JAIST
JAPAN ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY 1990

Japan Advanced Institute of Science and Technology
School of Materials Science

Dean‘s Welcome-

Japan Advanced Institute of Science and Technology (JAIST)

JAIST was established in October 1990 as Japan's first national graduate university, featuring a unique campus and educational research organization without an undergraduate faculty. The university focuses on conducting internationally advanced research in the field of advanced science and technology while providing graduate education based on that research. Together, we strive to make JAIST a leading research institute in materials science.

Professor Yoshifumi Oshima

-Top-notch faculty

JAIST actively recruits professors conducting world-class research from around the globe, passionately providing graduate education to cultivate leaders who will drive the next generation of science and technology. We have published numerous papers in premier journals, including Nature Materials, Nature Photonics, Nature Nanotechnology, Nature Communications, Advanced Materials, Advanced Functional Materials, Science Advances, Nano Today, Journal of the American Chemical Society, Nano Letters, ACS Nano, and more.

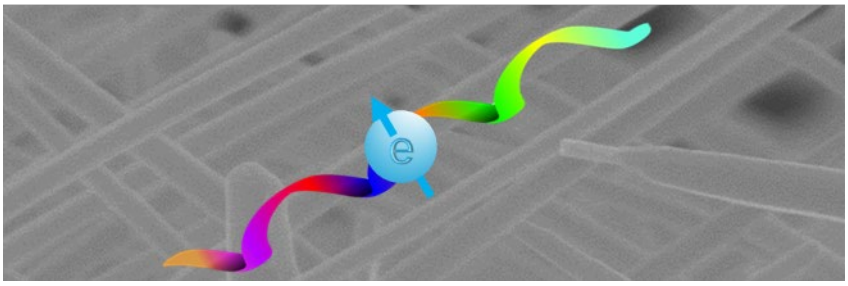
-Diverse environment

We actively promote student and faculty exchanges through collaborations with overseas educational and research institutions, enhancing the internationalization of education and research while fostering human resources capable of thriving on the global stage.

-Strong support for JAIST students

A variety of scholarships from both within and outside the university, along with on-campus dormitory accommodations, are available to ensure that students can conduct their research with financial peace of mind.

Semiconductor spintronics for future information technology

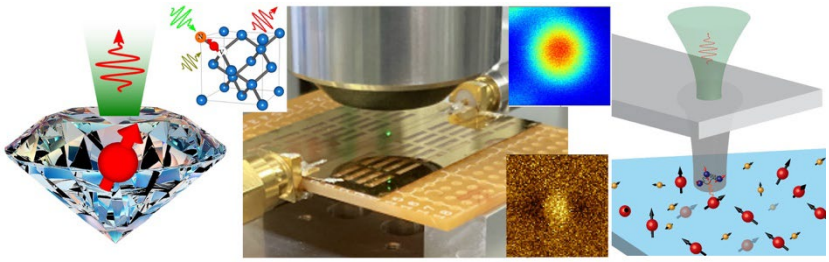


Assoc. Prof. AKABORI Masashi
https://www.jaist-akabori-lab.com/

Information technology supported by the electronics is based on controlling electric charge. Spintronics is controlling not only electric charge but also spin direction for future information technology. We are investigating semiconductor nanowire structures and semiconductor- ferromagnetic metal hybrid structures for spintronic applications. Our works are based on cleanroom and cryogenic technologies.

Keywords: *III-V semiconductors, Ferromagnetic metals, 2D materials, Nanowires, Hybrid structures, Cleanrooms, Liquid helium*

Quantum sensing and imaging

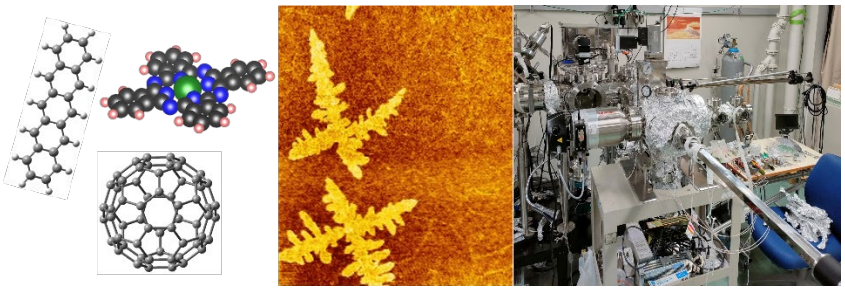


Assoc. Prof. AN Toshu
https://www.an-laboratory.com/

Spin states in diamond's atomic size defect structure: nitrogen-vacancy (NV) center exhibits extraordinary ability as not only a nanoscale sensor for magnetic, electric, and temperature sensing, but also quantum sensing finding wide application to physics, chemistry, biosensing, and quantum technologies. By attaching a tiny NV center to the apex of a scanning probe, we are developing a scanning NV probe enabling nano magnetic resonance imaging (MRI).

Keywords: *NV center, quantum technology, NV center, spintronics, nano MRI*

Tailor-made functionalization of organic thin films

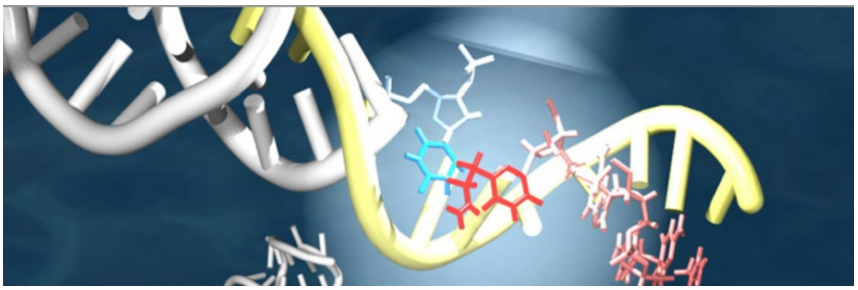


Asst. Prof. EGUCHI Keitaro
https://fp.jaist.ac.jp/public/Default2.aspx?id=721&l=1

Nanomaterials sometimes exhibit unique properties that are not found in bulk. We prepare well-defined model samples and measure their electronic structures to understand the origin of such unique properties. Also, we develop new measurement methods to reveal hidden electronic structures of samples. Based on the obtained results, we design and fabricate new functional devices.

Keywords: *self-assembled molecules, photoelectron yield spectroscopy, development of new measurement methods, organic electronics, surface/interface*

Challenges in nucleic acid therapeutics and DNA robotics

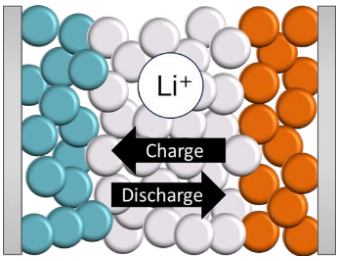


Prof. FUJIMOTO Kenzo
https://www.jaist.ac.jp/ms/labs/fujimoto/fujimotohp/

Fujimoto Laboratory will create innovative technologies, especially in the fields of nucleic acid therapeutics and DNA robotics, by integrating information, biotechnology, environment, and nanotechnology. The creation of intelligent nucleic acids with unprecedented functions is expected to lead to new pharmaceuticals, molecular sensors, molecular devices, and materials.

Keywords: *nucleic acid therapeutics, DNA robotics, nucleic acid chemistry*

Nanospace Chemistry
— Development of observation technology and controlling nanostructure —

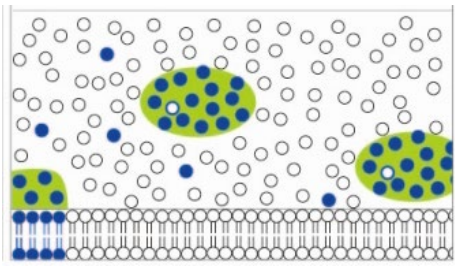


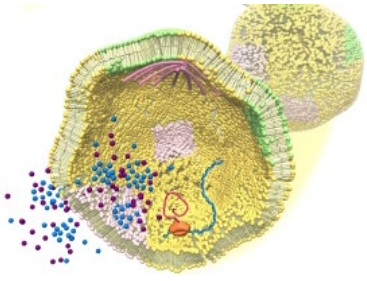
Prof. GOTOH Kazuma
https://www.jaist.ac.jp/nmcenter/labs/gotoh-www/

Our group emphasizes understanding microscopic and mesoscopic structures in nanospace of porous and layered materials such as carbon and inorganic compounds using analytical methods such as solid-state nuclear magnetic resonance (SSNMR). We contribute to revealing the mechanisms of secondary batteries containing these materials as electrode materials.

Keywords: *NMR, carbon materials, lithium ion batteries, sodium ion batteries, operando analysis*

Membrane biophysics: Design of an artificial cell model





Assoc. Prof. HAMADA Tsutomu
https://www.jaist.ac.jp/ms/labs/hamada/index.html

Living cells are a form of self-assembled soft matter. Lipid bilayer membranes are essential components of living organisms. We use a soft matter physics approach to cell-mimicking systems so that we can understand the physical principles of biological systems. We construct artificial lipid vesicles which produce cellular dynamics, such as micro-domain transformation and membrane fusion, and conduct quantitative analyses based on soft condensed matter physics.

Keywords: *lipid membrane, liposome, protocell, phase separation, soft matter*

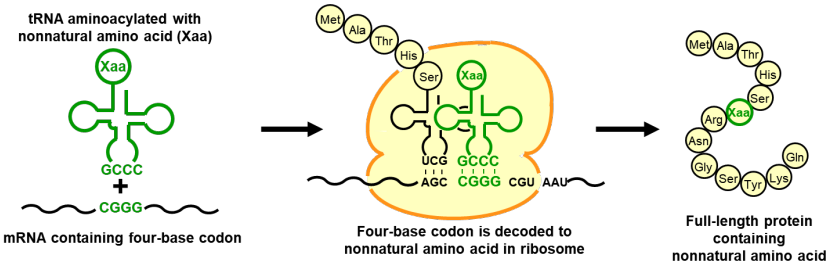
New robotics opened up by protein engineering

Assoc. Prof. HIRATSUKA Yuichi
https://www.youtube.com/watch?v=akl-gIALo2IAaa

Proteins with various functions are attractive molecular building blocks for micro-robots. In our laboratory, we are working on the development of microrobots that are powered by artificial muscles made from engineered protein molecules, with a particular focus on motor proteins.

Keywords: *molecular robotics, protein engineering, biophysics, micro/soft-robot, artificial muscle, micro-fabrication*

Unnatural Protein & Peptide Investigation

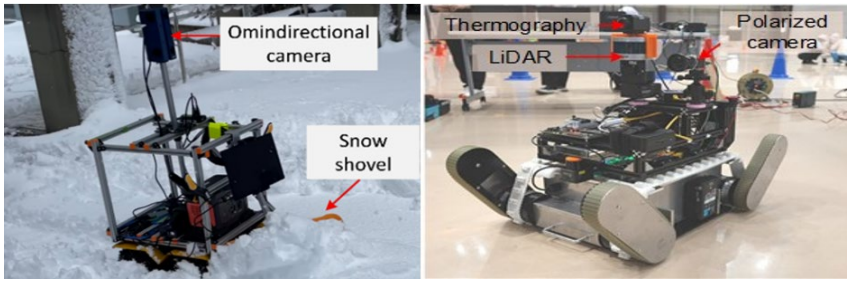


Prof. HOHSAKA Takahiro
http://www.jaist.ac.jp/ms/labs/hohsaka/

Living organisms synthesize various proteins using only 20 types of amino acids. By introducing unnatural amino acids through expansion of the genetic code, our laboratory investigates the design and synthesis of novel proteins and peptides with artificial functions for bioengineering and biomedical applications.

Keywords: *unnatural amino acid, genetic code expansion, cell-free translation*

Intelligent Environmental Sensing Using Unmanned Mobile Robot

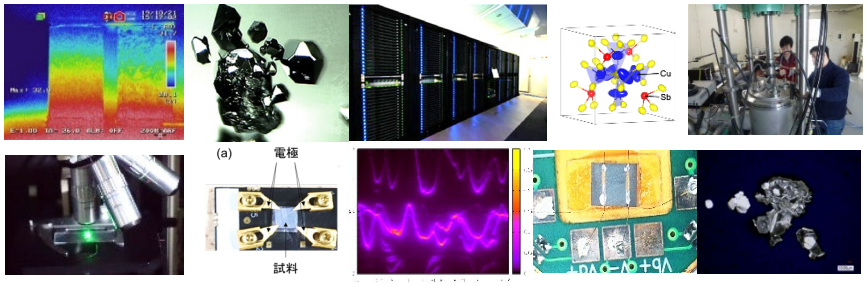


Assoc. Prof. JI Yonghoon
http://robotics.jaist.ac.jp

Our group conducts various research required for real-world applications through robot technology. Specifically, we analyze data from the various sensors mounted on the unmanned mobile robot and extract shape information or physical properties distributed in the environment such as material information to utilize them to solve various problems in our society.

Keywords: *mobile robot, robot vision, environmental sensing, SLAM*

Physics of Thermoelectric materials and Low-dimensional Materials



Prof. KOYANO Mikio
https://www.jaist.ac.jp/ms/labs/kotai/koyano/

Don't you like to utilize waste heat as useful electric power? Do you like to know how energy is dissipated in matter? Do you like to work with mysterious layered materials? Don't you try to improve your ability in Japan? Do you love science and technology?

Our laboratory develops environmentally friendly thermoelectric materials and studies how heat energy is converted to electricity in the thermoelectric materials. We also study the physics of low-dimensional materials and the intercalation compounds.

Keywords: *thermoelectrics, energy conversion, materials design, low-dimensional materials*

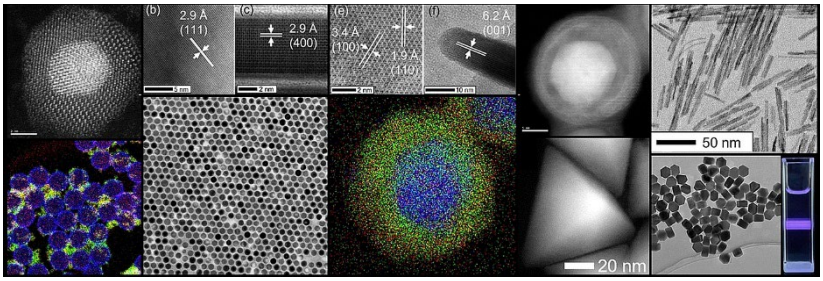
Enhancing Healing Power with Functional Biomaterials

Prof. KURISAWA Motoichi
https://kurisawa-lab.labby.jp/

Kurisawa Laboratory specializes in developing innovative nanomedicine for treating challenging diseases. Our pioneering work includes the development of green tea-based nanomedicine with inherent anticancer properties and synergistic effects with various therapeutics. Moving forward, we aim to tackle intractable diseases, including cancer, using green tea catechin derivatives.

Keywords: *drug delivery system (DDS), nanomedicine, cancer therapy, green tea catechin*

Nanoparticle Science and Technology From Synthesis to Applications

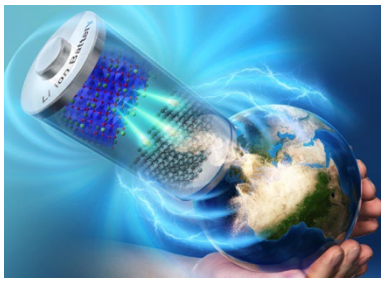


Prof. MAENOSONO Shinya
https://www.jaist.ac.jp/~shinya/index-en.html

Nanoparticles (NPs) have intermediate properties between atoms (molecules) and bulk crystals. Based on nanomaterials chemistry, we conduct comprehensive and cross-disciplinary research from the frontiers of synthesis and functionalization of various NPs to the application of these NPs in the energy and biomedical fields.

Keywords: *nanoparticles, energy-conversion materials, bio-nanotechnology*

Organic polymer/compounds to boost performance of Metal-ion Secondary Batteries



Prof. MATSUMI Noriyoshi
https://www.jaist.ac.jp/ms/labs/matsumi/

Our group is working on strategic design of functional polymer materials/compounds to enhance the performance of advanced Li-ion secondary batteries/Na ion secondary batteries through optimization of interfacial properties. These approaches have been effective in stabilizing Si based anode/LiNMC based cathode and enabling high rate charge-discharge performance in various battery systems.

Keywords: *polymer binders, electrolytes, additive, active materials, artificial SEI/CEI, metal-ion secondary batteries*

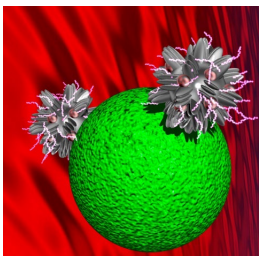
Interdisciplinary Polymeric Biomaterial Innovation

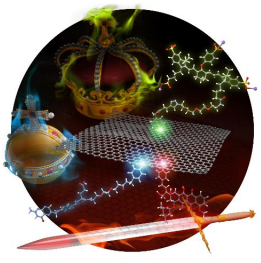
Prof. MATSUMURA Kazuaki
https://matsu-lab.info/

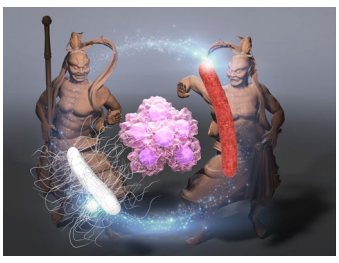
Matsumura Laboratory focuses on developing functional polymeric biomaterials for applications in drug delivery, tissue engineering, and cryopreservation. Our research emphasizes polyampholytes, zwitterionic polymers, biodegradable polymers and hydrogels. We aim to create materials that interact seamlessly with living systems, fostering interdisciplinary approaches combining chemistry, biology, and medicals science.

Keywords: *polyampholytes, zwitterionic polymers, drug delivery system, tissue engineering, hydrogels, cryopreservation*

Advanced therapy using functional biomaterials





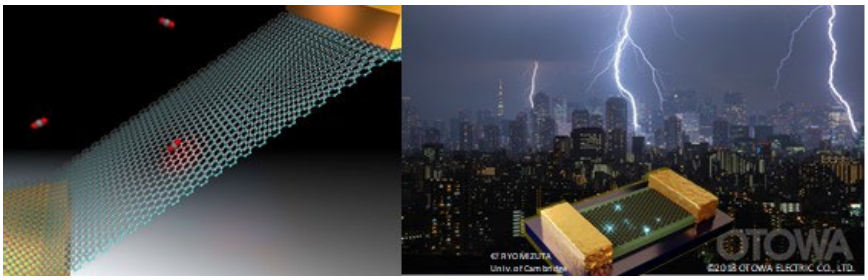


Assoc. Prof. MIYAKO Eijiro
https://miyakoeijiro.wixsite.com/eijiro-miyako-lab

Using various traits of functional biomaterials based on nanomaterials and/or living bacteria, we challenge to develop an innovative therapy against cancer and brain disorders. To this end, our work is focused on the preparation of high-quality biomaterials, the engineering of their surface and gene circuits, and their assembly and consolidation into a functional biomaterial to the innovative treatment, as well as to develop fundamental understanding of their nature.

Keywords: *nanomaterials, bacteria, biomaterials, biotechnology*

Empathetic and Symbiotic Nanotechnology with Nature



Prof. MIZUTA Hiroshi
https://www.jaist.ac.jp/ms/labs/mizuta-lab/english/

By listening to the silent voice (voice of the voiceless) of the natural world through nano-to-macro multiscale sensing technologies, Mizuta-Kareekunnan Group develops innovative technologies that enable us to forecast and prevent natural disasters such as fierce lightning and presymptomatic diseases, and explore actions to minimize damage.

Keywords: *graphene, 2D materials, NEMS, single-molecular sensing, lightning sensing*

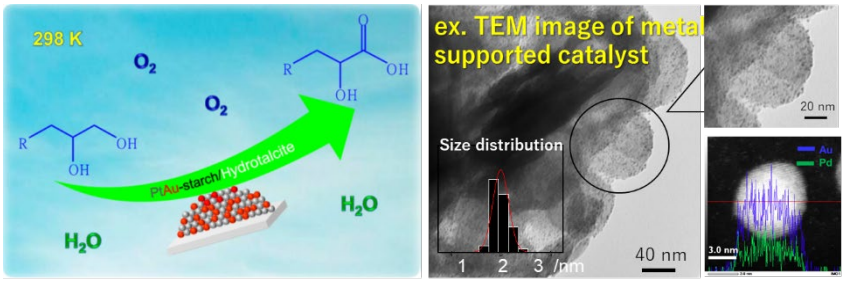
Innovating for a Greener Future through Advanced Materials Science

Prof. NAGAO Yuki
http://www.jaist.ac.jp/ms/labs/nagao-www/?lang=en

Nagao lab focuses on the advancement of next-generation fuel cells, batteries, supercapacitors, sensors, and protonic transistors, aiming for sustainable development. To support the global shift toward a decarbonized society, we are dedicated to researching ion-conducting polymer materials, inorganic materials, and organic-inorganic hybrid materials.

Keywords: *hydrogen society, sustainable energy development, nanoprotonics*

Functionalized Solid Catalyst for Energy & Resources Supply



Assoc. Prof. NISHIMURA Shun
https://www.jaist.ac.jp/~s_nishim/index

Solid catalyst has a key role on energy & resources supply in our society. Our aim is developing highly-functionalized catalyst process and revealing its mechanism by means of spectroscopic studies. In particular, we have focused on the transformation processes such as renewable biomass resources and wasted materials such as used oil and carbon dioxides.

Keywords: *metal nanoparticle, solid acid/base catalyst, catalyst design, mechanistic study*

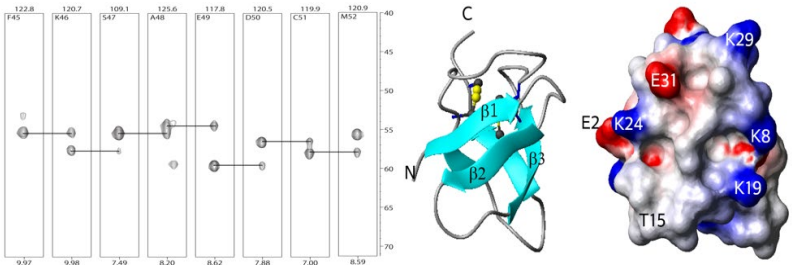
Development of Next-Generation Si-based Solar Cells

Prof. OHDAIRA Keisuke
https://www.jaist.ac.jp/ms/labs/ohdaira/

Expanding the use of photovoltaics is an urgent task toward achieving carbon neutrality. Our group focuses on the development of novel technologies to achieve higher performance and lower cost of silicon-based solar cells. We also study the long-term reliability and of photovoltaic modules including encapsulant-less novel module structures.

Keywords: *silicon solar cell, photovoltaic module*

Exploring structure-based protein function

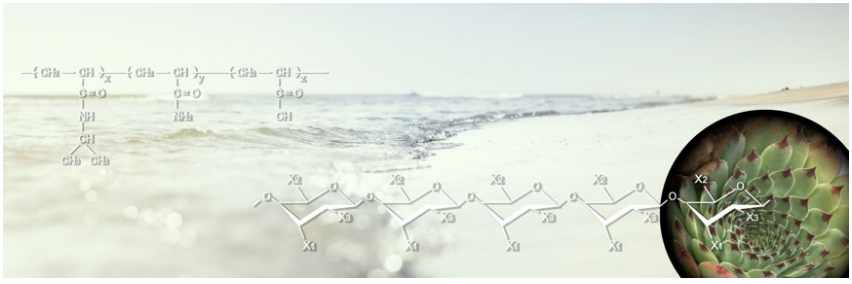


Prof. OHKI Shinya
https://www.jaist.ac.jp/nmcenter/labs/s-ohki-www/

Understanding functional mechanism of intriguing proteins at atomic resolution is undoubtfully important for developing new drugs, enhancing food production, improving environment and so on. To gain the deep understanding, we extensively employ solution NMR (nuclear magnetic resonance), one of the analytical tools, to uncover three-dimensional structure, dynamics and interaction of proteins.

Keywords: *protein science, structural biology, biophysics, biochemistry, NMR (nuclear magnetic resonance)*

Beyond Polymeric Organization: DRY & WET

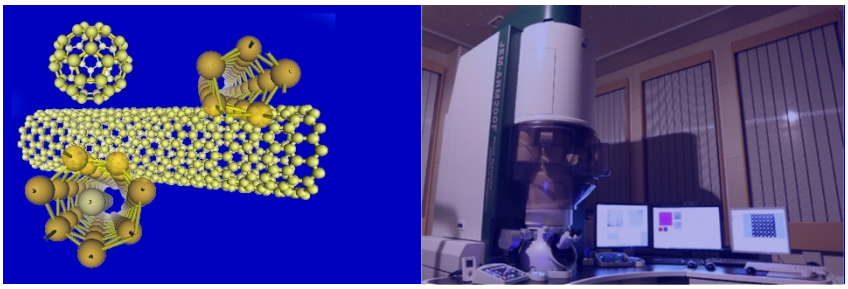


Assoc. Prof. OKEYOSHI Kosuke
https://sites.google.com/oke-acgroup.com/web

Inspired by history of natural environment and biomaterials, we are designing and fabricating functional soft materials through organizing polymeric materials. To propose advanced energy transforming systems, materials living with water are the target. Simultaneously, we are learning natural phenomena for design of polymer networks.

Keywords: *polymeric gels, water, soft matter, photo-functional materials, energy transformation*

Microscopic exploration of nano-scale properties

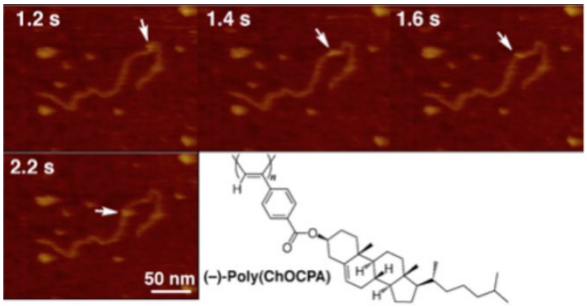


Prof. OSHIMA Yoshifumi
https://www.jaist-oshima-labo.com/english/

Nanoscale and atomic-scale materials have a variety of functionalities that have the potential to outperform current electronic devices and sensors. We are conducting research to reveal the properties of such nanoscale and atomic-scale materials by establishing our own nano-measurement methods based on transmission electron microscopy. We are developing our research internationally through collaborations both domestically and internationally.

Keywords: *transmission electron microscope, nanomaterials, 2D materials, design and development of measurements, data science, nanophysics*

Single Molecules Imaging: Development of Polymer Motor beyond Proteins



Assoc. Prof. SHINOHARA Ken-ichi
http://www.jaist.ac.jp/ms/labs/shinohara/

If a molecule can move unidirectionally using thermal fluctuation, a molecular motor having the function of substance transport and morphological change is created. In our recent study, molecular walking along a rail of a synthetic helical polymer was discovered by AFM video imaging. This walk was unidirectional processive movement in an organic solvent at room temperature (*Fig.*). This result is a breakthrough as the first step in order to create an artificial life-function.

Keywords: *molecular motor, molecular machine, AFM, laser trap, synthetic polymer*

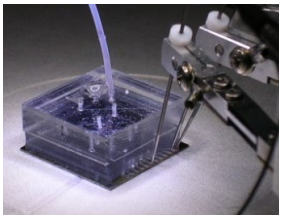
Compound semiconductor devices for future electronics

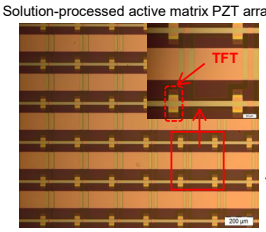
Prof. SUZUKI Toshi-kazu
https://www.jaist.ac.jp/nmcenter/labs/suzuki-www/

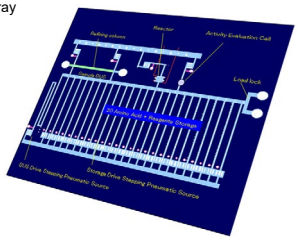
Suzuki laboratory conducts researches on compound semiconductor devices, which are important for future electronics, in particular for high-speed and energy-saving applications. We develop compound semiconductor device fabrication technologies, as well as device characterization methods in order to obtain deeper insights into device operations.

Keywords: *compound semiconductors, high-speed devices, energy-saving devices, device characterization methods*

Biomedical devices and sensors using cutting-edge nanotechnology





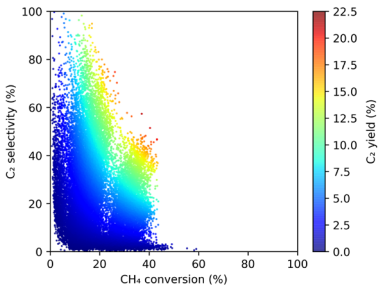


Prof. TAKAMURA Yuzuru
https://www.jaist.ac.jp/ms/labs/takamura

Yuzuru Takamura Laboratory is developing novel biochips for biomedical and environmental applications employing semiconductor, nano-Biomaterial, micro/nanofluidcs, and lab-on-a-chip techniques. Our interest extends to understanding of phenomena in nano & micro scale, new fabrication processes for biochips, and practical applications such as high sensitive point of care testing, analysis of single cell and ultra-compact analytical devices.

Keywords: *bioMEMS, microfluidics, analytical chemistry, biosensor, single cell analysis*

Data-driven catalysis with high-throughput experimentation

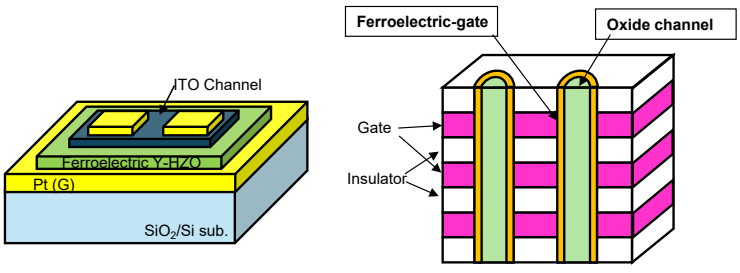


Prof. TANIIKE Toshiaki
https://www.jaist.ac.jp/ms/labs/taniike/en/

The data-driven approach applied in the field of catalysis, called catalyst informatics, is a potential game changer in R&D, though its implementation is bottlenecked by the scarce availability of sized data. Our group is practicing large-scale yet efficient catalyst R&D by generating sized and qualified data and screening numerous hypotheses with our own technologies for high-throughput experimentation and machine learning.

Keywords: *catalysis, high-throughput experimentation, informatics, machine learning*

Ferroelectric Films and Devices for Future Nonvolatile Memories

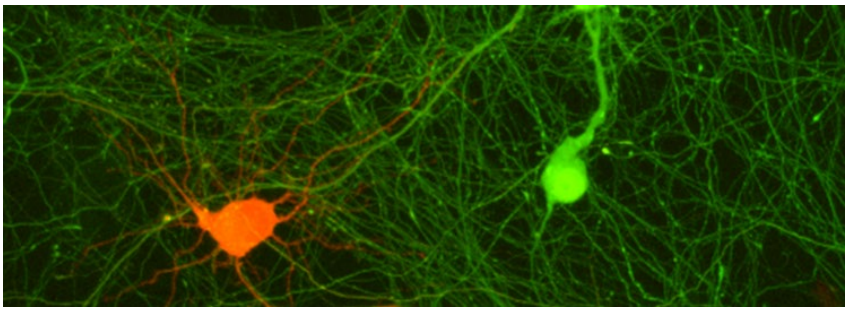


Prof. TOKUMITSU Eisuke
https://www.jaist.ac.jp/ms/labs/tokumitsu/

Future IoT and AI applications requires enormous semiconductor memory capacity. Our group focuses on the development of ferroelectric thin films and ferroelectric-gate transistors which leads to nonvolatile, high-speed, high endurance, low power consumption semiconductor memory integrated circuits. In particular, conductive oxide channel ferroelectric gate transistors are expected to be used for high-density 3D NAND structure memories.

Keywords: *ferroelectric film, nonvolatile memory, ferroelectric-gate transistor*

Molecular tools for neuronal signal detection

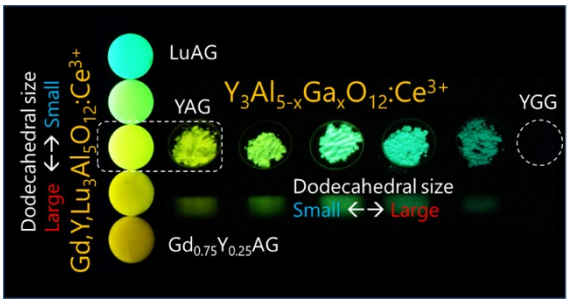


Assoc. Prof. TSUTSUI Hidekazu
https://www.jaist.ac.jp/ms/labs//tsutsui/

Technological advances in the measurements of neuron electrical activities are essential to explore the mystery behind neuronal circuit operations. By combining molecular biology and microfabrication techniques, we seek to develop next-generation molecular tools for the detailed detection of neuronal electrical activities.

Keywords: *neuron, synapse, DNA, protein, microfabrication, electrophysiology, bio-imaging*

Development of Optically Functionalized Materials

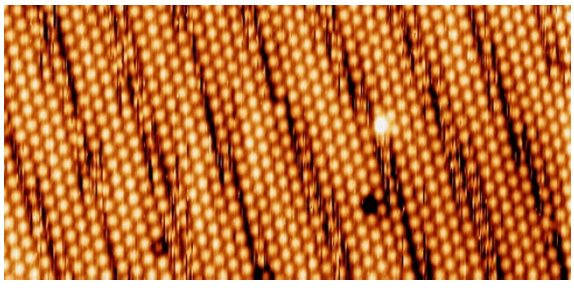


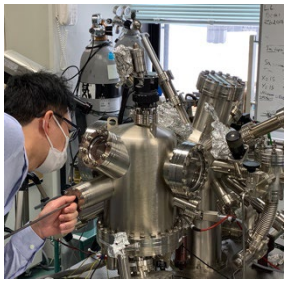
Assoc. Prof. UEDA Jumpei
https://uedalab.com/

Inorganic luminescent materials have been widely used in various applications. The optical properties of the luminescent materials vary greatly depending on the type of luminescence center, its geometrical and chemical coordination environment, and the electronic structure of the host material. By controlling the these factors, novel white LED phoshphors, persistent pshophors, luminescent themomters are developed.

Keywords: *lanthanide ions, transition mental ions, phosphors, persistent phosphors, storage phosphors, transparent ceramics*

Towards the atomistic understanding of surfaces and interfaces



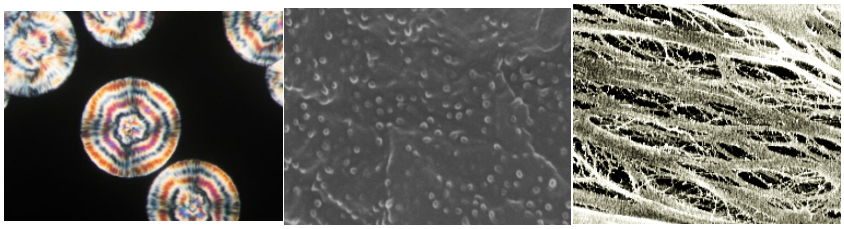


Prof. YAMADA-TAKAMURA Yukiko
https://www.jaist.ac.jp/ms/labs/yukikoyt/

Modern industry is founded on thin film materials technologies, ranging from protective coatings to electronic devices. To improve their performance, film-substrate interface is critical. The surfaces and interfaces become even more important in the growth of nanomaterials and their properties. Our aim is to develop new nanomaterials based on the understanding of surfaces and interfaces through advanced microscopies.

Keywords: *nanomaterials, 2D materials, thin films, surface structure, SPM, STM*

Rheology for Soft-Material Design

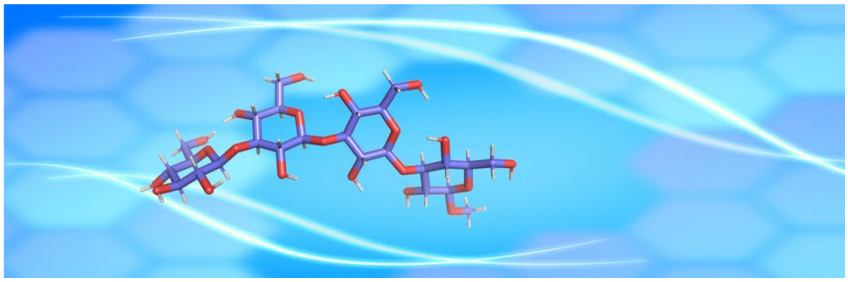


Prof. YAMAGUCHI Masayuki
https://www.jaist.ac.jp/ms/labs/yamaguchi/

Rheology - the new science of deformation and flow for a material showing complicated mechanical responses - is inevitable to develop advanced soft materials including polymers. Our lab. is carrying out material design of functional and high performance polymers based on the rheological approaches.

Keywords: *polymer rheology, polymer processing, polymer blends*

Sweet Science of Bio-functional Sugar Molecules

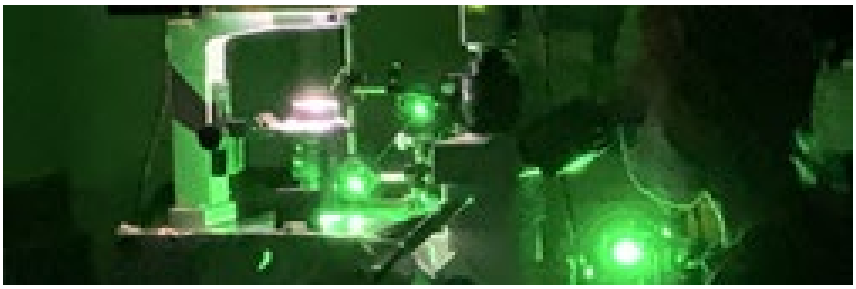


Assoc. Prof. YAMAGUCHI Takumi
http://www.jaist.ac.jp/ms/labs/t-yamaguchi/

Carbohydrates play crucial roles in a variety of biological events such as cell-cell communications. Our research seeks the underlying molecular basis for the function of carbohydrates, providing knowledge for the rational design of drugs and biomolecular engineering that contribute towards a detailed understanding of living systems.

Keywords: *glycoscience, protein science, biochemistry, bioinformatics, molecular simulation*

Surface-enhanced Raman spectroscopy for single-molecule detection



Assoc. Prof. YAMAMOTO S. Yuko
https://www.researchgate.net/profile/Yuko-Yamamoto-2

Yamamoto Laboratory focuses on molecular spectroscopy, especially surface-enhanced Raman spectroscopy (SERS). In SERS, Raman scattering signal extremely enhanced up to 10^{10}, enabling us single-molecule detection of the analytes. Plasmon resonance is key for this SERS enhancement, which is an oscillation of electrons in free electron-rich metals. Therefore, we also have an interest in plasmon resonance.

Keywords: *surface-enhanced Raman scattering (SERS), Raman spectroscopy, plasmon-enhanced spectroscopy*