

Visiting Professors



Visiting Professor
HAYAMI, Shinya (from *Kumamoto University*)

Molecular Spin Qubits in Spin Crossover Systems

Molecular magnetism is an attractive research area due to its interest as a quantum magnetism, such as single molecule magnets (SMMs) and molecular spin qubits (MSQs). We have attempted to control slow magnetic relaxation by using spin-crossover (SCO) compounds with controllable spin states and molecular distortions. Iron(III) SCO compounds ($S = 5/2 \leftrightarrow S = 1/2$) were prepared and investigated by single crystal analysis, magnetic susceptibility measurements, cw/pulsed electron paramagnetic resonance (EPR) and Mössbauer spectroscopy. The respective distortion parameters (Σ) are compared with those for previously reported SCO iron(III) compounds, and the distortion in HS state is larger than LS state. AC magnetic susceptibility has been also measured for the compounds at 2 K, and show frequency dependency. Pulsed EPR spectra were also measured in the LS state, T_m (coherence time) were estimated. These results are the first attempt to provide molecular design for the development of metal complexes with MSQ by using SCO compounds that can be tuned in the spin states and molecular distortions.



Visiting Associate Professor
MIURA, Hiroki (from *Tokyo Metropolitan University*)

Heterogeneous Catalysts for Sustainable Molecular Transformations

From the perspective of preventing global warming, it is essential to establish advanced carbon-circulation systems that utilize renewable resources such as biomass and waste plastics. Since biomass compounds and polyesters contain numerous C–O bonds, the development of efficient catalysts capable of transforming these bonds is crucial for establishing sustainable processes. Our group has focused on the unique catalysis of supported metal catalysts, in which metal nanoparticles and metal-oxide supports can work in cooperation to activate organic molecules. We recently demonstrated that the cooperation of gold nanoparticles and Lewis acid at the surface of metal oxides enabled highly efficient borylation of unactivated C–O bonds in alkyl esters and alkyl ethers. Furthermore, we found that the strong interaction between gold nanoparticles and organic radicals enabled radical silylation of unactivated C–O bonds in alkyl esters and alkyl ethers. These findings provide important guidelines for the design of highly active heterogeneous catalysts for sustainable molecular transformations.



Visiting Associate Professor
KAWASUGI, Yoshitaka (from *Toho University*)

Phase-Transition Devices Based on Molecular Strongly Correlated Electron Systems

Strongly correlated electron systems consisting of molecular materials are softer and have lower carrier densities than inorganic materials, making them highly sensitive to external fields such as strain and gate electric fields. We have fabricated phase-transition devices utilizing strain and electric fields in organic strongly correlated electron systems. Specifically, we employed bis(ethylenedithio) tetrathiafulvalene [BEDT-TTF] molecules. These devices exhibit a remarkable physical property change, transitioning from an insulator to a superconductor in response to external fields. Recently, we have focused on improving device performance through the fabrication of field-effect transistors using solid electrolyte gates. In solid electrolyte gate transistors, we have successfully observed a field-induced Mott transition where interacting “frozen” electrons dissolve into a conductive liquid state. We have also confirmed that solid electrolytes may possess superior carrier injection capabilities compared to ionic liquids, which are more prone to sample degradation.