Py/Pt/Co 三層構造における新奇スピン軌道トルクの観測

Observation of unconventional spin-obrit torque in Py/Pt/Co trilayer structure

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Control of magnetization vector using spin-orbit torque (SOT) is one of the promising writing method in next-generation spintronics devices [1]. SOTs have been mainly observed in the system consist of ferromagnetic metal (FM) / non-magnetic metal (NM) bilayer structures, where the spin current generated by the spin Hall effect (SHE) in NM gives the SOT to FM [1]. In contrast with this “conventional” SOT, it is theoretically and experimentally reported that the additional spin currents originated by the interfacial spin-orbit scattering at the FM/NM interface [2,3] and/or the anomalous Hall Effect (AHE) in FM [4,5] can be also a source of the SOT. This “unconventional” SOT is expected to have a different symmetry with the conventional one. In this work, we report the unconventional SOT in Py/Pt/Co trilayer system, in which the Pt/Co bilayer act as a spin current source.

Ta (1.4 nm) / Py (4.0) / Pt (1.2) / Co (0.5) / MgO (2.0) structure was prepared by rf sputter. In this system, the Co and Py layer correspond to a perpendicularly magnetized pinned layer (PML) and an in-plane magnetized free layer (IML), respectively. Current-induced torques were measured by the ac-current induced adiabatic harmonic Hall measurements [6]. Figure 1 shows the results of the angle-scan harmonic measurements for the cases with PML magnetized +z ($+m_z^{PML}$) and –z ($-m_z^{PML}$) direction. In Fig. 1(b), a valley and peak signal near φ = 0 and 180 degree are observed, which is attributed to the conventional SOT in this system. Importantly, a clear difference between two states is observed near φ = 90 and 270 degree. By careful examinations, it is found that this difference originated from the current-induced unconventional SOT acting on the IML. Moreover, we found that this torque is greatly affected by the thickness of the Pt layer. These results show clear evidence of the new type of the SOT generated by Pt/Co bilayers and offer a new perspective to the new mechanism of SOT.

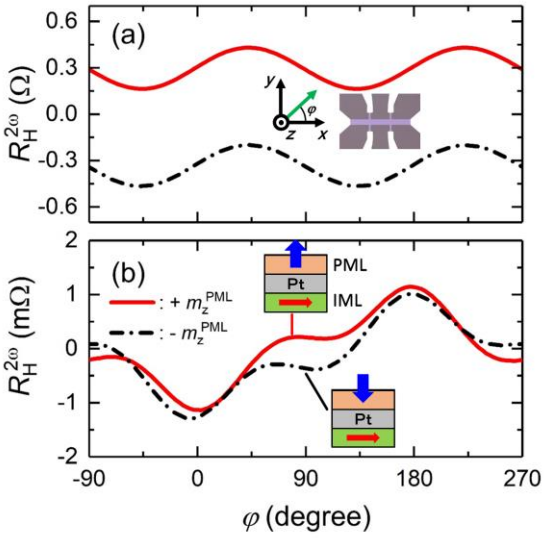

Figure1: Angle-scan harmonic measurement of Py/Pt/Co system with $\pm m_z^{PML}$ states. 1st (a) and 2nd (b) harmonic Hall resistance ($R_H^{1\omega}$ and $R_H^{2\omega}$) measured under external magnetic field of 65 mT. The inset of (a) shows the device picture and the configuration of the system.

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References:

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