Pt/Co/Ir 多層膜積層構造における ジャロシンスキー・守谷相互作用とスピン軌道トルク

Dzyaloshinskii–Moriya interaction and spin orbit torque in Pt/Co/Ir multilayers

東大理 [A], 物材機構 [B] ○石黒雄人 [A], 河口真志 [A], Yong-Chang Lau[A,B], 林将光 [A,B]

[A]Dept. of Phys. the Univ. of Tokyo, [B]National Institute for Materials Science

○Y. Ishikuro[A], M. Kawaguchi[A], Y. C. Lau[A,B], M. Hayashi[A,B]

E-mail: y.ishikuro@qspin.phys.s.u-tokyo.ac.jp

At the interface between a thin ferromagnetic (FM) layer and a heavy-metal (HM) layer, Dzyaloshinskii–Moriya interaction (DMI) emerges due to the strong spin orbit coupling of the HM layer or the interface states. DMI stabilizes homochiral Néel structures and Néel type skrymions. Recently, it has been reported that large DMI emerges in asymmetric HM1/FM/HM2 multilayers [1] and high domain-wall velocity was observed in similar structures with synthetic antiferromagnetic coupling between the FM layers [2].

We have studied the DMI and spin orbit torque in multilayers composed of Pt/Co/Ir stacking. The in-plane field dependence of the current-induced anomalous Hall loop shift [FIG. 1] is measured to estimate the strength of DMI and spin torque efficiencies [3] [FIG. 2]. By increasing Ir layer thickness, the structure inversion symmetry is broken and an increase of DMI is observed. In addition, an abrupt increase of spin torque efficiencies is observed when the coupling of the Co layers changes from ferromagnetic to antiferromagnetic.

[1] C. Moreau-Luchaire *et al.* Nat. Nanotechnol. **11**, 444 (2016).

[2] S. H. Yang, K. S. Ryu, and S. Parkin, Nat. Nanotechnol. **10**, 221 (2015).

[3] C. F. Pai, M. Mann, A. J. Tan, and G. S. D. Beach, Phys. Rev. B **93**, 1 (2016).

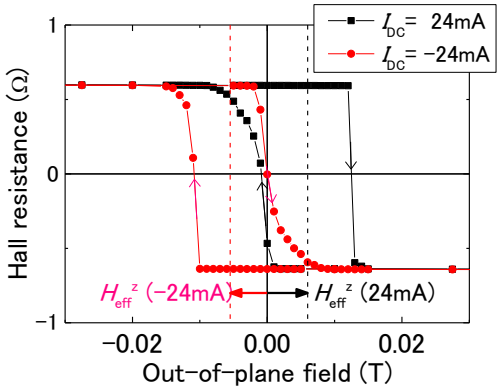

FIG. 1. Anomalous Hall loops for two different dc currents (I_{DC} =±24mA) for ferromagnetically coupled [0.6 Pt/ 0.9 Co/ 0.9 Ir]$_{x3}$ multilayers (unit: nanometers). The bias in-plane field is fixed to 0.5T. An out-of-plane effective field $H_{eff}^z(I_{DC})$ is induced by spin orbit torque.

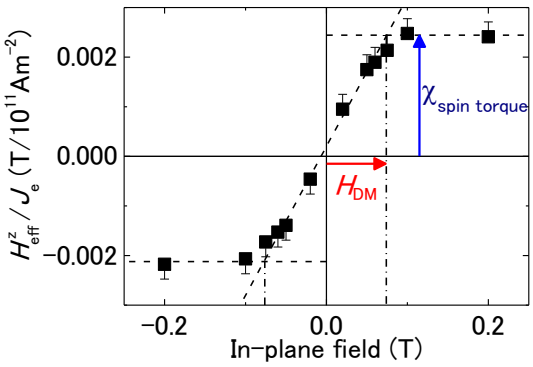

FIG. 2. Spin torque efficiency versus bias in-plane field for [0.6 Pt/ 0.9 Co/ 0.9 Ir]$_{x3}$ multilayers. As schematically shown, DMI field H_{DM} is extracted from the field at which the spin torque efficiency saturates.