# Research Profiles

*An invitation to Engineering in Nagasaki*


School of Engineering, Nagasaki University

April, 2026

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## Electrical and Electronic Engineering Program

## Structural Engineering Program



## Civil and Environmental Engineering Program



## Chemistry and Materials Engineering Program

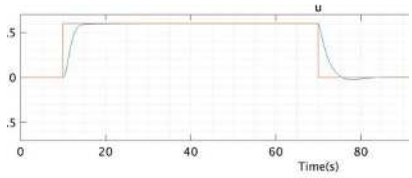
# Mechanical Engineering Program

| Name | Job Title | Area of Expertise |
|---|---|---|
| UCHIHORI Hiroshi | Professor | Underwater Robotics |

## 1. Main Research Topics

### ① Research for Underwater Vehicle Dynamics and Control

The motion of underwater vehicle is described by non-linear six-degree-of-freedom rigid body equations of motion. Furthermore, the coefficients of fluid dynamics force around the body must be determined by water tank tests. However, the hovering type underwater vehicles which have a frame type complex structure have not been fully modeled. So we are conducting the research about the modeling method and the control system for them.




Example of simulation result of the vehicle control

### ② Research for Guidance and Control using Underwater Imaging

When visual inspection of underwater structures using an ROV, the target object is tracked by visual navigation and control by human pilot using underwater camera, however, it requires high level skill to maintain a certain distance from the target while being influenced by tidal currents. For this reason, we are conducting research into semi-automatic target tracking using a stereo camera to recognize target image so that anyone can easily operate the vehicles. This research was selected for the Cabinet Office's 2024 AUV Demonstration Project, and the sea trial was conducted for the mooring chain.

Semi-automatic tracking mooring chain

### ③ Research for Low Cost AUV

Currently, ROV which has tether cable is mainly used for the underwater operation, furthermore, AUV have come into practical use, however, AUV is expensive. So we have started the low cost AUV research.

## 2. Keywords

Underwater vehicle, ROV, AUV, Guidance and Control

## 3. Remarks and Websites

Underwater Vehicle (ROV and AUV) have become an essential technology for inspecting the underwater structure like an offshore wind farm. Our research can contribute to spread of underwater vehicle instead of the human diver operation which is dangerous and high cost.

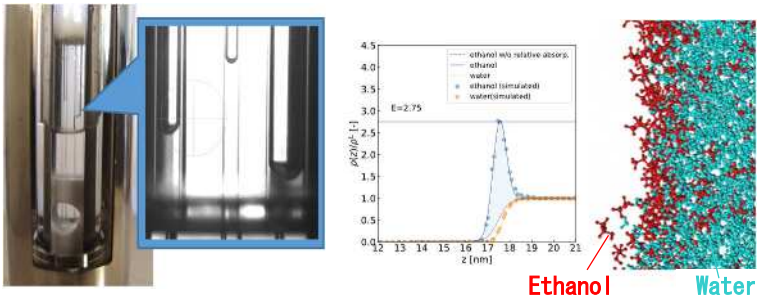
**researchmap:** https://researchmap.jp/hiroshi-uchihori
**Laboratory:** https://robotics-mech-nagasaki-univ.conohawing.com

| Name | Job Title | Area of Expertise |
|---|---|---|
| KONDOU Chieko | Professor | Thermal Engineering, Refrigeration |

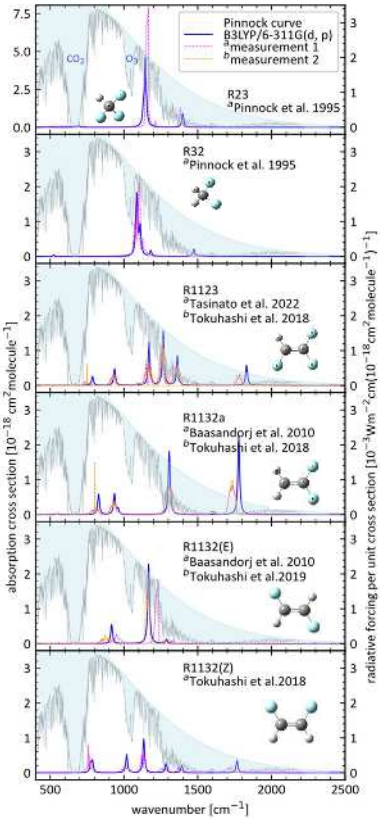
## 1. Main Research Topics

**(1) Thermophysical roperty measurement and energy analysis for new low global warming potential refrigerants**

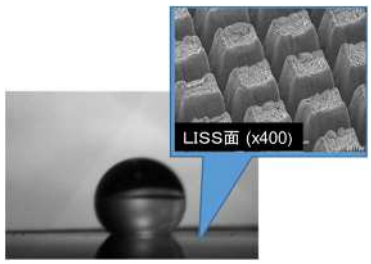
**(2) A new fabrication technique of boiling surface in passive cooling devices removing denser heat flux from semiconductors**




(Upper left) Surface tension measurement device. The measurement results for low-GWP refrigerants have been adopted by the REFPROP database of the US NIST and are disseminated worldwide. (Upper right) Mixture state near the vapor-liquid interface of water-ethanol system. In a mixture system, the concentration varies drastically at the interface. We reproduce this using molecular simulation to perform more accurate surface tension prediction.




(Right) Absorption cross section (infrared absorption capacity) of candidate refrigerants. Quantum chemical calculations are performed to obtain the atmospheric lifetime and global warming potential of various substances. The products generated during the decomposition process are also examined.




(Left) By using a laser to process metal surfaces such as aluminum to a depth of several to tens of microns, it is possible to change the wettability of various liquids. By utilizing this, it is possible to significantly improve boiling heat transfer performance, enabling the design of compact, high-performance coolers.

## 2. Keywords

global warming potential, refrigerants, heat pump, heat exchangers, cooling

## 3. Remarks and Websites

The data obtained from our laboratory are posted at the following URL.
Please take a look at the students' hard work.

**researchmap:** https://nagasakiuniv-mech.org/
**Laboratory:** https://researchmap.jp/kondou_chieko

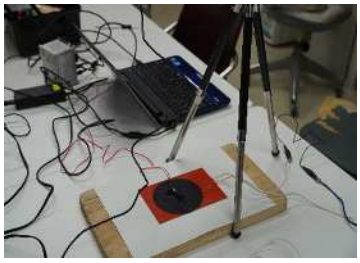
| Name | Job Title | Area of Expertise |
|---|---|---|
| SAIMOTO Akihide | Professor | Mechanics of Solids |

## 1. Main Research Topics

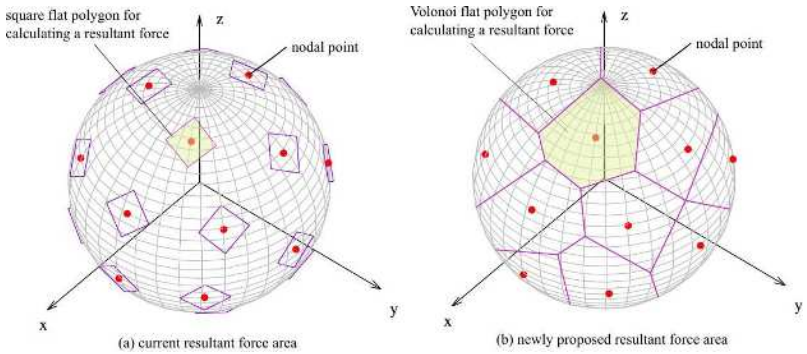
① **Development of an innovative system for numerical stress analysis**
A numerical calculation system that enables high-precision stress analysis of arbitrary three-dimensional elastic bodies using the body force method, which is a boundary stress analysis method is being developed. This system is particularly powerful for crack analysis.

② **High-precision processing of materials for electric devices by controlling crack propagation**
In general, machining of hard and brittle materials often results in reduced processing accuracy due to tool wear and heat generated. Additionally, coolants used to reduce the temperature of the cutting tools can contaminate the material. Therefore, we are researching a method to cut hard and brittle materials without using tools by controlling the crack path. Specifically, we are investigating the industrial application of crack propagation control for the processing of electronic devices using SiC and GaN as substrates, which are highly anticipated as power semiconductors.

③ **Numerical prediction of deformation and failure processes of solids based on numerical simulations of crack growth and coalescence**
As there exist a strong stress singularity at the crack tip, its numerical analysis is generally very difficult. In particular, numerical analysis of situations where multiple cracks exist and interfere with each other is almost impossible using general-purpose numerical methods such as FEM. Therefore, a powerful numerical evaluation system for predicting a behavior of crack growth and coalescence is being developed. This system has potential applications in the medical field, such as the analysis of fractures caused by excessive external forces acting on the human body.



Preliminary experiment for Wafer cleaving




New analysis strategy for calculating a 3D stress concentration using resultant force of surface area

## 2. Keywords

Stress analysis, Deformation analysis, Dynamic analysis, Electric device, Body force method

## 3. Remarks and Websites

We are conducting research on processing wafers made of semiconductor materials such as Si, SiC, and GaN into the desired shape without using cutting tools. These semiconductor materials share the common characteristics of being hard and brittle, making them unsuitable for mechanical processing that involves cutting or removal. On the other hand, their brittle nature means that they have low crack propagation resistance. Therefore, we are investigating methods for controlling crack propagation to perform fracture processing. Here, the key point is to establish a method for intentionally propagating cracks along a desired path, utilizing technologies such as lasers, ultrasonics, and non-contact heat sources.

**researchmap:** https://researchmap.jp/s-aki
**Laboratory:** http://www.mech.nagasaki-u.ac.jp/lab/solid/index.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| SAKAGUCHI Daisaku | Professor | Turbomachinery |

## 1. Main Research Topics

### ① Multi-objective Optimization of Turbomachinery

Turbomachinery plays a vital role in transporting fluids such as air and water. Additionally, when harnessing renewable energy sources like wind and tidal currents, the efficient design of turbomachinery is essential. Although turbomachinery can be designed using computer-based numerical simulations, the challenge lies in the fact that it requires the combination of many design variables—making it difficult to identify the optimal shape. To address this, a system that combines a genetic algorithm-based shape optimization method with an artificial-neural-networks has been developed, enabling the efficient and automated search for optimal designs. This system allows the computer to automatically modify shapes and search for the best design. It has been applied to various turbomachinery design goals, including improving efficiency, reducing noise, and expanding operational ranges. Through the development of high-performance turbomachinery, it will be contributed to energy conservation in the industrial sector.

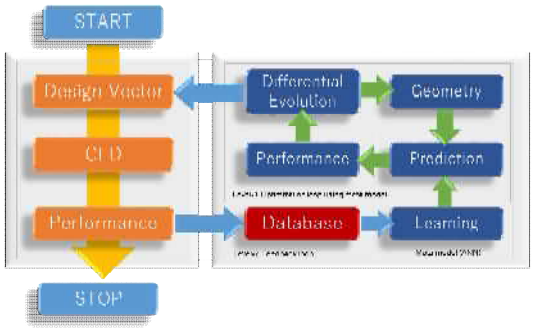



Fig.1 Multi-objective Optimization System

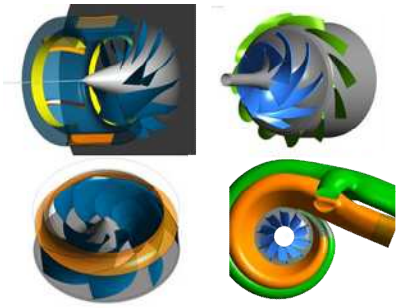


Fig.2 Applications to Turbomachinery Design

### ② Development of an Energy Harvesting Smart Buoy

Effective utilization of marine resources requires a sampling system capable of long-term, fixed-point observation over wide ocean areas. To address this need, it has been developed a smart buoy equipped with a tidal current turbine for independent power supply. The turbine was optimally designed to achieve high efficiency across a wide range of current velocities, corresponding to the roughly 6-hour tidal cycle.

The developed smart buoy is capable of measuring seawater temperature, tidal current velocity, salinity, chlorophyll concentration, and the FSI value which is an indicator of red tide. Leveraging the high-power generation capacity of the tidal turbine, the buoy can support multiple high-power-consuming sensors. This smart buoy is intended for various applications, including the efficient utilization of marine resources, remote monitoring of offshore aquaculture, and red tide sensing.

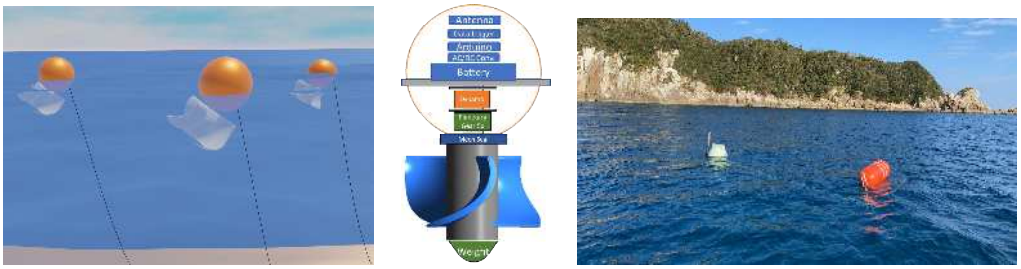



Fig. 3 Development and Demonstration Testing of a Smart Buoy

## 2. Keywords

Turbomachinery, Multi-objective optimization, Tidal turbine, Smart buoy

## 1. Remarks and Websites

AI based optimization system enables efficient design of turbomachinery, contributing to energy conservation and the development of renewable energy sources. In addition, the smart buoy equipped with a tidal current turbine is expected to provide fundamental data for future marine development.

**researchmap:** https://researchmap.jp/dai_sakaguchi

**Laboratory:** https://www.mech.nagasaki-u.ac.jp/lab/sakaguchi_lab/html/home.html

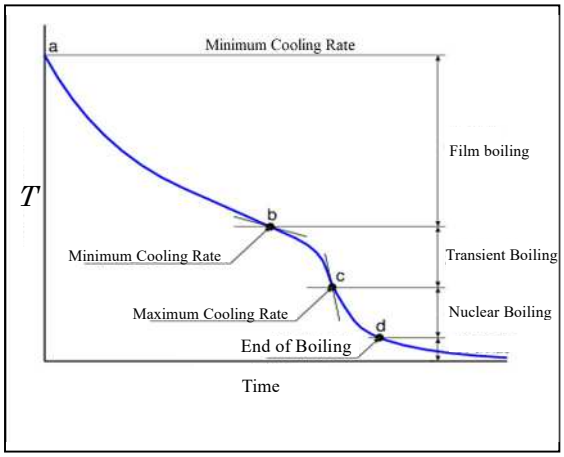
| Name | Job Title | Area of Expertise |
|---|---|---|
| MOMOKI Satoru | Professor | Thermal Engineering |

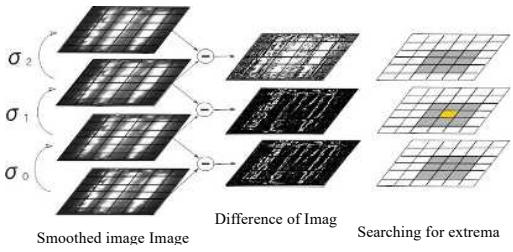
## 1. Main Research Topics

① Analysis on Heat Transfer Phenomena by Information Processing of Flow Patterns in Cooling of High Temperature Objects

The situation when cooling an extremely hot object with a liquid such as water is complex. Normally, the generated steam covers the surface (heat transfer surface), significantly reducing the cooling performance. Once the temperature of the object has dropped to a certain level, the heat transfer surface becomes wet, and normal boiling occurs, causing intense turbulence between the gas and liquid, resulting in rapid cooling. The purpose of this study is to predict the heat transfer performance in this case and to elucidate the mechanism leading up to the onset of wetting.

To quantitatively and accurately understand this phenomenon, it is important to measure the rapidly fluctuating local temperature, but this is not easy. Therefore, we take advantage of the fact that the gas-liquid state is turbulent depending on the heat transfer situation. By combining the results of appropriately processing observation images taken with a high-speed camera using a computer with knowledge of heat transfer phenomena, we are developing a system to obtain heat transfer information from image processing.。




Examination of feature points in film boiling phenomena images

② Development of program libraries for the thermophysical properties and its usage

We are investigating the development and use of PROPATH, a program library that calculates the main thermophysical properties of commonly used fluids such as water, air, and hydrogen - temperature, pressure, density, enthalpy, viscosity coefficient, thermal conductivity, etc. We are focusing on the value of data and how to access it, replacing the use of databases for predicting various physical properties that require different values in various situations.


WEB Interface of PROPATH

## 2. Keywords

Energy, Information Processing, Thermal Engineering, Heat Transfer, Manufacturing

## 3. Remarks and Websites

This research is characterized by its attempt to quantify the quantities necessary for thermal engineering by utilizing both thermal engineering and information engineering. In recent years, we have begun research into heat transfer phenomena in machining technology and their image processing. Considering the local temperature conditions inside tools and coolants during various special machining processes, we will build a more general "heat transfer model for predicting temperature changes in tools during machining."

**researchmap:** https://researchmap.jp/read0172749

**Laboratory:**

| Name | Job Title | Area of Expertise |
|---|---|---|
| YAZAWA Takanori | Professor | Mechanical Engineering |

## 1. Main Research Topics

We conduct research related to precision production and address various social issues based on its outcomes. With a focus on "measurement time as non-productive time," "minimizing work paths," and "achieving required uncertainty," we propose and research systems that can be implemented from the initial stages.

① **Research on non-contact on-machine measurement and corrective machining of dies and molds**

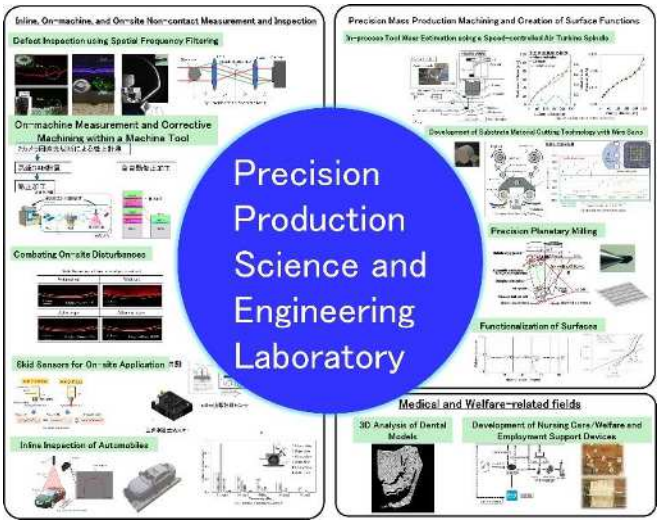
This research involves measuring and performing corrective machining on the shapes of dies and molds, which are processed by cutting and electrical discharge machining, directly on the machine tool in a practical amount of time. Currently, multiple systems are in the phase of social implementation.

② **Research on precision edge projection**

This is a high-precision edge projection system that uses spatial frequency filtering. It has numerous achievements in fields such as dimensional measurement, contour measurement, and defect inspection. It has achieved on-site measurements with a 6σ value of 1.8 μm

③ **Research on practical machining and measurement of next-generation semiconductor materials**

This research focuses on machining and measuring next-generation semiconductor materials such as SiC (silicon carbide) and GaN (gallium nitride) at practical speeds and precisions. The machining research primarily concerns wire saws, while the measurement research focuses on wafer shape error and internal stress.




## 2. Keywords

Production Engineering, Inline Measurement, On-machine Measurement, Shape Measurement, Edge Detection, Defect Inspection, Optical Design, Precision Mass Production Machining, Machining Phenomenon Analysis, Wire Saw, Creation of Surface Functions using Micro-scale Irregularities,3D Brain Analysis, Development of Assistive Devices with Voice Support

## 3. Remarks and Websites

Please contact us about anything related to production, such as building the optimal measurement system.

**researchmap：** https://researchmap.jp/t_yazawa
**YouTube：** https://www.youtube.com/watch?v=VMABRyYdJjE

| Name | Job Title | Area of Expertise |
|---|---|---|
| YAMAGUCHI Tomohiko | Professor | Thermal Engineering |

## 1. Main Research Topics

### ① Measurement of sound speed in gas

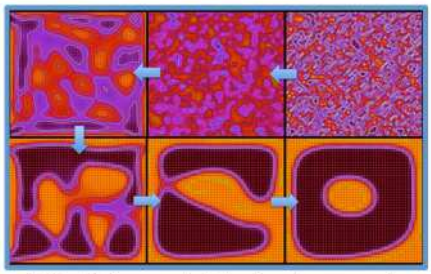
We accurately measure the speed of sound in gases from -20°C to 80°C and from 100 kPa to 1 MPa by using a spherical resonator. The speed of sound of hydrogen can be measured with an uncertainty of several hundred ppm by this apparatus. On the measurement of the sound speed of hydrogen sealing is difficult due to its small molecules and difficult to measure with high precision due to its high speed of sound. From the sound speed data, it is possible to calculate the specific heat of an ideal gas state, which is necessary for estimating thermal properties by equation of state.

### ② Development of global equation of state

We are developing a general equation of state that can be applied to various fluids, using excess Gibbs energy (activity coefficient) calculated by the group contribution method. I have developed the Volume and $g^E$ Translated Peng-Robinson (VTPR) equation of state and demonstrated that it can be used to calculate the thermal properties of mixtures using group contribution method parameters in collaboration with Professor Gmehling and Professor Rarey (University of Oldenburg) from 2002. We are working on applying SAFT-type equations of state to calculate the thermal properties of more complex mixtures, such as ammonia and water mixtures, and fluorocarbon and lubricant mixtures.

### ③ Numerical simulation for liquid-gas two-phase flow with large density difference in complex boundary

We are conducting the research about the numerical simulations of gas-liquid two-phase flow using the lattice Boltzmann method (LBM). It is possible to simulate heat and mass transfer in gas-liquid two-phase flows with large density ratios for low Reynolds number flows. Features of this numerical calculation method include its ability to handle complex boundaries, self-formation of free surfaces, and portability to parallel computer systems. The right figure shows a fluid with randomly distributed densities, which aggregates with other fluids of the same density to form a droplet and liquid film on the wall surfaces. We have conducted the research about numerical analysis of flow in complex channels simulating multi-layer sintered wicks in a heat pipe and bubble behavior considering wall wettability. Currently, we are attempting numerical simulations of water transport within plant xylem by LBM.



Lattice Boltzmann simulation for phase separation

## 2. Keywords

Numerical simulation of thermal fluids, Thermophysical properties of fluids, Equation of state

## 3. Remarks and Websites

We conduct a comprehensive range of research and activities, from measuring the thermal properties of fluids to developing equations of state. We are currently preparing to operate a apparatus for the sound speed in liquid measurement and are in the process of tuning the devices. In addition, we are conducting joint research with Saga University on the thermal properties of ammonia, for which demand is expected to grow significantly. Numerical simulation of heat and mass transfer has expanded rapidly with the advancement of computers. We are working on analyzing gas-liquid two-phase flow with large density difference in complex boundary, which has been difficult to calculate until now.

**researchmap:** https://researchmap.jp/yamagch
**Laboratory:** http://www2.mech.nagasaki-u.ac.jp

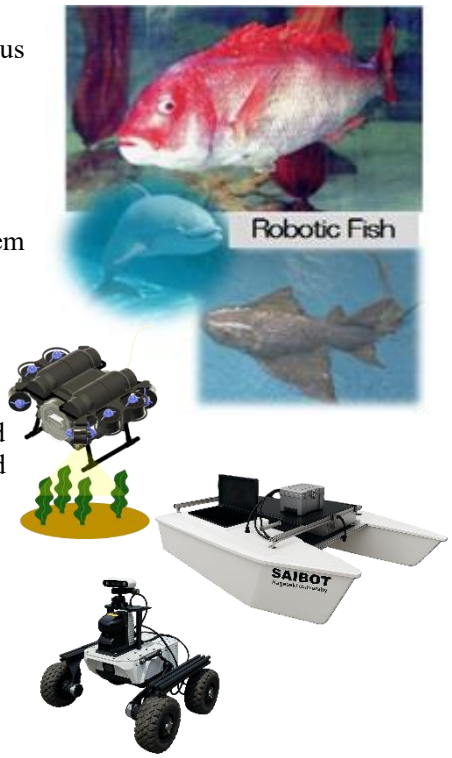
| Name | Job Title | Area of Expertise |
|---|---|---|
| YAMAMOTO Ikuo | Professor | Robotics, System Engineering, Dynamics & Control |

**1. Main Research Topics**

① **Robotics**
Offshore, Onshore, Aerospace, Medical robotics with autonomous function have been developed.

② **Offshore energy**
Total technologies for practical renewable offshore energy system such as offshore wind have been developed.

③ **Civil infrastructure**
Robotic systems for assessing the degradation of civil and industrial infrastructure, including bridges, tunnels, roads, and plants have been developed.




**2. Keywords**
Robotics, Offshore energy, Infrastructure inspection robot

**3. Remarks and Websites**
2025 IEEE/IFAC GOLD BEST PAPER AWARD at the ICCAD'25 (Development of Land Robot), 2005 Archipelago award, France (Bio-Manoeuvring Type Underwater Vehicle),The world record of autonomous underwater vehicle cruising 317km by Urashima from Feb.26-28,2005.
MARIN CONTROL SYSTEMS, IFAC International Journal Robust and Nonlinear Control, Vol.11, No.13, 2001, Wiley.
Practical Robotics and Mechatronics, Marine, Space and Medical Applications, ISBN978-4-320-08186-4, ISBN978-4-320-08191-8, IET.
Red Tide Monitoring, Smart Fisheries, pp.136-137, Midori Shobo, ISBN978-4-89531-885-3, 2023

**researchmap:** https://researchmap.jp/iyamamoto_nu
**Laboratory:** https://robotics-mech-nagasaki-univ.conohawing.com/
**Offshore Technology R&D Innovation Center HP:** https://sites.google.com/view/otic-nagasaki-u

| Name | Job Title | Area of Expertise |
|---|---|---|
| OKUMURA Tetsuya | Associate Professor | Tribology |

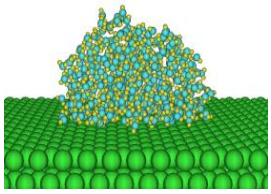
## 1. Main Research Topics

We conduct both fundamental research and technological development centered on the themes of "surface" and "water." Our investigations focus on phenomena occurring at and near solid–liquid and gas–liquid interfaces, employing experiments, analytical methods, and computer simulations. In particular, our simulations encompass a broad range of length scales—from the nanometer scale of atoms and molecules up to the meter scale—with the aim of elucidating the behaviors and underlying mechanisms of solids, liquids, and gases.

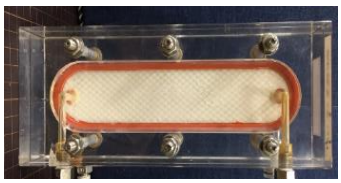
### ① Water desalination and Osmotic power generation

Our research aims to enhance the efficiency of seawater desalination and to develop salinity gradient power generation using osmotic membranes. Through a combination of simulations and experiments, we are engaged in the following studies:

- Impurity and ion transport mechanisms
- Evaluating membrane performance
- Recovery of membrane performance
- Membrane module performance improvement



Molecular simulation



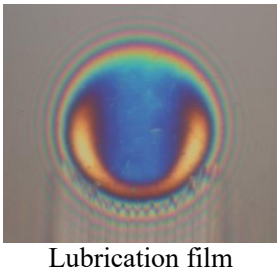
Membrane test rig

### ② Ttribology: friction, wear, and lubrication

To contribute to energy and resource conservation, our research aims to achieve low friction and low wear through the development of new technologies.

- Surface damage caused by raindrop impact
- Reducing friction in lubrication
- Mechanisms of nano-lubrication
- Corrosive wear in seawater environments
- Effects of hydrogen on lubrication performance

Corrosive wear

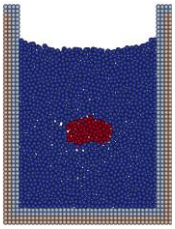


Lubrication film

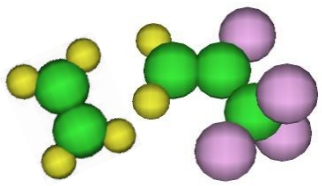
### ③ Reduction of environmental impact

To address urgent global challenges, we are conducting research aimed at developing effective solutions.

- Microplastic separation
- Red tide mitigation via plankton capture
- Next-gen refrigerant property prediction
- Wind turbine blade damage reduction



Bubble simulation



Molecular refrigerant analysis

## 2. Keywords

water, seawater, surface, interface, friction, wear, lubrication, membrane, corrosion, bubble

## 3. Remarks and Websites

Our research focuses on surfaces and interfaces. We undertake both technological development and fundamental studies aimed at advancing renewable energy technologies (e.g., salinity gradient power generation), promoting energy conservation (such as friction reduction), and reducing environmental impact (including removal of contaminants from water and development of novel refrigerants). Our investigations employ computer simulations and experimental validations spanning a broad range of scales, from the nanometer to the meter scale.

**researchmap:** https://researchmap.jp/okumurat

| Name | Job Title | Area of Expertise |
|---|---|---|
| KOYAMA Atsuhiro | Associate Professor | Strength and Fracture of Materials, Fatigue |

## 1. Main Research Topics

In order to prevent global warming, there are many things that must be done to reduce the weight and improve the efficiency of mechanical structures. To reduce the weight of mechanical structures, it is necessary to fully understand the strength properties of the mechanical structural materials and ensure the safety and long-term reliability of structures that use these materials. Therefore, we are conducting experimental research to understand the strength properties, especially the fatigue strength properties, of various mechanical structural materials.

① **Evaluation of fatigue characteristics of structural materials**

We investigate the fatigue properties of materials such as steel and aluminum alloys, as well as the fatigue properties of materials that have been joined by dissimilar metal bonding, welding, adhesives, etc. Furthermore, we obtain the fatigue strength properties not only in air at room temperature, but also in water. We obtain the S-N curves (Fig. 1) and fatigue crack growth behavior, providing basic data for reliability design.

② **Development and application of laser and electron beam induced acoustic microscope**

Micro-defects on the surface of a material or inside the material near the surface are one of the factors that have a significant effect on the fatigue strength of the material. In this research, we are developing the microscope system for non-destructive observation of micro-defects (micro-cracks, voids, etc.) near the surface of a sample using the laser or electron beam. (Figs. 2 and 3 are examples of images observed using the electron beam induced acoustic microscope.)

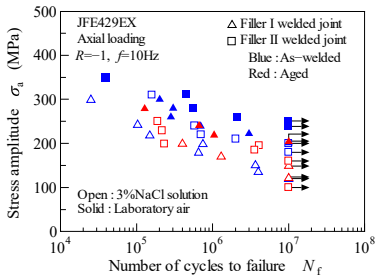



Fig.1 Comparison of fatigue strength characteristics of MIG-welded stainless steel in air and in 3% NaCl solution (*S-N* curves).

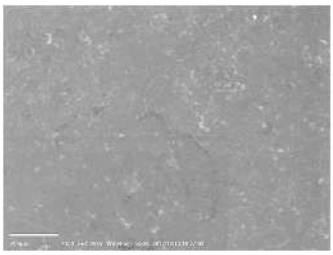


Fig.2 Surface observation of Aluminum alloy with 0.2 mm diameter hole inside.

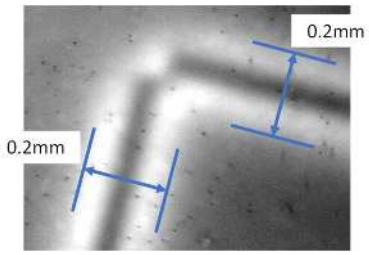



Fig.3 Image of internal hole observed using the electron beam induced acoustic microscope.

## 2. Keywords

Fatigue life, Fatigue crack growth behavior, SLAM, SEAM

## 3. Remarks and Websites

We can perform tensile and fatigue tests and provide highly accurate data.
In addition, because SLAM and SEAM can detect very small defects of about a few μm in size, we believe they can be applied to the inspection and quality assurance of semiconductors and MEMS materials.

If you provide us with test materials or observation samples, we will evaluate the material properties and provide you with the results.

**researchmap:** https://researchmap.jp/read0068615
**Laboratory:**

| Name | Job Title | Area of Expertise |
|---|---|---|
| SHIMOMOTO Yoichi | Associate Professor | Control Engineering / Machine Learning |

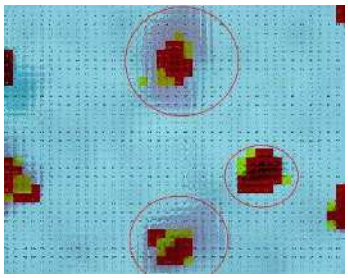
## 1. Main Research Topics

### ① Control theory and its applications

Control systems are generally designed based on a "mathematical model of the controlled object" that mathematically describes the characteristics of the controlled object, but there are always unpredictable differences between the characteristics of the actual object and the characteristics shown by the mathematical model. We regard such differences as uncertainty in the characteristics of the controlled object, and are conducting research into control system design methods that take this uncertainty into account.

### ② Research on the use of machine learning in oral cytology diagnosis

Oral cells are key to treating oral cancer. However, there is a shortage of pathologists who can perform this treatment, and it is difficult to increase the number of skilled pathologists at an early stage. Therefore, in this research, we are using machine learning, which is increasingly being used in image diagnosis and disease diagnosis, to research the construction of an image classifier that can classify oral cancer using oral cytology.



### ③ Research on the use of machine learning in buffing

In this research, we aim to provide a system that can supplement training data on metal surface defects similar to the Buff-Polishing Defect Dtaset (BDD) using image generation AI before the BDD is completed. Ultimately, we aim to present a method for generating large-scale datasets to support defect detection similar to BDD, and to efficiently support the discrimination and verification of BDD.

## 2. Keywords

Control Engineering, Control Theory, Mathematical Science, Machine Learning, Diagnostic Imaging

## 3. Remarks and Websites

**researchmap:** https://researchmap.jp/read0072742

**Laboratory:** http://www.mech.nagasaki-u.ac.jp/index.htm

| Name | Job Title | Area of Expertise |
|---|---|---|
| OTSUBO Tatsuki | Assistant Professor | Precision Engineering, Optical Measurement |

## 1. Main Research Topics

### ① Development of an On-Machine Non-Contact Shape Measurement System

On-machine measurement is a key technology that enables both high precision and high efficiency in machining, and it plays a critical role in the full automation of machining processes. However, because such measurements are performed using the spindle of the machine tool, motion accuracy tends to degrade during high-speed scanning. This degradation adversely affects measurement accuracy and limits the potential for improving measurement throughput. In this study, we developed a laser displacement sensor for on-machine measurement that incorporates the optical skid method, which effectively eliminates the influence of vibration and motion errors.

### ② Development of an In-Line Non-Contact Film Thickness Measurement System

We have developed a device that can measure the film thickness of paint surfaces that are still wet immediately after painting. The main feature of this measuring device is that it can accurately measure film thickness even when the object being measured is shaking, by eliminating the effects of the shaking while the object is suspended during painting.

Fig. On-machine measurement sensor

## 2. Keywords

Production engineering, 3D shape measurement, on-machine measurement, micromachining

## 3. Remarks and Websites

- We conduct research and development of manufacturing technologies (measurement and machining) that meet the needs of production sites.
- We specialize in developing in-line and on-machine measurement technologies.
- We are engaged in the development of measurement systems that are robust against external disturbances such as vibrations within factories.
- We can design custom-made measurement systems tailored to your specific requirements.

**researchmap:** https://researchmap.jp/otsubo

| Name | Job Title | Area of Expertise |
|---|---|---|
| Garcia Novo Patxi | Assistant Professor | Ocean Numerical Modelling |

## 1. Main Research Topics

### ① Optimization of tidal farm layouts

Tidal energy has two main advantages over other traditional renewable sources: its predictability and its periodicity. However, the Levelized Cost of Energy (LCOE) of this technology is still too high compared with solar PV or wind energy. To reduce tidal energy cost, we aim to optimize the spatial distribution of tidal turbines in a farm to mitigate wake losses and maximize the farm's energy yield.

Before carrying out the optimization work, a clear understanding of the turbine wake characteristics is crucial. Wake characterization is performed through the analysis of field and Computational Fluid Dynamics (CFD) simulations. For the optimization, the methodology we are using combines coastal ocean modelling with a genetic algorithm supported by artificial neural networks. This method allows the evaluation of many farm layouts with high accuracy and a relatively small computational effort.

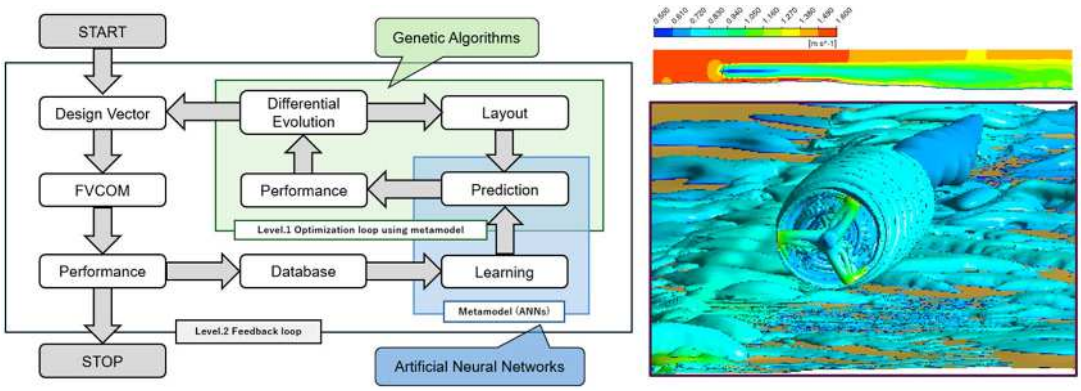



Fig.1 Tidal farm layout optimization system (left) and tidal turbine wake characterization with CFD simulation (right)

### ② Red tide prediction using coastal ocean model

In recent years, the frequency and intensity of red tides (or harmful algae bloom events) in coastal waters of Nagasaki Prefecture has increased. Besides the negative environmental impact, red tides have caused significant losses in the Nagasaki Prefecture aquaculture industry.

To mitigate the negative impact of red tides, we aim to develop an early warning system that alerts aquaculture operators before red tides reach the cage areas, allowing timely implementation of countermeasures to protect the cultivated fish. The objective of this research line is to couple a coastal ocean model with an ecosystem model that can predict the generation and circulation of red tides.

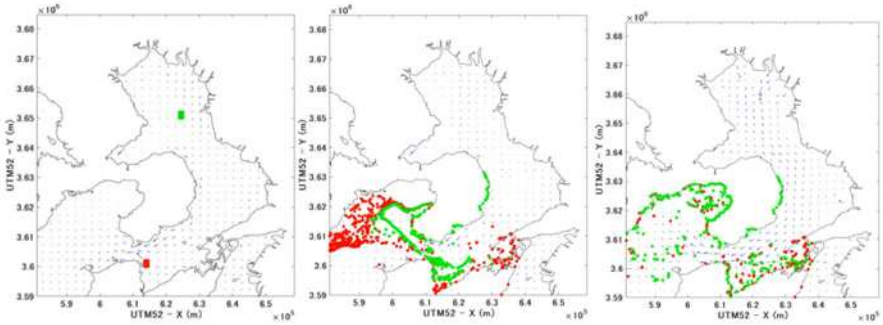


Fig. 2 Coastal ocean model results for particle circulation in the Ariake Sea.

## 2. Keywords

Tidal Energy, Farm Layout Optimization, Red tide

## 3. Remarks and Websites

The farm layout optimization research line aims to become a multi-objective optimization tool that can maximize energy yield from tidal farms while minimizing cost, space needed, or environmental impact. For the red tide prediction, future works will consider the combination of numerical modelling with machine learning to enable earlier prediction and faster response to red tide events.

**researchmap:** https://researchmap.jp/garcia_novo_patxi

**Laboratory:** https://www.mech.nagasaki-u.ac.jp/lab/sakaguchi_lab/html/home.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| KITAMURA Takuya | Assistant Professor | Fluid Mechanics |

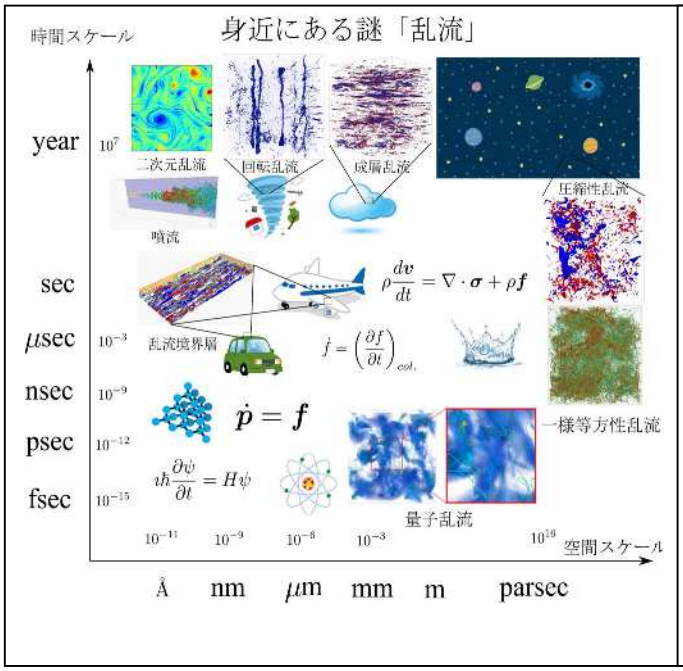
## 1. Main Research Topics

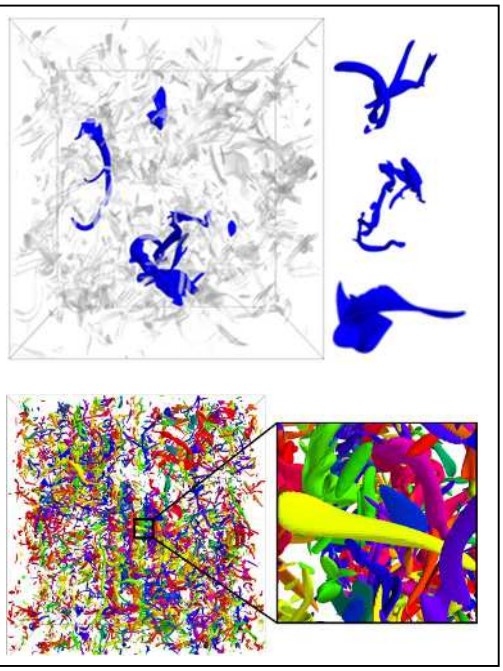
Turbulence is a significant phenomenon that appears across a vast range of spatiotemporal scales—from quantum to cosmic—and affects a wide variety of fields, including weather forecasting, the design of aircraft and automobiles, mixing and diffusion of heat and substances, and our understanding of oceanic and space environments. However, its behavior is extremely complex, and many aspects remain unresolved to this day. We are conducting fundamental research in fluid dynamics, with a focus on turbulence, in the following areas:

① **Statistical Theory of Turbulence**
We are conducting mathematical analyses to elucidate the statistical laws of turbulence.

② **Numerical Simulation of Turbulence**
We perform numerical simulations of turbulence using supercomputers.

③ **Experimental investigation of Turbulence**
We conduct turbulence measurements using hot-wire anemometry.



## 2. Keywords

Fluid Mechanics, Turbulence

## 3. Remarks and Websites

**Features:** Our research focuses on both fundamental and applied aspects of fluid phenomena using a three-pronged approach: theoretical analysis, numerical simulation and experiment.

**Research Achievements:** Publications include *Journal of Fluid Mechanics*, Vol. 1010 (2025), A14, among others.

**Future Outlook:** In addition to contributing to fundamental research in fluid dynamics, we are committed to promoting its practical implementation through applied studies.

**Ongoing Projects**: JSPS KAKENHI Grant-in-Aid for Scientific Research (C), 2025
/JHPCN-Q: “Parallel Computation of High-Reynolds-Number Turbulence Using Compact Finite Differences and Investigation of Turbulence Universality”
/Development Research: “Wind Tunnel Experiments on the Development of a High-Reynolds-Number Turbulence Generator for Offshore Wind Power and Its Impact on Wind Turbine Performance”

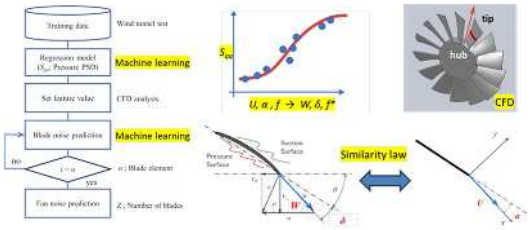
**researchmap:** https://researchmap.jp/tk-0426
**Laboratory:** https://www.mech.nagasaki-u.ac.jp/lab/kitamura_lab/index.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| SASAKI Soichi | Assistant Professor | Fluid Engineering |

## 1. Main Research Topics

### ① Machine Learning for Aerodynamic Noise

Fans are used for the heat exhaust of electronic devices, and there is a demand for these fans to operate quietly. I am engaged in research aimed at predicting the aerodynamic noise of fans by using machine learning. In data-driven machine learning, it is only possible to predict objective variables within the range of provided training data. This study focuses on methodology for the aerodynamic noise prediction using neural networks based on physical laws.



Machine learning of low-pressure fan noise

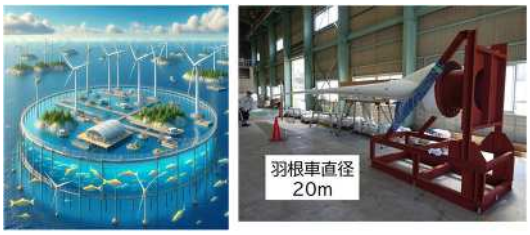
### ② Low GWP Binary Power Generation Units

According to international agreements on global warming, a numerical target has been set to reduce the use of HFC-based refrigerants as working fluids by 85% by 2036. To solve this societal issue, I am developing a low-GWP binary power generation unit. In addition, I am developing technologies to control the operation of these power-generation units through adaptive machine learning. A distinctive feature of this control is that the machine learns the optimal conditions for autonomous operation while continually experimenting in real-time.

R&D of low-GWP binary power generation unit

### ③ Stall-Controlled Wind Turbines

To create stall-controlled wind turbines, I aim to establish a unique methodology by integrating machine learning with the aerodynamic analysis of blade elements, thereby achieving blade design, aerodynamic noise prediction, and operation control. I am currently studying the feasibility of designing rotors based on Bayesian optimization. Furthermore, I am engaged in research on methodologies for predicting the aerodynamic noise generated from rotors based on trailing-edge noise theory.



Stall-controlled offshore wind turbine

## 2. Keywords

Fan, Aerodynamic Noise, Organic Rankin Cycle, Adaptive DOE, Wind Turbine, Water Tunnel Test

## 3. Remarks and Websites

A hydroelectric power generation machinery jointly developed by a corporation was implemented in Niigata Prefecture. I am also accepting researcher from a corporation involved in offshore wind power generation and am considering the application of stall-controlled wind turbines to offshore wind power generation. To implement outcomes in society, it is necessary to take the initiative and act proactively. By constantly maintaining the motivation for the future and staying close to society, I can realize the social implementation of our research. Through these research activities on renewable energy machinery, we are working to expand the scope of planetary health research.

(1) JSPS, KAKEN, Grant-in-Aid for Scientific Research (C), 21K12294, 2021-2024.
(2) JSPS, KAKEN, Grant-in-Aid for Scientific Research (C), 24K08325, 2024-2027.
(3) JST, Adaptable Seamless Technology Transfer Program through target-driven R&D, (2025.7, under reviewing.)

**researchmap**：https://researchmap.jp/read0055706?lang=en

| Name | Job Title | Area of Expertise |
|---|---|---|
| MOTOMURA Fumitaka | Assistant Professor | Laser Processing |

## 1. Main Research Topics

① **Elucidation of modified layer formation mechanism inside transparent material using ultrashort pulse laser**

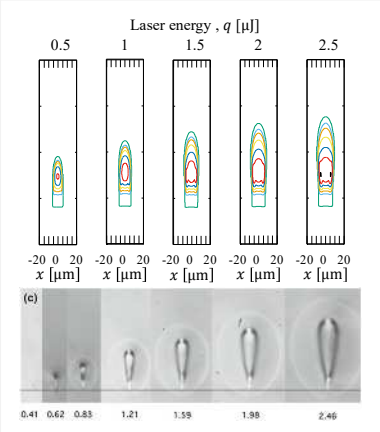
In this study, we developed a numerical simulator that reproduces the transformation inside a transparent solid caused by the advection and diffusion of laser light focused inside the solid. We found a correlation between the heterogeneous layer formed inside the solid and the spatial distribution of the refractive index obtained from the analysis. (refer to left figure below)

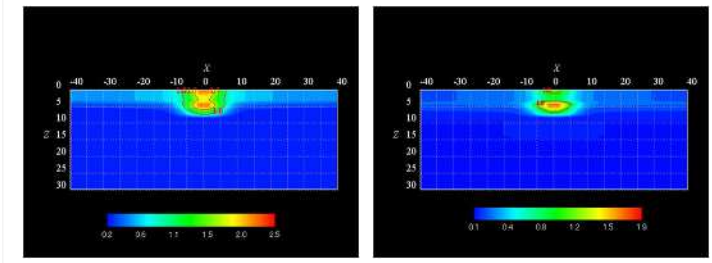
② **Development of laser dicing simulator for Si based multilayer film using pulsed laser**

This simulator allows the selection of optimal processing conditions for the simultaneous removal of multilayer films made of various compositions (metal, glass, resin), contributing to the desired processing accuracy and efficiency. An example of analytical results of the amount of ablation removal taking into account the temperature dependence of thermal and optical properties. (refer to right figure below)

③ **Refractive index analysis of Si based multilayer film using spectroscopy**

If the wavelength profile of refractive index of multilayer films with light-transmitting layer can be formulated, it will be advantageous for selecting the laser wavelength to be used in dicing processing. The wavelength profiles of laser beam absorbed in multilayer films are applied to estimate the spatiotemporal profile of the laser intensity in a numerical simulator.



Melting criteria　　Boiling criteria

## 2. Keywords

Laser dicing processing, Silicon based multilayer film, Numerical simulator, Spectroscopy

## 3. Remarks and Websites

In post-processing of semiconductor devices such as CMOS sensors, dicing processing using laser ablation phenomenon requires selection of optimal processing conditions according to model changes in multilayer structures. If we can elucidate complex and high-speed ablation phenomenon that is difficult to observe in situ and involves solid-liquid phase changes, we believe that even higher-precision processing can be achieved.

**researchmap**：https://researchmap.jp/fmtk_motomura

Laser dicing is key technology not only for single-layer structures of power semiconductors (such as SiC), but also for the singulation of CMOS sensor modules, etc. Developing a numerical simulator that reproduces complex laser ablation phenomenon will help us to correctly understand processing results and improve processing efficiency and accuracy.

| Name | Job Title | Area of Expertise |
|---|---|---|
| MORINAGA Akihiro | Assistant Professor | Robotics |

## 1. Main Research Topics

### ① Development of Marine Robots

This study develops underwater robotic platforms for station-keeping and target tracking without relying on costly navigation sensors. For ROVs (Remotely Operated Vehicles), usually teleoperated, image-based feedback control was introduced to enable autonomous station-keeping and target following. These methods allow efficient data collection and quantitative evaluation of area and volume in subsea infrastructure inspection and seagrass/coral reef monitoring. Marine environmental monitoring is further enhanced through cooperative control with Autonomous Surface Vehicles (ASVs) and optical wireless communication.

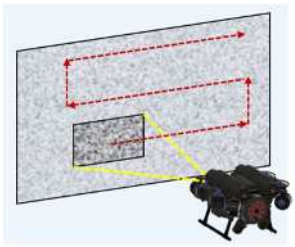


Fig.1 Semi-auto ROV

Fig.2 Seagrass survey

Fig.3 ROV–ASV cooperation

### ② Robots for Infrastructure Maintenance

This study focuses on the development of robotic systems to support infrastructure inspection and maintenance. For waterway tunnel inspection, we are developing a vessel-type robot capable of autonomous navigation along tunnel walls using LiDAR and other range sensors. For pedestrian space inspection, images acquired by a vehicle-type robot are analyzed to evaluate steps and obstacles. Furthermore, a window-cleaning robot combining a parallel wire mechanism with a multirotor system is being developed to achieve safe and efficient façade maintenance.

Fig. 4 Waterway inspection robot

Fig. 5 Pedestrian space inspection

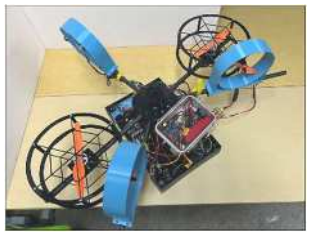


Fig. 6 Window-cleaning robot

### ③ Development of Rehabilitation Devices

A device is being developed for quantitative assessment of spasticity, a condition of excessive muscle tension after stroke or spinal cord injury. The wrist joint is passively moved, and resistance force is measured to construct a spasticity model. Model parameters are estimated using machine learning, enabling objective evaluation.

## 2. Keywords

Robotics, Autonomous Control, Image Sensing and Recognition, Machine Learning
Medical–Engineering Collaboration

## 3. Remarks and Websites

Based on autonomous control technologies utilizing image sensing and machine learning, our research extends to underwater exploration, infrastructure inspection, and rehabilitation support. Moving forward, we aim to advance social implementation of practical robotic technologies through field demonstrations and collaboration with industry.

**researchmap:** https://researchmap.jp/a_morinaga
**Laboratory:** https://robotics-mech-nagasaki-univ.conohawing.com/

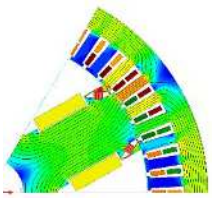
# Electrical and Electronic Engineering Program

| Name | Job Title | Area of Expertise |
|---|---|---|
| ABE Takashi | Professor | Electric Machinery, Power Electronics |

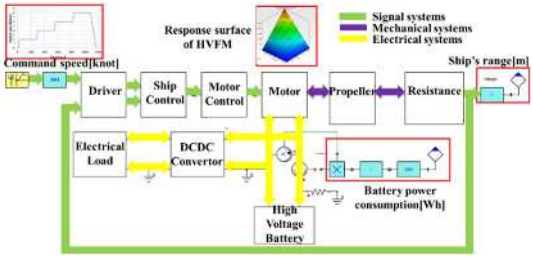
## 1. Main Research Topics

Our research focuses on the conversion, control, and efficient utilization of electrical energy to address various energy and environmental challenges expeditiously. We are advancing investigations into novel principal motors and high-performance motor drives and control systems by integrating academic and technological expertise in electrical machinery, power electronics (PE), and automatic control. Presently, we are pursuing research with the objective of applying these technologies to automobiles, ships, home appliances, and other domains.

### ① Research on high-performance motors

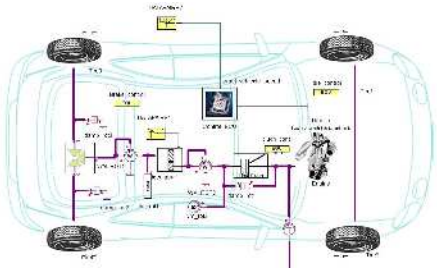


The research and development of a "half-wave rectified variable field flux motor" introduces an innovative magnetic flux generation principle that surpasses the capabilities of high-performance permanent magnet motors currently employed in various applications. This motor allows for the magnetic flux to be freely adjusted according to specific requirements. The design emphasizes high efficiency, high torque, and low vibration, utilizing the finite element method. Additionally, the development includes application-specific drive systems and control methods, alongside application-oriented system simulations that evaluate the entire electric drive system through simulations.




### ② Motor drive system development and system simulation

In the development of application-oriented motors, it is imperative to select, enhance, and develop diverse control and power conversion methodologies. Within our laboratory, we are engaged in research endeavors such as the "Development of a High-Efficiency Drive System for Small IPM Motors," which achieves high efficiency through portable battery operation, and the "Performance Enhancement of Switched Reluctance Motors," which leverages reluctance torque generated by the rotor's salient pole shape, obviating the need for permanent magnets. Additionally, we are advancing a "digital twin system" that facilitates fault diagnosis and prediction by employing simulation models of various electric drive systems.



## 2. Keywords

New principle motors, High performance motor drives, Model-based development

## 3. Remarks and Websites

We are developing motors and drive systems with new structures and principles that achieve high efficiency, high torque, and excellent control performance under various operating characteristics and usage environments, such as environmentally friendly electric drive systems for electric vehicles and battery-powered ships, as well as battery-driven home appliances.

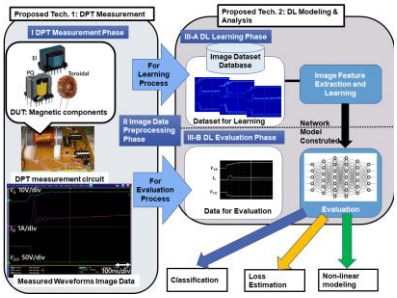
**researchmap:** https://researchmap.jp/abet_map
**Laboratory:** http://www.eee.nagasaki-u.ac.jp/labs/pec/abe-otomo-lab/index.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| ISHIZUKA Yoichi | Professor | Electronic Circuits and Integrated Circuit Engineering |

## 1. Main Research Topics

**① Research on high-speed response and flexible control of power conversion circuits with diversifying requirements**

We are developing power electronics design support technologies driven by power requirement data for direct current-driven loads such as data centers and lighting equipment.




**② Research on integrated power conversion circuits**

The performance improvement of processors such as CPUs and GPUs requires a stable supply of operating voltage under any operating condition. Globally, research is advancing to achieve stable power supply near the processor by integrating power conversion circuits with CPUs, referred to as Power SOC. In this laboratory, we are conducting research utilizing unique ideas such as MHz-driven digital control circuits and high-density implementation technology within this research field.

**③ Research on Bidirectional Power Conversion Systems with Batteries**

We are conducting research on high-power-efficiency bidirectional power conversion circuits for the effective utilization of renewable energy generated under limited conditions, focusing on further reduction of conversion losses and generalization.

**④ Research on solving social issues through the utilization of IoT/AI and sensor network technologies**

This research primarily focuses on the development of outdoor remote monitoring systems utilizing IoT/AI technology. In collaboration with Associate Professor Tomofumi Sugimoto, we have been developing systems for slope disaster prevention and preservation. Currently, we are expanding our research to include stability assessment of damaged stone walls at Kumamoto Castle and advanced cultivation techniques for open-field farming through joint research with the Nagasaki Prefectural Agricultural Experiment Station.

**⑤ Research on in-vivo low-invasive stimulation/sensing for medical research**

In the field of medical research, efforts are underway to measure and analyze various information from living organisms using small animals. However, there are many obstacles in this process that hinder the efficient implementation of research.

We are collaborating with the Inoue Tsuyoshi Laboratory at the Faculty of Medicine to address these issues from an engineering perspective. Through the development of low-invasive stimulation/sensing technologies and the proposal of new methods, we aim to support the smoother and more effective advancement of medical research.

## 2. Keywords

Electronic circuits, integrated circuits, IoT/AI

## 3. Remarks and Websites

**researchmap:** https://researchmap.jp/read0055707

**Laboratory:** https://pemsic.eee.nagasaki-u.ac.jp

*We also conduct education, research, and hub formation through the Center for Advanced Micro-Device Research (CAMRIS) at Nagasaki University's Integrated Production Science Division. For more details, please visit: https://camris.ist.nagasaki-u.ac.jp

| Name | Job Title | Area of Expertise |
|---|---|---|
| OHSHIMA Tamiko | Professor | Plasma Materials Science |

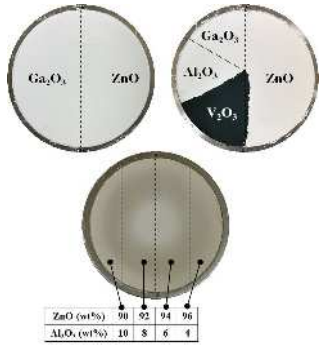
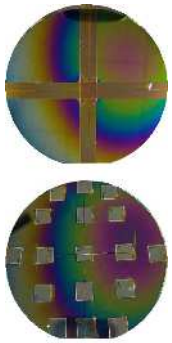
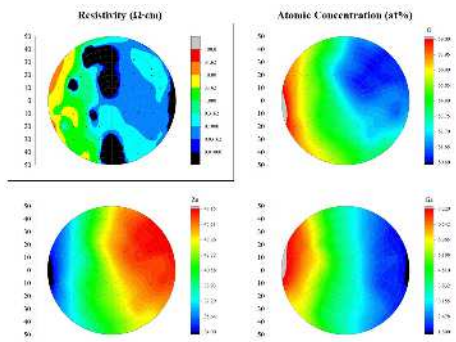
## 1. Main Research Topics

### ① Rapid and cost-effective material exploration using the powder sputtering method

In this approach, functional thin films are fabricated by directly using powder as the sputtering target material. Compared to conventional solid targets, powder targets offer several advantages:

- **Reduced target fabrication time**: By mixing powders, elemental combinations and composition ratios can be freely and widely adjusted. Moreover, since sintering is not required, targets composed of low-melting-point or multi-element materials can be fabricated in a short time.
- **Cost reduction**: For targets of the same size, powder targets can reduce costs by up to approximately 1/1000* compared to solid targets (*depending on the type of powder).

Additionally, powder targets are highly compatible with combinatorial thin film deposition. The spatial arrangement of powders within the target holder can be freely modified, allowing multiple powder types to be configured within a single cathode. This eliminates the need for large-scale equipment—only one cathode and power supply are required—and enables the fabrication of numerous composition-gradient films in a single deposition process. As a result, correlations between material composition and physical properties can be efficiently evaluated. By leveraging these benefits, we aim to establish methods for the rapid and cost-effective exploration and development of new and alternative materials.

| Powder target | Composition-gradient film | Evaluation of material composition and properties |
|---|---|---|
| Free placement of single or mixed powders | Si wafers and quartz glass | Thickness, Resistivity, Composition, and Crystal structure, etc. |
|  |  |  |



### ② Fabrication of High-Quality Carbon Nanostructures via Multi-Hollow Plasma CVD Method

We are synthesizing carbon nanoparticles (CNPs) using the multi-hollow plasma chemical vapor deposition (MHPCVD) method. This technique has previously demonstrated success in controlling the crystallinity, particle size, and deposition amount of silicon nanoparticles, and the key parameters influencing these controls have been identified. The objective of this study is to clarify the factors that control the crystallinity, particle size, and deposition amount of CNPs. In particular, crystalline CNPs are expected to enhance the performance of lithium-ion batteries. Therefore, we aim to clarify the structural control factors of CNPs through process optimization using the MHPCVD method.

## 2. Keywords

Sputtering, Powder Target, Combinatorial, Thin Film, Carbon Nano Particles

## 3. Remarks and Websites

My laboratory has conducted collaborative research on the exploration of electronic component materials. While solid targets are typically used for mass production, fabricating a new solid target each time the elemental composition or ratio is changed during the material exploration phase is both time-consuming and costly, often resulting in low target utilization efficiency. In this study, we aim to accelerate and reduce the cost of material exploration by directly using powder as the sputtering target. Once sufficient information is obtained, the solid target for mass production can be fabricated, thereby contributing to the shortening of the overall development timeline.

**researchmap:** https://researchmap.jp/tamiko_ohshima
**Laboratory:** https://plasma.eee.nagasaki-u.ac.jp

| Name | Job Title | Area of Expertise |
|---|---|---|
| TANAKA Toshiyuki | Professor | Electromagnetic Wave Application Engineering |

**1. Main Research Topics**

We are developing non-destructive and non-invasive testing devices that use electromagnetic waves and are also conducting research into electromagnetic compatibility (EMC) countermeasures.

① **Development of radar for detecting horizontal cracks on highways and bridges**

It is known that horizontal cracks occur inside the concrete of highways and bridges due to the frequent passage of heavy vehicles. Concrete is paved with asphalt, and horizontal cracks in the concrete cannot be seen with the naked eye, so regular inspections are important. In regular inspections, the asphalt is generally removed, and the concrete is destroyed to check for horizontal cracks. However, this method is time-consuming and expensive. Therefore, we are developing a radar device that can detect horizontal cracks non-destructively from above the asphalt.

② **Estimating rebar diameter using commercial radar.**

Using a concrete radar, it is easy to check whether the rebar is present or not. However, to investigate the durability of a concrete structure, the exact size of the rebar (rebar diameter) and its position (cover depth) are required. These accurate values cannot be obtained by normal use of radar. Therefore, our laboratory is developing an algorithm to non-destructively and simultaneously estimate the diameter of rebar in concrete, the cover depth of rebar, and the electrical constants of concrete.

③ **Development of blood vessel detection radar to assist laparoscopic surgery**

In laparoscopic surgery, the time it takes to drill a hole in the fat and deliver the medical equipment to the affected area cannot be ignored. This is because blood vessels are present in fat, and it is necessary to enter the area without damaging the blood vessels. For this reason, an antenna is placed on the laparoscopic forceps and emits electromagnetic waves from the antenna. The emitted electromagnetic waves are reflected by blood vessels, and by analyzing the received electromagnetic waves, it is possible to determine whether or not there are blood vessels nearby. This is expected to significantly reduce the time required for laparoscopic surgery.

④ **Distinguishing between natural and artificial teeth**

We are developing a device that can distinguish between natural teeth and dentures made of ceramics, zirconia, etc. This system uses a dielectric probe to instantly measure the electrical constants of an object and distinguish between natural and artificial teeth in real time. An important theme is the creation of a dielectric probe that can be used for teeth of various shapes.

⑤ **Monitoring the salinity of seawater**

We are developing a system that can observe the salinity of seawater in real time. Even if the seawater is deep at aquaculture sites, we can check the salinity without having to pump the seawater up. We also aim to simultaneously check the degree of pollution of seawater.

⑥ **Electromagnetic compatibility (EMC) measures**

Whenever electric current flows, unwanted electromagnetic waves are generated. Unwanted emitted electromagnetic waves can sometimes cause other electronic devices to malfunction. Therefore, we are developing a simple device for detecting leaked electromagnetic waves and a power supply circuit that does not emit unwanted electromagnetic waves.

**2. Keywords**

Electromagnetic wave applications, non-destructive testing, non-invasive diagnosis, electromagnetic compatibility (EMC)

**3. Remarks and Websites**

We aim to develop non-destructive testing equipment and non-invasive diagnostic equipment that utilize electromagnetic waves that do not currently exist. We will also conduct feasibility testing to see if this is possible in principle. We welcome inquiries about testing and diagnosis.

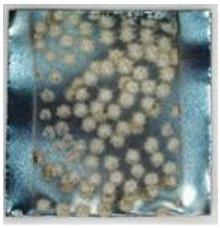
**researchmap:** https://researchmap.jp/read102593
**Laboratory:** https://www.eee.nagasaki-u.ac.jp/labs/emlab/study/staff/tanaka/

| Name | Job Title | Area of Expertise |
|---|---|---|
| NAKANO Masaki | Professor | Magnetics |

## 1. Main Research Topics

The researcher is engaged in the development of "small permanent magnets" through a "bottom-up approach utilizing film deposition." The objectives of this research are twofold: (1) to contribute to the advancement of novel devices, and (2) to aid in the miniaturization and enhancement of performance of magnets incorporated into existing devices. Three examples are provided below.

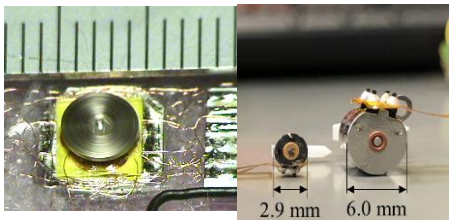
**Topic 1. Development of Micromagnets Using the Laser-Induced Forward Transfer Technique (photo on the right)**



Patterned micromagnet

Micromagnets intended for future applications, such as "insect-shaped microdrones" and "cell separation patterning magnets," necessitate integration with flexible substrates. However, conventional techniques that require high-temperature heat treatment are inadequate. The researcher has independently developed the LIFT method, which facilitates the direct transfer of magnetic materials of any shape at room temperature. The aim is to integrate this method with a multi-material manufacturing process to develop technology for embedding magnetic functions into next-generation medical devices, IoT devices, and other applications.

**Topic 2. Development of Rare-Earth Micromagnets Fabricated Using the High-Speed Film Deposition Method for Small Device Applications**

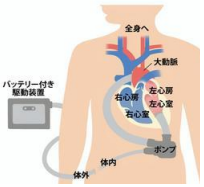



Miniaturized motors comprising PLD=made magnets

To generate a magnetic field within a specified volume, the magnet itself must possess a certain volume, which constrains its miniaturization. This study proposes a method for fabricating micromagnets using a distinctive "high-speed pulsed laser deposition" technique. By exploiting the advantages of this method for thick-film deposition to generate magnetic fields, the researcher contributes to the progression of "ultra-small device development" (photo on the right), which is anticipated to experience increased demand in the future.

**Topic 3. Development of Platinum-Based Magnet Ribbons by Combining High-Speed PLD and Exfoliation Phenomena**

Internal micropump




By focusing on the phenomenon where Fe-Pt magnets deposited on silicon substrates using the aforementioned high-speed pulsed laser deposition (PLD) method readily delaminate from the substrate, the researcher has produced Fe-Pt magnet ribbons for use in blood circulation micropumps (photo on the right). In addition to demonstrating excellent biosafety, these ribbons have also exhibited superior mechanical properties, as evidenced by tensile strength and cantilever tests. Research is ongoing, including the lamination of rare-earth magnets.

## 2. Keywords

Micro magnets, LIFT (Laser Induced Forward Transfer) technique, PLD(Pulsed Laser Deposition)method, Miniaturized devices

## 3. Remarks and Websites

In collaboration with multi-material manufacturing processes, we aim to develop this technology as an integrated formation and implementation technology for magnetic functions in next-generation medical devices and IoT devices.

**researchmap:** https://researchmap.jp/read0185023/
**Laboratory:** https://www.eee.nagasaki-u.ac.jp/labs/magnet/index.html

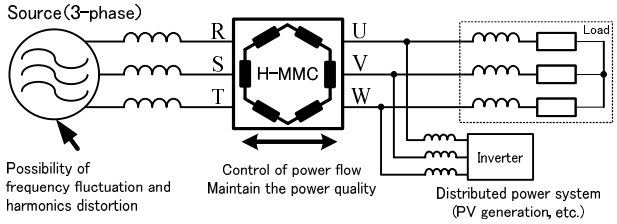
| Name | Job Title | Area of Expertise |
|---|---|---|
| HAMASAKI Shin-ichi | Associate professor | Power Electronics, Control Engineering |

## 1. Main Research Topics

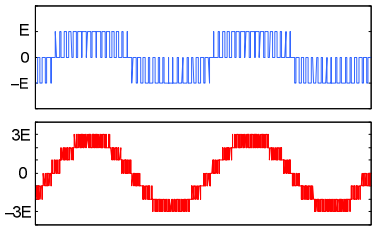
My main research topic is new circuits and control methods for power converters in power electronics, as well as their applications.

**① Research on novel power converter system based on modular multi-level converter**

The modular multilevel converter (MMC) is a circuit connection in which inverters are modularized into multiple stages. Research and development are currently underway on this technology, which is expected to be next-generation power conversion system that can reduce distortion in voltage waveforms through high voltage and multilevel output. In this research, I am studying the circuits and control of a new power conversion system based on the MMC, as well as its applications. As application examples, I am proposing the power flow controller using the hexagonal MMC (H-MMC) that performs three-phase AC-AC conversion to manage power transmission in the power grid, the power conditioner for mega solar power plants that performs DC-AC conversion, and an MMC integrated with a power storage device that can manage power by incorporating a power storage device.



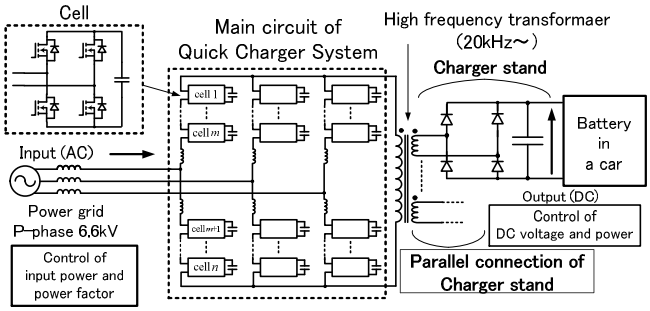

Power flow controller using H-MMC




Multi-level low-distortion voltage waveform

**② Research on novel circuit and its control for quick charger system of electric vehicle**

Research and development are being conducted on electric vehicle quick chargers to improve their efficiency and size to shorten charging times and popularize charging system infrastructure. In this research, we are researching a new circuit method and its control method that applies MMC as the system that can be expected to improve the efficiency and size of quick charger system. The proposed system supplies power directly from high voltage of 6.6 kV via the transformer, and by handling the large amount of power due to the high voltage, it is possible to manage and operate multiple charging stations as a single system, which is expected to improve efficiency and size.




③ Research on improving performance for power compensation system applying digital control

Power systems are becoming more complex due to the distributed installation of distributed power sources and energy storage devices. To ensure proper power management, various power compensation devices such as reactive power compensators, power flow controllers, and active filters are being researched and developed. In this research, we propose a new control method that applies digital control to the control of these power compensators to speed up response and thereby stabilize the power system to respond to fluctuations in the complex power network.

## 2. Keywords

Power conversion system, Multi-level converter, Quick charger, Digital control

## 3. Remarks and Websites

Modular multilevel converters are expected to be power converters capable of handling high voltages and large power, and their applications are diverse. The system proposed in this research is expected to have a wide range of applications in addition to the examples above.

In addition to the multilevel converter circuits shown above, I am also available to consult with you on circuit configurations and control methods, from basic systems using general inverters to applications.

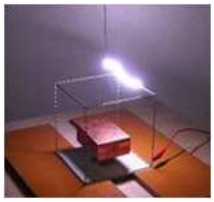
**researchmap:** https://researchmap.jp/read50176006
**Laboratory:** https://www.eee.nagasaki-u.ac.jp/labs/asca/

| Name | Job Title | Area of Expertise |
|---|---|---|
| FUJISHIMA Tomoyuki | Associate Professor | Lightning Protection, Electrical Discharge |

## 1. Main Research Topics

### ① Development of Simple Lightning Protection System for Electrical and Electronic Equipment Installed Outdoors

My laboratory is attempting to develop a low-cost, simple method of lightning protection to minimize damage from lightning to electrical and electronic equipment installed outdoors. Lightning protection cages and simplified lightning rods are devised and prototyped, and are currently conducting field tests to verify their effectiveness. Furthermore, we are working to improve communication performance by improving the cage shape and reducing the cost of simple lightning rods and grounding resistance.



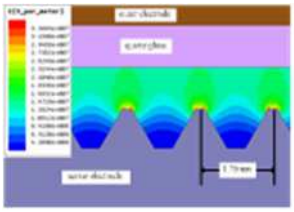

Simulated lightning strike test on lightning protection cage

### ② Simplification and IoT integration of soil moisture measurement using the principle of ground resistance measurement

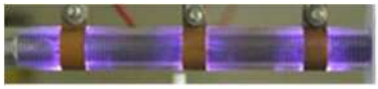
By applying the three-electrode method for measuring ground resistance, we have devised, prototyped, IoT-enabled, and implemented a system that can easily and with low power consumption monitor changes in soil moisture. By making it easier to obtain soil moisture data, we aim to contribute to smart agriculture.

### ③ Generation of ozone using a screw electrode ozonizer and environmental applications of ozone generated by electrical discharge

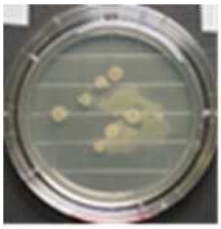
We are developing a system that efficiently generates ozone at concentrations and yields sufficient for practical use at a relatively low cost using dielectric barrier discharge (DBD). The generated ozone has strong oxidizing power and no residual toxicity, so we aim to apply it to environmental issues such as soil sterilization.



Electric field calculation



Discharge in ozonizer



Cultivation results of soil bacteria

## 2. Keywords

Simple lightning protection, Offshore wind power generation, Smart aquaculture system, Soil moisture measurement, Ozone, Dielectric barrier discharge

## 3. Remarks and Websites

We are primarily engaged in research and development of systems (lightning protection cages and simple lightning rods) that protect electrical and electronic equipment installed outdoors from damage caused by lightning strikes at the lowest possible cost.

Applying the knowledge gained from previous research on lightning protection, we are also considering measures to protect smart aquaculture systems and offshore wind power generation systems from lightning damage.

**researchmap:** https://researchmap.jp/read0185025

| Name | Job Title | Area of Expertise |
|---|---|---|
| FUJIMOTO Takafumi | Associate Professor | Antenna Engineering |

## 1. Main Research Topics

Radio waves play an important role in transmitting information, but recently, they have come to be utilized in fields other than communication, such as the medical field and energy field. In our laboratory, we conduct research and development on "antennas," which are the most important devices for utilizing radio waves, through simulation and measurement experiments.

### ① Development of Compact High-Performance Antennas for Communication

We conduct research and development on compact planar antennas with high performance characteristics such as broadband characteristics and multi-band operation.

**Compact Circularly Polarized Antenna for UWB**

We have developed a planar antenna with a circular polarization frequency bandwidth of over 80%. The circular polarization frequency bandwidth is at world-class level.

Top view　　Bottom view

**Multiband Printed Antenna**

We have developed a planar antenna that can be used in three frequency bands (2.45 GHz band, 3.5 GHz band, and 5 GHz band). By adopting a multilayer structure, we have enabled operation in three frequency bands while also achieving antenna miniaturization.

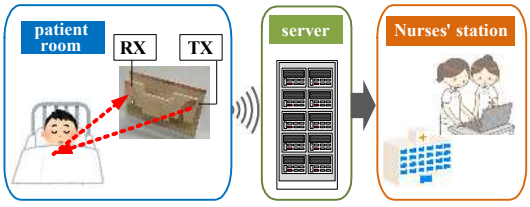
Final design　Upper　Middle　Lower

### ② Development of Planar Antennas for Radio Wave Applications

We conduct research and development on compact planar antennas for the purpose of utilizing radio waves in new fields such as medical applications.

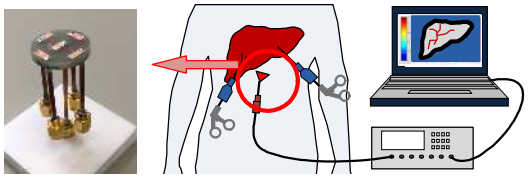
**Body Movement Detection and Monitoring System**

We are developing antennas for non-contact monitoring of patient body movement, bed exit, respiration, and heartbeat in hospitals and nursing care facilities.




**Radio Wave Endoscopic Antenna System**

We are developing radio wave endoscopic antennas capable of detecting blood vessels inside fatty tissue.



## 2. Keywords

Broadband antennas, Planar antennas, Radio wave applications, Medical applications, Sub-6 5G

## 3. Remarks and Websites

- The radiation characteristics required for antennas depend on the application. We can design and develop antennas according to specific applications.
- We possess multiple electromagnetic field analysis software packages for antenna design. We are also capable of measuring antenna characteristics up to 43 GHz.
- In addition to the above, we also conduct research on Sub-6 5G antennas, 28 GHz band 5G antennas, and antennas for wireless power transmission (rectennas).

**researchmap:** https://researchmap.jp/read0185026
**Laboratory:** https://www.eee.nagasaki-u.ac.jp/labs/emlab/study/staff/fujimoto/

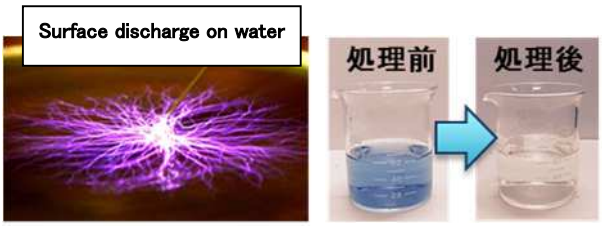
| Name | Job Title | Area of Expertise |
|---|---|---|
| FURUSATO Tomohiro | Associate Professor | High Voltage Pulsed Power Engineering |

## 1. Main Research Topics

Our laboratory specializes in high voltage, plasma, and pulsed power. These technologies are applied across cross-disciplinary fields—including electric power and energy, electronics, the environment, agriculture, food, and medicine—and contribute to the creation of new industrial applications. Our research covers both the active use of discharge plasmas (e.g., wastewater treatment) and the prevention of discharge plasma initiation (high-voltage insulation).

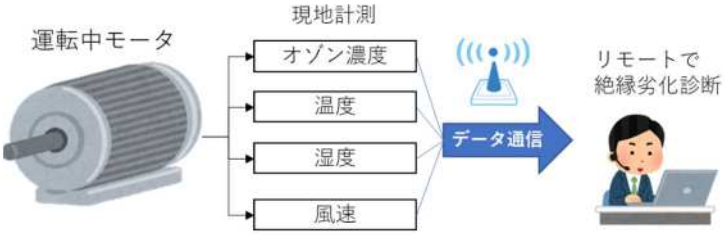
For generating discharge plasmas, we are equipped with pulsed-power supplies that temporally compress energy and release it in short bursts, as well as AC high-voltage sources for insulation studies, enabling us to produce discharge plasmas under a wide range of conditions. Below are some of our laboratory's research themes."

### ① Basic research on water treatment by surface discharge plasma on water using pulsed power




Water pollution from industrial effluents and domestic wastewater leads to severe environmental degradation, making the development of water purification technologies essential for a sustainable society. Our laboratory is working to improve water quality by generating 'artificial lightning' (discharge plasma) on the water surface using high-voltage and pulsed-power techniques. Because no chemical additives are used, this approach is attracting attention as an environmentally friendly technology.

### ② Insulation degradation diagnosis technology for industrial motor




At present, large industrial motors (hundreds of kilowatts or more) used in equipment such as pumps, compressors, and fans at power plants, petrochemical plants, and steelworks ensure safety through periodic teardown inspections. However, because disassembly is costly and time-consuming, there is a strong demand for convenient inspection methods that do not require disassembly. In this research, we are developing an online insulation-degradation diagnostic system that utilizes ozone concentration corrected for environmental factors. (Japanese Patent No. 7560367)

## 2. Keywords

Discharge plasma, pulsed power, high voltage, insulation diagnosis

## 3. Remarks and Websites

**Key Features & Research Achievements**

- Development of wastewater purification technology using water-surface discharge plasma generated by pulsed power
- Development of high-voltage insulation diagnostic technology for large industrial motors via ozone monitoring (Japanese Patent No. 7560367)
- Insulation design for power semiconductor devices

**Prospects**

- Pursue research on the decomposition and sequestration (fixation) of $CO_2$ using discharge plasmas.
- Advance insulation diagnostics by leveraging data science (AI).

**researchmap:** https://researchmap.jp/furusato/
**Laboratory:** https://pulsep.eee.nagasaki-u.ac.jp/

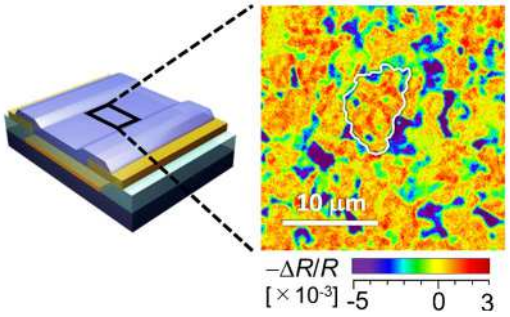
| Name | Job Title | Area of Expertise |
|---|---|---|
| MATSUOKA Satoshi | Associate Professor | Organic Electronics, Optical Physics |

## 1. Main Research Topics

Organic electronics and optical devices composed of functional organic molecules, such as flexible electronics and optical communication devices utilizing the flexibility of organic molecular crystals and the nonlinear optical response of the anisotropic molecular structure, respectively, have been developed for the next-generation information and communication technology. I investigate for improving the device performance by visualizing the spatial distribution of charge carriers and electric polarizations by means of the optical imaging technique.

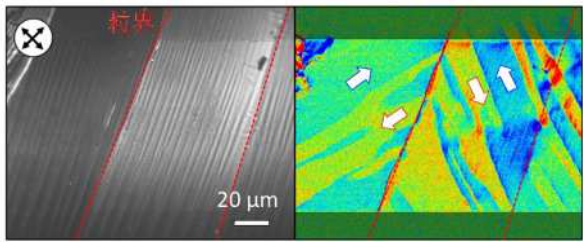
① **Visualization of charge carriers in Organic FETs**

I developed an optical gate modulation imaging technique which allows to visualize the charge carrier distribution in the organic semiconductor layer of organic field effect transistors. By means of the technique, I successfully observed the inhomogeneous carrier distribution in a polycrystalline organic semiconductor layer and revealed the anomalous electro-optic response in a single-crystal semiconductor layer.



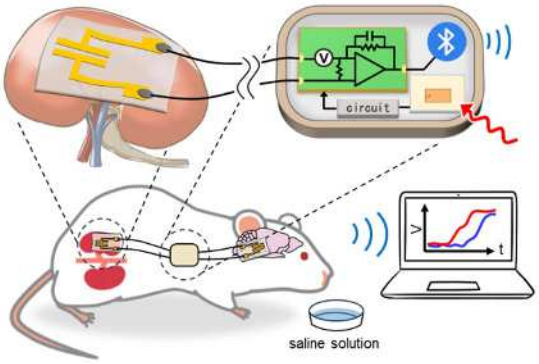

② **Visualization of electric polarizations using nonlinear optical responses and development of optical devices**

I observed the spatial distribution of electric polarizations in organic ferroelectric materials and electro-optic polymers by means of the field modulation imaging technique utilizing the nonlinear optical response induced by the broken inversion symmetry of organic molecules. It was demonstrated that the micro-meter scale ferroelectric domains and the reversal mechanism in ferroelectric films. The polarization orientation in the electro-optic polymer waveguide of the optical modulator can be evaluated by the technique, which encourages technological innovation with improving the device performance.




③ **Development of implantable sodium ion sensor device**

I investigated implantable sodium ion sensor devices for understanding the mechanism of the phenomena caused by excessive sodium intake in the body on biological functions. Flexible polymer sensors and wireless communication devices are utilized to measure the dynamics of living organisms without interference of natural movements.




## 2. Keywords

Organic field effect transistor(FET), Organic ferroelectric, Electro-optic polymer, Optical modulator

## 3. Remarks and Websites

**researchmap:** https://researchmap.jp/matsuoka-s_1122

| Name | Job Title | Area of Expertise |
|---|---|---|
| MARUTA Hidenori | Associate Professor | Industrial Electronics |

**1. Main Research Topics**

① **Edge-Shallow Neural Network Control of DC-DC converter**

DC-DC converter has an essential role in a wide range of electronic devices. With the rise of IoT devices, DC-DC converter is required not only to provide a stable power supply but also to provide a superior function for complex control to meet various demands.

Recent advancements in microcomputers have made it possible to perform complex signal processing and control at the very edge of IoT networks. This enables to form edge computing, where tasks that were previously impossible can now be carried out in edge-level computing resources. Our research is developing a new control method that leverages these advancements. We investigate the use of neural network, a most popular and practical type of AI, for such purposes. The training part that requires a large amount of computing resource and processing power is handled by powerful cloud resources via a network connection. Meanwhile, the inference or prediction part, which is the faster and requires less intensive computation burden is done directly on the edge device. This approach allows us to achieve superior levels of stability and fast response. The system can also adapt to changing conditions and external disturbances through its learning capabilities.

② **MPC and AI for Design and Control of DC-DC Converter**

Model based designing and controlling of complex systems requires models of individual systems and integrating them into one complete model. However, even if individual models are accurate, the precision of the overall model can decrease due to inconsistencies caused by connections or the propagation of disturbances throughout the system. Furthermore, in real operation, there is model uncertainty due to factors like component-level tolerances.

This research combines Model Predictive Control (MPC) with system identification to correct model inaccuracies. It is realized by using the prediction of the model and observed data to adjust discrepancies in the parameters in the model. Since a perfect or ideal model is impossible to obtain, the system is treated as a black box to a certain extent. We are currently developing specific methods that use AI techniques for estimation to improve the system's performance.

③ **Methodology of Anomaly Detection and Fault Diagnosis for Industry**

Detecting anomalies or faults from data is a difficult task for computers, while often easy for humans. This is because to give a quantitative definition of “anomaly” is challenging; which humans often rely on experience and intuition. In such cases, standard AI methods frequently fail to achieve high accuracy.

This research explores methods for detecting abnormal states, such as anomalies and faults, directly from data. Our specific examples are:

- Detecting smoke or fire from video data (surveillance footage).
- Detecting faults in a DC-DC converter from its observed values.

By combining model-based and AI-based approaches, we aim to develop a method that reflects the unique characteristics of the systems and to provide a superior function for several specific purposes.

**2. Keywords**

Power conversion, Model based method, AI, Anomaly, Fault detection

**3. Remarks and Websites**

**researchmap：** https://researchmap.jp/h_maruta
**Laboratory:** https://sites.google.com/view/maruta-lab/

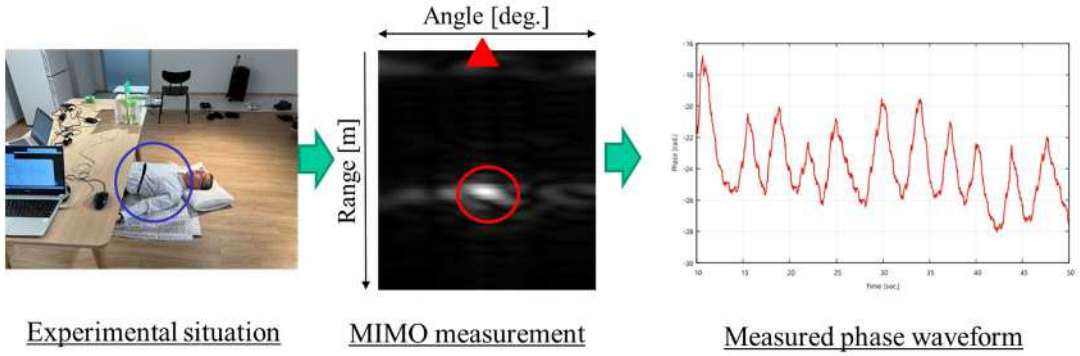
| Name | Job Title | Area of Expertise |
|---|---|---|
| MORIYAMA Toshifumi | Associate Professor | Microwave Remote Sensing |

## 1. Main Research Topics

Microwaves can propagate through space regardless of day and night or weather, and have been used for radar to observe a target remotely. Radar is now used in many applications, including preventing car collisions, detecting suspicious individuals at home, and monitoring the heart rate and respiration. In this research, I consider to observe the small displacement of objects and structures and to image the objects by radar.

### ① Real-time monitoring of small displacement, including heartbeat and respiration of human

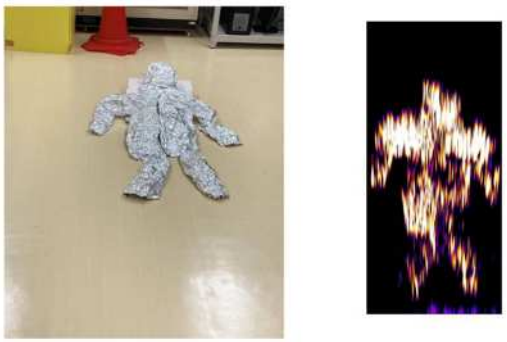
This research focuses on a technology for radar observation of the human heartbeat and respiration in real time without contact. Another application of this technology is to measure abnormal vibrations in infrastructure (such as buildings and bridges). The following figure shows an example of measuring heartbeat and respiration.




Experimental situation　　MIMO measurement　　Measured phase waveform

### ② Millimeter-Wave Imaging with GB-SAR

In this research, I am developing technology to detect landslide and hazards by imaging using millimeter-wave ground-based synthetic aperture radar (GB-SAR). It will contribute to safety and security for human activity. The image on the right shows a millimeter-wave radar image of aluminum foil imitating a human body.



アルミホイルの人体モデル　　79GHz GB-SAR画像

## 2. Keywords

MIMO FM-CW radar, Synthetic Aperture Radar processing, Small displacement

## 3. Remarks and Websites

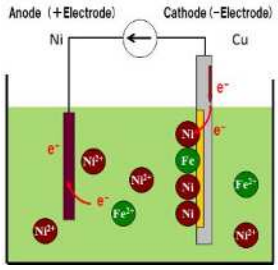
This research can non-contact real-time displacement measurement and daily fluctuations of structures such as buildings and bridges in the infrastructure and civil engineering fields, and non-contact measurement of human breathing and heartbeats in the medical field. It can also be applied in the field of security, such as detecting suspicious individuals. We would appreciate your consideration of collaborative research.

**researchmap:** https://researchmap.jp/read0147500
**Laboratory:** http://www.eee.nagasaki-u.ac.jp/labs/emlab/moriyama/index.htm

| Name | Job Title | Area of Expertise |
|---|---|---|
| YANAI Takeshi | Associate professor | Magnetic Materials and Their Applications |

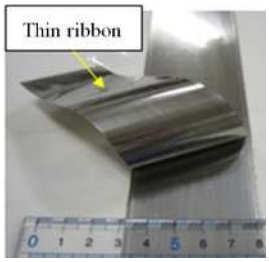
## 1. Main Research Topics

### ① Development of soft and hard magnetic thick films prepared using electroplating and electroless plating methods




We are studying preparations of magnetic materials for small magnetic devices using electroplating and electroless plating methods. Our research focuses on improving their magnetic properties and studying effective additives into the plating baths. Our laboratory can produce magnetic films with thicknesses in the range of approximately 1 to 20 μm in just a few minutes.

### ② Fabrication of soft magnetic ultra-thin ribbons




Power semiconductors such as SiC and GaN have become more widely used, leading to increases in the power and operating frequency of power electronics devices. Magnetic materials are essential components in these devices, used as core materials in transformers and reactors. We are developing soft magnetic materials with high saturation magnetic flux density for high-power applications.

### ③ Computer simulation of soft magnetic properties

We are investigating the application of induced magnetic anisotropy using external stress to improve high-frequency magnetic properties. As part of this investigation, we are developing a computer simulation method for studying magnetic properties. Based on micromagnetic theory, we are using parallel calculations with GPUs to perform multi-element analysis and determine magnetic properties in a short time.

### ④ Others（Novel electrolyte）


In wet processes such as electroplating and electroless plating, water is often used as a solvent. As water is decomposed to $H_2$ and $O_2$ gases when high voltage is applied during electroplating, some elements are difficult to obtain from an aqueous solvent. To address this issue, we are investigating the preparation of magnetic films using deep eutectic solvents. Additionally, we are also investigating the plating from solid electrolytes (gel plating) to reduce waste liquid.

## 2. Keywords

Magnetic films, electroplating, electroless plating, high frequency, power electronics, computer simulation

## 3. Remarks and Websites

With the rapid progress of power electronics technologies, there has been growing concern for several years now about the shortage of suitable magnetic materials for these applications. Recently, these concerns have become even more pronounced, and we strongly feel the increasing demand. We are working hard to meet these expectations through materials development in several areas, including metallic magnetic thin ribbons for high-frequency use, small magnetic films for medical applications, and soft magnetic films for sensors and other devices. If any of these topics interest you, please feel free to reach out to us.

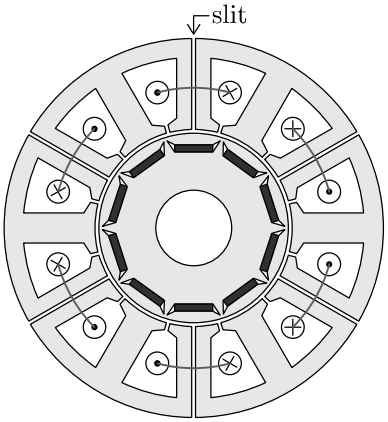
**researchmap:** https://researchmap.jp/read0125661
**Laboratory:** http://www.eee.nagasaki-u.ac.jp/labs/magnet/index.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| YOKOI Yuichi | Associate Professor | Electrical Machinery, Nonlinear Dynamics |

## 1. Main Research Topics

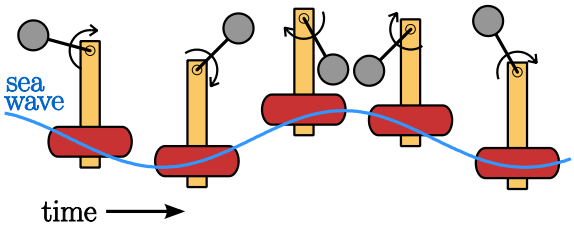
### ① Development of high-performance motors and generators

More than half of the total electricity consumed in Japan is used by motors. Additionally, under government policy, the adoption of electric vehicles powered by motors and wind power—one of the most promising renewable energy sources—is being accelerated. Against this backdrop, improving motor and generator performance, including efficiency, torque quality, and torque/power density, is becoming increasingly important. This research aims to enhance the performance of motors and generators by adopting ***concentrated winding***, a winding method for the coils that has not been widely used until now. Concentrated winding shortens the length of the wire, which can reduce losses and improve efficiency, as well as enhance torque and power density by reducing the overall size. However, conventional motor design methods are not directly applicable to this type of winding. Therefore, we are developing and proposing various new design techniques specifically for motors and generators using concentrated winding, with the goal of improving their performance. The right-hand figure shows a slit stator motor that we have developed to improve both efficiency and torque.




### ② Development of rotating-pendulum wave-energy converters

Nagasaki University is actively engaged in the development of ocean energy. This research aims to commercialize a wave power generation system that harnesses wave energy—a form of ocean energy abundantly available anywhere on the sea surface. Once realized, this system will enable the use of electrical energy in any marine area. The wave power generation mechanism under investigation utilizes the nonlinear characteristics of a nonlinear dynamical system known as a ***parametric pendulum***, which converts one-dimensional vibrations into rotational motion. In the proposed ***rotating-pendulum wave energy converter***, the vertical motion of ocean waves is treated as one-dimensional vibration, which causes the pendulum to rotate. Electricity is then generated by a rotary generator attached to the pendulum. This generation mechanism allows the mechanical pendulum and generator to be enclosed and isolated from seawater, significantly reducing the risk of failure due to salt damage. Furthermore, since the system only requires mooring for installation, it offers the advantages of lower installation costs and expanded applicability across various sea areas.




## 2. Keywords

Motor, Generator, Concentrated Windings, Wave power generation, Parametric pendulum

## 3. Remarks and Websites

In the development of motors and generators, we first understand the fundamental principles, and then validate them through simulations and experiments. To date, we have conducted joint research with industry on motors for electric vehicles and generators for wind power systems. The rotating pendulum-type wave energy conversion system is also being advanced as part of my role as a concurrent faculty member at the Nagasaki University Institute for Marine Industry.

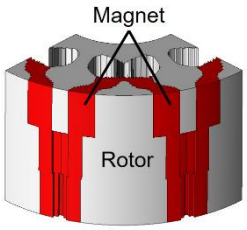
**researchmap:** https://researchmap.jp/u1.yokoi
**Laboratory:** https://motor.eee.nagasaki-u.ac.jp

| Name | Job Title | Area of Expertise |
|---|---|---|
| OTOMO Yoshitsugu | Assistant Professor | Computational Electromagnetism, Design Optimization |

## 1. Main Research Topics

### ① Topology optimization of rotating machines

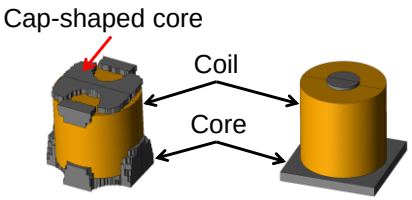
In the optimization of rotating machines, we need to consider various constraints while maximizing the motor performance. To address the above optimization problem, we have developed the topology optimization method, which freely determines the magnetic core and permanent magnet shapes without introducing shape parameters. Recently, we focus on developing the 3-D topology optimization method because this approach can directly improve the 3-D magnetic effect in the motor such as the end effect. The optimized rotor obtained using the 3-D topology optimization is exhibited in the figure.



Optimized 3-D rotor

### ② Topology optimization of wireless power transfer devices

The improvement of the magnetic coupling between Tx and Rx coils is crucial to enhance the power transfer efficiency of wireless power transfer (WPT) devices. In this study, we have developed the topology optimization method for WPT devices considering both magnetic and circuit properties. The optimized WPT coils obtained using the topology and parameter optimizations are shown in the figure. The key feature of the optimized coil obtained using the topology optimization is the cap-shaped magnetic core. This shape leads to achieving the power transfer efficiency over 90 %.



Topology optimization Efficiency: 94 %
Parameter optimization Efficiency: 82 %

### ③ Development of novel approaches for computational electromagnetism

The topology optimization of electric machines requires the long computation time to obtain the optimal shape. To address this problem, we have developed the novel approaches for computational electromagnetism (e.g. Homogenization method, Circuit analysis method, and Machine learning).

## 2. Keywords

Electrical machines, computational electromagnetism, shape optimization, topology optimization, rotating machines, wireless power transfer

## 3. Remarks and Websites

We have proposed the novel approaches to realize the superior electric machines using the topology optimization. In future works, we plan to develop the novel 3-D optimization strategies to apply the multi-physics problems.

**researchmap:** https://researchmap.jp/yoshitsugu_otomo
**Laboratory:** https://www.eee.nagasaki-u.ac.jp/labs/pec/abe-otomo-lab/index.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| Guan Chai Eu | Assistant Professor | Antenna and Wave Propagation |

## 1. Main Research Topics

Commercial services for the fifth-generation mobile communication system (5G) were launched throughout the world in 2020, setting the stage for the rise of new industries and applications. At the same time, debates around the 6G communication network design for Beyond 5G/6G are gaining momentum. As we progress toward the continued development of Society 5.0, which supports sustainable communication, there is an increasing demand for high-frequency devices with broader bandwidth, higher performance, and more compactness.

My research aims to meet these industry demands by developing novel communication system components such as antennas, Reconfigurable Intelligent Surfaces (RIS) reflectors, and high-frequency devices.

### ■ My Research Topics

**① Development of Circular Polarized Antenna for High-Capacity Communication System**

We are pursuing research on wideband smart antennas for next-generation mobile communication systems, having a focus on Beyond 5G. I am working on designing smart antennas for high-speed, high-capacity wireless communication in the Sub-6 GHz bands (3.7 GHz and 4.5 GHz). Also, I am conducting research in areas such as frequency selectivity and polarization diversity in the antenna to meet demands from the industry.

**② Development of Reconfigurable Intelligent Surface Reflector**

To establish a connection between non-terrestrial networks (NTN) and terrestrial networks (TN), polarization consistency must be maintained across the network. My research intends to study the conversion mechanism from linear to circular polarization in Reconfigurable Intelligent Surfaces (RIS) reflectors, as well as to create RIS reflectors that can serve as interfaces for seamless wireless communication between NTN and TN.

**③ 360° Phase Shifter**

Phase shifters are used to concentrate antenna radiation in a certain direction by producing incident waves whose phase was shifted by a specific angle in relation to the input signal. We have developed a compact phase shifter that can control the phase of the incident waves continuously from 0 to 360 degrees.

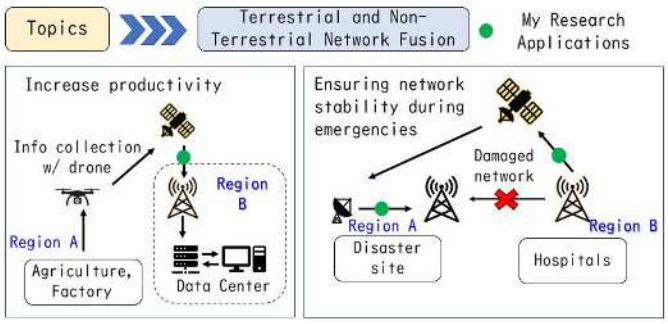



Figure 1 Network connection between TN and NTN.

## 2. Keywords

Local 5G、non-terrestrial network、circularly polarized antenna、RIS reflector、high-frequency devives.

## 3. Remarks and Websites

**Research Achievements:** My research outcomes are published in academic journals and international conferences. For more details, please visit the following research map link below.

**Future Outlook:** The number of B
eyond 5G-related IoT devices and the AI market size will continue to grow in future. In response to the growing demands of smart agriculture and automated/semi-automated factories, we are focusing on the development of communication devices operating in the microwave band.

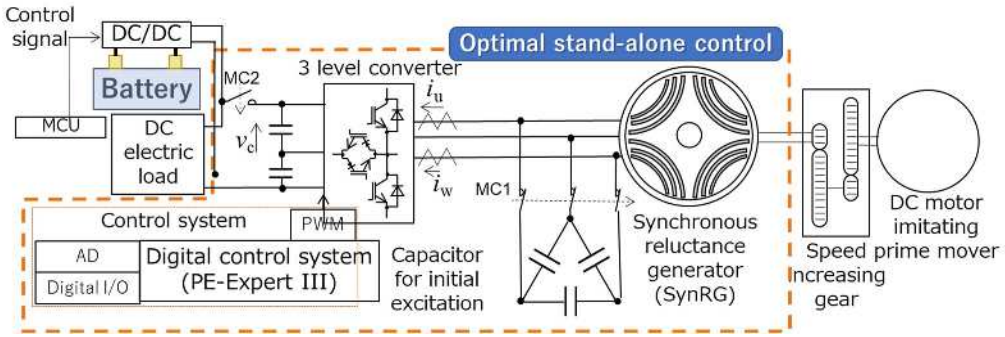
For those considering research collaboration, let's work together on the following topics to develop high performance passive microwave-band devices and antennas: (1) Wide Bandwidth. (2) Multifunctional antenna. (3) Size miniaturization. (4) Optimization of other performance characteristics.

**researchmap：** https://researchmap.jp/guance

| Name | Job Title | Area of Expertise |
|---|---|---|
| DAIDO Tetsuji | Assistant Professor | Motor Drive, Power Electronics |

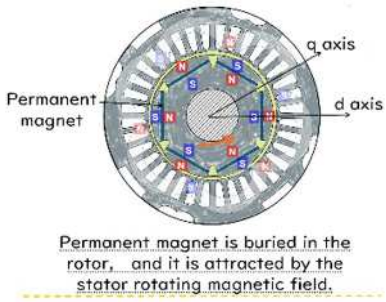
## 1. Main Research Topics

### ① Control of a high-efficiency distributed generation system using synchronous reluctance generators



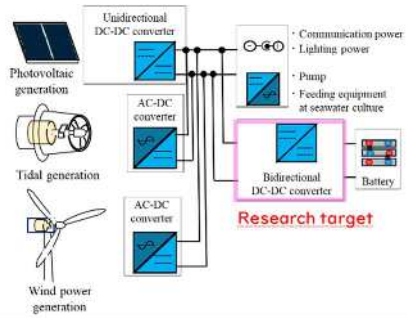

Synchronous reluctance generators (SynRG) do not incorporate rare-earth materials, thereby eliminating concerns related to the stability of their raw material supply. In addition, it is free from thermal demagnetization and its maintenance is easy. In recent years, the application of detailed finite element method analysis has significantly enhanced both the efficiency and power factor of SynRG.The conventional control method for SynRG uses the equivalent electrical circuit of SynRG. However, this equivalent circuit cannot consider local magnetic saturation, which reduces the prospected performance of SynRG. Therefore, this study considers an equivalent circuit that considers local magnetic saturation. This study aims to improve the maximum torque per ampere control of the SynRG.

### ② Encoder-less IPMSM control by means of PWM carrier -synchronized high frequency signal voltage injection




Pulse width modulation (PWM) carrier-synchronized with high-frequency signal voltage injection is a method for estimating the rotor position at a standstill and very low speed. This study has proposed a novel compensation method for the nonlinear voltage distortion of a voltage source inverter. In light of the recent advancements in microprocessor capabilities, this study investigates the application of minor sampling techniques to enhance the accuracy of rotor position estimation.

### ③ Designing and producing a non-isolated DC/DC converter for a battery energy storage




Offshore standalone power supply systems that exclusively utilize renewable energy sources require batteries to maintain a balance between power generation and consumption. The efficient regulation of battery charging and discharging is dependent on the use of a DC/DC converter. This research is centered on a non-isolated DC/DC converter, with its design and fabrication being conducted independently.

## 2. Keywords

Motor drive, Semiconductor power conversion, Power electronics

## 3. Remarks and Websites

In my research, I employ both computer simulations and experimental setups. I place particular importance on independently designing and constructing these experimental setups.

**researchmap:** https://researchmap.jp/pepep

**Laboratory (Japanese only):** http://www.eee.nagasaki-u.ac.jp/labs/asca/top.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| YAMASHITA Akihiro | Assistant Professor | Laser Ablation,<br>Magnetic Materials,<br>Electronic and Electrical Materials |

**1. Main Research Topics**

In this research, magnetic thin and thick films based on Fe, such as Nd-Fe-B and Fe-Co, are fabricated using Pulsed Laser Deposition (PLD), a method capable of forming films with thicknesses ranging from a few nanometers to several hundred micrometers. By optimizing laser irradiation conditions and target materials, we aim to develop magnetic films with excellent magnetic properties. Magnetic properties and microstructures of the fabricated films are evaluated using various characterization techniques.

With the miniaturization of electronic devices, there is increasing demand for high-performance and miniaturized magnetic materials. Our laboratory is developing magnetic films using PLD, which enables deposition over a wide thickness range from thin films to thick films. Below are several representative studies:

① **Development of Rare-Earth Thick Film Magnets for MEMS Applications Using PLD**

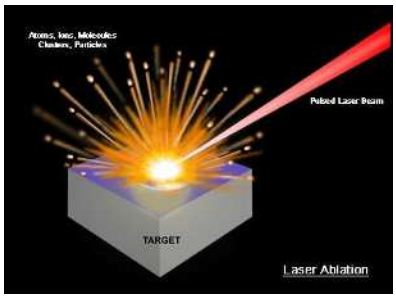
To explore MEMS (Micro-Electro-Mechanical Systems) applications, rare-earth-based magnetic films are deposited onto semiconductor substrates such as silicon and glass, and their magnetic and mechanical properties are evaluated.

② **Fabrication of Multilayer Nanocomposite Magnet Films Using Multi-Target PLD**

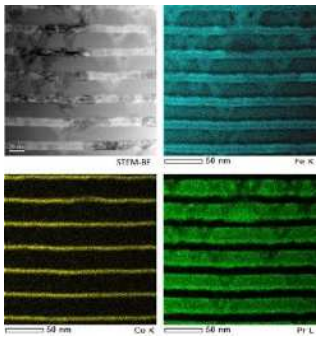
By combining multiple target materials, we fabricate multilayer nanocomposite magnetic films with periodic structures ranging from a few nanometers to several micrometers.

③ **Deposition Control by Magnetic Field Application to Plasma Plume during PLD**

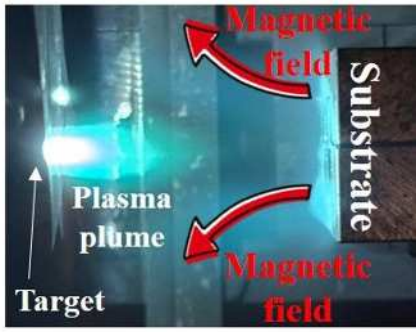
We investigate the effects of applying an external magnetic field to the plasma plume during deposition on the deposition rate, composition, and microstructure of metal films.




Schematic illustration of the laser ablation process
source: APPLIED SPECTRA official website



Cross-sectional TEM image of a multilayer sample fabricated using multi-target PLD




Deposition under an applied magnetic field

**2. Keywords**

Laser ablation, Magnetic materials, PLD method, Thin film, Micro Electro Mechanical Systems

**3. Remarks and Websites**

Our laboratory is engaged in the fabrication of magnetic films, which are being explored for applications in compact motors and MEMS devices, such as energy harvesting devices and microactuators.
Recently, we have also been working on the deposition of various metal and semiconductor materials using laser ablation techniques, expanding our research beyond magnetic films.

**researchmap:** https://researchmap.jp/aki-yama
**Laboratory:** http://www.eee.nagasaki-u.ac.jp/labs/magnet/index.html

# Structural Engineering Program

| Name | Job Title | Area of Expertise |
|---|---|---|
| NAKAHARA Hiroyuki | Professor | Aseismic Design for Building Structure |

**1. Main Research Topics**

① **Disaster Preventing Approaches through Seismic Retrofitting by CFT Braces on Existing RC Building**

② **Test and Analysis for Shearing Behavior of CFT Short Columns**

③ **Development and Practical Use of WGFST Members**

④ **Development of Maintenance-free Pontoon**

**2. Keywords**

Building structure, Aseismic design, Concrete-filled steel tubular structure, Maintenance-free pontoon

**3. Remarks and Websites**

**researchmap:** https://researchmap.jp/handle0207108

| Name | Job Title | Area of Expertise |
|---|---|---|
| YASUTAKE Atsuko | Professor | Architectural Planning, Housing |

**1. Main Research Topics**

**Summary**

The scope of my study is based on architectural planning, but it also extends to regional planning. We will propose new imagery of residential areas, regions, and cities by studying the history and origins of buildings and urban development. This research will be conducted through surveys of statistical data, examination of historical records, and field investigations. Our goal is to determine the architectural spaces that best address social issues such as population decline.

**① SHRINKING MASTER PLAN IN DEPOPULATION CITY**

In Japan, the number of housing units exceeds the number of households, posing significant challenges amidst population decline, vacant homes, and urban shrinkage. There is a pressing need to explore designs that utilize low-density urban environments and manage urban downsizing.

Our research laboratory focuses on former coal mining towns as pioneers of population decline. Many coal mines in Kyushu closed in the 1960s, leading to significant population decline due to outmigration of workers. We examine post-closure policies and their effectiveness to study the restructuring of cities. Building on this research, we investigate disadvantaged residential areas such as islands, sloped terrain, and suburban detached housing areas facing challenges of aging populations and vacant homes after children move out.

As part of experimental initiatives on sloped terrain, we explore the conversion of vacant homes into shared housing and assess the potential for student participation in local community management. Additionally, we initiate activities harnessing sloped terrains to explore new residential paradigms and evaluate community responses.

**② LIVING ENVIRONMENT AFTER DISASTER**

In recent years, natural disasters have become increasingly frequent. In Japan, when people are unable to remain in their homes after a disaster, temporary housing is provided. Our research focuses on the living environments of prefabricated temporary housing. Through surveys and behavioral studies with residents, we identify key challenges and propose solutions aimed at reducing the burden of environmental transition and fostering social interaction within these communities.

**③ PRESERVATION OF THE NEGATIVE HERITAGES**

Our research examines war and disaster-related remains from the perspective of community development, assessing their value as educational resources for citizens and as potential tourism assets. We investigate how these sites have been preserved and how they are currently used, while identifying the challenges involved. Since such sites rarely generate sufficient revenue as tourist attractions, we are exploring alternative methods of evaluation.

In Nagasaki—the last city to experience atomic bombing—we trace the post-war recovery process through studies of the Sakana-no-machi Housing Complex, a key project in the city's reconstruction. By analyzing this case, we aim to understand postwar housing recovery in Japan and explore its relevance for contemporary urban planning.

**2. Keywords**

Housing, Regional Planning, Post-disaster Reconstruction, historical building

**3. Remarks and Websites**

Looking ahead, our goal is to promote the positive reuse and management of vacant houses and buildings, while also focusing on the preservation and active tourism development of historical architecture and disaster-related heritage sites—often considered negative legacies. Through these efforts, we aim to contribute to sustainable and culturally rich urban and regional revitalization.

**researchmap:** https://researchmap.jp/yasutake8528521
**Laboratory:** https://www.st.nagasaki-u.ac.jp/laboratories/yasutake/

| Name | Job Title | Area of Expertise |
|---|---|---|
| UCHIDA Takahisa | Associate Professor | Structural Engineering |

**1. Main Research Topics**

① **A Study on Public Housing Complexes in Nagasaki City**

Public housing complexes were built to address the postwar housing shortage and have been constructed in large numbers across the country from the period of rapid economic growth to the present day. However, in recent years, due to factors such as a declining and aging population and the deterioration of buildings, the increasing number of vacant units in public housing complexes has become a nationwide issue. I'm conducting this research because I believe that, in order to make better use of existing public housing complexes, it is necessary to first assess their current status and then gain insights into strategies for addressing vacancies that are tailored to each specific complex.

**1-A. A Typological Analysis of Public Housing Complexes in Nagasaki City**

I'm focusing on housing complexes located near the city center within Nagasaki city limits that hold high potential for redevelopment. After assessing their current conditions—including age, vacancy rates, and transportation accessibility—we are attempting to categorize them. We believe it is necessary to categorize and analyze many of these housing complexes in Nagasaki City in order to identify redevelopment strategies that align with each complex's site conditions and the current state of its buildings.

**1-B. A Study on Housing Units in the Former Uo-no-Machi Housing Complex**

In the heart of downtown Nagasaki stands the Uo-no-Machi Housing Complex, built according to the "Type 48 (standard design for reinforced concrete public housing used nationwide)" One of its units has been restored and preserved. I believe that by reviewing the design history of the Uo-no-Machi Housing Complex through various historical documents, and by gaining an understanding of the social conditions and family structures of that era, we can deepen our understanding of both the Type 48 floor plan and this housing complex itself—insights that will prove valuable in proposing housing layouts suited to today's social context.

② **A Study on the Utilization of Vacant Houses on Slopes in Nagasaki City**

Due to its topographical characteristics, Nagasaki City features sloped areas near the city center lined with residential buildings. Among these, areas that were developed as residential zones long ago have seen a significant increase in dilapidated, vacant wooden houses. Since these sloped areas were developed as residential land before the Building Standards Act was enacted, they are often accessed only by stair-step paths or narrow roads too narrow for vehicles. As a result, many of these properties face difficulties not only in constructing new homes but also in demolishing vacant houses.

We are conducting research based on the belief that the effective utilization of these old vacant wooden houses and vacant lots near urban areas will lead to the revitalization of those specific neighborhoods and, in turn, contribute to the revitalization of the urban area as a whole.

**2. Keywords**

Architectural Design, Urban Planning, Public Housing Complexes, Measures to Address Vacant Homes
SDG s 17 (3. 11. 12.)

**3. Remarks and Websites**

I hope that by sharing the results of our research on the utilization of vacant wooden houses in public housing complexes and on slopes with local governments and businesses, I can help reduce the number of vacant units in housing complexes within Nagasaki City and address the issue of vacant homes. Furthermore, we plan to develop renovation floor plans for housing units and design proposals for vacant units, and we look forward to seeing these renovation designs come to fruition.

**researchmap:** https://researchmap.jp/uchida.archi

**Laboratory(architectural design office):** https://www.uchida-archi.com/

| Name | Job Title | Area of Expertise |
|---|---|---|
| SASAKI Kenji | Associate Professor | Concrete Engineering |

**1. Main Research Topics**

We are engaged in research on material and construction performance evaluation for enhancing the quality and productivity of concrete structures, developing low-carbon construction materials, and preserving historical structures.

Our research addresses each stage of concrete structures−from design and construction to maintenance and use−focusing on keywords such as "performance evaluation," "quality improvement," "extended service life," and "productivity enhancement." Furthermore, Nagasaki boasts numerous concrete structures recognized as historical assets, including Gunkanjima (Battleship Island) and atomic bomb ruins. We are also engaged in research aimed at their preservation and utilization.

① **Evaluation of material and construction performance of various concrete capable of contributing to improving quality and productivity**

Efforts are underway to utilize fly ash and crushed sand in concrete structures from perspectives such as extending service life, reducing environmental impact, effectively utilizing industrial by-products, and making effective use of locally sourced materials. However, to incorporate materials with limited or no usage history into concrete, it is essential to establish material and mix design methodologies while clearly defining construction performance and hardening characteristics (strength, shrinkage, durability, etc.). This research evaluates the effectiveness of fly ash blended with blast furnace cement in suppressing temperature cracking and improving durability in concrete. It also assesses the workability when crushed sand is used as fine aggregate. Furthermore, the research focuses on visualizing the concrete construction process using IoT sensors and developing methods to enhance the surface quality of concrete based on this visualization.

② **Development of Low-Carbon Construction Materials**

Concrete has been considered a material with a high environmental impact because the production of cement, its main constituent material, emits large amounts of $CO_2$. On the other hand, cementitious materials contain large amounts of calcium-based hydrates that react with $CO_2$, leading to their reevaluation as materials with high $CO_2$ fixation potential. Efforts to utilize them are actively underway. In this research, we are working on quality evaluation of low $CO_2$ emission concrete, establishing manufacturing methods for recycled aggregates and artificial crushed stone aimed at maximizing $CO_2$ fixation, and quality evaluation of concrete using $CO_2$ fixation materials.

③ **Study on assessment of present situation and conservation method of historical concrete structures**

To preserve structures of historical and cultural value, it is essential to accurately assess their current condition, elucidate the mechanisms of deterioration onset and progression, and establish highly effective preservation methods. This research focuses on evaluating the current material and structural integrity of historical structures on Hashima Island, such as revetment structures, production facilities, and residential facilities, to preserve and utilize them as cultural properties and World Heritage sites. It also involves assessing the performance of repair and reinforcement materials and examining repair and reinforcement methods that aim to balance authenticity preservation with effective conservation

**2. Keywords**

Concrete, Performance evaluation, Quality improvement, Service life extension, Productivity improvement, IoT sensors, Low-carbonization, Carbon neutrality, White carbon, Continuous fiber reinforcement, Historical structure

**3. Remarks and Websites**

We are available for collaborative research on concrete material and construction performance evaluation, development of low-carbon construction materials, application of new materials to concrete structures, and maintenance of concrete structures.

If you have any challenges related to the planning, design, construction, or maintenance of concrete structures, please feel free to contact us.

**researchmap:** https://researchmap.jp/concrete_kenjisasaki
**Laboratory:** https://www.st.nagasaki-u.ac.jp/laboratories/sasaki/

| Name | Job Title | Area of Expertise |
|---|---|---|
| SASAKI Sho | Associate Professor | Architectural design |

**1. Main Research Topics**

This laboratory focuses on architectural design (planning and design). SASAKI Sho serves simultaneously as a faculty member of this university, the principal of the architectural design office INTERMEDIA, and the representative of the regional hub facility Mio. Through these roles, he actively engages in professional practice in real time. The laboratory is characterized by sharing this practical knowledge and experience with students, encouraging them to think through various challenges together and work collaboratively toward solutions. In particular, by deeply exploring the unique local context of Nagasaki, the laboratory seeks to envision new possibilities for architecture and regional development in the future.
Examples of key perspectives include the following:

・To consider the nature of architecture and regional communities based on Nagasaki's unique history, climate, culture, and present conditions
・To explore what architecture can contribute to regions like Nagasaki that face challenges such as population decline, aging society, and depopulation
・To recognize the potential for architecture and communities unique to Nagasaki to emerge as context-specific solutions
・To recognize the potential for such architecture and communities to become generalizable models applicable to other regions in Japan and around the world
・While the design office INTERMEDIA, led by SASAKI Sho, has already begun engaging with various regional challenges, this laboratory aims to broaden that engagement beyond professional practice by working with students from a research-oriented perspective

**Specific Research Activities**

① Research on Regional Hub Facilities
② JR Michinoo Station Revitalization Project
③ Former Ryotei (Traditional Restaurant) Restoration Project


HOGET


mio


JR Michinoo Station Revitalization Project

**2. Keywords**

Architecture, design, urban planning, vacant houses, vacant shops, historical buildings, renovation, community, depopulation, declining birthrate and aging population, local community

**3. Remarks and Websites**

I have been involved in numerous projects as an architect, focusing on the renovation and adaptive reuse of vacant houses and unused commercial properties. At Mio in Shimabara, I am engaged not only as a designer but also as an operator responsible for the facility's management and ongoing activities. With the establishment of this laboratory, it will become possible to engage with local communities in more diverse ways across different regions. As regional challenges such as population decline, aging societies, increasing vacant properties, and the weakening of community ties continue to progress throughout Japan, we hope that students will participate proactively as active stakeholders—recognizing themselves as part of the communities they study and support.

**Reference Projects**

**HOGET** https://hoget.jp/ **Mio** https://mio-shimabara.com/
**JR Michinoo Station** https://prtimes.jp/main/html/rd/p/000000005.000126742.html

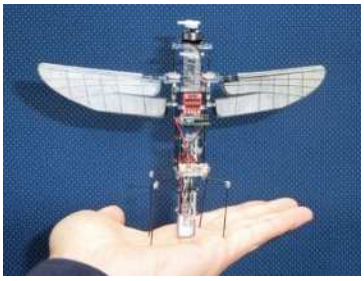
**researchmap：** https://researchmap.jp/sasakisho
**HP:** https://www.intermedia-co.jp/

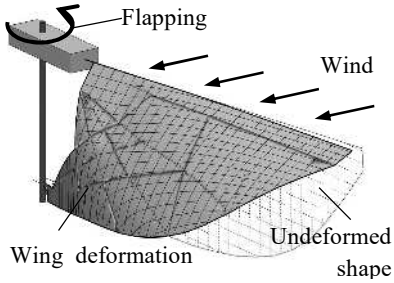
| Name | Job Title | Area of Expertise |
|---|---|---|
| NAGAI Hiroto | Associate Professor | Aeroelasticity, Aeronautics, Vibration |

**1. Main Research Topics:** We primarily study the design and analysis of large-scale or flexible structures that experience fluid-structure interaction (FSI) across various engineering fields.

① **Development of Small-Sized Flapping Drones**

Birds and insects achieve excellent flight performance through flapping flight, despite their small size. Inspired by this natural mechanism, we are developing compact, bio-inspired flapping drones equipped with flexible wing structures. These drones are designed and analyzed using a multiphysics approach that integrates fluid dynamics, structural mechanics, mechanical design, dynamics, and control engineering. Unlike conventional rotary-wing drones, flapping drones offer improved safety and quieter operation, making them suitable for use in natural environments and human-centered spaces.





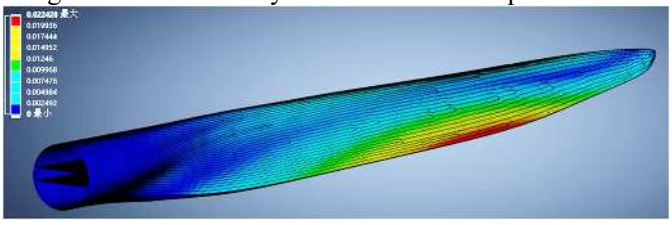

② **Fluid-Structural Interaction (FSI) Analysis of Large-Scale Structures**

Large-scale structures such as high-rise buildings, long-span bridges, and large wind turbines tend to become relatively flexible as their size increases, and thus are susceptible to fluid-induced vibrations such as vortex-induced vibration and flutter. In our laboratory, we analyze such vibration phenomena using fluid-structural interaction (FSI) techniques that couple computational fluid dynamics (CFD) with the finite element method (FEM). Our main research topics include:

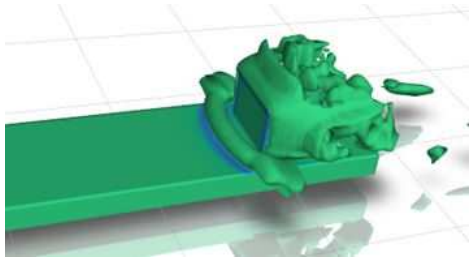
- Vibration analysis of large-scale structures subjected to both forced excitations (e.g., earthquakes and ocean waves) and flow-induced vibrations (e.g., vortex shedding)
- Simulation and prediction of aeroelastic responses in large-scale wind turbine blades
-

③ **Aerodynamic Analysis of Ships**

Wind-assisted propulsion technologies such as rigid sails and rotor sails have recently attracted attention in the maritime industry as a means of achieving carbon neutrality. We are conducting research on how ship motions and structural vibrations affect the aerodynamic performance of these wind-assisted propulsion devices. Additionally, we are investigating the influence of ship superstructure geometry on the airflow around ships, aiming to optimize aerodynamic design for fuel efficiency and environmental performance.



Deformation of large-scale wind turbine



Airflow around a ship superstructure

**2. Keywords**

Fluid-Structure Interaction (FSI), Structural Vibration, Aeroelasticity, Multidisciplinary Design Optimization (MDO), Bio-inspired Engineering, Flapping Drone Technology

**3. Remarks and Websites**

In our laboratory, we address fluid-structure interaction design and analysis across a wide range of engineering fields, including aircraft, ships, buildings, and wing turbines. We actively pursue interdisciplinary collaboration and practical applications across different research domains. If you are interested in our research, please feel free to contact us.

**researchmap:** https://researchmap.jp/nagai-hiroto

**Laboratory:** http://www.st.nagasaki-u.ac.jp/laboratories/nagai/

| Name | Job Title | Area of Expertise |
|---|---|---|
| YAMAGUCHI Kohei | Associate Professor | Bridge Engineering / Maintenance Management Engineering |

## 1. Main Research Topics

① **Establishing efficient maintenance methods by analysis of inspection data for airport infrastructure and bridges managed by local governments**



② **Development of bridge inspection and diagnosis support system using 3D data and image analysis**



③ **Establishment of an efficient bridge diagnosis method using generative AI**


④ **Estimation of internal defect shape in concrete using computed tomography and three-dimensional unsteady conduction analysis**

## 2. Keywords

Infrastructure, Bridges, Maintenance, Inspection and diagnosis, Municipal support

## 3. Remarks and Websites

**Laboratory: :** https://nagasakibridgelab.wixsite.com/mysite

Our lab. aims to tackle three pillars of themes in line with social needs: short-term, medium-term, and long-term. Our lab. focuses on the construction, renewal, and maintenance of social infrastructure in general, but mainly bridges. Our lab. also collaborates with our laboratory alone, management organizations (local governments, airport management organizations), and companies (NTT Domo Solutions, AGC, KOBLCO, etc.).

| Name | Job Title | Area of Expertise |
|---|---|---|
| CHAN Iathong | Assistant Professor | Structural Engineering |

**1. Main Research Topics**

**① NUMERICAL MODEL FOR 3D STEEL MOMENT FRAMES**

Most previous studies only considered the behavior of steel moment frames under unidirectional ground motions. Additionally, the numerical models of most previous studies considered the behavior of only beams and columns, and ignored the behavior of the panel zone of the beam–column connection.

Our research proposes a novel numerical model for studying steel moment frames under multi-directional loadings to consider the 3D elastoplastic behavior of beams and columns, as well as panels. The proposed numerical model was validated by analyzing cruciform subassemblies of beams, columns, and panels, and the analysis results were compared to the experimental results from previous studies. The results of the proposed numerical model corresponded well with the respective test results

**② REQUIRED COLUMN OVERDESIGN FACTOR OF 3D STEEL MOMENT FRAMES**

Steel moment frames are designed to ensure sufficient energy absorption capacity by achieving an entire beam-hinging collapse mechanism under severe earthquakes. Therefore, the column overdesign factor is stipulated in seismic design codes. Since square tube columns are often used for steel structure buildings in Japan, the two orthogonal planes of the structure are both designed as moment resisting frames. Considering the effect of bi-direction ground motions on the steel moment frames, the specified column overdesign factor is 1.5 or more in Japanese seismic design code. However, the required column overdesign factor of steel moment frames is obtained from analysis results conducted under unidirectional ground motions

Our research describes the results of the earthquake response analysis of 3D steel moment frames, and presents seismic demand for the column overdesign factor, depending on input direction and amplitude of the ground motion and width-thickness ratio of columns, required to keep the damage below the limit of plastic deformation of square tube columns.

**③ SEISMIC STRUCTURAL REINFORCEMENT IN DEVELOPING COUNTRIES**

In Japan, retrofit method with steel brace frame for RC structure are always used. Retrofitting with steel braced frame a lot of studs and anchor bolts are required to fix the steel frame and transmit the tensile stress of diagonal brace to the existing RC frame. However, this method needs heavy equipment and it is difficult to use particularly in rural area, constricted area or remote island.

For seismic retrofitting in the areas mentioned above, we have been developed a new seismic retrofitting method by using CFST (concrete-filled steel tubular) diagonal brace which act only compression, and propose a new hybrid pre-cast member composed of steel tube, cement grout and wood (WGFST) to satisfy the requests from developing area.

**2. Keywords**

3D steel moment frame; square hollow-section column; panel zone of beam–column connection; time-history response analysis; multi-directional ground motion; numerical model; multi-spring model; Composite members; Seismic retrofit; Brace member; CFST.

**3. Remarks and Websites**

We analyze the behavior of structures through loading experiments and numerical analysis to create better design methods and seismic resistance methods. We are also planning to develop construction method with good efficiency.

**researchmap：**https://researchmap.jp/dlucifer6

| Name | Job Title | Area of Expertise |
|---|---|---|
| NAKAO Nobuhiko | Assistant professor | Mechanical Engineering |

## 1. Main Research Topics

Bone is an important organ to support our body, and continually subject to mechanical forces. During walking, running and other exercises, daily forces change with time, and responding bone structures also do so. Metabolic activities of bone causing its structural changes result from activities of bone cells, for example, osteoblasts on the bone surface and osteocytes within calcified bone matrix. Osteoblasts and osteocytes sense the outer forces, and respond to those as sending biochemical signals. That is why researchers think that these bone cells are essential players in the mechanism of the structural changes of bone. My study aims to answer to the questions, "how osteoblasts and osteocytes sense the outer forces?", and "how these cells respond to these forces", focusing on subcellular elements, especially, biomolecules and their complexes.

### ① Analysis of mechanical properties of focal adhesions in osteoblasts

Osteoblasts play pivotal roles to new bone, where cells attach to the bone surface, and the extracellular forces from bone are input at attachment molecular complexes named as focal adhesions. Focal adhesions have structures which respond to the extracellular forces, supposedly with changes in their mechanical properties. These changes are closely related to cellular force-sensing, but are unclear in detail.
Thus, mechanical properties of focal adhesions were analyzed using cultured osteoblast cells derived from mice. By utilizing atomic force microscopy for molecular-level mechanical measurement, tensile-tests were performed for pre-formed focal adhesions on the cell surface. As a result, tensile stiffness of these molecular complexes was revealed to increase on the second timescale after the force application.

### ② Analysis of biochemical responses of focal adhesion-mediated osteocytes

Osteocytes regulate the activities of other bone cells (other osteocytes, osteoblasts, osteoclasts and so on). Osteocytes also have focal adhesions, and application of the excessive outer forces to them is suggested to cause programmed death named as apoptosis. Other previous studies suggest that apoptosis is important to reform the bone structures, but the relationship between magnitude of applied force and osteocyte death had been unclear.
In current experiments, using a magnetic tweezer, mechanical forces were applied to magnetic beads targeting focal adhesions of osteocytes isolated from the bone of mice. As a result, cells underwent apoptosis in the case of lager magnitude, while apoptosis did not occur in the case of smaller magnitude. Moreover, such apoptosis of osteocytes is revealed to need intracellular production of nitric oxide, a kind of small signaling molecule.

## 2. Keywords

bone cells, focal adhesions, biomolecules, molecular complexes, strength of materials, mechanical measurements

## 3. Remarks and Websites

My study is located in an interdisciplinary field between mechanical engineering (especially, material mechanics) and molecular and cell biology. In the future, I would like to expand the research subjects to various intracellular elements and their mutually interacting behaviors.

**researchmap:** https://researchmap.jp/nakao-nobuhiko
**Laboratory:** https://www.st.nagasaki-u.ac.jp/laboratories/nakao/

| Name | Job Title | Area of Expertise |
|---|---|---|
| HARADA Akira | Assistant Professor | Dynamics of Machine |

**1. Main Research Topics**

Even something very simple can exhibit unexpected behavior if handled in a clever way.Conversely, even something that is very complex can appear very simple when viewed from a different perspective.I am researching on methods for identifying the inherent characteristics of such systems and how to connect the identified characteristics to useful applications.

The main themes currently being addressed are listed below.

① **Application of metamaterial / bandgap principles in vibration control and seismic isolation**

In the world of electromagnetic waves, it has been noted that when the governing equation in a coupled system is transformed into an equation involving only the variables of the main system and the relationship between the variables of the secondary system (the equation of motion of the assumed system), the physical properties of the assumed system show negative values. This principle of metamaterials and band gaps can also be applied to the world of solid vibrations, demonstrating that it can be used for vibration control and seismic isolation purposes.

ex)Dynamics and Design Conference 2024

② **A Method for Creating a Reduced-Order Model for Nonlinear Vibration of a Distributed Parameter System**

I showed that it's possible to make a reduced-order model for weak nonlinear vibrations near linear natural frequencies by combining linear mode and POM (Proper Orthogonal Mode).

ex)Dynamics and Design Conference 2020

③ **Vibration control and seismic isolation methods from the viewpoint of wave propagation**

By utilizing the fact that the equation of motion for a spring-mass system is equivalent to the central difference approximation of the wave equation, I demonstrated that reflection does not occur and resonance does not occur by applying a control force so that the end where the traveling wave is reflected becomes equivalent to a continuous part in terms of mechanical conditions.

ex)https://doi.org/10.1299/transjsme.14-00629

④ **Parameter Identification of Orthotropic Anisotropic Laminates Using Optimization Techniques**

By appropriately setting the evaluation function, it was demonstrated that, theoretically, the fiber orientation angle and material constants of orthotropic laminated plates can be simultaneously identified.

ex)Dynamics and Design Conference 2021

**2. Keywords**

Dynamics of Machine, Distributed Parameter System, Nonlinear Vibration, Analysis Method

**3. Remarks and Websites**

**researchmap:** https://researchmap.jp/a_harada
**Laboratory:** https://www.st.nagasaki-u.ac.jp/laboratories/haradaakira/

Be firmly grounded in the fundamentals,
without forgetting the purpose of engineering,
in order to gain new insights,
I strive every day.

# Civil and Environmental Engineering Program

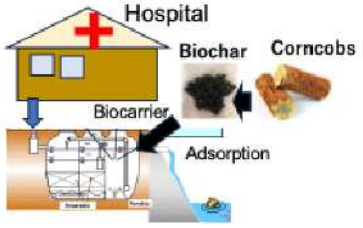
| Name | Job Title | Area of Expertise |
|---|---|---|
| ITAYAMA Tomoaki | Professor | Water Environmental Engineering |

## 1. Main Research Topics

**① Monitoring of toxic cyanobacteria in lakes and reservoirs, prediction of their occurrence, and development of ecosystem control and purification technologies**

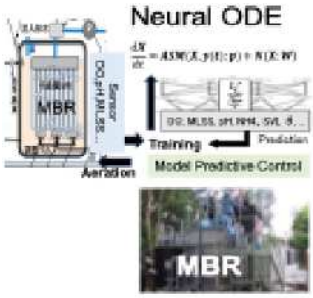

Excessive loading of nutrients such as N and P have caused eutrophication of lakes and reservoirs, leading to the proliferation of toxic cyanobacteria (toxic cyanobacteria) that produce toxins linked to liver cancer and other health issues. In developing countries with inadequate water treatment, this poses a direct health risk. Therefore, our laboratory studies on the methods to predict the occurrence of toxic cyanobacteria using IoT-based simple sensing, Bayesian statistics, deep learning, and molecular ecology. Additionally, we are exploring eco-friendly and low-cost purification methods using biochar. Moreover, theoretical foundations for ecosystem control techniques leveraging the predation of zooplankton, and practical technologies for reducing toxic cyanobacteria.

**② Development of wastewater treatment technology for small hospitals in developing countries affected by water pollution caused by antibiotics and other substances**




Hospital wastewater contains a high concentration of antibiotics and dangerous pathogens. In developing countries where much of this wastewater is discharged untreated, this poses significant health risks to humans and ecological risks to ecosystems. Additionally, not only antibiotics but also disinfectants and surfactants contribute to the increase of antibiotic-resistant bacteria in the environment. Therefore, a low-cost wastewater treatment system is essential for small-scale hospital wastewater treatment in rural areas of developing countries. We are also researching low-cost wastewater treatment methods that utilize the synergistic effects of inexpensive biological treatment methods and biochar derived from agricultural waste (such as corncobs), which possesses adsorption properties and serves as a microbial carrier. Additionally, we are advancing the implementation of IoT for remote monitoring and control.

**③ Study on sensing and AI predictive control methods for wastewater treatment system**




In biological wastewater treatment, it is extremely important to simultaneously reduce aeration volume and improve treatment efficiency while advancing automation of control systems. To this end, we are conducting research on sensing technologies for controlling activated sludge treatment, predictive methodologies such as time-series deep learning using AI predictions and neural differential equations that learn nonlinear dynamics, as well as model predictive control. In these efforts, we are utilizing a bench scale model wastewater treatment systems and a mini-plant-scale MBR (membrane bioreactor) system at Nagasaki University.

## 2. Keywords

toxic cyanobacteria, molecular ecology, wastewater treatment, ecological engineering, developing countries, hospital wastewater, antibiotics, surfactants, antibiotic-resistant bacteria (ARB), aqua informatics, sensors, AI, deep learning, Bayesian statistics

## 3. Remarks and Websites

We have successfully removed more than 95% of toxic cyanobacteria and cyanotoxins from Lake Victoria (Kenya) using a Biofence system using Biochar. Meanwhile, the use of biochar as a carbon sequestration technology is gaining global attention, and water treatment technologies utilizing biochar are particularly important in developing countries. Additionally, we have developed a Bayesian statistical method to predict the occurrence of toxic cyanobacteria in reservoirs. Furthermore, we are conducting water quality prediction for wastewater treatment using deep learning techniques and neural differential equations.

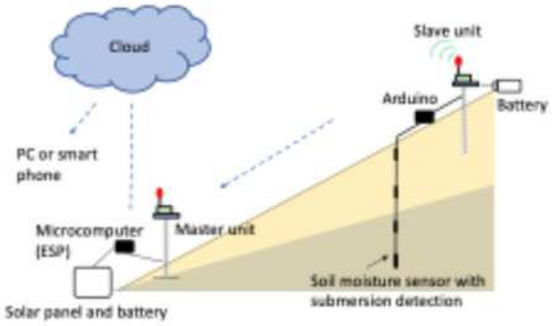
**researchmap:** https://researchmap.jp/read0080703-Itayama

| Name | Job Title | Area of Expertise |
|---|---|---|
| OMINE Kiyoshi | Professor | Geo-Environmental Engineering |

## 1. Main Research Topics

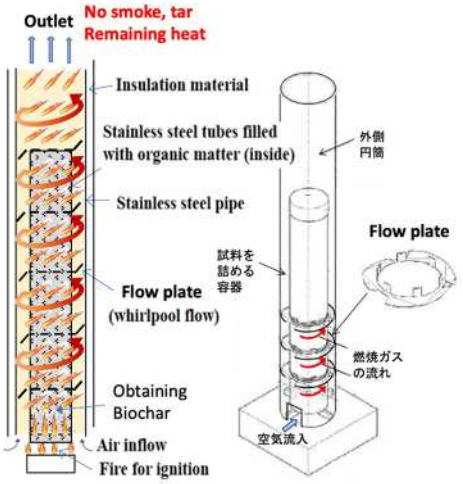
### ① Development of IoT ground deformation detection sensors for ground disaster

We develop an IoT ground deformation detection sensor that can visualize groundwater distribution on slopes by creating a simple sensor that can detect deformation and water inundation in the ground and combining it with low-power wide-area wireless communication (LPWA) that can operate for a long time with dry batteries. We aim to put this into practical use by using an inexpensive device that can visualize measurement results in real time via the Internet.




### ② Regeneration of organic waste into high-performance carbonized materials

We develop gasifier of organic waste without using fossil fuels, that regenerates a high-performance carbonized material, and achieves carbon negative, which reduces CO2 emissions. Using a newly developed pyrolysis gasification device, we are investigating the application of highly water-absorbent carbonized materials as a soft ground improvement material, porous carbonized materials as an adsorbent for deodorizing and purifying wastewater, and carbonized materials with low electrical resistance as electrodes for soil microbial batteries, as well as the application of these materials as water-retaining materials for desert greening and land degradation countermeasures.

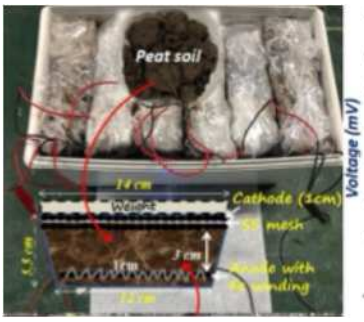


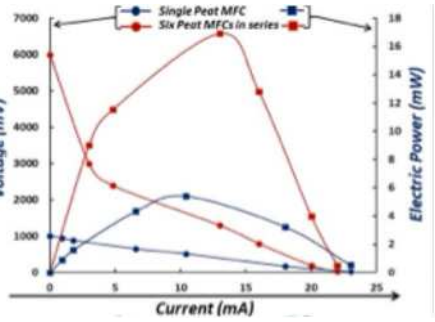

### ③ Mud dewatering technology that takes environmental impact into consideration

To effectively utilize mud with a high water content, a technology that can dewater without using energy is required. By combining drainage materials with a vacuum pump, we aim to improve the dewatering effect, while using a vacuum pump powered by a solar panel to realize a fossil fuel-free, environmentally friendly dewatering technology. We have confirmed its effectiveness through on-site dewatering tests using construction sludge and water purification sludge.

### ④ Development of soil microbial fuel cell

Soil microbial fuel cells are a new form of clean energy. We are developing compost-type microbial batteries that generate electricity through the metabolism of microorganisms during the composting of organic waste that generate electricity while cultivating plants. These batteries are being used to light up LEDs and as a power source for small sensors.




## 2. Keywords

Geoenvironmental engineering, Geodisaster prevention, Utilization of waste, Soil microbial fuel cell

## 3. Remarks and Websites

The project aims to solve global environmental problems such as landslides and land degradation caused by climate change, and to reduce and fix carbon dioxide emissions through the effective use of waste.

**researchmap:** https://researchmap.jp/read0043302

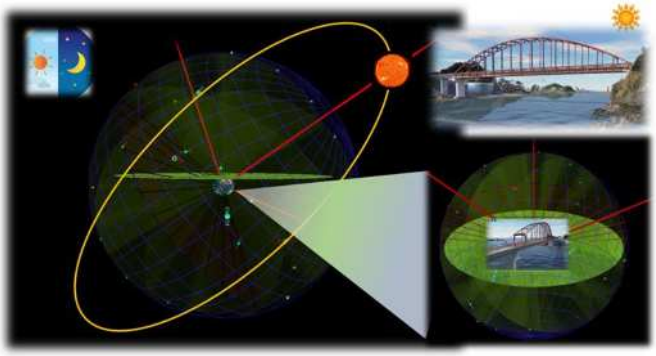
**Laboratory:** https://www.cee.nagasaki-u.ac.jp/~jiban/

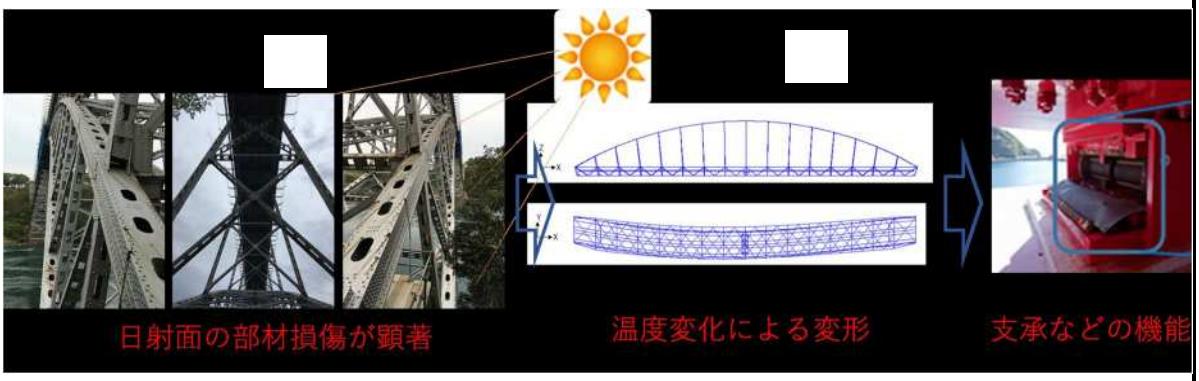
| Name | Job Title | Area of Expertise |
|---|---|---|
| OKUMATSU Toshihiro | Professor | Maintenance Engineering/ i-Construction |

## 1. Main Research Topic

UAVs have been representative infra-monitoring tools or platforms nowadays. However, there remains some risks for controlling and positioning of the object, and this could consequently lead to secondary accident. We are now developing localization, visualization, and path planning systems for infra-structure monitoring, which consist of sensing techs, such as RTK-GNSS, TS, and SfM (Structure from Motion) techs. By above, Unmanned autonomous construction system using sensor network is under developing.

① **Autonomous control by using GNSS for bridge detailed inspection**
② **Research on the correlation with solar radiation and temperature of bridge**
③ **3D visualization of bridge support behavior by using stereogram**
④ **Unmanned autonomous construction system using sensor network**






## 2. Keywords

GNSS, Bridge maintenance, Bridge vibration monitoring, i-construction, Environmental vibration

## 3. Remarks and Websites

Field measurement and developing Autonomous system related civil engineering field are welcome with future considerations.

**researchmap:** https://researchmap.jp/read0097496
**Laboratory:** https://www.cee.nagasaki-u.ac.jp/

| Name | Job Title | Area of Expertise |
|---|---|---|
| JIANG Yujing | Professor | Rock Engineering, Geotechnics for Hazard Mitigation |

## 1. Main Research Topics

Many critical facilities, from underground repositories for high-level radioactive waste to energy storage systems, road tunnels, underground spaces, and bridge foundations, are constructed within or on rock masses. Evaluating the mechanical and hydraulic properties of rock materials, as well as monitoring and assessing their behavioral changes during operation, is crucial and indispensable. Our research group has long been engaged in prototyping a series of mechanical testing apparatuses and improving a three-dimensional nonlinear stress-permeability numerical analysis model suitable for fractured rock materials, with ongoing applications to real-world projects.

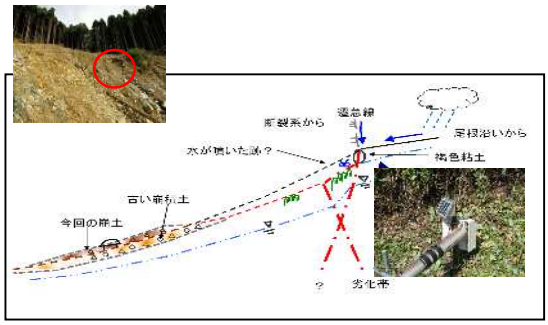
Even slopes that are stable under normal conditions may face collapse risks due to rainwater infiltration. We are advancing the slope hazard monitoring technology utilizing wireless network communication, as well as the construction and practical implementation of a disaster prevention for steep slopes.

Fundamental research and technological development related to deep-sea methane hydrate (MH) production and marine environmental assessment are being actively pursued both domestically and internationally. Additionally, considering sand production mechanisms from MH layers during extraction, mutual interference between production wells, and the triggering conditions for large-scale submarine landslides, we are conducting research and development on efficient production technologies that consider marine ecosystems.

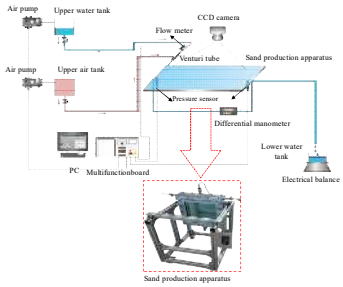
The main research themes are as follows:

① **Evaluation technology of supporting safety and soundness of rock structures**
② **Prevention and risk mitigation of slope failures caused by heavy rainfall**
③ **Methane hydrate production technology and impact assessment on the seabed environment**

Inspection and diagnosis of tunnels




Remote monitoring of landslide




Sediment discharge control in deep-sea MH layers

## 2. Keywords

Rock structure, Maintenance and management, Hazard mitigation, Methane hydrate production

## 3. Remarks and Websites

Through collaborative and commissioned research, we have been involved in numerous practical projects. Examples include: Construction of underground structures for pumped-storage power plants (Kyushu Electric Power Co., Inc.), In-situ foundation behavior assessment for nuclear power generator installation (Kagoshima), Evaluation of fractured rock properties for new bridge foundations (Kumamoto), Development of disaster prevention/mitigation databases and hazard assessment for steep urban slopes (Nagasaki City), Slope behavior monitoring in landslide-prone areas (Nagasaki Prefecture).

While new construction projects are declining, there is growing demand for: Integrity assessment and repair/strengthening of existing infrastructure, Ground disaster prevention/mitigation in slope-heavy urban areas like Nagasaki, Countermeasures against large-scale sediment disasters caused by extreme weather events. Proven experience in remote monitoring technologies and risk management database development, Over 10 years of field investigations and diagnostics for road disaster prevention as a TEC-DOCTOR for the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) Kyushu Regional Development Bureau.

We actively engage in R&D and provide technical consultations to address these societal challenges.

**researchmap：** https://researchmap.jp/read0043363
**Laboratory：** http://www.cee.nagasaki-u.ac.jp/~jiban/

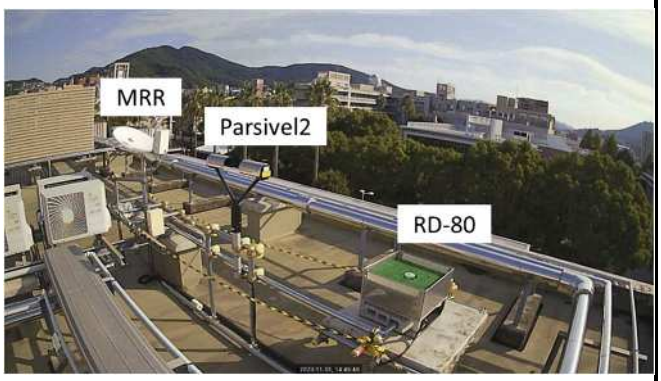
| Name | Job Title | Area of Expertise |
|---|---|---|
| SETO Shinta | Professor | Radio Hydrology |

## 1. Main Research Topics

### ① Satellite remote sensing of precipitation

We are involved in developing technology to observe global precipitation using precipitation radars and microwave radiometers board on satellites. The Japan Aerospace Exploration Agency (JAXA), in collaboration with the National Aeronautics and Space Administration (NASA), began operating the world's first spaceborne precipitation radar (PR) in 1997 (operations ended in 2015). As its successor, the Dual-frequency Precipitation Radar (DPR) has been in operation since 2014 and continues to operate today. Additionally, development has started on the spaceborne precipitation radar equipped with Doppler functionality (KuDPR).

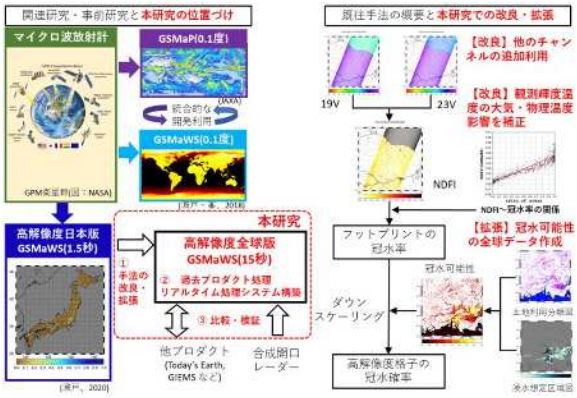
By combining the three-dimensional precipitation information obtained from the PR and DPR with high-frequency observations from multiple microwave radiometers such as AMSR2 and GMI, we have developed the Global Satellite Mapping of Precipitation (GSMaP). This system estimates global precipitation (excluding the polar regions above 60 degrees latitude) at a resolution of 0.1 degrees latitude/longitude (about 10 km) every hour. GSMaP is widely used in fields such as water resources and water-related disaster management, especially in Asian countries and other regions where ground-based precipitation observation methods are insufficient.




For about 20 years, Seto has been conducting joint research with JAXA, working to improve precipitation observation by means of precipitation radar and GSMaP. Since 2022, a compact precipitation radar (MRR) for verification purposes, as well as rain drop size distribution observation instruments (RD-80, Parsivel2), have been installed at Building 1, Faculty of Engineering, Nagasaki University. Based on these experiences, I hope to further research and apply satellite precipitation observation to water resources and disaster management in various regions around the world.

### ② Rapid detection method of flood inundation area

In various regions, floods caused by heavy rain have occurred, such as the July 2020 heavy rain (Kumagawa River) and the July 2018 heavy rain in western Japan (Hijikawa River, Takahashi River). Quickly estimating inundated areas is important for rescue operations and recovery support. However, since current estimations rely on aerial photographs and on-site observations, there are still challenges in terms of speed. It has been known that observations from satellite microwave radiometers can provide indicators that correlate well with the water surface area rate on the ground, but because their resolution is rather coarse—several kilometers or more—they have not yet been practically applied for these purposes. Seto is developing a method to quickly and at high resolution estimate inundated areas by first determining the flood susceptibility of each location using land use data and the results of pre-conducted flood simulations, and then combining that with observations from microwave radiometers.




## 2. Keywords

remote sensing、radar、microwave radiometer、precipitation、flood inundation

## 3. Remarks and Websites

**researchmap:** https://researchmap.jp/shintaseto
**Laboratory:** https://www.cee.nagasaki-u.ac.jp/~kankyo/

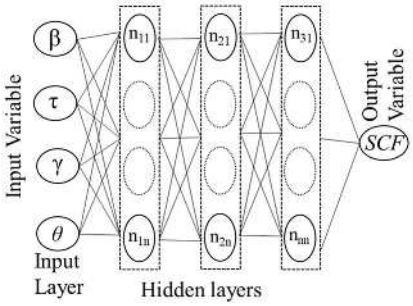
| Name | Job Title | Area of Expertise |
|---|---|---|
| NAKAMURA Shozo | Professor | Design, Maintenance and Management of Steel Structures |

## 1. Main Research Topics

### ① Maintenance of Existing Structures

Through field surveys and remote monitoring of existing structures, combined cycle testing, etc., I am conducting research into deterioration prediction methods, remaining strength and remaining life assessments, correlation between environments and corrosion states, and durability assessments of various corrosion prevention methods. When serious damage is found in existing structures, I investigate its cause and develop countermeasures. I am also conducting research into the application of artificial intelligence (AI) to bridge design and inspection.

Combined cyclic corrosion test



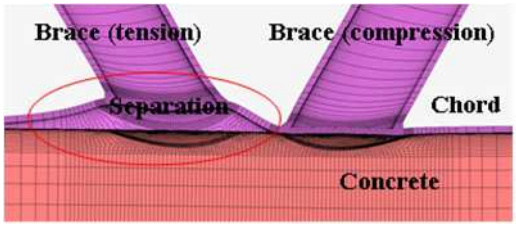

Artificial neural network model

### ② Design Method of Steel Bridges

I am conducting the following research on steel bridges using analytical methods such as the nonlinear finite element method.

- Effect of initial deflection on the buckling strength of welded box section members
- Stress concentration factors for fatigue design of concrete filled steel tubular (CFST) joints
- Effect of hysteretic characteristics of seismic isolation rubber bearings on bridge response

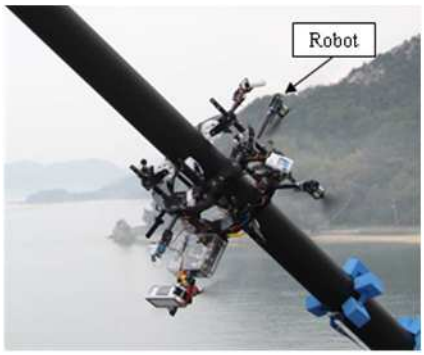
In addition, I am also conducting research into the rationalization of structures and design methods aiming at labor saving and cost reduction.




An analysis result of a CFST K-joint

### ③ Development of an inspection robot for cables in cable-stayed bridges

In order to dramatically improve the safety, efficiency, and economy of close-up visual inspection of cables, we developed a manually flying cable inspection robot for cable-stayed bridges that uses the cable as a guide, and applied it to inspect the cables of several actual cable-stayed bridges. Furthermore, in collaboration with other professors from the same graduate school, it was improved to an autonomous flying type, and also an image processing system that enables "splitting videos into still images and creating development diagrams" and "automatic detection of visible defects" was developed. We are currently investigating ways to expand the scope of application of this robot.




Inspection robot

## 2. Keywords

Steel structures, Maintenance and management of bridges, Structural design

## 3. Remarks and Websites

I have experience working for a private company (Kawasaki Steel Corporation), so most of my research is relatively practical. I also strive to provide technical support to national and local governments as a member of several committees.

**researchmap:** https://researchmap.jp/sh_nakamura_nu/
**Laboratory:** https://www.cee.nagasaki-u.ac.jp/~dokou/

| Name | Job Title | Area of Expertise |
|---|---|---|
| ISHIBASHI Tomoya | Associate Professor | Landscape Engineering, Urban History |

## 1. Main Research Topics

**① Historical study on urban formation and urban policy recommendations**

This research clarifies the changes in urban policies and plans and the transformation of urban spaces, and makes proposals for future urban policies. Specifically, it analyzes and examines primary sources such as comprehensive plans of local governments, minutes of council meetings, and various articles related to cities. Related studies have been reported as follows.

https://doi.org/10.2208/jscejaie.70.1 , https://doi.org/10.2208/jscejipm.75.6_I_287 , https://doi.org/10.2208/jscejipm.76.5_I_495

**② Proposal of a method for evaluating the value of important cultural landscapes while allowing for change and measures for applying this method to conservation and utilization plans**

Fifteen years have passed since the implementation of the cultural landscape preservation system. Based on surveys and reports, including a comprehensive analysis of 71 previously selected cases, this study provides a detailed analysis of the characteristics of nine cases, including those related to mining and manufacturing under Selection Criteria 6. This study focuses on the development of a preservation and utilization plan for the “Ceramic and Agricultural Village Landscape of Hasami Town, Nagasaki Prefecture.” It involves investigations and discussions related to deriving the intrinsic value of the area, as well as the process of organizing key issues in committees coordinating these efforts. The study was conducted with funding from the Japan Society for the Promotion of Science (JSPS) Grant-in-Aid for Scientific Research (JP22K14340).

https://doi.org/10.2208/jscejj.23-00095

**③ Multifaceted analysis of sustainable urban area size for disaster prevention and disaster mitigation and quality of life in era of declining population**

This project involves classifying the basis for setting urbanization boundaries in Nagasaki's urban planning and analyzing the unique history of urban expansion in Nagasaki City. Similarly, it analyzes and compares multiple cities to study classification items and analysis methods effective for reverse line drawing. The project also plans to trial the construction of a database in collaboration with the Ministry of Land, Infrastructure, Transport and Tourism's 3D urban model project “PLATEAU.” This is a joint research project with a construction consulting company specializing in urban planning.

**④ Practical research on the planning, development, and utilization of public space**

Currently, we are involved in the redevelopment plan for nine neighborhood parks in the Yokoo district of Nagasaki City, and the parks will be redeveloped based on this plan. This project is being conducted as a commissioned study from Nagasaki City, and we are engaged in activities such as supporting resident workshops to discuss park redevelopment and creating models of the parks scheduled for redevelopment.

## 2. Keywords

Urban History, Cultural Landscape, Disaster Reduction and Urban Planning, Public Space Design

## 3. Remarks and Websites

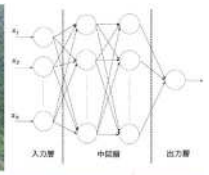
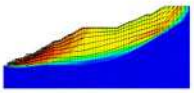
Drawing up a vision for the future of a city is an essential task for local governments, and we believe that discussions based on the historical context will lead to more effective policies. Improving the quality of public space will ultimately enhance the value of the city or region, and is expected to have a ripple effect on the promotion of settlement and tourism.

**researchmap：** https://researchmap.jp/tomoya_ishibashi

**Laboratory：** https://www.cee.nagasaki-u.ac.jp/~kankyo/

| Name | Job Title | Area of Expertise |
|---|---|---|
| SUGIMOTO Satoshi | Associate Professor | Geotechnical Engineering |

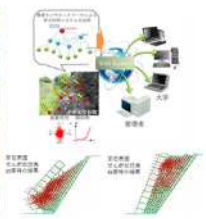
## 1. Main Research Topics


(1) **Research on evaluation of mechanical stability of slopes**

The purpose of this study is to develop an integrated solution system for slope disaster prevention. This is an attempt to estimate the ground information, determine whether monitoring is necessary based on the slope safety factor obtained from numerical simulation results based on the estimated ground information, identify locations where groundwater level and surface deformation should be monitored if necessary, and conduct field monitoring and data analysis based on these results in an integrated manner. The following are some of the examples of this project. We aim to elucidate the feasibility of a system that links three elements: (1) estimation and interpolation of ground information using AI technology, (2) seepage flow analysis and stability analysis of slopes applying the estimated ground information, and (3) remote monitoring based on the results of stability analysis.

(2) **Research on evaluation of mechanical stability of castle stonewalls**

The stone structures of castles, which are mainly composed of masonry walls, have been subject to collapse due to changes over time, which are believed to be triggered by large-scale earthquakes and repeated heavy rainfall in recent years. The stone structures of castles, which are mainly composed of blank masonry stonewalls, have been experiencing sudden collapses and deformation of the stonewalls due to changes over time triggered by large-scale earthquakes and repetitive heavy rains in some castles in Japan. Until now, the cultural value of these structures has been emphasized and there has been a tendency to be reluctant to reinforce and maintain them as structures, but the damage to Kumamoto Castle caused by the 2016 Kumamoto Earthquake has triggered calls for the restoration and repair of built stone structures from an engineering perspective. However, the mechanisms of the static and dynamic stability of these structures have not been clarified yet, and this study aims to clarify these mechanisms through the development and operation of a remote monitoring system for observing the deformation of built-up stone structures of castles, and through numerical simulations of stone wall models based on the discrete element method. The aim of this study is to clarify these issues through the development and operation of a remote monitoring system for observing the deformation of built-up stone structures of castles and through numerical simulation of stone wall models based on the individual element method.

(3) **Research on improvement of design values for ground anchors**

This research aims to improve the estimation method of circumferential frictional resistance of ground anchors in comparison with the existing design method for ground anchor construction. This research collects, organizes, and analyzes data from recent ground anchor construction projects, and proposes a new evaluation method for the frictional resistance $\tau$ of ground anchors. This will lead to appropriate maintenance and renewal of this method through effective use of ground investigation, improvement of design and construction quality, shortening of construction period, and cost reduction, aiming to extend the service life of the existing stock along roadside slopes.

## 2. Keywords

slope disaster / stonewalls / ground anchors / remote Monitoring / numerical simulation

## 3. Remarks and Websites

Since FY2023, I have overseen “Development of a method for extracting high-risk landforms for slope disaster prevention using new technologies” as one of the themes of “Construction of a smart infrastructure management system” under the Strategic Innovation Program (SIP: Phase 3) of the Cabinet Office. We are looking forward to hearing from you regarding joint research on the above-mentioned research themes.

**researchmap:** https://researchmap.jp/read0125663

**Laboratory:** https://www.cee.nagasaki-u.ac.jp/

| Name | Job Title | Area of Expertise |
|---|---|---|
| SUZUKI Seiji | Associate Professor | Environmental Hydraulics<br>River Engineering |

## 1. Main Research Topics

### ① Development of the Real-time inundation area information provision system

In recent years, heavy rain disasters such as river flooding and slope collapses have become more severe in Japan, and there has been no end to the flood damage and human casualties caused by river flooding and inland flooding. In order to protect from flooding during a disaster, it is necessary to accurately understand the locations of flooding and the risk level of your current location. Therefore, we are developing a "Real-time Flood Area Information System" that could become the most useful evacuation support tool during disasters. The system we are developing is divided into three major phases in order to enable the provision of real-time flood information during floods. The first phase involves developing a disaster prevention app that efficiently collects data from the entire watershed, including photos and videos taken by many residents with their mobile phones during floods, and collecting a large amount of flooded photos and videos with location and time information. In the second phase, image data recording flood conditions is collected in real time, and data on the time and location of the image is acquired. AI applying image analysis technology is then used to automatically estimate flood depth. Based on the large amount of estimated flood depth data, real-time flood depth maps and maps of predicted flood depths several minutes later are created. In the third phase, the created real-time flood area information and predicted flood area maps are provided to registered residents of the river basin via an app, for effective use in supporting evacuation decisions and evacuation route selection.

Fig Real-time inundation area information system

### ② Development of hydrosphere environment management technology with machine Learning

Aquatic environments are formed by a complex interplay of not only physical but also biochemical phenomena. This complexity makes predicting aquatic environments extremely difficult. Therefore, we are attempting to use machine learning, which has been rapidly evolving in recent years, to predict aquatic environments and utilize it for aquatic environmental management. Using image data acquired from UAV, we are developing methods to accurately extract water areas and create elevation data (DEM) that take water areas into account, as well as a method to predict the occurrence of red tides using machine learning.

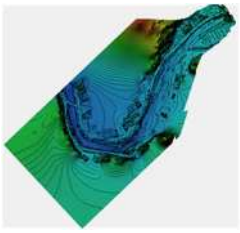


Fig DEM

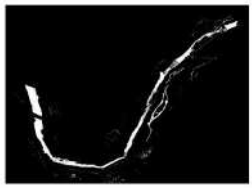


Fig Extraction of water area

## 2. Keywords

Disaster, inundation, water quality, machine learning, hydrosphere environment

## 3. Remarks and Websites

As water disasters become more severe and rapid changes in aquatic ecosystems become apparent, the importance of appropriate management and conservation of the water environment, including disaster prevention and mitigation, is increasing, and social demand for the development of low-cost, simple aquatic management technologies is expected to increase further.

**researchmap:** https://researchmap.jp/read0150870
**Laboratory:** https://www.cee.nagasaki-u.ac.jp/~suiken/

| Name | Job Title | Area of Expertise |
|---|---|---|
| NISHIKAWA Takafumi | Associate Professor | Structural Engineering |

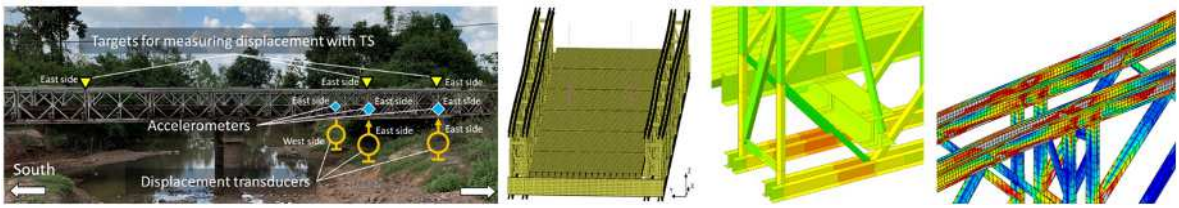
## 1. Main Research Topics

### ① Structural modeling for bridges based on sensing techniques

We are developing a method to create analytical models for structures such as bridges efficiently and accurately. We integrate optical measurement technology, including 3D laser scanning, image analysis, and vibration sensing, with highly accurate structural identification and machine learning.

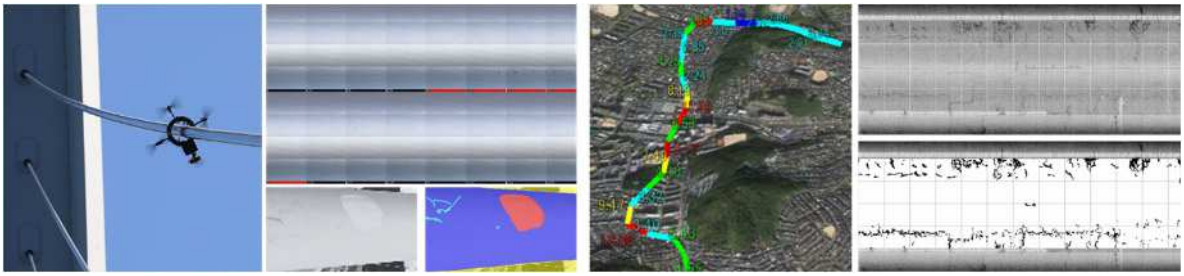

### ② Identifying structural characteristics of the Bailey bridge

A temporary-use bridge with prefabricated modular truss members, called a Bailey bridge, has often been used as a permanent bridge in many countries; however, there are no standards and methodologies for regular maintenance of this type of bridge. Hence, evaluating their structural soundness, such as the residual load-bearing capacity, is one of the significant challenges. This evaluation is necessary to make decisions regarding repair, reinforcement, and replacement. In this study, we are attempting to understand the structural characteristics of the Bailey bridge by conducting full-scale load testing, scale model tests, and structural analysis based on surveys.




### ③ Developing sensing methods for rational inspection of structures

We have developed various sensing technologies that advance structural inspections, such as image analysis for cable inspection robots on cable-supported bridges, road roughness estimation based only on the dynamic response of regular vehicles while driving, and robust and exact automatic pavement damage detection through analysis of drive records.



## 2. Keywords

Social infrastructure, Structural health monitoring, system identification, image processing, bridge maintenance

## 3. Remarks and Websites

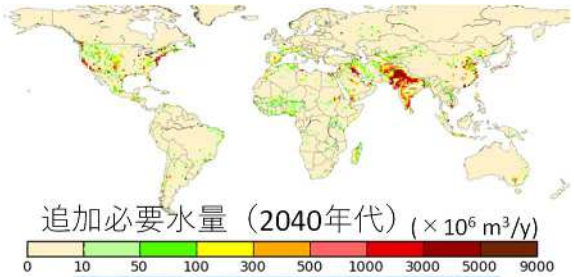
① By integrating structural identification with statistical analysis, we have achieved higher accuracy.
② As modular temporary bridges are rarely used in Japan, our research is conducted in Laos, Mozambique, and other countries, in collaboration with local universities and government agencies.
③ In image analysis, we combine evolutionary computation-based filters with original techniques such as multi-resolution and autonomous tracking, enabling stable detection of nearly all visible damage.

We aim to develop practical structural health monitoring that supports new approaches to infrastructure maintenance. The outcomes are expected to contribute to international cooperation projects (e.g., JICA), strengthen bridge management in developing countries, and promote local industry through the introduction of Japanese technology.

**researchmap:** https://researchmap.jp/nishikawa1019
**Laboratory:** https://www.cee.nagasaki-u.ac.jp/~dokou/

| Name | Job Title | Area of Expertise |
|---|---|---|
| YOSHIKAWA Sayaka | Associate Professor | Land Use Change, Remote Sensing, Hydrology |

**1. Main Research Topics**




① **Assessment of Water Resources due to Climate Change and Land-Use Change on the global scale**

We are estimating the water requirements from the past to the future on a global scale by organizing data on irrigated farmland areas and the spatio-temporal distribution of reservoirs. We also organize climate scenarios, socioeconomic scenarios, and other factors necessary for estimating water demand on the global scale.

② **Relationship Between Extreme Rainfall and Temperature Rise**

What is causing the recent increase in disasters caused by heavy rain? Global warming can be considered one key factor. How have temperature rises and heavy rainfall patterns changed in Japan? And to what extent can precipitation, which is the output of climate models used to assess the future impact of climate change, accurately represent these changes? This study aims to clarify these issues.

③ **Development of common socio-economic scenarios for climate change impact assessments in Japan**

Climate change is one of the biggest long-term challenges facing humanity. When predicting the impacts of climate change, scenarios based on assumptions about future conditions are commonly used. We are creating data (particularly on population, number of households, and land use in Japan) according with Japan's version of socioeconomic scenarios for the purpose of conducting nationwide unified the assessments of climate change and its applicability across multiple sectors in Japan.

④ **Deforestation Dynamics and the Factors of Change in Amazon**

Since the 1970s, Brazil's legal Amazon region has been hit by dramatic deforestation. Deforestation can cause long-term increases in temperature and decreases in evaporation and precipitation. However, as the world's largest producer of beef and soybeans, many countries, including Japan, rely on agricultural products from the Amazon. Using satellite remote sensing and statistical data, we are conducting research aimed at clarifying where and what crops are influencing land use changes, which countries they are exported to, and the connection between land use changes and the global market. We are also seeking to clarify the extent to which policies implemented during each administration have influenced land use changes. In both large-scale and small-scale agricultural and pastoral areas in the Amazon, irrigation has been initiated to increase crop yields, and efforts have also begun to clarify the impact of land use changes and irrigation activities on the water cycle.

**2. Keywords**

Land use/ Land cover, water resource, Remote sensing, socio-economic scenario

**3. Remarks and Websites**

Current projects

① Environment Research and Conservation Activities Strategic Research and Development Areas (I) S-24 (FY2025-2029)

② JSPS KAKENHI Grant-in-Aid for Scientific Research (B) (FY2025-2028)
'Global water resource assessment taking account soil salinity'

③ JSPS KAKENHI Grant-in-Aid for Challenging Research (Pioneering) (FY2024-2028)
'Does the global ESG trend pose a crisis to the future global food security? From the perspectives of Brazil and Japan'

**researchmap**：https://researchmap.jp/sayakayoshikawa

**Laboratory:** https://www.cee.nagasaki-u.ac.jp/~kankyo/

| Name | Job Title | Area of Expertise |
|---|---|---|
| TANAKA Wataru | Assistant Professor | River Engineering, Biology |

**1. Main Research Topic**

**(1) Elucidation of the Relationship Between the Causes of Riverbed Topography at River Confluences and Biodiversity**

Based on the confluence angle and tributary flow, we predict the factors that cause riverbed topography at river confluences. We also clarify the relationship between biodiversity at confluences and riverbed topography and elucidate the relationship between confluence conditions and biodiversity potential.

Specifically, we investigate the formation of temporary water bodies unique to confluence points after floods, which can occur due to differences in flow rates between the main river and its tributaries. Since these temporary bodies of water are utilized by fish for spawning, we are also examining their impact on biodiversity.

**(2) Hydrological and biological evaluation of traditional flood control methods:**

Traditional flood control methods used in Japan before the spread of modern engineering technology have withstood forces beyond expectations and are expected to be effective against the recent increase in severe disasters. We are evaluating the effectiveness of these methods and clarifying their impact on organisms compared to modern methods.

**(3) Small-scale natural restoration of three-sided concrete rivers and rock-bed rivers:**

Historical records and satellite imagery reveal that, following the 1982 Nagasaki Flood Disaster, river renovation using three-sided concrete rivers was carried out as part of the recovery efforts in Nagasaki City. Three-sided concrete sections and rock-bed rivers are prevalent in Nagasaki and tend to have monotonous environments, which reduces the diversity and abundance of organisms inhabiting them. Therefore, we are developing small-scale natural restoration methods for typical three-sided concrete rivers and bedrock-exposed rivers in Nagasaki. Specifically, we are installing permeable barriers called “barb structures” and monitoring their progress, as well as monitoring structures where the barriers themselves are formed by plants to automatically trap sediment while adjusting the barrier height.

**Wand formed at the confluence point**

**Waterfront environment restoration by barb structures**

**2. Keywords**

Flood disturbance, biodiversity, natural regeneration, aquatic ecology, ground beetle ecology

**3. Remarks and Websites**

Others

・Relationship between flood disturbance and species diversity of wandering beetles

・Elucidation of material cycles in floodplains and the sea

etc.

**researchmap:** https://researchmap.jp/susuma

**Laboratory:** https://www.cee.nagasaki-u.ac.jp/~suiken/

# Chemistry and Materials Engineering Program

| Name | Job Title | Area of Expertise |
|---|---|---|
| ARIKAWA Yasuhiro | Professor | Coordination Chemistry |

## 1. Main Research Topics

Compounds in which a metal ion is coordinated by organic or inorganic molecules, called ligands, are known as metal complexes. Using such metal complexes can convert stable small molecules such as hydrogen, nitrogen, oxygen, and carbon dioxide into valuable compounds or extract energy from them. In our laboratory, we particularly focus on the reduction of nitrogen and sulfur oxides, as well as their oxo-anions, to achieve detoxification and transformation into useful compounds. We also work on the conversion of carbon dioxide into valuable chemicals using visible light.

① **Development of multi-electron reduction reactions of small molecules**

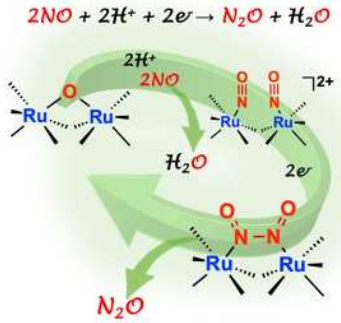



Fig. 1 NO Reduction Cycle

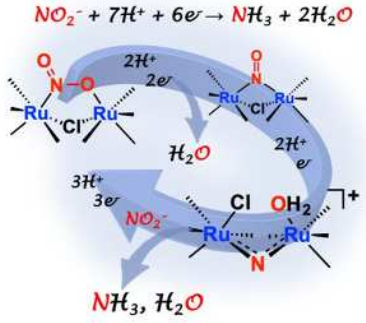



Fig 2 $NO_2^-$ Reduction Cycle

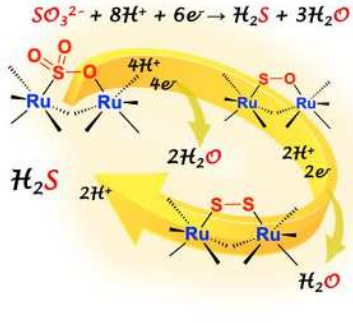



Fig. 3 $SO_3^{2-}$ Reduction Cycle

In our laboratory, we use a dinuclear ruthenium complex, in which two ruthenium metal ions are bridged by pyrazolate ligand, to achieve three distinct reduction cycles:

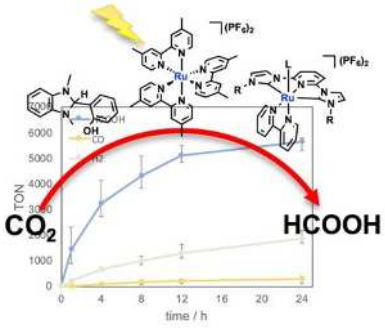
i) Conversion of two molecules of nitric oxide (NO) into nitrous oxide ($N_2O$) through 2 electron and 2 proton reduction (Figure 1) ($2\ NO + 2\ H^+ + 2\ e^- \rightarrow N_2O + H_2O$). Nitric oxide (NO) is readily oxidized in air to form toxic nitrogen dioxide ($NO_2$), but by reducing NO to nitrous oxide ($N_2O$), it can be detoxified.

ii) Conversion of nitrite ions ($NO_2^-$) to ammonia ($NH_3$) via a 6electron and 7 proton reduction (Figure 2) ($NO_2^- + 7\ H^+ + 6\ e^- \rightarrow NH_3 + 2\ H_2O$). This transformation is relevant to mitigating nutrient enrichment (eutrophication) in soils and water systems.

iii) Conversion of sulfite ions ($SO_3^{2-}$) to hydrogen sulfide ($H_2S$) via a 6 electron and 8 proton reduction (Figure 3) ($SO_3^{2-} + 8\ H^+ + 6\ e^- \rightarrow H_2S + 3\ H_2O$). This reaction is closely related to the global sulfur cycle.

② **Conversion of $CO_2$ into valuable chemicals using visible light**

Approximately half of the sunlight that reaches the Earth's surface is visible light. Therefore, if we can utilize the energy of visible light to convert $CO_2$ into valuable compounds, it could contribute significantly to building a sustainable society. In our research, we have successfully converted $CO_2$ primarily into formic acid (HCOOH) by employing complex catalysts.




## 2. Keywords

metal complex, nitrogen oxides, sulfur oxides, oxoanions, carbon dioxide, reduction reaction, artificial photosynthesis

## 3. Remarks and Websites

On Earth, there exists a natural process known as the nitrogen cycle. In this cycle, abundant nitrogen molecules in the atmosphere undergo various transformations through oxidation and reduction reactions. Among these processes, the reduction of nitrate ions to molecular nitrogen is particularly important and is referred to as denitrification. Our research focuses on this denitrification process. Specifically, we investigate the reduction of nitrogen oxides (such as NO and $N_2O$), sulfur oxides (such as SO), and their corresponding oxoanions ($NO_3^-$, $NO_2^-$, $SO_3^{2-}$) using metal complexes. In addition, we also study the visible-light-driven conversion of $CO_2$.

**researchmap:** https://researchmap.jp/arikaway

**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/sakutai/

| Name | Job Title | Area of Expertise |
|---|---|---|
| OHGAI Takeshi | Professor | Metallurgy |

## 1. Main Research Topics

The physical properties of metallic materials are determined by their microstructure, including grain size, lattice defect density, and the dispersion state of precipitates. The constituent phases of this microstructure change in such a way as to reduce Gibbs free energy, ultimately settling into a thermodynamically stable phase. This thermodynamically stable phase is uniquely determined by the alloy composition and temperature, and its database is summarized in a phase diagram. While the properties of these thermodynamically stable phases have already been elucidated, the properties of non-equilibrium phases during phase transformations, where atomic diffusion is insufficient, remain largely unknown and hold the potential to exhibit exceptionally superior properties. One method for producing these non-equilibrium phases is the solid solution preparation method using rapid cooling from the liquid or gas phase, but this requires high-temperature and high-vacuum conditions. On the other hand, the aqueous solution electrolysis method allows for the reduction of hydrated metal ions at room temperature and pressure, enabling the easy production of thermodynamically non-equilibrium phases. Below, I introduce research themes related to the production and property evaluation of non-equilibrium phases using the aqueous solution electrolysis method.

① **Electrochemical Synthesis of Nanochannel Structured Metal Oxide Films**

I have developed anodized aluminum oxide thick filters with numerous nanochannels which can be applied to a template material for developing a novel functional device.

② **Development of Metallic Multilayered Nanowires Array with CPP-GMR Response**

Using a pulsed current electrodeposition technique from an aqueous solution, I have fabricated a multi-layered nanowire array with alternating layers of ferromagnetic and antiferromagnetic metals. The multi-layered nanowire exhibited a giant magnetoresistance effect with applying current in perpendicular to the layered interfaces (see Fig. 1).

③ **Characterization of Iron-group Metal Based Amorphous Alloy Films Electrodeposited from Aqueous Solutions**

I have synthesized iron-group metal based amorphous alloy thick films by applying an induced co-deposition technique from an aqueous solution. The amorphous alloy thick films exhibited excellent mechanical performance with high-strength, high-corrosion-resistant, and catalytic properties.

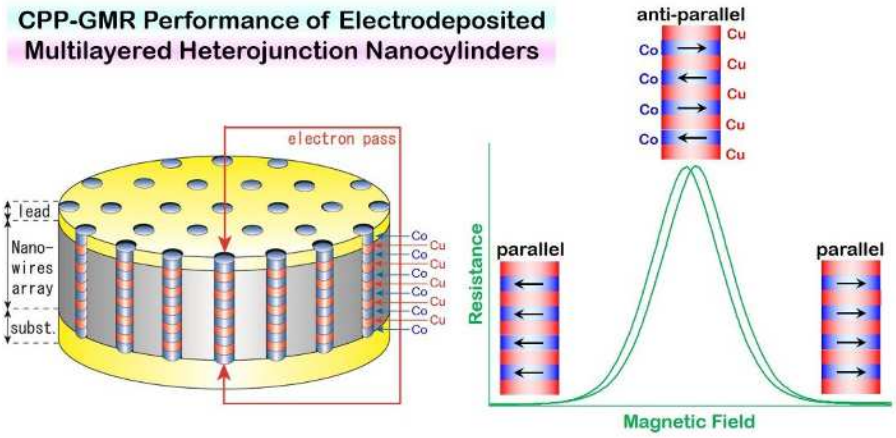



Fig.1 Electrochemical synthesis and characterization of metallic multilayered nanowires array with CPP-GMR (current perpendicular to plane giant magnetoresistance) response.

## 2. Keywords

Metallic materials, Metallic nanomaterials, Electrodeposition, Anodization, Metal surface finishing, High strength alloys, Magnetoresistance, Corrosion-resistance alloys

## 3. Remarks and Websites

I am currently developing new functional metallic materials with non-equilibrium phases utilizing metal surface treatment technology, mainly using an electrodeposition technique from aqueous solution.

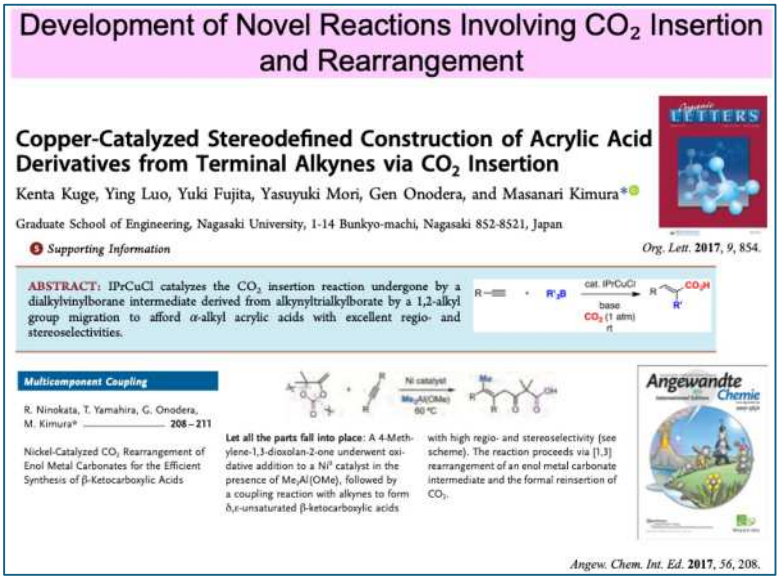
**researchmap:** https://researchmap.jp/read0118950

**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/soshiki/index.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| KIMURA Masanari | Professor | Organic Chemistry, Synthetic Chemistry |

## 1. Main Research Topics

We are pioneering new synthetic chemistry based on organic chemistry, and developing highly efficient synthetic methods for pharmaceuticals and bioactive compounds such as anticancer agents, antibiotics, and antiviral drugs. In addition, we aim to achieve technological innovation from a molecular chemistry perspective to address the urgent global issue of energy. Our research challenges include the development of reactions that utilize carbon dioxide as a carbon resource, the construction of carbon recycling systems for producing petroleum alternatives and fuels, and molecular transformation technologies related to hydrogen generation and utilization.




### ① Development of Novel Organic Synthetic Reactions

Our research focuses on the development of highly efficient synthetic methodologies utilizing metal catalysis. Key areas include cross-coupling reactions, novel transformations based on C–H activation of alkanes, multicomponent assembly reactions, and environmentally friendly reactions that proceed in water.

### ② Development of Pharmaceuticals and Bioactive Compounds

Functional and valuable compounds, including anti-dementia drugs**,** anticancer agents, non-steroidal anti-inflammatory drugs (NSAIDs), boron-containing compounds**,** agrochemicals, and functional luminescent materials, are synthesized using original reactions developed in our laboratory.

### ③ Design and Synthesis of Energy-Related Materials

Our research focuses on carbon fixation using carbon dioxide as a carbon resource, the synthesis of biomass-derived plastics, and catalytic reactions for hydrogen generation and utilization.

## 2. Keywords

Organic Synthesis, Catalytic Reactions, Carbon Dioxide, Organoboron Compounds, Pharmaceuticals and Drug, Hydrogen Generation & Storage

## 3. Remarks and Websites

We are focusing on green chemistry related to carbon neutrality and carbon recycling technologies. For example, we are involved in the development of resources utilizing small molecules, such as carbon dioxide and carbon monoxide. We are also developing catalytic reactions for the generation of hydrogen molecules. In addition, we are advancing technologies in synthetic and catalytic chemistry to support the synthesis of pharmaceuticals, as well as the creation of bioactive compounds, including functional materials containing boron atoms and agrochemicals. We have a proven track record of collaborative research with chemical and materials manufacturers, pharmaceutical companies, and petroleum and energy-related industries.

**researchmap：** https://researchmap.jp/read0185029/
**Laboratory:** http://www.cms.nagasaki-u.ac.jp/lab/yuuki/

| Name | Job Title | Area of Expertise |
|---|---|---|
| SAKUDA Eri | Professor | Photochemistry |

## 1. Main Research Topics

### ① Synthesis and Photophysical Properties of photofunctional compounds using main group elements

This study focuses on the creation of luminescent compounds by skillfully utilizing the characteristic excited-states of typical elements. For example, when organic compounds bridged by boron atoms are crystallized in various solvents, different crystal forms are obtained. By investigating the correlation between crystal systems/structures and luminescence, we were able to clarify the relationship between the boron environment and its luminescent properties (Figure 1).

Furthermore, the creation of luminescent complexes with substituent sites on the typical elements that exhibit different emission colors based on the surrounding environment was also investigated, along with their luminescent characteristics (Figure 2). Such luminescent compounds can be utilized in devices such as organic light-emitting diodes (OLEDs). Moreover, because their emission color is highly sensitive to environmental changes, these compounds hold promise for use as environmental-responsive sensors.

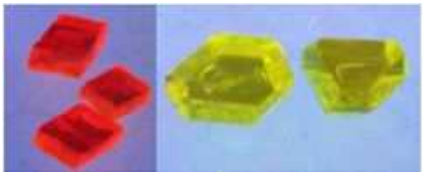


**Figure 1**: Examples of compounds whose emission color changes depending on the crystal system.

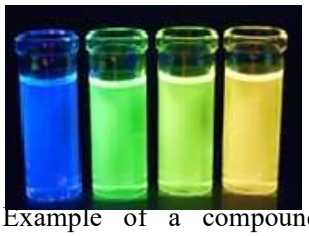


**Figure 2.** Example of a compound showing emission color change depending on solvent polarity

### ② Construction of energy conversion systems by utilizing the main group elements

In this study, we are also attempting to convert carbon dioxide into a valuable carbon resource by utilizing the excitation energy of compounds containing main-group elements and metal complexes. Most of the $CO_2$ photoreduction catalysts reported so far rely on rare metals, which pose challenges in terms of cost and resource scarcity. Therefore, the development of a $CO_2$ photoreduction system that utilizes main-group elements instead of expensive metals could contribute to the construction of a new artificial photosynthetic system that does not depend on rare metals.

## 2. Keywords

Photochemistry, Main group element, Metal complex, Energy conversion

## 3. Remarks and Websites

**researchmap：** https://researchmap.jp/sakueri
**Laboratory：** https://www.cms.nagasaki-u.ac.jp/lab/sakutai/
**Dynamic Exciton:Emerging Science and Innovation：** https://dynamic-exciton.jp/

In Research Project 1, the luminescent materials are expected to be applicable to displays and organic electroluminescent (EL) devices. In addition, their use as environmentally responsive sensors and in vivo probes is also envisioned. Meanwhile, Research Project 2 holds promise for applications in artificial photosynthesis systems and the development of systems that convert carbon dioxide into valuable carbon resources.

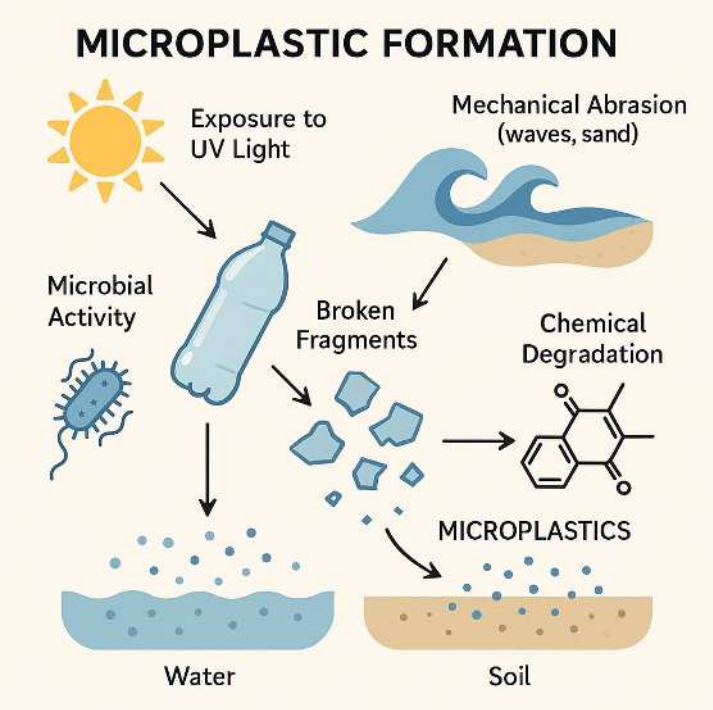
| Name | Job Title | Area of Expertise |
|---|---|---|
| NAKATANI Hisayuki | Professor | Polymer Engineering |

**1. Main Research Topics**

① **Elucidation of the mechanism of microplastic generation**
- Research on how polymer materials become microplastics in the environment from the perspectives of photodegradation and biodegradation.
- Evaluate the effects of UVA (ultraviolet rays) and microbial degradation.

② **Development of microplastic collection and recycling technologies**
- Explore the possibility of biological treatment of plastics through selective decomposition experiments using mealworms (insects).
- Evaluate the decomposition behavior of composite materials such as GFRP (glass fiber reinforced plastic).

③ **Design and certification evaluation technology for environmentally friendly polymer materials**
- Creation of polymers with photodegradability and biodegradability.
- Control of degradation behavior in the environment through functionalization.




**Mealworms feeding on polystyrene foam!**

**2. Keywords**

Microplastics, biodegradation, mealworms, recycling

**3. Remarks and Websites**

Innovative decomposition evaluation utilizing biological organisms, development of light decomposition and recycling technologies for difficult-to-decompose materials such as GFRP, and evaluation of behavior in actual environments.

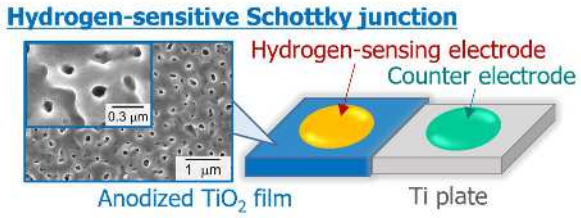
**researchmap:** https://researchmap.jp/read0111962
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/kobunshi/

| Name | Job Title | Area of Expertise: Functional Materials Chemistry, Chemical Sensors |
|---|---|---|
| HYODO Takeo | Professor | |

## 1. Main Research Topics

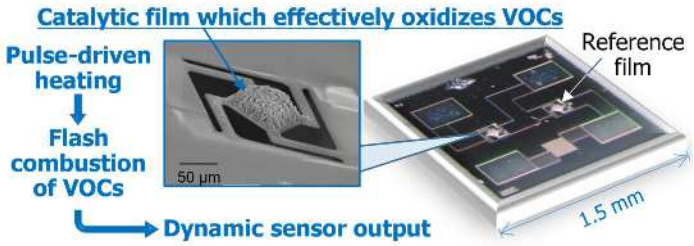
### (a) Highly sensitive and selective diode-type hydrogen sensors

The barrier height of the Schottky junction, which combines an anodically oxide film (e.g., $TiO_2$) with a noble metal such as Pd and Pt, is very sensitive to hydrogen under gaseous atmosphere. We have developed high-performance hydrogen sensors by their optimization of the composition and/or microstructure.



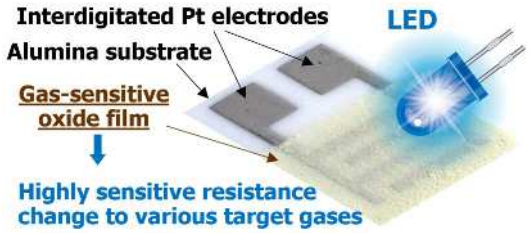

### (b) Adsorption/combustion-type VOC microsensors based on MEMS platforms

Modern microelectromechanical systems (MEMS) technology provides a micro platform for various gas sensors. An adsorption/combustion-type gas sensor with a catalyst film and a reference film, which are formed over Pt heaters, can high-sensitively detect various volatile organic compounds (VOCs, e. g., toluene) by the flash combustion of the VOCs adsorbed on the catalyst surface.




### (c) Light-driven semiconductor-type gas sensors operable at room temperature

General semiconductor gas sensors operate at elevated temperatures, while the effective light irradiation to the gas sensors by a light-emitting diode (LED) makes them detect some gases even at room temperature. The compositional and microstructural optimization of the oxide film significantly improves the gas-sensing properties.




### (d) Others

A variety of highly functional materials and devices, such as “oil-quality sensors” and “functional porous microspheres and electrodes” has been developed in our laboratory.

## 2. Keywords

Chemical sensors, Gas sensors, Oil-quality sensors, functional ceramics, mesoporous and macroporous materials, Electrochemistry, Semiconductor, Solid electrolyte, Hydrogen, Carbon monoxide, VOCs

## 3. Remarks and Websites

We conduct a number of research projects using funding from the Japan Society for the Promotion of Science (FY2021–FY2023: Grants-in-Aid for Scientific Research B "Highly sensitive and selective sensing technology for biogases based on dynamic adsorption combustion" and FY2024–FY2026: Grants-in-Aid for Scientific Research B "Development of ultrasensitive, highly selective, and rapid-response hydrogen-monitoring devices"), other competitive funds, and joint research grants. Please see the following websites for our various research results.

- **researchmap:** https://researchmap.jp/TH_nagasaki?lang=en
- **Lab. HP:** http://www.cms.nagasaki-u.ac.jp/lab/zaika/
- **ORCiD:** https://orcid.org/0000-0003-1605-5623
- **Google Scholar:** https://scholar.google.com/citations?user=5yPHuqoAAAAJ&hl=ja
- **J-Global:** https://jglobal.jst.go.jp/en/detail?JGLOBAL_ID=200901017381080194

| Name | Job Title | Area of Expertise |
|---|---|---|
| MURAKAMI Hiroto | Professor | Polymer Chemistry, Supramolecule |

## 1. Main Research Topics

**① Development of Functional Polyurethane Elastomer (Fig. 1)**

We focus on establishing a synthesis method for a novel polyurethane closslinked by polyrotaxane and investigating their various properties such as thermal, viscoelastic, and mechanical properties. The crosslinking points in polyurethane significantly influence its elastomeric properties. Meanwhile, the polyrotaxane has a topological structure where multiple ring molecules are mechanically interlocked by a linear polymer axis. These ring molecules can freely translate and rotate along the axis polymer. We expect that the unique characteristic of polyrotaxane plays important roles to create polyurethanes with excellent vibration isolation, self-healing, and cushioning properties.

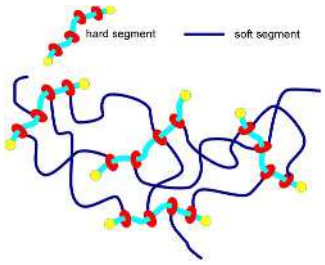



**Figure 1.** Cartoon of polyurethane closslinked by polyrotaxane.

**② Development of Easily Peelable Pressure Sensitive Adhesive (Fig. 2)**

In the technical development of adhesives, achieving both high adhesiveness and easy peelability is a crucial challenge. Furthermore, recyclability is also important from an environmental conservation perspective. Therefore, we are developing adhesives that are easily peelable using heat as a trigger and are reusable.

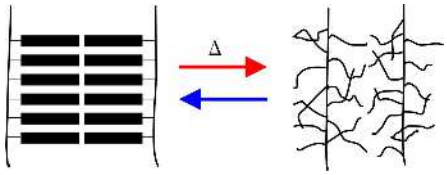



**Figure 2.** Mechanism of Easily peelable using heat as a trigger.

**③ Development of Electrochromic Devices with Nonvolatile Solvents (Fig. 3)**

To suppress damage to electrochromic (EC) devices, which can be caused by solvent evaporation, degradation of EC materials and counter electrode compensation materials, or physical cracks, we utilize viologen (V)-type ionic liquids as EC materials and ferrocene (Fc)-type ionic liquids as counter electrode compensation materials. We expect that liquefying these materials will not only resolve these issues but also allow for a higher concentration of EC substances, leading to the possibility of thinner EC devices and faster response times.


**Figure 3.** An electrochromic device constructed by a mixture of ferroceneion and viologen ionic liquids.

## 2. Keywords

Polyurethane, Pressure Sensituve Adhesive, Photochromic, Ionic Liqiud

## 3. Remarks and Websites

**researchmap:** https://researchmap.jp/hmrm090310051105
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/douteki/jp/index.html
Research ①: We have successfully developed highly extensible polyurethane elastomers. Our goal is to continue developing diverse functional polyurethane elastomers, not limited to polyrotaxane-based materials.
Research ②: In collaboration with industry partners, we're developing easily peelable acrylic and silicone adhesives.
Research ③: We have achieved multi-color electrochromism and are exploring applications for display devices like electronic paper.

**For more information, please feel free to get in touch.**

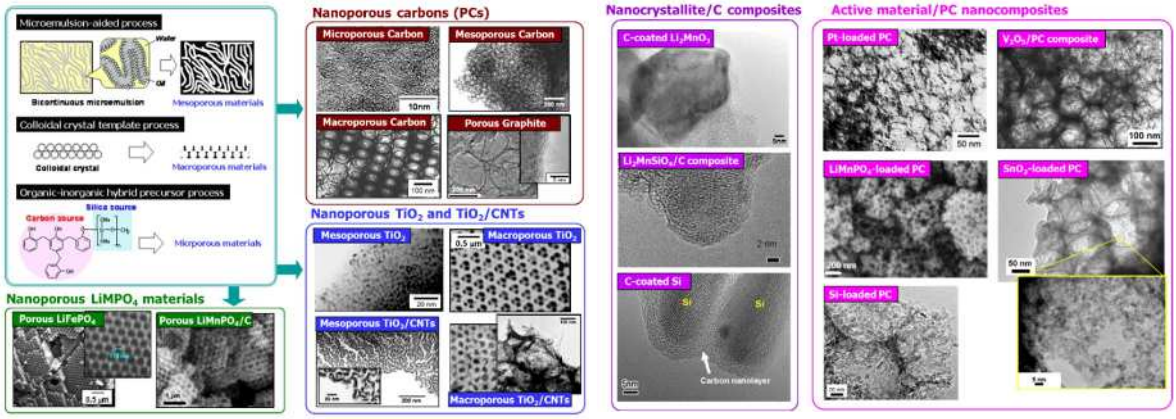
| Name | Job Title | Area of Expertise |
|---|---|---|
| MORIGUCHI Isamu | Professor | Inorganic Materials Chemistry, Electrochemistry, Colloid & Interface Chemistry |

## 1. Main Research Topics

Development of innovative materials and technologies that contribute to environmental conservation and efficient use of energy through the elucidation of science related to nano-interfaces and nano-spaces. The overview is shown below.

### ① Creation of novel functions via nano-interface and nano-space control

Synthesis of various nanoparticles, nanoporous materials and nanocomposites of carbons and metal oxides by soft chemical processes to investigate new functions such as adsorption&catalysis, charge-discharge functions and $CO_2$-reduction.




### ② Development of innovative energy storage devices

Aming for high-performance storage devices which are applicable to electric power grid-connection system, electric vehicles, energy regeneration, instantaneous power outage (low) backup, power assistance, and power tools, etc.

Development of advanced electrode materials for high performance Li- or Na-ion batteries, safe and stable all-solid-state batteries, electric double-layer capacitors, Li-ion capacitors, and other hybrid capacitors.

**Recent major publications**

*Nat. Energy*, **10**, 847 (2025); *J. Phys. Chem. C* **, 129**, 11905 (2025); *J. Mater. Chem. A*, **13**, 13962 (2025); *Carbon*, **235**, 120088 (2025); *Chem. Lett*., **53**, upae208 (2024); *Nat. Commun*., **15**, AN1708 (2024); *ACS Appl. Mater. Interfaces*, **15**, 30600 (2023); *Chem. Eng. J*., **429**, 132424 (2022); *Sci. China Tech. Sci*, **65**, 1 (2022); *ACS Appl. Energy Mater.*, **4**, 13841 (2021); *Nano Select*, **2**, 2121 (2021); *ACS Appl. Mater. Interfaces*, **12**, 43042 (2020); *J. Coll. Interface Sci.*, **552**, 412 (2019); *Sci. Rep*., **8**, AN8747 (2018); *Nanoscale*, **9**, 15643 (2017); *J. Phys. Chem. C*, **120**, 25717 (2016); *Nat. Commun*., **6**, AN6544 (2015); *Chem. Commun*., **50**, 7143(2014); *ACS Nano*, **8**, 3614(2014)

## 2. Keywords

Carbon neutrality, Nanotechnology, Soft chemical process, Energy storage devices, Li-ion battery, Na-ion battery, All-solid-state battery, Electric double-layer capacitor, Li-ion capacitor, Adsorption and separation, $CO_2$

## 3. Remarks and Websites

**Research topics available for joint research**

Development of $CO_2$ and other gas adsorption and separation materials, Analysis of structure and interface of nanomaterials, Development of Li-ion and Na-ion batteries as well as all-solid-state battery electrode materials, Development of EDLC and Li-ion capacitor electrode materials, etc.

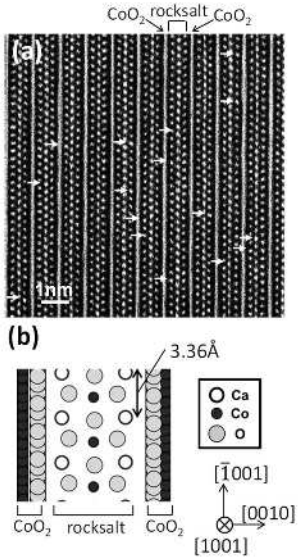
**researchmap：** https://researchmap.jp/I.Moriguchi
**Laboratory：** https://www.cms.nagasaki-u.ac.jp/lab/bukka/A/top.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| MORIMURA Takao | Professor | Crystal Structure Analysis |

## 1. Main Research Topics

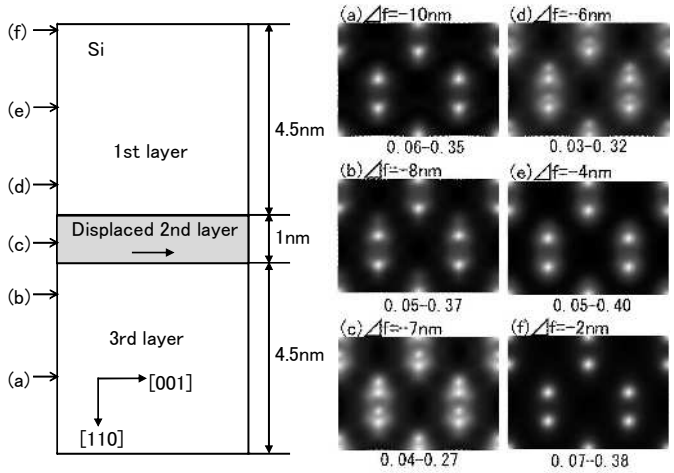
### ① Development and Structural Analysis of Thermoelectric Materials

We fabricate thermoelectric materials using methods such as spin-casting liquid quenching, sintering, and vapor deposition. We develop high-performance thermoelectric materials by combining physical property measurements, such as the Seebeck coefficient, electrical conductivity, and dimensionless figure of merit, with structural analysis using scanning transmission electron microscopy (STEM). The figure on the right shows an experimental STEM image of the Sr-doped misfit-type layered oxide $Ca_3Co_4O_9$ (a) and a projection from the [110] direction (b). In (a), Ca and Co atoms are observed as bright spots. Sites occupied by heavier Sr atoms are observed as brighter spots, as indicated by the arrows. This suggests that the added Sr is substituted and distributed within the misfit-type layered oxide $Ca_3Co_4O_9$, contributing to improved thermoelectric properties.




### ② Development of a Simulation Method for Scanning Transmission Electron Microscopy image

Quantitative analysis of STEM images requires solving the Schrödinger equation and simulating the images. In this research, we are developing a new STEM image simulation method by applying the Bloch wave method, which is advantageous for periodic structures, to crystals containing defects. The figures show schematic Si with the second layer slightly displaced in the [100] direction (left) and a simulated image (right) when an electron beam is incident from the [110] direction. By changing the objective lens focus Δf, images can be obtained near the depths indicated by the arrows, suggesting that 3D structural analysis is possible.




## 2. Keywords

thermoelectric material, Scanning transmission electron microscopy, Electron diffraction theory, Bloch wave method

## 3. Remarks and Websites

We are conducting research that lead to the development of high-performance materials through atomic-level structural analysis. Our goal is to clarify the mechanism behind the high thermoelectric properties. We are also conducting collaborative research on SiC defect structural analysis through Center for Advanced Microdevice Research in the Interest of Society (CAMRIS) in Nagasaki University.

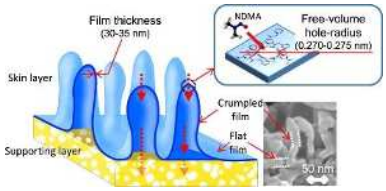
**researchmap:** https://researchmap.jp/read0172791/
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/kessho/

| Name | Job Title | Area of Expertise |
|---|---|---|
| FUJIOKA Takahiro | Professor | Environmental Engineering |

## 1. Main Research Topics

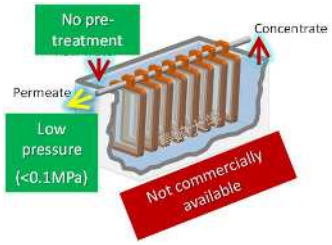
① **Development of high-rejection reverse osmosis membranes**

We are developing high-rejection reverse osmosis membranes that remove chemicals that are difficult to separate, which is an issue in the United States and other countries where sewage is purified and reused for drinking. Specifically, we remove *N-nitrosodimethylamine* (NDMA), a disinfection by-product.



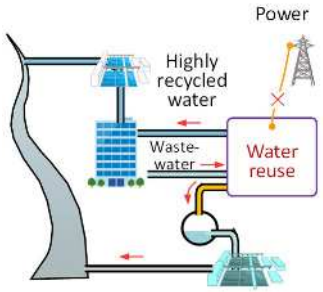

② **Development of advanced water purification technology directly from polluted river water**

In countries without well-developed sewage systems, such as Southeast Asia, the deterioration of water quality in tap water sources is a problem, and we are developing technology to perform advanced purification of these polluted water sources at low initial investment and operating costs. Specifically, we are developing nanofiltration membranes with pore sizes of a few nanometers and related technologies, and by omitting pretreatment, we aim to achieve an introduction cost that is 80% lower than conventional advanced water purification treatment.




③ **Development of net-zero energy advanced water reclamation technology**

We aim to significantly reduce water reclamation costs by introducing submerged nanofiltration membranes that do not require pretreatment when reclaiming sewage. In addition, energy is generated by subjecting the concentrated liquid generated during treatment to anaerobic treatment (methane fermentation treatment). By combining these energy-saving and energy-creating technologies, we aim to establish water reclamation technology that reduces overall power consumption to zero.




④ **Development of automatic algae measurement technology**

We are developing technology to automatically measure the concentration of algae (cyanobacteria and diatoms) present in surface water by species.


## 2. Keywords

Water treatment, Online water quality monitoring, Membrane separation

## 3. Remarks and Websites

**researchmap:** https://researchmap.jp/taka_fujioka
**Laboratory:** http://www.waterenviron.com/
**SATREPS project:** https://www.nusatreps.com

In this laboratory, we are conducting research to optimize the removal of trace organic compounds and pathogenic microorganisms using reverse osmosis and nanofiltration membranes as well as the other advanced water treatment technologies (ozone, activated carbon, ion exchange resins, ultraviolet-based advanced oxidation).

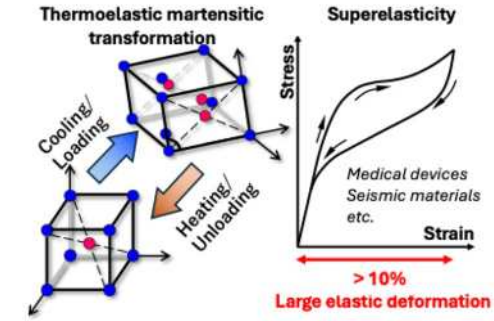
| Name | Job Title | Area of Expertise |
|---|---|---|
| AKAMINE Hiroshi | Associate Professor | Functional Alloys, Electron Microscopy |

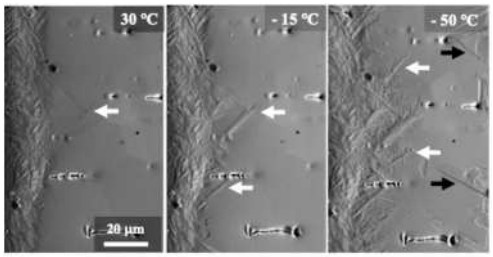
## 1. Main Research Topics

### ① Phase Transformation Mechanisms in Next-Generation Shape Memory Alloys

Shape memory alloys (SMAs) exhibit unique functionalities such as the shape memory effect, in which a deformed material recovers its original shape upon heating, and superelasticity, which allows elastic deformation exceeding 10%—far beyond that of conventional metals. These properties originate from a solid-state phase transformation known as the thermoelastic martensitic transformation. While SMAs are already widely used in consumer products and medical devices, further improvements in performance and cost-effectiveness could significantly expand their applications to fields such as civil engineering, architecture, and solid-state refrigeration.

We aim to elucidate the mechanisms of phase transformations through microstructural analyses, thereby developing novel SMAs and/or enhancing shape memory properties. Emphasis is placed on in situ observations under external fields such as thermal cycling and mechanical loading, which allow direct visualization of phase transformation processes.



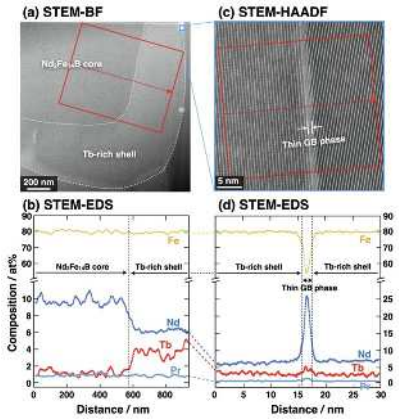




Direct observation of phase transformation upon cooling (Akamine et al. 2023)

### ② Microstructural Analysis Using Electron Microscopy

Electron microscopy is an important analytical technique for the development of advanced materials and devices based on nanotechnology. Modern electron microscopy enables nanoscale analysis of lattice defects, chemical composition, crystallographic orientation, and electronic states. Through electron microscopy-based characterization, we are actively engaged in collaborative research on the development of a wide range of functional materials.

- Deformation behavior of titanium alloys
- Grain boundary structure of neodymium magnets
- Microstructure of PLD-grown thick-film magnets
- Microstructure of fluoride-based ion battery materials




Microstructure analysis by STEM (Itakura et al. 2024)

## 2. Keywords

Shape memory alloys, Phase transformation, Electron microscopy

## 3. Remarks and Websites

We actively welcome collaborative research involving microstructural characterization using scanning electron microscopy (SEM) and transmission electron microscopy (TEM). In addition, evaluations of mechanical properties—such as tensile testing, thermal analysis, and electrical resistivity measurements—provide valuable insights for the development of advanced materials. Please feel free to contact us if you are interested.

We are also aiming to advance research on the practical implementation of shape memory alloys (SMAs) in society. Current interests include SMA-based actuators, solid-state cooling systems driven by thermal cycling, and structural applications in the fields of architecture and civil engineering. We welcome inquiries from those interested in collaboration.

**researchmap:** https://researchmap.jp/akhr-rmap
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/kessho/

| Name | Job Title | Area of Expertise |
|---|---|---|
| UEDA Taro | Associate Professor | Electrochemistry, Gas Sensors |

## 1. Main Research Topics

### (1) Development of Highly Sensitive Gas-Sensing Materials

Sensing materials for high-performance gas sensors have been developed. We have developed semiconductor-type sensors and electrochemical-type sensors capable of detecting combustible gases and carbon monoxide (CO). Detection of trace levels of volatile organic compounds (VOCs) emitted from human breath and skin is a primary objective.

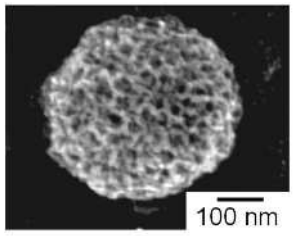



Fig. 1. pr-$SnO_2$ particle.

**Example 1: Porous Tin Oxide (pr-$SnO_2$) Particle**

Porous $SnO_2$ particles were synthesized by ultrasonic spray pyrolysis using a precursor solution containing tin ions and polymeric microspheres as a template (diameter: 70 nm), followed by thermal decomposition and crystallization (Fig. 1). The co-addition of noble metals and metal oxides significantly enhanced the sensor response to acetone.

https://doi.org/10.3390/chemosensors12080153 (Open Access)

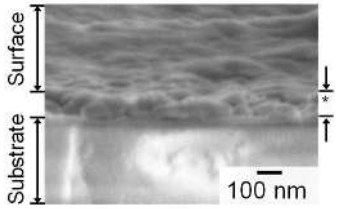



Fig. 2. Au-based thin film electrode*.

**Example 2: Au-Based Thin Film Electrodes**

Thin film electrodes were fabricated by spin-coating method using a solution containing gold and cerium ions onto a solid electrolyte substrate, followed by high-speed rotation and thermal treatment. The fabricated sensor exhibited highly sensitive detection of toluene (Fig. 2).

https://doi.org/10.1016/j.snb.2024.136217 (Open Access)

### (2) Elucidation of Sensing Mechanisms

Understanding sensing mechanisms is essential for the development of high-performance gas sensors. Gas adsorption behavior and surface reaction activity of sensing materials have been investigated using diffuse reflectance infrared Fourier transform spectroscopy (DRIFT) and electrochemical measurement techniques, respectively.

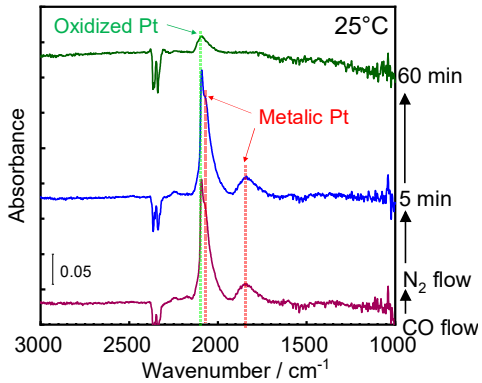



Fig. 3. DRIFT analysis of CO oxidation.

**Example 3: Analysis of CO Oxidation Behavior**

Efficient CO oxidation was promoted by highly dispersed metallic Pt, as evidenced by the disappearance of CO adsorbed on metallic Pt over time, in contrast to the persistent adsorption observed on oxidized Pt (Fig. 3).

https://doi.org/10.1007/s10853-023-08655-5

**Example 4: Analysis of Toluene Oxidation Behavior**

Electrochemical impedance measurements were conducted, and the electrochemical activity at the interface was evaluated from the resulting Nyquist plots. A smaller diameter of the semicircle reflects a higher electrode reaction activity. The significant decrease in diameter upon exposure to toluene indicates electrochemical oxidation of toluene at the interface (Fig. 4). https://doi.org/10.1016/j.snb.2024.136217 (Open Access)

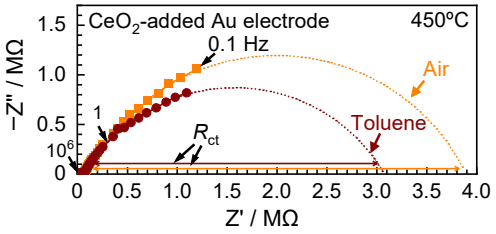



Fig. 4. Electrochemical analysis of toluene oxidation.

## 2. Keywords

Gas sensors, Functional ceramics, Solid electrolyte, Volatile organic compounds

## 3. Remarks and Websites

The development of gas sensors capable of analyzing exhaled breath and skin-emitted gases opens up new possibilities for early detection of diseases such as diabetes and cancer. It also enables efficient screening of patients with infectious diseases, such as malaria, in tropical regions. This technology is expected to greatly contribute to solving medical and health problems in the world.

**researchmap:** https://researchmap.jp/taroueda
**Laboratory:** http://www.cms.nagasaki-u.ac.jp/lab/zaika/zak.htm

| Name | Job Title | Area of Expertise |
|---|---|---|
| URITA Koki | Associate Professor | Surface Chemistry, Nanomaterial Science |

**1. Main Research Topics**

① **Research on Rare Resource Recovery Using Electrochemical Methods**

To build a sustainable society, securing energy resources and achieving carbon neutrality are global challenges. Many countries are beginning to shift toward environmentally conscious policies, making the stable supply of rare resources increasingly important. In this context, we have initiated research on the recovery of rare resources (such as Li) from waste Li-ion batteries (LIBs) and production scraps using electrochemical methods. These methods are derived from capacitive deionization (CDI) technology, which has long been used in seawater desalination processes. Our current goal is to achieve a Li-ion separation efficiency of 90%.

② **Material Design for Air Separation and $CO_2$ Capture**

Improving energy efficiency in combustion furnaces can be achieved through the use of oxygen-enriched air. Carbon molecular sieves (CMS) are materials capable of separating oxygen and nitrogen from air. However, if the barrier layer at the pore entrance of CMS is excessively thick, the permeation rate of oxygen molecules decreases, leading to reduced air separation performance. To address this, we are exploring air separation by forming ultra-thin barrier layers through electrochemical oxidation of activated carbon, which introduces oxygen-containing functional groups near the pore entrances.

**Achievement:** Enhanced $O_2$ selectivity of carbon molecular sieves by electrochemical oxidation for air separation, Carbon, 235, 120088 (2025) [Open Access].

③ **Local Structural Analysis of Materials for Energy Storage Devices**

Porous carbon materials, due to their electrical conductivity, nanoscale porosity, and high specific surface area, are widely used as electrode materials in rechargeable batteries and electric double-layer capacitors (EDLCs). In systems involving chemical reactions between electrolyte ions and electrodes—such as LIBs—active materials like $SnO_2$ and sulfur, which promise high capacity, undergo significant volume changes upon reaction with Li ions. By controlling the reaction space within the nanoscale pores of carbon electrodes, cycle stability can be improved. To answer the question, “What types of nanopores are effective for reactions between active materials and electrolyte ions?”, we observe electrode materials (e.g., sulfur-loaded carbon nanotubes, S@CNT) during discharge using transmission electron microscopy (TEM), identifying pore sizes that facilitate charge-discharge reactions.

Additionally, for EDLCs, we have identified optimal pore sizes and shapes by quantitatively evaluating pore structures via gas adsorption methods and characterizing pore morphology using TEM.

**2. Keywords**

Porous carbon, Air separation, Resource recovery, Electron microscopy, Adsorption

**3. Remarks and Websites**

- **K. Urita**, C. Urita, H. Tanaka, F. Vallejos-Burgos, H. Notohara, T. Araki, K. Horio, H. Furukawa, M. Yoshida, I. Moriguchi, "Tuning carbon black surface morphology via controlled thermal treatment atmosphere" App. Surf. Sci., 710(30), 163907 (2025).
- S. Wang, F. Vallejos-Burogs, A. Furuse, H. Otsuka, M. Nagae, Y. Kawamata, T. Ohba, H. Kanoh, **K. Urita**, H. Notohara, I. Moriguchi, H. Tanaka, J. P. Marco-Lozar, J. Silvestre-Albero, T. Hayashi, K. Kaneko, "Ambient pressure storage of high-density methane in nanoporous carbon coated with graphene" Nat. Energy, 10, 847-856 (2025).
- **K. Urita**, T. Ishida, K. Marubayashi, H. Tanaka, M. Hamasaki, Y. Yamane, J. Miyawaki, H. Notohara, I. Moriguchi, "Enhanced O2 selectivity of carbon molecular sieves by electrochemical oxidation for air separation" Carbon, 235, 120088 (2025).

**researchmap:** https://researchmap.jp/read0150871
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/bukka/A/top_e.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| UNNO Hideaki | Associate professor | Structural Biology; Biochemistry |

## 1. Main Research Topics

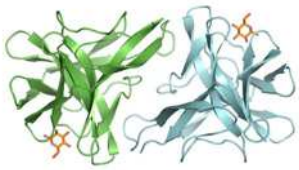
**1) Structural analysis for proteins.**

Our research targets enzyme proteins and carbohydrate-binding proteins (lectins). Using X-ray crystallography and cryo-electron microscopy, we elucidate their three-dimensional structures in detail. Through structural analysis, we further clarify the chemical reaction mechanisms catalyzed by proteins and the structural basis of protein function. Examples of proteins analyzed so far are shown below.。

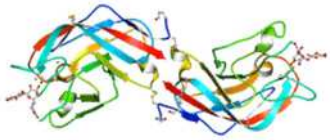
**Membrane pore-forming complex structure of the hemolytic lectin CEL-III from Cucumaria echinata (a sea cucumber)**.
CEL-III is a protein that functions as a toxin against other organisms. Through crystallographic analysis, we revealed how CEL-III perforates cell membranes and destroys cells.

**2) Discovery of novel lectins and their applications.**

Focusing primarily on marine invertebrates, we search for new lectins from these organisms. For each lectin discovered, we carry out detailed characterization—including structural analysis—to uncover its unique properties. We also work toward practical applications such as drug discovery by identifying useful activities, e.g., antiviral activity, exhibited by lectins. Examples of novel lectins discovered so far are shown below.



Lectin CGL1 from a bivalve (Pacific oyster)



Lectin AJLec from a sea anemone.

## 2. Keywords

Structural biology; biochemistry; enzymes; lectins; antiviral activity.

## 3. Remarks and Websites

Ongoing projects: protein structural analysis; discovery of novel lectins and its functional analyses.

**researchmap:** https://researchmap.jp/read0127731
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/seitai/

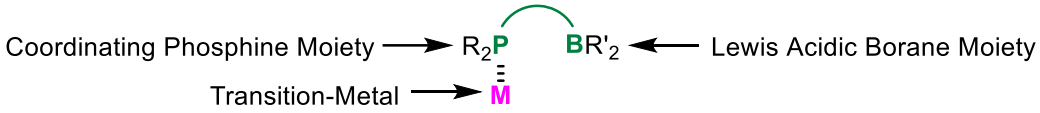
Selected Publications

H. Unno, et al., *J. Biol. Chem.* **289**(18), 12805–12812 (2014).
S. Urata, et al., *Antiviral Res.*, **240**, 16189 (2025).

| Name | Job Title | Area of Expertise |
|---|---|---|
| ONODERA Gen | Associate Professor | Organometallic Chemistry, Organic Synthesis |

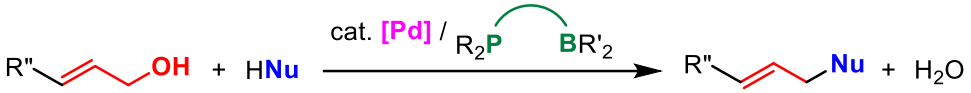
## 1. Main Research Topics

One of our research topics is the development of a novel organic synthesis method using a transition-metal catalyst bearing a Lewis acidic moiety. We designed and synthesized phosphine compounds bearing a Lewis acidic borane moiety. We have attempted to develop highly active transition-metal catalysts in which Lewis acid and transition-metal moieties can work in concert.




### ① Carbon–Oxygen Bond Activation of Allylic and Benzylic Alcohols

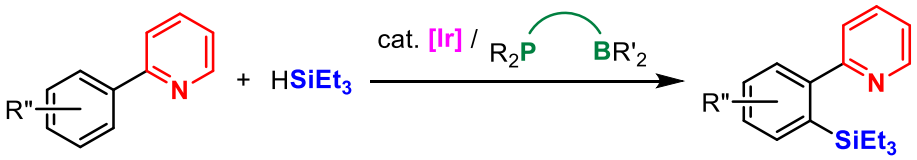
The substitution reactions of allylic and benzylic alcohols with nucleophiles (HNu) proceeded smoothly via carbon–oxygen bond cleavage using a palladium catalyst bearing a borane moiety.




References: *Org. Lett.* **2017**, *19*, 6148; *Adv. Synth. Catal.* **2018**, *360*, 1954; *Tetrahedron Lett.* **2020**, *61*, 152537.

### ② Aromatic Carbon–Hydrogen Bond Activation

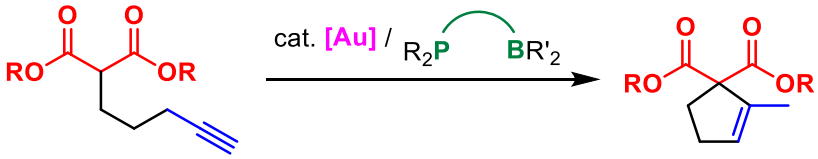
We reported that the aromatic carbon–hydrogen bond was cleaved, and hydrogen was substituted by a silyl group using an iridium catalyst bearing a borane moiety.




Reference: *Adv. Synth. Catal.* **2022**, *364*, 1223.

### ③ Dual Activation of Malonate Moiety and Alkyne Moiety

The novel cycloisomerization of a malonate derivative proceeded using a gold complex bearing a borane moiety.




Reference: *Adv. Synth. Catal.* doi.org/10.1002/adsc.70064.

## 2. Keywords

Transition-metal catalyst, Lewis acid, Organometallic chemistry, Organic synthesis

## 3. Remarks and Websites

Other research topics include the development of a novel molecular probe (in collaboration with the school of medicine) and novel organic synthesis using an external electric field.

**researchmap:** https://researchmap.jp/genonodera
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/yuuki/index.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| KAMADA Kai | Associate Professor | Inorganic Materials |

**1. Main Research Topics**

Current research focuses on the functionalities of low-dimensional ceramics (nanodots, nanowires, nanosheets), with particular emphasis on the synthesis and synergistic functions of inorganic–bio hybrid materials. In particular, we aim to create novel composite materials by chemically or physically combining ceramic nanoparticles (as inorganic components) with functional proteins such as enzymes (as biomolecular components).

Our goal is to develop materials that integrate the mechanical robustness of ceramics with the precise functionalities of biomolecules, and to construct innovative reaction systems that utilize energy transfer (light or heat) between inorganic materials and biomolecules within the composites. Additionally, we are developing new antibacterial and antiviral coating materials that leverage the bactericidal effects derived from the anisotropic shapes of two-dimensional sheet-like ceramics.

① **Photo-assisted activity control of enzyme bound to layered semiconductor**
A method has been developed to control the catalytic activity of enzymes bound to layered semiconductors by irradiating the semiconductor with light energy and transferring that energy to the enzyme. This is proposed as a novel approach to enzyme activity regulation.

② **Photocatalytic reaction of semiconductor using light energy emitted by photoenzyme or photoprotein**
By binding semiconductors to luminescent enzymes or proteins, I am developing a new photocatalytic system that does not require external light sources, using the light energy emitted by these biomolecules to excite the semiconductor.

③ **Antibacterial or antivirus coating materials based on layered ceramics**
Two-dimensional sheet-like layered ceramics possess rigid and extremely sharp fragments. I am developing liquid-based materials that form antibacterial or antiviral films by leveraging the physical impact of these fragments on microbes and viruses.

**2. Keywords**

Low dimensional nanostructured ceramics, inorganic-bio hybrids, antibacterial/antivirus coating

**3. Remarks and Websites**

**researchmap：** https://researchmap.jp/7000002048
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/nanokaimen/

| Name | Job Title | Area of Expertise |
|---|---|---|
| TAHARA Hironobu | Associate Professor | Electrochemistry, Functional Physical Chemistry |

## 1. Main Research Topics

### ① Development of Redox-Active Ionic Liquids and Functional Deep-Eutectic Solvents

Ionic liquids are salts composed of cations and anions that remain liquid at room temperature. Because they are scarcely volatile even under high-temperature or low-pressure conditions, they can be used as electrolytes without concern for evaporation. Leveraging their excellent ionic conductivity, we are developing new functional ionic liquids.

Our first focus is the creation of redox-active ionic liquids capable of reversible electron transfer. Some of these compounds exhibit electrochromism, changing color in response to their redox state. The display device shown in Fig. 1(a) employs a redox-active ionic liquid and can be colored or bleached with the voltage of a single alkaline battery.

Our second focus is the development of deep-eutectic solvents that liquefy host materials. By liquefying host molecules at high concentrations, we aim to incorporate poorly soluble guest molecules in equally high concentrations. A deep-eutectic solvent is a liquid obtained by mixing two or more high-melting-point substances, resulting in a pronounced depression of the melting point. Taking advantage of this behavior, we liquefy the host material itself, as illustrated in Fig. 1(b), to create a universal solvent capable of dissolving otherwise insoluble compounds.

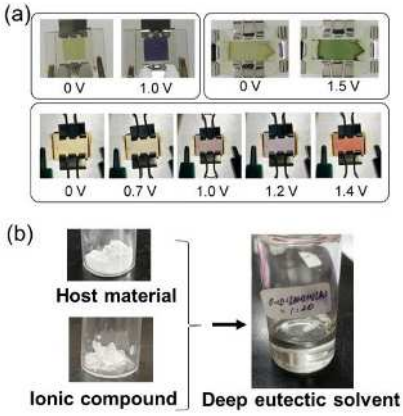



Fig. 1 (a) Coloration of electrochromic devices based on Redox-Active Ionic Liquids. (b)Deep eutectic solvent based on host material.

### ② Optical Responses of Metal and Semiconductor Nanoparticles

Metal and semiconductor nanoparticles ranging from a few to several hundred nanometers exhibit unique optical absorption and scattering phenomena known as Mie resonance and localized surface plasmon resonance (LSPR). Downsizing bulk metals, which ordinarily show only metallic luster, or semiconductors with low absorption coefficients, transforms them into materials with strong light absorption. Such nanoparticles can be applied in energy-conversion materials for photo-thermal, photo-electric, and thermo-electric technologies. We are pursuing the theoretical design of light-energy conversion and sensing materials based on nanoparticle technology.

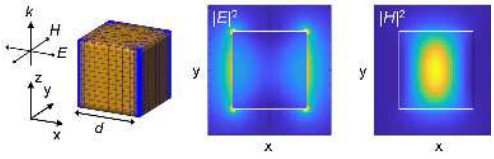



**Fig. 2 Electric field distributions around a PbS nanocube.**

## 2. Keywords

ionic liquid, electrochromism, deep eutectic solvent, surface plasmon resonance, Mie resonance, instrumental analysis

## 3. Remarks and Websites

**E-mail:** h-tahara@nagasaki-u.ac.jp
**researchmap :** https://researchmap.jp/ht_
**Laboratory:** http://www.cms.nagasaki-u.ac.jp/lab/softmater/en/index.html

We possess expertise in designing ionic liquids, synthesizing them with high purity, and engineering materials that exploit the optical resonances of noble metals and semiconductors. These efforts are underpinned by advanced analytical instrumentation and data-analysis techniques. For external users interested in the university's spectroscopic equipment, we offer technical consultation on both measurement and data analysis. If our research or capabilities align with your needs, please feel free to contact us. Offprints of our journal articles are also available upon request.

| Name | Job Title | Area of Expertise |
|---|---|---|
| DAO THI NGOC ANH | Associate Professor | Chemistry and Materials Science |

**1. Main Research Topics**

This laboratory uses a special biodegradable biopolymer, silk protein, to develop nanomedicines. Silkworm silk has a long history in the fabric industry and recently received great attention for biomedical applications. Silk protein was found to possess very potential characteristics for biomedical research, for example, stimulating cell proliferation, high biocompatibility, biodegradability and anti-inflammatory. We can produce many types of silk materials for pharmaceutical use, including nanoparticles, films, fibers, and hydrogels.

① **Creation of silk nanoparticles as a versatile drug carrier**

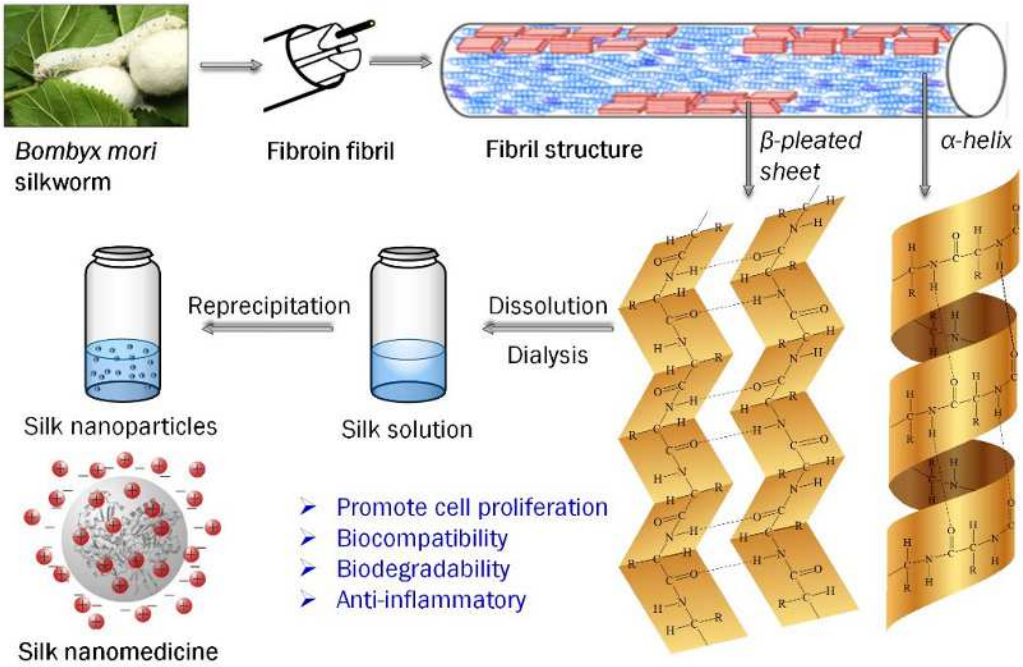
In this study, we aim to develop methods to fabricate silk nanoparticles with tunable surface charges and secondary structures for a wider range of drug applications with drug control release.

② **Multi-functionalized silk nanomedicine**

With the complexity of cancer and its treatments, it is essential for expanding the functionalities of silk nanoparticles to improve pharmaceutical effectiveness, including active targeting, imaging, and controlled drug release. In this research, we modify silk protein and its materials with various agents to enhance their functionalities in drug delivery.

③ **Silk hydrogel and film for localized cancer therapy**

Chemotherapy is a routine clinical practice for treating high-grade malignant glioma, but local chemotherapy for delivering therapeutic payloads effectively and sustainably is still in pre-clinical development. Silk hydrogel and film has been demonstrated to be well-tolerated *in vivo* with minimal inflammation or host immune response when implanted directly into tissues.




**2. Keywords**

nanomaterials, polymer chemistry, drug delivery, biosensors, cancer therapy

**3. Remarks and Websites**

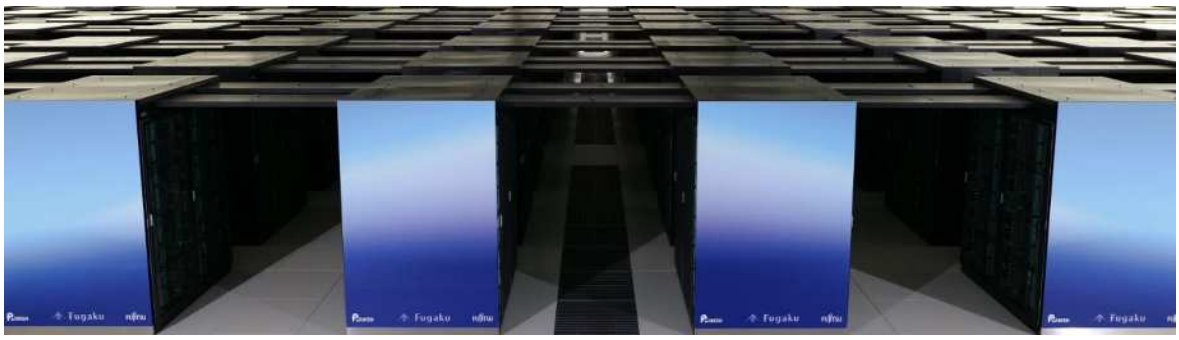
We are conducting research using funding from competitive and collaborative research funds, such as the Japan Society for the Promotion of Science's Grant-in-Aid for Scientific Research B (until FY2029 and the JGC-Saneyoshi Scholarship Foundation's Research Grant (until FY2025).

Research is a great way to contribute to society, while you can have fun discovering the secrets of the universe. We conduct various interesting studies using biopolymers and we welcome your participants.

**researchmap:** https://researchmap.jp/anhdao
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/kobunshi/

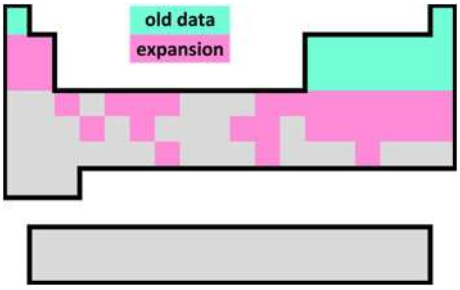
| Name | Job Title | Area of Expertise |
|---|---|---|
| CHAN Bun | Associate Professor | Quantum Mechanics, Computational Chemistry, Chemical Data Science |

## 1. Main Research Topic



Our research involves the use of high-performance computers for quantum chemistry. We develop new methods to accelerate the simulations, to model a wide range of chemical and materials systems. Such modellings are often conducted in collaboration with experimentalists, providing knowledge at the electronic level to develop new technologies. Below you will find a few examples of our work.

(1) High-precision quantum chemistry methods are traditionally applicable only to a limited range of chemicals, covering a small portion of the periodic table. We have developed a series of quantum chemistry methods to expand the scope of high-precision prediction, to provide reliable data for machine learning in chemistry.




- Chan, B. Accurate Thermochemistry for Main-Group Elements up to Xenon with the W*n*-P34 Series of Composite Methods. *J. Chem. Theory Comput.* **2021**, *17*, 5704.
- Chan, B. Compilation of Ionic Clusters with the Rock Salt Structure: Accurate Benchmark Thermochemical Data, Assessment of Quantum Chemistry Methods, and the Convergence Behavior of Lattice Energies. *J. Phys. Chem. A* **2023**, *127*, 5652.

(2) In a collaboration with several international research teams, we apply quantum chemistry to clarify structural features that leads to luminesce in a new type of glass materials.

- Hou, J.; Chen, P.; Shukla, A.; Krajnc, A.; Wang, T.; Li, X.; Doasa, R.; Tizei, L. H. G.; Chan, B.; Johnstone, D. N. et al. Liquid-Phase Sintering of Lead Halide Perovskites and Metal-Organic Framework Glasses. *Science* **2021**, *374*, 621.

## 2. Keywords

Quantum chemistry
Chemical physics
Molecular biology
Materials science
Chemical data science

## 3. Remarks and Website

**researchmap:** https://researchmap.jp/el_buno
**Laboratory:** https://sites.google.com/view/bunchan
**Google scholar:** https://scholar.google.com/citations?user=URuEgEoAAAAJ&hl=en

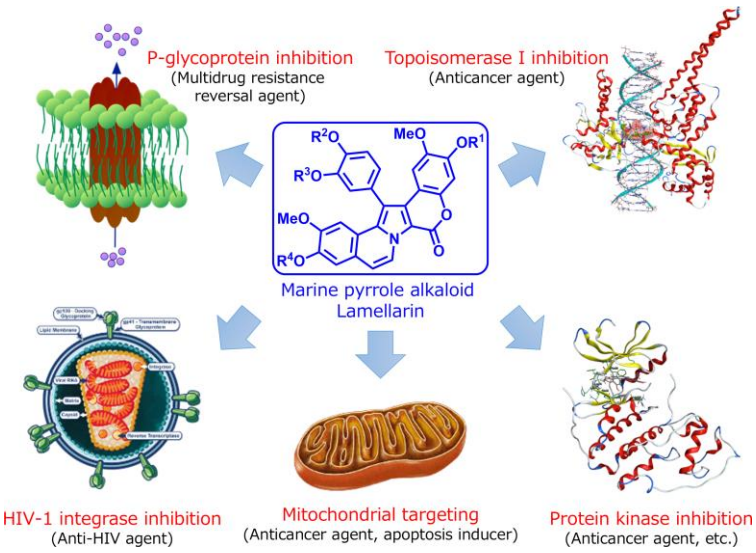
| Name | Job Title | Area of Expertise |
|---|---|---|
| FUKUDA Tsutomu | Associate professor | Synthetic Organic Chemistry |

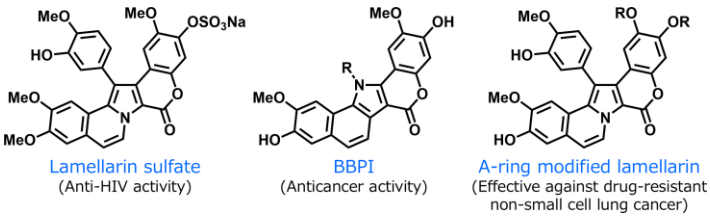
## 1. Main Research Topics

### ① Development of bioactive compounds based on marine natural products

Marine natural products contain a wide variety of bioactive compounds that are highly valuable for drug discovery. Our research focuses on the marine natural product "lamellarin," aiming to develop novel pharmacologically active compounds by leveraging its unique structure and biological activities.

Lamellarin was first isolated in 1985 by Faulkner and co-workers from a marine mollusk, *Lamellaria* sp. To date, over 70 related compounds have been reported. These compounds exhibit diverse biological activities, including topoisomerase I inhibition, protein kinase inhibition, and anti-HIV activity, making them promising candidates for pharmaceutical research.




We have developed several derivatives, including lamellarin sulfate with anti-HIV activity, BBPI with anticancer activity based on topoisomerase I inhibition, and A-ring modified lamellarin effective against drug-resistant EGFR C797S mutant non-small cell lung cancer.

Selected publications: *Biosci. Biotechnol. Biochem.*, **87**, 148 (2023); *Viruses*, **14**, 816 (2022); *Cancer Sci.*, **112**, 1963 (2021); *Bioorg. Med. Chem.*, **34**, 116039 (2021); *Biosci. Biotechnol. Biochem.*, **85**, 181 (2021); *Bioorg. Med. Chem.*, **27**, 265 (2019)

### ② Development of synthetic methods for drug discovery

To realize the above research, efficient synthetic methods are essential. Lamellarin features a polycyclic heterocyclic structure containing a pyrrole ring. We are developing a modular synthesis method that enables the introduction of functional modules into the pyrrole ring, serving as a foundational technology for drug discovery.

Selected publications: *Heterocycles*, **103**, 862 (2021); *Heterocycles*, **99**, 1032 (2019); *Heterocycles*, **98**, 916 (2018)

## 2. Keywords

Lamellarin, Heterocyclic compounds, Antitumor active compounds

## 3. Remarks and Websites

Lamellarin derivatives are expected to be applied as antitumor agents. We are currently conducting collaborative research with other institutions to explore their potential applications in cancer therapy. The synthetic methods we have developed are applicable to a wide range of heterocyclic compounds containing pyrrole rings and are expected to contribute to the development of pharmaceuticals and functional materials.

**researchmap:** https://researchmap.jp/t-fukuda
**Laboratory:** http://www.cms.nagasaki-u.ac.jp/lab/yuuki/

| Name | Job Title | Area of Expertise |
|---|---|---|
| YAMADA Hirotoshi | Associate Professor | Solid State Electrochemistry |

## 1. Main Research Topics

**Development of all-solid-state batteries (ASSBs)**

To practically realize all-solid-state batteries (ASSBs), which are the candidates of next-generation batteries, our group focuses on materials, processes, and designs of ASSBs. We have developed technologies to fabricate bulk-type ASSBs using oxide-based solid electrolytes and demonstrated that the ASSBs can be operated at room temperature. We further study the multiscale phenomena in the range from atoms/ions to whole ASSBs, in order to improve the battery performances like power density and cycle-ability, etc.

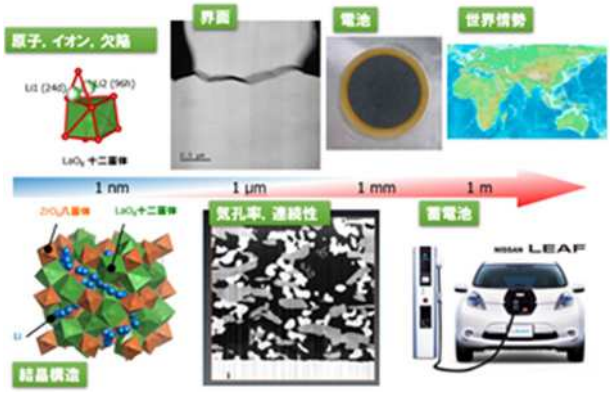



Figure Phenomena and their scales on the development of ASSBs.

**1. Preparation of electrochemically active interface between active materials and solid electrolytes.**

We develop methods to fabricate interfaces between active materials and solid electrolytes, which consists of different elements in each phase. Such interfaces must be densely packed without element interdiffusion. We carry out fundamental studies on the phenomena at the interfaces, which leads designs ideal electrode architectures and processes. The materials, architecture, and processes are simultaneously optimized.

Ad ditionally, we also focuses on mechanical properties of ASSBs, because the ASSBs contain internal stresses and strain caused by the fabrication and battery operation. Such strain induces fracture of interfaces in the ASSBs, which causes deterioration of battery capacity. We investigate the strain and the fracture of interfaces buried inside the ASSBs and improve cycle- ability of ASSBs.

**2. Development of all-solid-state lithium metal batteries.**

Lithium metal is known as ultimate anode because of its low electrode potential and large capacity. However, it is very difficult to reversibly charge/discharge lithium metal anode. We investigate causes of the difficulty and develop lithium metal anodes with high capacity, high power and high cycle-ability.

**3. Study of influence of local structure of solid electrolytes on their ionic conduction.**

Highly conductive solid electrolytes are necessary to fabricate practical ASSBs. We investigate influence of the local structure of solid electrolyte crystals on their ionic conduction and develop new solid electrolytes.

## 2. Keywords

All-solid-state batteries, solid electrolytes, interface

## 3. Remarks and Websites

We carry out whole studies on oxide-based ASSBs from the viewpoint of materials, processes, and architectures. The fields of the studies are widely spread in the multi-discipline sciences not only on solid state chemistry and electrochemistry but also analytical chemistry and material mechanics.

**researchmap:** https://researchmap.jp/0000-0003-0733-6992
**Group website:** https://www.cms.nagasaki-u.ac.jp/lab/bukka/B/

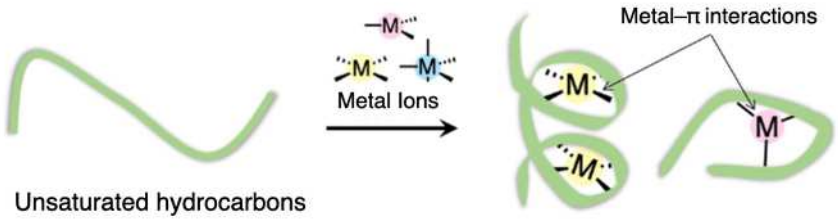
| Name | Job Title | Area of Expertise |
|---|---|---|
| OMOTO Kenichiro | Assistant professor | Coordination Chemistry<br>Supramolecular Chemistry |

**1. Main Research Topics**

My research focuses on the construction of supramolecular metal complexes—metal complexes with unique higher-order structures such as helices, rings, and sheets—by utilizing coordination bonds formed around metal ions to fix and assemble organic molecules. In particular, I aim to develop novel types of supramolecular metal complexes based on flexible coordination bonds that have not been widely exploited, such as metal–metal bonds and metal–π interactions. Furthermore, by integrating molecular design concepts from soft materials such as biological membranes and liquid crystals, I aim to create stimuli-responsive materials that combine both rigidity and flexibility.

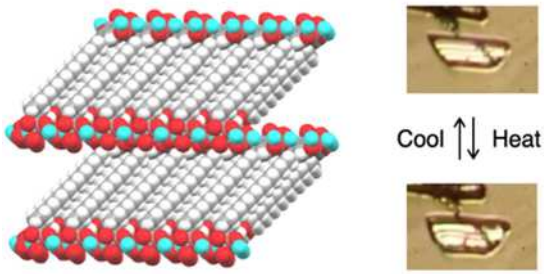
① **Metal-mediated folding of unsaturated hydrocarbons**

Several metal ions, such as Ag(I), are known to form coordination bonds (metal–π interactions) with C=C bonds of unsaturated hydrocarbons. In this study, I aim to develop methods for controlling and fixing the 3D structures of linear hydrocarbons bearing multiple C=C units through complexation with metal ions via metal–π interactions. The resulting complexes are expected to exhibit metal-dependent stereochemical structures and corresponding reactivities.




② **Development of Stimuli-Responsive Coordination Polymers via Incorporation of Soft Molecular Assemblies**

I am exploring the design of stimuli-responsive crystalline materials by incorporating soft molecular assemblies—such as those found in lipid bilayers and liquid crystal compounds—into the crystalline structures of coordination polymers. In particular, by embedding long alkyl chains into coordination polymers, I aim to induce thermal phase transitions within the crystal lattice, thereby enabling the control of small molecule adsorption/desorption and molecular transport in response to external stimuli.




**2. Keywords**

Supramolecular chemistry/Host–guest chemistry/Coordination chemistry/Coordinationpolymers

**3. Remarks and Websites**

**researchmap**：https://researchmap.jp/omoto_kenichiro
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/sakutai/
**Project**：KAKENHI, Grant-in-Aid for Scientific Research (C), JP23K04768

In Research Project 1, I aim to pioneer new possibilities in the development of novel reactions and photofunctional materials based on linear unsaturated hydrocarbons and metal clusters. Research Project 2 explores potential applications such as gas adsorption materials by utilizing the crystalline structures of metal complexes.

| Name | Job Title | Area of Expertise |
|---|---|---|
| TSUGAWA Tatsuki | Assistant Professor | Inorganic Materials Chemistry |

## 1. Main Research Topics

2D materials possess a high aspect ratio relative to their molecular-scale thickness and exhibit unique properties distinct from those of conventional bulk materials. These characteristics enable structural control and functional design at the nanoscale, and are expected to be applied in a wide range of applications, including next-generation electronic devices, electrodes, and sensors. In this study, we focus on the development of graphene oxide (GO) –based materials and promote research ranging from fundamental studies to applications in the environmental and energy fields.

### ① Functionalization of Graphene Oxide via Control of Oxygen Functional Groups

GO is obtained by oxidizing graphite powder followed by exfoliation into single layers (Fig. 1). This material contains various oxygen functional groups, such as hydroxy, epoxy, carbonyl, and carboxy groups, which impart diverse properties. In this study, we aim to develop high-performance functional materials by controlling the composition of oxygen functional groups introduced during the oxidation process, thereby optimizing the material properties according to specific applications.


Fig. 1 Flowchart for the synthesis of GO

### ② Development of Multifunctional Membranes Using 2D Materials

2D materials, including GO, exhibit excellent dispersibility in solvents and enable the formation of uniform, large-area film formation via solution processes such as spin coating and vacuum filtration. Furthermore, by controlling defect density, interlayer spacing, interfaces, and the degree of oxidation/reduction, it is possible to impart a variety of functionalities, including selective permeability for molecules and ions, superior barrier property, proton conductivity, and electrical conductivity.

In this study, we design and laminated membranes based on these 2D materials, aiming not only to achieve high selectivity in ion and gas separation membranes, but also to develop anticorrosion coating films, transparent conductive films that combine optical transparency and electrical conductivity, and solid electrolyte membranes for high-performance fuel cells (Fig. 2). Through these efforts, we aim to contribute to the development of high-performance devices in the environmental and energy fields.

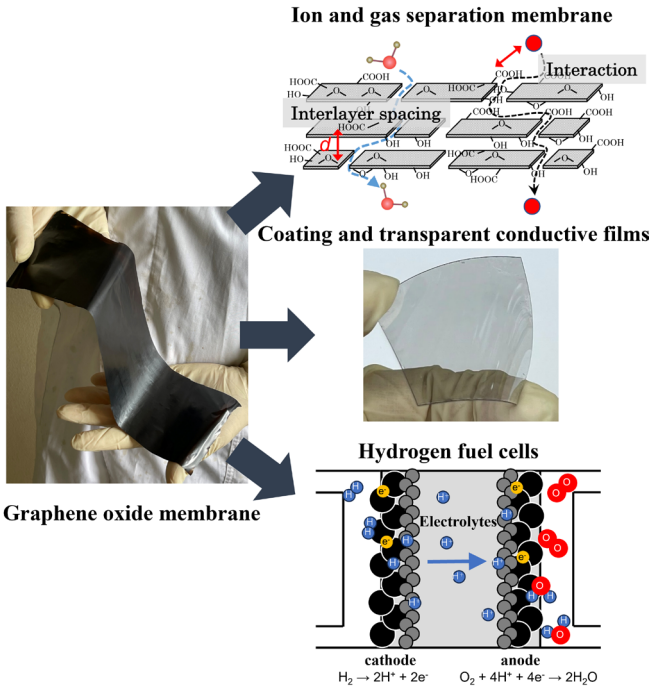



Fig. 2 Applications of GO membranes

## 2. Keywords

Graphene oxide, 2D materials, Proton conductivity, Barrier membrane, Separation membrane, Transparent conductive film, Hydrogen fuel cells

## 3. Remarks and Websites

We focus on the functionalization of graphene oxide through nanostructure control, integrating material synthesis, structural characterization, property evaluation, and device applications. We aim to advance sustainable carbon materials science and promote practical implementation in the environmental and energy sectors through industry collaboration.

**researchmap:** https://researchmap.jp/21039357-TSUGAWA

**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/zaika/zak.htm

| Name | Job Title | Area of Expertise |
|---|---|---|
| NAKAGOE Osamu | Assistant Professor | Surface Chemistry, Catalytic Chemistry |

**1. Main Research Topics**

① **Preparation of Cu nanoparticle loaded $TiO_2$ photocatalyst and improving photocatalytic activity for water splitting**

Photocatalytic hydrogen formation from water splitting reaction is the one of the most attractive topics for sustainable energy supply because of zero carbon emission process. However, the hydrogen formation has not been applied in industrial process due to its slow rate of the photocatalytic water splitting reaction. Especially, $TiO_2$, which is one of the most popular photocatalyst is inefficient and impractical for commercial application to photocatalytic hydrogen formation without modification of cocatalyst such as noble metal, although it is abundant, cost effective, and clean for environment on account of lacking of ionic leaching with self-oxidation. Noble metal, such as Pt, Au, and Rh, loading to $TiO_2$ can improve photocatalytic performance. Instead of Pt, Cu is good candidate for cocatalyst of $TiO_2$ because it has a pretty low cost compared to Pt, less than 1/3000 and about half of photocatalytic performance. Moreover, tuning size, oxidation state, and shape of Cu nanoparticle on $TiO_2$ improve photocatalytic performance owing to adjustment of its electronic properties, such as energy level, work function etc.

In this study, size tunable Cu nanoparticles were prepared by thermal reduction process of Cu precursor with amino-2-propanol (AmIP) as surfactant. The ratio between AmIP and $Cu^{2+}$ determined size of nanoparticle. Cu loaded $TiO_2$ catalysts ($Cu/TiO_2$) were obtained with impregnation method. As the result of photocatalytic water splitting reaction, as prepared catalysts had 1/3 the rate of hydrogen formation of Pt. It is expected that optimization of size and loading amount of Cu lead to enhance the rate of hydrogen formation.

② **Synthesis of CaO fine particle and application in Biodiesel fuel catalyst**

Biodiesel fuel (BDF), a substance defined as fatty acid methyl ester, is already required in the EU as a 10% or greater component of fuel for public transportation. BDF is produced by transesterification of fats and oils with methanol, using a homogeneous sodium methoxide as a catalyst. While sodium methoxide is highly active, there are disadvantages for washing BDF with water, including the removal of alkaline wastewater and the production of soap as a side reaction. In contrast, the use of solid base catalysts omits the water washing process. However, calcium oxide, a commonly used solid base, has a large particle size and low specific surface area, resulting in a significantly low reaction rate than homogeneous solution catalysts. Therefore, we synthesized 50-nm calcium oxide particles, approximately one-twentieth the size of those produced by conventional alkaline precipitation methods, in a polyacrylic acid solution. In this synthesis, a calcium carbonate precursor was formed within a random coil of size-controlled polyacrylic acid, and nanoparticles were then obtained by thermal decomposition in vacuum. So far, polyacrylic acid used as a template has been removed by oxidation in air, but by using accelerated oxidation removal using a combination of ozone and hydrogen peroxide, we aim to suppress particle growth and further improve performance.

**2. Keywords**

Heterogeneous catalysis, nanoparticle, nanocomposite, photocatalyst, solid state acid base catalyst

**3. Remarks and Websites**

I can prepare metallic and oxide nanoparticle, nanocomposite, and porous material it for heterogeneous catalyst and adsorbent since my research subject is surface chemistry and catalytic chemistry. Actually, I have collaborated photocatalytic application in water treatment with a private company.

**researchmap:**

**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/nanokaimen/

| Name | Job Title | Area of Expertise |
|---|---|---|
| NOTOHARA Hiroo | Assistant professor | Electrochemistry, Nanostructural Analysis |

## 1. Main Research Topics

Elucidation of charge-discharge mechanisms in carbon nanospaces.

With the expanding range of applications for energy storage devices, there is an increasing demand for higher performance secondary batteries. In lithium-ion secondary batteries, it is particularly important to develop electrode materials that can stably operate with high-capacity active materials such as Sn and $SnO_2$. It is known that when electrode active materials are supported within carbon nanospaces, they exhibit charge-discharge characteristics different from those in the bulk state and achieve high charge-discharge reversibility. However, the detailed mechanisms underlying these phenomena are not yet fully understood.

Our research group has been synthesizing composites in which electrode active materials are loaded within carbon nanospaces. In addition to conventional structural analyses such as XRD and SEM, we have been investigating the structure and charge-discharge mechanisms of these materials at the nanoscale by combining techniques such as gas adsorption isotherm measurements, scanning transmission electron microscopy (STEM), and electron energy loss spectroscopy (EELS).

In our recent studies, we elucidated the structural changes that occur during charge-discharge processes within nanospaces by STEM. We demonstrated that when $SnO_2$ nanoparticles are supported in the inner space of single-walled carbon nanotubes, the structural changes during charge-discharge differ from those of a bulk $SnO_2$ particle (see figure).

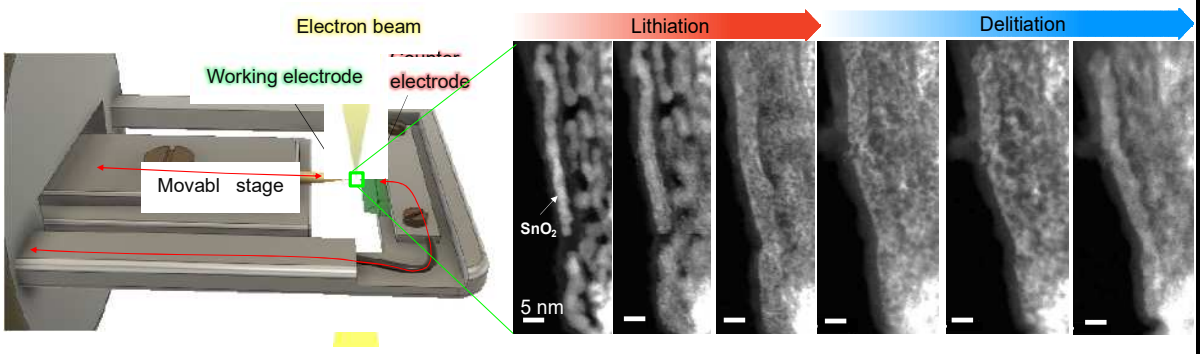



Fig. a) Schematic images of battery setup on TEM holder for in-situ STEM observation, b) Snapshots of STEM images of SnO2 embedded single-walled carbon nanotubes during initial lithiation and delithiation process.

## 2. Keywords

All-solid-state battery, Nanoporous carbon, nanoparticle/porous carbon composite, in-situ STEM

## 3. Remarks and Websites

My research interest lies in elucidating unique phenomena originating from nanostructures, not limited to battery materials. I hope to uncover the underlying mechanisms and apply these findings to broader technological developments.

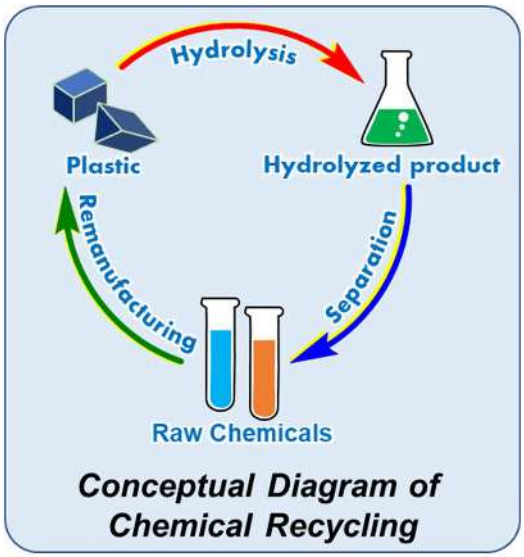
**researchmap:** https://researchmap.jp/notohara?lang=ja
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/bukka/A/top.html

| Name | Job Title | Area of Expertise |
|---|---|---|
| MOTOKUCHO Suguru | Assistant Professor | Polymer Chemistry, Environmental Materials Science |

## 1. Main Research Topics

### Chemical Recycling of Polyurethane

Currently, chemical recycling of polyurethane (PU) products remains a major challenge. Conventional degradation methods often suffer from uncontrollable side reactions, making it difficult to recover the original raw materials in high yield. As a result, practical implementation of closed-loop or horizontal recycling—where recycled materials are used to produce products of the same quality—has not yet been realized.



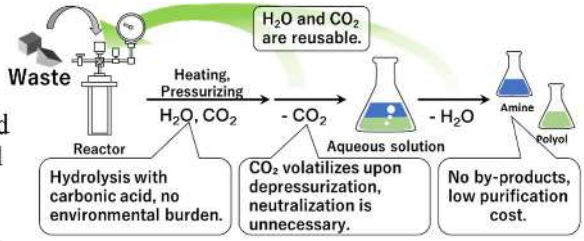
Conceptual Diagram of Chemical Recycling

In this study, we have developed a novel depolymerization process that uses carbonic acid, generated from water and carbon dioxide, as a catalyst. This method enables the quantitative recovery of reusable amines and polyols from model polyurethane without forming any unwanted byproducts.

Key features of our process include:

- Use of carbonated water as the catalyst—extremely low environmental impact
- Carbon dioxide naturally evaporates after the reaction, eliminating the need for a neutralization step
- The reaction proceeds under mild conditions, close to room temperature and atmospheric pressure

We have further applied this technique to commercial polyurethane foam (PUF) products with practical formulations. Using the recovered amines and polyols, we successfully regenerated PUF, thereby achieving complete horizontal recycling of polyurethane materials.




This research not only contributes to sustainable materials circulation, but also provides a highly practical technological platform for companies aiming to develop environmentally friendly products and reduce production costs.

## 2. Keywords

Chemical Recycling, Polyurethane, Carbon Dioxide, Building a Sustainable Society

## 3. Remarks and Websites

**Patents**

WO2025017988A1 Method for polyurethane foam

**Topic**

https://www.pu-forum.com/en/lecturers/#session2

**researchmap** : https://researchmap.jp/motokucho
**Laboratory** : https://www.cms.nagasaki-u.ac.jp/intro/organization.htm

| Name | Job Title | Area of Expertise |
|---|---|---|
| YAMAMOTO Masataka | Assistant Professor | Materials Science of Metals |

**1. Main Research Topics**

① **Balancing electrical conductivity and mechanical strength in Copper alloys**

With the recent advancement of electronic devices, the development of high-performance copper alloys, which serve as the base material, has become an important technology. In particular, the development of copper alloy wires with higher strength and conductivity is desired for applications such as lead wires, conductive spring materials, and DVD pickup wires. Generally, there is a trade-off between the conductivity and strength of copper alloys. The copper alloy currently in use is Cu-Be (copper-beryllium) alloys, but concerns about the toxicity of beryllium and its environmental impact have raised the need for alternative materials. I am focusing on Cu-Ti (copper-titanium) alloys, which have lower conductivity than Cu-Be alloys, and conducting research on techniques to improve conductivity while maintaining strength. Specifically, I am investigating the effects of adding third elements and aging heat treatments on the conductivity and strength of Cu-Ti alloys.

② **Fabrication of lightweight, high-strength metal-based composite materials**

One of the important issues to meet the demand for energy saving is to reduce the weight of transportation equipment. We are working on the development of metal-based composite materials with high strength by combining aluminum alloys and magnesium alloys with ceramic fibers and particles such as silicon carbide and alumina. In order to achieve the ideal strength, it is necessary to reduce casting defects. The purpose of this study is optimization of the casting process for fabricating the ideal metal-based composite materials.

③ **Increasing the strength and workability of magnesium alloys**

Magnesium is the lightest of all practical metals, but its low strength makes it unsuitable for use as a structural material. Furthermore, increasing its strength reduces its workability, limiting its range of application to small components. To resolve this dilemma, I am working to refine the crystal grains of magnesium alloys by devising casting methods, aiming to achieve both strength and workability.

**2. Keywords**

Copper alloy, Electrical conductivity, Mechanical strength, Magnesium alloy, Crystal refinement

**3. Remarks and Websites**

Although copper has a longer history than iron, systematic knowledge about the mechanisms of precipitation strengthening and electrical conductivity has yet to be developed. With the trend toward more advanced electrical equipment in automobiles and smaller electronic devices, the results of this research are expected to make a significant contribution to these areas.

**researchmap:** https://researchmap.jp/-ym
**Laboratory:** https://www.cms.nagasaki-u.ac.jp/lab/soshiki/

| Name | Job Title | Area of Expertise |
|---|---|---|
| CHANG Ying Shi | Assistant Professor | Chemical Engineering |

## 1. Main Research Topics

**① Nutrient recovery and water purification from aquaculture wastewater**

Recovering ammonia ($NH_3$) and phosphate ($PO_4^{3-}$) nutrients from aquaculture wastewater is a sustainable method for waste valorization. Conventional biological treatments are inefficient, often removing rather than recovering $NH_3$ while generating substantial $PO_4^{3-}$-rich sludge, consuming significant time, energy, and space. This research aims to intensify a sustainable vacuum membrane distillation (VMD) system to transform aquaculture wastewater into valuable resources and purified water (**Fig. 1**). Our goal is to achieve high-value nutrient recovery by concentrating $PO_4^{3-}$ up to 10-folds and simultaneously recovering >90% of $NH_3$ in highly concentrated forms, suitable for agricultural N-P fertilizer production, and purified water production for reuse within the aquaculture system or for drinking or irrigation purposes. The effect of operating parameters such as feed temperature, pH, and phosphoric acid concentration as an $NH_3$-absorbing medium will be evaluated and optimized for $NH_3$ recovery. Further, feed temperature and crossflow velocity will be optimized to maximize $PO_4^{3-}$ concentration and purified water yield. In addition, the fouling mechanism of VMD membrane towards complex aquaculture wastewater matrix, and the necessity of wastewater pretreatment will be elucidated. Overall, the research outcomes are expected to enhance circular aquaculture economy by transforming waste into valuable products, directly contributing to both environmental sustainability and improved water security.

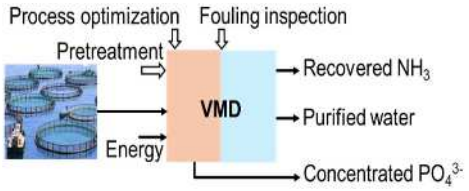



**Fig 1.** Overview of the research and targeted products

**② Perfluoroalkyl substance remediation**

Pre-concentrating perfluoroalkyl substances (PFAS) from contaminated water is a crucial step for their effective downstream destruction. Previous research by the applicant demonstrated that direct-contact membrane distillation (DCMD) using a commercial polyvinylidene fluoride (PVDF) membrane can pre-concentrate PFAS, however, surfactant-like PFAS fouled and diffused through the membrane, contaminated the permeate. This proposal aims to develop a novel amphiphobic PVDF surface-modified with silanized nanoparticles, designed to repel both surfactant and water (**Fig. 2**). Enhanced PFAS pre-concentration and water recovery will be achieved using optimal nanoparticle concentration and process conditions. The viability of the modified membrane performance will be assessed using real PFAS-contaminated groundwater. The research outcomes are expected to advance PFAS remediation, promote zero waste discharge, and enhance water security.

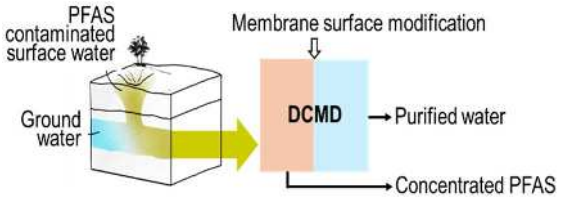



**Fig. 2** PFAS-contaminated groundwater remediation through DCMD

## 2. Keywords

Membrane separation, water and wastewater treatment, resource recovery, desalination, process engineering, membrane development

## 3. Remarks and Websites

**Future prospects and social implementation**

My research aims to revolutionize wastewater management by transforming pollutant streams into valuable resources. We develop scalable membrane technologies for broad commercial deployment, directly applicable to diverse wastewater matrices. These solutions empower operations of all scales, from small to large industrial facilities, to minimize effluent discharge, optimize resource recovery, achieve regulatory compliance, and fully embrace circular economy principles.

**On-going research funding**:

(1) KAKENHI Research Start up Support Project (FY2024–2025)
(2) KAKENHI Young Scientist Research Project (FY2025–2027)

**researchmap:** https://researchmap.jp/ChangYingShi

**Laboratory:** Water Treatment Laboratory https://www.waterenviron.com/home

| Name | Job Title | Area of Expertise |
|---|---|---|
| SANO Hideaki | Research associate | Inorganic Materials |

## 1. Main Research Topic

### ① Synthesis of alloys and composites from glycol derivative metal compounds

A glycol-derived metal compound has been developed as a complementary or alternative material to conventional metal alkoxides, enabling the facile synthesis not only of pure metals and ceramics, but also of alloys and composite materials.

Generally, metal alkoxides exist as solids or liquids at room temperature and become gaseous upon thermal decomposition, which makes it difficult to control the composition and morphology of the resulting metals or ceramics. In contrast, this glycol-derived metal compound remains solid even at high temperatures during thermal decomposition, allowing for easier shape control. By adjusting the decomposition atmosphere, it is possible to selectively produce metals, carbides, nitrides, or oxides. For example, YAG:$Ce^{3+}$ phosphor ceramics, which typically require high-temperature sintering around 1600°C, can be prepared at a relatively low temperature of 1300°C (see Fig. 1).

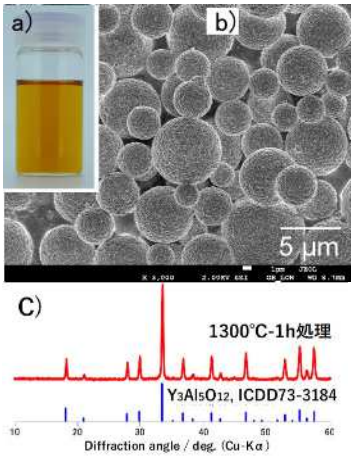



Fig.1 Prepared metal-containing glycol-derived solution (a), YAG:$Ce^{3+}$ phosphor ceramics fabricated using porous spherical PMMA particles heat-treated at 1300℃ for 1h (b) and X-ray diffraction profile of the ceramics (c).

### ② Research of the efficient reaction process by interface control

We are working on efficient reaction processes to produce desired oxide and non-oxide ceramics using low temperatures and short firing times, with minimal energy. To achieve this, we are developing methods that use nitrogen-containing monomers to help reduce and nitride the materials. We are also exploring ways to improve reactions by using templates with large surface areas, which allow more effective contact between materials. This technology is being applied to areas such as dental materials and carbon materials made from biomass.


1) S. J. Shi, V. Sivasankar, K. Omine, J. Li, H. Sano and M. Ahmed. 2025. “Immobilization of Microorganisms Using Carbon Carriers – Promoting the Reduction of Cr (VI) in the Cement Leachate.” *Sustainable Materials and Technologies* **45**(March): e01478. doi:10.1016/j.susmat.2025.e01478.
2) P. Z. W. M. Moh, O. Nakagoe, N. N. Hlaing, Y. Tabuchi, K.Kamada, H. Sano, and S. Tanabe. 2024. “Role of Mn in the Ni-Mn/SBA-15 Catalyst for Hydrogen Production by Biomass Steam Reforming at Relatively Low Temperature.” *Journal of Physical Chemistry C* **128** (18): 7518–28. doi:10.1021/acs.jpcc.4c00613.
3) H. Sano, K. Omine, M. Prabhakaran, A. Darchen and V. Sivasankar, “Groundwater fluoride removal using modified mesoporous dung carbon and the impact of hydrogen-carbonate in borehole samples”. *Ecotoxicology and Environmental Safety*, **165**, 232–242 (2018). doi.org/10.1016/j.ecoenv.2018.09.001


## 2. Keywords

Glycol derivatives, metals / alloys, carbides, nitrides, oxides, composites, shape control

## 3. Remarks and Website

We actively engage in collaborative research not only with other departments and courses within the Faculty of Engineering, but also with private companies. Our main research focus is on the development of materials related to metals and ceramics, both in nano and bulk forms. Thanks to access to many shared research instruments at Nagasaki University (https://nushare.ura.nagasaki-u.ac.jp/index.php), we also conduct joint research projects that focus solely on material evaluation.

Looking ahead, we plan to build a more efficient framework for materials development using materials informatics and artificial intelligence (AI). Beyond the traditional boundaries of our laboratory, we support external research needs by utilizing the inter-university equipment network (https://chem-eqnet.ims.ac.jp/). Our current projects include the development of equipment and control/analysis software for catalytic reactions related to $CO_2$ fixation, as well as fatigue testing systems for dental implants.

**researchmap**：https://researchmap.jp/quasers/

School of Engineering, Nagasaki University

# RESEARCH PROFILES

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