Study on current-induced domain-wall motions of antiferromagnetically coupled layered magnetic wires with various interlayer thickness

Nagoya Inst. Tech. [1], Kansai Univ. [2], Toyota Tech. Inst. [3]

°(M2) Musashi Shimazaki[1], Tatsuro Ohmasa[1], Tomoya Sakata[1], Masaaki Tanaka[1],

Syuta Honda[2], Hiroyuki Awano[3], and Ko Mibu[1] E-mail: mtanaka@nitech.ac.jp

Current-induced domain-wall motions (CIDWM) in perpendicularly magnetized ferromagnetic (FM) wires with nonmagnetic (NM) cap layer are affected by the spin Hall effect (SHE) of the NM layers and the reverse motions with respect to the electron flow were observed in the CIDWM in FM/NM layered wires [1]. In the FM/NM layered wires, the effective longitudinal magnetic field caused by the interfacial Dzyaloshinskii-Moriya interaction stabilizes the Néel domain walls (DWs) and the spin current via SHE drives the Néel DWs [2].

In this study, we investigated the stability of the Néel DWs of antiferromagnetically (AFM) coupled FM/NM/FM/NM wires [3] with various NM interlayer thickness. {Tb(0.36 nm)/Co(0.28 nm)}$_4$/Ru(t)/{Co(0.28 nm)/Tb(0.36 nm)}$_4$/Pt(3 nm) wires with the designed Ru thickness t of 0.44~0.73 nm were fabricated by electron-beam lithography and a lift-off method. The velocity of the CIDWM under in-plane magnetic fields was measured by Kerr microscopy (the inset in Fig. 1(a)).

Figure 1(a) shows the in-plane-magnetic-field dependence of DWs velocity of AFM coupled wires (t= 0.63 nm). The DW cannot move under the magnetic field of H_{L1} and H_{L2}. The stability of the Néel DWs was estimated by the value of H_L(=(H_{L2}- H_{L1})/2), which is called effective longitudinal magnetic field [2]. Figure 1(b) shows H_L as a function of the designed Ru thickness t. The values of H_L for the AFM coupled wires are much larger than those for the FM coupled wires (t=0.42 and 0.73 nm), which means that the AFM coupling interaction stabilizes the Néel DWs. The values of H_L shows a peak for at t=0.59 nm, which means the values of H_L depend on the AFM coupling interaction. The values of H_L as a function of Ru thickness may show two tendencies (red and blue broken lines). The origin of which will be discussed at the presentation.

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[3] S. -H. Yang *et al.*, Nat. Nanotechnol., **10**, 221(2015).

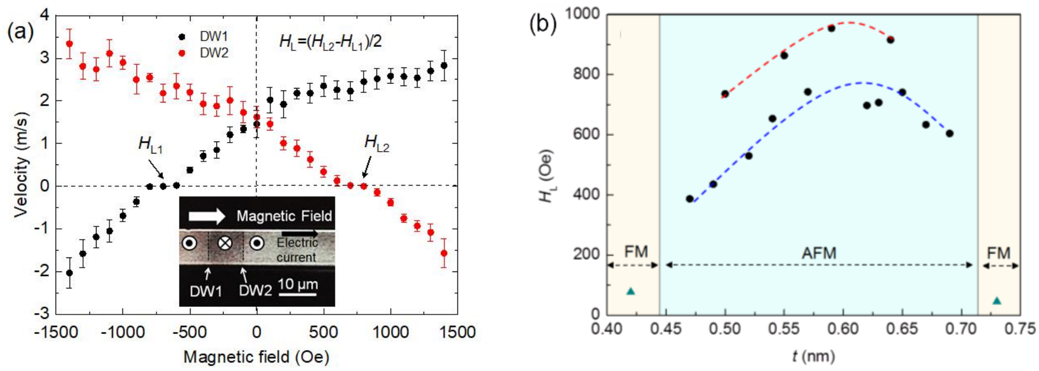

Fig. 1 (a) In-plane magnetic field dependence of DWs velocity of AFM coupled wires (t= 0.63 nm). (b) The dependence on the designed Ru thickness of effective longitudinal magnetic field in FM/NM/FM/NM wires.