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
Arima-Tokunaga Laboratory	Prof. Taka-hisa ARIMA Assoc. Prof. Yusuke TOKUNAGA	We are interested in transition-metal oxide compounds which show novel physical responses like 1) control of electric polarization of matter with a magnetic field, 2) change in shape of matter with a magnetic field, 3) control of magnetism of matter with an electric field, 4) control of optical property with a magnetic or electric field, and 5) directional birefringence/dichroism. All of these physical responses are related to the simultaneous breaking of more than one symmetry operation, referred to as 'multiferroicity'. We design multiferroic materials which are expected to host such novel responses, grow crystals, measure their physical properties, and investigate the origin of the physical responses from the microscopic point of view. We also utilize synchrotron and neutron facilities to reveal the symmetry breaking.	Multiferroics; Magnetism; Ferroelectrics; Crystal Growth; X-ray Diffraction;	Summer-program students can participate in crystal growths of some transition-metal oxide compounds by a floating zone method, flux method, or chemical vapor transport method. They can perform measurements of x-ray diffraction to characterize the obtained crystals and to analyze the crystal structure. They can experience measurements of dielectric properties, magnetic properties, and optical spectra at low temperatures as well as room temperature.
Otani-Laboratory	Prof. YoshiChika OTANI	The concept of spin current, a flow of spin angular momentum, appeared in the end of 20th century, and led to a new spintronic principle based on the atomic-scale angular momentum conservation such as spin-transfer-torque. The methods to generate, transport and detect the spin currents have been well established over the last decade, leading the spintronics research to a new phase. Recent studies revealed interconversions among quasi-particles such as electron, spin, phonon, photon and magnon etc. via spin current in a solid. These interconversions, called as "spin conversion", often take place in the nano-scale regions at the interfaces of deferent materials, and thus, have great versatility and application possibility. Our fundamental researches explore new processes of the spin conversion and clarify their mechanisms. We also develop the spintronics devices to control a variety of spin conversion processes using nanofabrication technologies.	Spin currents; spin torque; spin Hall effects; spin pumping; spin-orbit interaction	We are currently working on the following projects; 1. Mechanisms of pure spin current generation and detection 2. Magnetic phase transition by using spin current 3. Spin-to-charge current conversion at the Rashba interface and the surface state of topological insulator 4. Spin injection into quantum materials such as Weyl semimetals