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The Huge Magnetic Anisotropy of Fe_3Pt Alloy Thin Films

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The Fe-Pt alloy system has the three ordered phases in the bulk equilibrium phase diagram. Magnetic properties of Fe-Pt alloy system widely vary with their crystal ordering. The $L1_0$ ordered phase of FePt alloy thin films was reported to exhibit a large magnetic anisotropy of the order of 10^7 erg/cc at room temperature [1]. Recent work reported that the "quasi" $L1_2$ ordered phase of Fe_3Pt alloy thin films deposited onto MgO exhibits very large magnetic anisotropy constants ($K_1=-4\times10^6$, $K_2=2\times10^7$ erg/cc) [2]. The origin of the huge magnetic anisotropy of Fe_3Pt alloy thin films is still open to question. The purpose of this study is to elucidate the origin of the huge magnetic anisotropy by investigating the temperature dependence of the magnetic anisotropy of the Fe_3Pt alloy thin films.

Alloy thin films of Fe_3Pt were deposited onto MgO(100) and MgO(111) substrates at deposition temperature 400°C using an electron beam deposition system. The composition of the samples was analyzed by an energy dispersion fluorescence X-ray spectrometer. The crystallographic structure of the samples was measured by a high-power X-ray diffractometer.

Measurements of magnetic properties were carried out using a high sensitive vibrating samples magnetometer and a torque magnetometer.

The temperature dependences of the magnetic anisotropy constants K_1 and K_2 as well as the ratio $[M_s(T)/M_s(R.T.)]^2$ are shown in Fig.1. It is observed that the temperature dependences of K_1 and K_2 are very close to the curve of $[M_s(T)/M_s(R.T.)]^2$, indicating that the temperature variation is reasonably accounted for the M_s^2 law dependence. The present result is at variance with the M_s^{10} dependence law reported in the case of Fe both theoritically and experimentlly [3][4][5]. Further study is therefore neccessary to clarify this intriguing dependence and the details of it will be presented.

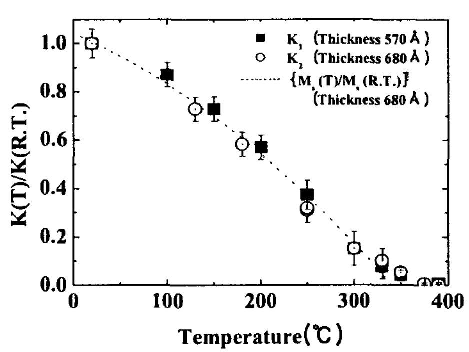

Fig. 1. Temperature dependence of K_1, K_2 and $[M_s(T)/M_s(R.T.)]^2$

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Effects of growth temperatures to the magnetic properties of Co/Ge(111) films

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Effects of growth temperatures to the magnetic properties of Co/Ge(111) ultrathin films have been studied using the surface magneto-optic Kerr effect technique. Annealing at high temperatures for Co/Ge(111) films leads to the cobalt germanide formation and the disappearance of ferromagnetism. However, ultrathin Co/Ge(111) films with fixed total thickness but fabricated at higher temperature show higher thermal stability. As an example for 22 monolayers Co/Ge(111) deposited at 200 and 300 K, the difference of the temperatures where ferromagnetism disappears upon annealing treatment is about 75 K. In additional, a plateau occurs in the Kerr intensity versus temperature curve for the films deposited at 200 K, while only monotonic decrease occurs for the films deposited at 300 K. The interface between Co overlayer and Ge(111) substrate shows a more ordered structure for films deposited at 200 K as revealed by low-energy electron diffraction measurements. The responses of magneto-optic signals could be explained by the different morphologies at the interfaces. A Co/Ge(111) system exhibits a strong in-plane anisotropy that is not altered by the interfacial conditions.