Visiting Professors

Visiting Professor
TANAKA, Koichiro *(from Kyoto University)*

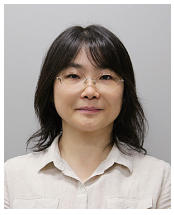
Ultrafast Laser Spectroscopy and Terahertz Optical Sciences

In recent years, the technology of ultra-short lasers and terahertz light has made remarkable progress, revealing unprecedented ultra-non-equilibrium physics and order formation of solid materials under high-intensity light irradiation. We make full use of such state-of-the-art optical technology to study the excited state dynamics of semiconductors, single-layer materials, photonic crystals, and metamaterials, as well as "non-equilibrium physics under high-intensity light fields." We are also looking for ways to bring out new physical properties by utilizing the interaction between light and matter. Specific research topics include (1) elucidation of non-equilibrium physical properties of solids in high-intensity light fields, (2) research on ultrafast nonlinear phenomena using ultrashort pulse lasers, and (3) new spectroscopy using terahertz light, (4) optical properties of monoatomic layer materials, (5) research on exciter quantum effects in semiconductors, *etc*.

Visiting Professor
OSAKA, Itaru *(from Hiroshima University)*

π-Conjugated Polymers for High-Efficiency Organic Photovoltaics

Organic photovoltaics (OPVs) have been attracting much attention due to lightweight, flexible, low-cost and low-energy solution-processability. Improving the power conversion efficiency is one of the important issues in OPVs. We designed and synthesized a series of π-conjugated polymers based on an extended fused ring, named dithienonaphthobisthiadiazole. The polymers had rigid and coplanar backbone structure, which resulted in high-crystalline structure in the thin film. The efficiency of the photovoltaic cells was as high as 12% when one of the polymers was combined with a fullerene acceptor, which was among the highest values for polymer/fullerene cells. Importantly, extremely high fill factors of over 0.8 were obtained, which was likely ascribed to the high charge carrier mobility. In addition, when another dithienonaphtobisthiadiazole-based polymer was combined with a nonfullerene acceptor, it showed high efficiencies of over 16%. Moreover, the polymer showed high photocurrent generation even with very small driving force energy. These results would be important guidelines for the development of high-performance polymers.



Visiting Associate Professor
AKIMOTO, Ikuko *(from Wakayama University)*

Time-Resolved Cyclotron Resonance of Optically Injected Free Carriers in Semiconductor Crystals

Momentum and spin are degrees of freedom for free carriers other than charge, which have recently attracted attention as valleytronics and spintronics. Silicon, a semiconductor commonly used in electronics, is also a strong candidate for valleytronics due to the multi-valley structures in its conduction band. Maintaining and transporting valley polarization is key to device design. Time-resolved cyclotron resonance (TRCR) can measure valley polarization by distinguishing electrons with different effective masses under a magnetic field. We performed TRCR measurements of optically injected electrons in a highly pure silicon crystal at cryogenic temperatures using a time-resolved electron spin resonator by applying an additional DC-electric field. Analysis of the evolution of the TRCR spectra after a laser pulse elucidates how the optically induced valley polarization is dispersed by intra-valley and inter-valley electron scattering under an operando DC-electric field. The results provide basic physical parameters for designing future devices.