Interfacial Dzyaloshinskii–Moriya interaction in bilayers of kagome-lattice ferromagnet Fe_3Sn and Pt

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Kagome-lattice magnets such as Mn_3Sn and Fe_3Sn_2 have been studied intensively because of their attractive spintronic properties owing to Weyl points in momentum space. Another interesting feature is the geometrically frustrated triangular-based kagome lattice, which may allow for the stabilization of nontrivial spin textures like the skyrmion crystal via the tuning of magnetic interactions. Motivated by a recent report of the film growth of kagome-lattice ferromagnet Fe_3Sn on Pt with strong spin-orbit coupling [1], we attempted to artificially control the magnetic anisotropy of Fe_3Sn using the interfacial Dzyaloshinskii–Moriya interaction.

Multilayers of SiO_x cap / t-nm-thick $Fe_3Sn(0001)$ / 10-nm-thick Pt(111) were fabricated on $Al_2O_3(0001)$ substrates by rf magnetron sputtering. The $D0_{19}$-type Fe_3Sn phase and its orientation relationship with the underlying Pt layer were characterized by transmission electron microscopy. Figures 1(a) and (b) show magnetization M curves of t = 0.80 and 0.48 nm, respectively, measured at T = 250 K in out-of-plane and in-plane magnetic fields H (M_{out} and M_{in}). For t = 0.80 nm, the M_{in} saturates at a low H, consistent with the in-plane magnetic anisotropy of the bulk [2]. In contrast, the M_{in} and M_{out} of t = 0.48 nm are comparable, suggesting that the magnetic anisotropy is modified by the interfacial Dzyaloshinskii–Moriya interaction. Interestingly, the films with the modified magnetic anisotropy exhibited unconventional Hall effect distinct from anomalous and ordinary Hall effects. On the basis of the t-dependent Hall effect measurements and numerical simulation, we discuss that a non-coplanar spin state with finite scalar spin charity is induced by the interfacial Dzyaloshinskii–Moriya interaction [3].

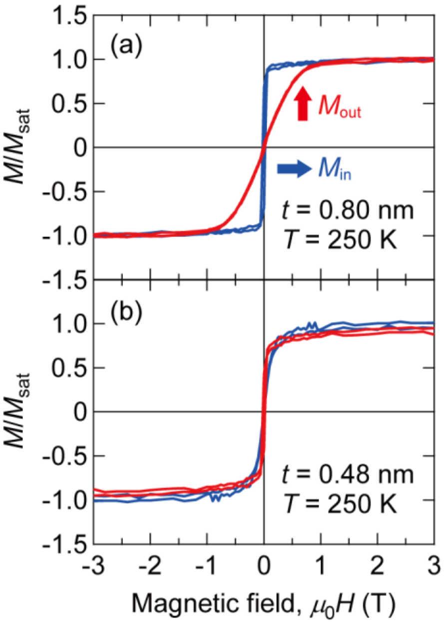

Fig. 1. (a) and (b) M (normalized by the saturation magnetization M_{sat} at 4–7 T) versus H curves at T = 250 K for t = 0.80 and 0.48 nm, respectively.

[1] A. Maeno *et al*., Ext. Abst. 80th JSAP Autumn Meeting, 18p-E216-16 (2019).

[2] B. C. Sales *et al*., *Sci. Rep.* **4**, 7024 (2014).

[3] K. Fujiwara *et al*., submitted.