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DEPENDENCE OF MAGNETOELASTIC ANISOTROPY ON THE Ni-SUBLAYER THICKNESS IN Ni/Pd NANOMULTILAYERS

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Ni/Pd 나노다층박막에서 Ni 층 두께에 따른 자기탄성 이방성의 변화 연구

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I. INTRODUCTION

Recently, Shin *et al.*[1-3] have reported observations of room temperature perpendicular magnetic anisotropy(PMA) in Ni/Pt and Ni/Pd multilayers, and they claimed stress-induced magnetoelastic anisotropy played a significant role to induce PMA in these system. In this study, to clarify the contribution of magnetoelastic anisotropy to the PMA observed in Ni/Pd nano multilayers, the magnetoelastic anisotropy energy was quantitatively determined by delicate *in situ* stress and *ex situ* magnetostriction coefficient measurements.

II. EXPERIMENT

Ni/Pd nanomultilayer films were prepared by sequential dc magnetron sputtering onto glass substrates at Ar sputtering pressure of 2 and 7 mTorr. Typical deposition rates, obtained under an applied power of 30 W to each target and a target-to-substrate distance of 75 mm, were 0.5 Å /s for Ni and 1.2 Å /s for Pd at 2 mTorr, and 1.0 Å/s for Ni and 3 Å/s for Pd at 7 mTorr. The Ni sublayer thickness t_{Ni} ranged from 5 to 20 Å, but Pd sublayer thickness t_{Pd} of 6 Å and the number of repeats of 30 were maintained to be constant for all samples.

III. RESULTS AND DISCUSSION

To investigate the magnetoelastic anisotropy, delicate *in situ* stress and *ex situ* magnetostriction coefficient measurements have been performed using an ultra-sensitive optical displacement sensing apparatus. Fig. 1 demonstrated that a tensile stress of $1.0\text{-}2.5\times 10^{10}$ dyne/cm^2 is existed in the Ni layer for the 7 mTorr samples, with decreasing trend with increasing the Ni sublayer thickness. However, interestingly, stress in 2 mTorr samples varied from tensile(4.3×10^{10} dyne/cm^2) to compressive(-0.2×10^{10} dyne/cm^2) with increasing the Ni sublayer thickness as shown in Fig. 1. However, the magnetostriction coefficients are negative in all samples, irrespective of Ar pressure as shown in Fig. 1 : the magnetostriction coefficient is negatively increased from -0.7×10^{-5} to -2.8×10^{-5} and -0.7×10^{-5} to -2.1×10^{-5} with increasing the Ni sublayer thickness for the 2 mTorr samples and 7 mTorr samples, respectively.

The magnetoelastic anisotropy energy K_e is determined using a relation of K_e=$-3/2\lambda\sigma$, where λ is the magnetostriction coefficient and σ is stress in the Ni layer. In Fig. 2 we plot the dependence of the magnetoelastic anisotropy energy on the Ni-sublayer thickness in the Ni/Pd nanomultilayers. We found that the dependence of the magnetoelastic anisotropy on the Ni sublayer thickness was very different for the samples of 2 mTorr and 7 mTorr. The magnetoelastic anisotropy for the samples prepared at 2 mTorr is largely dependent on the Ni- sublayer thickness : K_e is varied from 4.6× 10^5 to -0.8× 10^5 erg/cm^3 as shown in Fig. 2. However, the magnetoelastic anisotropy for the samples prepared at 7 mTorr is nearly constant with varying the Ni sublayer thickness : K_e of 3.5(± 0.7)× 10^5 erg/cm^3 is observed irrespective of the Ni-sublayer thickness as exhibited in Fig. 2. By phenomenological model we have found that the positive large magnetoelastic anisotropy existed in the samples prepared at a higher sputtering pressure plays a significant role to induce PMA in Ni/Pd nanomultilayers.

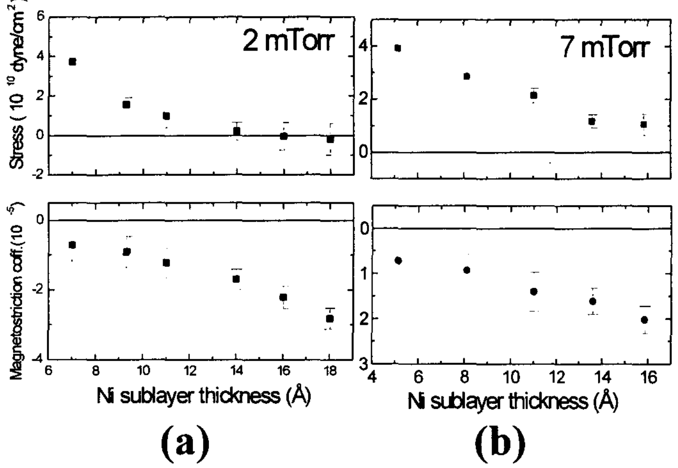

Fig. 1. Dependence of stress and the magnetostriction coefficient on the Ni-sublayer thickness for the samples of (a) 2 and (b) 7 mTorr.

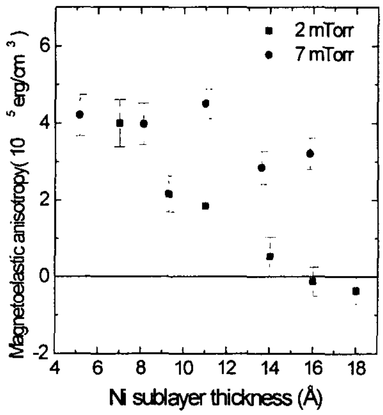

Fig. 2. Dependence of magnetoelastic anisotropy energy on the Ni-sublayer thickness for the samples of 2 and 7 mTorr.

IV.ACKNOWLEDGEMENT

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V. REFERENCES

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