INFLUENCE OF ADDITIVE ELEMTS ON THE MORPHOLOGY AND MAGNETIC PROPERTIES FOR HIGHLY COERCIVE FePt THIN FILMS

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I. INTRODUCTION

The magnetization of ferromagnetic nano-particles with a large uniaxial magnetocrystalline anisotropy is of great scientific and technological interest, since they are expected to be applied in forthcoming magnetic devices such as next generation ultrahigh density magnetic storage media (heat assisted magnetic recording, microwave assisted magnetic recording systems) and biasing nanomagnets. Among them, $L1_0$-ordered [CuAu (I)-type] FePt alloy possesses high uniaxial magnetocrystalline anisotropy (7.0×10^7 erg/cm^3), moderate saturation magnetization and high corrosion resistance, it has been attracted much attention for good candidate of future magnetic devices. It is also thought to overcome the instability of magnetization vectors caused by thermal fluctuation even in the nano-meters scaled particles. A lot of studies have been done for continuous films, granular films and self-assembled nano particles [2-6]. However, detailed morphology and magnetic properties of FePt thin films with a small addition of Cu and Ag has not yet fully understand. In this study, in order to investigate the effect of Cu and Ag content on the crystal orientation, surface morphology and magnetization process, FePt(Cu, Ag) thin films have been fabricated on MgO(100) single crystalline substrate.

II. EXPERIMENTAL PROCEDURE

All the samples were prepared using an ultrahigh vacuum magnetron sputtering system (ULVAC, QAM4) with co-deposition of Fe, Pt, Ag and Cu directly onto polished single crystalline MgO(100) substrate. The base pressure was under 7.5×10^{-7} Pa. High-purity argon of 0.2 Pa was introduced during sputtering. The substrates were heated to T_s = 700 ºC during deposition. The nominal thickness of FePt (Cu, Ag) layer was fixed at 10 nm. The compositions of the $(FePt)_{100-X}(Cu, Ag)_X$ films were determined by electron dispersive X-ray spectrometry (EDX), and they were confirmed to X_{Cu} = 0, 1.0, 5.0, 10.0, 20.0, 30.0 and X_{Ag} = 0, 1.0, 5.0, 10.0, 22.1, 29.3. The crystal structure was determined by X-ray diffraction with Cu-$K\alpha$ radiation. The film morphology was observed by atomic force microscopy (AFM). The magnetic properties were measured by a superconducting quantum interference device (SQUID) magnetometer.

III. RESULT AND DISCUSSION

From the XRD patterns, it was confirmed that the fundamental (002) peak, (001) and (003) superlattice peaks of the $L1_0$-FePt phase were clearly observed for all the samples. Therefore, it is confirmed that the c-axis of FePt layers was aligned perpendicular to the film plane. With increasing Cu content, the position of the peak was shifted to a higher angle, indicating that the crystal lattice was slightly contracted. However, in the case of Ag addition, the peak position was almost same. In addition, the reduction of the peak intensity was confirmed with gradual increase of the Ag content.

Remarkable difference in the morphology was observed for the FePt films with Cu and Ag addition. It was confirmed that the average particle size of FePt-Cu thin films was reduced from 72 nm to 46 nm with increasing Cu content from 0 (w/o Cu) to 30 at.%, while for the FePt-Ag thin films, the size was reduced from 72nm at 0 at.% to 33nm at 29.3 at.%. The magnetization measurements revealed that all the sample were perpendicularly magnetized and high coercivities (H_c) of more than 60 kOe was obtained for FePt-Ag

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thin films. However, it was also confirmed that H_c of 23.4 kOe was obtained for FePt thin film with 30 at.% Cu content. This is thought to due to the alloying ability of Ag and Cu to the FePt thin films, although Ag and Cu elements are known to an immiscible element to Fe.

IV. CONCLUSION

In this study, in order to investigate the effect of Cu and Ag content on the crystal structure, morphology and magnetic properties for FePt thin films, FePt-(Cu, Ag) thin films have been fabricated on MgO(100) single crystalline substrate. The (001) and (003) super lattice peaks and the (002) fundamental peak from the $L1_0$-FePt phase have been clearly observed for all the samples. It was confirmed that the position of the peak was shifted to the higher angle for FePt-Cu thin films, which indicates that the crystal lattice is slightly shrunk. It was also confirmed that the average particle size was reduced from 72 nm to 33 nm with increasing Ag content and high H_c more than 60 kOe was obtained for the FePt-Ag thin films.

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