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Temperature Dependence of Magnetic Anisotropy of Ultra-Thin Co Layers

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The magnetic properties of ultra-thin films are mostly governed by the interface magnetism. Depending on the interface structure, the magnetization of the system can be modified. In particular, interface strain between two adjacent layers is important parameters to control the magnetization orientation. Previously, we demonstrated that the magnetization orientation of ultra-thin Co layer can be tuned depending on the non-magnetic underlayer thickness by varying interfacial strain [1]. In this presentation, we will examine its temperature dependence magnetic anisotropy of the ultra-thin Co layer system. We prepared multilayers, consisting of an epitaxial Au/Co/Au/Cu(111) architecture on Si(111) substrates, to understand the temperature dependent magnetic anisotropy of an ultrathin Co layer. The room-temperature magnetization of an 8-monolayer (ML)-thick Co layer is predominately either in-plane or out-of-plane depending upon the thickness of the Au underlayer. Fig. 1 shows the spinwave frequency shift 8 ML Co with two different Au layer thicknesses. The Co magnetization can be tuned depending on the Au layer thicknesses at room temperature. This is attributed to the difference in the interfacial strain. Upon cooling samples, the sample with 2 ML Au underlayer changes its easy axis from in-plane to out-of-plane below 200 K (shown in Fig. 2). On the other hand, the sample with 6 ML Au underlayer remains its easy axis upon cooling. The x-ray diffraction experiments do not show any structural anomaly below 200 K for both samples. The possible physical mechanism of temperature dependent spin-reorientation transition is discussed.

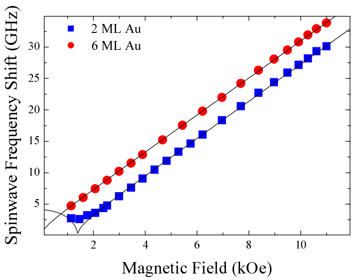

Fig. 1. Au thickness dependence spinwave frequency shift of Co thin films. The Co magnetization is out-of-plane when the Au underlayer thickness is 2 ML. When the Au underlayer is 6 ML, the Co magnetization becomes in-plane.

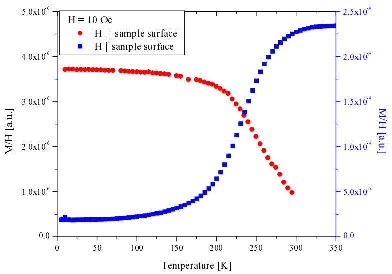

Fig. 2. The temperature dependence magnetization of ultra-thin Co 8 ML layer with 2 ML Au underlayer.

[1]. S. Park et al., Appl. Phys. Lett. 86, 042504 (2005).

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Magnetic Properties of [Pt/CoFeB/Pt] Thin Films With the Perpendicular Magnetic Anisotropy

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There are many attentions to the magnetic materials with the perpendicular magnetic anisotropy, on account of the needs of high density storage and the low driving current device.[1,2] We have prepared [Pt(x nm)/CoFeB(1nm)/Pt(1nm); x = 2.5,5,10,20] thin films with perpendicular magnetic anisotropy(PMA), as shown in Fig.1. The composition of CoFeB is 0.6 : 0.2 : 0.2, which is measured by inductively coupled plasma - atomic emission spectroscopy(ICE-AES). The boron content is high enough to be amorphous, as grown at room temperature.[3] However, we should have used the Pt layer under the CoFeB as a seed layer, and we have observed the thickness dependence of the saturation field to the in-plane direction of the films ,as well.(Fig.2)

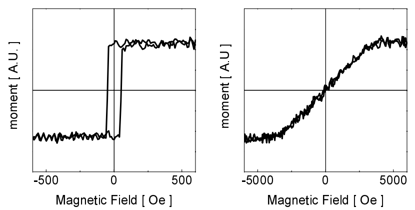

Fig. 1. magnetic moment vs magnetic field curve of [Pt(2.5nm)/ CoFeB(1nm)/Pt(1nm)], which is measuredby vibrating sample magnetometer(VSM) ; left : out-of-plane direction, right : in-plane direction.

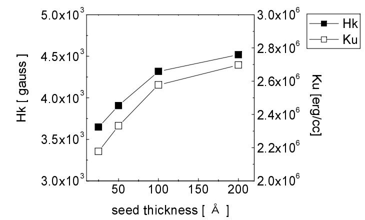

Fig. 2. the dependence of the Pt seed layer thickness with Hk, and Ku of [Pt(x nm)/CoFeB(1nm)/Pt(1nm)] thin films.

[1] D. Weller et al., IEEE Trans. MAG., 36, 10 (2000).
[2] S. Fukami et al., J. of Appl. Phys., 103, 07E718 (2008).
[3] T. Takeuchi et al, Japan. J. of Appl. Phys. , 46(25-28), L623 (2007).