Visiting Professors

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

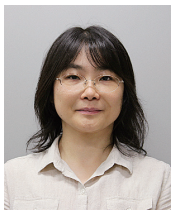
Ultrafast Laser Spectroscopy and Terahertz Optical Sciences

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)*

Pulsed EPR Spectroscopy of Electron and Hole Spins in Semiconductor Crystals

The coexistence of electrons and holes in semiconductors provides the functionality of optoelectronic devices, such as photo sensors, solar cells, and organic light emitting diodes (OLEDs). A microscopic understanding of the underlying physics of electron–hole interaction is essential for further development of devices. The pulsed electron–electron double resonance (DEER or PELDOR) technique, a pump–probe measurement of two-spin interactions, has been established to analyze the distance between separated spin labels in a molecule. However, it is challenging to apply this technique to the randomly distributed spin systems that are typically realized in optoelectronic devices. We have investigated the spin interactions between randomly distributed electron and hole traps created by optical excitation in a semiconductor by the DEER technique using arbitrary-waveform pulses of Gaussian and chirped rectangular microwave pulses. Adiabatic excitation of the spin system extracted widely distributed interacting distances of 3–4 Å, indicating reasonable values before tunneling recombination, from the vast background interactions.