Effect of the external field magnitude on the Spin-Orbit torques in perpendicularly magnetized Pt/Co system

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Electrical manipulation of magnetization is a key to develop the nonvolatile magnetic random access memories (MRAMs). Current-induced spin-orbit torques (SOTs) observed in symmetry-broken ferromagnet/heavy metal bilayer structures are one of the promising method to realize this [1, 2]. Although the SOT has been actively investigated so far, the detailed mechanism is still on debate. In order to clarify the physics of the SOT, in this study, we focused on the influence of the external field strength on the SOT.

Pt/Co systems were deposited on the thermally oxidized Si substrate using rf sputtering. In order to investigate the influence of the external field ($\mu_0 H_{ext}$) on SOT, we used angle-scanning harmonic measurements [3,4]. In this work, the measurements were performed under various system temperatures T and magnitudes of $\mu_0 H_{ext}$. The figure shows the two component of the SOT–induced effective fields (damping-like and field-like, respectively) per applied current under various $\mu_0 H_{ext}$ strength at T = 300 K. Both SOTs show clear dependence on $\mu_0 H_{ext}$ but the behavior is opposite; the field-like (damping-like) torque decreases (increases) with $\mu_0 H_{ext}$. Moreover, we found that the influence of $\mu_0 H_{ext}$ on the field-like torque is strongly affected by T and it diverges as T increases toward the Curie temperature. These results might suggest that the spin current scattering in ferromagnetic layer is a factor of determining the magnitude of the SOT.

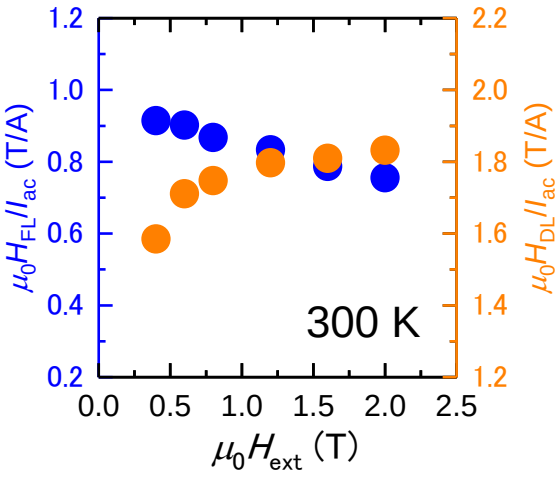

Figure: external field dependence of the SOT effective field per applied current at 300 K. Right (left) axis shows the damping-like (field-like) component of the effective field.

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[3] Y. Fan *et.al*, Nat. Mater. **13**, 699 (2014). [4] G. Yu *et.al*, Nat. Nanotechnol. **9**, 548 (2014).