Spintronics Based on Single-Molecule Quantum Magnets

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Electronics is a key technology in 20th century based on the freedom of the charge of the electron, while spintronics is a key technology in 21st century based on the freedoms based on the charge, spin, as well as orbital of the electron. The MRAM systems (magnetic random access memory) by using GMR, CMR or TMR have advantages such as no volatility of information, the high operation speed of nanoseconds, the high information memory storage density, and the low consuming electric power. Usually in these systems, the transition metal ions or conventional magnets are used, while in our study we use Single-Molecule Quantum Magnets (SMMs), which are composed of multi-nuclear metal complexes and nano-size magnets, and moreover show the slow relaxations with the double-well potential defined as DS^2 and quantum tunneling.

According to such a strategy, we have synthesized the conducting SMMs such as $[Mn_4(hmp)_6(MeCN)_2][Pt(mnt)_2]_6$, and $[Mn_2(5\text{-}Rsaltmen)_2][Ni(dmit)_2]_2$ because the SMMs can have artificial large spin quantum numbers of 10, 20, 30, etc, where we may discover the new quantum GMR phenomena. At the same time, we may obtain the high Tc SMMs by the interaction between the conducting electrons and localized spins of SMMs. Recently, we have succeeded the photo-induced insulator to metal transition in these systems.

As the second strategy, we have a plane of the input and output of one memory in SMMs of double-decker Tb(III) SMM (Pc_2Tb) by using the spin polarized STM. In this research, we have observed Kondo Effect at 4.8 K by using STS for the first time.

As the third strategy, we made the FET devices of SMMs. The Pc_2Dy device shows the ambipolar (n- and p-type) behavior, while the Pc_2Tb device shows the p-type behavior. Such a difference is explained by the energy levels of the lanthanide ions.