Observation of perpendicular magnetization in Cu layer inserted between Co and Pt layers

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Perpendicular magnetic anisotropy (PMA) in magnetic multilayers is strongly desired for the developments of high-density magnetic recording media. Co/Pt layers become one of the candidates possessing the PMA using the large spin-orbit interaction of Pt atoms and spin moments of Co atoms, which collaborates to enhance the PMA through the proximity effects at the interfaces. Recently, ultrathin Co/Pt layers have been also studied for the electronic field modulations of magnetic properties [1]. On the other hand, the Co/Cu multilayer structures possessing the in-plane anisotropy derived from the shape anisotropy have been investigated extensively for the giant magneto-resistance devices [2]. The Cu spacer layers bring an oscillatory behavior in the magnetoresistance through the exchange coupling between the Co layers [3]. Combining these previous works, our objectives consist of the following two ideas; (i) the insertion of the Cu layer as an inserted layer between Co and Pt in order to separate the proximity between them and (ii) the induction of PMA in Cu spacer layer. Therefore, in this presentation, we discuss the magnetic properties of the Cu spacer layer using x-ray magnetic circular dichroism (XMCD).

Samples prepared by rf-sputtering method consist of the stacked structures: MgO (2 nm)/Co (0.4 nm)/Cu (*t* nm)/Pt (2 nm)/Ta buffer layer deposited on the Si substrates with various Cu layer thicknesses (*t*). Samples of *t*=0.4 and 2.0 nm show the PMA and in-plane anisotropy, respectively. X-ray absorption spectroscopy (XAS) and XMCD measurements for Co and Cu *L*-edges were performed at BL-7A and 16A in Photon Factory (KEK). All measurements were carried out at room temperature in the total electron yield mode.

Figure 1 shows Cu *L*-edge XAS and XMCD at the normal incidence geometry. Clear XMCD signals reveal the induced magnetic moment at the Cu sites. The perpendicular magnetization in induced Cu layer between Co and Pt layers is involved by the element-specific hysteresis curves. The Cu layer thickness dependence in XMCD reveals that the PMA is derived from the proximity effects at the interfaces. Therefore, we found that the Cu spacer can control the magnetic properties of Co/Pt stacked structures.

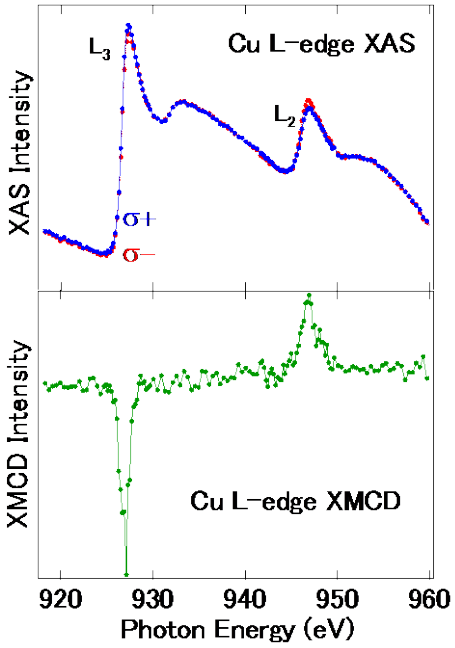

Fig. 1: Cu *L*-edge x-ray absorption spectra with polarized x-rays at normal incidence setup and XMCD of Co 0.4 nm /Cu 0.4 nm/ Pt 2 nm stacked structure.

[1] D. Chiba *et al*., Nature Materials **10**, 853 (2011).
[2] M.G. Samant *et al.*, Phys. Rev. Lett. **72**, 1112 (1994).
[3] S.S.P. Parkin *et al.*, Phys. Rev. Lett. **66**, 2152 (1991).