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Magnetic Properties and Microstructure of Zr Doped FePt Alloy Films

Sang Hyun Yang, Young Keun Kim, Seong-Rae Lee

Division of Materials Science and Engineering, Korea University, Seoul 136-701, Korea

Jong- Gab Na

Thin Film Technology Research Center, Korea Institute of Science and Technology Seoul, 136-791, Korea

1. INTRODUCTION

$L1_0$ compounds such as FePt and CoPt have drawn an attention for high density recording media application because they have high magnetic anisotropy of 7×10^7 erg/cc[1]. In order to get an $L1_0$ compound, an as-deposit disordered film must be post-annealed at relatively high temperature. Such high annealing temperature is unfavorable because of grain growth. Current studies on emerging high recording media such as FePt and CoPt films have been focused on restraining the growth of grains and improvement of decoupling. It was reported that CoPt/M[2](M=Ag,C) and FePt/SiO_2 multilayers[3] have smaller grains than that of pure FePt or CoPt. These films consisted of magnetically isolated the ordered phase which is embedded in an nonmagnetic phase. FePtX or CoPtX (where X is the third element) have been investigated. Doped Ag efficiently promotes the ordering process and inhibits the growth of grains in CoPt – Ag alloy film [4]. FePtX (X= W, Ti[5] and Si_3N_4[6]) showed a smaller grain than that of pure FePt. The Purpose of this study is to investigate effect of Zr doping on microstructure, ordering kinetics and magnetic properties

2. EXPERIMENT

70 nm thick. FePt-Zr (0~ 8 at.%) alloy films were prepared on glass (Corning 7059) substrate by dc magnetron sputtering in the high base pressure less than than 4×10^{-7} Torr. Composition of the films was controlled by using composite targets consisting of Pt and Zr chips on Fe target. The films were annealed at 500 °C for various times under a vacuum of 6×10^{-6} Torr. Magnetic properties were measured using a vibrating sample magnetometer (VSM). Structural properties were analyzed by an x-ray diffractometer(XRD) and a transmission electron microscopy (TEM). Composition analysis was done by XPS and RBS. The grain size was determined using bright field images of TEM

3. RESULT AND DISCUSSION

Fig.1 shows that the coercivity variation of the films as functions of Zr contents and annealing times. As the Zr content increased, the coercivities were increased faster. For 8 at.% Zr containg film, the maximum coercivity of 7300 Oe was obtained at 10 min annealing. In comparison, for FePt film, it took over 60 min annealing to obtain coercivity of 7378 Oe. The interesting phenomena are that the high Zr contained films(4 or 8at.% Zr) showed a high rate of ordering but also a high rate of disordering. It may be considered that point defects will expedite ordering phase transformation because of the addition of Zr of which atomic diameter is larger than that of Fe and Pt. When the films were annealed over 10 min, the $L1_0$ phase disappeared. If the Zr consumed the Pt to form compounds such as Pt_3Zr or, PtZr, then the ordered $L1_0$ phase could be distructed because the Pt content was decreased below the stable range of the phase. The role of the Zr is not known exactly yet. Figure 2 shows the average grain size variation as functions of annealing time and Zr content. As the Zr content increased, the grain growth was significantly retarded. The difference of grain size between FePt and FePt-Zr is clearly appeared in long time annealing. In summary, we fabricated FePt-Zr alloy films having the coercivity of 7300 Oe and grain size of 5 nm. Zr inhibited the growth of FePt grains effectively and enhanced the ordering transformation rate

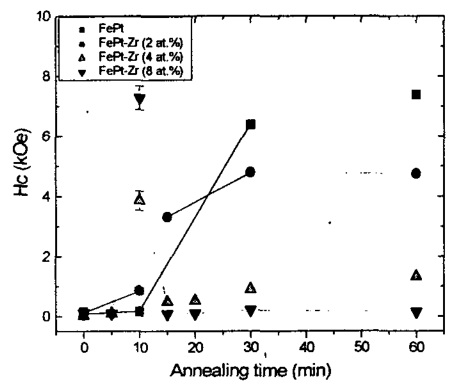

Figure 1. Variation of coercivities of the FePt-Zr annealed at 500 °C as a function of Zr contents and annealing times

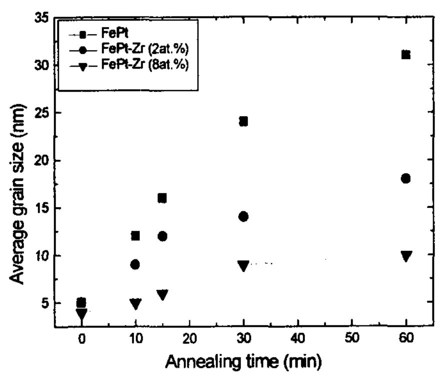

Figure 2 Variation of average grain size of the FePt-Zr films annealed at 500 °C as a function of Zr contents and annealing times

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