STUDY ON THE CORRELATION BETWEEN GROWTH STRUCTURE AND MAGNETOELASTIC PROPERTIES IN ULTRATHIN CoPd FILMS

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CoPd 박막에서 성장구조와 자기탄성성질의 상관관계에 대한 연구

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I. INTRODUCTION

Recent studies on the magnetoelastic(ME) coupling of ultrathin ferromagnetic films show that magnetoelastic coupling of ultrathin magnetic films are significantly different from the corresponding bulk value.[1,2] In this study, we have investigated the magnetoelastic properties of epitaxially grown CoPd alloy films on Cu/Si(001) in the monolayer regime via *in situ* stress and magnetoelastic coupling measurements with a submonolayer sensitivity.

II. EXPERIMENT

Our study was performed in an ultrahigh vacuum(UHV) chamber equipped with a highly sensitive optical deflection-detecting system for *in situ* magnetoelastic coupling and stress measurements, a submonolayer-resolution surface magneto-optical Kerr effects(SMOKE) measurement system, and a reflection high energy electron diffraction(RHEED) imaging system. The films were grown on 25-μm thick, 15-mm long, and 3-mm wide Si(001) wafers at ambient temperature. The substrates were cleaned chemically using 10 % HF solution to prepare H-terminated Si(001) surface before their introduction into the UHV chamber. Prior to the deposition of CoPd alloy film, 1000-Å Cu was predeposited as a buffer layer to provide a smooth (001) surface helping the epitaxial growth of CoPd film.

III. RESULTS AND DISCUSSION

Fig. 1 shows the Kerr hysteresis loops and low field magnetostrictive hysteresis loops measured along the sample width and length at representative alloy thickness. Ferromagnetic Kerr hysteresis loop and magnetostrictive hysteresis loops appears at 2 ML as shown in Fig. 1. It is worthwhile to note that magnetostrictive hysteresis loop can be observed even in the 2 ML-thick CoPd alloy film. It clearly shows that our magnetostrictive measurement system has monolayer sensitivity. In Fig. 2, we plot the magnetoelastic coupling coefficient as a function of film thickness. The magnetoelastic coupling coefficient is sensitively dependent on the CoPd alloy thickness as seen in the Fig. 2: it is increased from 0.72×10^{7} to 3.31×10^{7} J/m^{3} with varying the CoPd layer thickness from 2 ML to 10 ML. In order to elucidate the thickness dependence of the magnetoelastic coupling, we plot the magnetoelastic coupling coefficient as a function of film strain as shown in the inset of Fig. 4. We first tried to fit data using typical first-order strain-dependent correction equation, $B_2 = B_b + C'_1 \varepsilon$. The solid line in the inset of Fig. 2 shows a result of linear fitting using above equation. The estimated value of bulk magnetoelastic coupling(B_b) obtained from the linear fitting is 6.04×10^7 J/ m^3. Note that this value is two times larger than that of bulk single crystal, i.e., the first order strain correction ($C'_1 \varepsilon$) is not sufficient to describe the strain dependence of magnetoelastic coupling. Therefore, we introduced a second-order term in the strain dependent correction equation: $B_2 = B_b + C'_1 \varepsilon + C'_2 \varepsilon^2$. The solid curve in the inset of Fig. 2 shows a fitting result using the second-order strain correction equation. As seen in the figure, the fitting curve agrees well with the experimental data, which clearly demonstrates importance of second-order strain correction in understanding the magnetoelastic coupling of CoPd alloy. The estimated value of bulk magnetoelastic coupling(B_b) obtained from the second-order strain correction is 3.52×10^7 J/m^3, which is in agreement with the value of bulk single crystal alloy. Thus, we believe that second-order strain correction is essential to describe the dependence of magnetoelastic coupling on film strain in CoPd alloy films.

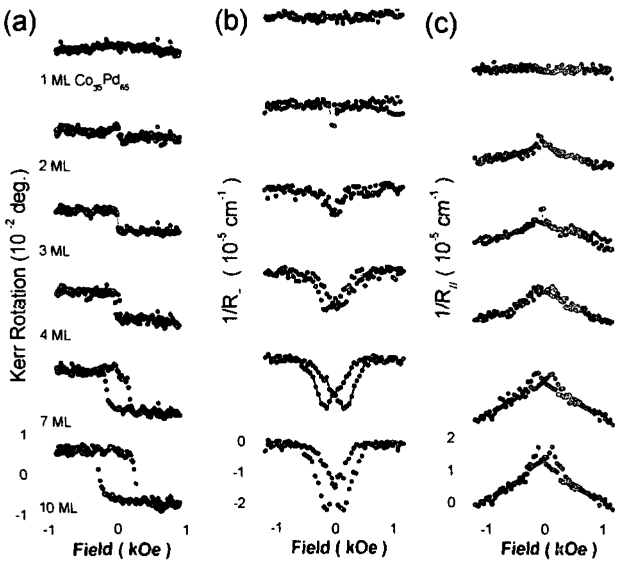

Fig. 1. (a) Longitudinal Kerr hysteresis loops and low field magnetostrictive hysteresis loops measured along (b) the sample length and (c) width at different CoPd alloy layer thicknesses.

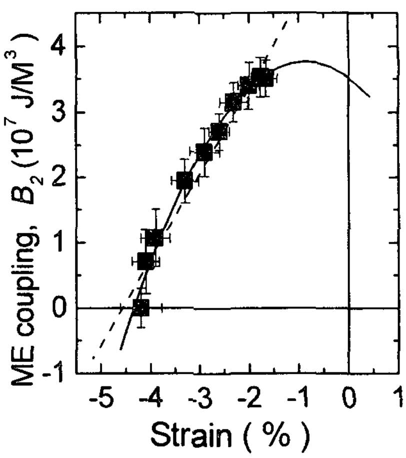

Fig. 2. Magnetoelastic coupling constant(B_2) as a function of CoPd alloy film thickness. The inset shows the dependence of magnetoelastic coupling on the film strain.

IV.ACKNOWLEDGEMENT

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V. REFERENCES

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