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STUDY ON THE MAGNETOELASTIC PROPERTIES OF $Co_{35}Pd_{65}$ ALLOY FILMS

KAIST J.-R. Jeong*, J.-W. Lee, J. Kim, S.-K Kim, and S.-C. Shin

$Co_{35}Pd_{65}$ 합금박막의 자기탄성 성질에 관한 연구

한국과학기술원 물리학과 정종률, 이정원, 김종결, 김상국, 신성철

I. INTRODUCTION

One of interesting studies in the area of ultrathin ferromagnetic films is to investigate the magnetoelastic properties, since a number of experimental and theoretical works have reported that the magnetoelastic contribution to the magnetic anisotropy is very important in ultrathin magnetic films [1,2]. For instance, the magnetoelastic anisotropy is responsible for the perpendicular magnetic anisotropy observed in Ni/Cu(001) films in the thickness range of 7-60 ML and Co single layers on Au(111). Very recently, Shin *et al.* has observed room-temperature perpendicular magnetic anisotropy in Ni/Pt and Ni/Pd multilayers, and reported that stress-induced magnetoelastic anisotropy also plays a significant role to induce PMA in these systems [2]. In this study, we have investigated the magnetoelastic properties of $Co_{35}Pd_{65}$/Pd(111) magnetic film. Especially, we report on the magnetoelastic coupling constant B_2 of $Co_{35}Pd_{65}$/Pd(111) films in the thickness range of 10-40 Å.

II. EXPERIMENT

$Co_{35}Pd_{65}$/Pd(111) films were prepared onto a 25 μm-thick Si(111) substrate. Co and Pd were co-evaporated from e-beam evaporator sources under the base pressure of 5×10^{-11} Torr. The growth rate of the alloy films was 1.79 Å/min. Si(111) substrates were cleaned chemically prior to their introduction in the chamber and annealed for 1 h at 900 K in ultrahigh vacuum (UHV). Prior to the deposition of $Co_{35}Pd_{65}$ alloy film, a 300 Å buffer layer of Cu(111) was deposited to provide a flat (111) surface for the growth of the $Co_{35}Pd_{65}$ films.

III. RESULTS AND DISCUSSION

Stress and magnetoelastic coupling constant of $Co_{35}Pd_{65}$/Pd(111) films was measured *in situ* during the deposition by a laser deflection technique using 1-D position-sensitive detector(PSD). Details of the measurement system will be reported elsewhere. Stress and magnetoelastic coupling constant were determined from the change of the curvature(R) of substrate using the following equations [3]:

$$\sigma = \frac{Y_s t_s^2}{6(1-\nu_s^2)t_f}\frac{1}{R} \quad , \qquad B_i = \frac{Y_s t_s^2}{6(1+\nu_s)t_f}\left(\left(\frac{1}{R}\right)^{length} - \left(\frac{1}{R}\right)^{width}\right)$$

For the measurements of B_i the substrate orientation has to be chosen so that the $[1\bar{1}0]$ direction of

$Co_{35}Pd_{65}$/Pd(111) runs parallel to the long cantilever beam axis and [112] directions are parallel to the width of the cantilever.

.Fig. 1 shows a stress evolution of (30-Å Pd/30-Å $Co_{35}Pd_{65}$/10-Å Pd) films. Here, the positive and negative slopes imply the existence of tensile and compressive stresses, respectively. A tensile stress in $Co_{35}Pd_{65}$ alloy layer and compressive stress in Pd overlayer was observed as shown in Fig. 1. This stress evolution can be simply understood from lattice mismatch argument, since the lattice constant of Pd is 2.2% larger than that of $Co_{35}Pd_{65}$ alloy. Using this stress evolution data the isotropic film strain can be calculated by $\varepsilon = \sigma(1 - v_f)/Y_f$ under the assumption of isotropic epitaxial film stress. In Fig. 2 we plot the magnetoelastic coupling constant as a function of film thickness. The inset of Fig. 2 shows that the measured hysteresis loop to determine the magnetoelastic coupling constant for the samples of 30-Å $Co_{35}Pd_{65}$ alloy sample. The magnetoelastic coupling constant (B_2) is increased from 1.55 × 10^7 to 3.89 × 10^7 J/M^3 with increasing the $Co_{35}Pd_{65}$ layer thickness. The measured magnetoelastic coupling could be correlated with strain using the relation of $B_{eff} = B_2 + \delta\varepsilon$. Using this strain dependent correction of B_{eff}, we have obtained B_{eff} = 5.06 × 10^7 J/m^3 -7.26 × 10^7 J/m^3 ε.

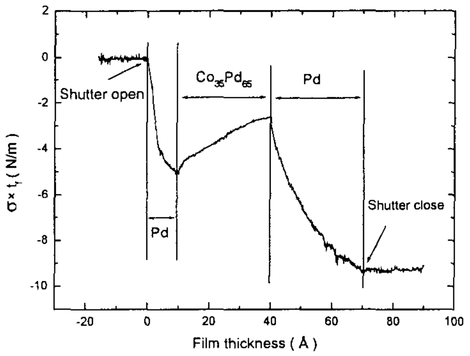

Fig. 1. Stress evolution during the growth of (30-Å Pd/30-Å $Co_{35}Pd_{65}$/10-Å Pd) film.

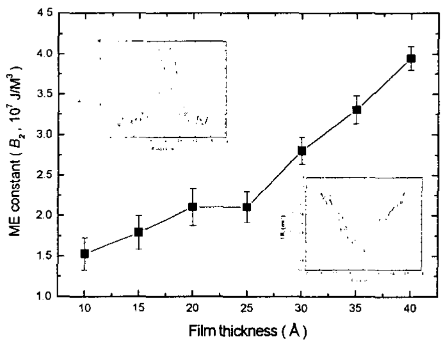

Fig. 2. Magnetoelastic coupling constant (B_2) as a function of $Co_{35}Pd_{65}$ alloy film thickness.

IV. ACKNOWLEDGEMENT

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V. REFERENCES

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