricultural fields

Runoff from agricultural fields includes nitrogen and phosphorus from fertilizers, and can be considered to contribute a large volume of the runoff load to closed water bodies such as lakes and estuaries. Runoff containing a particularly large volume of pollutants is generated when it rains. Targeting runoff during rainfall, we are seeking to understand and evaluate the volume of contaminants in runoff from agricultural fields and the characteristics of that runoff, and consider ways to reduce the resulting load.

Runoff from agricultural field

Theme 2 ▶ Study on water quality of the Umeda River

The eastern, interior part of Mikawa Bay (Atsumi Bay) suffers from chronic eutrophication, with damage to the finishing industry already being reported, including massive damage to the population of juvenile littleneck clams. The reason is through to be excessive nutrients being supplied from continental areas, but much remains unknown about the actual situation. Looking at the Umeda River, the second largest river in the region behind the Toyo River, as the subject of our survey, we are seeking to obtain an understanding of the characteristics of the pollutants in the drainage basin and consider ways to reduce the pollutant load.

Mikawa Bay

Theme 3 ▶ Survey on mercury contamination in the environment

The Minamata Convention on Mercury, ratified in October 2013, has brought further attention to problems relating to mercury. Mercury is easy to spread worldwide via atmospheric long-range transport. Some mercury compounds are removed from the atmosphere as a dry/wet deposition. Mercury ion in the water is readily methylated by both abiotic and biotic pathways. There are still many unknown elements in relation to the movement of mercury through the environment in Japan, however. We are continuously monitoring the input of contaminants from non-point sources at investigating sites.

Forest Stream Survey

Atmospheric observation

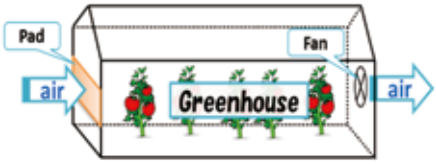
Atmosphere and Thermal Environment System Laboratory

Staff	• Lecturer **Tokairin, Takayuki** (E-mail：tokairin@ens.tut.ac.jp)
Laboratory URL	http://www.ace.tut.ac.jp/
Key words	plant factory, micro meteorology, computational fluid dynamics, environmental control

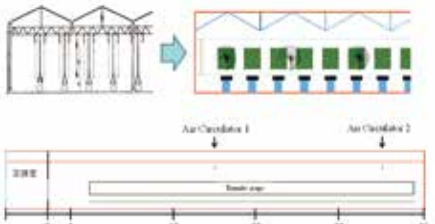
This laboratory mainly researches atmospheric and thermal environment inside a plant factory (greenhouse) using various sensors and computational fluid dynamics model (CFD model) to clarify the appropriate environment for plant growth. Details are described below.

Theme 1 ▶ Evaluation of environment for various types of plant factory (green house) using a computational fluid dynamic model.

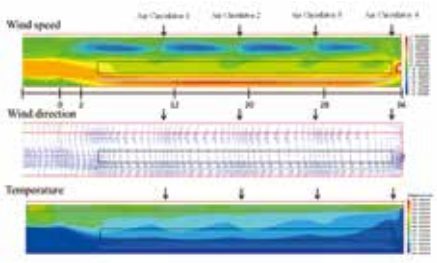
Atmospheric and thermal environment inside a plant factory (greenhouse) have been evaluated mostly based on empirical method, therefore it is difficult to know the detailed distribution of air temperature, humidity, airflow and CO2 concentration and their control. The objective of this study is to evaluate and predict the detailed distribution of environmental components mentioned above in a plant factory for contribution to the environmental control to maximize crop yield. In future, photosynthesis model will be considered for modeled crop in CFD to clarify the effect of CO2 application on crop yield.



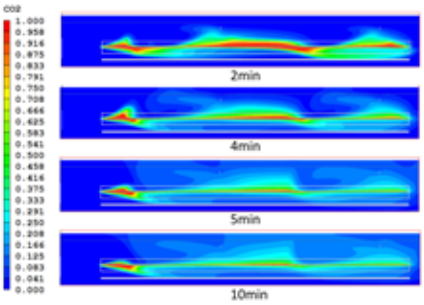
Plant factory equipped with a pad and fan evaporative cooling system



Modeled plant factory.



Calculated wind and temperature fields using a computational fluid dynamics model.



Calculated CO_2 distributions due to CO_2 application in a modeled crop.

Coastal Environmental Research Laboratory

Staff	• Assistant Professor **Okabe, Takumi** (E-mail : okabe@ace.tut.ac.jp)
Laboratory URL	http://www.umi.ace.tut.ac.jp/
Key words	Coastal sediment management, coastal morphology, estuarine environment, rip currents

Theme 1 ▶ Monitoring coastal morphology for regional sediment management

A large number of technical hurdles remain before we can achieve a measurement method for understanding sediment transport in water areas such as rivers and coasts. In particular, long-term coastal management requires a monitoring method providing continuous and highly-frequent topographical information on shallow sea areas. This research theme concentrates on small vessels for whitebait fishing in which fishermen operate in shallow sea areas. By recording and analyzing position and water depth during the operation of these fishing vessels, we are undertaking research to develop a low-cost monitoring method that can provide highly-frequent and continuous region-wide bathymetry data. Moreover, we are also using this data to research into analytical methods to calculate bathymetric changes and volume of sediment transport, along with methods of data assimilation.

Small fishing vessels in the Enshu-Nada coast

Theme 2 ▶ Material transport and ecosystems in an estuarine tidal flat

Ecosystems and environment in coastal zones are heavily influenced by economic activities, such as deterioration of water quality and man-made changes to coasts. Fisheries are no exception. Because reducing the numbers of fish catches is a critical issue, water resource management and environmental conservation are thus vital in order to maintain sustainable fishing. This research theme targets abundance of juvenile littleneck clams in Rokujo tidal flat, a primarily setting site for juvenile of manila clam in Japan, seeking to make clear their generation mechanism by investigating relationship between mechanisms and material transport in the tidal flat. We are especially focused on the relationship between waves, currents and sediment transport and juvenile littleneck clams setting and movement. Unlocking the sediment transport mechanisms around estuaries and tidal flats will allow us to present the optimal sediment environment for the development of juvenile clams, intending to point the way to the recovery of clam resources.

Japanese littleneck clam juveniles on Rokujo tidal flat

Theme 3 ▶ Water quality variations in an estuary

Interest in water environment has increased significantly in recent years, and a variety of regulations intended to conserve water quality have served to improve water quality in rivers and estuaries. On the other hand, hypoxia has a large impact on aquatic ecosystems and water quality in estuaries, coastal waters and freshwater lakes, and its formation and movement is related to hydrology. In order to protect waters from the hypoxia and to improve methods of water quality management, therefore, there is a requirement to understand the movement of these water masses based in the hydraulic characteristics. This research theme is focused on a estuary lagoon, Hamana Lake, intending to make clear the mechanism by which the hypoxia is formed and moves, upwells, and influences the water quality of shallow water areas in the lake. In order to make clear the mechanism, we are also taking into account a variety of other elements, including weather, tides and currents.

Field measurements in Hamana Lake

Socio-Economic System Laboratory

Staff	• Professor **Shibusawa, Hiroyuki** (E-mail：hiro-shibu@tut.jp)
Laboratory URL	http://www.pm.ace.tut.ac.jp
Key words	Urban and regional economics, industrial policy, simulation

The studies in my office are classified into two fields. One is about socio-economic system analysis for city, region and industry and another is about evaluation methodology for policy and project.

Theme 1 ▶ Socio-Economic System Analysis for City, Region and Industry

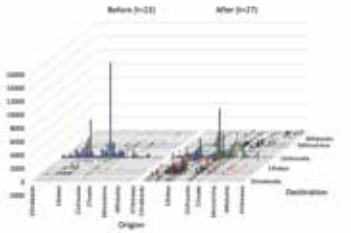
In order to understand socio-economic structures and to be able to predict the future, there is a vital requirement to fuse the accumulation of academic data with analysis methods. We are pursuing the construction of economic systems in urban and regional areas and industrial clusters, although with their analysis and application. Based in approach of economics and simulation methods, we are developing a methodology for analyzing the variety of issues that can arise in urban and regional areas and industrial clusters, and conducting analysis that targets urban and regional areas and industrial clusters. Some of the themes we are working with include the economic effect of large risks such as earthquakes, the regional economic effect of the innovation of next generation automobile technology, the economic effect of ports, and the economic effect of the formation of compact cities.

Modeling for Regions

Theme 2 ▶ Evaluation methodology for policy and project

We are pursuing the formulation of basic scientific theories required in order to support spatial policies for urban and regional areas, and the application of these theories. Based in economics, regional science, inter-industry analysis and econometrics, we implement analysis and simulations on a variety of socio-economic phenomena and policy issues that have a spatial dimension. Some of the themes we are working with include the development of an econometric model for urban and regional areas, calculation of the economic effects provided by technological revolutions in industry clusters, analysis of inter-organizational learning in an intellectual society and quantitative analysis that makes use of GIS and spatial economic data.


Modeling for Industries


Modeling for Transportation

Urban and Transportation Systems Laboratory

Staff	• Associate Professor **Sugiki, Nao** (E-mail：sugiki@ace.tut.ac.jp) • Associate Professor **Matsuo, Kojiro** (E-mail：k-matsuo@ace.tut.ac.jp)
Laboratory URL	http://www.tr.ace.tut.ac.jp
Key words	Road traffic management, public transport network, traffic big data, intelligent transport systems (ITS), travel behavior analysis, public service demand, urban model, microsimulation

This laboratory researches the following themes in the pursuit of the ideal state for a safe, convenient, comfortable, and environmentally-friendly urban structure and transport systems that is in unison with regional society, and how it might be realized.

Theme 1 ▶ Traffic safety management methods that make use of traffic big data

The effective and efficient realization of traffic safety management that lies at the center of improving the road traffic environment demands a scientific understanding of the risks posed by traffic accidents. Our laboratory is aiming to construct a traffic safety management method that uses not only traffic accident statistical data, but also traffic big data such as drive recorder data, vehicle probe data, and three dimensional road space data. Our approach is focused on Aichi Prefecture and Toyohashi City, and includes the construction of an accident risk statistical model, the evaluation of accident risks by location and type of accident and an analysis of their causes, the observational survey, analysis and construction of a simulation model for detailed traffic flows at specific accident risk points, and the proposal and evaluation of traffic safety measures based on all of this information.

Extraction of rat-run traffic from car probe data

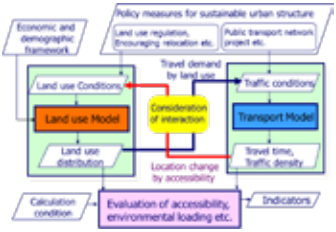
Theme 2 ▶ Local public transport network planning considering taxi mode

It is important to consider ideas that make use of taxi mode in local public transport network. Taxi mode is an individual and door to door transport system and has the advantage of being able to meet the diverse needs which mass transit systems such as railways and buses could not meet. Our laboratory analyses the actual situation and of taxi trips and the mechanisms of the use taxi mode based on digital daily log data and evaluates several policies that make use of taxi mode as a local public transport network through simulations and so on.

Distribution of departure and arrival points of taxi trips in Toyohashi (Left: Departure, Right: Arrival)

Theme 3 ▶ Future public service demand estimation for sustainable urban structure

It is concerned in the local government it becoming severe to offer public service at the same level now by annual revenue decrease under a population decline and aging society. Emerging pressures for more efficient and effective public management require more rational approach in forecasting future demand for public services before such problems will be actualized. Our laboratory develops the method to estimate the future distribution of population or households and grasp the change of urban service demand including transportation using urban model considering interaction between land use and transportation, in particular, microsimulation model. And we evaluate policy measures for sustainable urban structure, such as encouraging relocation policy to , improving or rebuilding of public transport network.



Analysis framework of urban model considering interaction between land use and transportation

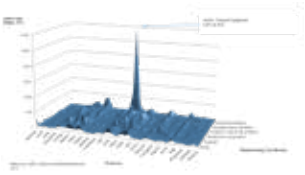
Business Risk Management Laboratory

Staff	• Professor **Fujiwara, Takao** (E-mail：fujiwara@las.tut.ac.jp)
Key words	Management of technology (MOT), business of science, real options, option games theory, timing options

This laboratory is studying the following topics as Studies on Industrial clusters, Valuation of start-ups at death-valley, Option-games analysis, and Timing option.

Theme 1 ▶ Study on open innovation and industrial clusters: MOT, business of science

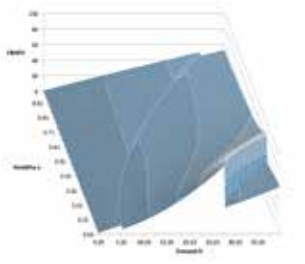
Regardless of advances in information and communication technology, the world has not flattened out but is rather showing a tendency to form up into industrial clusters. While heavily concentrated industrial clusters display selective and concentrated economy, they are also vulnerable weak to uncertainty. This creates a necessary condition for a business or and financial engineering model that can achieve a return on investment from even high birth and high death rate projects from basic research. Our laboratory is conducting research on the investment strategy of the business portfolio that can respond to uncertainty as MOT (Management of Technology) and the business of science.



Japan's 3Dminesional Industrial Structure

Theme 2 ▶ Study into valuation of start-up's early negative profits period: Real options

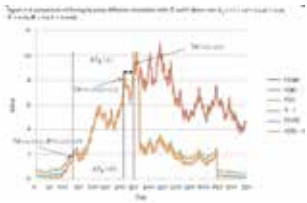
When it comes to rapid conversion from projects of basic research, start-ups have superiority over major large companies from the perspectives of combing revolutionary technology and niche markets. However, start-ups also have a tendency to collapse in after a short time due to lack of funding. This creates a requirement for an optimal valuation and implementation method that will allow revolutionary ideas to be implemented during their negative profits period. Our laboratory is performing research into the investment potential of revolutionary but high risk projects by using real options to convert the negative NPV (Net Present Value) into the positive ENPV (Expended Net Present Value) of the project.



Option-games Model

Theme 3 ▶ Study on strategic partnership in the trade-off between flexibility and commitment: Option games

Real options are reliant on flexible values that wait until uncertainty has been reduced. There is also a requirement, however, to evaluate a commitment value - limiting the risk of being overtaken by a rival company - from game theory and then striking an overall balance. Therefore, during strategic alliances under uncertainty, there is a demand for the proposal of scenarios in which the information sharing strategy can shift Nash equilibrium from the Prisoner's Dilemma to Pareto optimality. Our laboratory is using an option games approach to a conduct research into the optimization of the tradeoff between these two values.



Timing Option

Theme 4 ▶ Study on optimal timing of irreversible investment under uncertainty: Timing option

In the development of technology and products, future profits are an uncertain and investment should become an irreversible sunk cost. At this severe condition, the optimum timing is decided by waiting to invest until the present value of total return on investment can exceed the investment value with the value of waiting option. Of course, it is also possible to instead quickly make a withdrawal investment in order to limit downside risk as the negative profits of project or calculate the potential value of expanding an R&D investment as a growth option in order to create an upside opportunity for the future new market. Our laboratory team is conducting research into the timing option of investment decision by developing a model of underlying asset behaviors under uncertainty.

Advanced Agricultural Engineering Laboratory

Staff	• Professor **Takayama, Kotaro** (E-mail：kt026@edu.tut.ac.jp)
Laboratory URL	http://www.recab.tut.ac.jp/index.html
Key words	intelligent greenhouse, plant diagnosis, plant factory, photosynthesis, sensor, smart agriculture

The main research and development of this laboratory are relating to environmental control and optimum design of intelligent greenhouse and plant factory, plant diagnosis/monitoring for agricultural production.

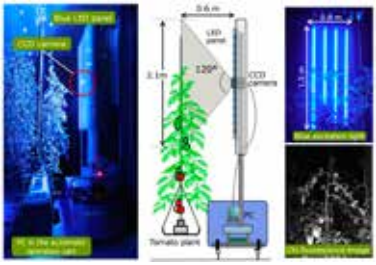
Theme 1 ▶ Optimum design of intelligent greenhouse and plant factory for sustainable food production

The intelligent greenhouse is an advanced greenhouse equipped with an automated environmental control system and conducting year-round plant production of various plants including vegetables and ornamental foliage plants under the sun. And, the plant factory is a facility achieving an extremely steady plant production under fully controlled environmental condition without sunlight. Currently, the computerized plant production based on the concept of Speaking Plant Approach (SPA) attracts attentions as an implementable key technology to achieve a significant productivity improvement in intelligent greenhouse and plant factory. The concept of SPA defines that the optimization of cultivation conditions should be based on measurements of the plant biological and physiological information and it is getting feasible according to a recent development of information technology, i.e. artificial intelligence and bioinformatics symbolized by omics.

Plant factory and intelligent greenhouse

Theme 2 ▶ Plant diagnosis robot and precise plant data for agricultural production

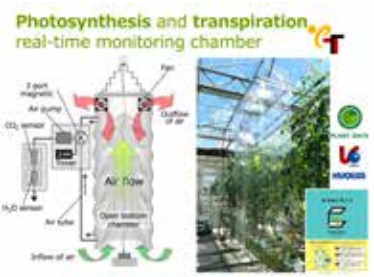
Chlorophyll fluorescence (CF) imaging technique is useful to evaluate the photosynthetic functions. CF is red light emission from plant leaves, which is generated by residual light energy that is not used for photosynthetic reactions. So, the precise measurement of CF allows us to evaluate the status of photosynthetic functions without touching the plants. The figure shows a CF imaging robot, which was developed in our previous studies and come onto the market in 2015. The CF imaging robot proved an apparent heterogeneous distribution of photosynthetic functions across the cultivation area (> 1 ha). Such information is probably useful to optimize the environmental control and crop maintenance strategies.



Chlorophyll fluorescence imaging robot for plant health diagnosis

Theme 3 ▶ Real-time monitoring of photosynthesis and transpiration

A variety of instrumentations for environmental control such as CO2 enrichment, supplemental lighting and air circulation have been installed in commercial greenhouses and utilized to increase the net photosynthesis. However, the extent of the contribution of each environmental control instrumentation to the crop photosynthesis is not clear. We developed a real-time photosynthesis and transpiration monitoring system that is able to be installed in commercial greenhouses and applied to obtain the time course of photosynthesis and transpiration of full-size tomato plant grown in a semi-commercial greenhouse. This system is going to be commercially available until 2020.



Photosynthesis and transpiration real-time monitoring chamber

Faculty members

Department of Mechanical Engineering

Mechanical Systems Design

Name	Position	Field	Research Interests	Page
Adachi, Tadaharu Dr. Eng.	Professor	Solid Mechanics	(1) Mechanical properties of materials and composites (2) Impact Engineering	2
Kawamura, Shozo Dr. Eng.	Professor	Mechanical Vibrations	(1) Modeling and Analysis of Structures (2) Inverse Analysis of Vibratory Systems	3
Shibata, Takayuki Dr. Eng.	Professor	Precision Engineering, Micro/Nanotechnology	(1) Micro/Nanofabrication (2) MEMS/NEMS (Micro/Nano Electro Mechanical Systems)	5
Abe, Yohei Dr. Eng.	Associate Professor	Forming Processes	(1) Forming Processes of Lightweight Parts (2) Joining Processes by Plastic Deformation	4
Takeichi, Yoshinori Dr. Eng.	Associate Professor	Tribology	(1) Analysis of Solid Lubrication (2) Surface Analysis for Tribology	2
Nagai, Moeto Ph.D. in Eng.	Associate Professor	Micro-Nano Systems Engineering	(1) Single Cell Processing Systems for Life Science (2) Microorganisms-driven Intelligent Microsystems	5
Matsubara, Masami Dr. Eng.	Assistant Professor	Mechanical Vibrations	(1) Modeling and Analysis of Structures (2) Tire dynamics	3
Ishii, Yosuke Dr. Eng.	Assistant Professor	Solid Mechanics	(1) Mechanical properties of materials and composites (2) Ultrasonic nondestructive evaluation	2

Materials and Manufacturing

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Izaki, Masanobu Dr. Eng.	Professor	Thin Film Science and Technology	(1) Preparation and Structural Controlling of Oxide Films (2) Study on High Performance Solar Cells	8
Miura, Hiromi Dr. Eng.	Professor	Processing for Microstructural Control	(1) Severe Plastic Deformation for Ultrafine Grains in Metallic Materials (2) Dynamic and Static Recrystallization of Metallic Materials	7
Todaka, Yoshikazu Dr. Eng.	Professor	Physical Metallurgy	(1) Structure and Property Control of Metallic Materials (2) Development and Characterization of Functional Materials	6
Kobayashi, Masakazu Dr. Eng.	Associate Professor	Analysis and evaluation of material microstructure	(1) Characterization of microstructure in materials by high-resolution X-ray CT (2) Evaluation and control of microstructures in metals	7
Yasui, Toshiaki Dr. Eng.	Associate Professor	Surface Modification Joining Process	(1) Surface Modification by Plasma and Ion Process (2) Welding between Dissimilar Materials by Friction Stirring	9
Yokoyama, Seiji Dr. Eng.	Associate Professor	Physical Chemistry of Metals	(1) Recycle of Waste Materials (2) Properties of Metallic Materials	8
Sasano, Junji Dr. Energy Sci.	Assistant Professor	Electrochemical Engineering	(1) Thin Film Formation by Electrochemical Processes (2) Design of Chemical Processes Based on Thermodynamics	8
Yamada, Motohiro Dr. Eng.	Assistant Professor	Coating Process	(1) Cold spray process for functional materials (2) Suspension plasma spray process	9
Adachi, Nozomu Ph. D.	Assistant Professor	Materials Science	(1) Mechanical property control of metallic materials through deformation process (2) Dynamic mechanical response of metallic materials	6
Kage, Azusa Ph.D.	Assistant Professor	Biomechanics	(1) Swimming in low Reynolds number conditions (2) Collective motion of microswimmers	5

System Control and Robotics

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Uchiyama, Naoki Dr. Eng.	Professor	Systems and Control Engineering	(1) Energy-Saving/Precision Control of Industrial Machines (2) Design and Control of Mechatronic Systems	12
Sato, Kaiji Dr. Eng.	Professor	Precision Mechatronics Control Engineering	(1) Design and Control of Precision Robots/, Mechatronic Systems and their Components (2) Practical Controller Design Method for High Performance Motion Systems	10
Sano, Shigenori Dr. Eng.	Associate Professor	Control Engineering and Identification	(1) Identification / Control of Mechanical system (2) Robotics / Mechatronics	10
Sakaguchi, Tatsuhiko Dr. Eng.	Associate Professor	Manufacturing Systems Engineering	(1) Scheduling (2) Supply Chain Management	12
Mashimo, Tomoaki Dr. Eng.	Associate Professor	Micro Robotics Micro Actuators	(1) Sensors and Actuators (2) Robotics/Mechanism design (3) Modeling and Control	11
Shirasuna, Miyori Dr. Eng.	Assistant Professor	Signal processing and data analysis	(1) Signal processing (2) Multivariate analysis, datamining	12
Akiduki, Takuma Dr. Eng.	Assistant Professor	Signal Processing and Soft Computing	(1) Information processing using dynamical systems (2) Human activity sensing and recognition	11

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Yanada, Hideki Dr.Eng.	Professor	Fluid Engineering, Fluid Power Systems	(1) Electrohydrodynamics (2) Fluid power pumps and actuators	16
Iida, Akiyoshi Dr. Eng.	Professor	Fluid Dynamics, Aeroacoustics	(1) Control of Turbulent Flow (2) Aeroacoustics	15
Nakamura, Yuji Dr. Eng.	Professor	Chemically Reacting Flow, Scale modeling	(1) Scale Modeling of Space Fire (2) Micro-scale Combustion	13
Suzuki, Takashi Dr. Eng.	Associate Professor	Thermal Engineering	(1) Gas-liquid Two-Phase Flow (2) Improvement of Liquid Atomization	14
Sekishita, Nobumasa Dr. Eng.	Associate Professor	Fluid Dynamics	(1) Wind Tunnel Experiment of Turbulent Shear Flow (2) Development of Flow Measurements and Analysis	15
Yokoyama, Hiroshi Dr. Eng.	Associate Professor	Aeroacoustics, Computational Fluid Dynamics, Flow control	(1) Control of Flow and Aerodynamic Noise (2) Energy Converting Machine (3) Musical Instruments	16
Matsuoka, Tsuneyoshi Dr. Eng.	Associate Professor	Combustion engineering	(1) Flame spread in narrow space (2) Development of hybrid rocket motor (3) Optical measurement for solid combustion	13
Nishikawara, Masahito Dr. Eng.	Assistant Professor	Heat Transfer, Fluid Dynamics	(1) Loop Heat Pipe (2) Two-phase Flow in porous media (3) Electrohydrodynamics	16
Yoshinaga, Tsukasa Dr. Eng.	Assistant Professor	Fluid Dynamics, Aeroacoustics	(1) Fluid Dynamics in Speech Production (2) Musical Instruments	15

Department of Electrical and Electronic Information Engineering

Electronic Materials

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Matsuda, Atsunori Dr. Eng.	Professor	Applied Materials Science	(1) Advanced Amorphous Materials (2) Inorganic-Organic Hybrid Materials (3) All-Solid-State New Batteries	18
Uchida, Hironaga Dr. Eng.	Professor	Magnetics	(1) Nano-scale Magnetic Structures (2) Development of measurement methods	19
Yatsui, Takashi Dr. Eng.	Professor	Nano-quantum opto-electronics	(1) Nano-scale light mater interaction (2) Diamond spin quantum sensor (3) High performance photodetector for automated drive system (4) Near-field assisted artificial photosynthesis	
Muto, Hiroyuki Dr. Eng.	Professor	Inorganic Materials, Structural Ceramics	(1) Development of nano structure controlled functional ceramics (2) Deformation mechanisms and processes of structural ceramics	20
Inoue, Mitsuteru	Professor	Electronics Magnetics	(1) Artificial magnetic lattice (2) Nano-magnetic materials and their application	19
Lim, Pang Boey Dr. Eng.	Professor	Optical, Optical Memory and Application	(1) Hologram Memory (2) Evaluation of Hologram Material (3) Collinear Holography	19
Nakamura, Yuichi Dr. Eng.	Associate Professor	Electric Materials Processing	(1) Thermoelectric Materials and Systems (2) Functional materials and processing	19
Hattori, Toshiaki Dr. Sci.	Associate Professor	Analytical Chemistry	(1) Electroanalytical Chemistry (2) Characterization of Polyelectrolyte	21
Kawamura, Go Dr. Eng.	Associate Professor	Nanomaterials Science	(1) Plasmonic Photocatalyst (2) Liquid Phase Synthesis	18
Kato, Ryo Dr. Sci.	Associate Professor	Analytical Chemistry, Organic Chemistry	(1) Anion and Pesticide Sensing by Chemical Sensor (2) Molecular Recognition at The Interface (3) Gas Sensing by Polymer Nanofiber	21
Goto, Taichi Dr. Eng.	Assistant Professor	Spintronics, Optics, Magnetics	(1) Nano Spin Wave Devices (2) Magnetic and Optical Materials (3) Micro Magneto-Optical Q-Switched Laser	19
Hikima, Kazuhiro Dr. Sci.	Assistant Professor	Inorganic Materials Science, Device, Related Chemistry	(1) Li-excess Cathode Materials with High Capacity (2) All-Solid-State Batteries Based on Sulfide Electrolyte	18
Tan, Wai Kian Dr. Eng.	Assistant Professor	Advanced Functional Oxide Nanomaterials, Inorganic Materials	(1) Functional Oxide Nanomaterials and Nanocomposites (2) Development of metal-air battery	20

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Takikawa, Hirofumi Dr. Eng.	Professor	Plasma Technology and Application Engineering	(1) Plasma system and Applications (2) Surface and nanofilms (3) Renewable energy and related technology	23
Hozumi, Naohiro Dr. Eng.	Professor	Measurement Techniques, Dielectrics and Electrical Insulation, Ultrasonics	(1) Ultrasonic micro-imaging techniques for medical and biological applications (2) Diagnosis and precise measurement for high voltage insulation systems	24
Inada, Ryoji Dr. Eng.	Associate Professor	Electrochemical Energy Devices	(1) Next-Generation Lithium-Ion Batteries (2) Oxide-Based All-Solid-State Batteries (3) Solid Electrolyte for Sensing Devices	22
Murakami, Yoshinobu Dr. Eng.	Associate Professor	Electrical Insulation Measurement Technique	(1) Measurement on Dielectrics and Electrical Insulation (2) Development of functional insulating materials	24
Harigai, Toru Dr. Eng.	Assistant Professor	Plasma Process Engineering	(1) Plasma Nanotechnology (2) Carbon Nanomaterials	23
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Integrated Electronics

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Sawada, Kazuaki Dr. Eng.	Professor	Semiconductor Devices	(1) Bio-sensing devices (2) Smart CMOS/CCD image sensors	25
Wakahara, Akihiro Dr. Eng.	Professor	Crystal Growth, Optoelectronics	(1) Heteroepitaxy and its applications to optoelectronics (2) Optoelectronic integrated devices/system on Si-based ICs and MEMS	27
Ishikawa, Yasuhiko Dr. Eng.	Professor	Semiconductor Devices Si photonics	(1) Photonic devices integrated on Si (2) Band-engineered SiGe photonic devices	26
Okada, Hiroshi Dr. Eng.	Professor	Semiconductor Devices	(1) Compound semiconductor based electronic devices and integrated systems (2) Nano materials and fabrication processes for electronic devices	29
Kawano, Takeshi Dr. Eng.	Associate Professor	Micro/Nano Devices, Neural Interface Devices	(1) Neural interface devices (2) Nanoscale neuroprobes (3) Integration of Mirco/Nano devices	28
Sekiguchi, Hiroto Dr. Eng.	Associate Professor	Crystal Growth, Optical Devices	(1) Heteroepitaxial Nitride-based Devices (2) Semiconductor nanostructure for optical devices	27
Noda, Toshihiko Dr. Eng.	Associate Professor	Integrated circuit, Sensing devices	(1) Integrated multimodal sensors (2) Robust packaging technology	30
Takahashi, Kazuhiro Dr. Eng.	Associate Professor	Micro/Nano Electro Mechanical Systems	(1) BioMEMS sensor (2) MEMS-based optical devices	25
Yamane, Keisuke Dr. Eng.	Assistant Professor	Crystal Growth, Optoelectronics	(1) III-V-N/Si Heteroepitaxy for Multi-junction Solar Cells (2) Substrate Engineering for Opto-electronics	27
Lee, Youna Master of science	Research Associate	Semiconductor Devices	Multimodal bio-sensing device	25
Moïse, Sotto Master	Research Associate	Photonic Devices Photonic Crystal	Photonic crystal resonators on silicon platform	26

Information and Communication System

Name	Position	Field	Research Interests	Page
Ohira, Takashi Dr. Eng.	Professor	Wave Engineering	(1) Microwave Circuits (2) Wireless Power Transfer	31
Ichikawa, Shuichi Dr. Sci.	Professor	Computer Science, Computer Architecture, Parallel Processing	(1) Custom computing & special-purpose computer architecture (2) System Security and Information Security (3) Parallel Processing and High Performance Computing	32
Uehara, Hideyuki Dr. Eng.	Professor	Communication Engineering	Wireless networks and communications	33
Tamura, Masaya Dr. Informatics	Associate Professor	Microwave Engineering	(1) Microwave Circuits (2) Wireless Power Transfer	34
Takeuchi, Keigo Dr. Informatics	Associate Professor	Information and Communication Engineering	(1) Wireless Communications (2) Multi-Antenna Systems (3) Space-Time Signal Processing	35
Miyaji, Yuichi Dr. Eng.	Assistant Professor	Communication Engineering	(1) Ad hoc Networks (2) In-Band Full-Duplex Communications	33
Abe, Shinji M. Eng.	Research Associate	Wave Engineering	Wireless Power Transfer	31

Department of Computer Science and Engineering

Computer and Mathematical Sciences

Name	Position	Field	Research Interests	Page
Ishida, Yoshiteru Dr. Eng.	Professor	System and Information Science	(1) Biological Information System and Complex Systems (2) Intelligent Information Processing	38
Suzuki, Koutarou Ph. D.	Professor	Information Security	(1) Cryptographic Primitive (2) Cryptographic Protocol	39
Fujito, Toshihiro Ph. D.	Professor	Computer Science	(1) Algorithms (2) Combinatorial Optimization	40
Kawai, Kazuhisa Dr. Eng.	Associate Professor	Computer Science and Engineering	(1) Computers and Education (2) Science Communication	41
Kurita, Noriyuki Dr. Eng.	Associate Professor	Quantum Biology, Bio-informatics	(1) Ab Initio Molecular Simulations for Biological Molecules (2) In Silico Drug Discovery for Alzheimer's Disease	42
Sato, Yukinori Ph.D.	Associate Professor	Computer architecture, High-performance computer system, Software performance engineering	(1) Memory-centric customization and co-design methodology for FPGA accelerators (2) Computer systems performance engineering (3) Automatic customization driven by mathematical optimization and deep learning	43
Takahashi, Chako Ph. D	Assistant Professor	Statistical machine learning, statistical mechanics of information processing	Inference and learning based on statistical-mechanical approximations	40
Harada, Koji Dr. Eng.	Assistant Professor	Mathematical Biology, Virology, Complex Systems	A mathematical study for the development of a novel therapy for AIDS	38
Wasa, Kunihiro Ph. D.	Assistant Professor	Theoretical computer science	Algorithm design and analysis for enumeration problems and combinatorial reconfiguration problem	39
Goto, Hitoshi Dr. Sci.	Professor	Computational Chemistry, ChemoInfomatics, High-performance Computing	(1) Molecular Simulation and Crystal Structure Prediction (2) Protein-Ligand Docking by using Coarse-Grained Potentials (3) Deep Neural Nets for Prediction of Molecular Activity and Property	44

Data Informatics

Name	Position	Field	Research Interests	Page
Aono, Masaki Ph. D.	Professor	Data Science	(1) Data Science (Texts, 2D/3D Media, Time Series) (2) Information Retrieval (3D shapes/scenes, Images, Videos) (3) Deep Learning Applications for Multi-modal Media	45
Umemura, Kyoji Dr. Eng.	Professor	Information Engineering	(1) Internet Application (2) Information Retrieval	46
Kitaoka, Norihide Dr. of Eng.	Professor	Speech information processing	(1) Speech recognition (2) Friendly spoken dialog system (3) Multimodal interface	47
Akiba, Tomoyoshi Dr. Eng.	Associate Professor	Natural Language Processing, Spoken Language Processing	(1) Machine Translation (2) Information Access (3) Speech Interface	48
Watanabe, Kazuho Dr. Eng.	Associate Professor	Statistical Learning and Inference	(1) Statistical Learning Theory (2) Machine Learning Algorithms	49
Asakawa, Tetsuya Ph. D.	Assistant Professor	Data Mining	(1) Emotion analysis, Sentiment analysis (2) Deep Learning	45
Yoshida, Mitsuo Ph. D.	Assistant Professor	Web Engineering, Computational Social Science, Natural Language Processing	(1) Web and Social Media Mining (2) Research Evaluation on Social Media (3) Science of Science	46
Tsuchiya, Masatoshi Ph. D.	Associate Professor	Natural Language Processing, Applied Information Systems Engineering	(1) Natural Language Processing (2) Web information system (3) User authentication	50

Human and Brain Informatics

Name	Position	Field	Research Interests	Page
Kitazaki, Michiteru Ph. D.	Professor	Perceptual Psychology, Cognitive Neuroscience, Virtual Reality	(1) Perception and action of mobile observers (2) Embodied reality and virtual reality (3) Implicit social cognition.	51
Nakauchi, Shigeki Dr. Eng.	Professor	Computational Neuroscience	(1) Vision Science (2) Image Technology	52
Minami, Tetsuto Ph. D.	Professor	Cognitive Neuroscience	(1) Target: cognitive processing such as face processing, attention, and emotion. (2) Method: behavioral measures, EEG, fMRI, eye-tracking, and virtual reality.	53
Fukumura, Naohiro Dr. Eng.	Associate Professor	Computational Neuroscience	(1) Computational Theory of Human Motor Control (2) Learning Models for Sensory-Motor Transformation	54
Matsui, Toshie Ph. D	Associate Professor	Auditory perception and cognition	(1) Computational model of human auditory system (2) Music perception and cognition and its development	55
Murakoshi, Kazushi Dr. Eng.	Associate Professor	Computational Intelligence, Neural Information Science	Mechanisms of humans or animals information processing approach by the information science method based on both psychological and physiological data	56
Ueda, Sachiyo Ph. D.	Assistant Professor	Perceptual Psychology, Cognitive Science	(1) Ensemble perception (2) Body and spatial perception	51
Hine, Kyoko Ph.D.	Assistant Professor	Cognitive Science, Vision Science	(1) Unconsciousness and consciousness (2) Visual perception and cognition	52
Koida, Kowa Dr. Eng.	Associate Professor	Visual neuroscience	(1) Neural basis for visual sensation and cognition (2) Developing innovative methods for neuroscience	57

Media Informatics and Robotics

Name	Position	Field	Research Interests	Page
Okada, Michio Dr. Eng.	Professor	Interaction and Communication Design	(1) Social Robotics (2) Human-Robot Interaction Studies (3) Cognitive Science in Communication	58
Kuriyama, Shigeru Dr. Eng.	Professor	Computer Graphics and Visual Media Interaction	(1) Motion data informatics (2) Smart images and graphics for illustrations and craftworks (3) Graphics and image-based optical controls	59
Miura, Jun Dr. Eng.	Professor	Intelligent Robotics	(1) Intelligent mobile robots / Personal service robots (2) Visual scene recognition (3) Human-robot interaction.	60
Ohmura, Ren Dr. Eng.	Associate Professor	Ubiquitous Computing, Context-aware Systems, Network Systems	(1) Real world information processing obtained from IoT environment (2) Applications based on human context (3) Sensor devices and network systems for supporting (1) and (2)	61
Kanazawa, Yasushi Dr. Eng.	Associate Professor	Computer Vision, Image Processing	(1) Image Matching for 3-D reconstruction (2) 3-D scene reconstruction from images (3) Image processing for dichromats	62
Sugaya, Yasuyuki Dr. Eng.	Associate Professor	Computer Vision	(1) Mixed Reality (2) Ellipse detection and fitting (3) 3D reconstruction from images	63
Hasegawa, Komei Ph. D. in Eng.	Assistant Professor	Human-Agent Interaction	(1) Human-Agent Interaction (2) Social Robotics (3) Interaction Design	58
Hayashi, Kotaro Dr. Eng.	Assistant Professor	Human-robot interaction, Intelligent Robots, Cognitive Science	(1) Recognition and action planning for real-world intelligent systems (2) Design for the robot which can behave like human (3) Human-robot interaction	60
Ohshima, Naoki Ph.D. in Eng.	Lecturer	Human-Robot Interaction, Human-Agent Interaction	Social robots that can involve in conversation with people using verbal and non-verbal means of communication	64

Department of Applier Chemistry and Life Science

Molecular Design Chemistry

Name	Position	Field	Research Interests	Page
Itsuno, Shinichi Ph.D (Eng.)	Professor	Polymer Synthesis, Organic Synthesis	(1) Synthesis of optically active polymers (2) Design of polymeric chiral catalyst for asymmetric synthesis	66
Matsumoto, Akihiko Ph.D. (Sci.)	Professor	Adsorption science Porous materials Environmental adsorption technology	(1) Surface functionalization of porous solids and characterization of molecular adsorption (2) Adsorption separation technology for environmental protection	67
Saito, Yoshihiro Ph.D. (Anal. Chem.)	Professor	Analytical Chemistry Separation Science	(1) Development of novel microscale sample preparation method (2) Miniaturization and hyphenation of separation techniques	68
Tanaka, Saburo Ph.D. (Eng.)	Professor	Sensor Engineering Applied Physics	(1) Application of SQUID magnetic sensor (2) Thin film fabrication	71
Yoshida, Eri Ph.D. (Eng.)	Associate Professor	Supramolecular chemistry Polymer chemistry	(1) Self-assembly of amphiphilic polymers (2) Controlled/living radical polymerization	69
Haraguchi, Naoki Ph.D. (Eng.)	Associate Professor	Polymer Chemistry, Organic Chemistry	(1) Synthesis of functional polymer microsphere (2) Synthesis of polymeric chiral organocatalyst	70
Ariyoshi, Seiichiro Ph.D. (Eng.)	Associate Professor	Sensor Engineering Applied Physics	(1) Terahertz superconducting detectors (2) Terahertz imaging spectroscopy (3) Terahertz-wave applications	72
Ito, Hiromitsu Ph.D. (Sci.)	Assistant Professor	Adsorption technology Nanospace science and engineering	(1) Molecular arrangement with nanospace (2) Gas adsorption and separation mechanism on porous materials	67
Fujisawa, Ikuhide Ph.D. (Eng.)	Research Associate	X-ray Crystallography, Organic Chemistry	(1) Determination of molecular structures (2) Synthesis of Polymeric Catalyst	66

Molecular Functional Chemistry

Name	Position	Field	Research Interests	Page
Iwasa, Seiji Ph.D. (Eng.)	Professor	Organic Synthesis	(1) Total synthesis of bioactive organic compounds (2) Development of catalytic asymmetric reactions (3) Development of molecular sensors	73
Tsuji, Hideto Ph.D. (Eng.)	Professor	Polymer Chemistry and Engineering	(1) Development of bio-based, sustainable, and biodegradable polymers (2) Stereocomplex formation between enantiomeric polymers	74
Mizushima, Takanori Ph.D. (Sci.)	Professor	Functional Catalytic System Engineering	(1) Synthesis of solid catalysts for petrochemical industries (2) Development of high-performance systems for degradation of environmental pollutants	75
Daimon, Hiroyuki Ph.D. (Eng.)	Professor	Waste Management, Supercritical Fluid Engineering	(1) Production and utilization of biomass, Environmental information analysis (2) Application of supercritical fluid technologies	78
Nakano, Hiromi Ph.D (Eng.)	Professor	Ceramics, Transmission electron microscope	(1) Synthesis of new phosphors (2) Property and structural analysis for anisotropic material (3) Characterization of ceramics by TEM	79
Oguchi, Tatsuo Ph.D. (Eng.)	Associate Professor	Combustion Chemistry Reaction Mechanism	(1) Elementary reaction analysis for combustion and environmental chemistry (2) Reaction modelling and development for combustion system	76
Shibatomi, Kazutaka Ph.D. (Phar.)	Associate Professor	Organic Chemistry	(1) Design and synthesis of new chiral catalysts (2) Development of asymmetric reactions (3) Synthesis of biologically active molecules	77
Arakawa, Yuki Ph.D. (Eng.)	Assistant Professor	Polymer chemistry, Liquid crystal chemistry	(1) Synthesis of novel liquid crystal molecules (2) Development of high birefringence liquid crystal materials	74
Satoh, Hirohisa Ph.D. (Eng.)	Assistant Professor	Inorganic synthetic chemistry Solid physics	(1) Synthesis and structure analysis of rare earth manganites (2) Thermal and magnetic properties	75
Ohkita, Hironobu M. Eng.	Research Associate	Heterogeneous catalyst and catalysis	Development and application of the novel catalysts for petrochemical industry	75

Molecular Biological Chemistry

Name	Position	Field	Research Interests	Page
Eki, Toshihiko Ph.D. (Phar.)	Professor	Molecular Genetics, Biochemistry	(1) Analysis of Dicer-related Helicases in C. elegans (2) Yeast- and Nematode-based bioscience and biotechnology (3) DNA barcoding of soil organisms	80
Takashima, Kazunori Ph.D. (Eng.)	Professor	Applied High voltage Engineering	(1) Environmental pollution control using discharge plasma (2) Electrostatic micro-manipulation of DNA molecules	81
Tanaka, Terumichi Ph.D. (Agri.)	Associate Professor	Biochemistry, Molecular Biology	(1) Analysis on transfer RNA-related enzymes (2) Creation and analysis of new type RNA protease inhibitor	82
Numano, Rika Ph.D. (Med. Sci.)	Associate Professor	Molecular Biology, Neuroscience, Chronobiology	(1) Functional analysis of chronobiology (2) Optogenetics research of neuroscience (3) Technical development for regenerative medicine	83
Tero, Ryugo Ph.D. (Sci.)	Associate Professor	Physical Chemistry of Interfaces	(1) Artificial lipid bilayer membranes at solid-liquid interfaces (2) Activities of proteins on and in lipid bilayers (3) Bimolecular membranes on single atomic sheet: lipid bilayers on graphene derivatives	84
Nakabachi, Atsushi Ph.D. (Sci.)	Associate Professor	Biology of Symbiosis, Entomology, Microbiology	(1) Elucidation of the mechanism of fusion between distantly-related organisms (2) Development of environment-friendly pest control methods (3) Discovery of bioactive substances from symbiotic bacteria	87
Yoshida, Sachiko Ph.D. (Phar.)	Lecturer	Physiology, Developmental Neuroscience	(1) Dynamics of cerebellar development (2) Biosensing for artificial organs, brain systems and cancer	85
Yamada, Takeshi Ph.D. (Eng.)	Lecturer	Microbiology Environmental Biotechnology	(1) Biological wastewater & waste treatment (2) Ecophysiology of microorganisms (3) Detection technology for microorganisms	86
Hirose, Yuu Ph.D. (Sci.)	Assistant Professor	Genome Biology, Photobiology	(1) Genome analysis of photosynthetic organisms (2) Molecular process of photoacclimation	80
Kurita, Hirofumi Ph.D. (Eng.)	Assistant Professor	Applied Electrostatics Biomolecular and Cellular Engineering	(1) Molecular damages and cellular responses induced by atmospheric pressure plasma (2) Electrostatic manipulation of water-in-oil droplets and its application for life science	81

Department of Architecture and Civil Engineering

Architecture and Urban Design

Name	Position	Field	Research Interests	Page
Saito, Taiki Dr. Eng.	Professor	Seismic Engineering	(1) Earthquake response analysis of buildings and non-structural elements (2) Seismic isolation and response control techniques for buildings	90
Matsushima, Shiro Dr. Design.	Professor	Architectural Design, Technology, and Management	(1) Theory and method in advanced architectural design (2) Design Technology and Project Management (3) Community development	96
Nakazawa, Shoji Dr. Eng.	Professor	Structural Engineering	(1) Buckling analysis and seismic response analysis of shell and spatial structures (2) Development of a seismic resistant performance evaluation technique based on seismic risk analysis (3) Development of a grid computing system for solving a structural optimization problem and a seismic risk	91
Asano, Junichiro Dr. Eng.	Professor	Urban Planning	(1) Development and Application of Land Use Control (2) History of Urban Planning in Modern Era	98
Tsuzuki, Kazuyo Ph.D.	Professor	Building Environmental Engineering, Ergonomics	(1) Thermal comfort, thermoregulation, and sleep (2) Desiccant system, renovation, and health effect (3) Performance and environment	94
Nakamori, Yasuyuki Ph.D. in Letters	Professor	Japanese Literature Architectural Theory	(1) Haikai; Basyo, sikou, tyoumu (2) Architectural Theory of William Merrell Vories	100
Matsui, Tomoya Dr. Eng.	Associate Professor	Building Structural Engineering	(1) Evaluation of Seismic resistant performance of RC buildings (2) Development of Composite Concrete Encased Steel Structural System (3) Development of Retrofit Method of Building	92
Matsumoto, Yukihiro Dr. Eng.	Associate Professor	Structural Engineering	(1) Buckling and Seismic design methodology for shells and space structures (2) Structural Design Methodology of Hybrid Structures using Fibre Reinforced Polymer (FRP) (3) Structural Health Monitoring (SHM) using Fibre Optic Sensors	93
Shimazaki, Yasuhiro Dr. Eng.	Associate Professor	Environmental Engineering, Thermal Ergonomics	(1) Evaluation and design of indoor/outdoor thermal comfort (2) Measurement of thermo-physical properties (3) Ergonomics applications contributing to enhancing QOL (Quality Of Life)	95
Mizutani, Akihiro Ph.D.	Associate Professor	Architectural Design, Urban Design	(1) Architectural design and planning (2) History and Theory of computational design in architecture	97
Ono, Haruka Dr. Eng.	Lecturer	International Urban Planning	(1) International urban and regional planning (2) Territorial Design	99
Karashima, Kazuki Dr. Eng.	Assistant Professor	Urban Planning, Regional Planning	(1) Development of design techniques for creating resilient urban/regional structure (2) Development of Methods/technology for collaborative planning among municipalities towards sustainable urban and regional society	98
Hayashi, Kazuhiro Dr. Eng.	Assistant Professor	Structural Engineering	(1) Health monitoring of reinforced concrete piles (2) Development of new type Structural members using ultra-high strength steel H-SA700	90
Liu, Yichen Dr. Env.	Assistant Professor	Urban Planning history	(1) Formation and Transformation of the Concessions and Foreign Settlements in East Asia (2) Living Environment and Environmental Protection	98
Takiuchi, Yuji Dr. Eng.	Assistant Professor	Structural Engineering	(1) Structural optimization of shells and spatial structures (2) Buckling strength evaluation of spatial structures (3) Evaluation of seismic resistance capacity of spatial structures	91
Yuan Jihui Ph.D.	Assistant Professor	Built thermal environment engineering	(1)Research on highly reflective and retro-reflective building coating for urban heat island mitigation (2)Research on weather data used for air-conditioning heat load calculation	94

Urban and Regional Management

Name	Position	Field	Research Interests	Page
Inoue, Takanobu Dr. Eng.	Professor	Water Environment Engineering	(1) Water Quality Analysis of Fresh Water (2) Water Conservation Engineering	102
Miura, Kinya Dr. Eng.	Professor	Geotechnical Engineering and Applied Mechanics	(1) Evaluation of Seismic Resistance and Seismic Design of Ground-Structure System (2) Coupled Water-Heat-Deformation Analysis of Ground and Soil Structure	101
Kato, Shigeru Dr. Eng.	Professor	Coastal Engineering, Coastal Disaster Mitigation	(1) Sediment Dynamics and Topographic Changes in Coastal and River-mouth Region (2) Natural Disaster in Coastal Zone	103
Shibusawa, Hiroyuki Dr. Eng.	Professor	Regional and Urban Economics Computational Economics	(1) Socio-Economic System Engineering (2) Evaluation of Urban and Regional Economic Systems (3) Input-Output Analysis	107
Fujiwara, Takao Doctor of Economics	Professor	Management of Technology	(1) Ecosystem of high tech start-ups (2) Investment analysis on social infrastructure Risk management of techno & social changes	109
Takayama, Kotaro Dr. Agr.	Professor	Agricultural Engineering	(1) Optimum design of intelligent greenhouse and plant factory for sustainable food production (2) Plant diagnosis robot and precise plant data for agricultural production (3) Real-time monitoring of photosynthesis and transpiration	110
Yokota, Kuriko Dr. Eng.	Associate Professor	Water Environmental Chemistry	(1) Water Quality Analysis (2) Material dynamics of water environment	104
Sugiki, Nao Dr. Environment and Information Studies	Associate Professor	Transportation Engineering, Infrastructure Planning	(1) Future Public Services Demand Estimation and Policy Evaluation (2) Landuse and Transport Model (3) Land-Use Micro-Simulation System	108
Matsuo, Kojiro Dr. Eng.	Associate Professor	Transportation Engineering, Infrastructure Planning	(1) Traffic Management that Make Use of Traffic Big Data (2) Local Public Transport Systems (3) Travel Behavior Analyses and Simulation	108
Matsuda, Tatsuya Dr. Eng.	Lecturer	Geomechanics, Applied Mechanics	(1) Study on the stability of seabed under the structure due to Earthquake and Tsunami (2) Fundamental study of the liquefaction in the ground due to sea wave	101
Tokairin, Takayuki Dr.Eng.	Lecturer	Urban thermal environment, Atmospheric environment	(1) Development of a numerical model for the evaluation of thermal environment in urban. (2) Application of computational fluid dynamics model for agriculture.	105
Okabe, Takumi Dr. Eng.	Assistant Professor	Coastal Engineering	(1) Monitoring coastal morphology and environments (2) Rip currents and beach-safety management	106

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RESEARCH OUTLINE 2020-2021

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