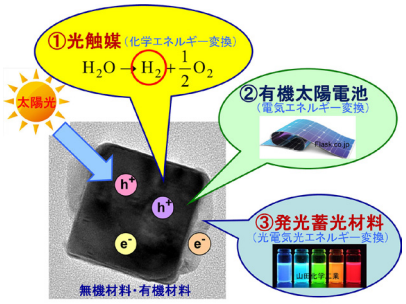
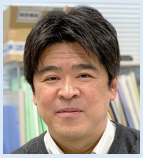
Innovative Chemistry

Department of Chemistry

Surface Physical Chemistry



Photocatalysts have attracted considerable attention due to their potential applications for water-splitting to generate hydrogen gas by using solar energy. As H2 is clean and free from CO2 emissions, photocatalysts are expected to address many problems such as the energy crisis, environmental pollution, and global warming. However, the efficiency of photocatalysis is still not sufficient for industrial use; hence, further activity enhancement is required. The efficiency of photocatalysis is determined by the competition between electron-hole pair recombination and the rate of charge transfer to the reactant molecules. Therefore, we are studying the behaviors of photogenerated charge carriers to elucidate the mechanism. These researches should shed light on the development of highly efficient solar light driven water splitting photocatalysts.

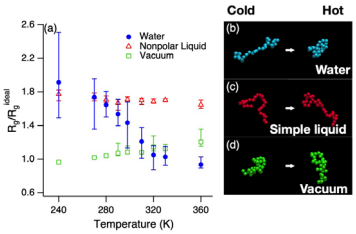


Prof. YAMAKATA Akira

■Research Themes

photocatalysis/solar cells/ ultrafast laser spectroscopy/ reaction dunamics

Theoretical Physical Chemistry



By using theoretical approaches such as statistical mechanics, thermodynamics, and molecular simulation, we are tackling a wide range of research issues related to liquids, solutions, interfaces, phase transitions, polymers, proteins, viruses, and cells. The latest research topics include solute size dependence of hydrophobic interactions, solubility of solutes, effective interactions, ion-specific effects on phase separation, structure of interfaces near the triple critical point of three-phase equilibrium systems, structural stability of proteins, co-solvent effects on proteins, and design principle of biological molecular motors and their efficiency of the free energy transduction, etc.

Prof. KOGA Kenichiro

■Research Themes

Interface/Nano-confined system/ Wetting transition/Phase transition/ Solvent-induced interaction/ Hydrophobic interaction/Aqueous solution/Ion-specific effect

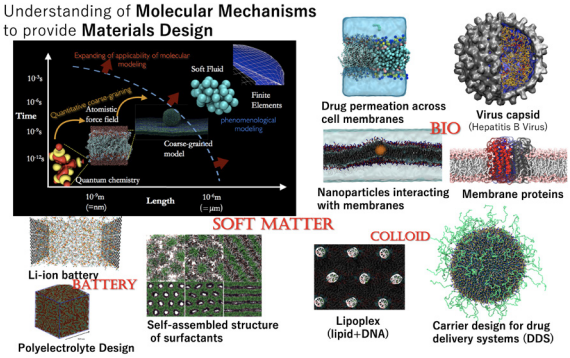
Assoc. Prof. SUMI Tomonari

■Research Themes

Liquids and solutions/Liquid state theory/Protein science/Biophysics/ Theoretical biology

Theoretical and Computational Chemistry

We use molecular simulation techniques to understand and predict various functions of molecules and molecular assemblies such as lipid membranes, aiming to inform the design of new materials. In order to tackle technical issues in bio- and soft-materials, we utilize multiscale molecular modeling, ranging from sub-atomic scales of quantum mechanics, to the coarse-grained molecular level, reaching to the micron scale. By developing these simulation techniques and applying them to contemporary problems, we expand the frontiers of molecular simulations.

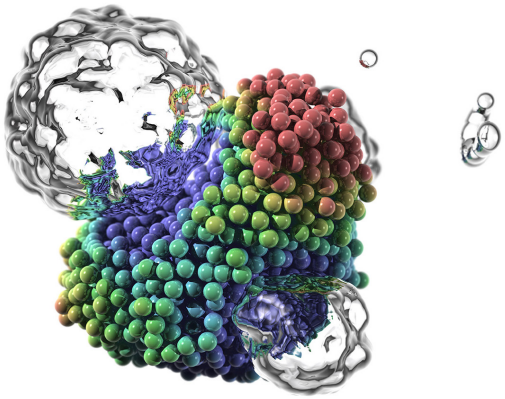


Prof. SHINODA Wataru

■Research Themes

computational chemistry/molecular simulation/ biomembranes/lipid membranes/biomolecular self-assembly/soft materials

Theoretical Chemistry

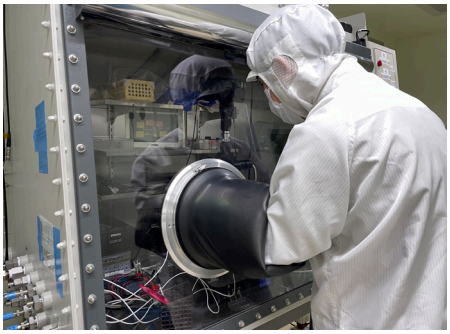


We use computer simulations and statistical mechanics theory to explore the unusual properties of water and ice.

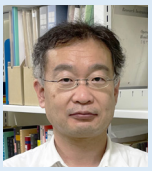
Assoc. Prof.
MATSUMOTO Masakazu

■Research Themes
theoretical chemistry/molecular dynamics/science of water and ice

Quantum Physics in Condensed Matter



The objective of our group is to study new functional materials and devices through chemical and physical approaches. Main research subjects are to develop superconductors with high transition temperature and novel physical properties, and to exploit new functional devices made of organic molecules, two-dimensional layered materials, and topological materials.

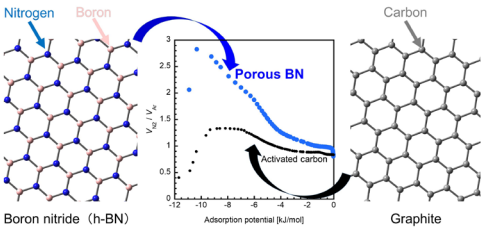


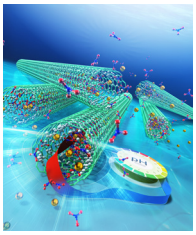
Assoc. Prof. GOTO Hidenori

■Research Themes
solid-state chemistry/superconductor/two-dimensional layered material/organic FET

Inorganic Chemistry

Since the adsorption of molecules and ions into solid pores proceeds spontaneously by selecting the appropriate material, so that the separation and purification process of mixtures can be constructed without any energy supply. We focus on fundamental phenomena to stabilize adsorbed species and to determine the ability. That can build design guidelines for inorganic porous materials that we should aim for in the next generation.

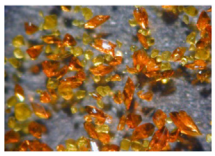




Prof. OHKUBO Takahiro

■Research Themes
adsorption/separation/pore/nanocarbon/porous ceramics

Coordination Chemistry

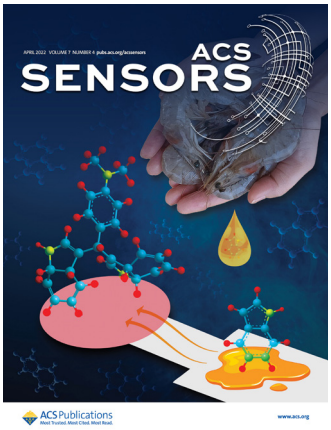


In our research group, we are studying on the synthesis of novel transition metal and lanthanoid complexes with unique molecular and crystal structures, which are expected to exhibit useful magnetic and optical properties and highly selective reactivity. In particular, we are challenging to synthesize manganese model clusters for the oxygen-evolving center in photosystem-II, metal complexes that exhibit stimuli-responsible spin-crossover or chromotropic behavior, and to elucidate the mechanism of absolute spontaneous resolution, which selectively generates optically active compounds from non-chiral sources.

Prof. SUZUKI Takayoshi

■Research Themes
Oxygen-Evolving Catalyst/ Polynuclear Complexes/ Spontaneous Resolution/ Chirality

Analytical Chemistry



We are developing a high-performance separation and determination methods using a laser and simple chemical sensors using paper substrates. We are also developing analytical methods for vesicles released by biological cells, environmental pollutants, active components contained in food, and chemicals that serve as indicators of food degradation. We are also working on research on high-performance separation using capillary electrophoresis and new analytical methods with nanochannels.

Prof.
KANETA Takashi

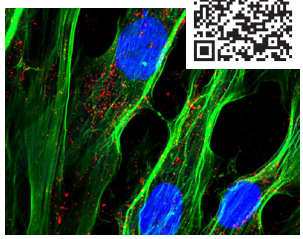
■Research Themes
Analytical Chemistry/ Bioanalysis/Environmental Analysis/and Food Analysis

Assoc. Prof.
TAKEYASU Nobuyuki

■Research Themes
Nanotechnology/Materials / Nanomaterials

Nanochemistry

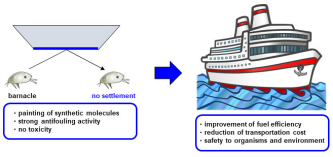
The aim of our research is to explore nanometrology by exploiting the novel functionality of inorganic nanomaterials. We are currently investigating nanoscale properties of biological samples and electronic devices, through optical responses of nanodiamonds and metallic nanoparticles.



Assoc. Prof.
FUJIWARA Masazumi

■Research Themes
nano science/quantum technology/iorganic chemistry/ analytical chemistry

Organic Chemistry



Development of New Synthetic Reactions and Its Application to the Synthesis of Biologically Active Organic Compounds

Biologically active natural products have been regarded as the promising drug candidates and useful tool for life science. Particularly, because of their potent biological activities, natural products isolated from marine organisms have attracted much attention of organic chemists, biologists, and pharmacologists. We are studying the developing new synthetic reactions and its application to the total synthesis and structural elucidation of biologically active organic molecules such as marine toxins, antitumor, and antifouling compounds.

Prof. KADOTA Isao

■Research Themes

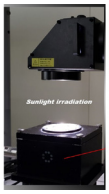
Organic Synthesis/Natural Product/Total Synthesis/Biologically Active Molecule/Structural Elucidation/Antifouling Agent

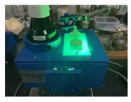
Assoc. Prof. TAKAMURA Hiroyoshi

■Research Themes

Organic Synthesis/Natural Product/Total Synthesis/Biologically Active Molecule/Structural Elucidation/Antifouling Agent

Functional Organic Chemistry





By utilizing transition metal catalysts, we can develop organometallic reagents and complexes that exhibit reactivities and selectivities distinct from those observed in classical methods. Additionally, precise control over the reactivities of both the reagents and catalysts can be achieved by fine-tuning the ligands (organic compounds) bonded to the transition metals. Our focus is on advancing the development of new carbon-carbon bond-forming reactions, capitalizing on the unique characteristics of organometallic complexes composed of metals and organic compounds. These reactions serve as a foundation for synthetic organic processes.

Prof. NISHIHARA Yasushi

■Research Themes

Transition metal catalysts/Organic photovoltaics/Organic field-effect transistors/Bond activation/Organoboron chemistry/Organofluorine chemistry

Asst. Prof. MORI Hiroki

■Research Themes

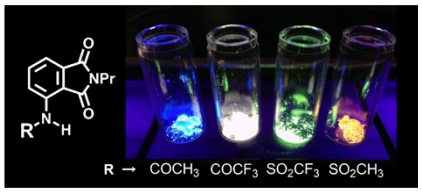
Transition metal catalysts/Organic material chemistry/Functional polymers/Organic solar cells/Organic semiconductors/Semiconducting polymers/Heteropolycyclic aromatic compounds

Asst. Prof. TANAKA Kenta

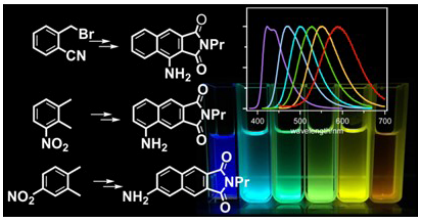
■Research Themes

Synthetic organic chemistry/Photocatalysis/Visible light/Organophotocatalyst/Flow synthesis/Electrosynthesis

Synthetic and Physical Organic Chemistry



In Synthetic and Physical Organic Chemistry research area, we investigate organic photochemistry to develop novel functional molecule, such as luminescent materials organic semiconductors. Our research subjects are as follows.



Assoc. Prof. OKAMOTO Hideki

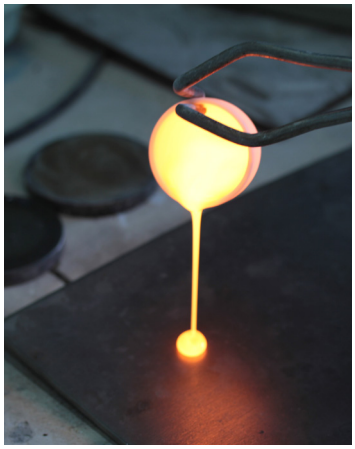
■Research Themes

Organic photochemistry/Organic functional molecule/Fluorescence/Polycyclic aromatic hydrocarbon/Organic semiconductor

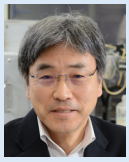
Innovative Chemistry

Department of Applied Chemistry

Environmental Amorphous Materials Science



Glass has excellent properties of transparency and moldability, which gives it various applications used in our daily life such as clear windows, containers, bottles, lens and fiber-form optics and so on. Another advantage of glass is its ability as a solvent, which allows it to dissolve and retain various elements including toxic and/or radioactive ones. Glass can be a key material to solve environmental and energy problems. In our group, we contribute to resource and energy saving through the research and development of functional glass and ceramic materials. We are also studying on efficient process of recycling inorganic wastes based on physics and chemistry of glass materials.



Prof.
NANBA Tokuro

■Research Themes

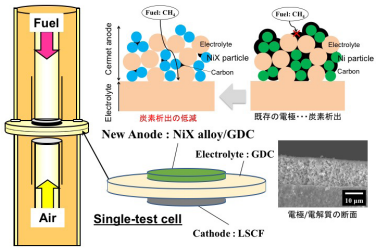
glass science/environmental inorganic materials science/ inorganic materials chemistry

Assoc. Prof.
BENINO Yasuhiko

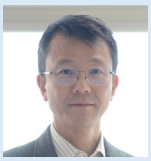
■Research Themes

glass science/environmental inorganic materials science/ inorganic materials chemistry

Environmental Inorganic Materials Science



We are developing novel electrode materials and electrolytes to enhance the performance of solid oxide fuel cells, which are gaining attention as a clean and efficient power generation system. Specifically, our focus lies on the utilization of biogas as a fuel. Additionally, we are working on the development of new separation materials that achieve efficient water/ alcohol and oil/water separation with low energy consumption. This is accomplished by leveraging the unique pore structure of zeolites, the superhydrophilicity of titanium oxide photocatalysts, and the combination of hydrophilic and hydrophobic surfaces.



Prof. KAMESHIMA Yoshikazu

■Research Themes

inorganic materials chemistry/ inorganic environmental materials/ inorganic interface chemistry

Assoc. Prof. NISHIMOTO Shunsuke

■Research Themes

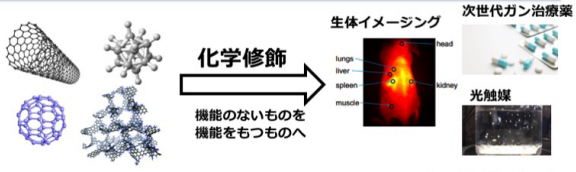
inorganic materials chemistry/ inorganic environmental materials/ inorganic interface chemistry

Advanced Organic Materials

有機機能材料学研究室

（環境理工学棟8階：田嶋智之講師）

有機反応による化学修飾で機能性分子を！



有機機能材料学研究室では，有機化学を駆使し，緻密な分子設計に基づく有機機能材料の開発を行うことで，環境技術や人類に貢献することを目指しています。

期待される応用分野
ホウ素中性子捕捉療法、光触媒、グリーンケミストリー

研究室HPはこちら

Our research interests include (1) chemistry of nanocarbons (fullerenes and carbon nanotubes), (2) chemistry of main group elements, (3) self-assembly and photoproperties of organic semiconductors, (4) chemical modification of clusters, and (5) fabrication and properties of nanohybrids.

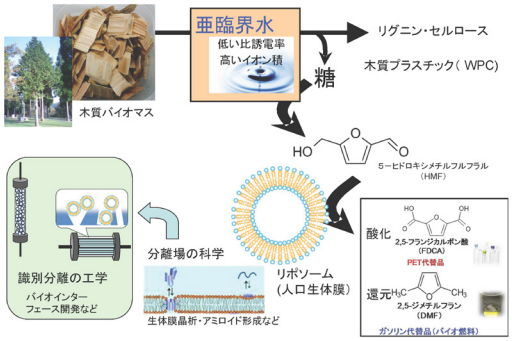
Assoc. Prof.
TAJIMA Tomoyuki

■Research Themes

Organic Chemistry/Photochemistry/ Nano carbon chemistry/Main group element chemistry

Environmental Process Engineering

In order to convert an unusable material to a valuable material, we research to propose an environmental-friendly chemical processes. We proposed the three chemical processes shown in the figure to produce a monomer to make a bioplastic from woody biomass. As the first process, we used subcritical water to hydolyze cellulose and hemicellulose. We converted monosaccharide to 2,5-Hydroxymethylfrufral (HMF) by the quick extraction as called as Slug Flow as the second process. We proposed a converting chemical process using a metal catalyst with liposome, which is an artificial cell membrane, to produce 2,5-frandicarboxylic acid.



Prof.
KIMURA Yukitaka

■Research Themes
environmental-friendly chemical processes/slug flow

Assoc.Prof.
SHIMANOUCHI Toshinori

■Research Themes
environmental-friendly chemical processes/slug flow

Inorganic Materials

Synthesis and characterization of functional ceramic thin films
Developments of functional ceramic materials by soft chemical methods
Biogenous iron oxides for novel nanometric materials
Catalysis related to ferroelectricitys

Prof. FUJII Tatsuo

■Research Themes
Inorganic Materials/Ceramics/Thin Films & Fine Particles/Magnetic Materials/Dielectric Materials/ Battery Materials

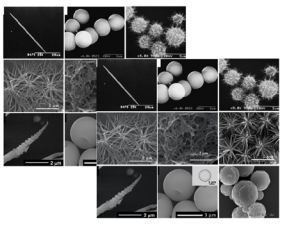
Assoc.Prof. KANO Jun

■Research Themes
Inorganic Materials/Ceramics/Thin Films & Fine Particles/Magnetic Materials/Dielectric Materials/ Battery Materials

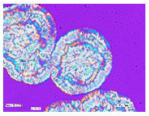
Asst. Prof.
TAKAHASHI Masakuni

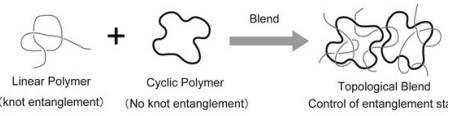
■Research Themes
Inorganic Materials/Ceramics/Thin Films & Fine Particles/Magnetic Materials/Dielectric Materials/ Battery Materials

Environmental Polymer Chemistry



Polymer materials are indispensable as materials that support our daily lives, and by precisely controlling their molecular structures and aggregation states, it is possible to express advanced functions. We are studying the development of materials that contribute to environmental conservation, such as plant-derived biomass plastics and super engineering plastics.





Prof.
KIMURA Kunio

■Research Themes
Polymer chemistry, Polymer physics/Organic chemistry/Physical chemistry/ Environmental materials

Assoc. Prof.
YAMAZAKI Shinichi

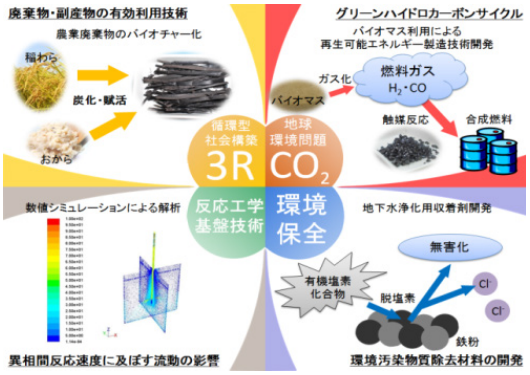
■Research Themes
Polymer chemistry, Polymer physics/Organic chemistry/Physical chemistry/ Environmental materials

Asst. Prof.
ATARASHI Hironori

■Research Themes
Polymer chemistry/ Polymer physics/Organic chemistry/Physical chemistry/ Environmental materials

Environmental Reaction Engineering

Our research targets are in four fields, the development of a recyclable society, global environmental problems, environmental protection, and basic reaction engineering technology. Our goal is to address these issues using chemical engineering approaches. Our recent research has focused on recycling waste, biomass, and green hydrocarbons, searching for effective catalysts to remove contamination matter in groundwater, and stirring operation between different phases.

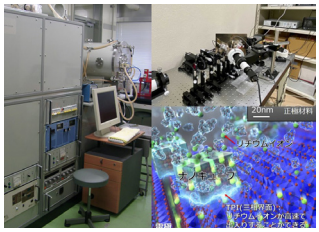


Prof. Uddin Md. Azhar

■Research Themes

Chemical reaction engineering/ Catalytic chemistry

Solid State Chemistry



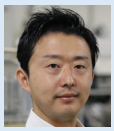
Research on the development of new functional ceramics (structural materials and electronic materials) and their application to various electronic elements and electrochemical devices has been carried out. Attempts have been made to fabricate ceramics using internal stress and interfaces between different substances, and to fabricate ceramic solids from liquid and gas phases. Attempts have also been made to fabricate ceramics using internal stress and interfaces between different materials, and to fabricate ceramic solids from liquid and gas phases. We comprehensively evaluate the effects of mechanical external force, electric field application as an external field, and electromagnetic wave irradiation on the electromagnetic properties of ceramics.

Prof.
KISHIMOTO Akira

■Research Themes

Ceramics/Functional materials/millimeter-wave irradiation heating/ionic conductor/ dielectric materials

Assoc. Prof.
TERANISHI Takashi



■Research Themes

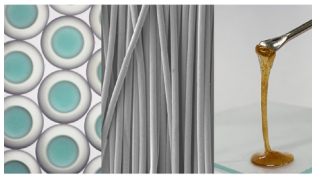
Ceramics/Functional materials/millimeter-wave irradiation heating/ionic conductor/ dielectric materials

Asst. Prof.
KONDO Shinya

■Research Themes

Ceramics/Functional materials/millimeter-wave irradiation heating/ionic conductor/ dielectric materials

Interface Process Engineering



Under the catchphrase Process Innovation for Product Innovation, we study on the development of new materials and the proposal of new processes, using a chemical engineering approach that integrates a wide range of disciplines with interface as the keyword. We explore new manufacturing methods for functional materials based on polymer chemistry, biotechnology, organic chemistry, and microfluidics. Specifically, we fabricate functional soft materials including polymer particles, capsules, fibers, and gels.

Prof. ONO Tsutomu

■Research Themes

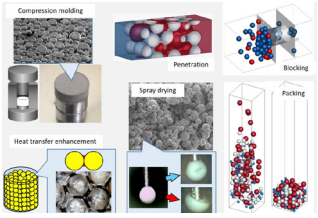
Chemical engineering/Interfacial chemistry/Polymer chemistry/ Microfluidics/Soft Matter

Asst. Prof.
WATANABE Takaichi

■Research Themes

Chemical engineering/Interfacial chemistry/Polymer chemistry/ Microfluidics/Soft Matter

Fluid and Particle Process Engineering



In chemical processes for producing inorganic materials, organic materials, and polymer materials, particulate solid material so called "Powder" are used as intermediates and final products. Our research works are investigation and establishment for the designing and controlling methods of a series of processes from production to handling of particulate solid materials. Main topics are development of dry surface cleaning method, compression molding, powder property evaluation method, kneading, layer formation during drying, particle generation by spray drying as a process involving heat and mass transfer, gas-solid chemical heat storage. We are also conducting mesoscale numerical calculations of particle dispersion systems as basic research on interfacial phenomena and interactions between particles.

Prof.
GOTOH Kuniaki

■Research Themes
Chemical engineering/ Powder technology/ Thermal engineering/Heat and mass transfer/Numerical simulation

Assoc. Prof.
NAKASO Koichi

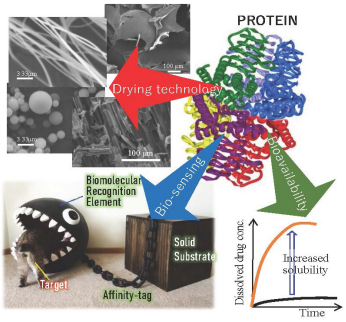
■Research Themes
Chemical engineering/ Powder technology/ Thermal engineering/Heat and mass transfer/Numerical simulation

Asst. Prof.
MINO Yasushi

■Research Themes
Chemical engineering/ Powder technology/ Thermal engineering/Heat and mass transfer/Numerical simulation

Bioprocess Engineering

Bioprocess engineering group is aiming to realize the industrial utilization of functional proteins: Proteins are often too unstable against dehydration, contact with a solid surface, etc., to be applied as therapeutic agent and sensing probe. We have been engaged in developing the technologies to maintain functional proteins against the loss of their structure and functionality due to dehydration and immobilization. Now, our research interests are expanded to solid dispersion of water-insoluble drugs, nano-spinning of edible polymers, protein immobilization with controlled orientation, etc.



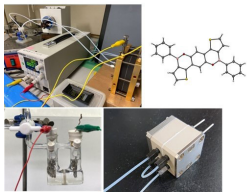
Prof. IMAMURA Koreyoshi

■Research Themes
chemical engineering/drying technology/encapsulation/ amorphous solid dispersion/ adsorption

Asst. Prof.
IMANAKA Hiroyuki

■Research Themes
biosensing/chemical engineering/protein engineering/ protein structure prediction

Synthetic Process Chemistry



We study innovative organic synthetic processes driven by organic electron transfer reactions. In these electrochemical methods, electricity is used as a driving force, enabling the greener chemical transformation without toxic and hazardous chemical reagents. Based on the electrochemical organic synthesis, we focus on developing novel chemical transformations for facile access to organic functional materials such as active materials for organic semiconductors and light-emitting materials, and biologically active compounds. Microflow reactions have attracted a great deal of attention in recent years, and we are also working to develop reactions that combine flow chemistry with electrochemical methods. The machine learning-assisted optimization of organic chemistry has also been investigated.

Prof.
SUGA Seiji

■Research Themes
Organic photochemistry/ Organic functional molecule/ Fluorescence/Polycyclic aromatic hydrocarbon/Organic semiconductor

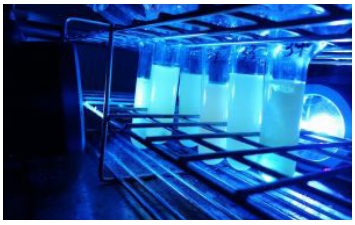
Assoc. Prof.
MITSUDO Koichi

■Research Themes
Organic photochemistry/ Organic functional molecule/ Fluorescence/Polycyclic aromatic hydrocarbon/Organic semiconductor

Asst. Prof.
SATO Eisuke

■Research Themes
Organic photochemistry/ Organic functional molecule/ Fluorescence/Polycyclic aromatic hydrocarbon/Organic semiconductor

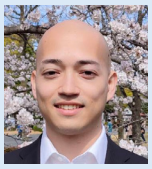
Organometallic Chemistry



Modern synthetic methods are required to construct complex molecules from readily available materials. We are trying to develop an innovative catalytic system, using not only the typical transition-metal catalyst but also organocatalyst and photocatalyst.

Prof. MIURA Tomoya

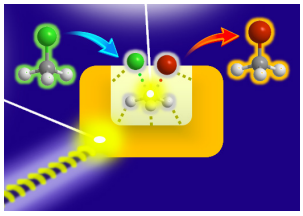
■Research Themes
Organic Synthetic Chemistry/
Organometallic Chemistry/
Nanotechnology and Materials



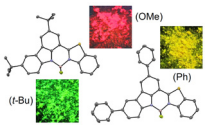
Asst. Prof. YAMAZAKI Ken

■Research Themes
Organic Synthetic Chemistry/
Organometallic Chemistry/
Computational Chemistry

Synthetic Organic Chemistry



We develop catalysts and catalytic reactions for the chemical fixation of carbon dioxide (CO_2). CO_2 is not only a greenhouse gas but also a renewable carbon source, and CO_2 fixation is an important technology for the creation of carbon-neutral societies based on circular economy. On the other hand, fluorescent dyes and circularly polarized luminescence (CPL) dyes are expected to find various applications such as organic functional materials. We study these subjects taking advantage of organic synthesis.



Prof.
EMA Tadashi

■Research Themes
organic synthesis/
catalysis/carbon
dioxide fixation/fluorescent dyes/
circularly polarized luminescence
dyes

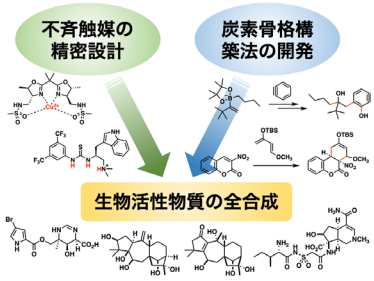
Assoc. Prof.
TAKAISHI Kazuto

■Research Themes
organic synthesis/
catalysis/carbon
dioxide fixation/fluorescent dyes/
circularly polarized luminescence
dyes

Asst. Prof.
MAEDA Chihiro

■Research Themes
organic synthesis/
catalysis/carbon
dioxide fixation/fluorescent dyes/
circularly polarized luminescence
dyes

Bioorganic Chemistry



There have been obtained many natural organic compounds that exhibit unique biological activities. These bioactive substances are useful as pharmaceuticals and their lead compounds. We are developing methods for the chemical synthesis of these bioactive compounds with diverse functional groups and complex carbon skeletons. Considering the viewpoint of “clean,” that is environmentally benign, organic synthetic chemistry, we have been designing a catalyst system that can stereoselectively synthesize organic compounds with various functional groups, and have been developing carbon-carbon bond formation reactions that can construct complex carbon skeletons.

Prof. SAKAKURA Akira

■Research Themes
synthetic organic chemistry/bioactive
natural compound/catalyst/total
synthesis

Assoc. Prof. MIZOGUCHI Haruki

■Research Themes
synthetic organic chemistry/bioactive natural
compound/catalyst/total synthesis

Industrial Catalysis

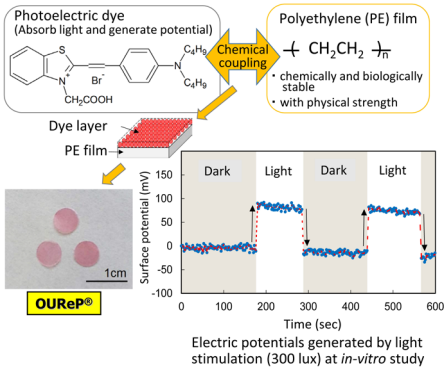
To promote research and technological development of innovative chemical catalytic methods of great industrial importance for solving global problems. Although the Faculty of Engineering of Okayama University was established with high expectations from the people of Okayama Prefecture, we recognize that our contribution to the local community is still far from sufficient, and we will promote practical application-oriented chemical research based on coordination chemistry to achieve harmony between the economy and the environment through down-to-earth regional and industry-academia collaboration. Through research and other activities, we aim to nurture proud Japanese people with a firm and unshakable core.

Senior Asst. Prof.
OSHIKI Toshiyuki

■Research Themes
carbon recycling/homogeneous catalysis/polymer synthesis

Polymeric Materials

・Nanomaterials of High-Performance Polymers
– Creation of Super Materials by Novel Methodology for Morphology Control –



Electric potentials generated by light stimulation (300 lux) at *in-vitro* study

・Development of a Retinal Prosthesis by Using Photoelectric Dye-Coupled Polyethylene Films
(Okayama University-Type Retinal Prosthesis: OUReP)
・Functionalized Polysaccharide Material
・Microwave Assisted Polymeric Material Processing

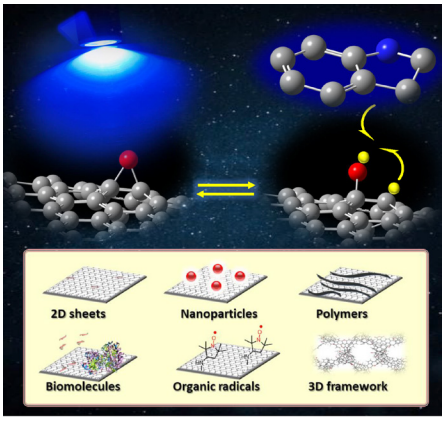
Prof.
UCHIDA Tetsuya

■Research Themes
Nanotechnology/Materials/Composite materials and interfaces/Nanotechnology/Materials/Polymer materials/Life Science/Biomaterials

Senior Asst. Prof.
OKIHARA Takumi

■Research Themes
Nanotechnology/Materials/Polymer materials/Nanotechnology/Materials/Green sustainable chemistry and environmental chemistry/Nanotechnology/Materials/Organic functional materials

Functional Molecular Engineering



Based on the mechanism of oxidation/exfoliation of bulk carbons, we have proposed the optimum reaction conditions through cyclotron-based mechanistic studies. We can provide > 100 grams of graphene and graphene oxide, and apply various applications.

Assoc. Prof. NISHINA Yuta

■Research Themes
Nanocarbon, catalysis, energy storage, biomaterial, polymer