TA01

Nucleation-type Magnetization Reversal Process in Microfabricated FePt (001) Dots

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The understanding of the magnetization reversal process in nanomagnets is an essential issue for the further development of magnetic storage devices. Especially, nanostructured $L1_0$-FePt has attracted much attention for ultrahigh density magnetic recording media because of the high magnetic anisotropy (Ku), leading to the high thermal stability of magnetization in reduced dimensions. In previous papers, it was reported that a nucleation-type magnetization reversal process was observed in FePt particulate films [1] or microfabricated FePt dots. [2] In this study, the temperature dependence of the magnetic properties was investigated for microfabricated FePt (001) dots, and their coercivity mechanism was discussed using phenomenological analysis which has been used for rare-earth transition metal sintered magnets. [3] Furthermore, the simulated results performed by a micromagnetic simulator were compared to the experimental results.

Thin films were prepared on a MgO (001) single crystal substrate using ultrahigh vacuum magnetron sputtering system. First, a 1 nm-thich Fe seed and a 40 nm-thick Au buffer layers were deposited on the substrate at room temperature. Then, a 50 nm-thick FePt layer was grown on the Au buffer layer at 300°C, and subsequently annealed at 500°C. The thin films were patterned into circular dot shapes through the use of electron beam lithography and Ar ion etching. The structural characterization was performed using x-ray diffraction. The magnetic properties were measured by SQUID magnetometer and magneto-optical Kerr effect. The magnetic domain structures were observed by magnetic force microscopy (MFM). The micromagnetic simulation was performed using the OOMMF simulator. [4]

Only the peaks from the FePt (001) plane are observed in the x-ray diffraction pattern, indicating that the preferential crystallographic orientation normal to the film plane is the (001) direction. After patterning the thin film into the circular dot with the diameter of 250 nm, coercivity (H_c) enhances up to 7.5 kOe from 0.8 kOe for the thin film. Furthermore, H_c= 10 kOe is obtained after annealing the dots at 500°C, which is attributable to the recovery from microfabrcationdamages. From the magnetization curves and the MFM images for the dots, it is confirmed that the dots show a typical nucleation-type magnetization reversal. According to the temperature dependence of magnetic properties, the defect region for the dots after annealing is estimated to be 18 nm, which is smaller than 26 nm for the dots before annealing and is in agreement with the enhancement of H_c due to the recovery from the damages by annealing. The micromagnetic simulation for the dot without defects shows that a quite larger H_c than the experimental result is obtained. In the case of the dot with a defect, however, H_c drastically decreases with increasing the defect size. The simulated result with a 20 nm-size circular defect is comparable to the experimental value, which is almost consistent with the results of phenomenological analysis.

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TA02

Enhanced Perpendicular Coercivity and Magnetic Anisotropy of FePt films by using Ag Capped Layer

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The $L1_0$ FePt film normally has (111) preferred orientation and its magnetic anisotropy can be changed from in-plane to perpendicular direction as introducing MgO (200) underlayer [1]into FePt film. In this study, the effects of MgO and Ag capped layer on the microstructure, coercivity, and magnetic anisotropy of the FePt film are investigated. The MgO underlayer with 5nm thickness is deposited onto naturally oxidized Si (100) substrates by rf magnetron sputtering at ambient temperature under an Ar pressure of 10 mTorr. The FePt magnetic layer with thickness in the range of 5-20 nm and a MgO capped layer or an Ag capped layer of 5 nm thickness are deposited sequentially by dc or rf magnetron sputtering onto the MgO underlayer. The as-deposited films are annealed at 600 °C for 30 min in vacuum which higher than 5×10^{-7} Torr.

Comparing the M-H loops of MgO 5nm/FePt 20nm with Ag 5nm/FePt 20nm films,although the in-plane coercivity is decreased slightly from 6965 Oe to 6780 Oe when MgO capped layer is replaced by Ag capped layer, the perpendicular coercivity of FePt films is enhanced greatly from 3169 Oe to 6726 Oe. The TEM bright field image of the Ag 5nm/FePt 20nmfilm shows a granular structure and its average grain size is only about 24 nm. Comparing with the reports of Lee *et al.* [2]and Kuo et al. [3], a large grain size of above 30 nm will be obtained even annealing at a temperature of 500 °C for pure FePt films. As shown in Fig. 1, the Ag atoms diffused from capped layer into the FePt magnetic layer areconfirmed by AES analysis, and they mainly distribute at grain boundary of FePt that will hinderthe grain growth and increase the grain boundary energy, therefore decrease the grain size and enhance perpendicular coercivity of the FePt film.

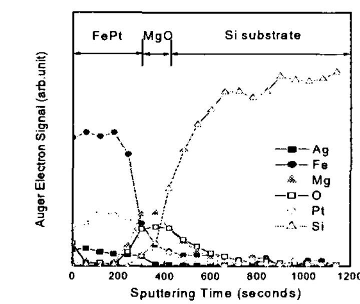

Fig. 1. AES elements depth profiles of the Ag 5nm/FePt 20nm/MgO 5nm/Si multilayer films annealed at 600°C

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