Influence of Pt and Au spacer layer on perpendicular exchange bias and oercivity in Pt/Co/spacer/Cr_2O_3/Pt stacked films

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The perpendicular exchange bias (PEB), appeared in the interface between ferromagnetic (FM) and antiferromagnetic (AFM) materials, is of vital importance to realize modern spintronic devices, such as a spin valve with the advantages of high speed operation, high integration and low power consumption [1]. The PEB field (H_{ex}), the magnetic field (H) shift from origin H=0 of magnetization curve, can be controlled by tuning the interface exchange interaction. Previous studies showed the enhancement in H_{ex} by inserting a spacer layer, e.g., Pt, at the FM/AFM interface [2]. This, however, resulted in the increase of the coercivity (H_c) which was an obstacle for device applications. To have an actual system with a high H_{ex} and a low H_c is still challenged.

This study investigates the influence of Pt and Au spacer layers on the H_{ex} and H_c of stacking films: Pt/Co(0.4 nm or 0.6 nm)/(Pt or Au)(0.5 nm)/Cr_2O_3(150 nm)/Pt(20 nm) deposited on α-Al_2O_3 substrates using a DC magnetron sputtering. Structural characterizations were carried out using a reflection high-energy electron diffraction, an X-ray diffraction and an X-ray reflectivity. Magnetic properties were characterized by means of a vibrating sample magnetometer, a magneto-optic Kerr effect (MOKE) magnetometer, and a soft and a hard X-ray magnetic circular dichroism. Fig. 1 shows the temperature dependence of the H_{ex} and H_c for typical samples (with similar 0.4-nm-thick Co layer) with Pt (Fig. 1a) and Au (Fig. 1b) spacers. The results showed that the H_{ex} was highly degraded in the Pt-spacer sample, while that for the Au-spacer sample was significantly increased. Moreover, the Au spacer also suppressed the enhancement in H_c that usually occurs at around room temperature when using Pt. The difference in H_{ex} is due to the in-plane interfacial magnetic anisotropy at the Pt/Cr_2O_3 interface, which cants the interfacial Cr spin from the surface normal and results in a degradation in the PEB. More details will be discussed in the presentation.

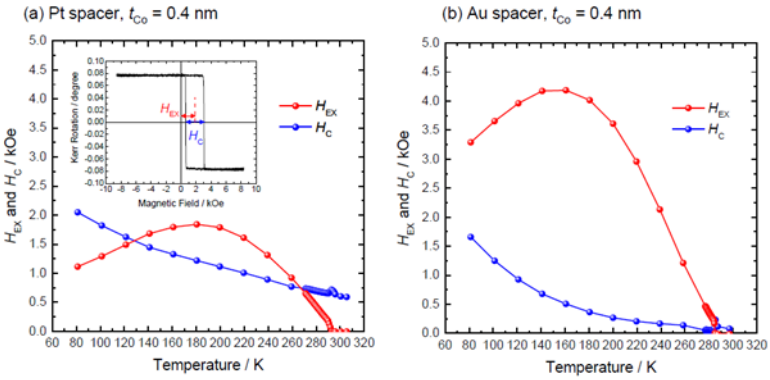

Fig. 1: Temperature dependence of H_{ex} and H_c for films with (a) Pt spacer, and (b) Au spacer (0.4-nm-thick Co layer). Inset shows the typical MOKE loops exhibiting H_{ex} and H_c.

References:

(1) X. He et al., Nature Mat. **9**, 579, (2010); (2) Y. Shiratsuchi et al., Appl. Phys. Express. **6**, 123004, (2013);