Tokyo University of Science

RIST TUS

Research Institute for Science & Technology

2025 / 2026

The Edge of Cross Disciplines




Information and Societal

Center for Fire Science and Technology

Research Center for Space System

Research Center for Multi-Hazard Urban

Division of Co-creative Design Innovation

Division of Smart Healthcare Engineering

Medical Data Science

Division of Digital Transformation

Statistical Science Research Division

Division of Architecture and Urban Cultural

Parallel Brain Interaction Sensing Division

Bio and Pharmacy

Nucleic Acid Drug Discovery Center

Research Center for Drug Discovery and Applied Sciences

Division of Superior Cells and DDS Development for Regenerative Medicine

Division of Biological Fluctuations

Division of Aging Biology

RIST TUS

Research Institute for Science & Technology

Structural Materials

Division of Implementation of Sustainable Technology in Society

Division of Composite Materials Engineering

Fundamentals

Division of Joint Research of Geometry

Division of Research for Photonics-

Division of Mathematical Modeling

Modern Algebra and Cooperation with

Division of Nano-quantum Information

Functional Materials

Water Frontier Research Center (WaTUS)

Carbon Value Research Center

Division of Colloid and Interface Science

Renewable Energy Science & Technology Research Division

Research Group for Advanced Energy Conversion

Division of Nanocarbon Research

Research Centers

These are research organizations that obtain the research funding needed for their activities from the national government, from local governments, and from industry and other sources, and that carry out initiatives that are strategically important for their research.

Joint Usage / Research Center

A nationally selected organization for joint use / joint research open to public and funded partially by MEXT.

Research Hubs

Core centers for cross-disciplinary and cross-institutional research, drawing on the collective expertise of the university's faculty.

Research Divisions

These are core research organizations comprised of researchers selected from within TUS and from outside the TUS in order to provide a synergistic effect. They develop interdisciplinary and cross-disciplinary"Only at TUS"research activities.

The Open Innovation Projects

These are research organizations that promote the co-creation of new value with the aim of contributing to society through both TUS and corporations.

Building a better future with

Innovation [SSI]

Disaster Prevention

Research

Regeneration Research

and Natural Science

Electronics Convergence

Engineering

Science and Technology

Message from the Director

The Research Institute for Science and Technology (RIST) is a cross-disciplinary research organization within the Organization for Research Advancement that was established in 2015 as a general research institution. Its forerunner, the Institute for General Research, was established in 1981. Education, research, and social contributions, the three pillars of Tokyo University of Science (TUS), are synergistically related, and the many cutting-edge integrated research projects conducted at RIST play a major role in training students to take a broad perspective and create social value.

As of April, 2025, five Research Centers, one Joint Usage/Research Center, two Research Hubs, twenty-one Research Divisions, one Open Innovation Project, and one Endowed Research Project are active at RIST. In all our activities, in addition to actively pursuing basic science in various academic fields, we promote close cooperation between disciplines and conduct innovative research by removing bureaucratic barriers both inside and outside the university. We began promoting research focused on environmental and energy issues even before the United Nations established its SDGs (Sustainable Development Goals) in 2015.

The four research centers, two research hubs, and one co-creation project that were launched in or after FY2021 and are currently active are outlined as follows.

The Water Frontier Research Center is the successor to the Water Frontier Science & Technology Research Center (WFST), which was established under a Ministry of Education, Culture, Sports, Science and Technology branding project in 2016 and launched in 2021. It was established as a research center to promote cutting-edge research related to “water interfaces,” the behavior of water on material surfaces, and to provide comprehensive services for cooperatively finding solutions to problems faced by industry.

The Space System Creation Research Center was established in 2021 from a reorganization of the Photocatalyst International Research Center (established in 2013) and the Space Colony Research Center (established in 2017). It has been building and expanding a human resource base consisting of next-generation space scientists and engineers capable of operating at the international level, and it has been developing technologies required for space habitation involving water, air, food, energy, and so on to create a virtuous cycle between earth and space with a focus on photocatalysis. It also conducts research and development on technologies necessary for humans to stay in extreme enclosed environments for prolonged periods, and it has been developing integrated systems that encompass the science and technologies necessary for creating future space planes as well as the legislation that governs commercial space transportation. For two years starting from 2022, the Research Center for Near-Future City Function by Terrestrial-Space Dual Development operated as an educational project (in the field of co-creation) under the Program on Open Innovation Platforms for Industry-Academia Co-creation (COI-NEXT) run by the Japan Science and Technology Agency (JST).

The Research Center for Drug Discovery and Applied Sciences was established in 2023 to carry on the Chemical Biology Division Supported by Practical Organic Synthesis, which had been active until 2022, through collaboration with researchers in the field of molecular biology. The goal of this Center is to create drugs by carrying out drug discovery research on new substances developed by TUS using our proprietary organic synthesis technology.

The Nucleic Acid Drug Discovery Center was launched in 2024 based on the research results of the Division of Nucleic Acid Drug Development, which was active until 2023. With a view to commercializing nucleic acid drugs, the center aims to create nucleic acid drugs for new target diseases through the establishment of new methods for synthesizing chemically modified nucleic acids, the development of artificial molecules that stabilize nucleic acid drugs, and the establishment of DDS and formulation methods.

One of the research hubs, the Carbon Value Research Center was developed in January 2022 with the aim of utilizing the science and technology of the university's faculty to develop essential chemical science and technology, such as artificial photosynthesis, that will contribute to carbon neutrality, through collaboration and joint research with external organizations. The Center is developing carbon value science and technology by pursuing the science and technology of green hydrogen production and the synthesis of useful materials utilizing carbon dioxide as a source of carbon.

The other research hub, the Research Center for Multi-Hazard Urban Disaster Prevention was launched in August 2023. The Center will create and implement a new science of urban disaster management that addresses multi-hazards in which hazard chains occur across time and space causing an increase in damage, through strong collaboration of disaster management researchers on various hazards and data science researchers. Through this Center, we aim to build a safe and security society in which no one is left behind in a sustainable and diversity-conscious manner.

With our Open Innovation Projects, we aim to contribute to the creation of new value by disseminating, both inside and outside the university, the results and findings of joint research involving both university faculty and companies. These research activities, which could be described as “knowledge co-creation”, are expected to produce solid research results in line with the medium-term R&D strategies of corporations and other participants. In 2022, a new Open Innovation Project, the Research ＆ Development Platform of Functional Green Building Materials, was launched in collaboration with Shimizu Corporation. This project promotes research and development aimed at the social implementation of environmentally friendly architecture.

Through collaboration on research across Research Centers, Research Hubs, and Research Divisions, RIST aims to enhance the fluidity and mobility of faculty personnel. By taking advantage of appealing research environments that are rich in vitality and unity, we aim to foster highly creative, diverse human resources who will lead the next generation of society, and to become an international hub for interdisciplinary research. We will also create new academic trends and produce visible research outcomes unique to Tokyo University of Science, which we have named “TUS SciTech”.

Dr.Hiroshi Nishihara

Director
Research Institute for Science and Technology
Tokyo University of Science

Science

INDEX

Only at TUS

Functional Materials

Established: April, 2021

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Water Frontier Research Center (WaTUS)

Objectives	To discover principles and mechanisms of interaction between water and materials surface including how to control them by interdisciplinary research collaboration.
Future Development Goals	To promote advanced research on water interface by collaboration, and to form a research organization offering one-stop service for water science and technology.

Director
Professor,
Department of Mechanical Engineering,
Faculty of Engineering
Masahiro Motosuke
Ph.D

Water is one of the most familiar substances but there are many unexplained issues, especially around the interface with materials surface. We, WaTUS, tackle all research relating to “water interface” by interdisciplinary approaches and aim to provide practical solutions to industries as well.

Core of excellence for research and development of “Water Interface”

Background

“Water” is one of the most essential substances which supports our basis of lives in various forms, and we, not only the human being but also all the life cannot survive without the benefit of water. It plays crucial roles to transfer oxygen, nutrition and waste, and to assist structuring and fulfilling cells, tissues and organs. Additionally, in industrial fields, it is of importance in drinking, cleaning, immersion, coating and so on. So, it is no exaggeration to say that water is the longest and most frequently used substance in our history. However, there are still plenty of unexplained issues in its properties, performance and function; especially, interaction between water and materials’ surface, namely “water interface”, is generally very complicated and particularly difficult to be fully understood (Fig. 1).

To tackle these issues, a former research center, Water Frontier Science and Technology Research Center (W-FST) was launched on November 2016. Through research activities of W-FST, it is found that the topic of “water interface” is crucial and is highly needed both for academics and industries. Then we concluded to keep our continuous challenges and progresses to these issues by expanding and deepening the fields. Then, the successive research center “Water Frontier Research Center (WaTUS)” has been established after the reorganization on April 2021 to highly promote our research activities. The logotype of our center (Fig. 2) represents “water” encompassing its molecule, nature of continuum, and interfacial behavior.

Our mission

We, WaTUS, aims to pursue leading-edge research and developments relating to “Water Interface” with multi-disciplinarily collaborative research. Our mission is to perform following missions (Fig. 3);

(i) Pursuit of state-of-the-art science and technologies of water interface by collaboration and technical excellence
(i i) Establishment of international research core of excellence
(i i i) Provision of “one-stop service” of water research for industries
(i v) Visualization of TUS through our research activities

Formation of research and development hub for “Water Interface” through our research means to create the place where researchers all over the world can join and to establish research organization which can provide practical solutions to industries.

To carry our above-mentioned missions, highly intensive collaborations of fundamental research and technical developments with researchers inside and outside of the center become a key.

Research organization of WaTUS

WaTUS promotes interdisciplinary collaborative research to achieve our goals. We consist of matrix-based research units with approaches (Materials development, Measurement & Analysis, and Theory & Simulation) and targets (Materials & Water, Life & Water, and Environment & Water). In this 3 x 3 matrix-based research unit (Fig. 4), our center encourages researchers who develop novel materials with high functionality, ones who develop cutting-edge measurement and analysis techniques, and ones who perform advanced theoretical consideration and simulation, to perform intensively flexible collaborative studies expecting synergetic effects. Also, more flexible style of collaboration involving ones outside of the center are appreciated in this center.

Materials and Water : this unit pursues research and development considering relation between water and materials from atomic to macroscale.

Life and Water : this unit pursues research and development contributing to human beings and medical diagnostics or medical and biological engineering.

Environment and Water : this unit pursues research and development for environment and industries. Earth science and energy conservation is also included in this unit.

In addition, events such as the Water Frontier Symposium and evening seminars are held to promote the output of research activities and enhance mutual exchange among related researchers. We also disseminate our research activities and achievements to the public through conferences and exhibitions.

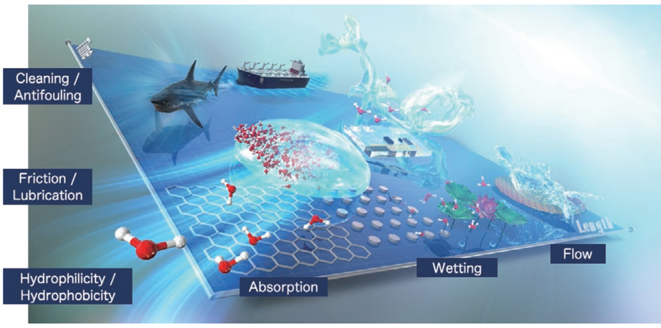

Fig. 1 Various phenomena and applications of “Water Interface” from atomic/molecular scale to macroscale

Fig. 2 Logo of Water Frontier Research Center (WaTUS)

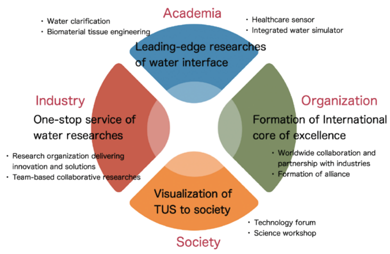

Fig. 3 Strategies of WaTUS

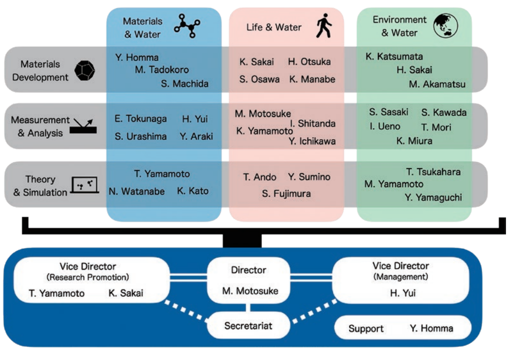

Fig. 4 Matrix-based research units in WaTUS

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Carbon Value Research Center

Objectives	We aim at developing technologies based on basic researches for green H_2 production and CO_2 utilization by converting it into valuable products.
Future Development Goals	We will contribute to achievement of carbon neutral and solution of resource, energy and environmental issues we are globally facing.

Director
Professor,
Department of Applied Chemistry,
Faculty of Science Division I
Akihiko Kudo
Ph.D. (Science)

For a carbon neutral society, it is indispensable to develop technologies utilizing CO_2 as a carbon source for production of valuable compounds. Our CV center study science and technology using photocatalysts and batteries that are our strong research fields for the CARBON VALUE that contributes to the solution of resource, energy, and environmental issues.

Carbon value beyond carbon neutral ~ Green H_2 production and CO_2 utilization ~

Background of the establishment

Due to the concern about climate change and global warming, the movement toward decarbonized society is being accelerated globally. In October, 2020, Japanese government announced that Japan would achieve "Carbon neutral" (i.e., net emission of greenhouse effect gas is zero in total) by 2050. The Green Growth Strategy, which connects challenges for carbon neutral with an economical and industrial growth, was formulated. In 2021, the summit among university's presidents on the contributions toward carbon neutral was held and, based on the discussion done here, "University Coalition for Carbon Neutrality" was established.

Based on the social background mentioned above, our university ranked research fields relating to "carbon neutral" as a strategical key area, and then "Carbon Value Research Center", where researchers on artificial photosynthesis, electrochemical CO_2 reduction, secondary batteries, hydrogen usage gathered, was launched in January, 2022.

Aims of our CV center

The CV center develops original and essential technologies for CARBON VALUE by which CO_2 is converted to valuable products as a carbon source through collaborations. The CV center aims to solve the resource, energy, and environmental issues by social implementation of the total system based on our basic research through the carbon value technology.

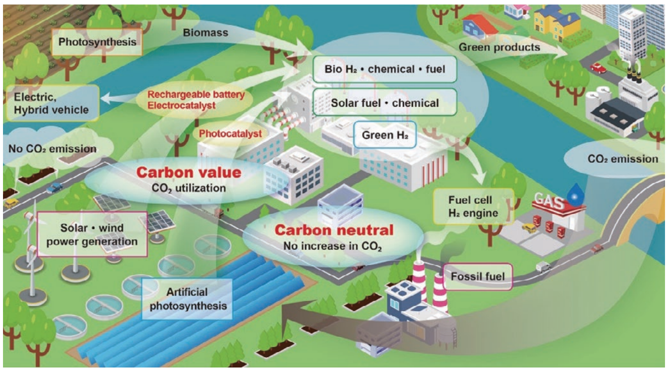

Fig. 1 Future vision that our CV center aims

Research system of CV center

About 10 researchers from Tokyo University of Science belong to the CV center. The researchers collaborate with each other and also outside researchers. We work on developments of photocatalysts and semiconductor photoelectrodes for artificial photosynthesis, electrocatalysts for electrochemical reduction of CO_2 using a renewable electricity, and secondary batteries for storage of the renewable electricity, and minimization of platinum in a fuel cell for usage of green hydrogen. In addition, CO_2 storage and adsorption, and measurement technology are also studied. The collaboration will be expanded to accelerate the research in the future.

Main research topics in our center

- **Manufacturing of highly-valuable products by CO_2 reduction**

To manufacture highly-valuable products (i.e., gasoline, jet fuel, olefin, and alcohol) from CO_2 as a carbon source, we work on the development of CO_2 reduction technologies. CO_2 reduction by artificial photosynthesis using sun light, H_2O and photocatalysts/semiconductor photoelectrodes, and an electrochemical reaction of CO_2 with renewable electricity are studied for the direct CO_2 reduction.

- **Green hydrogen production with renewable energy**

Hydrogen is also an essential material from a perspective of carbon neutral. Because hydrogen burns without emitting CO_2, it is attracted as a clean energy source. In addition, hydrogen is indispensable as a basic material in a chemical industry. Today, an industrial production of hydrogen is based on a steam reforming method, in which fossil fuels (i.e., petroleum, natural gas, and coal) are reacted with water at high temperature. Therefore, consumption of fossil fuels and emission of CO_2 are still remaining. To achieve carbon neutral, technological development of green hydrogen production from water with renewable energy is desired. Our CV center conducts the research on artificial photosynthesis in which green hydrogen is produced by water splitting using a photocatalyst that is the strength of our university. The green hydrogen can be utilized for a carbon value technology such as hydrogenation of CO_2 to produce valuable compounds in a chemical industry.

- **Development of batteries supporting carbon neutral society**

When green hydrogen is considered as a clean energy, the application to a fuel cell technology becomes important. Our CV center works on reduction in an amount of platinum and even platinum free in fuel cells, because platinum is rare and expensive. A secondary battery to store renewable electricity is also a key technology for green hydrogen production and CO_2 reduction by electrochemical reactions. Developments of not only lithium but also sodium ion battery are important from a view point of stable supply of the alkaline metal resource. The secondary battery contributes to carbon neutral in an electric vehicle.

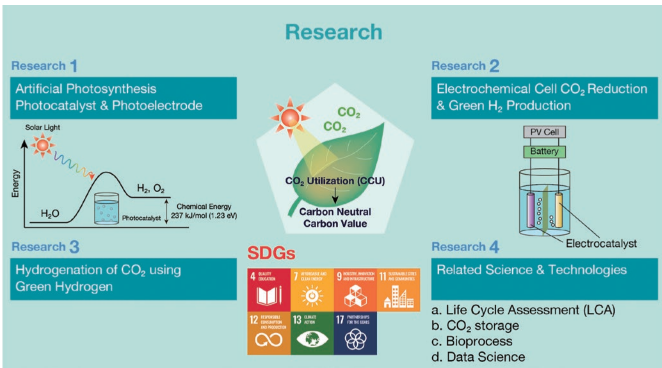

Fig. 2 Research topics in our center

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Division of Colloid and Interface Science

Objectives	To play a leading role in colloid and interface science both in Japan and the world.
Future Development Goals	Promoting researches on "experimental and theoretical elucidation of the dynamic behavior of interfaces" and "construction of new functional interfaces" in collaboration with different fields such as chemistry, physics, biology, and mechanical engineering.

Director
Professor,
Department of Industrial Chemistry,
Faculty of Engineering
Mineo Hashizume
Dr. Eng.

It may be said that knowledge in the field of surface and interface science is necessary to understand all tangible "things". We aim to utilize the strengths of the group of experts in various fields related to interface science, not only to connect the results obtained to the development of next-generation materials, but also to pioneer new academic fields.

Basic and applied researches on phenomena at various interfaces

Interface science is a field of study that deals points, lines, surfaces, and volumes (spaces), and uses geometry such as dimensions, sizes, shapes, boundaries, front and back, and connectivity as elements, and comprehensively systematizes these phenomena. In particular, interface science deals mainly with "particles" (all three dimensions are colloidal dimensions), "lines (wires)" (two dimensions are colloidal dimensions), and "membranes" (only one dimension is colloidal dimension), where at least one of the three dimensions is a colloidal dimension (1 nm - 1 µm), making it a unique academic field that deals with a wide range of research topics. This division views the interface as a "spatio-temporal functional expression field that integrates different fields". Starting from the verification and demonstration of conventional interface theories, we aim to create new physical properties, functions, and theories, and ultimately develop unprecedented novel functional materials. Specific research targets are diverse, include soft (mainly organic) materials, hard (mainly inorganic) materials, nanomaterials, and biomaterials. We promote projects from both basic and applied perspectives.

Tokyo University of Science has traditionally had laboratories specializing in "interface science" on each campus. The Division of Colloid and Interface Science was established in 1981 by the researchers specializing in this fields, and has been active as a cross-campus and cross-departmental research center, and its activities are widely recognized in Japan and around the world. The first Director, Professor Kenjiro Meguro (Faculty of Science Division I) was succeeded by Professor Tamotsu Kondo (Faculty of Pharmaceutical Sciences), Professor Minoru Ueno (Faculty of Science Division I), Professor Kijiro Konno (Faculty of Engineering), Hiroyuki Ohshima (Faculty of Pharmaceutical Sciences), Professor Takeshi Kawai (Faculty of Engineering). Since 2018, Professor Hideki Sakai (Faculty of Science and Technology) has led the division as the director. In the meantime, the division had been shifted to the Center for Colloid and Interface Science during FY 2008-2012, because a project application was accepted as the MEXT Program for the Development of Strategic Research Bases.

We would like to introduce our recent activities. In FY 2013-2017 (Director: Prof. Kawai), we divided the research subjects of interface science into two major areas, soft and hard interfaces, and worked to deepen our understanding of dynamic interface phenomena. The soft and hard interfaces here are different from the general definition that distinguishes between then by the substances that make up the interface. A "soft interface" is a dynamic interface in which the molecules (atoms) forming the interface are constantly replaced during normal observation time, such as micelles (molecular assemblies) of surfactants. On the other hand, a "hard interface" is a rigid interface in which there is (almost) no replacement of surface constituent molecules (atoms), such as metal nanoparticles. The division members were divided into groups dealing with "soft interfaces" and "hard interfaces", and each interface was further classified into one-dimensional, two-dimensional, and three-dimensional interfaces. We promoted accurate understanding of the phenomena at the interface and "manufacturing" research using interface science (Fig. 1). The researchers who conduct research on the theme of interface science from the aspects of chemistry, physics, bioscience, theoretical chemistry, and other fields have collaborated to achieve synergistic results, especially with regard to "stimulus-responsive interfaces that respond to external stimuli such as light, temperature, and electricity".

In FY 2018-2022 (Director: Prof. Sakai), the researchers who specialize in physics, mechanics, pharmacology, theoretical science, and measurement science joined the membership, which was previously mainly consisted of chemists. With the support of advanced measurement science and theoretical science, we have set a new goal of conducting "accurate understanding of the interface dynamics/reaction mechanism at the interface" regarding "manufacturing using interface science". Especially in the fields of "advanced interface measurements", "stimulus-responsive materials", and "biofunctional interfaces", we were able to achieve many results, including collaborations among members with different specialties. We also strengthened our ties with

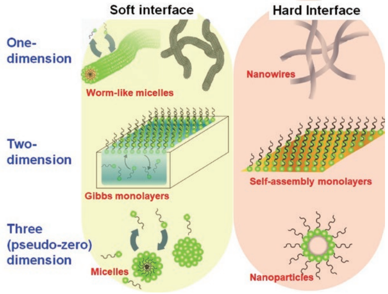

Figure 1

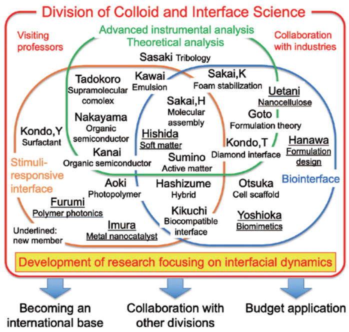

Figure 2

industry by actively holding seminars by corporate researchers. In addition, we contributed to public outreach, such as by cooperating with open colleges.

From FY 2023, together with the new members, we will promote research development with a focus on "dynamics at interfaces" as the most important issue, based on the achievements accumulated by the division so far. For example, in understanding the dynamic functions of materials formed by molecular assemblies, we will understand the linkage of "dynamics of molecules" → "dynamics of molecular assemblies" → "dynamics of functions of molecular assemblies" and link this knowledge to the "creation of functional materials" based on new ideas. In addition, we will promote activities aimed at turning our university and this division into an international research base in interface science research, through active dissemination of our results overseas, participation in international conferences, and collaboration with overseas universities.

Regarding the operation of the division, we have set "advanced interface measurements/theoretical analyses", "stimuli-responsive interfaces", and "biointerfaces" as priority themes, and promote research development with an awareness of collaboration between members while utilizing their specialties (Fig. 2). In particular, we will promote further collaboration between experts in both materials fabrication and theory in order to understand and utilize dynamics at interfaces as described above. In addition, we will work on creating a system that feeds back the results obtained in one material system to other systems and utilizes them. We will develop the results of "only at TUS", and integrate collaborations within the group, and in the future, we will open up new research areas by the entire division and lead to the acquisition of external research funds. We will also continue the cooperation with industry that we have cultivated so far, and continue activities such as cooperating with open colleges. As for international activities, we aim to effectively coordinate the efforts of individual members so far and develop the division into an international base. We will continue the activities such as research presentations in English by graduate students at the summer symposium. We also start activities to publish an English book on dynamics of interfaces.

Established: April, 2020

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Renewable Energy Science & Technology Research Division

Objectives	To propose a foundation for stable and low-cost power supply/management, and to activate and promote research, development and education of renewable energy utilization technology at TUS.
Future Development Goals	Through active interaction among the Division members from different backgrounds, we will promote both internal and external joint research to create novel concepts for renewable energy technology.

Director
Professor,
Department of Electrical Engineering,
Faculty of Science and Technology
Mutsumi Sugiyama
Ph.D.

In response to the trend of times, this division is created by reorganizing the Photovoltaic Sci & Tech Division established in 2010. We are composed of members from different fields of expertise in various renewable energy devices and systems. We will develop unique renewable energy and integrated systems/infrastructures such as solar-wind-biomass power generation.

Research and development on renewable energy and systems such as solar, wind, biomass etc.

Global warming is one of the most serious challenges facing humanity in the 21st century. To address this issue, it is essential to shift our energy systems away from dependence on fossil fuels such as coal, oil, and natural gas, and toward renewable energy sources such as solar, wind, and biomass. While conventional power supply systems primarily relied on nuclear and thermal power plants to provide a stable energy supply, today's energy landscape has become far more complex. A wide variety of renewable energy sources are now connected to the power grid, and their output often fluctuates due to weather and seasonal factors. As a result, the operation and management of energy systems and infrastructure has become increasingly sophisticated and critical. Moreover, challenges related to cost and energy conversion efficiency cannot be addressed by conventional technologies alone. In response to these societal needs, the Division of Renewable Energy promotes a wide range of research activities aimed at supporting the adoption and stable operation of renewable energy technologies. Our key research objectives include:

(i) Development of cost-competitive power generation materials comparable to fossil fuel-based systems.
(ii) Advancement of power management technologies that efficiently integrate multiple types of renewable energy sources.
(iii) Creation of next-generation energy technologies through novel materials and system designs.
(iv) Promotion of collaborative research with both internal and external institutions.

Through these initiatives, we aim to contribute to the realization of a sustainable and resilient energy future.

Members of the Division

The Division consists of 20 members listed as follows, who all have different fields of expertise in physics, chemistry, electrical power, electronics, materials and management. We are gathered together to deepen the discussion on the development of renewable energy utilization technology and aim for major developments through synergistic effects.

Table Members of Renewable Energy Science & Technology Research Division

Name	Job title	Affiliation of key role	Main research field
Mutsumi Sugiyama	Professor/ Director	Faculty of Science and Engineering, Department of Electrical Engineering	Semiconductor material engineering / Thin film solar cell
Takashiro Akitsu	Professor	Faculty of Science Division II, Department of Chemistry	Coordination chemistry / Photofunctional fuel cells of organic/ inorganic hybrid materials
Yuzuru Ueda	Professor	Faculty of Engineering, Department of Electrical Engineering	Electricity and energy engineering / Photovoltaic system
Morio Nagata	Professor	Faculty of Engineering, Department of Industrial Chemistry	Organic photovoltaic cell / Artificial photosynthesis
Junji Kondoh	Associate Professor	Faculty of Science and Engineering, Department of Electrical Engineering	Photovoltaic power system / Wind power generation / Power conditioning system
Noboru Katayama	Associate Professor	Faculty of Science and Engineering, Department of Electrical Engineering	Fuel cells / Hydrogen storage / Diagnosis for energy devices
Takashi Ikuno	Associate Professor	Faculty of Faculty of Advanced Engineering, Department of Applied Electronics	Surface and interfaces / Photovoltaic devices / Nanogenerators
Tomoyuki Haraguchi	Junior Associate Professor	Faculty of Science Division II, Department of Chemistry	Coordination chemistry / Dye sensitized solar cell
Yuka Takagi	Junior Associate Professor	Faculty of Science and Engineering, Department of Electrical Engineering	Ferroelectric Materials, Energy Storage, Metamaterials
Daisuke Nakane	Assistant Professor	Faculty of Science Division II, Department of Chemistry	Coordination chemistry / Bioinorganic chemistry / Catalytic chemistry
Cui Jindan	Assistant Professor	Faculty of Engineering, Department of Electrical Engineering	Photovoltaic system / Energy management system
Kohei Terashima	Assistant Professor	Faculty of Engineering, Department of Architecture	Solar heat utilization / Photovoltaic system
Yuya Takekuma	Assistant Professor	Faculty of Engineering, Department of Industrial Chemistry	Organic photovoltaic cell, Materials informatics
Yukai Wang	Assistant Professor	Faculty of Science and Engineering, Department of Electrical Engineering	Power system stability analysis, Smart grid, Countermeasures for low-inertia power systems
Yoichi Hirata	Visiting Professor	Suwa University of Science, Faculty of Engineering	Photovoltaic power generation system / Wind-power generation / Micro grid
Yasuyuki Watanabe	Visiting Professor	Suwa University of Science, Faculty of Engineering	Molecular electronics & Bioelectronics / Photosynthetic engineering
Sho Shirakata	Visiting Professor	Ehime University	Semiconductor material engineering / Thin film photovoltaic cell, CIGS solar cell
Satoshi Ohnishi	Visiting Researcher	National Institute for Environmental Studies	Energy economics / Low carbon city management
Ayaka Kanai	Visiting Researcher	Nagaoka University of Technology	Thin film photovoltaic cell / Optical Properties of Semiconductor
Daisuke Kodaira	Visiting Researcher	University of Tsukuba	Smart grid / Energy storage system management / PV generation forecasting

Research Activities

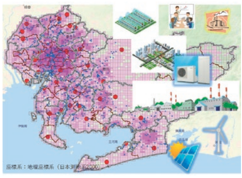
As a research and development hub for renewable energy technology, we will realize novel renewable energy materials and power generation systems through vertical integration of technologies, as well as educate the next generation of researchers and disseminate the technology to society. Specifically, the following activities will be carried out:

• Renewable energy materials group:

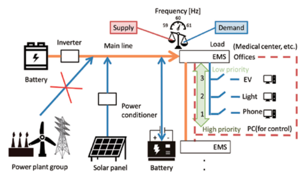
(i) Proposal of ultra-high efficiency power generation device by tandem configuration of thin film solar cells.
(ii) Establishment of hydrogen production technology using solar cell thin films and charging technology such as supercapacitors.
(iii) Development of ultra-low-cost solar and fuel cell materials and manufacturing methods, and examination of their common basic technology.

• Energy management group:

(i) Development of technologies of failure diagnosis, remote diagnosis, power generation prediction and AI utilization for energy loss control.
(ii) Integration of smoothing technology development for wind × solar power generation and power storage technology such as batteries and flywheels.
(iii) Solar matching for agriculture and application of renewable energy technologies to smart houses.



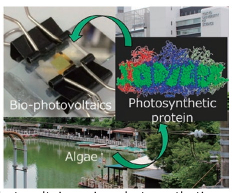
Design and evaluation on renewable energy system utilizing regional characteristics



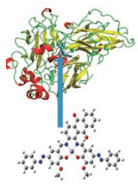
Renewable energy recovery system assuming a blackout due to a disaster

Monitoring of output power from multiple small wind turbines, and a prototype of a flywheel energy storage system

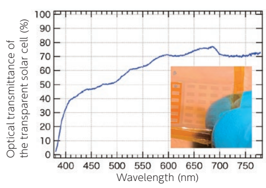
Polymer electrolyte membrane fuel cell and automatic humidity control system for supply air



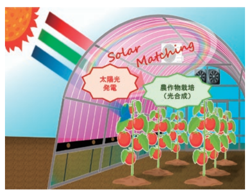
Bio-photovoltaics using photosynthetic proteins from algae



Photofunctional metal complex and catalytic enzyme for biofuel cell



Transparent solar cells fabricated on bio-derived transparent film substrates



Solar matching (Co-developing technology both photovoltaics and photosynthesis)

Figs. Research theme of Renewable Energy Science & Technology Research Division

gunji@rs.tus.ac.jp

Research Group for Advanced Energy Conversion

Objectives	This research aims at the development of novel "Only at TUS" energy systems based on SDGs by establishing elemental know-how of the systematic material-to-system research.
Future Development Goals	Practical use of secondary cells and fuel cell systems, building of efficient thermoelectric conversion systems, and the development of new light-reactive materials.

Director
Professor,
Department of Pure and Applied Chemistry,
Faculty of Science and Technology
Takahiro Gunji
Dr. Eng.

An efficient, new energy system based on Sustainable Development Goals (SDGs) is needed. In this group, specialists in chemistry, mechanical engineering, electronic engineering, and system engineering come together to develop and test a new, efficient system for the generation, storage, and utilization of clean energy by "Only at TUS".

The development of a system for the generation, transformation, storage, and utilization of energy by "Only at TUS"

The development and use of highly efficient energy systems are a matter of urgency, because the exhaustion of petroleum resources and the resultant economic instability are a call to action. The problem is conspicuous in our country since it depends heavily on the import of petroleum. Studies are being carried out in the Division of Ecosystem Research and the Advanced EC Device Research Division, on the development and testing of an electrochemistry device for commercialization purposes.

The United Nations has set 17 targets as global SDGs, and these targets are indispensable for future technical development. The following two relate to our research group:

SDG 7: "Ensure access to affordable, reliable, sustainable, and modern energy for all."

SDG 12: "Ensure sustainable consumption and production patterns."

In our research group, we will study the development and environment-friendly use of new energy, following a product of the Advanced EC Device Research Division, on electrochemical devices, hydrogen energy, heat energy, and light energy.

Our research group consists of two teams: the research team for energy transformation and the research team for energy storage. The research team for energy transformation takes charge of the development of technology and materials for the generation and transformation of energy. The research team for energy storage takes charge of the development of technology and materials on the storage and utilization of energy. Both teams cooperate mutually with the aim of building a system for the generation, transformation, storage, and utilization of energy. When an advanced energy device is created, its development is accelerated by cooperation between group members beyond the limit of their specialty and research fields, to overcome current problems and improve the fundamental knowledge level among group members, furthering collaboration.

Based on "Only at TUS", a researcher on the front line participating in this research should be able to accumulate information and technological know-how from scholars in the various fields and achieve high technical development and originality.

A characteristic feature of our research group is the inclusion of the "Sustainable Energy Systems and Materials" course from the Graduate School of Science and Technology curriculum. The participation of both students and teachers is indispensable for the development of new materials and systems. We plan to hand-down technology and knowledge from generation to generation through research proceeds of students who carry the science and technology of the next generation, and we plan for an aggressive exchange between students and teachers in order to achieve the goal of this research group early.

Research on energy conversion

Based on outcomes from the Division of Ecosystem Research and the Advanced EC Device Research Division, the development of highly efficient, environment-friendly organic synthetic processes, and highly sensitive and functional light-reactive polymers are advancing. One of the aims of this research group is the development of new catalytic reactions for the highly selective reduction of carbonyl groups to methylene groups, to be used in applications for organic compounds made up of elements other than oxygen. Another objective of this group is the development of a polymer that responds to multiple forms of energy, by designing a polymer that reacts stepwise to light and heat. In addition, high-speed material screening will be carried out using a combinatorial experimental method.

The generation and utilization of bio hydrogen will be proposed in relation to SDG 12, based on life-cycle assessment (LCA). A system consisting of the generation of hydrogen from waste wood, its purification, storage, and use in the generation of electricity through fuel cells, as well as in charge storage in capacitors will be built and evaluated based on LCA.

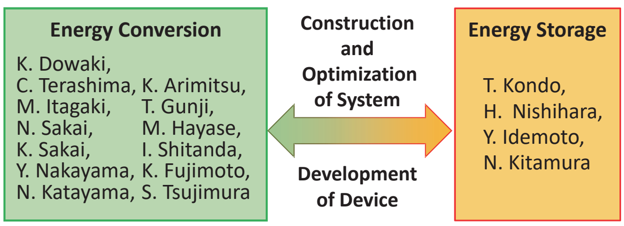
We will manufacture a printable wearable biofuel cell with paper and transfer sheet. For example, a fuel cell that uses organic material in urine as fuel can be used for urine detection (Elderly care, health maintenance). By using lactic acid in sweat as fuel, one can monitor the health of athletes. In order to make the wearable device, we prepare mesoporous carbon materials suitable for use as enzymes, and then develop a printable paper device using the carbon as the electrodes.

In the development of the polymer electrolyte fuel cell, we synthesize a metal-complex-supported conductive diamond as the electrode catalyst and develop a novel silicon-based polymer as the electrolyte.

Research on energy storage

We aim to prepare high-capacity electrodes with structures that are well controlled at atomic-to-micro levels and perform high-throughput material screening, and device-oriented electrochemical and structural analyses. For optimization of nano and micro structures of the electrodes, we will prepare the powder using liquid-phase synthetic methods like solvothermal synthesis, and then perform a surface coating on the pristine powder.

Atomic configurations of the materials will be simulated computationally for theoretical screening. In addition, we will investigate degradation mechanisms of the batteries under various operation conditions, by means of selected electrochemical techniques such as in-situ analyses of the atomic and electronic structures using neutron and synchrotron X-ray sources and in-situ electrochemical impedance spectroscopy (EIS) by cooperating with energy conversion group. This strategy enables us to produce a customized and appropriate device design based on a working condition and a purpose of use.



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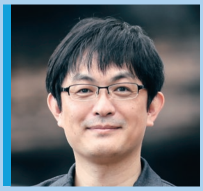
Division of Nanocarbon Research

Objectives	To investigate novel properties relating to carbon nanotubes and graphene, and to develop material sciences utilizing the nanospace of nanotubes and the interaction between nanotubes and various molecules.
Future Development Goals	To promote advanced researches on nanocarbons based on tight and highly active collaborations of division members.



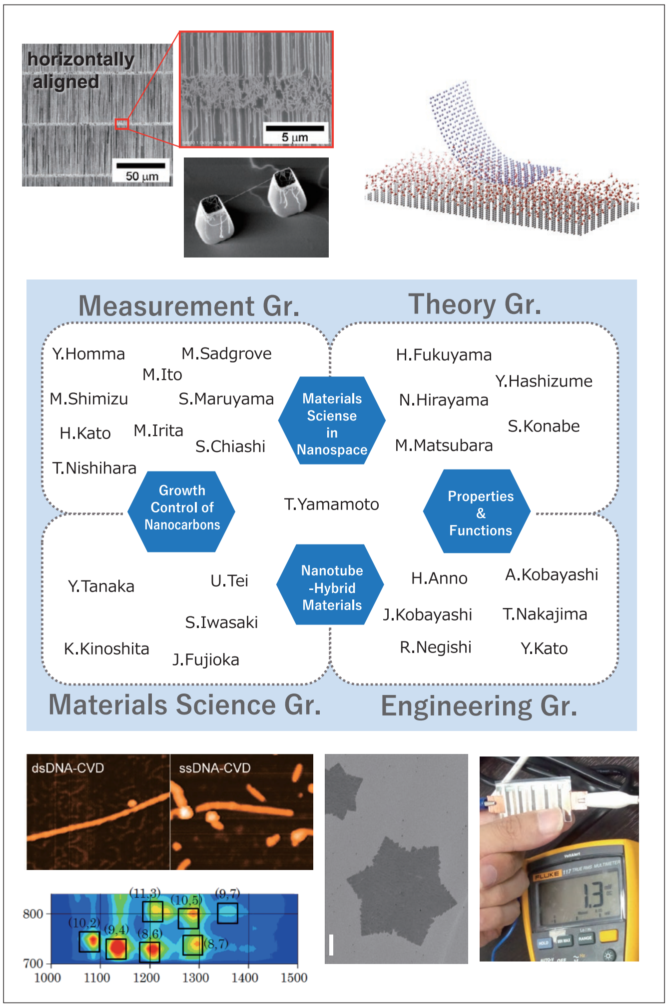
Director
Professor,
Department of Physics,
Faculty of Science Division I
Takahiro Yamamoto
Ph.D.

Nanocarbon is an active research field with increasing publications. Our research division is unique in that advanced researchers of nanocarbons are getting together and perform researches with wide scopes. In particular, tight collaborations between theorists and experimentalists are our strength. We are aiming at creating new fields and technologies based on our researches.

Research and development on nanocarbon materials

Carbon nanotubes and graphene are low dimensional materials (with linear and flat shapes, respectively) composed of networks of 6-members rings (honeycomb structure). Owing to strong covalent bonds of carbon atoms, they have excellent mechanical strength and chemical stability enough to sustain the monolayered structure in a free space. Furthermore, they exhibit properties peculiar to the geometrical configuration and low dimensionality, which cannot be expected for three-dimensional crystals. As you can see from the fact that the Nobel Prize in Physics 2010 relates to graphene, nanocarbons such as carbon nanotubes and graphene are extensively studied in basic science. In the future, nanocarbons are expected to play a main role in an industrial revolution as iron and silicon did in the Industrial Revolution and the information technology revolution, respectively.

The Division of Nanocarbon Research covers topics of nanocarbons from fundamental to applied researches by collaboration of experts in theoretical and experimental condensed matter physics, electrical engineering, thermal engineering, and biophysics. We expect synergy effects by enhancing mutual discussion and exchange of ideas in the division.



Research topics

Materials Sciences in Nanospace

- We use an individual single-walled carbon nanotube as a well-defined nanospace, and study the interactions between nanotubes and molecules such as water and alcohol by optical spectroscopy, electron microscopy and molecular dynamics simulations. Thereby, we elucidate the structure and phase of the molecules in the nanospace. We also study the interaction between nanotubes and polymers, aiming at application of polymer-nanotube composites.
- We regard systems composed of nanotubes with adsobates or defects as extended composites, and study the basic properties by first-principles electronic state calculations and model calculations.

Nanotube-Hybrid Materials

- We study structural properties of composites composed of nanotubes and biomolecules (DNA, protein). Specifically, we fabricate biodevices with nanotubes functionalized by DNA, and examine whether the structural properties of the biomolecules are retained, and whether the molecular recognition function is retained.
- We theoretically investigate the host-guest interactions of the nanotube/biomolecule composites, and clarify the effect on the properties of the composites.

Growth Control of Nanocarbons

- We develop techniques for precise structural control of nanocarbons based on the various nanotube synthesis techniques such as vertically-aligned growth on silicon and silica substrates and horizontally-aligned growth on quartz substarte.
- We study novel synthesis methods of nanocarbons utilizing arc discharge by changing the discharge ambience, electrode materials, etc. We also study novel methods for graphene synthesis.

Properties and Functions

- We develop the physics of energy conversion based on nanocarbons and its application.
- We establish the basic science for nanocarbon-based paper electronics.

Structural Materials
Established: April 2023

hiroshi@kobalab.com

Division of Implementation of Sustainable Technology in Society

Objectives	The objective is to provide concrete solutions to realize a sustainable society by creating new products which create new value.
Future Development Goals	Promotion of NEDO projects, shared use of living labs, to launch 1 new product/year, to establish 1 startup/year, and to apply for 3 patents/year.

Director
Professor,
Department of Mechanical Engineering,
Faculty of Engineering

Hiroshi Kobayashi
Ph.D

The true longing of engineering is to “make something useful.” The social implementation of university-originated products mainly consists of publishing findings in papers and commenting on them as academics. Whereas, in engineering, I think that we should implement it as a real object and even see how it’s used and useful. This division aims to be a role model for the social implementation.

Commercializing university-originated medical, welfare, and life support technologies and energy ones that will realize a sustainable society.

First goal is social implementation

This division places a strong emphasis on practicality and realization, and aims to go beyond papers and commercialize technologies that create new value that will open up new markets. To that end, it combines the component technologies of its members, actively collaborates with external organizations, and conducts collaborative research and development with an awareness of concrete applications as an exit point. As a result, it will commercialize products and launch startups, and actively promote the social deployment of new university-originated technologies.

To date, it has launched startups, commercialized products, and filed patent applications every year, and was selected for NEDO’s “Recycling Technology Research and Development Project to Build a Highly Efficient Resource Circulation System.” It has also created a living lab environment and begun using it as a shared facility across organizations.

Startup Establishment

Two starups have established so far: Core Health Co., Ltd. in 2023 and Beyond Optical Technologies Co., Ltd. in 2024, and have been certified as university-based startup companies.

[CoreHealth Co., Ltd.]

Founded by Prof. Hiroshi Kobayashi in September 2023. The lumbar support device Muscle Suit, sold by Innophys, a university-certified startup also founded by Kobayashi in 2013, is sold in 22 countries around the world as an assist device. On the other hand, by simply wearing the Muscle Suit and moving for about one minute, it can be used for “healthcare” by increasing the range of motion of the hip joint, correcting the tilt of the pelvis, opening the rib cage, and resulting in improved posture and easier walking, as well as training inner muscles that are not easily strengthened. CoreHealth Co., Ltd. aims to popularize healthcare that can only be achieved with such muscle suits, and as of June 2025, 18 units are being used in nine facilities nationwide.

[Beyond Optical Technologies Co., Ltd.] Fig.1

Founded by Prof. Yutaka Takemura in November 2024. Certified as a venture company spun out of Tokyo University of Science. Established to widely return research results to society. Utilizing near-infrared hyperspectral imaging endoscope technology developed by Takemura’s research group ahead of the rest of the world, it has become possible to non-destructively inspect and visualize deep tissues and foreign objects that could not be seen by the human eye until now. This innovative technology aims to provide new value to medical and industrial sites and realize a safe and secure future through non-destructive inspection technology. The company utilizes optical technology to provide equipment and technology that enables non-destructive inspection and image analysis using visible light and near-infrared hyperspectral imaging for a wide range of environments and objects, from narrow spaces and objects 1 mm square to structures of about 1 m, and is expected to be applied in a wide range of fields.

Living Lab: Fig.2

A simulation laboratory equipped with a full range of living environments that can be used in real life, including a wheelchair-accessible kitchen, living room, dining room, bedroom, bathroom, toilet, and stairs. Motion capture equipment is also installed, and it is being used as a shared facility for research by members of this department (measuring daily activities, verifying the operation of life support robots, etc.). It is also used for industry-academia collaboration (verifying and advising on developed nursing robots) and education (practical classes such as an introduction to design thinking).

NEDO: “Research and development project for recycling technology to build a highly efficient resource circulation system”: Fig. 3

Kobayashi, Hashimoto, Takemura, Arai, Hayashi, Hayakawa, Wada, and Nagano are participating. This is a 1 billion yen project (responsible part) for five years starting from FY2023, and we are developing a fully automated device that picks up small waste home appliances piled up in scrap yards, sorts them, and recovers resources. So far, the project has progressed according to schedule and has been highly evaluated.

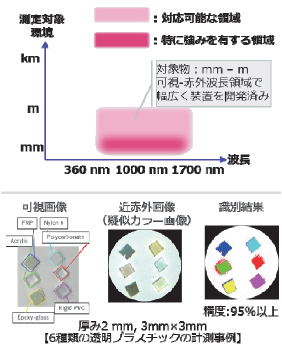


Fig.1 Near-infrared hyperspectral imaging

Fig.2 Living laboratory

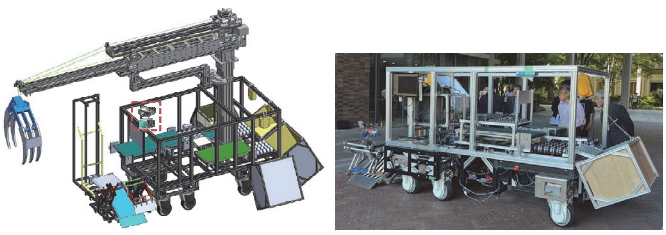


Fig.3 Small-sized waste home appliance fully automatic identification vehicle

Structural Materials
Established: April 2023

rmatsuza@rs.tus.ac.jp

Division of Composite Materials Engineering

Objectives	Experts in various specialized fields, such as molding process, fracture mechanics, material science, and numerical simulation, collaborate to achieve rapid technological development, with a focus on composite materials.
Future Development Goals	The division aims to be a center of research and development where the results of basic research at the university are used as seeds to promote the development of applications in collaboration with industry.

Director
Professor,
Department of Mechanical and Aerospace Engineering,
Faculty of Science and Technology

Ryosuke Matsuzaki

Doctor of Engineering

The division is equipped with an advanced experimental and analytical environment with faculty members who are capable of advancing research centered on composite materials in a cross-sectional manner. We also actively promote collaboration with industry, government, and academia outside the university. If you are interested in working with us, please feel free to contact the head of the division.

We conduct research on a wide range of lightweight and high-strength composite materials, such as CFRP, from the fundamentals to applications.

Overview of the Division

The Division of Composite Materials Engineering promotes research on composite materials with members who have extensive knowledge of materials and structures. Composite materials have been mainly used in the aerospace field, but their adoption in the automotive industry has been increasing in recent years, and their application to flying mobility is expected to expand in the future (Figure 1). In order to utilize composite materials in these new industrial fields, new design, evaluation, and molding methods specific to CFRP are required. In this division, research is being conducted with a particular focus on simulation technology and new forming methods.

Interdisciplinary Team and Shared Facilities

This division consists of 12 faculty members in the following three fields: chemistry, materials, and mechanics. The unique feature of this division is that the faculty members in these three fields cooperate with each other to conduct research on composite materials from materials to structures in an integrated manner. In addition, the division shares the use of laboratories in the Noda 10 Building.

Name	Job Title	Affiliation
Ryosuke MATSUZAKI	Director / Professor	Department of Mechanical and Aerospace Engineering, Faculty of Science and Technology
Shinji OGIHARA	Vice Director / Professor	Department of Mechanical and Aerospace Engineering, Faculty of Science and Technology
Jun KOYANAGI	Professor	Department of Materials Science and Technology,Faculty of Advanced Engineering
Koji ARIMITSU	Professor	Department of Pure and Applied Chemistry,Faculty of Science and Technology
Hiroshi OKADA	Professor	Department of Mechanical and Aerospace Engineering, Faculty of Science and Technology
Akiyuki TAKAHASHI	Professor	Department of Mechanical and Aerospace Engineering, Faculty of Science and Technology
Yasuo KOGO	Professor	Department of Materials Science and Technology,Faculty of Advanced Engineering
Ryo INOUE	Associate Professor	Department of Mechanical Engineering, Faculty of Engineering
Yutaro ARAI	Junior Associate Professor	Department of Materials Science and Technology,Faculty of Advanced Engineering
Fikry MOHAMMAD	Assistant Professor	Department of Mechanical and Aerospace Engineering, Faculty of Science and Technology
Yutaka OYA	Assistant Professor	Department of Materials Science and Technology,Faculty of Advanced Engineering

Simulation, 3D Printing, and Industry Collaboration

Simulation technology ranges from material simulation at the atomic and molecular level to fracture analysis at the structural level, and is studied in parallel with experimental verification. With the recent improvements in computer performance, numerical analysis has become an important tool, and we are benefiting from it.

As a new forming method, we are focusing on 3D printing of composite materials (Figure 2). Conventional composite molding relies on the know-how of skilled craftsmen and molds, and as a result, it is difficult to produce a wide variety of products. On the other hand, general thermoplastic resin-laminated 3D printers have low mechanical properties of resin, making it difficult to fabricate aerospace and automotive product-level structures. However, recent progress in research on carbon fiber composite 3D printers has solved these problems, and high-strength 3D modeling for automotive and aerospace applications is now possible. In this division, research is being conducted on new optimal design methods applicable to carbon fiber composite 3D printers, understanding the mechanism of molding by 3D printing, and functionalization.

The division emphasizes industry-academia collaboration and serves as a partner for commissioned and joint research to meet the needs of industry. We also focus on training engineers in composite materials. Our goal is to create synergies between the university and industry by producing a large number of ready-to-work engineers who have acquired skills through research. Our research division is characterized by education and research activities based on strong collaboration between industry and academia.

Figure 1 We expect personal flight mobility to become commonplace with the development of composite materials engineering.

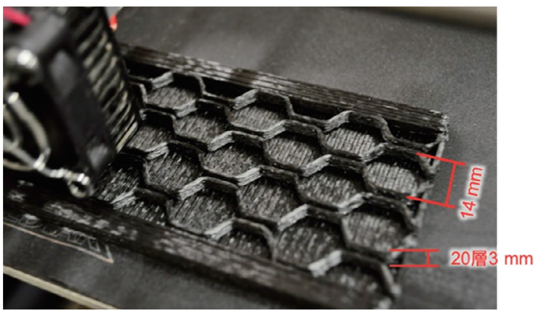


Figure 2 Honeycomb structure molded by composite 3D printer

twada@rs.tus.ac.jp

Nucleic Acid Drug Discovery Center

Director
Professor,
Department of Pharmaceutical Sciences
Takeshi Wada
Doctor of Science

Objectives	We aim to create nucleic acid drugs to treat unprecedented target diseases through the synthesis of novel chemically modified nucleic acids and the establishment of DDS and formulation methods.
Future Development Goals	Our goal is to make a breakthrough in the field of nucleic acid drugs through the collaboration of researchers in TUS.

This center was established by a cross-departmental team of in-house researchers working on nucleic acid or other fields. By a succession of networks and joint research created through the activity of the TR center, we aim to develop innovative nucleic acid drugs from TUS.

Development of nucleic acid-based drugs that are expected to be a next-generation drug

History of This Center

Among the activities of the Translational Research (TR) Center, which was headed by Prof. Yoshikazu Higami from 2014 to 2018, the field of nucleic acid medicine-related research has been particularly outstanding and is one that has attracted social attention and demand today. Our university has several researchers who are active worldwide in the field of nucleic acid drug discovery, and they all participated in research as members of the TR Center. In 2017, the Nucleic Acid Drug Discovery DDS Discussion Group was established, represented by Prof. Makiya Nishikawa, and researchers involved in nucleic acid medicine at our university gathered to discuss the development of nucleic acid medicine. As a result, the Nucleic Acid Drug Discovery Research Division was launched in April 2019 as the successor to the TR Center. After the three-year establishment period ended, the period was extended for another two years. In 2021, the head of the department, Prof. Wada, was selected for the “Innovative Next Generation of Oligonucleotide Therapeutics (INGOT) Project,” one of the research projects in the “Drug Discovery Platform Technology Development Project for the Realization of Next-Generation Treatment and Diagnosis (RNA Targeted Drug Discovery Technology Development)” promoted by the Japan Agency for Medical Research and Development (AMED), and has achieved remarkable achievements. As such, research is progressing and accelerating, so we plan to reorganize the research department into a research center, which will be launched in April 2024. In addition, based on the research results of the department, a drug discovery venture was established in September 2023 with researchers from our university, the University of Tokyo, Keio University, and Tokyo Medical and Dental University as founders. In addition, we work closely with the “Nucleic Acid and Peptide Drug Discovery and Therapeutic Research Center (TIDE Center)” established at Tokyo Medical and Dental University (Institute of Science Tokyo), aiming to form a base for nucleic acid drug discovery in the Tokyo Biocommunity (GTB).

Research Objectives

Nucleic acid drugs are medicines consisting of chemically synthesized DNA or RNA derivatives, and target DNA, RNA or proteins related to diseases (Figure 1). Therefore, a wide range of research fields are required for the development of nucleic acid drugs, but our university has extremely excellent researchers in each field, and by bringing them together at this center, we can expect a great synergistic effect of promoting the development of our own nucleic acid drugs. Our research center aims to develop new nucleic acid derivatives that are more effective, stable, and safe than conventional nucleic acid drugs, and to establish new carrier molecules and formulation technologies that bind to nucleic acids to improve stability and pharmacokinetics. In addition, we aim to select disease areas related to cancer, the immune system, and the metabolic system as targets for these nucleic acid drug molecules, and to lead to the development of treatments using new nucleic acid drugs. In this way, it is expected that our excellent researchers involved in nucleic acid drug discovery will gather in this department and promote the development of original nucleic acid drugs for unique targets.

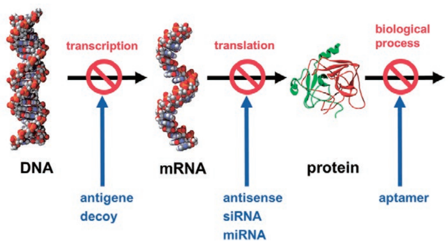


Figure 1 Oligonucleotides as therapeutic agents

Members

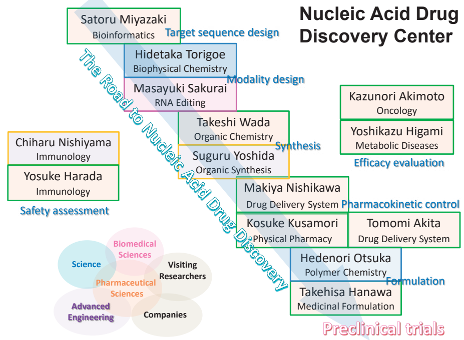
In-house Members

Faculty of Pharmaceutical Sciences
Takeshi Wada (Organic chemistry)
Makiya Nishikawa (Drug delivery system)
Takehisa Hanawa (Medicinal formulation)
Yoshikazu Higami (Molecular pathology and metabolic diseases)
Kazunori Akimoto (Molecular pathology)
Yosuke Harada (Immunology)
Kosuke Kusamori (Physical pharmacy)
Tomomi Akita (Drug delivery system)

Faculty of Science
Satoru Miyazaki (Bioinformatics)
Hidetaka Torigoe (Biophysical chemistry)
Hidenori Otsuka (Polymer chemistry)

Faculty of Advanced Engineering
Chiharu Nishiyama (Immunology, allergy and molecular biology)
Suguru Yoshida (Organic synthesis)

Research Institute of Biomedical Sciences
Masayuki Sakurai (RNA editing)



Current Situation of Nucleic Acid Drugs and Our Research Topics

Nucleic acid-based drugs are anticipated to be an epoch-making remedy for the treatment of intractable hereditary diseases. The global market size of nucleic acid-based drugs is predicted to expand to 19 billion dollars in 2030 from 2 billion dollars in 2018, according to the estimation of Seed Planning Inc., a marketing research and consulting enterprise. Although much effort has been devoted to the research of nucleic acid-based drugs, only 17 drugs have been approved so far. There are a lot of challenges to overcome for the development of potent nucleic acid drugs, and a breakthrough is required for further progress in this area. To address this issue, we are dealing with the following topics;

1. Development of an efficient method to synthesize boranophosphate oligonucleotides which is anticipated as an alternative candidate of phosphorothioate
2. Establishment of a scalable synthetic method of artificial cationic oligosaccharides and peptides that bind to and stabilize nucleic acids.
3. Construction of a highly target selective drug delivery system through the elucidation of interaction between nano-structured nucleic acid and cells
4. Development of antisense drugs that target such as wound and bladder cancer remedy
5. Development of a novel formulation method of nucleic acid drug
6. Research on the control of aging, aging related diseases and metabolic abnormalities by nucleic acid drugs
7. Development of nucleic acid drugs which regulate autoimmune response and rejection reaction during an organ transplantation
8. Development of effective breast cancer drugs using novel artificial cationic molecules and siRNAs
9. Establishment of investigation technology via bioinformatics and AI to determine the sequence of a mRNA that codes disease-related protein

Bio and Pharmacy
Established: April 2023

shiina@rs.tus.ac.jp

Research Center for Drug Discovery and Applied Sciences

Objectives	Our goals include the efficient production of pharmaceutical products from natural and/or artificial compounds. In our research center, our team will collaborate with researchers within the campus, as well as outside, who have made considerable achievements in the field of molecular biology, thereby completely exploiting synthetic organic technologies from which the representative research can derive its strength.
Future Development Goals	Recently, the discovery of new medicines originating from academia via industry-university collaboration from an industrial viewpoint has attracted a significant amount of attention. Results obtained from such research provide a methodology for solving various issues associated with the development of drugs derived from natural sources.

Director
Professor,
Department of Applied Chemistry,
Faculty of Science Division I

Isamu Shiina
Ph.D

In this project, novel biological research will be conducted by completely exploiting organic synthesis technology, referred to as the "total synthesis of naturally occurring products," which has been scarcely used so far for the discovery of new drugs. Synthetic studies based on natural product-derived compounds lead to the production of novel drugs with a unique mechanistic MOA and pave the way for the treatment of intractable diseases that have not been treated thus far.

Structure-Activity Relationship (SAR) and Mode of Action (MOA) Studies Using New Compounds Developed at the Tokyo University of Science

Development of New Synthetic Methods for the Effective Transformations in Organic Chemistry

A majority of the products that are used as medicines by humans comprise carbon-based organic compounds, which are synthesized by combining multiple chemical reactions. However, when it is crucial to perform several reaction steps before achieving the synthesis of the desired compound, considerable time and effort are spent, as well as a considerable amount of waste is generated, thereby adding to the environmental burden.

Our synthetic team is conducting research on reaction methods that can improve the synthetic yield of pharmaceutical products to the maximum. Hence, in 2002, our team developed a new dehydration condensation agent, namely 2-methyl-6-nitrobenzoic anhydride (MNBA), which can drastically enhance the production efficiency of antibiotics and anticancer drugs.

Dehydration condensation is a structural transformation where two hydrogen atoms and one oxygen atom are simultaneously removed from organic molecules, and two compounds are ligated using a reagent such as a dehydrating condensation agent. For decades, dehydration condensation has been employed to construct the basic skeleton of pharmaceuticals. However, as conventional methods require harsh reaction conditions, including the use of an acid catalyst or high temperatures, issues related to the destruction of reagents or compounds that serve as the raw materials were noted.

With the establishment of the Shiina laboratory in 1999, compounds and reaction conditions for the invention of the fastest dehydration condensation reaction in the world were thoroughly analyzed, which finally led to the development of MNBA.

After the establishment of this new technology, MNBA has been widely used to synthesize new antibiotics, molecular target anticancer drugs, and drugs for diabetes treatment, and more than 19,000 successful results have been reported worldwide (Please check YouTube using "YouTube MNBA Shiina" as the keyword, Fig. 1).

Fig. 1 Efficient Synthesis of Various Compounds Using MNBA
(The Shiina Research Group)(https://www.youtube.com/watch?v=Dw1ajJchujw)

A New Method for the Inhibition of Cancer Cells (Total Synthesis of Vesicle Protein Transport Blocker, M-COPA)

In this center, research on the "Development of New Reactions" and "Total Synthesis of Natural Products" is interconnected as major research topics. Total synthesis involves the artificial synthesis of natural-derived chemical substances with complex molecular structures using a minimum amount of raw materials. For example, some rare chemical compounds extracted from soil-borne bacteria exhibit anticancer properties. If these compounds can be artificially synthesized, not only the stable production of medicines can be achieved but also the chemical structures that are optimum for pharmaceuticals, including the suppression of side effects, can be designed.

In the total synthesis research, MNBA is predominantly used for the synthesis of organic compounds exhibiting anticancer properties.

Our team completed the total synthesis of M-COPA, which limits the function of the Golgi apparatus that is responsible for the transport of intracellular proteins. Both domestic and international research groups have attempted to apply this compound to cancer cells activated by the Golgi apparatus to block transportation pathways and to suppress the growth of cancer (Fig. 2). At the Shiina laboratory, our team has worked toward the development of a large-scale method to prepare M-COPA for use in animal experiments.

Each reaction step was analyzed to ensure gram-scale production, or higher, of M-COPA with seven consecutive stereogenic carbons. Our team established largescale synthesis by effectively employing organic reactions, such as asymmetric aldol reaction, intramolecular Diels–Alder reaction, and MNBA dehydration condensation reaction. Experiments to verify the effect on cancer cells using M-COPA via total synthesis have been conducted, and even the inhibition of proliferation of cancer, which has been thought to not be cured using the current anticancer drugs, has been observed. In addition, other outstanding achievements have been consistently reported in articles. The design of a synthetic method in the anticipation of the development up to industrial use has played an important role in successfully achieving this objective.

In addition, these results have also been presented on YouTube.

These can be viewed on the YouTube handle "YouTube M-COPA Shiina" or "YouTube Shiina Laboratory TUS."

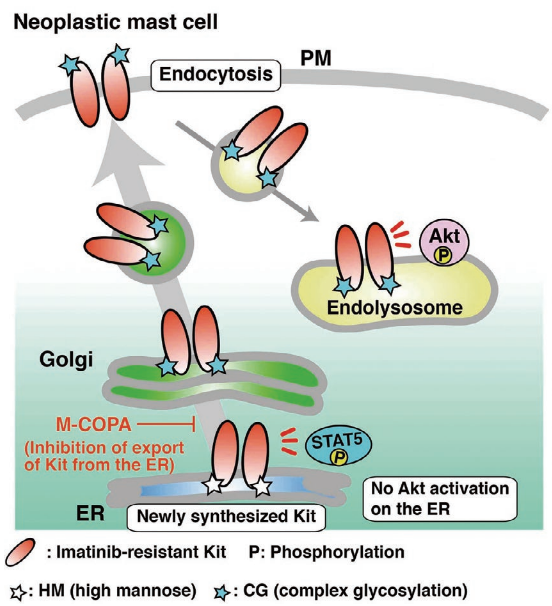


Fig. 2 Proliferation Suppression Mechanism of Cancer Cells using M-COPA
(Fig. 2 was created by Dr. Yuuki Obata who collaborates with Prof. Shiina: *PLOS ONE*, 12(4), e0175514 (2017))

Bio and Pharmacy

Established: April, 2021

makiya@rs.tus.ac.jp

Division of Superior Cells and DDS Development for Regenerative Medicine

Objectives	To develop “superior cells” and DDS that can precisely control the function and *in vivo* fate of the cells for accelerating regenerative medicine.
Future Development Goals	To create a novel and unique research field focusing on “superior cells” by collaboration of researchers with a variety of expertise.

Director
Professor,
Department of Pharmacy,
Faculty of Pharmaceutical Sciences

Makiya Nishikawa

Ph.D.

Cell-based therapy and regenerative medicine can be accelerated by applying the drug delivery system (DDS) concept, in which drugs are delivered at the right time, to the right site of action, and in the right amount, to cells administered to patients for disease treatment. Our division aims to develop “superior cells” with extreme functionality and DDS that enhance their functionality.

Development of superior cells and DDS for accelerating regenerative medicine

History and Background of This Division

DDS research has been actively pursued at Tokyo University of Science since the early days. This division traces its origin to the DDS Research Division established in 2003 within the Research Institutes for Science and Technology at Tokyo University of Science. In 2015, the “Fusion of Regenerative Medicine with DDS Division” was launched under the leadership by Professor Kimiko Makino, focusing on collaborative research in regenerative medicine and the development of DDS for intractable diseases. To further advance these efforts, a predecessor roundtable entitled “Superior Cells and DDS Development for Regenerative Medicine” was launched in 2020, and this was formally re-established as a division in April 2021.

Research Purposes and Goals of This Division

With the overarching goal of accelerating cell-based therapies and regenerative medicine, the division aims to (1) develop “superior cells” by enhancing the functionality of therapeutic cells, and (2) establish DDS technologies that enable precise control over the in vivo behavior of cells and other bioactive agents. The division also targets the development of therapeutic modalities for diseases affecting the respiratory system, brain, immune system, cancer, and bone.

Members and Their Roles in This Division

The division consists of four collaborative groups that work together to advance integrated research:

(1) Superior Cell/DDS Development Group

This group focuses on designing and developing superior cells and DDS technologies to regulate the behavior and in vivo distribution of cells and bioactive compounds. The objective is to create “superior cells” that exceed conventional functionalities by incorporating novel functions, constructing multicellular spheroids and organoids, and leveraging extracellular vesicles such as exosomes. The group also applies DDS platforms to these cells and evaluates their efficacy in disease models.

(2) Cell Function Regulation System Development Group

This group is engaged in the creation of novel compounds that modulate cellular functions, as well as functional materials to support cell-based therapies and regenerative medicine. These developed tools are provided to other groups for application and evaluation, and the findings are used to refine and enhance the compounds and materials.

(3) Physical Property Control/Analysis Group

This group is responsible for evaluating the physicochemical properties of superior cells, DDS formulations, and functional materials developed by other groups. The results are fed back to improve the design and performance of these technologies.

(4) Cell/Tissue Regeneration Group

This group investigates the mechanism of tissue regeneration in organs such as the lung and bone and explores therapeutic interventions for related diseases. The group also studies interactions between superior cells/DDS and the immune system.

Figure 1 outlines the members and functional roles of each group. Through close collaboration among these teams, the division builds upon Tokyo University of Science’s legacy in DDS research while fostering a new phase of interdisciplinary advancement in cell-based therapies and regenerative medicine.

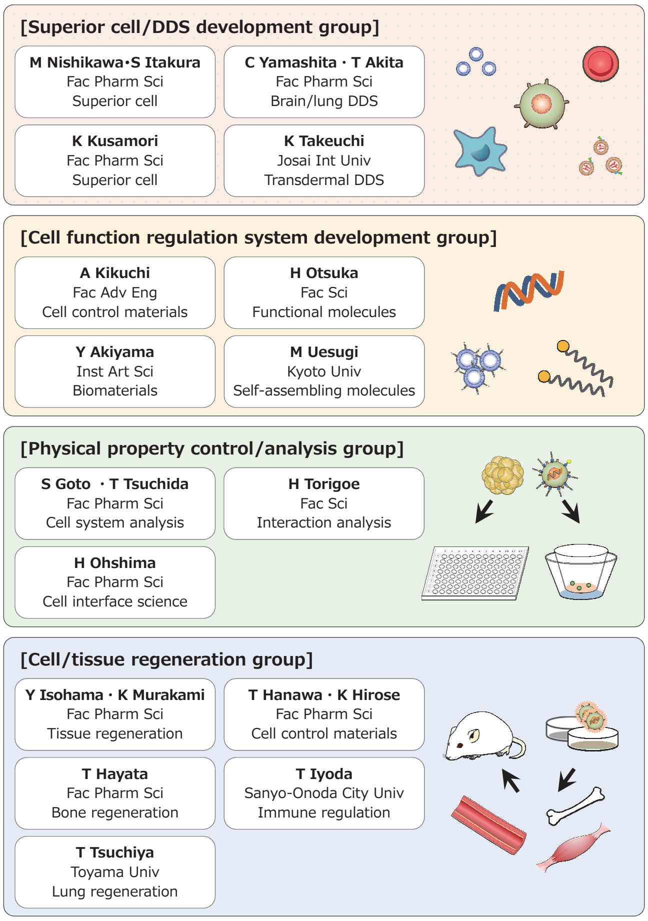


Figure 1 Members and roles of each group.

Established: April, 2025

miyagawa@rs.tus.ac.jp

Division of Biological Fluctuations

Objectives	To comprehensively elucidate the relationship between the environment and living organisms and to clarify the mechanisms of their adaptive capacity.
Future Development Goals	We aim to establish a novel scientific discipline based on biological fluctuations, advancing a unified understanding of diverse biological phenomena.

Director
Professor,
Department of Biological Science and Technology,
Faculty of Advanced Engineering
Shinichi Miyagawa
Ph.D.

In response to the challenges of a rapidly changing global environment, this division aims to elucidate the mechanisms of biological fluctuations in living systems. Our novel approach seeks to advance insights into environmental adaptation and diverse biological phenomena, contributing to a sustainable society.

Research on adaptive strategies unveiled by biological fluctuations.

Background

Previous research initiatives within the Comprehensive Research Institute, the Division of Agri-Biotechnology (2015-2019) focusing on “food” and the Division of Biological Environment Innovation (2020-2024), which addressed “environment”. These studies highlighted various environmental and societal challenges faced by living organisms, clearly demonstrating that a rapidly changing and harsh environment compels life to adapt for survival and propagation. Under such circumstances, it is an urgent imperative to elucidate the impact of the environment on biological activity and scientifically clarify the fundamental basis for the survival and prosperity of organisms, particularly their strategies for environmental response and of biological diversity.

Objectives

Addressing global environmental issues requires understanding organisms’ inherent adaptive capacity. We have termed the driving force enabling organisms to flexibly respond to diverse internal and external environments, and to adapt by altering their form and function, as “biological fluctuations”. This research division aims to identify and comprehend biological fluctuations across a wide range of biological phenomena, thereby understanding the fundamental principles by which organisms respond and change in adaptation to the environment. This endeavor seeks to generate novel research concepts that will provide insights into resolving contemporary environmental challenges.

What are biological fluctuations?

We define “biological fluctuations” as the driving force enabling organisms to flexibly respond to diverse internal and external environments, adapting through changes in their morphology and function. Biological fluctuations possess the following characteristics:

- “Fluctuations” are observed at all hierarchical levels, including molecular, cells, tissues, organs, individuals, populations, and ecosystems.
- For instance, developing cells exhibit flexibility; their fate is not solely determined by genome, but guided by environmental sensing and intricate signaling, enabling proper differentiation and adaptation.
- These biological fluctuations varies across species and developmental stages, even for identical biological phenomena.
- While appearing unstable, biological fluctuations ultimately contribute to robust macro-scale systems, supporting the production of next-generation evolution, and overall health.

Research Activities

We define “biological fluctuations” as the driving force enabling organisms to flexibly respond to diverse internal and external environments, adapting through changes in their morphology and function.

Within this division, each member will observe “biological fluctuations” in their respective research areas to elucidate the mechanisms of organisms’ inherent adaptive capacity. We will clarify both unique and common mechanisms of these fluctuations across various species and cells, revealing the specific and universal principles of environmental response. Common research themes include establishing new model systems for biological responses, developing novel analytical techniques, elucidating environmental sensing mechanisms, and clarifying signal transduction, gene expression, and metabolic pathways.

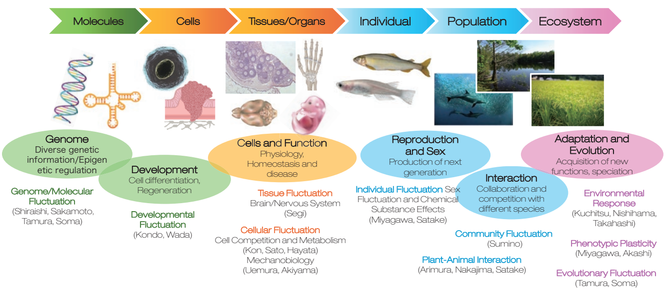
Cellular fluctuations enable responses to internal and external environments, ensuring optimal development, growth, and homeostasis in individuals. Robustness at ecosystem levels is maintained by biological diversity, which represents a form of biological fluctuation. Identifying and clarifying fluctuations at molecular and cellular levels across all biological phenomena will reveal fundamental principles of environmental response, providing pathways to resolve contemporary environmental challenges.

Members

Biological fluctuations are phenomena observed across different hierarchical levels: molecular, cellular, tissue/organ, individual, population, and ecosystem. This research division will categorize these into four groups: ① Molecular, ② Cell/Tissue/Organ, ③ Individual/Population, and ④ Ecology/Evolution, with each group advancing the elucidation of the molecular basis of life fluctuations. Emphasis will also be placed on interactions between different hierarchical levels to unveil robust environmental response capabilities that are unpredictable from the behavior of individual components.

- Molecular level
  Members: Shu Kondo, Mitsunori Shiraishi, Naoyuki Wada, Takuya Sakamoto
- Cellular/Tissue/Organ level
  Members: Eri Segi, Masayoshi Hayata, Satoshi Sato, Shunsuke Kon, Yoshitsugu Akiyama, Masao Uemura
- Individual/Population level
  Members: Shinichi Miyagawa, Genichiro Arimura, Shinichi Satake, Yutaka Sumino, Ushi Nakajima
- Ecology/Evolution level
  Members: Fuminori Takahashi, Koji Tamura, Akiko Soma, Ryuichi Nishihama, Kazuyuki Kuchitsu, Hiroshi Akashi

Strategies for environmental response at multiple levels and biological fluctuation



ynakamur@rs.tus.ac.jp

Division of Aging Biology

Director
Professor,
Department of Applied Biological Science,
Faculty of Science and Technology
Yoshikazu Nakamura
Ph.D.

Objectives	Our division aims to elucidate the molecular mechanisms of aging regulation by focusing on various metabolites, as well as the epigenome, mitochondrial function, and immune function.
Future Development Goals	We aim to develop methods for the prevention, suppression, and reversal of aging based on an understanding of the biological process of aging.

Our division aims to advance aging research from a unique perspective of Tokyo University of Science through collaboration among outstanding researchers both within and outside the university who are interested in aging research.

Investigate the mechanisms of aging with the aim of suppressing and reversing the aging process.

Background and purpose of the division

Aging control is influenced by changes in environmental and stress-related factors. Our division focuses on lipids, water-soluble metabolites, the epigenome, mitochondrial function, and immune function, all of which dynamically change due to external factors. By understanding the essence and fundamental principles of aging, we aim to develop preventive and intervention methods against aging. To achieve this goal, we conduct interdisciplinary research in collaboration with outstanding researchers from the Faculty of Science and Technology, the Faculty of Pharmaceutical Sciences, and the Research Institute for Biomedical Science, as well as leading external researchers. This unique and powerful approach enables Tokyo University of Science to advance aging research.

Research Organization and Members

IIn our research division, we collaborate closely with four groups and experts from diverse fields to advance research aimed at elucidating the molecular mechanisms of aging and regulating aging processes.

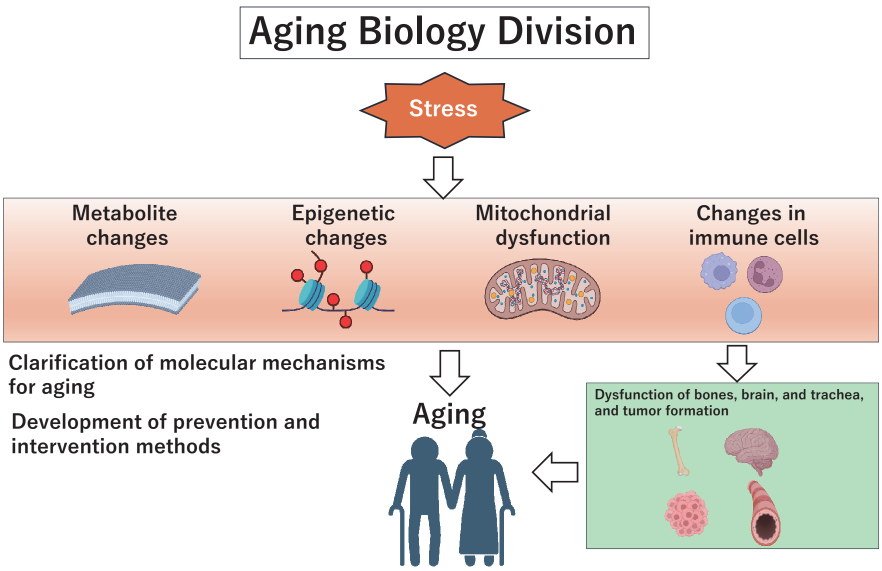
(1) Lipid and Water-Soluble Metabolites Group
(Yoshikazu Nakamura, Kyohei Higashi, Yuhei Mizunoe, Kaori Kanemaru, Masahiro Komeno, Atsuo Sasaki, Takehiko Sasaki)
The aging hallmarks that indicate characteristics of aging include features related to nucleic acids and proteins. However, features related to lipids and sugars, despite being major constituents of cells like nucleic acids and proteins, are not included. Therefore, the Lipid and Water-Soluble Metabolites Group aims to demonstrate that lipids and their metabolic pathways constitute novel factors regulating aging. The group strives to develop new aging intervention methods targeting lipids. Additionally, the group conducts research focusing on aging regulation through water-soluble metabolites such as sugars and polyamines.

(2) Epigenome Group
(So Maezawa, Motoshi Hayano, Kai Otsuka, Yusuke Kishi)
Epigenetic changes occur in response to various external factors such as environment and stress. Recently, it has become evident that epigenetic changes are involved in aging regulation. Therefore, the Epigenome Group aims to identify epigenetic modifications relevant to aging control and develop aging intervention methods targeting these modifications.

(3) Mitochondria Group
(Yoshikazu Higami, Yuka Nozaki, Shigeru Yanagi, Masaki Kobayashi)
Mitochondria are the energy factories of cells, but aging and improper lifestyle factors can impair mitochondrial function. Dysfunctional mitochondria produce reactive oxygen species and induce oxidative stress, thereby promoting aging. Thus, maintaining mitochondrial quality and function is a crucial challenge for aging suppression. The Mitochondria Group focuses on the homeostatic maintenance mechanisms of mitochondrial proteins and aims to develop methods for maintaining mitochondrial quality and activating mitochondria to suppress aging.

(4) Immune Group
(Tomokatsu Ikawa, Akihiko Yoshimura, Hiroshi Haeno, Koichi Saeki)
Aging of the immune system leads to chronic inflammation throughout the body and accumulation of senescent cells, accelerating systemic aging. Recent studies have highlighted the involvement of external factors such as stress and environment in immunosenescence. However, detailed mechanisms regulating immunosenescence remain unclear. Therefore, the Immune Group aims to elucidate the mechanisms of immunosenescence and develop methods to control immunosenescence by targeting these mechanisms. The group also aims to develop aging suppression methods utilizing immune cells with enhanced senescent cell clearance capabilities.

In addition to these groups, we also include outstanding researchers specialized in bone (Tadayoshi Hayata, Naoyuki Wada), brain (Teiichi Furuichi), trachea (Tomoko Masaike), oncology (Mahito Sadaie, Shunsuke Kon), and primate aging models (Rafael de Cabo).

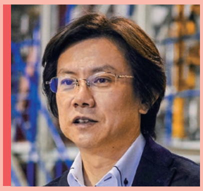


Information and Societal
Established: April, 2004

kmatsu@rs.tus.ac.jp

Center for Fire Science and Technology

Objectives	To promote the development of fire science and fire safety engineering, as well as the training of young researchers and specialist professionals.
Future Development Goals	To establish an education and research center at the highest level of the world, to meet various social demands concerning fire safety, and to contribute to society.



Director
Professor,
Department of Global Fire Science and Technology,
Graduate School of Science and Technology
Ken Matsuyama
Dr. Eng.

Safety and security play pivotal roles in social development. TUS has, as a core of the fire safety engineering community both domestically and internationally, contributed to their advancement. In recent years, major cities in East Asia in particular have been undergoing marked development at a speed that no other Asian countries, including Japan, have ever experienced. We have a duty to mitigate this urgent situation sufficiently and, at the same time, to develop the innovative educational research system to prevent the occurrence of such fire accidents.

Research on the safety technology to protect human life and property from fires, and research on the fire science to support it.

Fire science at TUS

In 1981, Tokyo University of Science established Department of Fire Science and Technology in its Institute for Science and Technology. The aim was to set up a research center that would promote research on the safety technology to protect human life and property from fires, and research on the fire science that supports the technology. This development was initially started by the inauguration of a course on Architectural Fire Safety Engineering when the Department of Architecture, TUS was founded some 50 years ago. In this way, TUS laid the foundations of research and education on fire science ahead of the times, when such developments were unknown in other universities. These foundations have yielded a strong record of accomplishment of achievements since then, as amply illustrated in the fact that we have received two prestigious awards from the International Association for Fire Safety Science, the highest authority body of its kind in the world. The first of these was awarded for “Meritorious achievements in research contributing to the advancement of fire safety science”, and the second was for “Meritorious achievements in education producing numerous researchers in fire science”. In the past, Japan has suffered many fires in large buildings, which have claimed a large number of human lives. Members of the Department of Fire Science and Technology, TUS have been involved in appraising the majority of these serious building fires since 1968.

In recognition of this record of accomplishment, the Department was included in the 21st Century COE Program of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in fiscal 2003, as a “Center of Advanced Fire Safety Science and Technology for Buildings”. It is currently engaged in activities aimed at establishing itself as a research and education center on fire science and fire safety engineering at the world’s highest level. Other aims are to promote the advancement of fire safety engineering and the training of young researchers and specialist professionals. We will continue our efforts in offering innovative education and research to protect human lives and properties from fires. Following the 21st Century COE Program, which concluded in 2007, the Global COE Program 2008, which would conclude in 2012, further adopted the “Center for Education and Research on Advanced Fire Safety Science and Technology in East Asia”. Now, the Center restarted as a five-year project after having been selected as a 2013 recipient of the Private University Strategic Research Formation Assistance Grant from the MEXT. “Fire Safety Information Center in Asia based on Sharing Expertise-New Fire Safety in Information Society” was started. Fire Safety Information in Asia as a research base that focuses on building a network of networks, and works together to reduce fire risk in Asian cities, we have realized the global development of science, which is an issue for the 21st century.

Since April 2018, it has been playing a role as permanent organization of “Fire Science Research Center”, as a center for fire science and fire safety engineering that represents East Asia.

Fire Research and Test Laboratory

Taking the opportunity of being adopted as the 21st Century COE Program, this laboratory was built in March 2005. It is one of the largest and most functional laboratories in the world meant solely for fire science. Built at Noda campus, it has a building area of 1,500 m², and gross floor area of 1,900 m², and a height of 20 m (Photo1). Members of the Center constructed a basic plan and did the designing utilizing their wealth of experiences, so that the laboratory would enable us to promote world-leading researches on fire sciences.

In March 2006, a large-scale fire furnace was added. Other large-scale experimental facilities to be included in the laboratory are composite furnace, fire resistance assessment machines for exterior wall materials, and combustion performance testing facilities, which are needed internationally, to contribute to the advancement of innovative researches.

Graduate School of Global Fire Science and Technology

The Master’s Course in Fire Science & Technology at the Tokyo University of Science’s Graduate School of Global Fire Science & Technology was established in April 2010 is the first postgraduate fire science course in Asia, and is aimed at those employed in the area of fire science and safety (such as the construction, firefighting, and non-life insurance industries) as well as students from Japan and overseas who want to become fire safety technicians and fire officers.

The graduate school represents one aspect of the MEXTs Center of Excellence (COE) program, “Center for Education and Research on Advanced Fire Safety Science & Technology in East Asia”, being promoted by the Center for Fire Science and Technology, and aims to establish Asia’s first definitive fire science education facility. The school to familiarize students with basic theory in a practical setting uses the Fire Research Test Laboratory.

In addition to the Master’s Course, students also have the opportunity to continue their studies, such as Doctoral Course in Fire Science & Technology established in April 2012. The Department of Global Fire Science and Technology is scheduled to be set up in April 2018 under the Graduate School of Science and Technology by reorganization of the Graduate School.

Designated Performance Evaluation

In order to improve fire safety technology and improve reliability at the Fire Science Research Center, the Building Standard Law has been applied to the construction method of buildings as a designated performance evaluation body designated by a designated performance evaluation body of the Ministry of Land, Infrastructure and Transport. Carry out performance evaluations required to obtain Minister of Land, Infrastructure, Transport and Tourism approval.

Performance evaluation is conducted by an evaluator who has expert knowledge of the field of performance evaluation based on the business method approved by the Minister of Land, Infrastructure, Transport and Tourism.

Research Promotion Plan

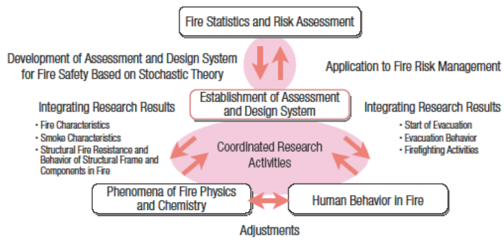


Fig. 1 Interrelationships of research areas and structures

Photo 1 Fire Research and Test Laboratory

Fig. 2 Home Page
「Center for Fire Science and Technology」
https://gcoe.tus-fire.com/

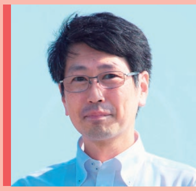
Information and Societal

Established: April, 2021

ssi@rs.tus.ac.jp

Research Center for Space System Innovation[SSI]

Objectives	To develop a virtuous cycle between earth and space research and solve various problems common to both.
Future Development Goals	Through technology transfer to collaborative private companies, SSI aims to enhance state-of-the-art technologies that can improve life on earth and are usable in space.



Director
Professor,
Department of Electrical Engineering,
Faculty of Science and Technology

Shinichi Kimura

Ph.D.

The goal of the center is to become an innovation-driven hub for outer space and earth research through collaboration with various entities. These collaborations will allow innovation by fostering excellent human resources. Researchers, businesspersons, and students can explore the frontiers of space.

Living in space, bringing benefits to earth!
–Trial for Space-Terrestrial Dual Development on Space Living and Spacecraft–

Background of SSI Establishment

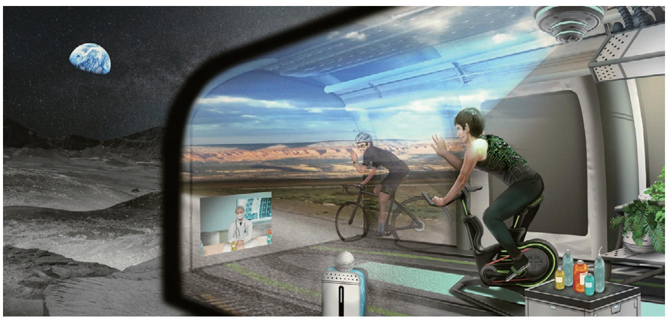
In recent years, space research has gained considerable attention. Space systems are multidisciplinary, and in addition to aerospace engineering, require expertise of various domains. As exemplified by recycling-based living in the closed environment of space, technologies required for humanity to reach into space are closely related to solving various earth-related problems, such as sustainable development and a recycling society.

About the Center

By pooling research and education activities related to space development and space environment utilization at Tokyo University of Science, the research center can be used for comprehensive analyses of various technological challenges, including research related to space travel.

The aim is to develop a creation hub in which cross-disciplinary technologies and human resources can be pooled to form a virtuous cycle to solve problems common to both space and earth.

- By utilizing photocatalytic technology, which is the specialty of our university, we aim to develop life-support technologies in space and realize a safe and comfortable living environment on earth.
- We will demonstrate suborbital spaceplanes under development, and develop a new "space" market in partnership with the industry.
- The Research Center for Space Colony, which has been researching and developing space-stay technologies, will shift its focus to "dual development on earth and in space, and the development of space vehicles to bridge the two," to achieve strategic development.
- We will provide a place for education based on space research opportunities, secure and foster PhD students and young researchers, and develop an environment where they can experience "real" research.



Research Organization of SSI

▪ Education Unit
–Education based on "real" technology and experience that can be used in space–

Utilizing Tokyo University of Science research, such as flight missions, rocket launches, theoretical research in astrophysics, and astronomical observations, for the purpose of education can be an incentive for both researchers and students. In addition to participating in numerous missions, we will cooperate with domestic and international space development organizations, space venture companies, and space development companies and actively use the results for education.

▪ Photocatalysis International Unit
–Solving resource and environmental problems by using photocatalysis–

Photocatalysts, such as titanium dioxide, can effectively decompose organic pollutants and exhibit antibacterial and disinfecting properties because of their strong oxidative decomposition. Considerable research is being conducted on artificial photosynthesis using photocatalysts (hydrogen production by water decomposition and generation of valuable substances by carbon dioxide reduction). By advancing these studies, we can address existing issues, such as environmental purification and energy production, on earth and implement solutions in space.

▪ Space Colony Unit
–Advancement of space-stay technologies and promotion of their use, with a focus on space habituation–

We will conduct cross-disciplinary research on various technologies related to clothing, food, and housing that have not been directly related to space so far, as well as infrastructure construction technologies, such as electric power and telecommunications, in closed environments. In addition, we will collaborate with companies and research institutes for the development of space-stay technology to allow humans to stay in an extreme closed environment for a long time. The results can be applied in case of common problems such as disasters or food scarcity on earth.

▪ Spaceplane Unit
–Development of spaceplanes that can facilitate easy space travel–

The Spaceplane Unit is focused on the integration of technologies including system optimization technology, fault-tolerant systems, LOX/LNG engine operation, autonomous navigation technology, composite airframes and propellant tanks, and legalization of commercial space transportation. This integration is necessary to allow travel to and from space using spaceplanes in a manner similar to airplanes under the motto "Space is for everyone."

nihei@rs.tus.ac.jp

Research Center for Multi-Hazard Urban Disaster Prevention

Director
Professor,
Department of Civil Engineering,
Faculty of Science and Technology
Yasuo Nihei
Ph.D.

Objectives	Our mission is to develop and apply innovative urban disaster prevention studies that target multi-hazards, with the ultimate goal of fostering a safe, sustainable society that values diversity and ensures no one is left behind.
Future Development Goals	We are dedicated to stimulating research exchanges both within and beyond the university, focusing particularly on multi-hazard urban disaster prevention. Notably, we aim to foster the expansion of connections among young researchers and students.

Earthquakes, floods, wild fires and other natural disasters are occurring frequently all over the world. Even a single hazard can cause great damage, but multi-hazard disasters, where multiple hazards occur at the same time and in the same area, pose a threat to the survival of a nation. Our center, which brings together researchers of various hazards and data science, is taking on this difficult challenge. Why not join us in this endeavor?

Disaster prevention and technology to protect lives and livelihoods from multi-hazard disasters

Background and history of the establishment of our center

Various disasters occur around the world, including earthquakes, tsunamis, floods, wild fires, and heat waves. Japan is also in a location where various natural disasters occur frequently, and in the past, it has experienced the Great Kanto Earthquake in 1923, the Great Hanshin-Awaji Earthquake in 1995, the Great East Japan Earthquake in 2011, and the Noto Peninsula Earthquake in 2024. In the future, it is expected that there will be an earthquake directly beneath the capital, an earthquake in the Nankai Trough, and a super typhoon. A major characteristic of these disasters is the occurrence of "multi-hazard disasters" in which multiple hazards such as earthquakes, tsunamis, floods, storm surges, strong winds, volcanic eruptions, and fires occur at the same time and in the same area. Although each hazard can cause great damage, when multiple hazards occur, the damage becomes severe and the damage is expected to exceed the annual national budget. In recent years, the effects of climate change have become apparent, and there are concerns about the increase in the probability of occurrence of multi-hazards such as earthquakes and floods, which have different mechanisms of occurrence. Previous disaster prevention research and technology have been established and systematized for each hazard, but it is essential to elevate these to an academic system that corresponds to multiple hazards and create a comprehensive urban disaster prevention science that collaborates with various fields such as science and engineering, life science, humanities and social science. With this background, our university applied for the "Creation and Practice of Multi-Hazard Urban Disaster Prevention Science" to the "Future Academic Promotion Initiative" publicly solicited by the Science Council of Japan in 2022, and was selected in 2023. As a recipient of that research system, our center was established in 2023.

Direction of the center

At this center, we aim to elevate previous research for each hazard, such as natural disasters and major fires, to an academic system that corresponds to multiple hazards, to create and practice breakthroughs in comprehensive urban disaster prevention science through collaboration and fusion between researchers from different fields, and to contribute to the creation of a safe and secure society that is sustainable, considers diversity, and leaves no one behind. Our university has many disaster prevention researchers on various hazards (earthquakes, fires, floods, etc.), as well as many researchers in data science. Taking advantage of these strengths, we will create and practice new urban disaster prevention studies through two cross-sectional collaborations: "disaster prevention researchers on various hazards" and "the fusion of disaster prevention researchers and data science researchers." In addition, we will actively collaborate with government agencies and private companies to implement the academic knowledge and results obtained in society.

Research group

At the time of its establishment, the center had only 10 members from the university, but now the research structure consists of 36 members from the university and 2 from outside the university (as of July 2025). In order to take advantage of the unique characteristics of our university, the members' specialties are very diverse (Figure 1). Hazards are diverse, including earthquakes, tsunamis, floods, volcanoes, fires, infectious diseases, and heat waves. In addition, many researchers at the center are not originally specialists in disaster prevention and mitigation, and the center is composed of experts in not only data science, but also drone and image analysis, disaster information and transportation, materials and sensor development, VR, urban development, evacuation shelters and medical care, and risk assessment. In this way, not only hazards but also specializations are "multiple." These diverse experts collaborate and cooperate to advance research, and more than 10 joint research projects are carried out every year.

Establishment of the consortium

In order to implement the results of the center in society, a consortium preparatory committee was launched in May 2024 to collaborate with private companies and government agencies, and an official consortium was established in April 2025. By the end of 2024, 31 companies had joined, and regular study sessions and exchange meetings were held to deepen interactions with center members and consider joint research. The consortium's activities are based on the three "co"s of co-creation, co-education, and co-existence, and it contributes to "building a safe and secure society with well-being" even under the occurrence of multi-hazards (Figure 2).

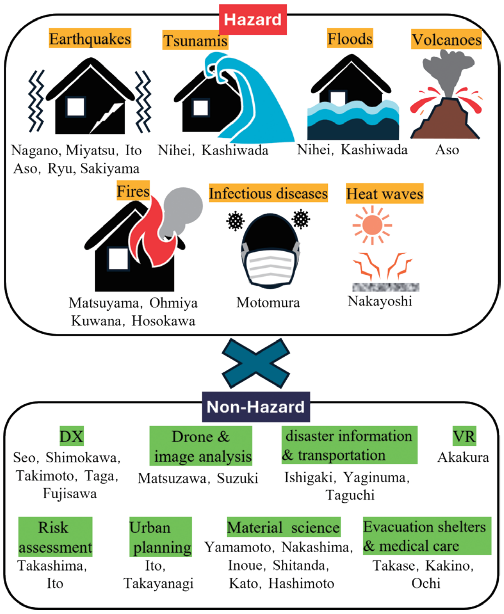


Figure 1 Membership and specialization of the center

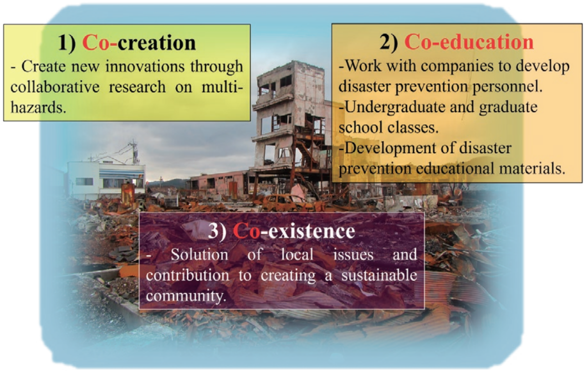


Figure 2 Objective of the consortium

Information and Societal
Established: April, 2024

masao.kakihara@rs.tus.ac.jp

Division of Co-creative Design Innovation Research

Objectives	The aim of this research division is to develop new methodologies for problem-solving and innovation using a co-creative design thinking approach originating from Asia.
Future Development Goals	We plan to hold an international symposium in close collaboration with Singapore University of Technology and Design (SUTD).

Director
Professor,
Department of International Digital and Design Management,
School of Management
Masao Kakihara
Ph.D.

The research division aims to be an academic hub for design research at Tokyo University of Science. Our goal is to propose theories and practical frameworks for design thinking from an Asian perspective.

Theory building and practical application of co-creative design thinking approach originating from Asia

Objective

The purpose of this research division is to develop a methodology for design thinking that incorporates unique Asian perspectives and cultural characteristics to address various "wicked problems" in Asia (especially Japan), rather than merely importing American or European design thinking methodologies.

To achieve this, it is essential to start by examining and organizing what constitutes "Japanese/Asian problems" and "Japanese/Asian approaches." This requires conducting research that integrates social science and engineering approaches and fostering collaboration with various international research centers in the Asian region.

Researchers from two newly established departments at our university, which aim to lead education and research based on domestic design thinking, are at the core of this effort. They have already initiated various collaborations with international research institutions and researchers, and they plan to further deepen these partnerships to construct a "design thinking methodology originating from Asia" and actively disseminate the results both domestically and internationally.

Figure The positioning of this research division

Academic collaboration with SUTD

As one of the core activities of this research division, we will work closely with Singapore University of Technology and Design (SUTD), which is currently serving as a hub for design research in Asia and actively promoting various research activities. While advancing various joint research projects, we plan to collaborate on establishing educational programs for design thinking and design management and co-host an international symposium within the established period of this research division.

Photo Singapore University of Technology and Design

Research Areas

This research division will conduct research in the following four areas:

[Theory] Development of Asian Design Thinking Methodologies
We aim to develop a new design thinking methodology originating from Asia, which is neither American nor European. This will be achieved by critically reviewing American and European design thinking methodologies and closely collaborating with external research institutions in the Asian region.

[Application 1] Service Design
We will explore the design thinking methodologies required for developing various services and businesses for individuals and groups, and examine the effectiveness of specific problem-solving strategies. We will particularly focus on: a) healthcare (patient communication), b) DX (digital transformation) solutions, and c) educational services.

[Application 2] Product and Environmental Design
We will examine the effectiveness of approaches for creating innovation through the development and introduction of products that support activities of people and organizations in local communities and office spaces as places for human collaboration.

[Application 3] Policy and Ecosystem Design
We will evaluate the effectiveness of design thinking as a methodology for constructing and improving the processes and policies of consensus building and decision making necessary for collaborative innovation. Special attention will be given to entrepreneurship and governmental policy issues.

Information and Societal

Established: April, 2022

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Division of Smart Healthcare Engineering

Director
Associate Professor,
Department of Electrical Engineering,
Faculty of Science and Technology
Takahiko Yamamoto
Ph.D.

Objectives	This division aims to conduct interdisciplinary research that contributes to the creation of a smart, healthy, and longevity society by researchers in a wide range of fields, including physiology, materials engineering, metabolism, integrated circuit engineering, radio frequency systems, and wireless communication engineering.
Future Development Goals	We are promoting active interactions among division members covering a wide range of specific fields, to emphasize joint research within and outside TUS, and to encourage young researchers.

This division conducts basic and interdisciplinary research on basic technologies and cross-disciplinary related to biometric sensing for health diagnosis to telemedicine, and high-quality, secure wireless communication, with the aim of supporting a smart, healthy, and longevity society in which people can lead healthy and high quality of life.

Creation of a Smart, Healthy, and Long-Lived Society that Supports People's Daily Life with High Quality of Life

The stresses that people may experience in their daily lives in society, even if they seem small and insignificant, increase the risk of various diseases. Research is needed to create a society in which people can live healthy daily lives with a high quality of life, even when their physiological functions are impaired or lost due to disease. This division advocates the value of smart healthcare systems that support to realize such a society and conducts research on the development of elemental technologies and their effective integrations.

Research Structure and Members of this Division

This division is divided into four major groups, and some of their research activities are presented below.

○ Sensing Group

・Elucidation of the mechanisms of health promotion and longevity through physical activity

Based on exercise physiology, behavioral physiology, material science, and metabolism, this group uses non-contact methods to quantify the amount of physical activity using animal models and explore the optimal amount of physical activity for physical and mental health in order to elucidate the mechanisms of health promotion and longevity from daily physical activity.

・Analysis of nanoscale materials derived from skeletal muscle/fat tissue on physical function and mental health.

Quantitative visualization of various mental and physical functions in humans is being attempted. In particular, Yanagita, Umezawa, and Kobayashi in our members have collaborated on a health promotion/longevity mechanism through exercise that is opened up by brain-organ communication, and are currently working on a research project to reveal the mechanism of brain-peripheral organ communication associated with changes in the amount of physical activity. The physicochemical and biological properties of nanoscale structures produced and released by muscle and fat cells in response to environmental stimuli are also being studied to visualize brain-organ communication.

○ Device Operation and Control Group

・Transcutaneous energy transmission for body-implanted electronic devices

Transcutaneous energy transmission and information transmission systems for medical electronic devices implanted inside the body are studied. This system completely reduces the risk of infection when supplying the driving energy essential for device operation. and achieves miniaturization and weight reduction through battery-free operation (Figure 1).

・Development of an electromagnetic phantom

When conducting wireless power or information transmission between inside and outside living organisms, it is essential to investigate the effects of the presence of living bodies on the operation of the equipment and the electromagnetic radiation from the equipment to ensure stable operation of the equipment. By using materials that mimic the electromagnetic properties of living bodies, these studies can be performed without animal experiments. In this research, we are developing various types of simulated living organisms.

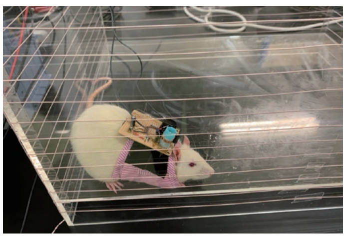

Figure 1　Wireless power transmission to an implantable momentum meter

○ Integrated Circuits and Signal Processing Group

The Transmission Group and the Information and Communication Group conduct research on high-frequency and high-speed signal processing circuits, low-voltage and low-power circuits, and their miniaturization, which are essential for hardware implementation. We develop high-performance amplifiers (low noise, high input impedance), analog-to-digital conversion circuits (ADC), and digital-to-analog conversion circuits (DAC) with high resolution and low power consumption, which are essential for measuring minute bioelectric potentials. In addition, as sensing devices become increasingly popular, we are analyzing device variation and studying variation-resistant circuits to realize robust circuits that are low-cost and highly resistant to variation.

○ Information and Communication Group

・Small antennas installed near living bodies

We are researching and developing compact, high-gain biometric antennas that can be used near living bodies and are not easily affected by them.

・Low power, high quality and secure wireless communication

This group is researching communication methods that achieve high speed, large capacity, high quality/low latency, multiple simultaneous connections, and low power consumption without degrading transmission quality. These are envisioned for transmitting biometric and other information measured by the sensing group to medical facilities using wireless communications. In addition, research will be conducted to promote the safe and secure use of radio waves by protecting information and communications from unauthorized access and malicious attacks.

Table 1　Member and Main Research Field

Affiliation	Job title	Name	Main research field	Group
Department of Electrical Engineering, Faculty of Science and Engineering	Associate Professor, Director	Takahiko Yamamoto	Medical Electronic Systems	Device Operation and Control
Department of Electrical Engineering, Faculty of Science and Engineering	Professor	Kenichi Higuchi	Wireless Communi-cations	Information and Communication
Department of Electrical Engineering, Faculty of Science and Engineering	Professor	Akira Hyogo	Electronic Circuits and Integrated Circuits	Integrated Circuits and Signal Processing
Department of Information Science, Faculty of Science and Engineering	Professor	Shigeo Akashi	Information Theory	Information and Communication
Department of Pharmacy, Faculty of Pharmaceutical Sciences	Professor	Akiyoshi Saito	Pharmacology	Sensing
Noda Division, Institute of Arts and Sciences, Institute of Arts and Sciences	Professor	Shinya Yanagita	Neurology and Exercise Physiology	Sensing
Department of Medical and Robotic Engineering Design, Faculty of Advanced Engineering	Associate Professor	Masakazu Umezawa	Pharmaceutical Science and Materials Engineering	Sensing
Department of Electrical Engineering, Faculty of Science and Engineering	Junior Associate Professor	Ryoichi Miyauchi	Integrated circuits, biological signal mea-surement systems.	Integrated Circuits and Signal Processing
Department of Pharmacy, Faculty of Pharmaceutical Sciences	Junior Associate Professor	Daisuke Yamada	Neurochemistry	Sensing
Department of Electrical Engineering, Faculty of Science and Engineering	Assistant Professor	Takanori Hara	Wireless Communications	Information and Communication
Department of Medicinal and Life Sciences, Faculty of Pharmaceutical Sciences	Assistant Professor	Yuka Nozaki	Functional biochemistry	Sensing
Tokyo City University	Visiting Professor	Tatsuji Matsuura	Integrated Circuits and Signal Processing	Integrated Circuits and Signal Processing
Tokyo Polytechnic University	Visiting Professor	Fukuro Koshiji	Bio-Communication	Information and Communication
Nippon Medical School	Visiting Professor	Shoji Yokobori	Emergency Medicine	Clinical engineering and medicine
Nippon Institute of Technology	Visiting Researcher	Kenko Ohta	Emotion Analysis	Sensing
Tokyo International University	Visiting Researcher	Natsuko Kubota	Physiology	Sensing
Institute of Science Tokyo	Visiting Researcher	Hiroki Sato	Integrated circuits and software engineering	Integrated Circuits and Signal Processing
Ochanomizu University	Visiting Researcher	Masaki Kobayashi	Metabolism	Sensing
Toyama Prefectural University	Visiting Researcher	Ryo Kishida	Integrated Systems and Reliability	Integrated Circuits and Signal Processing
ZENKIGEN	Visiting Researcher	Issei Hashimoto	Sensitivity Engineering	Sensing
Jichi Medical University Saitama Medical Center	Visiting Researcher	Chinori Umeda	Clinical engineering	Clinical engineering and medicine

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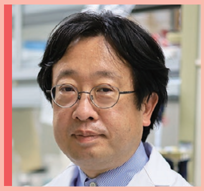
Medical Data Science

Objectives	Toward the realization of "Medical Data Sciences" based on digital medical data, we aim to solve the needs of clinical sites using data science methods and identify novel biomarkers for stratification.
Future Development Goals	In addition to the multifaceted analyses of global public medical data, it is expected that the unique "Medical Data Sciences" will be established by promoting cooperation with the National Cancer Center and the Jikei University School of Medicine.



Director
Professor,
Department of Pharmaceutical Sciences

Kazunori Akimoto
Ph.D.

This division has been launched by a group of researchers specializing in data sciences and disease biology, crossing the boundaries of the faculties and campuses of TUS. We aim to construct "Medical Data Sciences" at TUS by forming a network both inside and outside TUS, such as in collaboration with the National Cancer Center and the Jikei University School of Medicine.

Construction of "Medical Data Sciences" establishing novel preventive and therapeutic methods for diseases at TUS

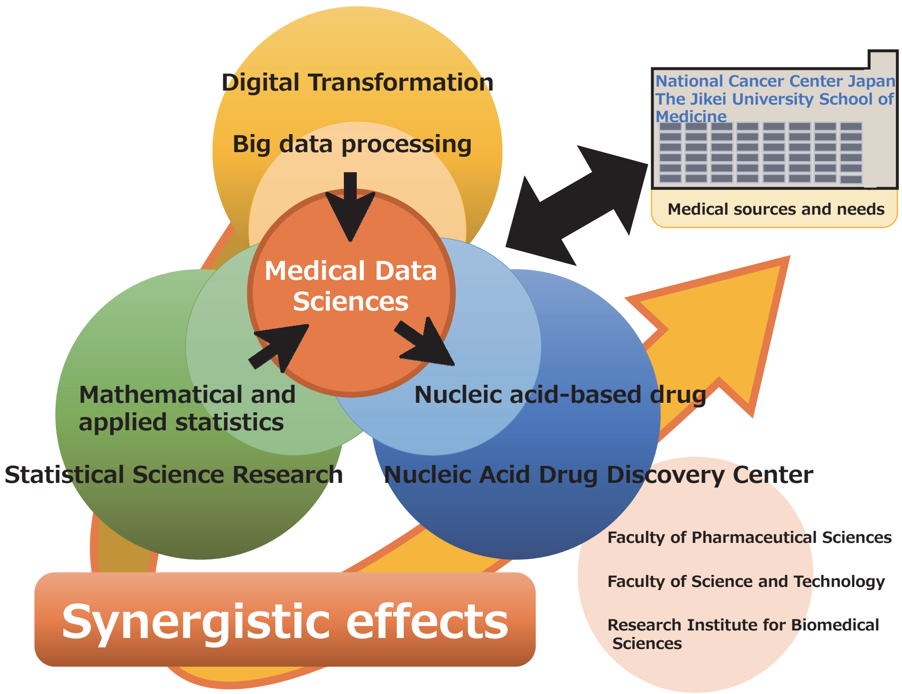
Objectives

The realization of "Medical Data Sciences" is becoming indispensable for establishing preventive and therapeutic methods for the cure of diseases. In medical care, Precision Medicine is being established: patients are stratified into specific groups by analyzing various medical big data, and the appropriate treatment is precisely selected for each patient group. However, at present, there are various problems pose barriers and is a limit to the provision of precise medical care. The purpose of launching this division is combined with data science methods and disease biological methods to solve the medical problems by the collaboration with NCC-EPOC, the Jikei University School of Medicine, and TUS. The outcomes are expected to prevent disease progression, extend healthy life expectancy, and realize high QOL and rehabilitation of patients.

This division will promote new patient stratification and proposals for treatment methods by using data science research on medical big data as a starting point. There are various challenges to be overcome in the realization of "Medical Data Sciences". Therefore, we will make full use of data science methods accumulated in TUS to solve the problem and develop the theoretical foundation for proposing new therapeutic agents and treatments. A series of research will enable the creation of new academic fields and the establishment for the theoretical foundation of "Medical Data Sciences". Furthermore, we will promote next-generation education and the development of researchers who will adapt and develop "Medical Data Sciences" based on medical big data.

Current Situation of "Medical Data Sciences"

Attempts to solve medical problems with data science methods have become a global trend. Such efforts are also being actively carried out in Japan. This division uses NCC, the Jikei University School of Medicine and global medical databases as medical sources and needs, but is characterized by using the data science methods accumulated at TUS. This is made possible by gathering specialists highly specialized data science and disease biology of TUS. Although the network scale of researchers is smaller than the global networks by other groups, it secures the diversity of researchers' specialties and enables them to cooperate closely and flexibly carry out research activities.



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Division of Digital Transformation

Objectives	Development of new integrated big data processing manners through breakthrough on mathematical theories in theory level, modeling methods in fundamental level, and statistical analyses of results in application level.
Future Development Goals	Development of big data processing manners that give accurate predictions for practical missions through mutually and spirally reflecting feedbacks between machine learning systems and statistical analyses of their results.

Director
Professor,
Department of Industrial and Systems Engineering,
Faculty of Science and Technology
Hiroyuki Nishiyama
Ph.D.

This research division aims to give high-performance and more accurate big data processing manners with mutual feedbacks between machine learning systems and statistical analyses of their results, based on mathematical foundations in various levels. The processing manners include redesign from theory and implementation of systems and analyses. We believe that the challenges of this division will open new horizons for big data processing.

R&D on integrated big data processing manners based on new theory and implementation. They include mathematically redesigning machine learning systems and implementing high accurate and safe A.I. In addition, they achieve high confidential big data processing, through statistically analyzing the results generated by the systems.

Introduction and Background

In most science areas, which include DNA & molecule designs in micron level and earth environment sciences in macro level, it is so important to extract meaningful information from big data, which is superficially useless data with huge size. The extraction techniques are called data mining. Data mining is so costly that it is difficult to process it in traditional ways. To achieve much more efficient and accurate data mining and result in innovative science technologies, we have to propose new approaches based on mathematical theorems in algorithms and execution styles.

Division of Super Distributed Intelligent Systems, which is the previous division, especially focuses attention to medical and bio-systems, and has developed next generation data mining software together with researchers in artificial intelligence and statistics areas. In the process of that, we have found that we have to not only enhance parallelization/distribution and propose new approaches based on mathematical theorems to achieve new innovative technologies. In Division of Digital Transformation, we will improve the results of the previous division, and develop new big data processing manners based on performance and accuracy issues that the results have exposed. For example, we will continuingly enhance execution efficiency in the low level that is related with programming languages, parallel/distributed algorithms, and network protocols. In addition, we will design new deep learning manners based on adjusting their super-parameters based on combinatory theorem. Eventually, we will apply these techniques and models to several areas such as image processing, power systems, machine learning, robot systems, software engineering tools and so on, including data mining.

Research Hierarchy

We address the issues of big data processing in three hierarchical levels, "applications", "fundamentals", and "theories" as follows:

1.Applications

In this level, members who are specialists of each applications investigate issues of the applications based on their expertise, propose approaches to solve the issues, and check validity of results given by the solution. In the process, they give new models based on characteristics of the applications, and develop systems implementing the models. The results given by the systems are validated in mathematical methods.

2.Fundamentals

In this level, members directly improve performance of fundamental techniques such as A.I. and machine learning, and propose new approaches of them. The improvement of performance includes network performance in distributed systems and sensor networks, and learning performance of A.I. through parallel and distributed techniques. The new approaches include improvements of parallelism in instruction level on GPU, improvement of accuracy of existing machine learning, and development of new machine learning model based on biological systems. The fundamental techniques and systems developed in the level are validated in mathematical methods.

3.Theories

In this level, members give proofs of techniques with black box parts such as deep learning and machine learning. Furthermore, through knowledges obtained in the process, they propose new methods or system models.

Research Topics

We currently have two main projects as follows:

① Genomix Data Science Medical Care of Cancer

It is a project that is advanced with National Cancer Center Exploratory Oncology Research & Clinical Trial Center (NCC-EPOC) as a cooperative research (Fig. 1). In this project, the purposes in the applicative level are cancer prevention, lengthening the time of a healthy life, improvement of quality of life and rehabilitation. Also, we are developing methods special to each applicative level purpose through fusing data sciences such as mathematical statistics, machine learning, information processing and statistical analysis, and cancer biological experiments.

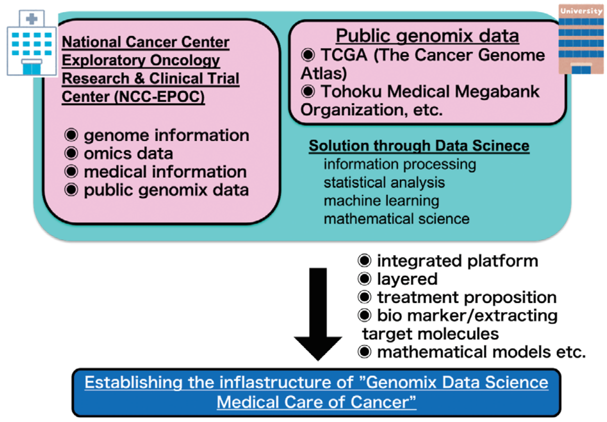

Fig. 1 Genomix Data Science Medical Care of Cancer.

② Implementation and Practical Realization of Cerebral Apoplexy Prevention by AI

We are developing the system that enables AI to support a doctor medically examining or treating patients of cerebral apoplexy using medical big data and engineering big data. This project started as one of NEDO projects, implementing two kinds of A.I.s, which were A.I. α based on just medical information and A.I. β based on both of medical information and engineering information.

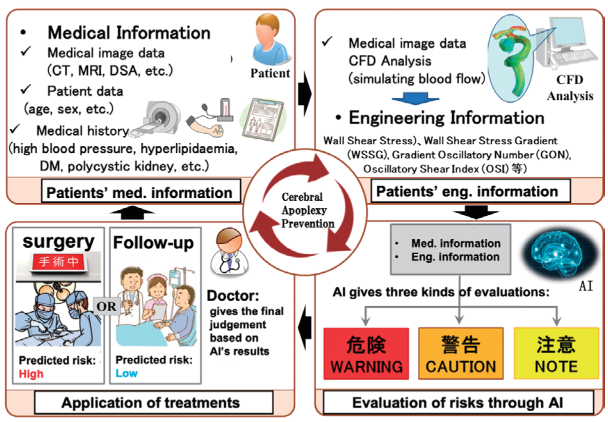

Fig. 2 Cerebral Apoplexy Prevention by AI.

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Established: April, 2025

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Statistical Science Research Division

Objectives	In this research division, researchers with an interest in fundamental, unifying theories come together to advance the study of core concepts and methodologies. Additionally, we aim to create new theoretical frameworks suited to the era of data science and to pioneer emerging fields.
Future Development Goals	This research division contributes to the advancement of mathematical data science by collaborating closely with the Data Science Center, conducting joint research with industry partners, and serving as a hub for international research in statistical science.

Director
Professor,
Department of Applied Mathematics,
Faculty of Science Division I

Hidetoshi Murakami

Ph.D.

Many professors specializing in statistics are affiliated with our university, spanning multiple campuses and undergraduate departments. In this research division, these experts in statistical science come together to collaborate and engage in research that is unique to the Tokyo University of Science. Looking ahead, we aim to establish the "International Statistical Science Research Center" and the "Data Science Theory Research Center".

Development of mathematical and applied statistics and their fusion

Background and Purpose of the Research Department

"Statistical science" is a field that applies probability theory to develop optimal statistical methods for identifying the characteristics of populations based on observed data. In recent years, "data science" - closely linked to big data and artificial intelligence (AI) - has drawn increasing attention. At the core of these emerging disciplines lies statistical science (or statistical theory), which has gained renewed importance.

In response, our university must establish a research infrastructure that not only leads Japan but also contributes globally to the advancement of data science. However, research in data science spans a wide range of fields. Tokyo University of Science is actively pursuing excellence in this area, aiming to earn global recognition. Tokyo University of Science is place to many faculty members who specialize in statistics, with experts located across all its campuses. Notably, Tokyo University of Science stands out in Japan for having an exceptionally large number of researchers in mathematical statistics, a field focused on the theoretical foundations of statistical inference. We also have a strong track record in medical statistics, having previously offered specialized programs for working professionals.

With these strengths, we aim to establish a vibrant research hub that brings together experts across campuses and departments to collaborate on innovative projects unique to Tokyo University of Science. This research department will unite researchers from diverse fields who share an interest in foundational theory. Our goal is to elevate the study of essential statistical theories and methodologies, foster the creation of new theories, and pioneer emerging fields in the era of data science.

Research Group

This research department is roughly divided into three groups that conducts research in the following fields.

Mathematical Statistics Basis Group

(Leader: Professor Hiroki Hashiguchi (Department of Applied Mathematics, Faculty of Science Division I))

The Multivariate Analysis Group includes faculty members from the Kagurazaka, Katsushika, and Noda campuses, as well as visiting professors and associate professors. Building on the current research themes of each member - such as multivariate missing data analysis, high-dimensional data analysis, random matrix theory, and dimension reduction methods - the group conducts research aimed at expanding into the Applied Statistics Research Group. The Statistical Model Group, composed of faculty from the Kagurazaka and Noda campuses, focuses on topics including statistical modeling and model selection, nonparametric methods, and contingency table analysis. The methods explored by the Mathematical Statistics Foundations Group are grounded in well-established theoretical principles and function as "white box" approaches - transparent and interpretable. In contrast, methods for solving real-world problems — such as heuristic techniques and deep learning - often resemble a "black box", lacking interpretability.

A key challenge in building the theoretical foundation of data science is to bridge this gap: to illuminate the black-box nature of such solutions using the rigorous, transparent methodologies of mathematical statistics and related fields.

Applied Statistics Research Group

(Leader: Professor Takashi Sozu (Department of Information and Computer Technology, Faculty of Engineering))

In the field of medical statistics (biostatistics), faculty members based at the Katsushika Campus engage in research focusing on methodologies for study design and statistical analysis, with particular emphasis on medical and clinical research applications. In the domain of educational engineering, faculty members from the Kagurazaka Campus will lead research initiatives aimed at developing innovative educational methods and systems, grounded in quantitative analytical approaches. Furthermore, in recent years, there has been a notable increase in research activity across emerging interdisciplinary areas such as sports statistics, marketing analytics, and related fields. These efforts are being actively pursued, primarily by visiting professors and visiting associate professors. To further enhance these initiatives, the university plans to promote collaborative research projects that include student exchange programs, thereby fostering interdisciplinary engagement and academic mobility. In the area of statistical machine learning and mathematical optimization, faculty members at the Kagurazaka Campus undertake advanced research on the following themes:

- Natural language processing that integrates statistical and machine learning approaches with symbolic reasoning models
- Large-scale nonlinear optimization in the context of big data analytics and machine learning applications
- Statistical methodologies for computer-assisted data mining and pattern recognition
- Quantitative approaches in marketing science and business data science

These research activities are expected to contribute significantly to the advancement of foundational theory and applied methodologies in data-driven disciplines.

Deta Analysis Group

(Leader: Professor Kouji Tahata (Department of Information Sciences, Faculty of Science and Technology))

The Data Analysis Team is created to address the increasing need for precise and flexible analytical methods in today's society, where a wide variety of complex data is generated and accumulated daily. The team aims to strengthen collaboration with external partners through the Data Science Center, which facilitates joint research with companies and research institutions. To achieve this, the team adopts a flexible structure that allows researchers with the appropriate expertise to be assembled according to the specific needs of each project.

While the Mathematical Statistics Group focuses on the theoretical development of statistical methods, and the Applied Statistics Group emphasizes practical applications in areas such as medicine, finance, education, and sports, the Data Analysis Team bridges the gap between theory and application. Its primary objective is to develop and apply statistically sound, interpretable methods to analyze complex real-world data.

The team actively engages in cross-disciplinary challenges, utilizing advanced techniques such as statistical modeling in big data environments, interpreting machine learning and deep learning results, causal inference, Bayesian estimation, and data visualization. Researchers from various campuses and departments collaborate to form optimal project teams, providing a high degree of flexibility to meet diverse research needs.

Building on Tokyo University of Science's long-standing strength in mathematical statistics, the Data Analysis Team aspires to become a central hub for exploring the role of statistical analysis in supporting scientific decision-making amid real-world complexities.

Name	Job title	Department and Faculty
Shin ANDO	Professor	Department of Business Economics, School of Management
Hiroki HASHIGUCHI	Professor	Department of Applied Mathematics, Faculty of Science Division I
Toshiya IWASHITA	Professor	Noda Division, Institute of Arts and Sciences
Takeshi KUROSAWA	Professor	Department of Applied Mathematics, Faculty of Science Division I
Takuya MATSUZAKI	Professor	Department of Applied Mathematics, Faculty of Science Division I
Hidetoshi MURAKAMI	Professor	Department of Applied Mathematics, Faculty of Science Division I
Takashi SEO	Professor	Department of Applied Mathematics, Faculty of Science Division I
Takashi SOZU	Professor	Department of Information and Computer Technology, Faculty of Engineering
Kouji TAHATA	Professor	Department of Information Sciences, Faculty of Science and Technology
Nobuhiko TERUI	Professor	Department of Business Economics, School of Management
Sadao TOMIZAWA	Professor	Department of Information Sciences, Faculty of Science and Technology
Michiko TSUBAKI	Professor	Department of Management, School of Management
Yuki WATANABE	Professor	Center for Teacher Education, Organization for Education Advancement
Shuji ANDO	Associate Professor	Department of Information Sciences, Faculty of Science and Technology
Yannan HU	Associate Professor	Department of Applied Mathematics, Faculty of Science Division I
Asanao SHIMOKAWA	Associate Professor	Department of Mathematics, Faculty of Science Division II
Aki ISHII	Junior Associate Professor	Department of Information Sciences, Faculty of Science and Technology
Shummin NAKAYAMA	Junior Associate Professor	Department of Applied Mathematics, Faculty of Science Division I
Ayaka YAGI	Junior Associate Professor	Department of Applied Mathematics, Faculty of Science Division I
Yuki ANDO	Assistant Professor	Department of Mathematics, Faculty of Science Division II
Kento EGASHIRA	Assistant Professor	Department of Information Sciences, Faculty of Science and Technology
Tomotaka MOMOZAKI	Assistant Professor	Department of Information Sciences, Faculty of Science and Technology
Tomohiro OHIGASHI	Assistant Professor	Department of Information and Computer Technology, Faculty of Engineering
Koki SHIMIZU	Assistant Professor	Department of Applied Mathematics, Faculty of Science Division I
Shoma TAMORI	Assistant Professor	Department of Medicinal and Life Sciences, Faculty of Pharmaceutical Sciences
Hikaru YAMAGUCHI	Assistant Professor	Department of Information Sciences, Faculty of Science and Technology
Takayuki SHIOHAMA	Vishiting Professor	Department of Data Science, Faculty of Science and Technology, Nanzan University
Takahiro NISHIYAMA	Vishiting Professor	Department of Business Administration, School of Business Administration, Senshu University
Hiroshi YABE	Vishiting Professor	Department of Informatics and Data Science, Faculty of Engineering, Sanyo-Onoda City University
Tamae KAWASAKI	Visiting Associate Professor	Department of Economics, College of Economics, Aoyama Gakuin University
Kazuyuki KOIZUMI	Visiting Associate Professor	Faculty of Health Data Science, Juntendo University
Tomoyuki NAKAGAWA	Visiting Associate Professor	School of Data Science, Meisei University

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Established: April, 2025

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Division of Architecture and Urban Cultural Regeneration Research

Objectives	Focusing on the preservation and sustainability of architectural and urban culture, we aim to connect academic research with regional initiatives to foster mutual growth.
Future Development Goals	By nurturing researchers and building internal frameworks, we integrate academic fields related to sustainable urban and architectural renewal, connecting cultural understanding with regional contribution.

Director
Associate Professor,
Department of Architecture
Faculty of Engineering

Madoka Kayanoki

Dr. Eng.

The Division of Architecture and Urban Cultural Regeneration Research seeks to create livable, sustainable urban spaces through integrated research in architecture and urban planning. From historical preservation to advanced structural technologies, our objective is to foster strong ties between our university and local communities.

Sustaining Architectural and Urban Culture: History, Planning, Technology & Community Collaboration

Background and Objectives of the Division

In response to the increasingly complex and interrelated challenges facing today's urban environments and lifestyles, this division aims to develop and deepen a new integrated body of knowledge — **the Study of Regenerative and Sustainable Urban Space** — that guides the formation and renewal of sustainable urban environments.

The division also seeks to expand a collaborative research network with academic institutions, local governments, and private-sector partners, from areas surrounding our campus to communities across Japan. Through these efforts, it will serve as a central hub that connects various architectural, urban, and community-based initiatives at Tokyo University of Science, while actively communicating our contributions to regional development in a visible and meaningful way.

Research Structure and Members

This research division is composed of faculty members specializing in architecture and urban studies from the Kagurazaka, Katsushika, and Noda campuses. By integrating research on history, design, and community development with engineering studies on building and urban performance and disaster prevention, we aim to preserve and sustain architectural and urban cultures.

This research institute is organized around four core categories, where experts from diverse fields collaborate to generate integrated knowledge and promote interdisciplinary research:

- Architectural and Urban History, Preservation, and Renewal
  Revitalizing architectural and urban spaces by preserving cultural values while adapting them to modern needs
- Architectural Planning and Environmental Design
  Designing and improving spaces that balance human-centered perspectives with environmental performance
- Urban Analysis and Community Planning
  Analyzing urban spaces through data-driven approaches and building sustainable local communities
- Disaster Recovery, Urban Fire Safety, and Structural Reinforcement
  Creating disaster-resilient cities and enhancing the structural resilience of buildings

These research groups will work in close coordination, integrating theory and practice to explore holistic approaches to the next generation of architectural and urban spaces.

In addition, we aim to strengthen institutional collaboration within the university, fostering the convergence of a broad range of academic disciplines related to regenerative urban environments. By deepening our understanding of diverse cultures and academic perspectives, we seek to contribute visibly and meaningfully to regional development.

University and Regional Engagement

There has been increasing discussion on the role universities should play in contributing to society and how local collaboration should be integrated into higher education. In this broader context, the importance of giving back to society through research and education is crucial. Today, universities are expected to be active social entities, engaging in collaborative efforts with local communities, industries, and public institutions.

As a university with multiple campuses in Tokyo and Chiba, we recognize the value of contributing to each locality's appeal and vitality. By leveraging expert knowledge in architecture and urban studies, we aim to support the effective use of local resources, address regional challenges, and build cooperative relationships with local governments, residents, and businesses. We believe in fostering meaningful connections among these stakeholders through collaborative initiatives.

We envision active engagement beyond the Tokyo metropolitan area, including technical cooperation in disaster-affected regions and other areas across Japan facing urban and architectural challenges. Through an interdisciplinary approach that integrates diverse areas of expertise, our division is committed to addressing not only theoretical issues but also real-world, practical challenges.

□ Katsushika

Faculty members of our division are collaborating to evaluate the historical significance of the former Mizumoto Elementary School — a rare wooden school building remaining within Tokyo's 23 wards and a designated cultural property of Katsushika Ward — as well as to study methods for seismic reinforcement in response to structural safety concerns.

As another example, faculty and students worked with the Kanamachi Mirai Council to engage with the local community and help plan a park as a regional center.

□ Kagurazaka

We conducted architectural surveys and created scale models of two important buildings in Kagurazaka: Traditional ryotei "Uotoku" (closed in 2022) and the Tokyo Kagurazaka Association Office, commonly known as "Kenban."

In another initiative, our faculty and students participated in various activities aimed at the restoration and utilization of Sotobori, a cultural asset adjacent to our university.

□ Noda

In collaboration with the local community, we host the annual Tone Canal Theater Night, an event that showcases the cultural and historical charm of the Tone Canal area.

□ Toyama Prefecture (Affected by the Noto Peninsula Earthquake)

In response to earthquake damage in Imizu City, Toyama Prefecture, we are working with the Toyama Prefectural Wood Research Institute to develop earthquake-resistant shelters using locally sourced timber.

Information and Societal
Established: April, 2021

takemura@rs.tus.ac.jp

Parallel Brain Interaction Sensing Division

Objectives	We aim to move beyond conventional brain research focused on individuals, and instead explore inter-brain dynamics and group formation through advanced sensing technologies.
Future Development Goals	We will host seminars and workshops to foster a shared language among researchers, promote interdisciplinary collaboration, and nurture the next generation of scientists.

Director
Professor,
Department of Mechanical and Aerospace Engineering,
Faculty of Science and Technology
Hiroshi Takemura
Doctor of Engineering

Our division integrates multidimensional expertise in neuroscience from within and outside the university. We aim to build a collaborative research platform that explores brain interactions across individuals, pioneering a new academic field—“Connected Neuroscience,” or the “Parallel Brain”—originating from Tokyo University of Science.

The Future of Neuroscience: Toward a Connected Brain World

Background and purpose of the division

Neuroscience is undergoing rapid evolution in the 21st century. Maintaining brain health is expected to improve quality of life in aging societies, while understanding brain information processing mechanisms holds promise for groundbreaking technological innovations. As the Internet of Things (IoT) and wearable devices increasingly connect humans to digital networks — forming the Internet of Bodies (IoB) — it is not difficult to envision the next phase: the Internet of Minds (IoM), where human cognition itself becomes interconnected.

Anticipating this future, our division at Tokyo University of Science aims to establish a multidisciplinary research platform that integrates expertise in brain science, neural systems, and information technologies. We are pioneering a new academic field — Connected Neuroscience, or the Parallel Brain — to explore how multiple brains interact and synchronize in both physical and digital environments.

Research Organization and Members

Our division proposes innovative technologies for sensing and replicating biological information based on synchronized (parallel) measurements of brain activity across multiple individuals, including both mice and humans. This approach enables us to investigate the dynamics of group formation and inter-brain interactions in social contexts.

We are organized into three synergistic research groups:

Animal Experiment Group (Mouse/Human) :
This group conducts multidimensional research on cognition-related brain health and disorders, including depression (characterized by pessimistic cognition), dementia (with impaired memory and cognition), and autism (involving deficits in social cognition and communication). From molecular mechanisms to neural circuits and animal models, we aim to uncover underlying processes and develop novel therapeutic and diagnostic strategies.

Sensing Group :
Focusing on developmental disorders, this group analyzes gaze behavior and physiological indicators to understand personality traits and brain dysfunction. We aim to develop advanced measurement technologies and assistive devices that support both research and clinical applications.

Mathematical Model Group :
This group constructs theoretical models of brain information processing systems. Drawing on data from brain imaging, cognitive psychology experiments, and brain-inspired algorithms, we aim to describe inter-brain dynamics and social cognition through mathematical frameworks.

Members and Collaboration

The division consists of 18 researchers in interdisciplinary neuroscience-related fields, including the Faculty of Science and Technology (Hiroshi Takemura, Takeo Ushijima, Takahiko Yamamoto, Akari Hagiwara, Takumi Asakura, Masataka Yamamoto), the Faculty of Pharmaceutical Sciences (Akiyoshi Saito, Daisuke Yamada), the Research Institute for Biomedical Sciences (Takeshi Nakamura, Shingo Koinuma), the Faculty of Engineering (Osamu Sakata, Takuya Hashimoto), the Faculty of Advanced Engineering (Eri Segi (Nishida), Kanzo Suzuki), the Institute of Arts and Sciences (Hiroko Ichikawa), and three visiting researchers: Ryohei Hasegawa and Toshihiro Takamatsu from the National Institute of Advanced Industrial Science and Technology (AIST) and Asami Oguro-Ando from the University of Exeter Medical School. Each member contributes unique expertise and facilities, enabling collaborative research that transcends disciplinary boundaries. This structure allows us to pursue innovative projects that would be difficult to realize in conventional research settings.

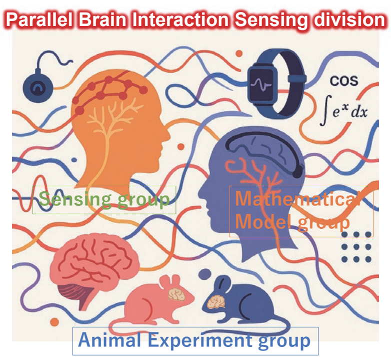
Ongoing Research Topic

We are mainly engaged in collaborative and cooperative research use of the unique talents and strengths of each member. The following is a port of list of ongoing collaborative research projects that transcend the boundaries of each specialized field, which are possible only in this division. For details, please see the division’s website.

- Elucidation of brain functions controlling social behavior
  (Prof. Segi and Prof. Oguro-Ando [University of Exeter])
- Investigation of cross-species vocal communication
  (Prof. Ichikawa, Prof. Saito, and Prof. Yamada)
- Examination of cross-species vocal communication: Relationship between ultrasonic vocalizations in mice and the effects of ultrasonic listening in humans
  (Prof. Ichikawa, Prof. Saito, Prof. Yamada, and Prof. Asakura)
- Analysis of Stress-Induced Depression-like State
  (Prof. Saito, Prof. Yamada, Prof. Takemura, and Prof. Yamamoto)
- Study on the Relationship between Human Gait Behavior and Personality Traits: Extraction and Evaluation of Gait Characteristics Derived from Human Internal State
  (Prof. Ichikawa, Prof. Takemura, and Prof. Yamamoto)
- Biomechanical Analysis of Age-Dependent Gait Deficiency in Cerebellar Neural Transmission Deficient Mice
  (Prof. Hagiwara, Prof. Takemura, and Prof. Yamamoto)
- Evaluation of the neural basis of stress sensitivity in synaptic protein-deficient mice
  (Prof. Hagiwara, Prof. Saito, Prof. Yamada, Prof. Takemura, and Prof. Yamamoto)
- Analysis of Jakmip1-deficient mice, a mouse model for autism
  (Prof. Saito, Prof. Oguro-Ando, Prof. Hagiwara, Prof. Yamada)
- DNA methylation analysis in various mouse models
  (Prof. Oguro-Ando, Prof. Segi, Prof. Saito, Prof. Hagiwara, Prof. Yamada)
- Examination of cross-species vocal communication: Relationship between ultrasonic vocalizations in mice and the effects of ultrasonic listening in humans
  (Prof. Ichikawa, Prof. Saitoh, Prof. Yamada and Prof. Asakura)
- Unveiling Emotional Resonance in Classical Music Through Brainwave Analysis
  (Prof. Asakura, and Prof. Hasegawa)
- Research on Causality Analysis Technology Between Various Biological Signals for Visualization of Brain-Gut Correlation Phenomenon
  (Prof. Sakata)

Toward Future Advancement

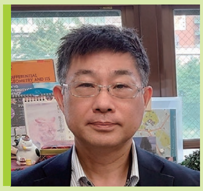
Our division continues to evolve by integrating collaborative and individual research efforts. We aim to further develop the field of “Parallel Brain” through interdisciplinary synergy, and by strengthening ties with clinical institutions such as medical schools and hospitals. In doing so, we will enhance the university’s neuroscience research infrastructure and actively contribute to the education and training of the next generation of researchers.



koike@rs.tus.ac.jp

Division of Joint Research of Geometry and Natural Science

Objectives	The members of this research division aim to construct the comprehensive geometric theory of the natural science (in wide sense) of the quantum mechanics, the condense matter theory, molecular biology, the grain boundary structure theory and composite materials mechanics, and feedback to each of the above fields of the natural science.
Future Development Goals	For the above objectives, we promote to make research alliance with other divisions in our research institute and institutes other universities.



Director
Professor,
Department of Mathematics
Faculty of Science

Naoyuki Koike
Ph.D.

The pure mathematics is divided broadly into three research fields of the algebra, the analysis and the geometry. The members of this research division aim to construct the comprehensive geometric theory of the natural science in wide sense of the quantum mechanics, the condense matter theory, molecular biology, the grain boundary structure theory and composite materials mechanics, and feedback to these fields of the natural science.

Joint research of the geometry and the natural science of the quantum to these mechanics, the condense matter theory, molecular biology, the grain boundary structure theory and composite materials mechanics

Geometry and Natural Science

The geometry is divided broadly into three fields of the differential geometry, the topology and the algebraic geometry. In the differential geometry, it was originally aimed to research a differential manifold M equipped with a geometric structure g (where a differentiable manifold means the space where the continuity and the differentiability of maps between the spaces can be defined) and investigate the properties of figures in the space (M,g) which are invariant under transformations of M preserving g invariantly. Note that the whole of such transformations of M preserving g invariantly is a Lie group (that is, a differentiable manifold equipped with a suitable group structure). Later, in the differential geometry, it also has been aimed to research the theory of the connections of principal bundles and their associated vector bundles over the space (M,g) in order to research the gauge theory (in the theoretical physics) from the viewpoint of the differential geometry. For example, the theory unifying the gravitational field and the electromagnetic field is researched by using the principal bundle having the unitary group U(1) of degree one as the structure group over a 4-dimensional Lorentzian manifold (M,g). Thus the differential geometry is closely connected to the theory of Lie group actions and the gauge theory, and hence can be applied to the researches of the quantum mechanics and the condensed materials physics. In the geometric analysis (which is researched by using both of the differential geometry and the analysis), the mean curvature flow and the harmonic flow etc. are researched, where the mean curvature flow means the gradient flow of the (-1)-multiple of the volume functional, and the harmonic flow means the gradient flow the (-1)-multiple of the (usual) Energy functional. We aim to apply these researches to those of the grain boundary and the cluster. Also, we aim to apply these researches to that of the shape of double helices of polydeoxyribonucleotides constructing DNA and so on in the molecular biology. Furthermore, we aim to apply the research of the strength of the grain boundary to that of the composite materials mechanics. The topology aims to research a topological space X (where can be defined the continuity of maps between the spaces) and investigate the properties of the figures in X which are invariant under continuous transformations of X. Also, the various algebraic topological invariants (for example, the homotopy group and the homology group) are used in this research. The knot theory is very important in the research field of the topology and the research of DNA・RNA. The knot means a circle continuously embedded into the 3-dimensional sphere (or the 3-dimensional Euclidean space). Here we note that knots in the 3-dimensional Euclidean space are regarded as knots in the 3-dimensional sphere because the 3-dimensional Euclidean space is identified with an open portion of the 3-dimensional sphere. Main research theme of the knot theory is to investigate whether two knots in the 3-dimensional sphere are mapped to each other by a homeomorphism (a continuous one-to-one map such that its inverse also is continuous) of the 3-dimensional sphere. The knot theory is important in the research of the topological global structure (the structure of double helices) of polydeoxyribonucleotides constructing circular DNA (in the molecular biology). Also, knots and the mapping class group are sometimes researched by using the gauge theory, which is one of so-called the topological field theory. In the algebraic geometry, are researched the structure of the common zero-point set of some polynomials over the affine space or the projective space. This research is used to investigate the moduli space of the space of various kind of connections of the principal bundle and hence is applied it to various researches of the gauge theory.

The research themes in this research division

As above, each research field of the geometry are connected closely to those of the quantum mechanics, the condensed matter physics, molecular biology and grain boundary-composite materials mechanics. In detail, we aim to perform the following four researches.

I. The research of the condensed matter physics in the view-point of the geometric variational theory

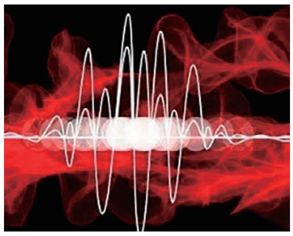
II. The research of the quantum walk in the view-point of the geometric gauge theory

III. The research of DNA・RNA in the view-point of the knot theory, the topological field theory and the geometric variational theory

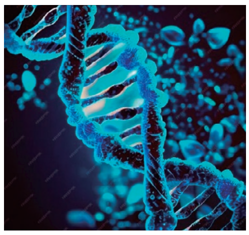
IV. The research of the grain boundary in the view-point of the geometric analysis and its application to the composite materials mechanics

About the detail of the research methods of the above I～IV, see the following page in the original homepages of this research division.
RIST-TUS-Geo.Nat.Sci.-about-e

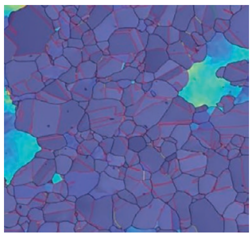
I. Crystal structure



II. Quantum state



III. DNA



IV. Grain Boundary

Fundamentals

Established: April, 2025

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Division of Research for Photonics-Electronics Convergence

Objectives	We conduct interdisciplinary research with researchers in the fields of optical communication, wireless communication, network engineering, electronics, quantum optics, and condensed matter physics.
Future Development Goals	Our division aims to serve as a center for research and development, where the results of basic research at the university are used as seeds to promote the development of practical applications through collaboration with industry and government.

Director
Associate professor,
Department of electrical engineering
Faculty of engineering

Yutaka Fukuchi
Ph.D.

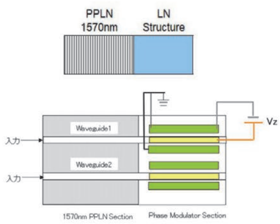
Our division is equipped with advanced experimental equipment and an environment for analysis and computing, along with faculty members capable of advancing research on photonics-electronics convergence in a cross-disciplinary manner. We also actively promote collaboration with industry, government, and academia. If you are interested in working with us, please feel free to contact the head of the division.

Cutting-Edge Joint Research on Photonics-Electronics Convergence Technologies

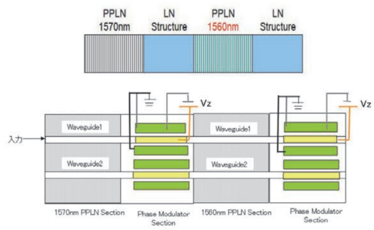
Optical communications, which support global Internet traffic, have significantly improved in performance over the past three decades and will continue to demand higher speeds and larger capacity. This is due to the anticipated increase in data traffic driven by developments such as 4K/8K ultra-high-definition broadcasting, immersive metaverse environment, autonomous mobility, and large-scale AI computing.

To construct future exabit/s-class and energy-efficient optical communication systems, breakthroughs are needed to overcome current technical limitations. We are developing, both theoretically and experimentally, high-functional optical signal processing technologies employing advanced quasi-phase-matched nonlinear optical devices. These functional devices can process ultra-fast and ultra-wideband data signals all-optically with minimal latency and power consumption.

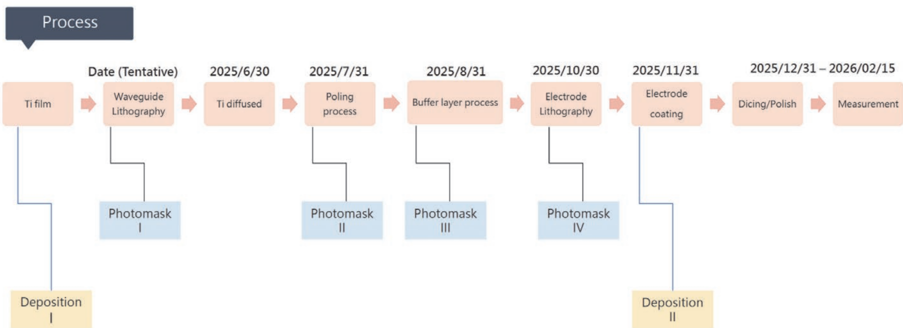
Our research includes both theoretical modeling and experimental demonstrations, and we have achieved high performance in the system experiments. Through joint research with domestic companies and overseas universities, we also aim to realize a new generation of smart optical communication systems suitable for practical use.

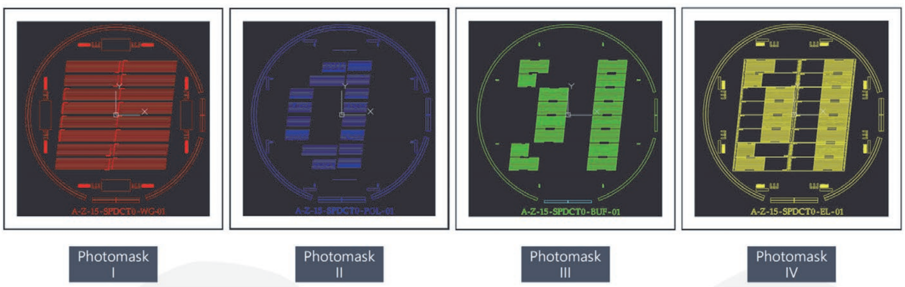


- Temperature : 60℃
- PPLN wavelength : 1570.0nm
- PPLN length : Typ. 10mm
- Phase modulator : V_{pi} > 50V
- Chip dimension : ~23mm (L) x ~6mm (W) x ~0.45mm (H)



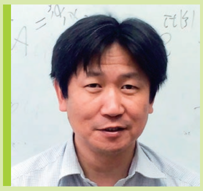
- Temperature : 60℃
- PPLN wavelength : 1570.0nm + 1560.0nm
- PPLN length : Typ. 10mm
- Phase modulator : V_{pi} > 50V
- Chip dimension : ~46mm (L) x ~6mm (W) x ~0.45mm (H)





kato@rs.tus.ac.jp

Division of Mathematical Modeling



Director
Professor,
Department of Mathematics,
Faculty of Science Division I

Keiichi Kato
Ph.D.

This division has been established on the April of 2025, as the succession of Division of Research Alliance for Mathematical Analysis. Our aim is to make interdisciplinary researches between mathematical analysis, numerical analysis, physics, chemistry, biology and technology. The members of our division are willing to cooperate to those who need to techniques of mathematical analysis, numerical analysis or theoretical physics.

Objectives	To make interdisciplinary researches with researchers of mathematical analysis, numerical analysis, physics, chemistry, biology and engineering.
Future Development Goals	We make research alliance with other divisions in our research institute and institutes outside the university.

Interdisciplinary researches between mathematical analysis, science and engineering

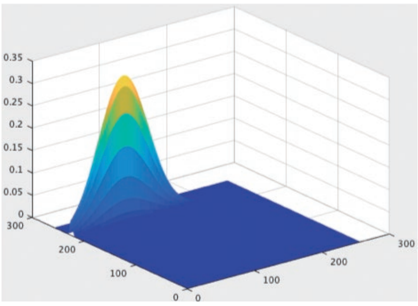
This division has been established on the April of 2025, as the succession of Division of Research Alliance for Mathematical Analysis. The aim of our division is to make alliance research over mathematical analysis, numerical analysis, physics, chemistry, biology and engineering.

Alliance inside the division

We make research alliance based on Three groups(Group of mathematical physics, Group of mathematical biology and Group of mathematical engineering) .

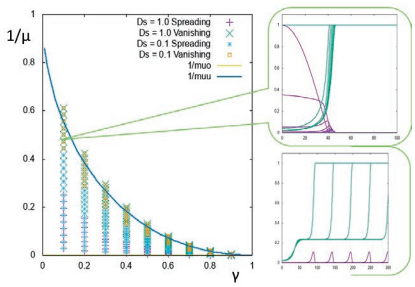
• Group of mathematical physics

The aim of the group is to establish original numerical method for Schrödinger equations based on representation of solutions via wave packet transform due to K. Kato and apply it to condensed matter physics. We have succeeded to establish original numerical method and are applying it to compute numerical solutions of Schrödinger equations.



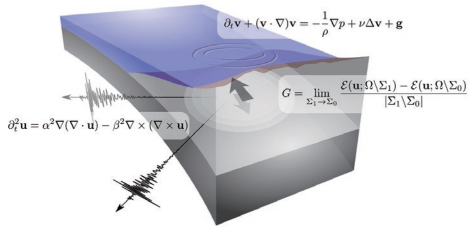
• Group of mathematical biology

We investigate asymptotic behavior of solutions of mathematical models including epidemiological models and Keller–Segel system for cancer invasion. One of our study is a free boundary problem that describes the spatial propagation of a transmitted disease. By a joint work among E. Ishiwata, T. Ushijima, Y. Enatsu, we have obtained a new result for existence and nonexistence of a traveling wave solution (a solution propagating in a direction with the same profile and the same speed). Starting February 2018, we have organized regular seminars relating to infectious diseases in Kagurazaka campus. In the seminar, talks on infectious diseases are given by researchers in the field of mathematics, biology, medical science.



• Group of mathematical engineering

This is a research group focused on mathematical analysis of various phenomena in continuum mechanics and applying to inverse problems. Especially, we study fracture phenomena for elastic structures, motion of vortex filaments, faulting rupture in seismology and so on. As regards inverse problems, we deal with reconstruction problems for discontinuity embedded in a medium, such as cracks, cavities, inclusions and obstacles, from observed data, which are arising from non-invasive tests for a living body, non-destructive tests in engineering and inversion of source process in seismology. The aim of the group is to provide theoretical foundations and their numerical implementation.



Alliance with other divisions in RIST

From the beginning of the 21st century, the importance of mathematics has been known more and more even in our country. In the research institute for Science and technology(RIST), we have two mathematical division: this division and the division of modern algebra and cooperation of engineering(DMACE). We will make research alliance with other divisions such as divisions of condensed matter physics, divisions of chemistry, divisions of biology and divisions of engineering with cooperation of DMACE.

Alliance with other institutes

On the January of 2020, we have concluded the agreement for research alliance between RIST and Research Alliance Center for Mathematical Sciences(RACMaS) in Tohoku University. We will promote research alliance between this division and RACMaS based on the agreement. We also try to make research alliance with other institutes.

Fundamentals

Established: April, 2021

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Modern Algebra and Cooperation with Engineering

Objectives	To research and develop algebra itself and algebra based engineering, also to make cooperative research on algebra and engineering, thereby to make a contribution to mathematics and engineering.
Future Development Goals	To make contribution to mathematics and engineering, and to continue to be the center of research on algebra and its applications to engineering.

Director
Professor,
Department of Mathematics,
Faculty of Science and Technology

Hiroyuki Ito

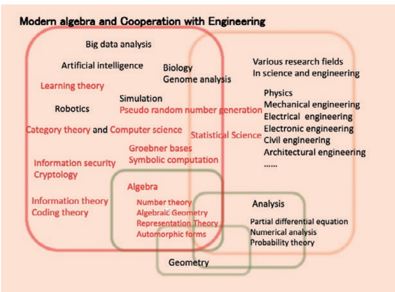
Doctor of Science

This division do research from purely theoretical mathematics to experimental engineering, and make cooperative environment between mathematicians and researchers in algebra based engineering. Furthermore, the division will contribute to make cooperative research between algebra and engineering which induces mathematical innovation. The division continue to play an important role as the international hub for research on algebras.

Theoretical research on algebra and its applications on engineering

Background and purpose of the division

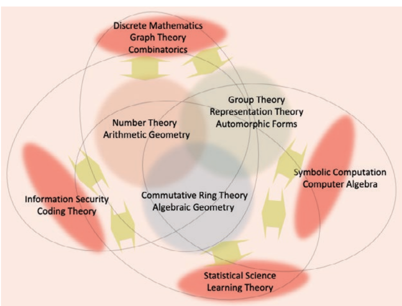
It is important for mathematics, which has more than 2000 years history for research, to interact with other research fields outside mathematics. Research area of pure mathematics is roughly divided into three parts, algebra, geometry and analysis. One can think that algebra and analysis are two wheels of a cart, via geometry and geometric objects. In its long history, analysis, which treat mainly continuous objects, has been developed in interaction with various engineering technology. On the other hand, algebra, which treat mainly discrete objects, has been started to make interaction with information science, information technology, electrical and mechanical engineering, etc., after 20th century, and produce many useful results and effects which are indispensable for modern human life. Our division based on algebra are going to cooperate with another division “Research Alliance for Mathematical Analysis”, and are going to be a basis of science and technology to cooperate with various research areas. And finally, to be a center of research on algebra and algebra based engineering.



Research on Modern Algebra and Cooperation with Engineering

The division consists of various researchers inside Tokyo University of Science, whose research fields are number theory, arithmetic geometry, algebraic geometry, commutative algebra, representation theory, automorphic forms, algebraic topology, discrete mathematics, combinatorial design, computational mathematics, computer algebra, cryptology, information security, coding theory, applied algebra, and statistical science. In the past, these researchers have cooperated with each other in the occasion of seminars, workshops and international meetings. As an activity of this division, we pursue further cooperative relationship not only inside the division, but also outside the division, and we are going to produce many cooperative research between pure mathematics and engineering.

More precisely, the division consists of three groups for purely mathematical research and four groups for applied research. Pure mathematics groups are managed by holding seminars, workshops and symposiums on algebra, algebraic geometry, number theory, and so on. Engineering groups are also managed by making a place for engagement of researchers of pure mathematics and engineering, and by proposing and developing many research plans for both sides, mathematics and engineering. Furthermore, the division do cooperative research under continuously pursuing the deep cooperation with Research Alliance Center for Mathematical Sciences, Tohoku University.



There are three special features of this division. 1) The generations of researchers are widely distributed. 2) They have enough experiences of joint research not only for domestic but also for international. 3) The researchers have been managed continuously various seminars and symposiums inside Tokyo University of Science.

About the Future of Modern Algebra and Cooperation with Engineering

Since making relationship between person and person in various research fields has already done, the next step is expanding the relationship between person and person to the cooperative relationship between person and group, group and group. Furthermore, develop a new cooperative research fields based on algebra. Also keep to play an role as an international research hub cooperate with Research Alliance Center for Mathematical Sciences, Tohoku University.

Name	Job title	Affiliation	Main research field
Hiroyuki Ito	Professor	1S	Algebraic geometry, Applied algebra
Masanari Kida	Professor	1S	Number theory
Naoko Kunugi	Professor	1S	Representation theory
Yosuke Sato	Professor	2S	Computer algebra
Hiroshi Sekigawa	Professor	OS	Computational Mathematics
Takao Satoh	professor	2S	Algebra, Geometry
Katsunori Sanada	Professor	TE	Ring theory
Hiroki Aoki	Professor	MA	Automorphic forms
Tomokazu Kashio	Professor	MA	Number Theory
Nobuko Miyamoto	Associate professor	IS	Discrete mathematics
Kouji Tahata	Professor	IS	Statistical science
Katsusuke Nabeshima	Associate professor	OS	Computer algebra
Hisanori Ohashi	Associate professor	MA	Algebraic geometry
Yoshitaka Hachimori	Associate professor	MA	Algebra, Number theory
Kenta Noguchi	Associate professor	IS	Graph theory
Yasutaka Igarashi	Associate professor	EE	Information security, Cryptanalysis
Takashi Nakamura	Associate professor	CU,Noda	Analytic number theory
Sho Yoshikawa	Junior associate professor	1S	Number Theory
Takenori Kataoka	Junior associate professor	2S	Number Theory
Yuta Kozakai	Junior associate professor	KK	Representation theory
Yuya Matsumoto	Junior associate professor	MA	Number theory Algebraic Geometry
Ayako Itaba	Junior associate professor	CU, Katsushika	Algebra, Noncommutative algebraic geometry
Yuta Katayama	Assistant professor	1S	Number theory
Kyoichi Suzuki	Assistant professor	1S	Representation theory
Densuke Shiraishi	Assistant professor	2S	Number Theory, Arithmetic Geometry
Fuetaro Yobuko	Assistant professor	MA	Arithmetic Geometry, Algebraic Geometry
Mahiro Atsuta	Assistant professor	MA	Number Theory
Hyuga Yoshizaki	Assistant professor	MA	Number Theory
Mutsuo Oka	Guest Professor	Prof.Emer. TIT	Singularity theory
Ryotaro Koshio	Guest Reseacher	SHANON Co. Ltd.	Representation theory

1S=Department of Mathematical Information Science, Faculty of Science Division I
OS=Department of Mathematical Information Science, Faculty of Science Division I
KK=Mathematics and Science Education, Graduate School of Science
2S=Department of Mathematical Information Science, Faculty of Science Division II
TE=Center for Teacher Education
MA=Department of Mathematics, Faculty of Science and Technology
IS=Department of Information Sciences, Faculty of Science and Technology
EE=Department of Electrical Engineering, Faculty of Science and Technology
CU,Noda=Noda Division, Institute of Arts and Sciences
CU,Katsushika=Katsushika Division, Institute of Arts and Sciences

Fundamentals
Established: April, 2025

fumiki@rs.tus.ac.jp

Division of Nano-quantum Information Science and Technology

Objectives	Our research division aims at optimization of the operation/readout condition for superconducting, and optical qubits.
Future Development Goals	This division will contribute to the practical realization of the quantum computer in 2050.

Director
Professor,
Department of Physics,
Faculty of Science Division I

Fumiki Yoshihara
Ph.D.

The research of quantum computers has been very active during recent years. One of the reasons for the rapid progress is the improvement in coherence time of the qubit due to the advancement of nanotechnology. However, the current status of the quantum circuit has not yet attained its full implementation. We must accelerate the pace of research and development toward the truly fault-tolerant quantum computer.

Nanotechnology and its applications to quantum information and electronics

Background

In recent years, demonstrations of quantum supremacy by Google and later the University of Science and Technology of China, the establishment of IBM's commercial quantum computer, and the D-Wave System's large quantum annealing machines, quantum information processing has made remarkable progress. All of the above systems are based on superconducting qubits, but quantum computing systems based on other systems such as ions, cold atoms, semiconductors, and light are also being actively researched around the world.

Our targets

Our division mainly investigates the superconducting qubit. Qubit cause errors like ordinary classical semiconductor circuits. For example, malfunction of the qubit comes from the breakdown of the quantum superposition state. Such phenomenon is called decoherence. Even for the state-of-the-art superconducting qubit, its coherence time is still in the order of milli seconds. The fault-tolerant quantum computer would be realized by employing a quantum error correction procedure, and it would deliver truly practical applications. The division plans to carry out research of several kinds of fault-tolerant quantum circuits with superconducting qubits. It is expected that the fault-tolerant quantum computer would appear by 2050, and we would try to contribute to its realization.

In this division, we have succeeded in developing a novel qubit called a superconducting bosonic qubit and have shown that it is a scalable quantum information processing platform. In the future, we are planning a demonstration experiment of quantum error correction using these qubits.

Integrability and operability are the advantages of superconducting qubits, and its disadvantage, the short coherence time, has been significantly improved in recent years. Besides the superconducting qubit, qubits based on other physical systems, like photon, ion, cold atom and electron spin in quantum dot have been investigated. In our division, optical qubits are also being investigated, along with the superconducting qubits.

Moonshot Research & Development Program

The research subject "Developing bosonic code using superconducting resonator" was adopted to the government moonshot research & development program in 2020. The program leader is Prof. Tsai. Prof. Yoshihara, Takayanagi, Watabe, and Hashizume join this program.

This program continues until 2025 (https://ms-iscqc.jp).

Members

Affiliation	Name
Tokyo University of Science	Fumiki Yoshihara
Tokyo University of Science	Jaw-Shen Tsai
Tokyo University of Science	Kaoru Sanaka
Tokyo University of Science	Mark Paul Sadgrove
Tokyo University of Science	Noboru Watanabe
Tokyo University of Science	Yoichiro Hashizume
The University of Tokyo	Hideaki Takayanagi
Shibaura Institute of Technology	Shohei Watabe
The University of Tokyo	Yasuhiko Arakawa
Riken	Seigo Tarucha
NEC	Tsuyoshi Yamamoto
NTT	Shiro Saito
JST	Jun'ichi Sone
NICT	Sahel ASHHAB

Open Innovation Project

Established: June, 2022

manabu@rs.tus.ac.jp

Research & Development Platform of Functional Green Building Materials

Objectives	Our goal is to achieve the societal implementation of environmentally conscious architecture by developing a system to assess and visualize the life cycle CO_2 emissions of non-structural components, considering their lifespan. Additionally, we promote research and development of high-performance materials and construction methods that reduce CO_2 emissions during manufacturing and construction.
Future Development Goals	We will achieve the design and construction methods with innovative functional building materials based on new concepts while taking advantage of the industry-academia collaboration and science-engineering partnership, toward the ultimate goal of environmentally conscious architecture.

Director
Professor
Department of Architecture
Faculty of Science and Technology

Manabu KANEMATSU
Ph.D

What is Environmentally conscious architecture, and how should it be designed and constructed? What materials and construction methods contribute to that realization? Our goal is to create and enhance the academic research field that bridges cutting-edge and fundamental research areas with practical application areas, bringing together Tokyo University of Science's scientific and engineering expertise and Shimizu Corporation's practical and operational capabilities towards achieving the design and construction methods required to realize truly environmentally conscious buildings.

Toward the realization of environmentally conscious architecture through research and development of high-performance materials and design-construction methods contributing to CO_2 emission reduction

Background and Purpose of the Project

As efforts towards decarbonization spread throughout society, the role served by the construction sector, which forms the foundation of people's activities and lives, is immensely significant. It is essential to conduct a comprehensive examination that combines the academic foundation required for achieving highly advanced environmentally friendly architecture with the practical capability to implement these concepts in the real world. Given the significant advancements in energy conservation, renewable energy, and CO_2 reduction during the operational phase of buildings, the proportion of environmental impact generated during material procurement, production, and construction processes is relatively increasing throughout the entire building lifecycle. In particular, nonstructural components, which produce about 20% of the "Embodied Carbon" emissions during the construction phase, play an important role in controlling the diverse performance and functionality of spaces. On the other hand, while there are a vast number of combinations of materials and construction methods, and there have been many individual studies on it and social implementations from the perspective of environmental considerations, efforts to optimize the environmental impact, performance, and functionality of entire buildings have not been sufficient.

This project aims to establish practical design and construction methods that minimize environmental impacts throughout the entire lifecycle, by developing the evaluation methods for environmentally friendly architecture. Our fusion research project will serve as a platform for the development of new functional building materials that bridge advanced foundational research and practical applications, with the goal of creating new research fields.

Towards Achieving Environmentally Friendly Architecture through Reduction of Environmental Impact in Non-Structural Components

In the pursuit of reducing environmental impacts associated with non-structural components, a comprehensive assessment considering both Embodied Carbon and operational carbon emissions during the operational phase is necessary to evaluate the entire lifecycle CO_2 emissions of buildings, known as "Whole Life Carbon." In addition, it's essential to take into account the impacts of performance as building components on environmental impact the use of recycled materials, and other practical initiatives. However, when compared to structural materials, the inadequate progress in establishing a comprehensive database for non-structural materials, which is crucial for accurately calculating Embodied Carbon, is also a noteworthy concern.

Therefore, this project will advance research and development through the establishment of the following working groups for "Investigation of Environmentally Friendly Architecture Strategies," which aims to construct evaluation and optimization methodologies for the design and construction of environmentally friendly architecture, as well as "Research and Development of Environmentally Friendly Construction Methods," which involves the implementation of specific material and construction method developments.

i)Investigation of Environmentally Friendly Architecture Strategies
WG0: CO_2 Reduction Strategy
ii)Research and Development of Environmentally Friendly Construction Methods
WG1: Exterior Materials / WG2: Interior Materials /
WG3: Opening Components / WG4: Substrate Materials

In the WG0, we will promote research and development of materials and methods that achieve a high level of environmental performance and functionality for exterior materials (WG1), interior materials (WG2), opening components (WG3), and substrate materials (WG4), which have a significant impact on Whole Life Carbon.

Based on the achievements of the past three years, this project will enter Phase 2 (from 2025), aiming for further collaboration with society and practical implementation.

Contribution of this Project

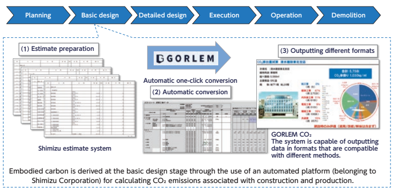
By advancing this industry-academia collaboration as a comprehensive, open innovation-based project, we aim to create pioneering examples across a broad spectrum of interdisciplinary fields and take a leading role in environmental conservation within the construction industry. The realization of this initiatives is expected to result in the following contributions to the societal issue:

Establishment of an ecologically congruous society via the formulation of methodologies underpinning design and construction facets of environmentally mindful architecture.

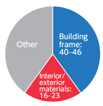
Pioneering the development and real-world assimilation of novel material technologies and construction methodologies that underpin environmentally conscious architectural endeavors.

The crystallization of an integrated framework that fosters both foundational research and societal deployment, culminating in the creation and implementation of pioneering environmentally conscious technological paradigms.

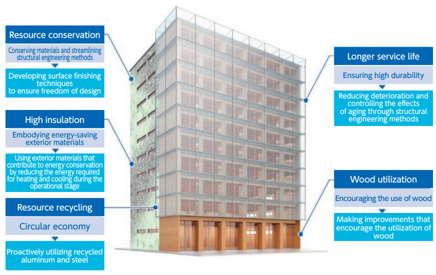
Nurturing a cadre of adept professionals pivotal to the realization of environmentally conscious architectural endeavors.

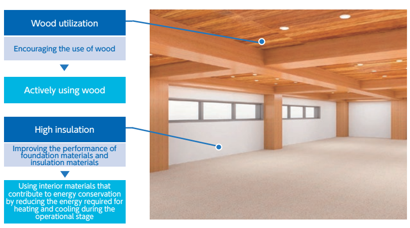


Items	A	B	C	D	E	F
Total floor area (m²)	3,700	4,100	6,500	7,500	16,000	19,000
CO_2 emissions (kg-CO_2 / m²)	1,300	1,300	1,200	1,200	1,100	1,400
Building frame (%)	40	40	42	43	46	42
Exterior materials (%)	8	9	7	6	4	12
Interior materials (%)	12	11	12	10	12	11



Examples of life cycle CO_2 calculation results (six office building examples) are based on the "LCA Guidelines for Buildings" published by the Architectural Institute of Japan Interior and exterior materials (non-structural components) play a functional role in determining the direct performance of buildings, and their share of CO_2 emissions cannot be ignored.





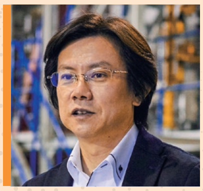
Examples of efforts aimed at achieving environmentally friendly construction

Joint Usage/Research Center

Established: July, 2009 kasaianzen-ml@tusml.tus.ac.jp

Research Center for Fire Safety Science

Objectives	The purpose of this center is to promote research and education on fire safety and to contribute to the promotion of fire safety research and education in Japan, as well as scientific education and research for the next generation of students and researchers, by providing for joint research and use.
Future Development Goals	We would like to further strengthen the activities of the center by enhancing its networking and human resource development functions to form a center of excellence for education and research institutions in the field of fire science around the world.



Director
Professor,
Department of Global Fire Science and Technology,
Graduate School of Science and Technology
Ken Matsuyama
Dr.Eng.

This center is expected to achieve efficient and effective results by taking on the role of consolidating knowledge in Japan, with the aim of contributing to the reduction of fire damages and the control of potential fire risks. At the same time, a great deal of research is being conducted with a focus on "theory" in fire science across multiple disciplines and "practical" responses through large experimental facilities.

As a Joint Usage/ Research Center, cutting-edge joint research is being conducted with researchers from around the world.

Objectives

The Research Center for Fire Safety Science conducts collaborative research with researchers within and outside the Tokyo University of Science. The Center aims to promote research and education on fire safety and facilitate collaborative research. By publishing its outcomes, the Center contributes to the advancement of fire safety research and education of those who will lead the next generation. Research centered on multidisciplinary theoretical and practical aspects of fire safety utilizing large-scale experimental facilities is being conducted, contributing to reducing fire losses. The Center solicits research proposals from domestic and international sources, aiming to contribute to reducing fire risks in urban spaces utilizing state-of-the-art technologies.

Open Call Schedule

The Center invites and accepts research plans from public basically once a year research activities of the selected plans start at the beginning of each academic year. However, research of urgency may be accepted at any point of an academic year as needed.

The rough schedule of the application is as follows:

- Announcement of the theme : early February
- Application period : February to mid-March
- Notification of acceptance : March to April
- Conducting collaborative research : April to next March
- Briefing report of achievement : by next April

Reference Research Theme

The following proposals are open: Priority Research Proposals A, Large-scale Experimental Research Proposals B, and General Proposals C through H.

[Priority Research Category]

A. Research on the early detection of catastrophic events

In fires, sudden and rapid changes (referred to as catastrophic events) can occur, leading to a dramatic increase in damage. Examples include ignition, transition from smoldering to flaming, flashover, and backdraft. Detecting signs of these events before their occurrence will reduce fire damage and firefighting risks. In AY2025, we solicit research that contributes to the early detection of catastrophic events from a wide range of perspectives.

[Large-scale Experimental Research Category]

B. Experimental research on building structural fire resistance

Large-scale experimental challenges to use the Structural Fire Resistance Furnace or the Multiple Full-scale Furnace.

[General Research Category]

C. Research on building fire safety

D. Research on material combustion science

E. Research on firefighting and disaster prevention

F. Research on large-scale fires

G. Research on fire safety and risk assessment

H. Other research contributing to the advancement of fire science and technology

Management Structure and Assessment Procedure

The Research Center for Fire Safety Science Committee ("the Committee"), playing the central role in the Center, consists of a chairperson and 10 members (5 from inside and 5 from outside of TUS).

The Committee is the supreme decision-making body of the Center that develops a research and operation policy, formulates a management policy (including budget drafting), and plans research projects such as deciding a theme to call for entries.

Aiming to support smooth operation of the Center, the Research Theme Selection Committee and two special committees (called Working Groups or WG) are placed under the Committee. The Research Theme Selection Committee and two special committees function as follows respectively:

The Research Theme Selection Committee

This committee makes judgment on acceptance or rejection of applications received. Judgment will be made considering whether the research objective is defined clearly, the plan and the methodology are appropriate, proposed budget is reasonable, and whether the research outcome has potential for further development.

Facilities and Equipment Control Committee (WG)

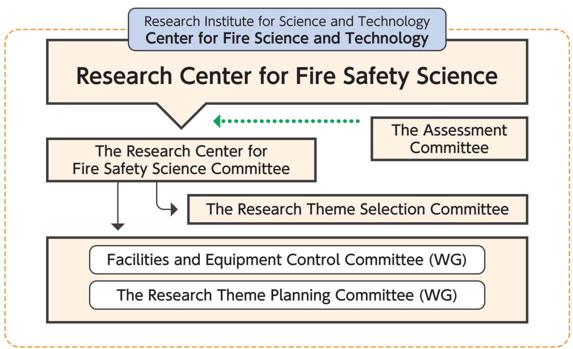
This committee (WG) is primarily involved in the operation planning of the full-scale experimental facilities. It is also responsible for the maintenance of facilities and equipment installed in the institution. In addition, it gives users instruction on how to use these facilities and equipment and on safety control.

The Research Theme Planning Committee (WG)

This committee (WG) draws out research themes and projects that are appropriate for the collaborative use or research and that serve the purpose of the Center and fulfill a social need.

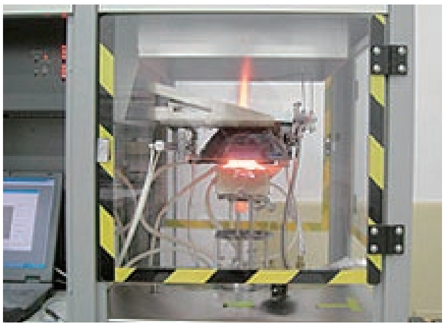
The Assessment Committee

This committee functions as an assessing body of the Center by providing interim and ex-post evaluation on the progress and outcome of research projects.



(Management Structure)

Example of Available Facilities/Equipment

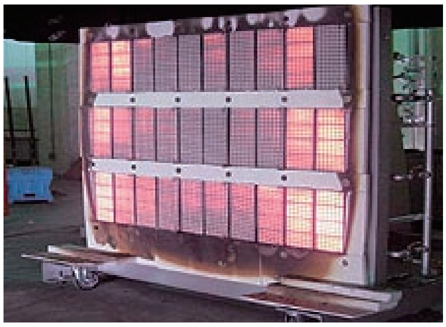


Cone Calorimeter Testing Device (ISO 5660)

This device is used to examine ignitability and the exothermal properties of construction materials using thermal radiation. A test object is placed under the conical-shape electric heater, which controls the thermal radiation to the object, and a pilot flame, is applied to the object 10mm from its surface. The ignition time and the heat release rate can be measured per thermal radiation that can be set in the range of 0 to 50 kW/m^2.

FTIR Gas Analyzer

This unit is designed to be connected to the combustion and smoke generation tester and enables high-speed and continuous analysis of combustion gas. A measured value can be updated at short intervals (five to ten seconds). This unit specializes in measuring certain types of gas that is result from combustion in fire.



ICAL Testing Unit (Heat Radiation Panel)

This unit is designed to elucidate the burning behavior of combustible materials under the condition where a certain heat flux was given through radiative heat transfer. The unit can also be used to investigate the behavior of members exposed to radiative heat. The panel heater has a heating area of 1.75 m (W) × 1.38 m (H). Members can be exposed experimentally to surface temperatures up to 950 and a heat flux of 50 kW/m^2.

Calorimetry Hoods (5 m × 5 m)

This unit is used to analyze the burning characteristics of furniture and equipment in a room by burning them and collecting the burning gas. The duct is equipped with devices for flow measurement and sampling. The design heat release rate is 2 MW at maximum, and the smoke suction power is 600 m^3/min at maximum. A movable unit (4 m × 4 m) is also available.

Full-Scale Compartment for Fire Experiment (with Water Pump)

This fire compartment is 6 m (W) × 6 m (D) × 2.7 m (H) in actual size, and the sprinkler system can be attached to the ceiling. The compartment is mainly used to evaluate the fire extinguishing performance of sprinkler systems and also has used for experiments on smoke movement during sprinkler system activation.

Room Corner Testing Unit (ISO 9705)

This unit is comprised of a space of 2.4 m (W) × 3.6 m (D) × 2.4 m (H) (approximately, the size of a 6-tatamimat room) and an opening 0.8 m (W) × 2 m (H). It can be used to recreate a fire in a room with furniture and dry walls, which can be developed into a fully developed fire.

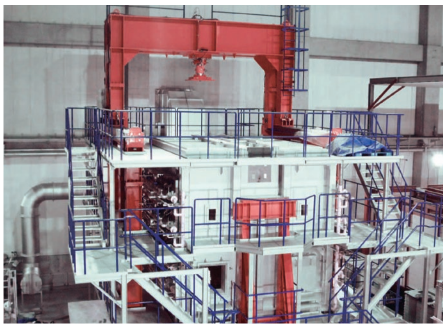
In addition, flashover experiments can be performed with this unit by recreating fires that spread to entire rooms in a short time period, and then combustible gas concentration and temperature distribution data can be collected. The development of the fire can be captured by video camera.

Structural Fire Testing Furnace (Medium scale)

This unit is used to evaluate the fire-resistive performance of various structural members such as columns, beams, floors and walls. The unit can control the heat to the standard heating temperature and furnace pressure set by ISO 834.The heating furnace, with dimensions of 1.5 m (W) × 1.5 m (D) × 1.5 m (H), can also provide immediate heating.

Structural Fire Testing Furnace (Large scale, for Walls)

This unit is used to evaluate the fire-resistive performance of an exterior wall under fire and can control the heat to the standard heating temperature and furnace pressure set by ISO 834. There are 20 burners on the lateral side, and this can heat up to a 3.5 m × 3.5 m area. The unit is also suitable for performing heat tests.



Multiple Full-scale Furnace

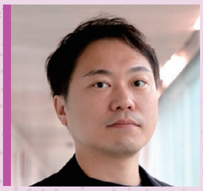
This device is used to measure the fire-resistive duration of horizontal materials of buildings including beams, floors and roofs by using the standard heating test (ISO834). Fire-resistive performance of any kind of horizontal materials can be evaluated by the heating test using this device. Put a full-scale model of 3 m (W) × 4 m (D) on the top the heater like covering it and then turn on the burner to heat the model from beneath.

Endowed Research Project

Established: April, 2025

mhayano@rs.tus.ac.jp

Division of Molecular Biology of Aging



Director
Associate Professor,
Research Institute for Science and Technology

Motoshi Hayano

Ph.D.

Objectives	We will analyze aging across species using molecular biology, physics, and AI, and promote social implementation including startups.
Future Development Goals	Analysis of aging as a mechanism for temporal regulation in organisms.

We aim to decipher the biology of “time” beyond humans — through cross-disciplinary research on aging and species diversity — while developing impactful diagnostics, therapeutics, and services for global deployment.

To understand how organisms determine “time” and to develop methods to measure and intervene in aging.

Background and Objectives of the Research Division

Aging is a physiological change in cells and organs over time and is known to be a major risk factor for various diseases in humans. However, in other species — such as turtles or jellyfish — aging does not necessarily lead to functional decline or disease. Even within a single organism, some cells age more readily, while others exhibit enhanced robustness.

From a biological standpoint, analyzing the responses and aging phenomena that occur in diverse organisms in response to both internal and external environmental conditions is essential for understanding the meaning and function of “time” in biology. At the cellular level, the inability to maintain function over time leads to a breakdown of homeostasis in the organism as a whole, which we refer to as “disease.” When the condition lacks a specific diagnosis, we use general terms such as “age-related organ dysfunction,” “frailty,” or “aging.” However, at the cellular level, disease and aging are not fundamentally different. Based on the idea that aging is treatable by improving biological function, innovation focused on predicting and extending healthspan is gaining momentum, along with corresponding investment and business development. In addition, as concepts like hedonic and eudaimonic well-being suggest, it is equally important to understand and sustain “happiness” alongside functional aging in humans.

With this in mind, our division aims to uncover the diversity of aging through the lens of the biology of time, while simultaneously creating innovation and social impact that maximize the value of healthspan and well-being in humans.

Research Topics

1. Regulation of Aging through the Epigenome

The epigenome refers to mechanisms that regulate gene expression quantitatively and qualitatively in an acquired manner, and it plays a crucial role in directing stem cells to differentiate into specific cell types such as neurons or hepatocytes. Recently, the concept of “epigenomic memory” has emerged, highlighting how environmental factors such as diet and exercise can leave molecular “marks” distinct from DNA sequences, which are retained over time and influence gene expression and cellular function. We have established a novel mouse model, ICE (Inducible Changes to the Epigenome), for studying epigenomic control of aging (Hayano* and Yang* et al., Cell 2023; Yang et al., Cell 2024; Kato et al., Dev. Cell 2021). This project aims to elucidate when and how aging is initiated, as well as the pace of aging (see figure).

2. Objective Measurement of Aging

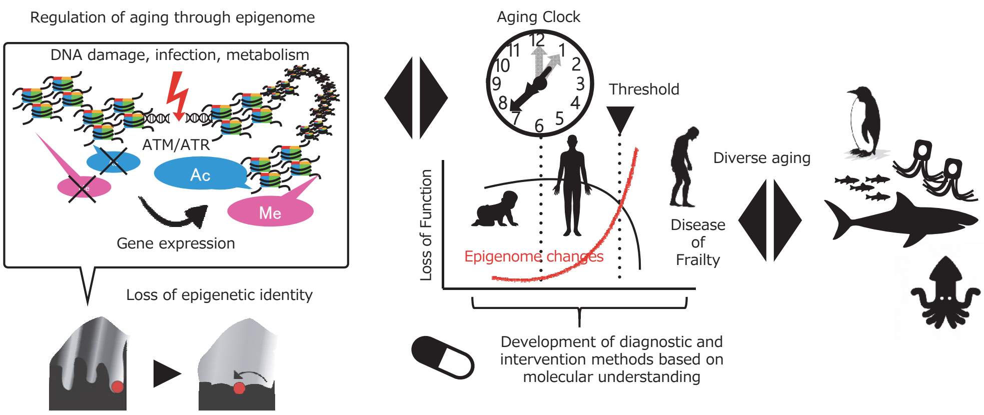
Biological aging clocks, which provide objective indicators of functional aging distinct from chronological age, are becoming increasingly refined. These clocks primarily use DNA methylation but are expanding to include biomarkers such as circulating peptides, gut microbiota, speech, and movement data. In this study, we aim to establish objective aging metrics by comparing samples from mice, humans, and various species. In addition to epigenomic data, we will incorporate physical properties such as tissue viscoelasticity. For human studies, we will integrate medical and healthcare data with surrogate models, longitudinal learning, and personalized health digital twins (see figure).

3. Molecular Understanding of Aging across Diverse Species

We will investigate molecular mechanisms of aging across a wide range of species — from the Greenland shark, known to live over 400 years, to short-lived species such as ayu (sweetfish) and giant squids. We will also study jellyfish that undergo repeated self-renewal through parthenogenesis, penguins with unique gut microbiota, and other organisms exhibiting unique temporal dynamics. These investigations aim to uncover the molecular underpinnings of time-related biological change across evolutionary contexts (see figure).

4. Development of Interventions Targeting the Reversibility of Aging

We define aging as the progressive loss of function and homeostasis in cells and organs over time. This project aims to develop therapeutic strategies targeting the molecular mechanisms underlying aging-related decline. Our approaches include the development of medical devices based on non-visual photoreceptor OPN5 using non-invasive 380 nm light, epigenomic interventions for conditions such as sarcopenia and dementia through drug or functional food development, and ex vivo genome editing for therapeutic applications. These technologies will be advanced in collaboration with startups and industry partners to promote societal implementation (see figure).



Accelerated aging via the epigenome and reversibility

Development of photocatalysts aiming at artificial photosynthesis solving resources, energy, and environmental issues

- Photocatalyst for green hydrogen production and CO_2 utilization using water as an electron donor -

CO_2 can be converted to various fuels and chemicals, if we have cheap and abundant green hydrogen that is produced from water using a renewable energy as shown Fig.1. We can also produce green NH_3 that has attracted attention as not only a chemical fertilizer but also a H_2 carrier. Therefore, it is important to develop the science and technology for green H_2 production to solve resources, energy, and environmental issues. The green H_2 production by water splitting using a renewable energy is a light energy conversion of an uphill reaction and called as an artificial photosynthesis. Development of a highly efficient photocatalyst for the artificial photosynthesis has been desired for carbon neutrality.

We have developed various visible light-driven photocatalysts by transition metal doping into wide bandgap photocatalysts such as TiO_2 and $SrTiO_3$. Among these photocatalysts, it was found that $SrTiO_3$:Ir,Sb,Al showed a high activity for water splitting to produce green H_2 using visible light up to 660 nm. This photocatalyst shows a top-class performance as a single particulate metal oxide photocatalyst for water splitting.

It is indispensable to use water as an electron donor for photocatalytic CO_2 reduction, if one thinks artificial photosynthesis of a solar energy conversion. In this photocatalytic reaction, a cocatalyst loaded on a photocatalyst powder plays an important role for formation of an active site for the CO_2 reduction. We found that Ag cocatalyst-loaded $NaTaO_3$ doped with Ca^{2+}, Sr^{2+}, Ba^{2+} showed the activity for photocatalytic CO_2 reduction to form CO using water as an electron donor. The CO formation selectivity reached almost 90% even in an aqueous medium. Moreover, Rh-Ru cocatalyst showed the activity for CH_4 formation of an 8-electron reduction product of CO_2. Thus, we have found efficient cocatalysts for photocatalytic CO_2 reduction.

A Z-scheme photocatalyst system consisting of $(CuGa)^{0.5}ZnS_2$ of a CO_2-reducing photocatalyst, $BiVO_4$ of an O_2-evolving photocatalyst, and reduced graphene oxide (RGO) as a solid electron mediator was active for not only water splitting but also CO_2 reduction under visible light irradiation. CO formed with about 12% of the selectivity by just bubbling of a CO_2 gas into the suspension of those materials in water. This photocatalyst can utilize up to 520 nm of visible light in a solar spectrum. When a Co complex was added into the Z-schematic photocatalyst system, the CO formation selectivity reached more than 90% even in an aqueous medium accompanied with O_2 evolution of a water oxidation product. In this system, the Co complex functioned as not only an electron mediator but also a CO_2 reduction site. So, a hybridization of a powdered photocatalyst with a molecular catalyst is a useful strategy for the photocatalytic reduction of CO_2.

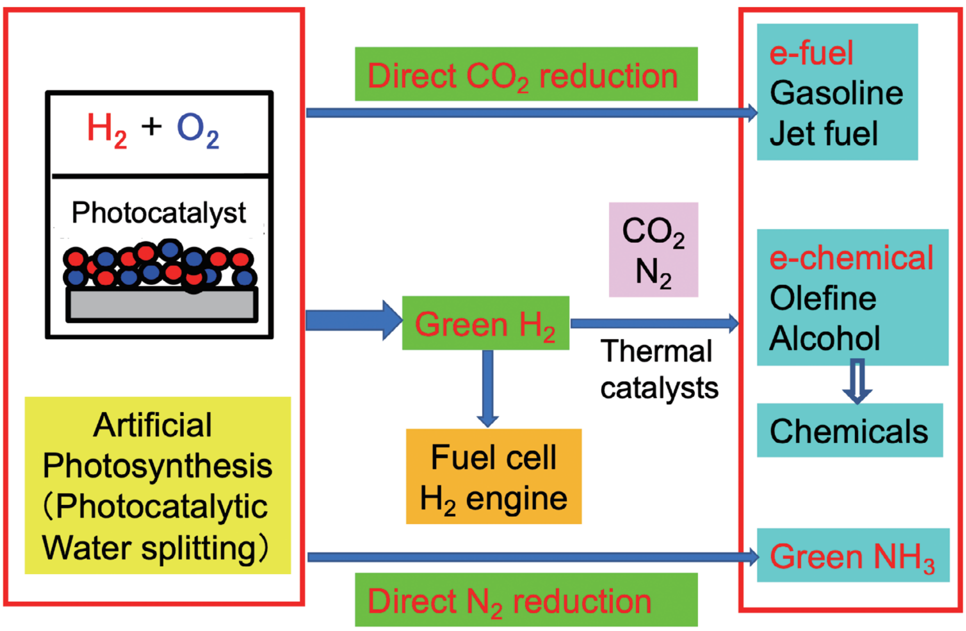


Fig. 1 Production and utilization of green H_2

FOCUS 2

The Research & Development Platform of Functional Green Building Materials

- Towards the Social Implementation of Environmentally Conscious Buildings -

This project aims to promote the social implementation of environmentally conscious buildings (see Fig.1) by developing a system that evaluates and visualizes CO_2 emissions from non-structural components throughout their entire life cycle. Concurrently, the project will advance the research and development of high-performance materials and construction methods that minimize CO_2 emissions during manufacturing and construction. The target components are exterior and interior finishes, openings, and base materials.

This project, which began in the 2022 financial year, comprises four working groups (WGs) that are developing materials and construction methods. At the same time, WG0 is integrating the knowledge gained from these groups to conduct an environmental impact assessment. Here are some of the results. Some of the key outcomes from this project are summarized here.

(1)Development of a new curtain wall using aluminum sashes

WG3, led by Dr. Takase, is developing a new curtain wall(CW) (Fig.2) with high thermal performance by combining wood and recycled aluminum composite frames with Low-E triple glazing. In the curtain wall design, three key points were identified for carbon reduction: high thermal insulation/heat reflection, use of recycled aluminum, and utilization of wood.

Comprehensive performance evaluation was conducted from an life-cycle CO_2 ($LCCO_2$) perspective using an embodied carbon calculation tool and thermal load simulation. As a result, for example, when analyzing embodied carbon by component (Fig.3), the wood-aluminum composite CW using 70% recycled aluminum reduces CO_2 emissions by 39%, and the CO_2 reduction rate compared to aluminum CW is 34%, demonstrating significant effectiveness.

(2) Texture Printing

WG1, led by Dr. Kanematsu, is aiming to realize texture printing technology that enables the printing of arbitrary textures. For example, as a completely new finishing technique for concrete surfaces, they are developing technology to reproduce free textures and colors using UV printers, as well as methods for applying glaze. By combining with texture printing technology, they have successfully achieved arbitrary textures as shown in Fig.4, while also demonstrating the superiority of these technologies in terms of $LCCO_2$.

(3) Towards Phase 2

In Phase 2, based on the knowledge and technical seeds obtained in Phase 1, we will reorganize into five working groups and promote research and development aimed at further social implementation, while also establishing evaluation methods for environmentally conscious architecture.

Fig. 1 Conceptual diagram of environmentally conscious architecture

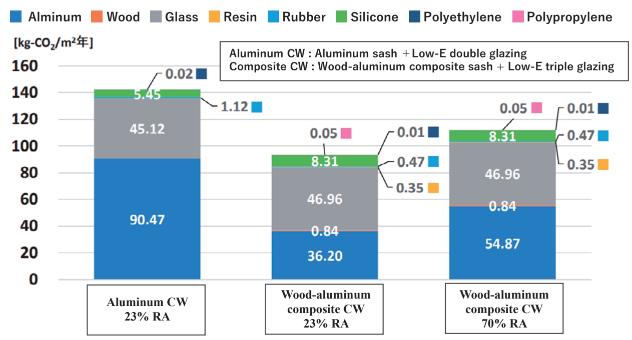


Fig. 3 Breakdown of CO_2 emissions by component in the manufacturing stage of CW using recycled aluminum(RA)

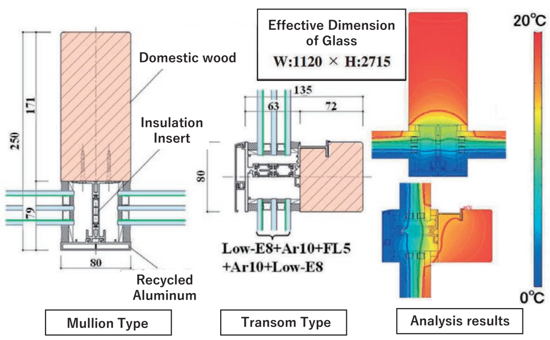


Fig. 2 Cross-sectional view of CW composite made from wood and recycled aluminum

Fig. 4 Various textures achieved using the developed printing technology

RIST Organization Chart

- Chairman of the Board of Governors
  - President
    - Organization for Research Advancement
      - Research Institute for Science & Technology
        - Research Institute for Science & Technology Steering Committee

Research Institute for Science & Technology

Research Centers
- Center for Fire Science and Technology
- Water Frontier Research Center
- Nucleic Acid Drug Discovery Center
- Research Center for Space System Innovation [SSI]
- Research Center for Drug Discovery and Applied Sciences

Joint Usage / Research Center
- Research Center for Fire Safety Science

Research Hubs
- Carbon Value Research Center
- Research Center for Multi-Hazard Urban Disaster Prevention

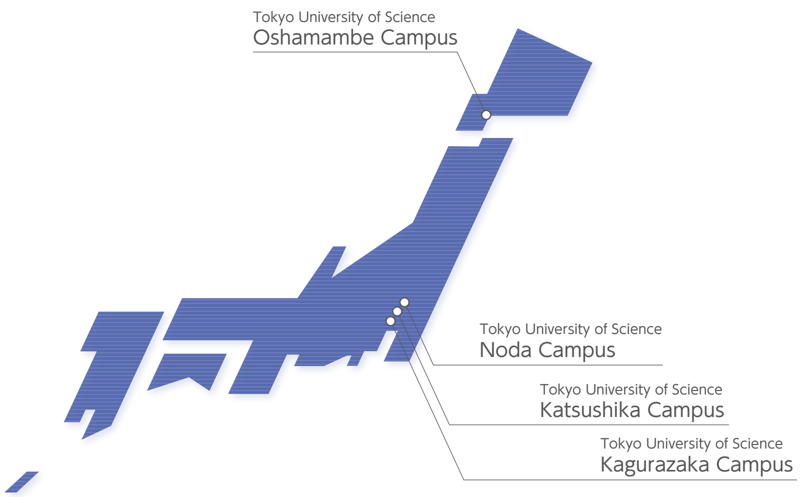
Research Divisions
- Division of Colloid and Interface Science
- Division of Joint Research of Geometry and Natural Science
- Division of Co-creative Design Innovation Research
- Division of Architecture and Urban Cultural Regeneration Research
- Division of Research for Photonics- Electronics Convergence
- Division of Superior Cells and DDS Development for Regenerative Medicine
- Renewable Energy Science & Technology Research Division
- Division of Implementation of Sustainable Technology in Society
- Division of Mathematical Modeling
- Division of Smart Healthcare Engineering
- Division of Biological Fluctuations
- Research Group for Advanced Energy Conversion
- Modern Algebra and Cooperation with Engineering
- Medical Data Science
- Division of Digital Transformation
- Statistical Science Research Division
- Division of Nanocarbon Research
- Division of Nano-quantum Information Science and Technology
- Parallel Brain Interaction Sensing Division
- Division of Composite Materials Engineering
- Division of Aging Biology

The Open Innovation Projects
- Research & Development Platform of Functional Green Building Materials

Endowed Research Project
- Research Division of Molecular Biology of Aging

2025.4.1

Campus Map



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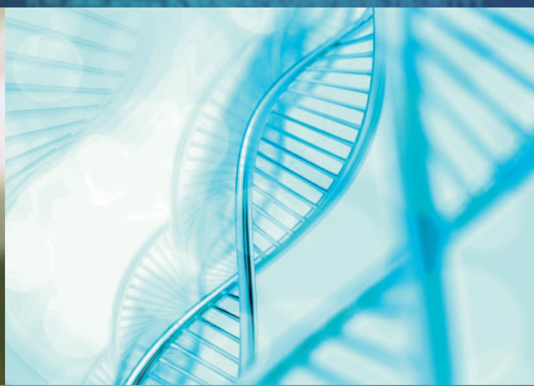

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