Department of Applied Physics

Laboratory	Professor / Associate Professor	Theme of research
Applied Interface Physics (Spin Electronics)	Yasuo ANDO, Professor Mikihiko Oogane, Associate Professor	The spintronics field has been attracting attention. In our laboratory, we are discovering new phenomena utilizing character of spins in the ferromagnetic thin films and thier multi-layers. In addition, we have been developing novel spintronic devices such as non-volatile magnetic memory and ultra-sensitive bio-magnetic sensors.
Applied Solid State Physics (Mathematical Physics)	Kumiko HAYASHI, Associate Professor	We study the motion of nano-scaled molecules based on mathematical physics and statistical mechanics. The data obtained by large-scale computer simulation or micro- scopic imaging are analyzed to (1) elucidate the mechanism of protein motors, (2) apply the fluctuation theories of non-equilibrium statistical mechanics to biomolecules, (3) classify the data of protein simulations by using the method of manifold learning, and so on.
Applied Solid State Physics (Solid State Physics)	Yukihiro SHIMIZU, Associate Professor Hiroki TSUCHIURA, Associate Professor	・ Theoretical study of chemical reactions on the catalyst based on the DFT calculation, and the application to the exhaust purification ・ Development of new method of electronic state calculations, such as tensor network, for the strongly correlated systems ・ Theoretical study for finite-temperature magnetic properties of rare- earth permanent magnets ・ Theoretical study for superconductivity in strongly correlated electronic systems, and topological materials
Applied Solid State Physics (Optical Science and Materials)	Takumi FUJIWARA, Professor Yoshihiro TAKAHASHI, Associate Professor	1. Creation of heat flow circuit using magnon thermal conductivity material 2. Physics and development of chemically strengthened glass 3. Giving high thermal conductivity to glass 4. Evaluation of thermal properties of thin films using laser light 5. Development of new phosphor and its biological applications 6. Light wave-controlling devices based on glass and glass-ceramics 7. Novel Heat-storage material and thermal magagement for efficient energy utilization
Applied Solid State Physics (Quantum Information Physics)	Hiroaki MATSUEDA, Professor	Information-theoretical notions such as quantum entanglement are powerful tools in many branches of theoretical physics. We aim to construct mathematical basis for next-generation interdisciplinary physics by dealing with various problems such as condensed matter physics, mathematical physics, and space-time physics. In particular, we are interested in reconstruction of renormalization group in terms of singular value decomposition, composite-operator and tensor-network approaches to spectroscopy for strongly interacting quantum many-body systems, photoinduced phase transition, and close relationship between quantum information and space-time. These examinations are also applied to the study of performance of quantum computation and machine learning.

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Applied Material Physics (Solid State Physics)	*Akimasa SAKUMA, Professor	Our group is concerned with theoretical studies on condensed matter. The main interests lie in (1) analyzing magnetic properties of practical magnetic materials by means of the first-principles calculations in order to provide theoretical guidelines for developing novel materials, and in (2) studying spintronics to understand various non-equilibrium phenomena with respect to both the charge and the spin of electrons in magnetic multi-layered systems.
Applied Material Physics (Functional Crystalline Materials)	Yuzuru MIYAZAKI, Professor Kei HAYASHI, Associate Professor	We have been exploring novel energy-harnessing materials, such as thermoelectric materials, cathode materials for rechargeable batteries and photovoltaic materials. Functions of a solid substance primarily depend on the electronic structure, directly derived from its crystal structure. Through high-quality structure analyses using neutron and X-ray diffraction, combined with first-principles calculations, we have been fabricating materials with desired functions. For developing future device technologies, challenges on off-diagonal thermoelectric devices and flexible thermoelectric materials are currently underway.
Applied Material Physics (Low Temperature Physics and Superconductivity Physics)	Masatsune KATO, Associate Professor	・ Search for new high-temperature superconductors has been carried out using soft-chemical synthetic techniques in order to discover a room-temperature superconductor. ・ Basic physical properties have experimentally been studied in order to elucidate the mechanism of high-temperature superconductivity. ・ Heat transport due to spins in low-dimensional quantum spin systems has been investigated.
Applied Material Physics (Biophysics and Bioengineering)	Shoichi TOYABE, Professor Shuichi Nakamura, Associate Professor	We are exploring the physics and engineering of autonomous and soft systems like biological phenomenon. Especially, with a focus on the mechanical motions such as the bacterial motion and biological nano-motors and the information processing such as the gene replication, we are studying the physics of nano-sized autonomous system subjected to thermal fluctuations. Furthermore, we are developing a novel engineering concept to produce artificial nanomachines by imitating the biological nano machineries.
Institute for Materials Research (High Field Laboratory for Superconducting Materials)	Satoshi AWAJI, Professor Shojiro KIMURA, Associate Professor	Our laboratory is one of five steady high magnetic field facitlties in the world. We develop high filed magnets and supercondcing materials. In addition, the research in high magnetic fields on a solid state physics and superconducting materials, and a material development using magnetic fields are performed using a 30 T hybrid magnet, a 25T cryogen-free superconducting magnet and a 20T superconducting maget and so on.
Institute of Multidisciplinary Research for Advanced Materials (Nanoscale Magnetism)	Satoshi OKAMOTO, Professor Nobuaki KIKUCHI, Associate Professor	Our main reserch is to exprore the magnetic functionalities from a nanoscale point of view. High-perfirmance magnetic meterials are utilized for various fields such as information comunucation technology, energy conversion and saving, electric mobilities, and so on, and these are indispensable our daily life. Our current research projects are high-performance permanent magnets, next-generation ultra-high density magnetic recroding, and high frequency spin dynamics.

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Institute of Multidisciplinary Research for Advanced Materials (Synchrotron Radiation Soft X-ray Microscopy)	Masaki TAKATA, Professor Takeo EJIMA, Associate Professor Susumu YAMAMOTO, Associate Professor	Remarkable advances in nanotechnologies for semiconductor lithography and for bio-science are expected by utilizing soft X-ray with wavelengths less than 15 nm. In order to manipulate the soft X-rays, we are studying and developing cutting-edge optical-elements of high-performance and/or multifunction, and our goal of the study is establishment of the soft X-ray optical technology. In the present project, a soft X-ray microscope has been experimentally produced for high spatial resolution with the help of optical interference effect, and is applied to the evaluation of the microscopic electronic-structures of materials and high-resolution observation of biological samples. In addition, a new soft X-ray optical system has also been developing to improve spatial resolution of soft X-ray microscopes.
Institute of Multidisciplinary Research for Advanced Materials (Quantum Electron Science)	Masahiko TAKAHASHI, Professor Noboru WATANABE, Associate Professor	Properties of matter, such as reactivity and functionality, are determined by the motion of electrons bound in matter. For this reason we develop and employ new spectroscopic methods using high-energy electron scattering in order, for instance, to visualize the electron motion in stable species and more importantly the change of electron motion in transient species, which is the driving force behind any chemical reactions. The project involves: 1. Development of a real-time spectroscopic complex for visualizing electron and nuclear motions during chemical reaction, 2. Molecular orbital imaging by electron momentum spectroscopy, 3. Development of multidimensional coincidence techniques for studies of stereo-dynamics in electron-molecule collisions.
Institute of Multidisciplinary Research for Advanced Materials (Quantum Optoelectronics)	Shigefusa CHICHIBU, Professor	The main research themes are basic research and application of optoelectronic semiconductor materials such as (BAlGaIn)N and (MgZn)O: epitaxial growth of their films and quantun structures; luminescence dynamics of excitons in them; coherent light source based on cavity polaritons.
Advanced Institute for Materials Research(AIMR) (Device/System Group)	Shigemi MIZUKAMI, Professor	We develop new inorganic materials and organic/inorganic hybrid interface for studying on the physical phenomena related to charge, spin, and light using an ultrafast pulse laser. Based on these foudamental researches, we also develop spintronic memory and ultrafast spin devices.

Note: Professor with * mark will retire on March 2022.