BIAS DEPENDENCE OF SPIN SIGNALS IN GRAPHENE & A NOVEL MAGNETIC SWITCHING EFFECT IN FULLERENE-COBALT NANOCOMPOSITES

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1st topic: Spintronics using graphene garners much attention since 2007. Several groups, including us, successfully observed spin injection, generation of a pure spin current and Hanle-type spin precession in single- and multi-layer graphene at room temperature. Spin precession was conducted by applying an external magnetic field perpendicular to the graphene (Hanle-type spin precession), and spin diffusion length and time are so far estimated to be 1.6 μm and 150 ps at room temperature. The spin diffusion length is possibly enhanced up to ~5 μm in multi-layer graphene. After the breakthrough, a number of studies have been conducted from various points of views, such as anisotropic spin relaxation, a spin drift effect, bias dependence of spin signals, enhancement of spin diffusion time, and so on. Among them, the bias current dependence of spin signals for positive and negative electric current has been revealed to be unique. In the presentation, we introduce the basic concept of spin injection and generation of a pure spin current for observing spin transport in graphene, and then focus on the bias dependence of the spin signals in single- and multi-layer spin valves.

2nd topic: Study on organic molecule(OM)-ferromagnetic metal(FM) nanocomposites, where nanoparticles of ferromagnetic metal are embedded in organic molecules, has played an important role in the field of organic spintronics. In such a structure, tunnel magnetoresistance(MR) effect appears as the result of spin-dependent electron tunneling between Co nanoparticles and it has been revealed that MR ratio was enhanced by high order co-tunneling within a Coulomb Blockade(CB) region and high spin polarization due to existence of the compound of OM and FM. Remarkably, the MR ratio in C_{60}-Co granular reaches to several hundreds % at 4.2 K, which is extremely larger than that observed in inorganic (Al-O_x)-Co granular. We have obtained huge MR ratio of 1,400,000% at 1.8 K in C_{60}-Co nanocomposites around the first threshold voltage of CB, where about 4 percent reduction of the V_{th} of the CB under external magnetic field of 5 T was clearly observed. In addition, the *I-V* characteristic exhibited the same magnetic field dependence at the second threshold voltage as observed in the first threshold voltage, which was originated not from Avalanche breakdown or a space charge effect but from the CB effect. Although a similar phenomenon was reported, where MR ratio was 3,000%, the background physics was unclear. We conclude that our finding is ascribed to correlation between superparamagnetism of the Co nanoparticles and the CB effect from a theoretical model building. In the presentation, we introduce the details of the above topic.