IMCE

2024

Institute for Materials Chemistry and Engineering

Kyushu University

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Kyushu University

Greeting

Since its inception 20 years ago, the Institute for Materials Chemistry and Engineering (IMCE) at Kyushu University has been committed to producing world-class research results in the interdisciplinary field of materials chemistry. While continually strengthening our fundamental research capabilities, we consistently aim to fulfill our crucial mission: to respond to the diverse and evolving needs of society with state-of-the-art scientific and technological prowess. As outlined in our 4th Mid-term Plan, which began in 2022, the overall objective of the institute is to contribute to the development of interdisciplinary fields in materials science and chemistry, and to establish research bases that lead internationally. Specifically, our missions include:

1. Conducting research that ranges from the fundamental to the applied, all the way to societal implementation, while bolstering and fostering collaborations with both domestic and international research institutions.
2. Contributing to the achievement of a decarbonized society through innovations in materials chemistry and by extending our research capabilities into fields such as energy, environment, and life sciences.
3. Promoting advanced, interdisciplinary collaborative research in the field of materials and devices as a cooperative research base.

The Institute comprises four research departments: Fundamental Organic Chemistry, Applied Molecular Chemistry, Integrated Materials, and Advanced Device Materials. These departments focus on various aspects of materials chemistry, including molecules, molecular and atomic assemblies, nanomaterials, and advanced device materials. Since 2015, we have strategically advanced international collaborative research and bolstered our international capacities by establishing the Division of Soft Materials. Our institute is an active participant in the MEXT's 'Network Joint Research Center for Materials and Devices'. We maintain close collaborations with institutions such as RIES (Hokkaido University), IMRAM (Tohoku University), CLS (Tokyo Institute of Technology), and SANKEN (Osaka University). This collaboration has allowed us to establish a comprehensive network across Japan, annually conducting over 400 joint research projects. Researchers from universities and research institutions nationwide are encouraged to participate in joint research initiatives at our bases.

In order to ensure the continued scientific and technological prowess, industrial strength, and international competitiveness of Japan, it is crucial to nurture the next generation of young researchers who will advance fundamental research. We cooperate closely with several faculties, including the Graduate School of Engineering, the Graduate School of Science, the Interdisciplinary Graduate School of Engineering Sciences, and the Graduate School of Integrated Frontier Sciences. Together, we provide interdisciplinary research guidance in graduate education, leveraging the unique characteristics of the institute. Our goal is to foster the development of human resources, enabling young researchers to fully exhibit their abilities based on their own innovative ideas. Our attractive research organization and cutting-edge research environment are ready and eager to welcome many undergraduates, graduate students, and young researchers to the Institute for Materials Chemistry and Engineering.

Director

Shiyoshi YOKOYAMA

Organization

Division of Fundamental Organic Chemistry

- Nanomaterials and Interfaces
- Theoretical Chemistry
- Molecular Materials Chemistry
- Chemistry of Functional Molecules
- Advanced Organic Synthesis

Division of Applied Molecular Chemistry

- Chemistry of Molecular Assembly
- System of Functional Molecules
- Biomedical and Biophysical Chemistry
- Hybrid Molecular Assemblies
- Theoretical Molecular Science
- Inorganic Materials Chemistry

Division of Integrated Materials

- Design of Nano-systems
- Nanostructured Integrated Materials
- Heterogeneous Integrated Materials
- Nanoscale Characterization of Materials

Division of Advanced Device Materials

- Nano Scale Evaluation
- Photonic Materials
- Carbon Materials Science
- Energy Storage Materials
- Microprocess Control

Division of Soft Materials

- Soft Materials Chemistry
- Nano-bio Device
- Mechanobio-materials

Evaluation Center of Materials Properties and Function

- Office of Research Support

Campus

The Institute conducts research on two campuses.

Chikushi

Ito

Inter-university Research Project

The institute is participating in the following projects and promoting collaborative research.

Network Joint Research Center for Materials and Devices

We are carrying out a joint research project with the RIES of Hokkaido University, the IMRAM of Tohoku University, the LCS of Tokyo Institute of Technology and the ISIR of Osaka University to promote research on materials and devices.

Crossover Alliance to Create the Future with People, Intelligence and Materials

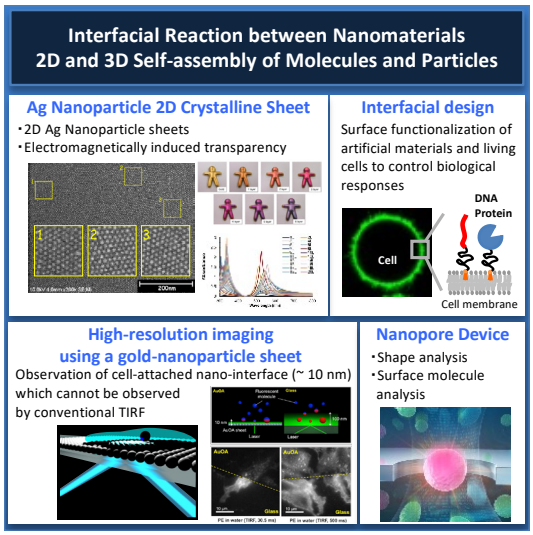
We are promoting a joint research among five research institutes of NJRC. Researchers are divided into four groups, and we are promoting collaborative research that spans across fields and institutes.

Integrated Research Consortium on Chemical Sciences

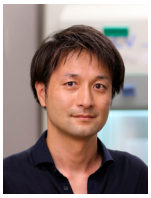
We are collaborating with the ICAT of Hokkaido University, the RCMS of Nagoya University, the IRCELS of Kyoto University to promote research in chemical sciences and aim to establish a world-class research hub.

Nanomaterials and Interfaces

Our group is studying about the interfacial phenomena between metals, metal oxides, semiconductors and soft materials in nanoscale. Our research target is not only to investigate new physicochemical phenomena on cutting edge of interdisciplinary field of science, but also to develop the new concept for future green and bio-technologies. Our topics include (1) Collective plasmon excitation on 2D crystalline sheets composed of Au and Ag nanoparticles, (2) High sensitive biosensor and high resolution bioimaging by use of localized surface plasmons, (3) Surface plasmon enhanced optoelectric devices such as LED and photovoltaic cells.



Professor
Kaoru TAMADA

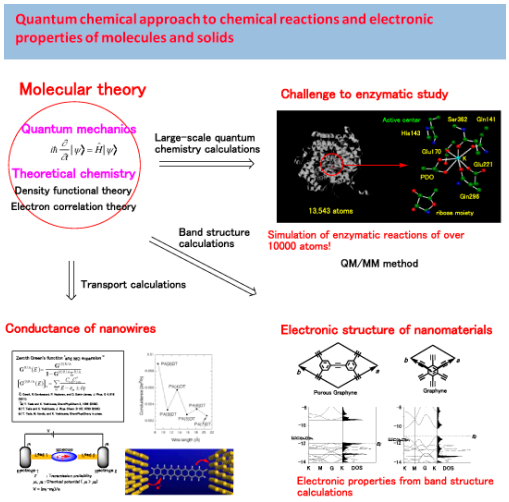


Associate Professor
Yusuke ARIMA

Assistant Professor
Yuto KAJINO

Theoretical Chemistry

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.

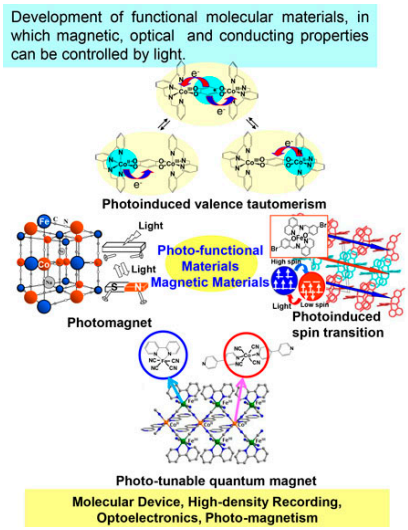


Associate Professor
Yoshihito SHIOTA

Assistant Professor
Yosuke SUMIYA

Molecular Materials Chemistry

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.



Professor
Osamu SATO

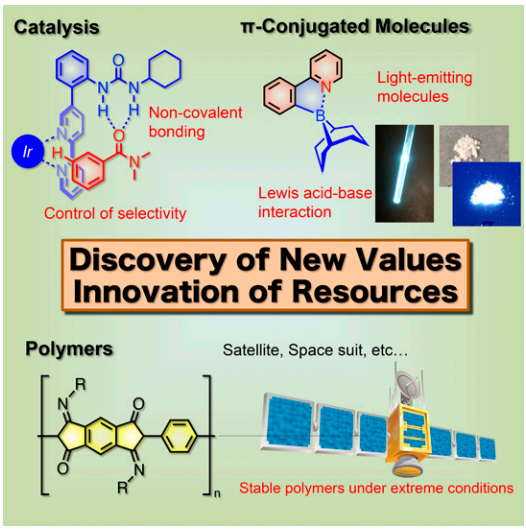
Assistant Professor
Shinji KANEGAWA

Assistant Professor
Shu-Qi WU

Research Assistant Professor
Shengqun SU

Chemistry of Functional Molecules

We create novel transition metal catalysts which can realize high activity and selectivity, and develop highly efficient and practical synthetic organic reactions, such as C-H transformations. We also create high-performance organic functional materials, such asϖ-conjugated molecules and polymers. We aim to solve energy and environmental problems through these projects. (1) Creation of high-performance catalysts (2) Development of novel and practical synthetic organic reactions, such as C-H bond transformations (3) Creation of novel organic functional materials

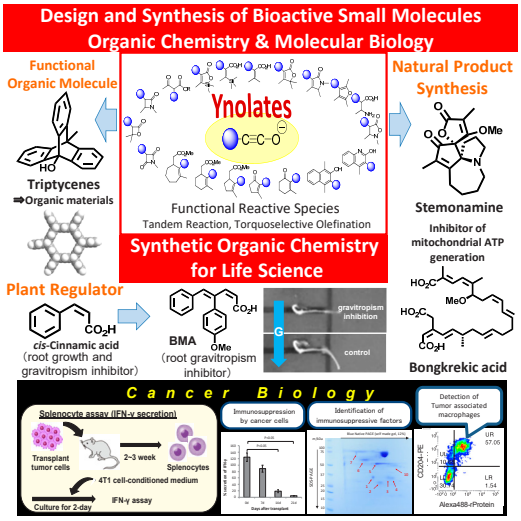


Professor
Yoichiro KUNINOBU

Assistant Professor
Kohei SEKINE

Advanced Organic Synthesis

Our research group designs and synthesizes useful bioactive organic molecules based on synthetic organic chemistry, and develops novel and effective synthetic methods. Recent studies: (1) synthesis of apoptosis inhibitors, antitumor agents, and plant growth regulators; (2) new synthetic methods using ynolates; (3) synthesis of functional iptycenes; (4) molecular release reactions; (5) elucidation of the cancer-induced immunosuppression; (6) generation of anticancer reagents based on the novel mechanistic insights.



Professor
Mitsuru SHINDO

Associate Professor
Arihiro KANO

Assistant Professor
Takayuki IWATA

Chemistry of Molecular Assembly

Synthes is 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 nonlinear 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.
○Photoinduced electron transfer and high charge mobility in porphyrin-fullerene supramolecules.
○Synthesis and photoelectronic properties of novel polycyclic π–electronic compounds.
○Photomechanical effect and photochemical reaction of aromatic diimides.

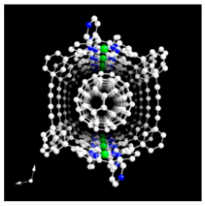


Fig . 1. Self-assembled porphyrin nanotube including linear array of fullerene C_{60}.

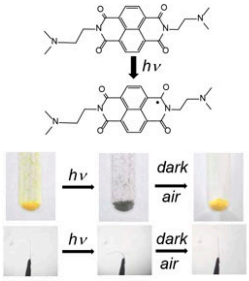


Fig . 2. Color change and crystal bending of naphthalene diimide upon photo-irradiation.

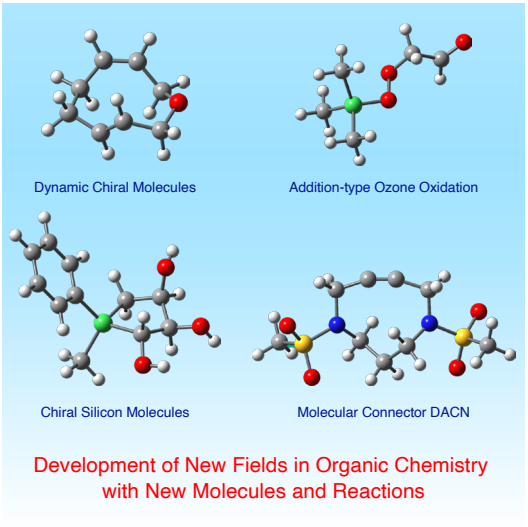
supramolecular assembly, π-electronic systems, porphyrins, fullerenes, photoinduced electron transfer, aromatic diimides, photomechanical effect,

Associate Professor
Fumito TANI

Assistant Professor
Kenta GOTO

System of Functional Molecules

Three-dimensional molecular design is important for creation of novel molecular functionality. We are focusing on the design of unique chiral molecules and the construction of novel chiral architecture based on these. Our recent works are (1) asymmetric synthesis of chiral organosilicon compounds and creation of novel chiral material based on this, (2) Creation of planar chiral heterocylic compounds and development of novel chiral-technology based on this.



Professor
Katsuhiko TOMOOKA

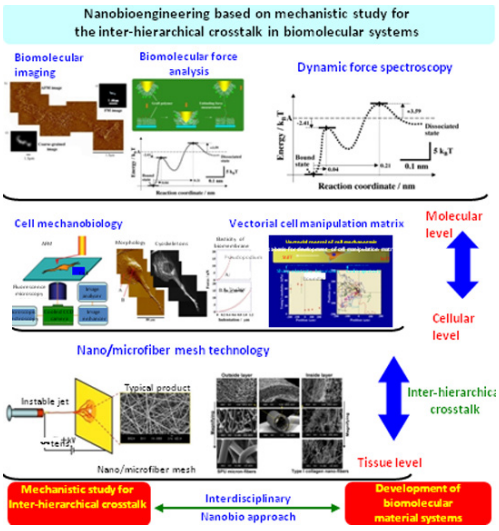
Assistant Professor
Yuya KAWASAKI

Assistant Professor
Tatsuya MORI*

* Cross Apointment Special Project

Biomedical and Biophysical Chemistry

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.



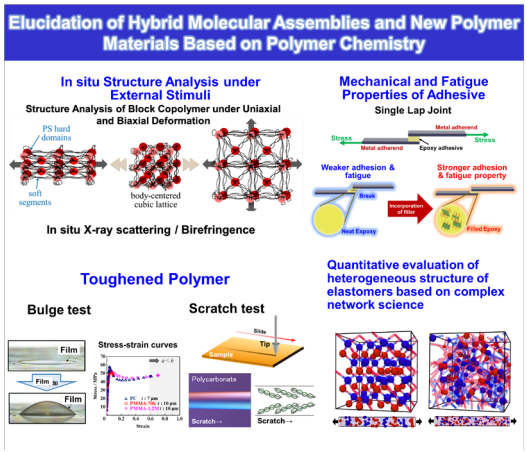
Professor
Satoru KIDOAKI

Associate Professor
Hirohiko ISE

Assistant Professor
Thasaneeya KUBOKI

Hybrid Molecular Assemblies

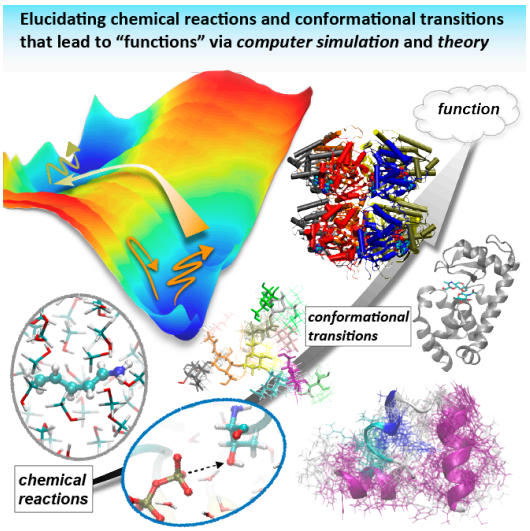
We have tried to make nano-structure controlled brand-new polymer materials with various high properties and functionals based on polymer chemistry, which includes polymer synthesis, elucidation of structure-properties relationship. Followings are some examples. (1) In situ structure analysis under external stimuli of crystalline and amorphous polymers, and elastomers using synchrotron X-ray scattering/diffraction measurement, birefringence measurement, and infrared spectroscopy, (2) mechanical and fatigue properties of single lap-joints of adhesive, (3) preparation of toughened polymers, (4) quantitative evaluation of heterogeneous structure of elastomers based on complex network science.

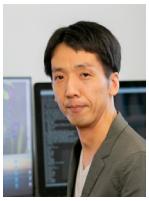


Associate Professor
Ken KOJIO

Theoretical Molecular Science

Conformational dynamics and fluctuations are essential for molecules to react and function in condensed phase. As molecular understanding of these motions are difficult to reach via experiments, our lab use computer simulations and theoretical analyses to study chemical reactions and conformational transitions of molecules in solution. The goal is to elucidate the molecular mechanisms that lead to functions of biomolecules and macromolecules. We also develop theoretical approaches to reveal the hierarchy of events that occur in condensed phase.





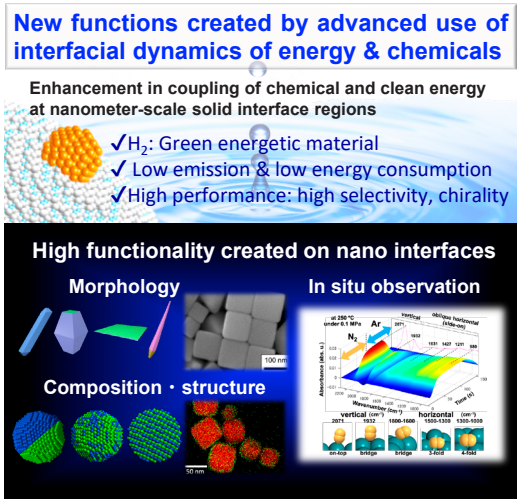
Assistant Professor
Kyohei KAWASHIMA*

* Special Project

Associate Professor
Toshifumi MORI

Inorganic Materials Chemistry

Our group are developing new functional chemicals and materials that take advantage of the characteristics of various elements. In particular, we are developing the nanoscale materials which exhibit high functionality in physical properties such as energy/chemical conversion (catalysis), energy storage (hydrogen storage), and mass transport (ion/atom diffusion, quantum diffusion) to build a sustainable chemical process that saves energy and resources.



Assistant Professor
Masaki DONOSHITA

Assistant Professor
Tomohiro NOGUCHI*

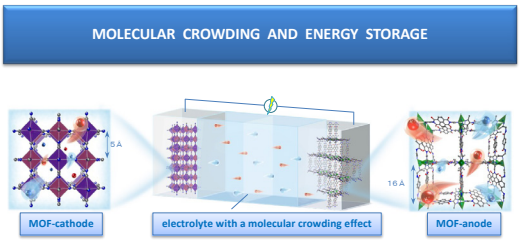
Assistant Professor
Akihiko ANZAI*

* Special Project

Professor
Miho YAMAUCHI

With Division

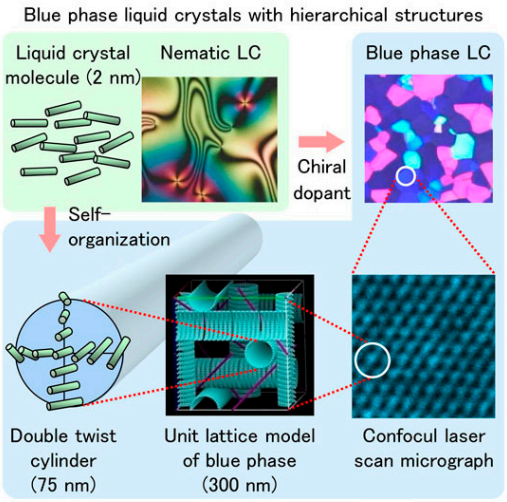
Our research interests center on the application of biologically inherited system to energy storage. Life has selected specific elements including sodium, potassium and chlorine as a charge carrier to maintain homeostasis and adapt to environmental stress by adjusting its membrane potential. We are currently studying physicochemical properties of novel aqueous as well as solid electrolyte composed of these privileged elements and biomolecules. Our ultimate goal is to develop a robust and easier-to-recycle secondary battery, which may contribute to the promotion of distributed energy resources.



Associate Professor
Masato ITO

Design of Nano-systems

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.



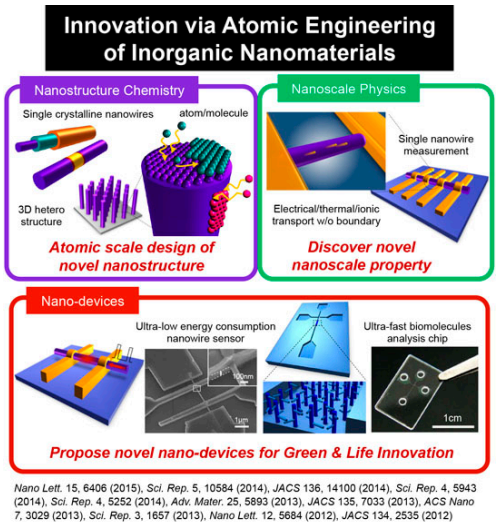
Professor
Hirotsugu KIKUCHI

Associate Professor
Yasushi OKUMURA

Research Assistant Professor
Hiroyuki MATSUKIZONO

Nanostructured Integrated Materials

Our laboratory aims to 1) synthesize novel nanostructured materials, 2) explore the novel nanoscale physical properties using single nanoscale object device, and 3) develop these novel materials for real industrial applications.



Nano Lett. 15, 6406 (2015), *Sci. Rep.* 5, 10584 (2014), *JACS* 136, 14100 (2014), *Sci. Rep.* 4, 5943 (2014), *Sci. Rep.* 4, 5252 (2014), *Adv. Mater.* 25, 5893 (2013), *JACS* 135, 7033 (2013), *ACS Nano* 7, 3029 (2013), *Sci. Rep.* 3, 1657 (2013), *Nano Lett.* 12, 5684 (2012), *JACS* 134, 2535 (2012)

Professor
Takeshi YANAGIDA*

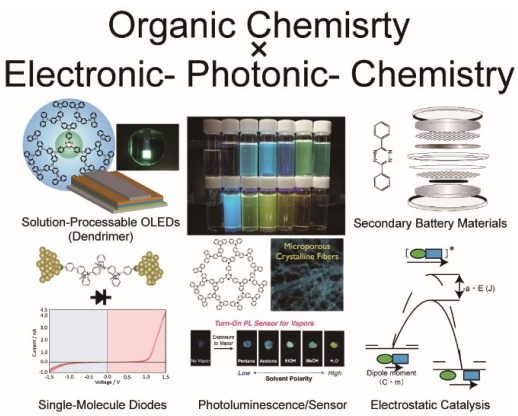
Professor
Johnny Chung Yin HO*

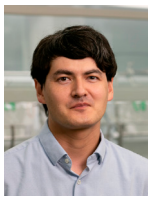
Associate Professor
Sen Po YIP

* Cross Apointment

Heterogeneous Integrated Materials

Our laboratory aims to synthesize new materials based on synthetic organic chemistry, polymer chemistry, and electro-chemistry. In particular we are developing 1) solution-processable organic-electronics materials for OLED application, and 2) cathode materials for next-generation secondary batteries.





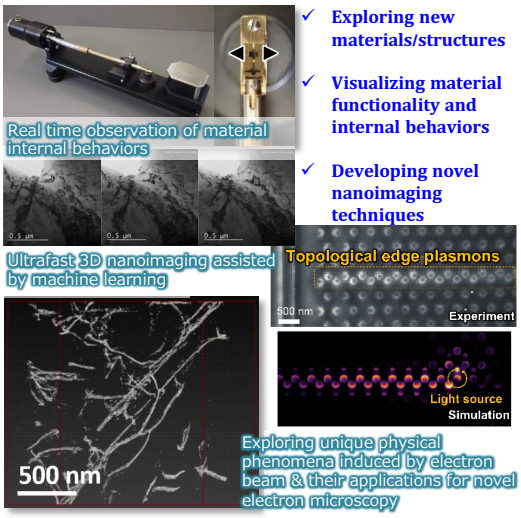
Associate Professor
Ken ALBRECHT

Assistant Professor
Kohei NAKAO*

* Special Project

Nanoscale Characterization of Materials

Focus on developing and utilizing advanced transmission electron microscopy, so-called “in-situ nanoimaging” to visualize investigate how materials response to external stimuli, i.e., heat, light, stress; such findings provide direct proof of underlying-mechanisms behind complex phenomena, and enhance understanding of macro-scale properties. Real-time nanoimaging demands hundreds or thousands of times faster data acquisition methods than conventional TEM imaging, which motivates us to strive novel methodology developments such as machine-learning-assisted image denoising for ultrafast 3D nanoimaging. Our unique imaging capabilities/expertise will unveil various physical/chemical phenomena at the nanoscale.



- ✓ **Exploring new materials/structures**
- ✓ **Visualizing material functionality and internal behaviors**
- ✓ **Developing novel nanoimaging techniques**

Professor
Mitsuhiro MURAYAMA*

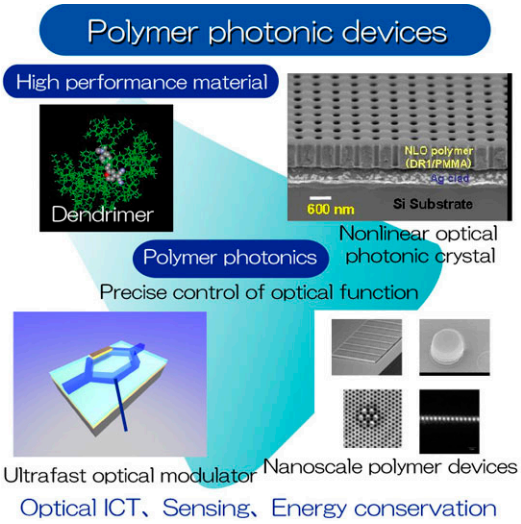
Associate Professor
Hikaru SAITO

Assistant Professor
Shiro IHARA

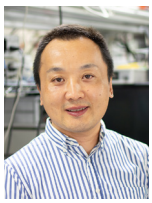
* Cross Apointment

Nano Scale Evaluation

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.



Professor
Shiyoshi YOKOYAMA

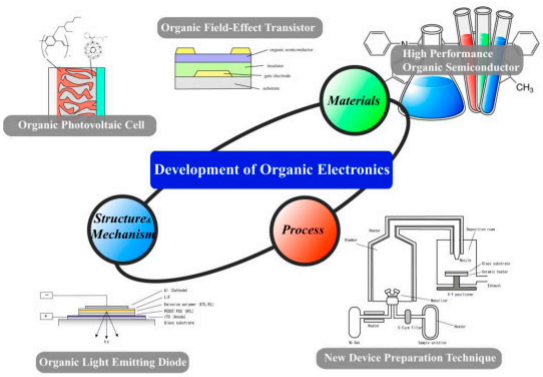


Associate Professor
Guowei LU

Assistant Professor
Hiromu SATO

Photonic Materials

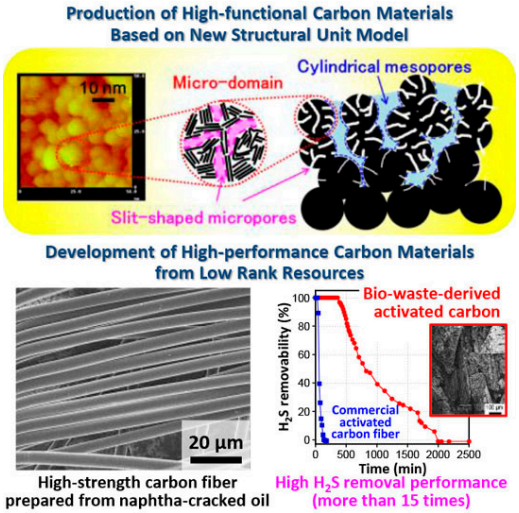
This research section has been pioneering the R&D of organic electronics including organic electroluminescence (EL) devices, organic solar cells, organic transistors and organic memories. The R&D activity is divided to three groups, device structure, high performance materials and fabrication processes 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.



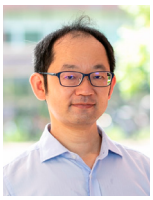
Associate Professor
Katsuhiko FUJITA

Carbon Materials Science

We develop new functional carbon materials for effective usages of energy resources and study their industrial applications. For example, we fabricate carbon nano-fibers (CNFs) having different shape, size, and surface properties, and optimize them for applications such as FC, LIB, and capacitor. We have found remarkably improved performance and durability for systems using our newly developed carbon materials, and have presented many patents and scientific papers. We are actively collaborating with various companies, and working on commercialization of our products.



Professor
Seong-Ho YOON

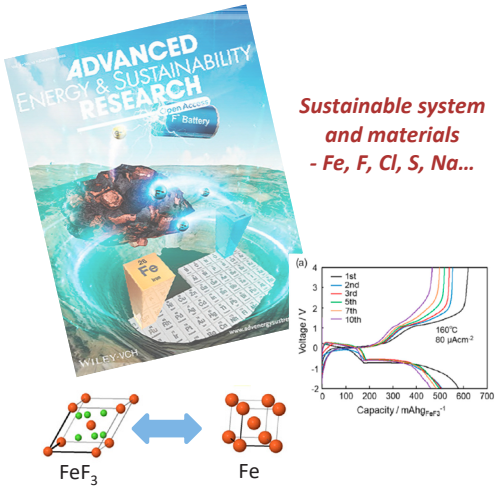


Associate Professor
Jin MIYAWAKI

Associate Professor
Koji NAKABAYASHI

Energy Storage Materials

Energy conversion devices using electrochemical reactions, such as batteries, have become indispensable in present society. Not only high performance but also sustainable development is required, and new device corresponding to it is necessary. Our aim is to develop such new battery materials and battery systems from the standpoint of material chemistry and electrochemistry. Currently, our main research fields are; (1) Development of new materials for cation-shuttle batteries: sulfur-based positive electrode materials, Li, Na conductive solid electrolyte (2) Development of new anion-shuttle batteries and materials: fluoride/chloride ion shuttle batteries

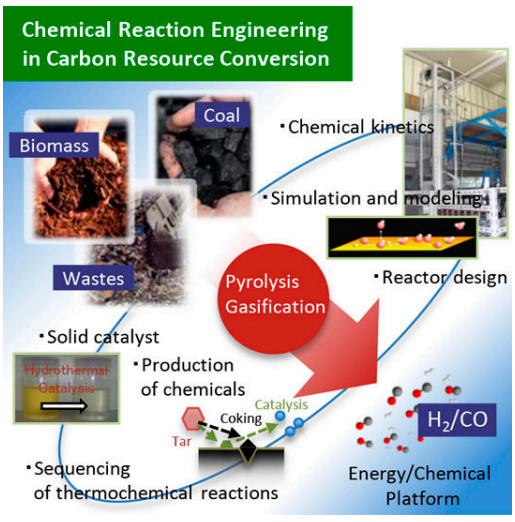


Professor
Hikari SAKAEBE

Associate Professor
Atsushi INOISHI

Microprocess Control

Main purpose: development of thermochemical reaction systems for converting carbon resources such as coal, biomass and wastes into H2/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 thermo-chemical reactions of coal and biomass, conversion of heavy oil and tar in nano/sub-nano spaces, radi-cal-driven rapid gasification of carbonized solids, pre-cise control of chemical vapor infiltration processes.



Professor
Jun-ichiro HAYASHI

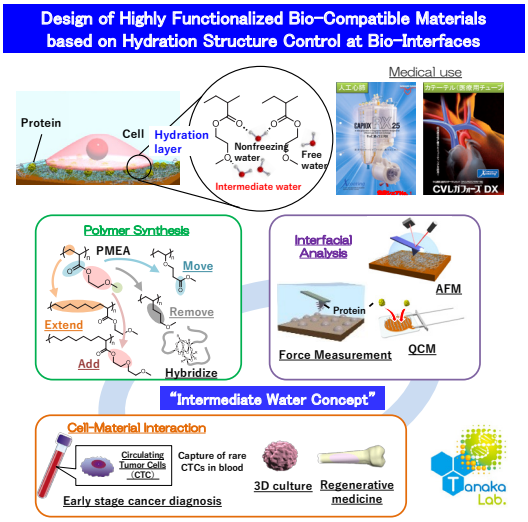
Associate Professor
Shinji KUDO

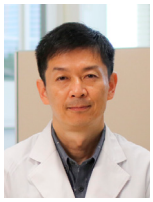
Assistant Professor
Syusaku ASANO

Research Assistant Professor
Urampully Muhammed
ASHIK

Soft Materials Chemistry

In order to attain the high “quality of life (QOL)”in aged society, the breakthrough in the research field of biomaterials (bio-compatible materials) is required. Our research aim to clarify the origin of bio-compatibility based on the role of hydrated water on bio/material interfaces, and to develop novel biomaterials with extremely high bio-compatibility, selective control of cell behavior.





Professor
Masaru TANAKA

Associate Professor
Takahisa ANADA

Assistant Professor
Iksung CHO

Reseach Associate Professor
Shingo KOBAYASHI

Associate Professor
Junjie LI*

* Special Project

Nano-bio Device

Professor (Dual Post)
Kaoru TAMADA

Associate Professor (Dual Post)
Yusuke ARIMA

Mechanobio-materials

Professor (Dual Post)
Satoru KIDOAKI

Assistant Professor (Dual Post)
Thasaneeya KUBOKI

Office of Research Support

Staff members are dedicated to research support tasks, including managing and operating large analytical equipment, as well as environmental and safety management. They possess advanced knowledge of their assigned analytical methods and provide guidance and education on measurement methods to users. Additionally, they actively handle advanced measurement contract analysis from researchers within and outside the institute, as well as from companies.

Senior Technician
Mitsutaka UMEDU
Senior Technician
Keiko IDETA
Senior Technician
Taisuke MATSUMOTO
Senior Technician
Takeshi TANAKA
Technician
Kanako IMAMURA

Shared Instruments

The institute is promoting the sharing of large equipment owned by the institute through collaborative research and joint usage programs. Evaluation Office of Materials Properties and Function operates and manages the equipment, and actively responds to inquiries and commissioned analyses from both internal and external researchers and companies.

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1. Solid and liquid nuclear magnetic resonance
2. Solid nuclear magnetic resonance
3. Transmission electron microscope
4. Single crystal X-ray structure analysis
5. X-ray diffractometer
6. Small angle X-ray scattering
7. Scanning electron microscope
8. Double focusing mass spectrometry
9. Matrix assisted laser desorption ionization time of flight mass spectrometry

Others
- Electron spin resonance
- Cold spray ionization mass spectrometry etc.

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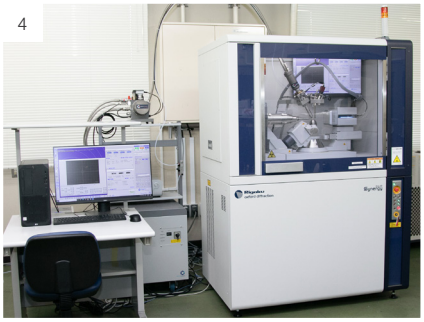

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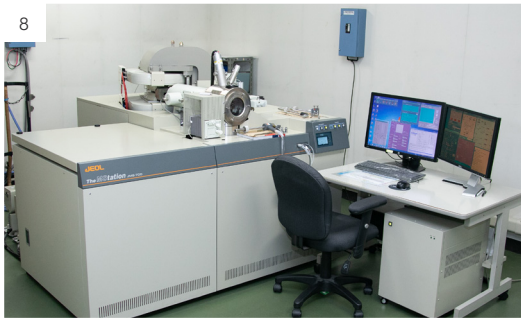

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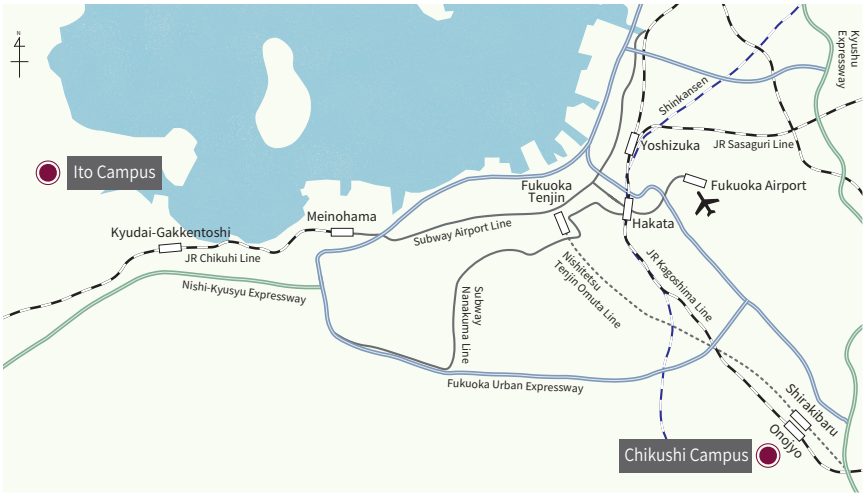
Affiliate Subdivisions

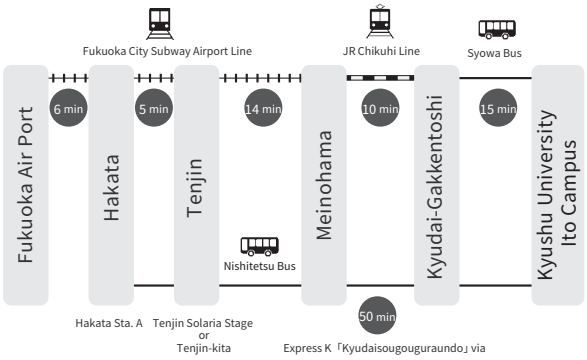
Each research field is affiliated with one of the academic departments or graduate schools. Undergraduate and master's/doctoral students conduct their research in one of the following departments or graduate schools.

Campus	Collaborating Departments
Ito	School of Engineering, Graduate School of Engineering / School of Science, Graduate School of Science
Chikushi	Interdisciplinary Graduate School of Engineering Sciences / Graduate School of Integrated Frontier Sciences

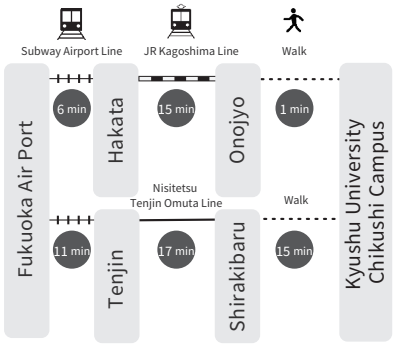
Access



Ito Campus



Chikushi Campus



Institute for Materials Chemistry and Engineering, Kyushu University

Chikushi Campus 6-1 Kasuga koen, Kasuga-shi, Fukuoka 816-8580, Japan TEL&FAX +81-92-583-7839
Ito Campus 744 Motooka, Nishi-ku, Fukuoka 819-0935, Japan TEL +81-92-802-2500 FAX +81-92-802-2501

https://en.cm.kyushu-u.ac.jp

April 1, 2024