

Coercivity Enhancement of FePt (001) Thin Films via Ag Additive

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FePt ordered phase is one of the most potential candidates for future magnetic recording due to its large magnetocrystalline anisotropy constant ($\sim 7 \times 10^7$ erg/cm³). This high magnetic anisotropy could thermally stable and exhibit perfect ferromagnetic properties even grains size down to 5 nm and possibly achieve up to 1 T bit/in.² recording densities [1]. In this article, we fabricated *in-situ* ordered [Fe (1 nm)/Pt (1 nm)]₁₀ multilayers at 500 °C on MgO (001) substrates and to study the beneficial effects of symmetric Ag additive layers on the magnetic properties and magnetization reversal of FePt films. Ultrathin Ag additive layers, 0.5 nm each, were symmetrically introduced into [Fe/Pt] bilayers by a Knudsen cell. Two layers (Ag_{2P}) located atop of the 3rd and 7th [Fe/Pt] bilayers, respectively. Five layers (Ag_{5P}) located atop of every two [Fe/Pt] bilayers, respectively. For comparison, we introduced only one Ag layer atop of the 5th [Fe/Pt] bilayer with a thickness the same as total thickness of two (1 nm) and five (2.5 nm) layers, respectively. The out-of-plane coercivity values of the FePt films without and with Ag_{2P} are about 4400 and 6310 Oe, respectively. With Ag_{5P} introduced into FePt films, the coercivity is 40% larger than those without Ag. However, the coercivity of the films with a single 1 nm Ag layer is 4900 Oe, which is only 12% larger than those films without Ag. The highest coercivity is 75% larger than pure FePt films via introducing Ag_{5P} as shown in Fig. 1. It is worthwhile to note that the coercivity of FePt films with symmetric Ag layers is always larger than those films with a single Ag layer of the same total thickness. The more effective enhancement in coercivity with symmetric Ag layers is due to the relative uniformly distributed defects than that of a single Ag layer induced pinning effects to impede domain wall movement. From the measurement of angular dependence coercivity shows a tendency of the domain-wall motion shift towards rotation of reverse-domain type upon the introduction of Ag layers into FePt films as seen in Fig. 2. This implies that the grains of the FePt are less magnetically coupled and the reversal of magnetization is more independent via Ag additive. The separated magnetic domains caused by the Ag additive as observed from the MFM images, which may inhibit the domain-wall extension, thus effectively enhances the coercivity of the FePt films.

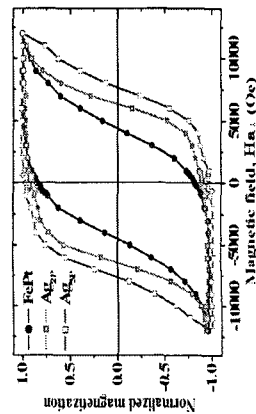


Fig. 1. Perpendicular magnetization curves for the FePt, Ag_{2P}, and Ag_{5P} films.

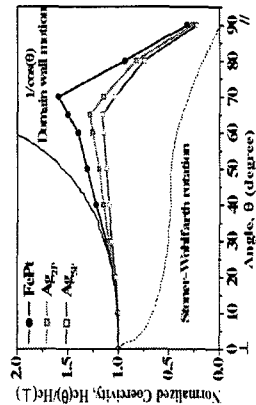


Fig. 2. Angular dependence coercivity profiles for the FePt, Ag_{2P}, and Ag_{5P} films.

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Electrochemical Preparation of Co₃Pt Nanowires

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The synthesis and study of nanowires is of interest for underlying physics and potential applications in nanoscale devices. Compared to other magnetic metallic compositions, Co-Pt alloy nanowires have been explored for applications in sensors and high density recording media due to their highly perpendicular anisotropic properties, in particular the composition of Co₃Pt that belongs to the category of the highest magnetic anisotropy materials [1,2]. In this paper, we engineer Co-Pt alloy nanowires in the form of Co₃Pt phase in AAO nanotemplates by DC electrodeposition and investigate correspondingly the structural and magnetic properties of the magnetic nanowire arrays as a function of Co concentration. The Co-Pt alloy nanowires were DC electrodeposited in anodic aluminum oxide (AAO) nanotemplates from a single bath which contains CoSO₄·7H₂O and PtCl₄. The morphology examination by SEM and TEM shows well-aligned, robust, individual Co-Pt alloy nanowires, while HRTEM reveals the lattices of the atomic arrangement in the nanowires. The uniformity of the alloy composition was performed by elemental line scan and mapping, which proves the homogeneous distribution of the two elements, Co and Pt, throughout the nanowires. The structure of the Co-Pt alloy nanowire arrays in high Co concentration were analysed by XRD for the cases of (A) Co_{0.7}P_{0.3}, (B) Co_{0.4}P_{0.6}, and (C) Co_{0.2}P_{0.8}, with the peaks in the spectra assigned to face-centered-cubic (fcc) Co₃Pt phase (L1₂), which are further corroborated by SAED study and the appearance of more peaks in XRD diffraction patterns after heat treatment. In the magnetic measurements, Co-rich nanowires display a well-defined ferromagnetic behaviour, in contrast to near superparamagnetic response of the Pt-rich nanowires, unambiguously showing the perpendicular anisotropy. The effect of annealing on the microstructure and magnetic properties of the nanowires were investigated by thermal treatment of the nanowires at 600-650°C in vacuum, leading to improvements in the crystallinity and magnetic performance of the nanowires. In short, the fabrication of Co-Pt nanowire arrays with fcc-Co₃Pt phase was accomplished by DC electrodeposition in the AAO nanotemplates.

This work was supported by the Korea Research Foundation grants KRF-2004-005-D00057 and KRF-2005-210-D00023, by grant A050750 of the Korea Health 21 R&D Project, Ministry of Health & Welfare, and by grant M10500000105-0510000-10510 from the National Research Laboratory Program of the Korea Science and Engineering Foundation.

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