In-plane component suppression and K_u enhancement of FePt-oxide granular films by using (Pt, Ag)-C/ FePtCu-C stacked granular buffer layers

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Investigation of nanostructure and magnetic properties of the granular films deposited on stacked buffer layers (BLs) of Pt-C/ FePtCu-C and Ag-C/ FePtCu-C are reported. By optimizing the thickness of Pt-C/ FePtCu-C and Ag-C/ FePtCu-C BLs, maximum K_u of 2.7×10^7 and 2.2×10^7 erg/cm^3, respectively, can be obtained. In addition, the amount of magnetic grain with c-axes parallel to the film plane of those granular films is suppressed. Furthermore, FePt grain size of the granular film deposited on Ag-C/ FePtCu-C BLs is smaller than that of deposited on Pt-C/ FePtCu-C BLs.

Index Terms— **granular films, stacked buffer layers, melting, c-axis parallel to the film plane, FePt grain size**

I. Introduction

To ensure that hard disk drive (HDD) remains competitive in the data storage, recently a new design of magnetic recording technology, heat assisted magnetic recording (HAMR) has been launched into the market to replace currently commercialized perpendicular magnetic recording. The L10 type FePt phase which has high uniaxial magneto-crystalline anisotropy energy, K_u of 5.0×10^7 erg/cm^3 at room temperature is a promising material for the HAMR medium. Regarding nanostructure of the medium, a granular structure with fine columnar and isolated magnetic grains, small angular distribution of c-axis, and high degree of order are desirable, however, these goals are still unaccomplished. Based on our previous study in K_u of FePt granular film, there is a disorder portion at the initial growth region which deteriorate K_u [1-2]. Many studies on adding various grain boundary materials, such as carbon [3-4], SiO_2 [5], TiO_2 [6], and B_2O_3 [7] into FePt thin films are still unable to obtain a satisfactory result so that other approach, such as the utilization of a buffer layer (BL) in between the FePt-oxide granular film and the MgO underlayer is conducted [8]. According to our previous results, C and FePtCu-C BL [9] show large magnetic grains and high K_u. On the other hand, Pt-C BL [10] shows small magnetic grains and low K_u. Therefore, to satisfy both requirements we have investigated stacked BL. In this paper, we report the evaluation results of the nanostructure and magnetic properties of the granular films with stacked BLs, which consist of FePtCu-C deposited on Pt-C BL and FePtCu-C deposited on Ag-C BL.

II. Experiments

All samples were prepared using RF/DC magnetron sputtering (Canon Anelva C3010-P7-UHV; 7-chamber configuration with single-side film fabrication, each process can be carried out in an independent chamber separated with gate valve). The in-line sputtering equipment is almost the same model as that for the mass production of PMR media. The stacking structure of the samples is amorphous glass substrate (0.635 mm thick)/ $Co_{60}W_{40}$ (Ar gas pressure: 0.6 Pa, film thickness: 80 nm, substrate temperature: RT)/ MgO (4 Pa, 5 nm, RT)/ Pt-50vol%C or Ag-50vol%C BL (0.6 Pa, 0.2 or 0.6 nm, RT)/ $Fe_{35}Pt_{35}Cu_{30}$-30vol%C BL (8 Pa, 0 – 2.0 nm, RT)/ Magnetic layer (8 Pa, 5 nm, 550 °C)/C (0.6 Pa, 7 nm, RT). Pt-50vol%C or Ag-50vol%C BL was used as the seed layer, and $Fe_{35}Pt_{35}Cu_{30}$-30vol%C BL was used as the ordring layer. $Fe_{50}Pt_{50}$–30vol% B_2O_3 sintered targets were used for the magnetic layer. *M-H* loops were measured by using a vibrating sample magnetometer equipped with a SQUID detector (Quantum Design, MPMS3) at the maximum applied field of 70 kOe. Torque curves were measured by using a physical property measurement system with a torque magnetometer option (Quantum Design, PPMS) with the maximum applied field of 90 kOe [11]. Crystal structure was examined using out-of-plane and in-plane X-ray diffraction (XRD) measurements with Cu Kα radiation at wavelength of 1.542 Å (Rigaku, SmartLab; 9 kW/ parallel beam configuration/ 2D detector). Nanostructure of the films was observed by transmission electron microscopy (TEM) with an acceleration voltage of 300 kV.

III. Results And Discussion

Fig. 1 shows dependence of M_s and K_u of Pt-C or Ag-C/FePtCu-C/ FePt-B_2O_3 granular film in stacked BL on FePtCu-C BL thickness. When FePtCu-C thickness is varied from 0 to 0.6 nm, M_s increases from 690 to 810 emu/cm^3. For thickness more than 0.6 nm of M_s shows no obvious change. When FePtCu-C deposited on Pt-C BL, maximum K_u of 2.7×10^7 erg/cm^3 is obtain at FePtCu-C and Pt-C thickness of 1.2 and 0.2 nm, respectively. When FePtCu-C deposited on Ag-C BL, maximum K_u of 2.2×10^7 erg/cm^3 is obtain at FePtCu-C and Ag-C thickness of 0.4 and 0.6 nm, respectively.

Fig. 2 shows in-plane XRD profiles of Pt-C or Ag-C/FePtCu-C/ FePt-B_2O_3 granular films. For both granular films, at Bragg angles of around 33°, 47°, and 69°, the (110), (200), and (220) diffractions of the $L1_0$-FePt phase are observed, respectively, which reveals that the FePt magnetic grains have *c*-plane sheet

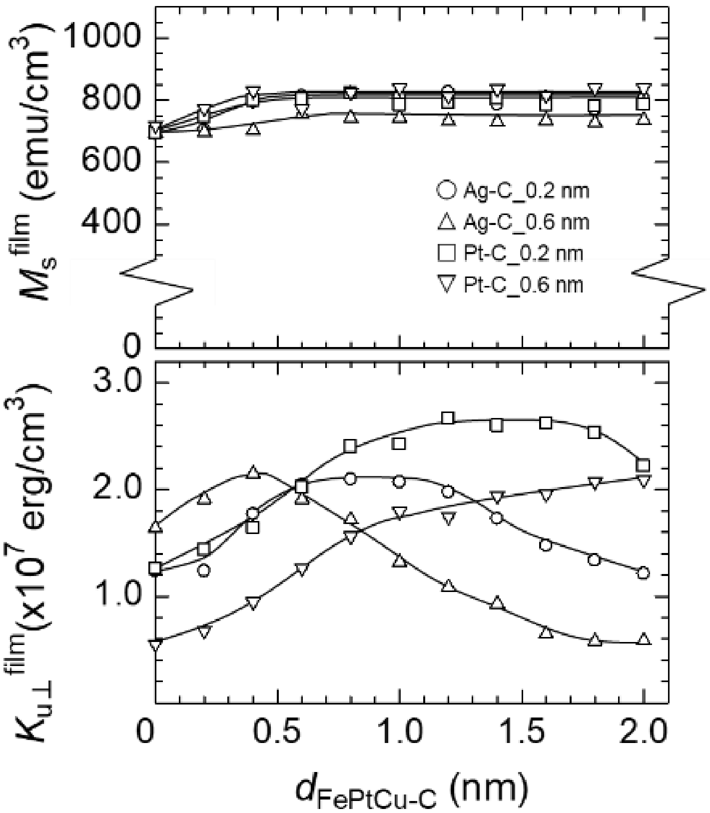

Fig. 1 Dependence of M_s and K_u of Pt-C or Ag-C/FePtCu-C/ FePt-B_2O_3 granular films.

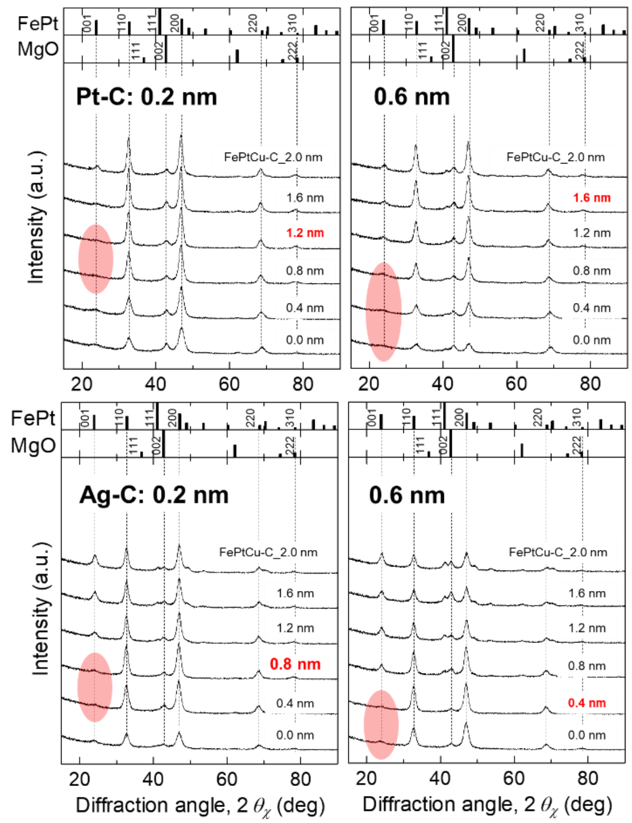

Fig. 2 In-plane XRD profiles for Pt-C or Ag-C/FePtCu-C/ FePt-B_2O_3 granular films.

texture. Focusing at the Bragg angle of around 24°, the integral intensity of (001) diffraction of FePt-B_2O_3 using FePtCu-C/Pt-C or Ag-C BL stacked buffer layer is small.

IV. Conclusion

Stacking FePtCu-C layer as the barrier layer on (Pt, Ag)-C buffer layer to prevent diffusion of BL elements results in low in-plane component, high Ku.

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