Visiting Professors

Visiting Professor
FUKUI, Ken-ichi *(from Osaka University)*

Ionic Liquid/Organic Semiconductor Interfaces for Efficient Carrier Transport

Local analyses of electrolyte/organic semiconductor electrode interfaces at controlled electrode potentials are of fundamental importance to understanding the origin and properties of the electric double layer (EDL) at the interfaces, which is necessary for their application to EDL-organic field effect transistors (OFETs). Ionic liquids (ILs) gated EDL-OFETs can be operated with ultralow voltage (~0.1 V), however, ILs sometimes cause operational instability due to their unusual interface structuring. By using an IL (EMIM-FSA) and ruburene crystal, IL-derived bias stress was observed, which increased operational voltage of the EDL-OFET by 33% in 2 h. Electrochemical FM-AFM and molecular dynamics (MD) simulation revealed that the formation of structured IL layer on the surface of hole-injected rubrene; anions in the IL monolayer probably trapped hole carriers by orienting their polar parts. Application of higher magnitude of OFF-state gate voltage immediately reset the IL-derived bias stress by separating the anion–hole pairs, but the same shift occurred in the same time scale by the local structural change of the interface.

Visiting Professor
SHIMADA, Kenya *(from Hiroshima University)*

High-Resolution Angle-Resolved Photoemission Study of Correlated Materials

In order to understand the physical properties of solids, we are studying the electronic structures by means of high-resolution angle-resolved photoemission spectroscopy (ARPES) using synchrotron radiation. We have also developed an ARPES system using an ultraviolet laser ($h\nu$ = 6.36 eV) to pursuit ultimate spatial, energy, and angular resolutions (<10μm, <1meV, <0.05°). By combining synchrotron radiation and laser ARPES measurements as well as extensive density functional theory (DFT) calculations, we could elucidate the termination dependent electronic structures of an antiferromagnetic topological insulator $MnBi_4Te_7$. The topological surface state is gapped for quintuple-layer (QL) termination but gapless for the septuple-layer (SL) termination. The spin texture is expected to be different for both terminations. While the DFT calculations reasonably reproduce the s-p electron bands, it is still challenging to predict magnetic 3d electronic bands. In the case of oxygen adsorbed Fe(100) surface states, we found significant deviations from the DFT results due to momentum- and orbital-dependent electron correlation effects.

Visiting Associate Professor
KATSUKI, Hiroyuki *(from Nara Institute of Science and Technology)*

Coherent Control in Condensed Systems

My research is focused on the ultrafast dynamics and coherent control in the condensed systems, especially in strongly coupled systems. We have recently demonstrated the ultrafast visible-pump THz-probe measurement of the carrier dynamics in a thin film of $CH_3NH_3PbBr_3$. As the pump photon energy changes around the bandgap, we can observe the drastic change of the THz transmission intensity. The results are analyzed based on the efficiency of the Auger-like process which is only observable for free carriers, and it is shown that the thermal excitation of the excitons to generate free carriers in the conduction band is not efficient in this material.

We are interested in a vibrational strong-coupling system in which a mid infrared photon is mixed with molecular vibrational quanta and forms a polaritonic quasi-particle. This phenomenon accompanies the local deformation of the potential surface, which can modulate the wave packet motion on the potential. Our final goal is the control of the wave packet motion and the photochemical reaction based on the modulation of the potential surface.