UTSIP Kashiwa 2025   Program A

Host Laboratory List

Division of Transdisciplinary Sciences

- Advanced Materials Science
- Advanced Energy

Division of Biosciences

- Integrated Biosciences

Division of Environmental Studies

- Environment Systems

Division of Transdisciplinary Sciences

Department of Advanced Materials Science

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Mayumi Laboratory	Assoc. Prof. MAYUMI Koichi	The research goal of our group is to reveal molecular mechanisms for macroscopic properties of soft matter systems. One of our targets is to understand toughening mechanisms of polymeric materials. Recently, controlling nano-structure has improved significantly the mechanical toughness of polymer-based materials. The tough polymeric materials are expected to be applied for biomaterials, soft robots, and structural materials for automobiles and airplanes. We study nano-structure and dynamics of the tough polymeric materials by means of neutron, X-ray, and light scattering techniques. Based on the observed nano-scale structure/dynamics and macroscopic mechanical properties, we aim to establish molecular understandings of toughening mechanisms for polymeric materials and discover novel molecular designs for tough materials. For example, we have for the first time discovered reversible strain-induced crystallization of polymer chains in hydrogels and developed tough and highly reversible polymer gels (Science, 372, 1078 (2021)). The reversibility of the strain-induced crystallization allows the tough hydrogels to rapidly recover from mechanical stress, which is important for artificial ligaments and joints.	Polymer; Soft Material; Mechanical Property; Nano Structure; Scattering Techniques	We are interested in the microscopic structural change of polymeric materials under stress fields. For the summer programme, we propose the microscopic structural analysis of polymer gels/solutions under external stress fields by using scattering techniques combined with deformation devices. From the observation of the microscopic structural change under stress fields, we reveal the molecular origin of macroscopic mechanical properties of polymeric materials.

Division of Transdisciplinary Sciences

Department of Advanced Energy

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Inomoto-Tanabe Laboratory	Prof. INOMOTO Michiaki Assoc. Prof. TANABE Hiroshi	Fusion energy is an essential technology for realizing a sustainable society due to its abundant resources and low environmental impact. We are conducting laboratory plasma experiments for understanding of basic plasma physics and its application for developmemt of fusion core plasma. High-energy ions are necessary to generate nuclear fusion reactions, so high-temperature plasma, especially high ion temperature, is required to achieve energy through nuclear fusion. We are studying the magnetic reconnection phenomenon observed in the solar atmosphere and the magnetosphere as one of the highly efficient ion heating methods for fusion plasma. Magnetic reconnection is a phenomenon in which magnetic field lines reconnect in highly conductive plasma, and is considered as an efficient process of converting magnetic energy into ion kinetic/thermal energy. Thus, magnetic reconnection has large potential as a fusion plasma heating method, and we are developing a plasma merging method to realize high-power ion heating. In addition to developing a fusion plasma heating method using magnetic reconnection, we aim to elucidate the elementary process of magnetic reconnection through laboratory experiments.	Plasma experiment; Fusion energy; Laboratory astrophysics; Magnetic reconnection; Spherical tokamak	Many kinds of magnetically confined fusion plasmas have a torus shape and the tokamak type is intensively developed due to its excellent performance. Among tokamaks, those with a thick torus shape (low aspect ratio of major radius to minor radii) are called “spherical tokamaks” and have better economic efficiency. In Kashiwa campus, we operate the spherical tokamak merging device UTST to develop an effective ion heating technique by using magnetic reconnection. In the magnetic reconnection that occurs in spherical tokamak merging experiments, strong magnetic field perpendicular to the reconnecting magnetic field lines exists. This unique condition generates a quadrupole electric potential structure, which significantly affects the energy conversion process during magnetic reconnection. The purpose of this program is to find the conditions adequate for ion heating by clarifying the relationship between the generated electric potential and the plasma flow, or between the plasma waves and the particle acceleration, etc.

Division of Biosciences

Department of Integrated Biosciences

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Laboratory of Signal Transduction	Assoc. Prof. SUZUKI Kuninori	The budding yeast Saccharomyces cerevisiae is a very attractive model organism for studying the fundamental theories and concepts of eukaryotic cells. We applied the power of yeast genetics to understand many aspects of yeast cells. Our current research is mainly focused on (1) molecular mechanism of autophagosome formation using live imaging techniques, (2) molecular mechanism of autophagic body degradation by biochemistry, (3) screening of new membraneless organelles, and (4) analysis of intracellular phospholipid dynamics. (1) Autophagy is a major pathway of bulk degradation of cytoplasmic materials. In yeast, autophagy has been studied as a cellular response for survival during nutrient-limited conditions. During autophagy, cytoplasmic components are enclosed in a membrane compartment, called an autophagosome. We have been studying the molecular mechanism of autophagosome formation by live imaging and quantitative analysis of microscopic images. (2) The autophagosome fuses with the vacuole, to become an autophagic body. The cytoplasmic components to be degraded are sequestered from the hydrolytic enzymes in the vacuolar lumen by the autophagic body membrane. Thus, degradation of the autophagic body membrane is necessary for proteolytic enzymes to access the cargoes of the autophagic body. We are trying to elucidate the molecular mechanism of autophagic body membrane degradation by biochemical analysis. (3) Nucleolus is a membraneless organelle that has been known for a long time. Recently, membraneless organelles have become known not only in the cell nucleus but also in the cytoplasm. However, no comprehensive screening has been performed so far. We have screened novel membraneless organelles from a unique viewpoint. We have been analyzing the obtained candidates using bioimaging techniques. (4) Phospholipid is a main component of biological membranes. Recent studies have shown that phospholipids dynamically traffic between membrane organelles via membrane contact sites. We are analyzing phospholipid dynamics using a fluorescent probe which we have found and biochemical methods. Our ultimate goal is to draw a comprehensive map for phospholipid dynamics in eukaryotic cells.	autophagy; cell biology; live imaging; membrane organelles; membraneless organelle	(1) Live imaging of autophagosome formation by fluorescence microscopy. (2) Analysis of phospholipid transfer from the endoplasmic reticulum to autophagosome membranes by FRAP (fluorescence recovery after photobleaching) analysis. (3) Analysis of the autophagosome formation process by deep learning. (4) Morphological classification of autophagosome formation by multivariate analysis of high-dimensional morphometric data. (5) Molecular analysis of domains of the yeast vacuolar phospholipase Atg15. (6) Live imaging of autophagic body degradation by fluorescence microscopy. (7) Biochemical analysis of autophagic body degradation by biochemistry. (8) Live imaging of membraneless organelles by fluorescence microscopy. (9) Regulation of the formation of membraneless organelles by chemical reagents and temperature changes. (10) Live imaging of lipid dynamics using a fluorescent probe. (11) Analysis of phospholipid dynamics by thin-layer chromatography.

Division of Environmental Studies

Department of Environment Systems

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Energy and Environment Laboratory	Lecturer AICHI Masaatsu	Current approaches to energy supply and consumption face problems such as climate changes and dwindling resources. The development of key technologies for saving energy, switching to renewable energy resources, and appropriate CCUS is required. Our goal is to perform research that will contribute to the development of these technologies, especially by taking advantages of the characteristics of subsurface formations. For example, we study ways of developing a sustainable energy system, especially through hydrogeological and thermo-poro-mechanical modeling of geothermal heat pumps, geothermal power plants, and the geological sequestration of carbon dioxide. On the other hand, we also start to study how to adapt to global warming. Combining mitigation and adaptation is an attractive choice but it is not simple because one countermeasure possibly causes another environmental effects. For example, though the groundwater becomes more important water resource under changing climate, the overexploitation of groundwater possibly causes another environmental problem such as land subsidence, sea water intrusion in coastal area, so on. We try to predict and prepare for this kind of domino-like propagation to other environmental problems in advance.	subsurface resource; land subsidence; numerical modeling; anomaly detection; uncertainty analysis	Detection of the start of plastic land subsidence from time series monitoring data Subsurface fluid resources such as groundwater, natural gas, etc., are important for our societies. On the other hand, land subsidence caused by subsurface fluid abstraction has been one of the severe environmental problems. It is important to avoid the land subsidence problems for the subsurface resource production to be sustainable. The subsurface formation elastically deforms under small disturbance while the plastic deformation occurs if the load exceeds the yield stress. Then, controlling the abstraction rate so that the effective stress does not exceed the yield stress of geological formations is important. However, this is practically difficult because of the limitation of our knowledge on subsurface structures. One of the possible ideas is a monitoring-based approach to check whether the plastic deformation occurs or not and stop the production before the land subsidence becomes large. The research questions concerning this idea are what kind of and how accurate monitoring system is required, and how we can detect the elastic-plastic transition from the monitored data. In this theme, we tackle these questions with combinations of numerical simulation, laboratory experiments, time series data analysis, and/or machine learning approaches.