Role of Cu insertion layer at the Pt/Co and Co/AlO_x interfaces with interfacial Dzyaloshinskii-Moriya interaction and perpendicular magnetic anisotropy

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I. Introduction

The spin orbit coupling related phenomena such as the interfacial perpendicular magnetic anisotropy (iPMA), the interfacial Dzyaloshinskii-Moriya interaction (iDMI) have been heavily investigated [1-4] because of their application of non-volatile memory devices and new type future information storage devices such as spin transfer torque-magnetic random access memory (STT-MRAM) and skyrmion based logic or race-track memory [5-6]. Especially, the interface is an important place in many physical phenomena and Brillouin light scattering (BLS) measurement is powerful tool to investigate such interfacial phenomena. In this study, we mainly investigate the contribution of each TOP and BOTTOM interface to the iDMI, PMA, and MOKE amplitude modulations as an ultra-thin Cu layer (0-0.5 nm) is inserted in the Pt/Co or Co/AlO_x interfaces by employing MOKE and BLS measurement.

II. Experiment

We prepared two wedge shaped samples on the top of the thermally-oxidized Si/SiO_2 wafer. The wedge sample structures are Si/SiO_2/Pt(4 nm)/Cu(0.0~0.5 nm)/Co(1.1 nm)/AlOx(2 nm) and Si/SiO_2/Pt(4 nm)/Co(1.1 nm)/Cu(0.0~0.5 nm)/AlOx(2 nm). All samples were deposited by DC magnetron sputtering with a base pressure of ~7×10^{-8} mbar. In order to observe the magnetic properties and role of Cu inserting layer, we performed MOKE and BLS measurement. For the details of BLS measurement conditions, we remark proper references in this abstract [1-3].

III. Results and Discussion

Figure 1(a) shows the effective uniaxial anisotropy (K_{eff}) of BOTTOM and TOP samples as functions of the Cu-insertion layer The K_{eff} of TOP sample is slowly decaying with t_{Cu}, while K_{eff} of BOTTOM sample rapid decays. At a glance, the contribution to the PMA from top interface is not negligible, however not significant, and the PMA of the system mainly came from the bottom Pt/Co interface.

From systematic BLS measurements, we obtained iDMI energy densities corresponding to spin wave vector

(D_k) and external magnetic field (D_H) at the BOTTOM and TOP samples as a function of t_{Cu} as shown in Figure 1(b). Consequently, we conclude that the PMA from the bottom interface (Pt/Co) is not totally blocked by a 1-2 ML thick Cu-insertion layer, while iDMI energy from (Pt/Co) is clearly suppressed with a 1-2 ML thick Cu-insertion layer. These facts clearly indicate that iDMI and PMA mainly came from the BOTTOM interface (Pt/Co); however, PMA and iDMI go different ways despite the same physical origin, spin orbit coupling.

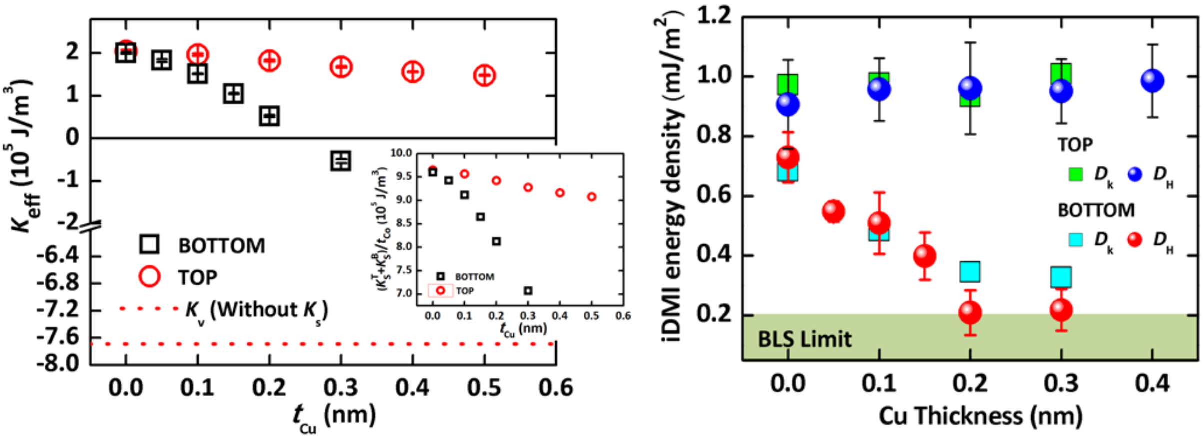

Fig. 1. (a) Effective uniaxial anisotropy (K_{eff}) as a function of t_{Cu} for BOTTOM and TOP samples. The positive K_{eff} implies perpendicular easy axis, and K_v is volume anisotropy. Effective uniaxial anisotropy contributed volume anisotropy energy(inset). (b) iDMI energy density from SW dispersion relations (D_k) and external magnetic field dependence measurements (D_H).

IV. References

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