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STRESS-INDUCED ANISOTROPY IN Co/Pd MULTILAYER FILMS

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1. Introduction

Co/Pd multilayer films are of great interest today because of their novel properties and potential technical applications to magnetic and magneto-optical recordings [1,2]. The perpendicular magnetic anisotropy in this system is generally believed to be caused by the Néel's surface anisotropy[3]. However, recent studies have indicated that the stress-induced magnetic anisotropy also plays a role, especially for the samples prepared by sputtering[1]. In this paper, we report the magnetoelastic contribution to the magnetic anisotropy in Co/Pd multilayer films by *in situ* stress-measurements.

2. Experiment

Co/Pd multilayer films were prepared by dc magnetron sputtering from 2-in.-diameter Co and Pd targets on 130-μm-thick glass substrates at the Ar sputtering pressure of 10 mTorr. Stress of a multilayer film was measured *in situ* during the deposition using a home-made optical displacement probe[4]. A change in the gap distance between the probe and the substrate, caused by stress of a deposited film, was detected by measuring a corresponding change in the reflectivity from the back side of the substrate. The sensitivity of the probe was 59 mV/μm and thus, good enough to detect stress caused by deposition of a monatomic-layer-thick Co or Pd. To clarify the magnetoelastic contribution to the magnetic anisotropy, we measured the stress in the Co sublayer for a series of the samples with different Co sublayer thickness, but having a constant Pd sublayer thickness.

3. Results and Discussion

Fig. 1 shows a plot of the stress vs. the Co-sublayer thickness for a series of the samples having a constant Pd-sublayer thickness of 9 Å. A distinct drop in the stress can be seen when the Co-sublayer thickness is larger than about 5 Å. A sudden drop in the stress is believed to be related with a structural change from a coherent to incoherent interfacial matching between Co and Pd sublayers with increasing the Co-sublayer thickness. The critical thickness for a coherency-incoherency transition observed in our samples is agreed with a theoretical value of ~ 5 Å estimated by den Broeder *et al*[1].

The stress-induced magnetic anisotropy energy K_λ is given by

$$K_\lambda = -\frac{3}{2}\lambda\,\sigma_{co} \qquad (1)$$

where λ is the magnetostriction coefficient and σ_{Co} is the stress of the Co sublayer. Because of a negative λ for Co/Pd multilayers, the strained Co sublayer yields a positive perpendicular anisotropy energy. In Fig. 2, the stress-induced anisotropy K_λ is plotted, together with the magnetic anisotropy energy K_u. As seen in the figure, K_λ of ~ 3.11×10^6 erg/cm^3 and ~ 1.87×10^6 erg/cm^3 are obtained for the coherent and incoherent samples, respectively. The Néel's surface anisotropy K_N in our samples, obtained from a plot of $K_u t_{Co}$ vs. t_{Co} is estimated 0.16 erg/cm^2. The contribution of K_N to K_u for the samples showing the perpendicular magnetic anisotropy are estimated between 4×10^6 erg/cm^3 and 8×10^6 erg/cm^3. Hence, the magnetoelastic contribution to the perpendicular magnetic anisotropy is 40 % ~ 50 % in comparison with the contribution by the Néel's surface anisotropy.

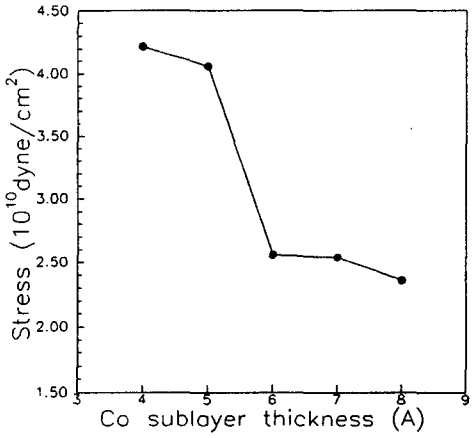

Fig. 1. A plot of the stress vs. the Co-sublayer thickness for the samples with 9Å-Pd.

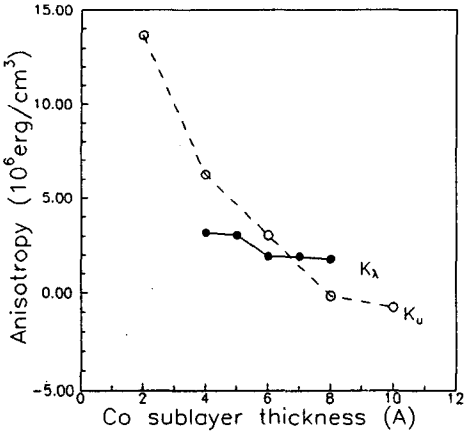

Fig. 2. A plot of the anisotropy energy and stress-induced anisotropy as a function of Co sublayer thickness.

4. References

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