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# Structural and Magnetic Properties of FePt-$B_{X\ at.\%}$ (X= 5, 10, 15, 25 and 33) thin Film by Post-Annealing

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Abstract

Multi-layer film of MgO/$(FePt\text{-}B)_{50nm}$/ MgO was deposited on Si(100) substrates by RF magnetron sputtering. The boron chips were uniformly placed on the FePt target. The boron content of thin film was found to be about 5, 10, 15, 25 and 33 at.% by using a CAMECA SX-51 wavelength dispersive spectroscopy (WDX). It is observed that X-ray diffraction patterns of FePt-B film by post-annealing exhibited a transformation from disordered fcc structure to ordered $L1_0$ phase with fct structure from around 400 °C. By adding B, annealing temperature for ordering is about 200 °C lower than that of pure FePt. This remarkable decrease of the annealing temperature is closely related to the high diffusivities of Fe and Pt associated with the defects caused by movements of B atoms. The maximum coercivity($H_c$) for FePt films was found to be ~ 13 kOe after annealing at 600 °C for 1hr.

Results and Discussion

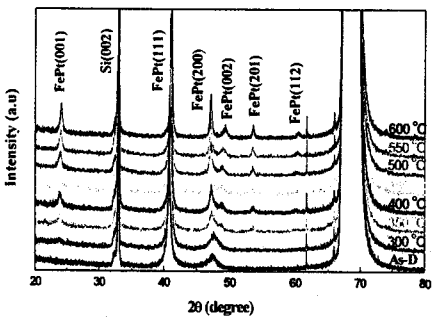


Fig. 1. Typical spectra of θ-2θ scans for Si/MgO/$(FePt\text{-}5\%B)_{10nm}$/MgO

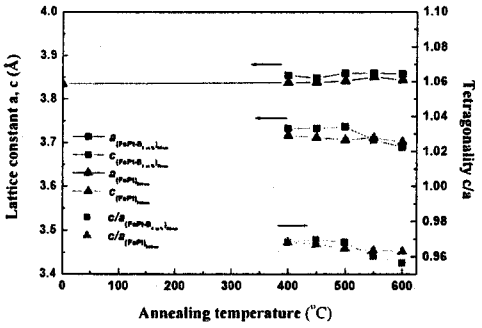


Fig. 2.Temperature dependence of the lattice constants *a*, *c* and axis ratio(*c*/*a*) $(FePt\text{-}5\%B)_{50nm}$ films

We have prepared 50 nm thick FePt-B films with an MgO underlayer and caplayer (20 nm thick). Fig.1 shows the x-ray diffraction patterns of FePt-5%B film annealed at various temperatures in a vacuum of $10^{-6}$Torr for 1 hr. It is observed from the pattern that FePt-5%B film retained the disordered fcc structure annealed at 300 °C. The fundamental (111) diffraction

peak is observed in the as-deposited film, superlattice (001) and the tetragonal (200) and (002) peaks appeared at $T_A$= 350 °C but the other superlattice peaks except the (001) not appeared to 600 °C. The tetragonal (200) and (002) peaks perfectly separated from 400 °C. Intensities of all the peak are more pronounced with an increase in annealing temperature. This reveals the transformation of FePt film from disordered fcc structure to ordered $L1_0$ phase with fct structure around 350 °C. The appearance of superlattice peaks may be attributed to a texture evolution process due to annealing which results in a disorder-order transformation in FePt-5%B thin films. We also investigated the changes of the lattice constants by post-annealing, to see the effect of B in FePt thin film.

Fig. 2 shows the variation the lattice constants ***a***, ***c***, and their ratio (***c/a***) for $FePt_{300nm}$, $(FePt\text{-}5\%B)_{50nm}$ as a function of $T_A$. $FePt_{300nm}$ thin film was deposited by RF magnetron sputtering system to compare a structural properties with $(FePt\text{-}5\%B)_{50nm}$. Depending on annealing temperature, the lattice constant ***a***, ***c*** of $FePt_{300nm}$ and lattice constant ***a*** of $(FePt\text{-}5\%B)_{50nm}$ film nearly did not changed, but the lattice constant ***c*** of $(FePt\text{-}5\%B)_{50nm}$ decrease from 500 °C remarkably. The values of lattice constant ***a***, ***c*** for $(FePt\text{-}5\%B)_{50nm}$ film were investigated more large than $FePt_{300nm}$ film. However, values of ***c*** for $(FePt\text{-}5\%B)_{50nm}$ film appeared lower than $FePt_{300nm}$ film from above 500 °C.

References

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