Quantum Molecular Spintronics Based on Single-Molecule Magnets: Single-Molecule Memory, Spin Qubits, and Rabi Nutation at RT.

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Spintronics, based on the freedoms of the charge, spin, and orbital of the electron, is a key technology in the 21st century. Magnetic random access memory (MRAM), which uses giant magnetoresistance (GMR) or tunneling magnetoresitance (TMR), have several advantages over conventional systems, such as nonvolatile information storage, high operation speeds on the order of nanoseconds, high storage densities, and low power consumption. Although bulk or classical magnets composed of transition metal ions are normally used, in our study, we use single-molecule magnets (SMMs) to overcome "Moore`s Limitation". SMMs undergo slow magnetic relaxation due to the double-well potential, defined as $|D|S^2$, and quantum tunneling, making them excellent materials for quantum computers and high density memory storage devices. I will talk single-molecule memory, spin qubit, and Rabi nutation at RT. Finally, I will talk the SMMs encapsulated into Single-Wall Carbon Nano Tube (SWCNT) to realize the new spintronics.

We usually use the double-decker phthalocyaninato Tb(III) SMM (TbPc2) as a single-molecule memory. On Au(111) substrate, we sublimated TbPc2. Then, by tunneling magnetoresistance (TMR) using STM tip with one Co atom, we have succeeded to put the spin up and down on TbPc2 and read them.

As for the quantum computer, we synthesized 0 ~ 3 dimensional V(TCPP) compounds. In the 3-D compounds, we have realized spin qubit and observed Rabi nutation even at RT. due to the rigid lattice as shown in the right.

As for the new quantum molecular spintronics, we have succeeded to encapsulate some SMMs into the single-wall carbon nano tube (SWCNT). The SMMs behaviors have been improved by the encapsulation into SWCNT.