IMCE

Institute for Materials Chemistry and Engineering

KYUSHU UNIVERSITY

Greetings from the Director

The Institute for Materials Chemistry and Engineering (IMCE) at Kyushu University was founded on April 1, 2003, following the merger and reorganization of the Institute of Advanced Material Study (a research institute attached to Kyushu University) and the Institute for Fundamental Research of Organic Chemistry (a joint education and research facility within Kyushu University). Since the reorganization, the IMCE has had two missions: to conduct cutting-edge research in areas from basic chemistry to process engineering, which concern the creation of highly functional substances and materials and the development of related engineering based on practical application; and to nurture young people through research. In particular, the objective of the IMCE is to advance "cutting-edge research in materials chemistry" which is necessary for the foundations of nanotechnology, information sciences, environmental and energy technology, bio/life sciences and other advanced industrial technologies that will support the 21st century. The IMCE is comprised of four divisions. In cooperation with research groups related to the synthesis of new functional molecules, the chemistry of new molecular assemblies, the chemistry of organic-inorganic hybrid materials, and the processing of advanced materials into devices, each of the divisions continues to work day and night to form a world-class core research base on the basic science and application of the structure and functions of materials from an atomic, molecular and nanoscale to a macroscale.

The IMCE conducts activities in collaboration with the graduate schools of sciences, engineering and interdisciplinary engineering sciences, across the three Hakozaki, Ito and Chikushi campuses respectively. In terms of the characteristics of each campus, advanced basic research is conducted in basic materials chemistry on the Hakozaki campus, in soft materials oriented toward life sciences on the Ito campus, and in new materials that support environmental and energy technologies and in organic/high polymers that lead the way in IT on the Chikushi campus.

With the incorporation of national universities as a turning point, the administration of our universities is in a state of great change. As well as working assiduously in the pursuit of research and educational achievements in a competitive environment, both our university and individual departments are being compelled to achieve a slim and efficient organization as well as a flexible administration with a rationality unfettered by convention. To achieve these objectives, not only is it necessary to promote a cycle of reforms based on regular self-examination and assessment, but it is essential that we facilitate active personal exchanges both within and outside the university. After several years of hard work, we have established administrative and personnel systems centered around the Director, and our efficient and flexible system-building has yielded results. We have invited many young and energetic researchers to become IMCE members, and through personal exchanges with other departments within the university, we have assembled an outstanding materials chemistry research team at Kyushu University, and we are producing advanced research results. Furthermore, in the future, we plan to become a leading center of materials chemistry through wide-ranging cooperation led by individual IMCE members or groups based on international, domestic, intra-university and industry-academia links. We sincerely look forward to your continued constructive criticism, encouragement and considerate support for the IMCE.

Hideo Nagashima
Director, IMCE

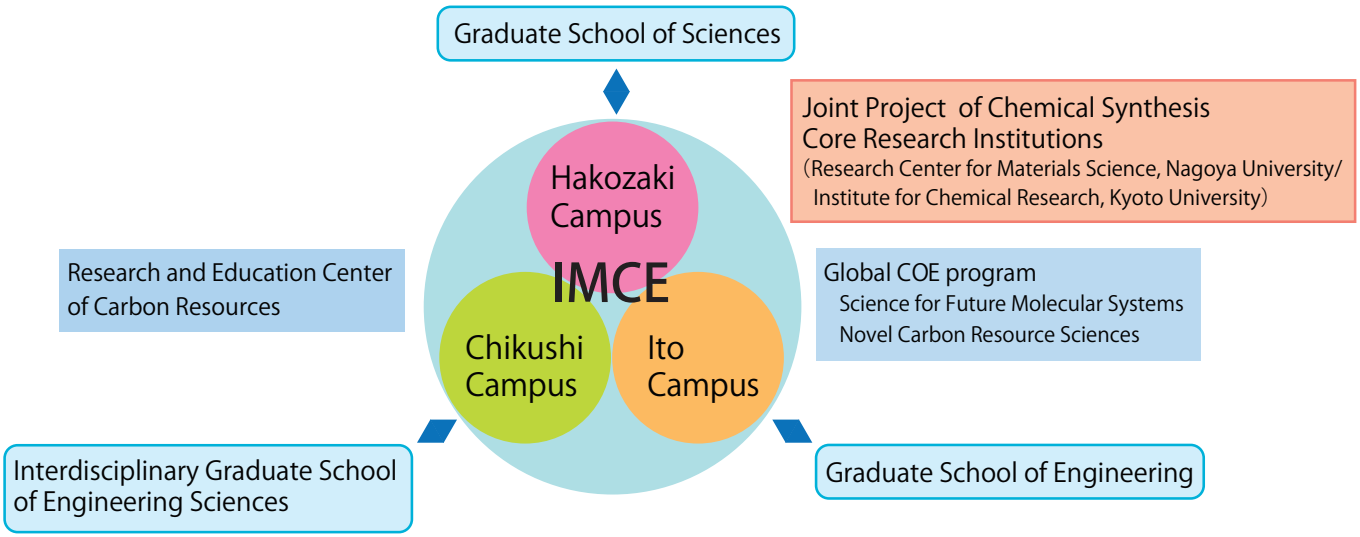
History

1944	Research Institute for Wood, Kyushu Imperial University (3 divisions) founded.
April 1949	Reorganized as the Kyushu University Research Institute of Industrial Science (5 divisions).
May 1987	Reorganized as the Kyushu University Institute of Advanced Material Study (3 research divisions (13 research fields) + 2 guest departments).
April 1, 1993	Kyushu University Institute for Fundamental Research of Organic Chemistry (3 research divisions) founded.
April 1, 2003	Institute for Materials Chemistry and Engineering established following the merger and reorganization of the Kyushu University Institute of Advanced Material Study and the Kyushu University Institute for Fundamental Research of Organic Chemistry.

Research

Our goal is to produce results of the highest global standard in “cutting-edge research in materials chemistry,” and to establish ourselves as an international center of “materials chemistry”.

- Building a world-class center of materials chemistry research with a world-class group of researchers.
- Assuming the role of a joint domestic/international collaborative research center by utilizing the characteristics of research institute attached to a university.
- Sharing the benefits of our basic research results with society.



Organization

Division of Fundamental Organic Chemistry

Physical Organic Chemistry 6
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Theoretical Chemistry 7
Professor — Kazunari YOSHIZAWA
Assistant Professor — Yoshihito SHIOTA
Research Assistant Professor — Takashi KAMACHI

Synthetic Methodology and Catalysis 7
Professor — Junji INANAGA
Assistant Professor — Hiroshi FURUNO
Research Assistant Professor — Satoaki ONITSUKA

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Associate Professor — Fumito TANI
Research Assistant Professor — Takehiro OHTA

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Assistant Professor — Junji TANAKA

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Organic Structures and Properties
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Research Assistant Professor — Masamichi NISHIHARA
Sota SHIBAHARA

Structure Analysis of Molecular Assemblies
Functional Characterization of Molecular Assemblies
Characterization of Functional Molecules

Soft Interfaces
Professor — Atsushi TAKAHARA
Research Associate Professor — Motoyasu KOBAYASHI
Hirohmi WATANABE
Research Assistant Professor — Daisuke MATSUKUMA
Yoshiko HARADA
Moriya KIKUCHI
Taiki HOSHINO
Jin NISHIDA
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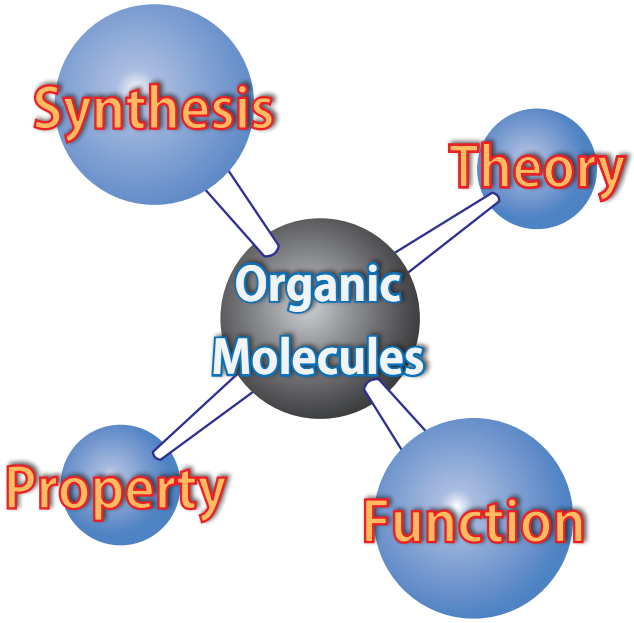
Fundamental Materials Science

Analytical Center

Associate Professor — Takaaki SONODA
Technical Person — Mitsutaka UMEDU
Keiko IDETA
Taisuke MATSUMOTO
Takeshi TANAKA

Division of Fundamental Organic Chemistry



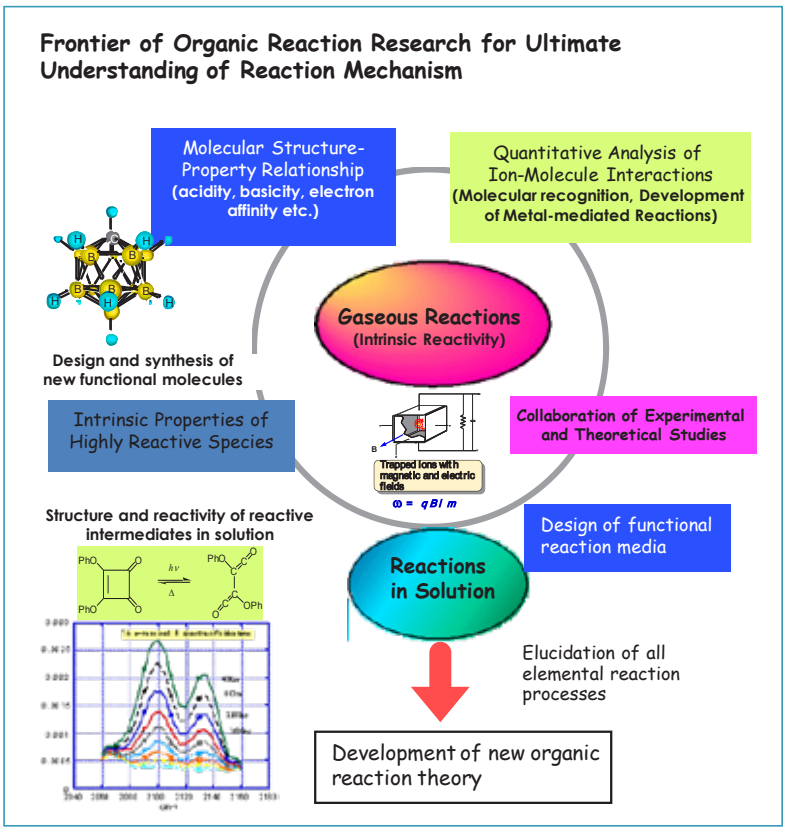
In addition to clarifying the characteristics of organic molecules, especially substances that exhibit specific optical, magnetic, conductive or other physical properties, the aim of the Division of Fundamental Organic Chemistry is to develop molecules that exhibit distinctive functions through establishing design principles using theoretical chemistry and property analysis, and realizing empirically these principles. The division is also engaged in the development of ultra-efficient and highly-selective reactions of organic molecules, and the development of highly-controlled methods of material transformation.

Physical Organic Chemistry

Hakozaki Campus

Professor
Masaaki MISHIMA

It is our ultimate goal to predict completely the transition state of organic reactions that determines reaction path and the energy required, giving us the most efficient strategy for new design of organic reactions and organic materials. Researches on the intrinsic properties of organic molecules in the gas phase, detailed reaction mechanisms and reactive transients that intervene in the reaction process are in progress.



Theoretical Chemistry

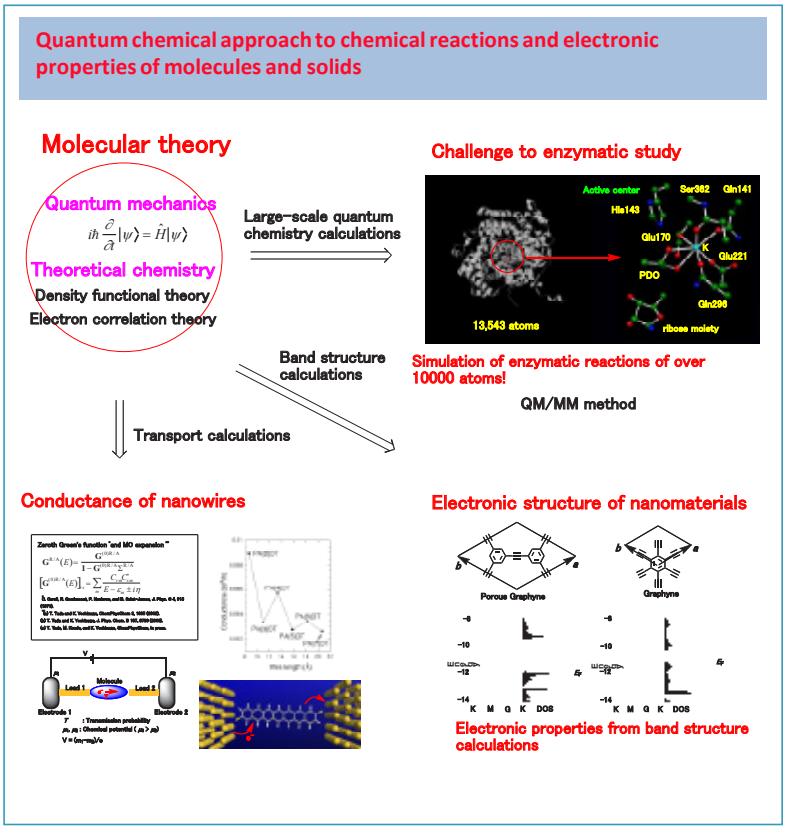
Ito Campus

Professor
Kazunari YOSHIZAWA

Assistant Professor
Yoshihito SHIOTA

Research Assistant Professor
Takashi KAMACHI

Our research group uses quantum mechanics to look at the electronic properties and reactivity of molecules and molecular assemblies. We are interested in a detailed understanding of structure-function relationships in a wide range of subjects in chemistry, material science, and biochemistry. The creation of new concepts and findings based on quantum chemistry is our main interest.



Synthetic Methodology and Catalysis

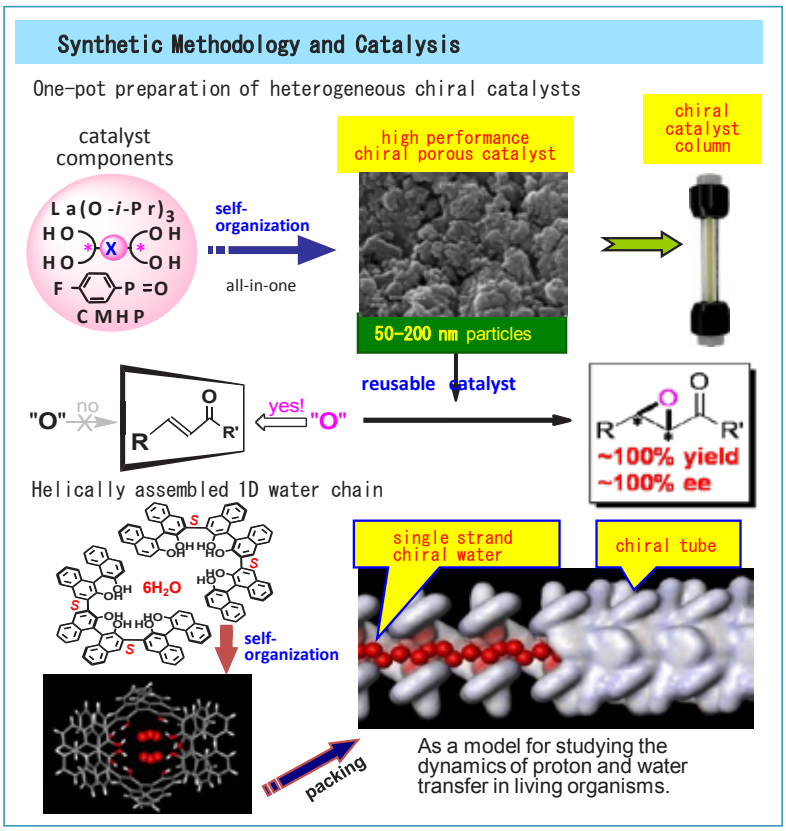
Hakozaki Campus

Professor
Junji INANAGA

Assistant Professor
Hiroshi FURUNO

Research Assistant Professor
Satoaki ONITSUKA

The emerging utility of chiral and non-racemic organic compounds, e.g., as pharmaceuticals and liquid crystals, strongly requires the development of new and highly efficient methods that afford them in a really practical way to benefit human life. Thus, our current research in this area focuses on the development of "environmentally friendly" methods for asymmetric catalysis. Development of novel functional molecules is also our current interest.



Advanced Molecular Conversion

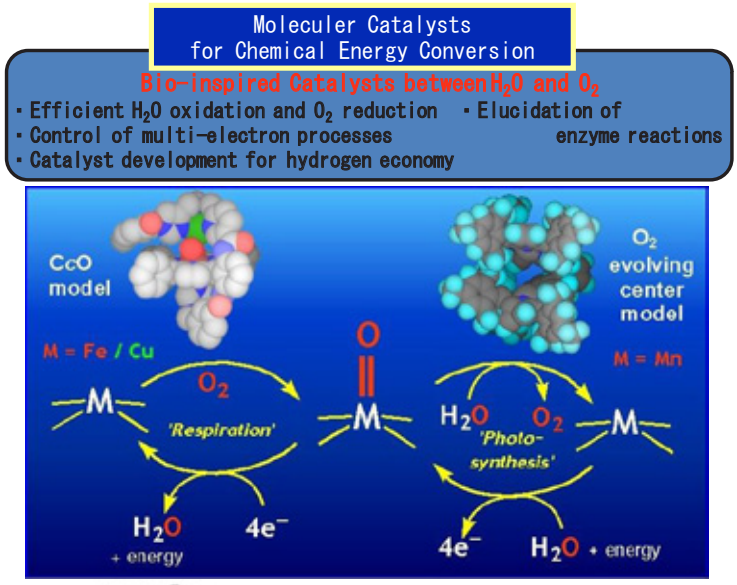
Hakozaki Campus

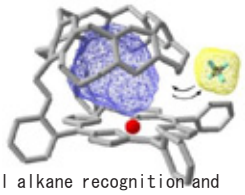
Professor
Yoshinori NARUTA

Associate Professor
Fumito TANI

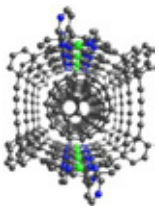
Research Assistant Professor
Takehiro OHTA

Since energy conversions by bio-systems are consisted by chemical energy conversions between H_2O and O_2 are environmentally benign and highly efficient, it offers fundamentals for hydrogen economy. We aim the elucidation of reaction mechanism of enzymes (cytochrome c oxidase and oxygen evolving center), which work in respiration and photosynthesis, respectively, with chemical models and extend them to molecular catalysts.





Small alkane recognition and reaction



C60 incorporated into porphyrin-nanotubes

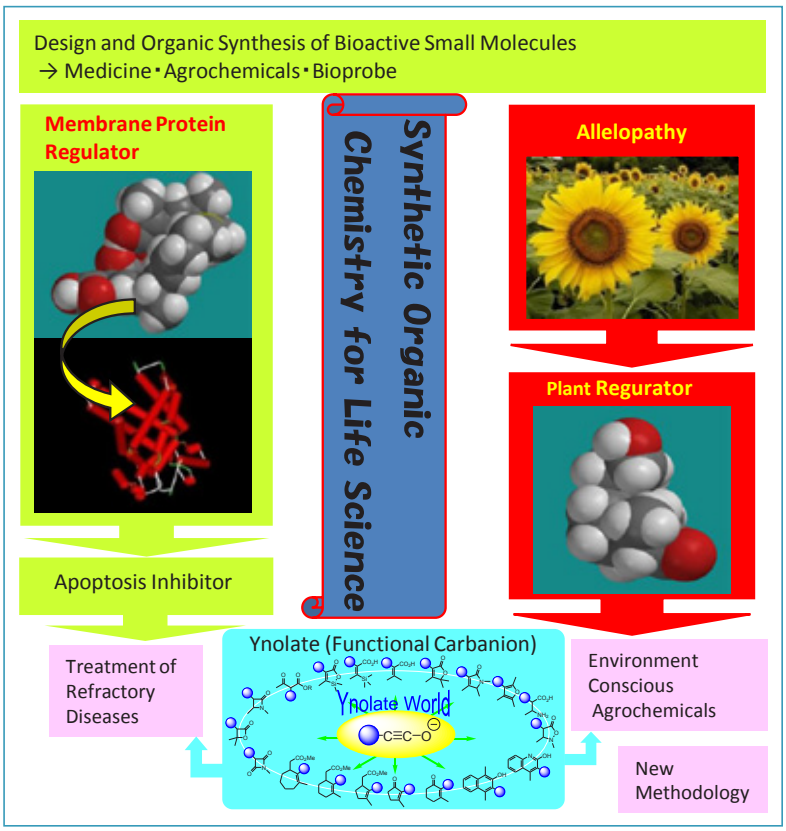
Advanced Organic Synthesis

Chikushi Campus

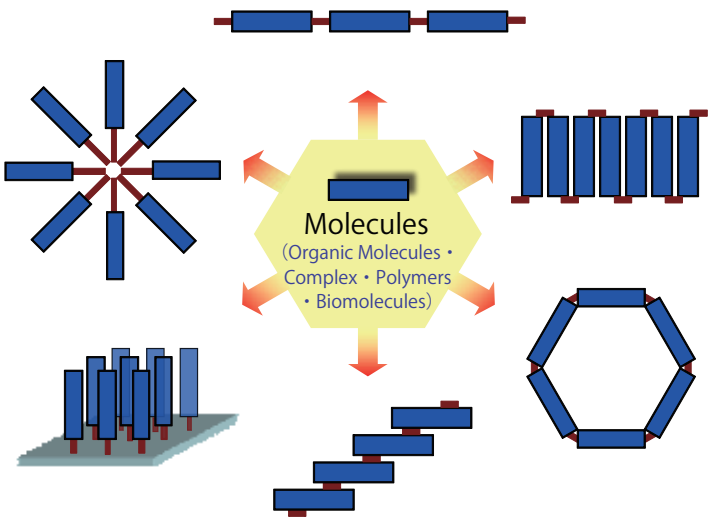
Associate Professor
Mitsuru SHINDO

Assistant Professor
Junji TANAKA

This research group is working to design and synthesize useful bioactive organic molecules based on synthetic organic chemistry and to develop new and effective synthetic methodologies. For examples, natural and unnatural membrane protein inhibitors and allelochemicals are efficiently synthesized, and these products are modified and hybridized with biomolecules.



Division of Applied Molecular Chemistry



The aim of the Division of Applied Molecular Chemistry is to establish the basic chemistry of atomic clusters, molecular clusters and supermolecules – which are unexplored areas of materials chemistry at the atomic and molecular levels – and to apply this to the design of molecular structures and electronic structures, synthesis, the development of physical properties and reactivity, and to functional molecules. Through the advanced control of physical properties and reactivity at the molecular level, the division aims to build macromolecules with higher-order structures, and to establish bottom-up nanotechnology. By creating molecules and molecular clusters that have new functional characteristics, and by evaluating the properties of these, the division aims to expand into nanomolecular materials.

Cluster Chemistry

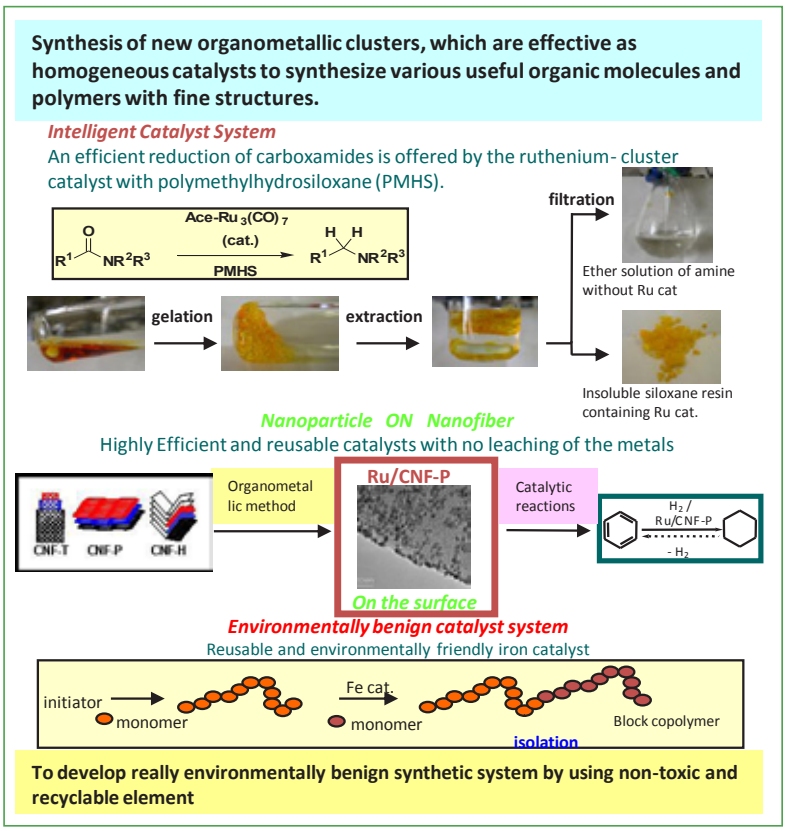
Chikushi Campus

Professor
Hideo NAGASHIMA

Associate Professor
Yukihiro MOTOYAMA

Assistant Professor
Yusuke SUNADA

Our research focuses on fundamental chemistry of "highly reactive" metal cluster molecules (atomic conglomerates) and its application to new molecular catalysts and catalytic processes. The processes bring about the development of efficient and selective preparative methods for organic and polymer molecules having fine structures, which are good precursors for fine chemicals and materials.



Chemistry of Molecular Assembly

Hakozaki Campus

Professor
Teruo SHINMYOZU

Assistant Professor
Kenta GOTO

- Synthesis and function of supramolecular structures: molecular tubes, capsules, photo-swichable chiral hosts.
- Construction of bi-stable molecular aggregates via cooperative hydrogen bonding: Exploration of their non-linear phenomena.
- Organic synthesis via photochemical reactions.
- Synthesis and properties of new cyclophanes and their application to molecular wires.
- Synthesis, structure, and function of thermo-responsive triblock polymers.

○Synthesis and function of supramolecular structures: molecular tubes, capsules, photo-swichable chiral hosts.
○Construction of bi-stable molecular aggregates via cooperative hydrogen bonding: Exploration of their non-linear phenomena
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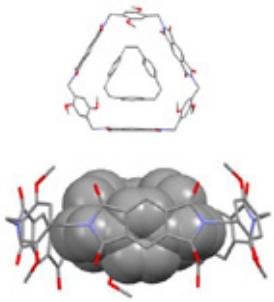
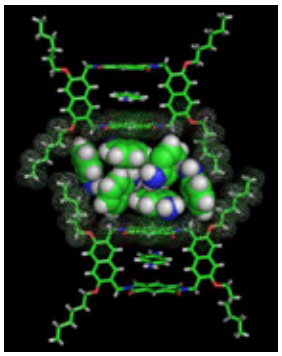


Cyclophane-type macrocycles are used as building blocks for the formation of tubular structures. The inclusion properties of these molecules are studied, and the "cyclophane in cyclophane" was characterized by X-ray crystallography.



Cyclic aniline trimers are found in the hydrophobic void space formed by pyromellitic diimide-based macrocycle in the solid state, where self-complemenatry N-H..π interactons play an important role for the formation of the trimers.

supramolecular assembly, π-electronic system, highly strained molecule, thermo-responsive polymer

System of Functional Molecules

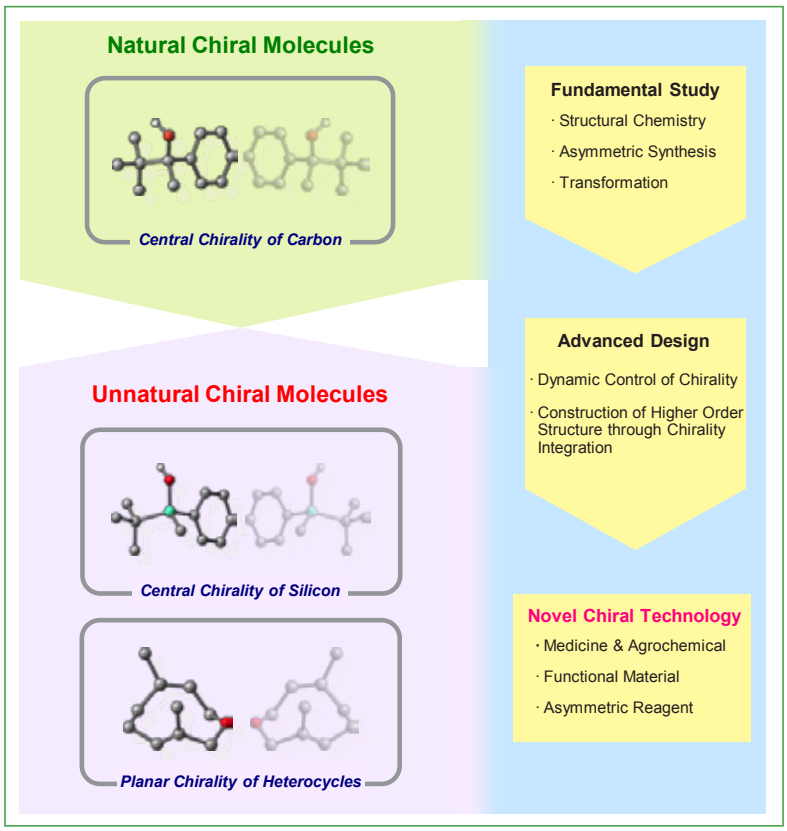
Chikushi Campus

Professor
Katsuhiko TOMOOKA

Associate Professor
Masato ITO

Assistant Professor
Kazunobu IGAWA

Chirality is a key feature in the three-dimensional molecular design that is closely associated with the molecular functionality. We have focused on the novel chiral architecture arising from a Si-centered chirality as well as a planar chirality imposed by the topological constraint, not only to gain deeper understanding on the role of chirality widely distributed throughout nature but also to create novel chiral materials by the integration of these unique chiralities, which should significantly contribute to the advancement of chiral technology.



Biomolecular Chemistry

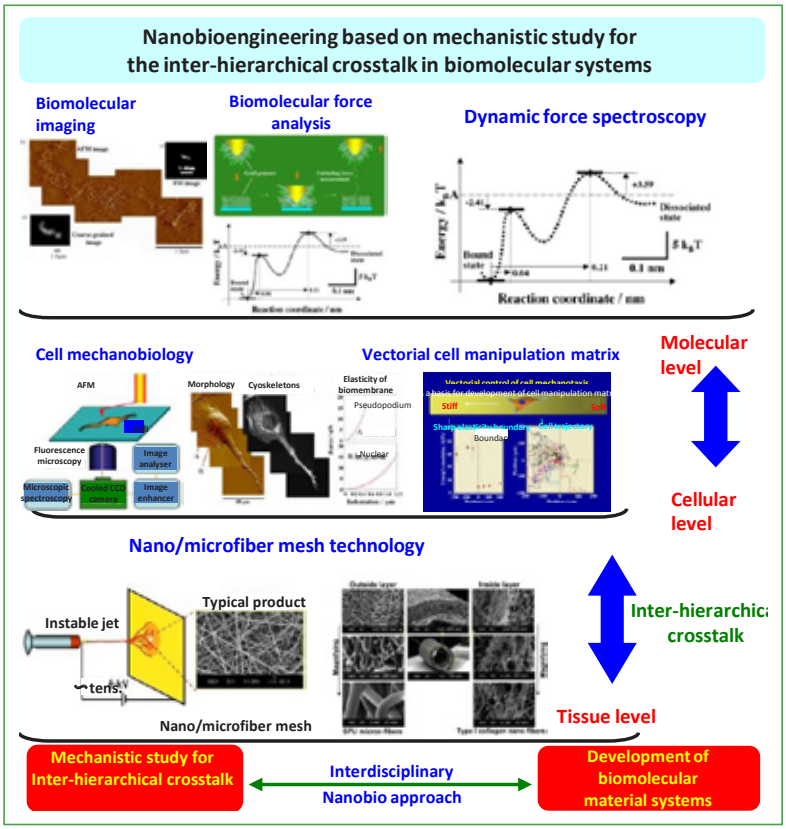
Ito Campus

Professor
Satoru KIDOAKI

Research Assistant Professor
Tatsuya OKUDA

Research Assistant Professor
Thasaneeya KUBOKI

Our lab works for the development of high-functional biomaterials/biomolecular systems such as cell manipulation matrices and molecular recognition devices. To effectively design such the systems, deep understandings for the biophysical principles on various aspects of the biosystems are required. We are trying to elucidate the inter-hierarchical crosstalk mechanisms in the biosystems, and to apply those to develop the novel nanobiotechnology.



Hybrid Molecular Assemblies

Ito Campus

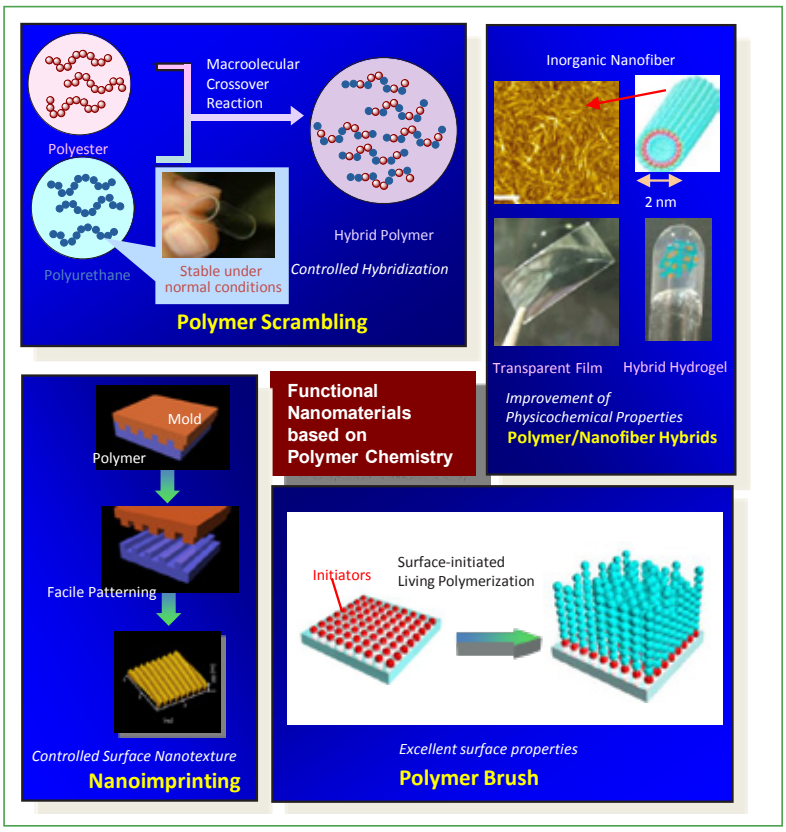
Professor
Atsushi TAKAHARA

Associate Professor
Hideyuki OTSUKA

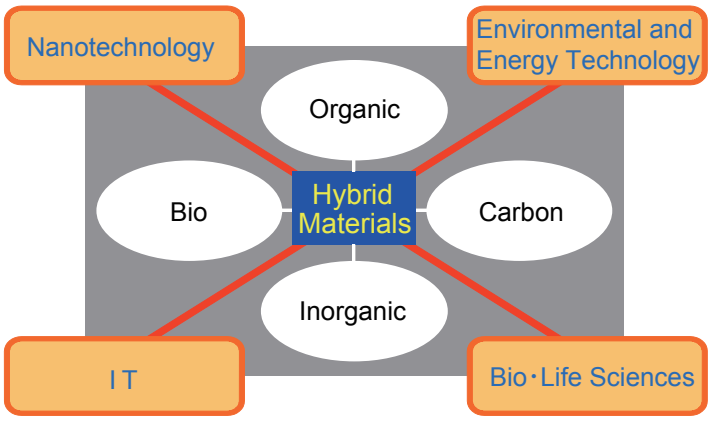
Research Assistant Professor
Masamichi NISHIHARA

Research Assistant Professor
Sota SHIBAHARA

In order to realize novel functional polymeric materials, precise control of structures and properties at nano- to meso-scopic scale is important. Researches on (1) precise polymer reaction based on dynamic covalent chemistry, (2) (polymer/inorganic) hybrids from inorganic nanostructures, (3) nano-structure control and fabrication of polymeric materials, and (4) control of surface properties by polymer brushes, are in progress.



Division of Integrated Materials



By freely using such techniques as molecular nanotechnology, the microfabrication of bulk materials and self-organization, the Division of Integrated Materials aims to create and apply hybrid materials that are positioned on the edge of conventional academic fields, such as organic-inorganic-bio and carbon-organic materials. In particular, the aim of the division is to develop new functional materials by blending dissimilar functions such as electronic functions and bio functions, and to establish a base for practical application. In addition to using the fusion of various types of materials to promote the development of physical/chemical/bio functional materials that are also biocompatible and compatible with the environment, the division is also engaged in the careful evaluation of the physical properties of each material.

Integrated Biomaterials

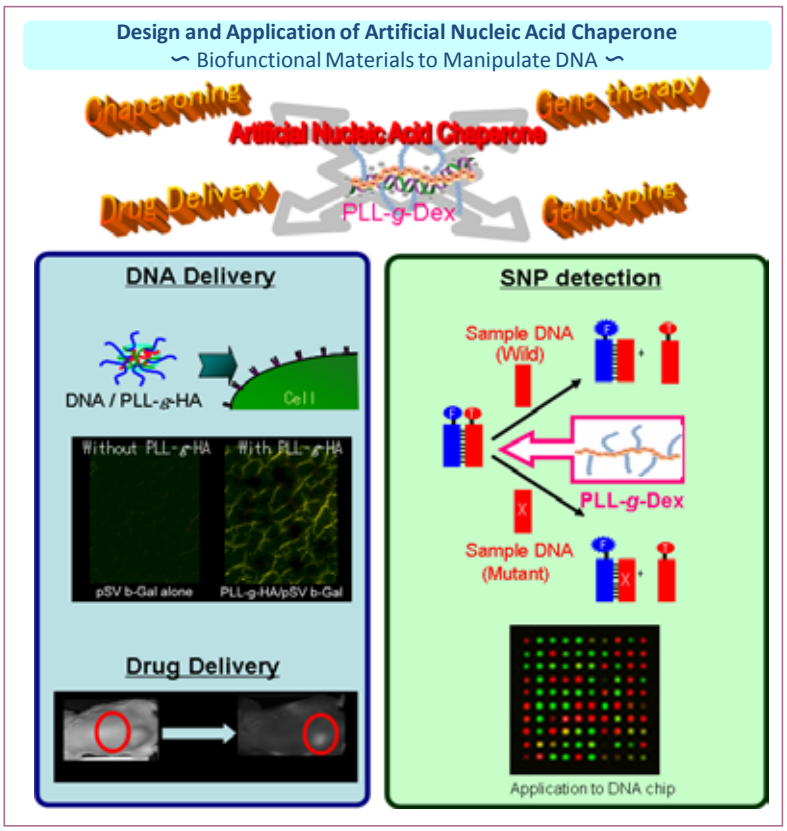
Ito Campus

Professor
Atsushi MARUYAMA

Assistant Professor
Arihiro KANO

Research Assistant Professor
Naohiko SHIMADA

Polymer-based biomaterials are a key for development and improvement of diagnostic, therapeutic and medicinal technologies. Fundamental studies interactions between artificial materials and biological components to create biomaterials with desired functions and biocompatibility are focused. Biomaterials that help understanding of properties and function of biomolecules are also involved in our interests.



Design of Nano-systems

Chikushi Campus

Professor
Hirotsugu KIKUCHI

Associate Professor
Yasushi OKUMURA

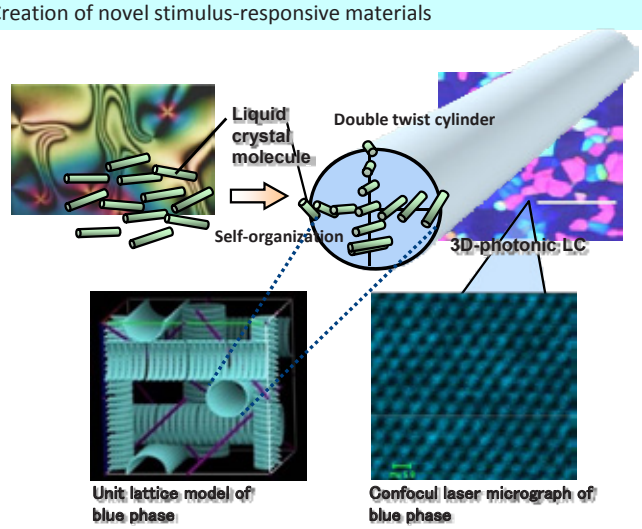
Assistant Professor
Hiroki HIGUCHI

Molecular self-assembly, which is an interdisciplinary subject extending over chemistry, physics and biology, derives the spontaneous nano-ordering being able to contribute much to key technologies of the bottom-up type electric and photonic devices. The focus of our studies is creating novel soft-matter with unique photonic structures and functionality through chemical and physical programming of topological frustration for the molecular assembling geometry of liquid crystals and polymers. We have developed novel functional materials showing fast electro-optics and photo-controllable photonic band.

Soft materials such as liquid crystals and polymers, which possess hierarchical structures in diverse time and length scales

⇩

Creation of novel stimulus-responsive materials



Applications

- Tunable photonic LC
- Electro-optic and electro-chemical device
- Fast response display device

Keywords

Soft matter, Liquid crystals, Polymers
Photonic crystals, Electro-optical devices
Electro-chemical devices, Display devices

Heterogeneous Integrated Materials

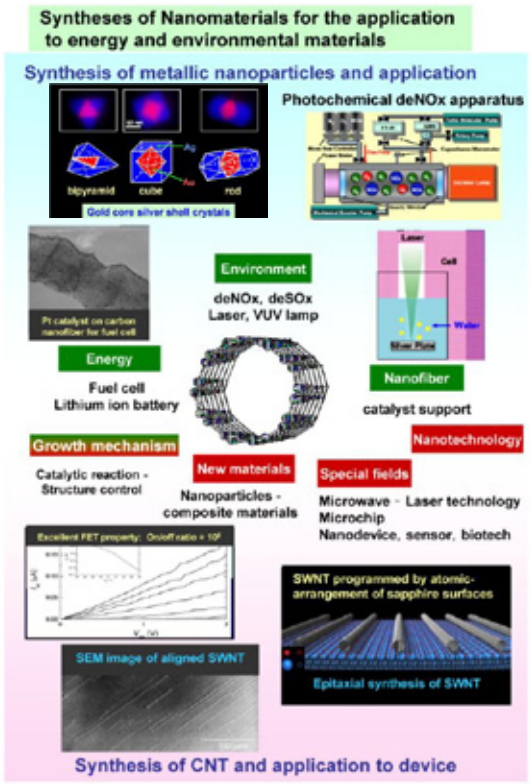
Chikushi Campus

Professor
Masaharu TSUJI

Associate Professor
Hiroki AGO

Assistant Professor
Takeshi TSUJI

Nanoparticles, nanowires, and nanotubes are key materials in nanotechnology. This research section studies preparation of these nanomaterials using laser ablation in liquid phase, microwave heating, and thermal methods. In the carbon nanotube research, the growth mechanism, directional growth, and structure control are studied. Transistors with the aligned nanotubes are also fabricated. Application of photochemical process to NOx removal is also in progress to develop new techniques for conservation of atmospheric environment.



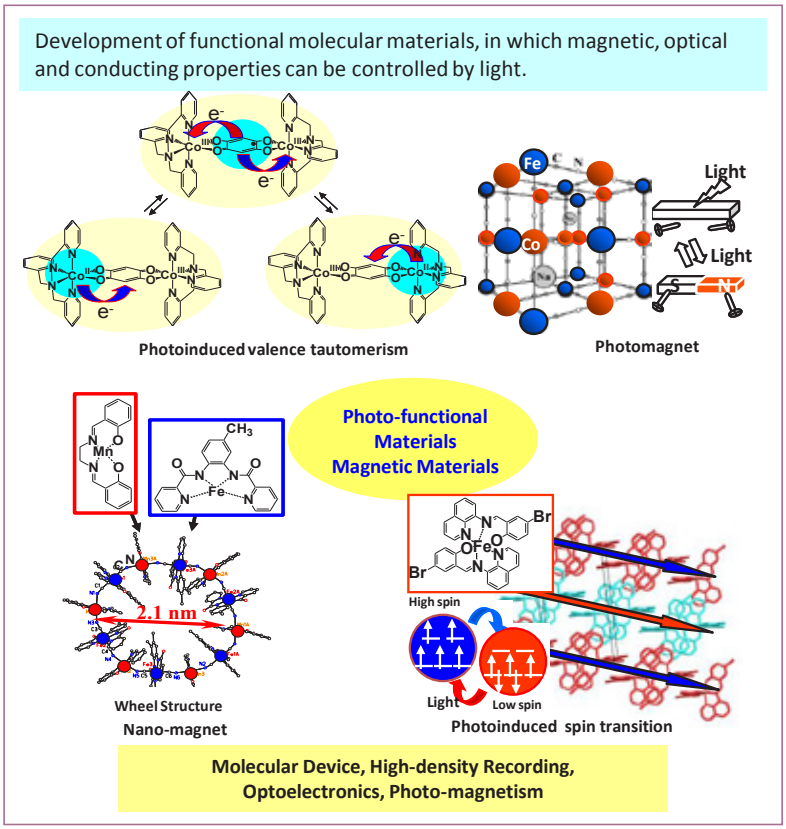
Nanostructured Integrated Materials

Chikushi Campus

Professor
Osamu SATO

Assistant Professor
Shinji KANEGAWA

A reversible tuning and a persistent modification of physical properties by external stimuli are one of the main challenges in materials science.
Especially, photo-control over the physical properties is important from the viewpoint of the practical application as well as the basic science. The photo-tunable compounds can be used future memory devices, optical switches and so on. Along this line, we are currently studying photo-tunable molecular magnets, valence tautomeric compounds, spin-crossover complexes and photonic crystals.



Division of Advanced Device Materials

The Division of Advanced Device Materials aims to realize nanostructured bulk materials and to realize advanced devices through the measurement and functional analysis of the microstructures of precisely built molecular and atomic clusters, and through the development of processes to realize ordered arrays. In particular, with a focus on inorganic nanomaterials, the aim of the division is the clarification of the correlation between structure and function, the development of new optical materials that use nanoparticles, and the establishment of a fundamental engineering for the process design and controls that are necessary for the achievement of large-scale ordered arrays of nanostructures.

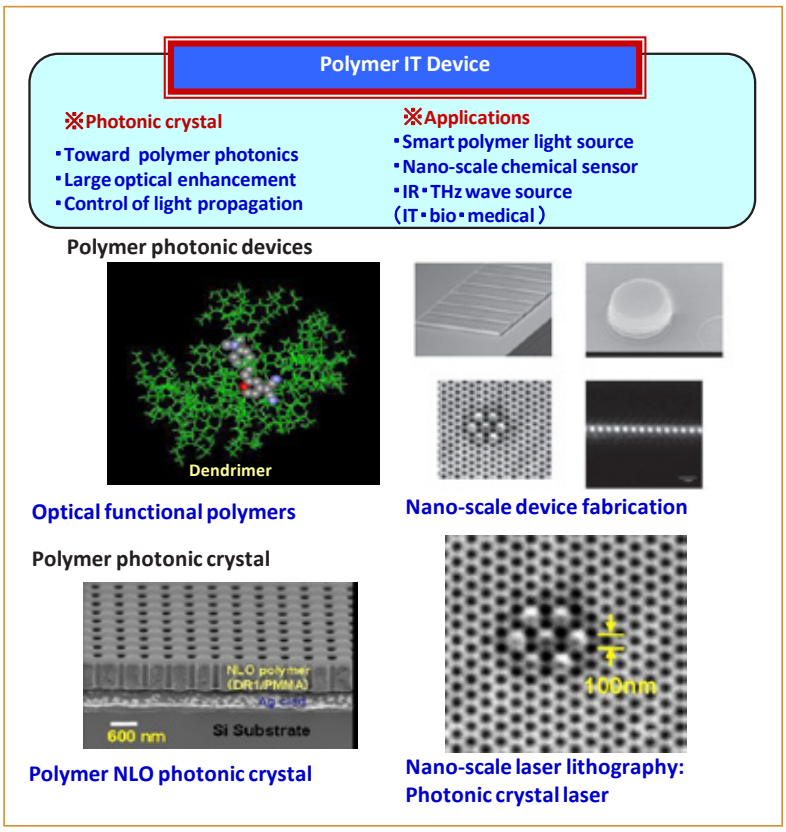
Nano Scale Evaluation (Yokoyama Group)

Chikushi Campus

Professor
Shiyoshi YOKOYAMA

Assistant Professor
Shinichiro INOUE

Our research project is focused on creation of organic and polymer photonic materials and devices based on molecular building blocks and nano-micro-scale device fabrications. Research interest is in the demonstrating the potential of high-performance polymer materials for revolutionary components and devices. These include polymer photonic crystal devices leading to a large reduction in operating energies.



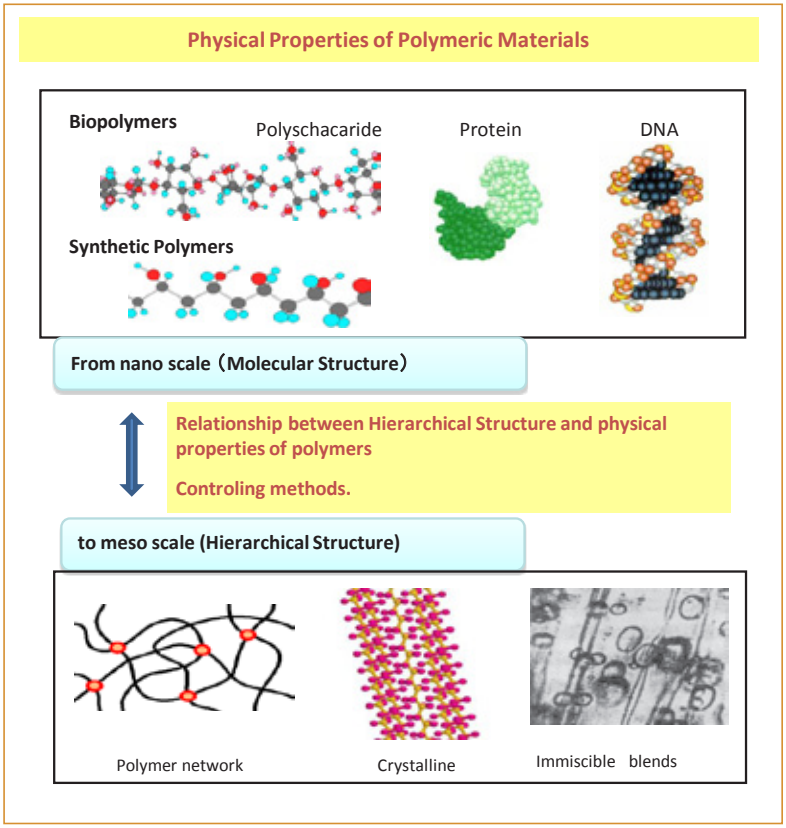
Nano Scale Evaluation (Takahashi Group)

Chikushi Campus

Associate Professor
Yoshiaki TAKAHASHI

Assistant Professor
Akihiko TAKADA

Hierarchical structures and physical properties of polymers as well as those of analogous soft matters are studied by microscopic observations, thermal analysis, rheological and scattering experiments. Solution Properties of natural polymers in ionic liquids is also studied in our group.

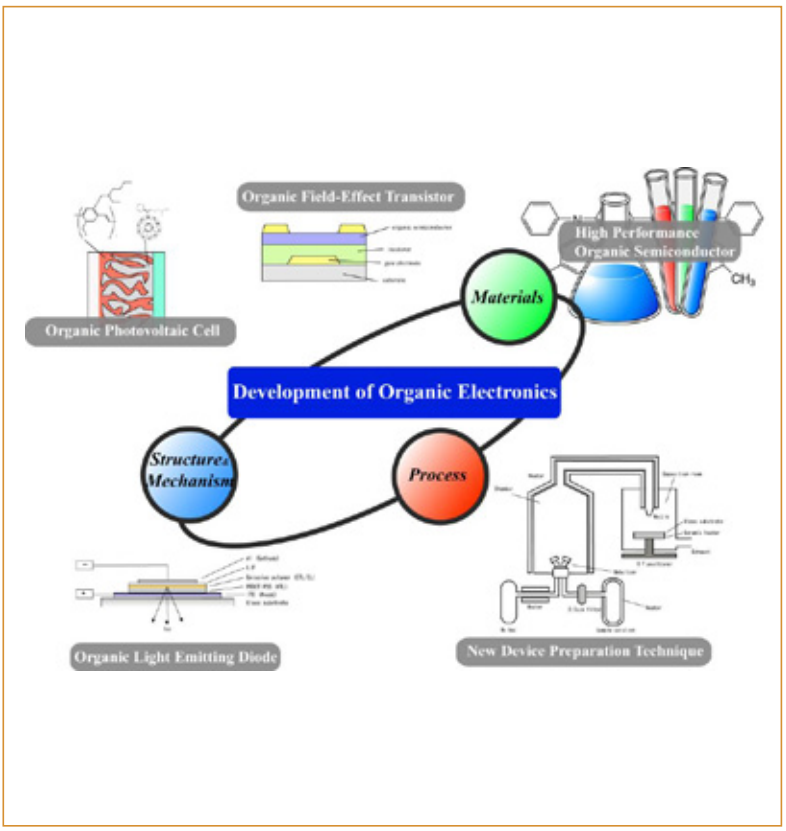


Photonic Materials

Chikushi Campus

Associate Professor
Katsuhiko FUJITA

This research section has been pioneering the R&D of organic electronics including organic electroluminescence (EL) devices, organic solar cells, organic transistors and organic memories. The R&D activity is divided to three groups, device structure, high performance materials and fabrication processes to understand comprehensive organic electronics. Organic semiconductors have significant advantages, ex. flexibility and printability. Utilizing the advantages, new classes of electronic devices are being developed.



Processes in Extreme Conditions

Chikushi Campus

Professor
Yoon SEONG-HO

Associate Professor
Yozo KORAI

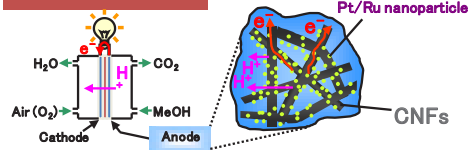
Assistant Professor
Jin MIYAWAKI

Our research group develops new functional carbon materials for effective usage of energy sources and studies their industrial applications. For example, we fabricate carbon nano-fibers (CNFs) having different shape, size, and surface properties and applies further modifications for applications such as fuel cells and capacitor. We have found remarkably improved performance and durability for the systems using the CNFs, and have presented many patents and scientific papers. We are actively collaborating with various companies, and working on commercialization of our products.

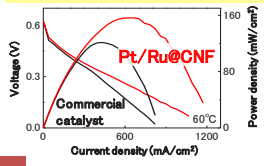
Development of Functional Carbon Materials for Energy and Environmental Engineering

Carbon NanoFibers (CNFs)

Fuel Cell Electrode



➢ Improved DMFC Performance

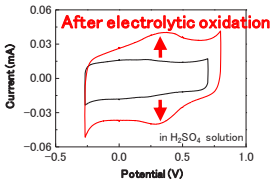


Development of New Surface Oxidation Process

Stack Electrolytic Oxidation System

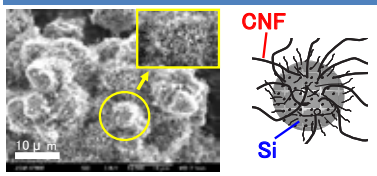
Productivity: 100 g/stack

➢ Enhanced capacitance

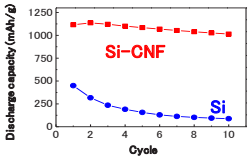


Application to Li-Ion Battery

CNF growth on Surface of Si particles



➢ High discharge capacity
➢ Improved cycle characteristics



Energy Storage Materials

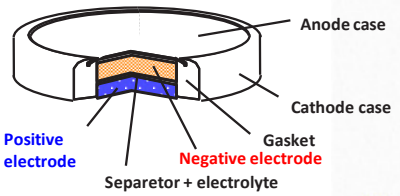
Chikushi Campus

Professor
Jun-ichi YAMAKI

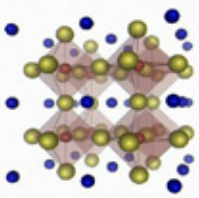
Associate Professor
Shigeto OKADA

To create high-performance electrochemical energy conversion devices, our laboratory covers fundamental studies as well as the foundation for practical applications. From the viewpoint of materials chemistry and electrochemistry, we create novel battery materials, which are based on the understanding of physicochemical phenomena, in order to improve the performance of power storage devices. In particular, we focus on high-power lithium ion batteries for use in hybrid vehicles, which will reduce environmental burdens. In addition, we fundamentally study on the design of electrode reactions for innovative energy conversion devices with high environmental compatibility for next generation.

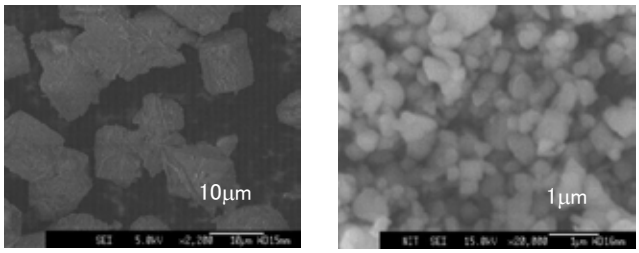
Development and research of power storage devices with nano-size active materials



2032 type Li coin cell for electrochemical measurements



Novel fluoride perovskite positive-electrode material



Particle size comparison of $LiMnPO_4$ positive-electrode prepared by (left) conventional solid state synthesis method and (right) Li excess method

Lithium battery, post-lithium ion battery, iron-air rechargeable battery, thermally-stable electrolyte with fluoride solvent, rare-metal-free positive-electrode materials, synthesis method for nano-sized materials, computer simulation technique for battery performance

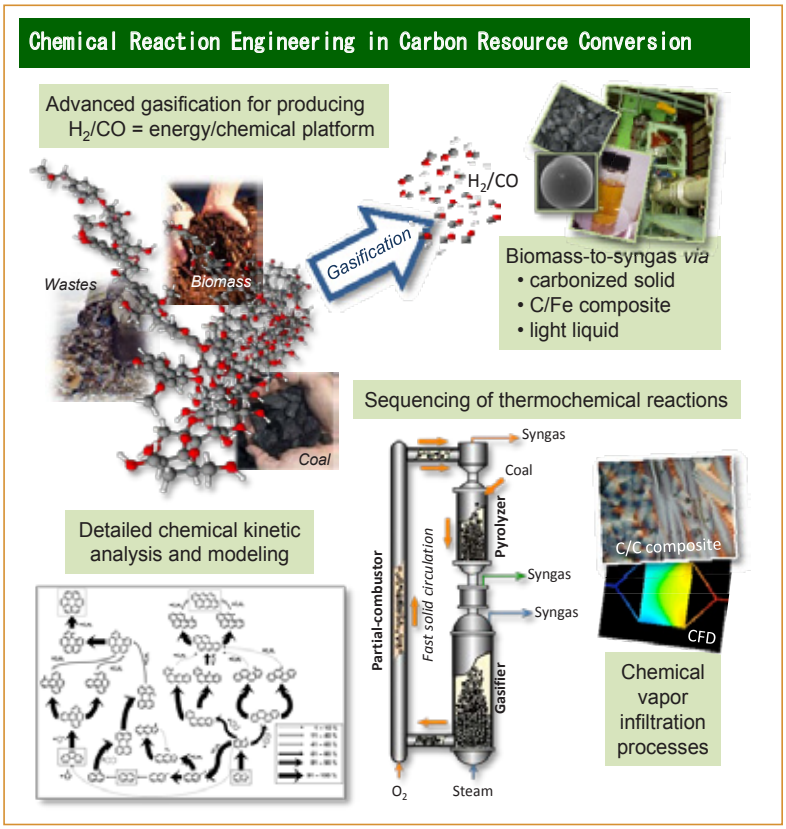
Microprocess Control

Chikushi Campus

Professor
Jun-ichiro HAYASHI

Associate Professor
Koyo NORINAGA

Main purpose: development of thermochemical reaction systems for converting carbon resources such as coal, biomass and wastes into H_2/CO that is to be the common energy/material platform in future sustainable carbon cycle chemistry (SC3) systems. Current topics: detailed chemical kinetic analysis and modeling, sequencing of parallel/consecutive thermochemical reactions of coal and biomass, conversion of heavy oil and tar in nano/sub-nano spaces, radical-driven rapid gasification of carbonized solids, precise control of chemical vapor infiltration processes.



Access

Chikushi Campus

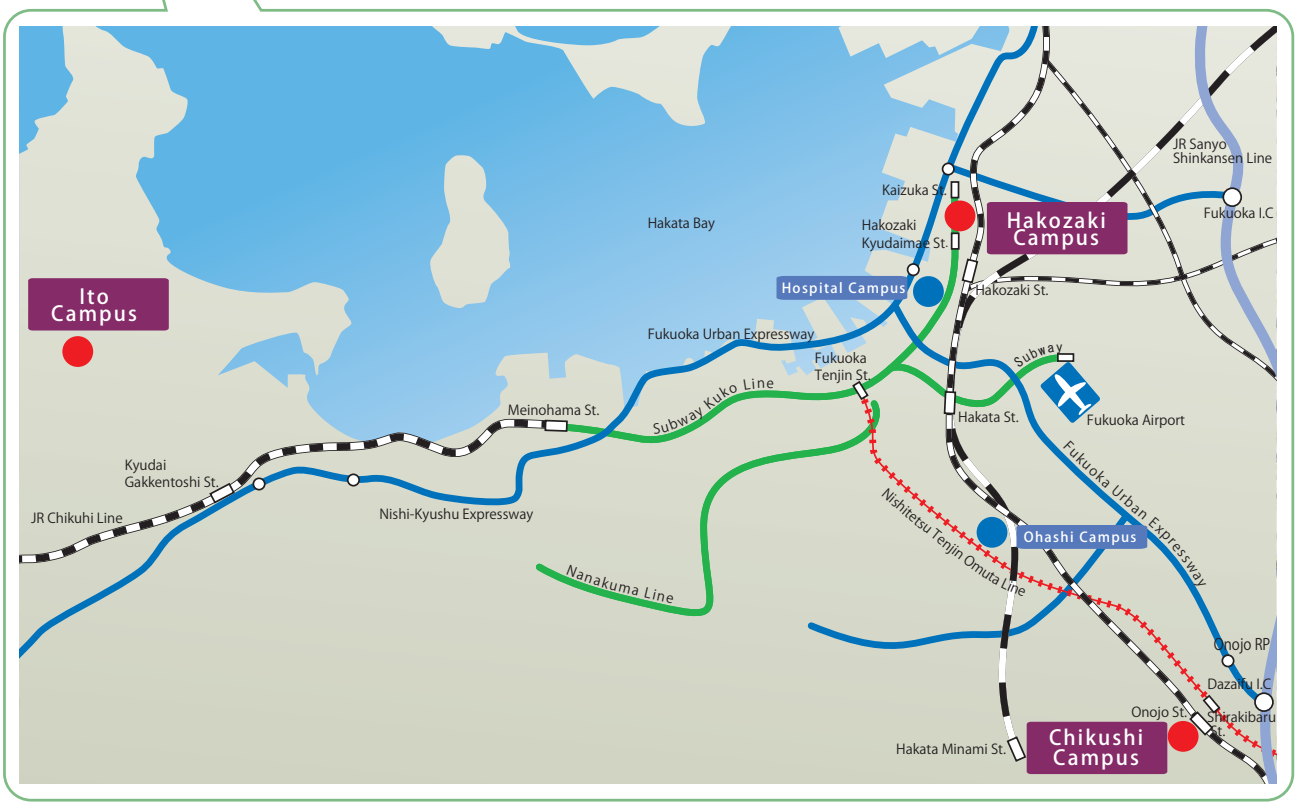
6-1 Kasuga-koen, Kasuga-city, Fukuoka
816-8580

Hakozaki Campus

6-10-1 Hakozaki, Higashi-ku, Fukuoka
812-8581

Ito Campus

744 Motooka, Nishi-ku, Fukuoka
819-0395



■Chikushi Campus

Fukuoka Airport→(Subway Kuko Line)→Hakata St. → (Transfer to the JR Kagoshima Line)→Onojo St. →Chikushi Campus

■Hakozaki Campus

Fukuoka Airport→(Subway Kuko Line)→Nakasu-Kawabata St. → (Transfer to the Subaway Hakozaki Line)
→Hakozaki-Kyudaimae St. →Hakozaki Campus

■Ito Campus

[Route1]
Fukuoka Airport→(Subway Kuko Line)→Meinohama St. → (Transfer to the JR Chikuhi Line)→Kyudai-Gakkentoshi St.
→(Transfer to the Showa bus)→Ito Campus
[Route2]
Fukuoka Airport→(Subway Kuko Line)→Hakata St. or Tenjin St. → (Transfer to the Nishitetsu Bus)→Ito Campus

2009.12

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