Effect of MgO seed layer misorientation on the texture and magnetic property of FePt-C granular film

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FePt-C based granular films with $L1_0$-ordered FePt nanoparticles have been considered as the most promising candidate for heat-assisted magnetic recording (HAMR) media for the recording density exceeding 1 Tbit/in^2. For the practical application of $L1_0$-FePt films as HAMR media, the thin-film structure has to be optimized with excellent alignment of the c-axis normal to the film plane and small grain size of less than 6 nm with less than 10% size distribution. In our previous work [1)], we demonstrated well-isolated uniform microstructure with high $\mu_0 H_c$ in FePt-C granular film on polycrystalline MgO underlayer. However, there are some remaining issues for the practical application, i.e. large switching field distribution and large in-plane hysteresis in the magnetization curve which could be an origin of poor SNR[2)]. In this work, we investigated the origin of the large in-plane component in the magnetization curve by comparing the FePt-C granular films deposited on a MgO single-crystalline substrate and a poly-crystalline seed layer.

10 nm thick FePt-*28vol.%* C were deposited by co-sputtering Fe, Pt and C at 600^{o}C under 0.48Pa Ar on MgO (100) substrate (Sample A) and glass/ NiTa(100nm)/ MgO(10nm) stacking (Sample B), respectively. MgO seed layer was RF sputter deposited on the amorphous NiTa layer under an Ar pressure of 5.2 Pa at room temperature (RT) using a MgO target. The orientation and phase mapping experiments were conducted on a FEI Tecnai F20 TEM with a field emission gun and an accelerating voltage of 200 kV using the ASTAR™ (NanoMEGAS, Brussels, Belgium) system.

Figure 1 shows the in-plane and out-of-plane magnetization curves of Sample A and Sample B. $\mu_0 H_c$ of Sample A and Sample B are 4.3 and 3.7 T, respectively. Although both of the films show strong perpendicular anisotropy, compared with Sample A, Sample B presents a loop with smaller coercivity, broaden of switching field distribution and in-plane minor loop. By comparison of the orientation maps in Fig.2, one can see that the MgO seed layer introduces significant misorientation of the (001) texture along the normal direction and it should mainly responsible to the decay of magnetic properties in Sample B. With further ASTAR analysis, we found that about 23% of FePt grains in Sample B have 45^o or even 90^o miorientation from the [001] direction. They are mainly originate from misorientated MgO seed layer grains, MgO surface roughness and MgO grain boundaries which were confirmed by cross-sectional HRTEM observation.

Reference

1) A. Perumal, Y. K. Takahashi, and K. Hono, Appl. Phys. Express 1, (2008) 101301.
2) L. Zhang Y.K. Takahashi, A. Perumal, and K. Hono, J. Mag. Mag. Mater, 322 (2010) 2658.

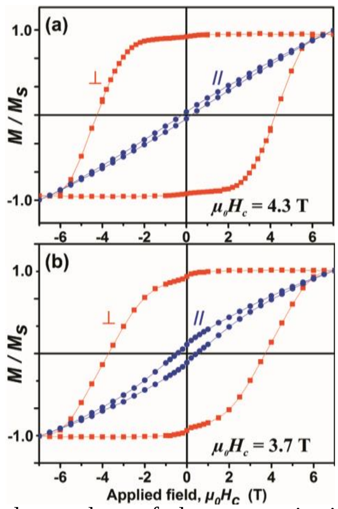

Fig.1 In-plane and out-of-plane magnetization curves of (a) Sample A and (b) Sample B.

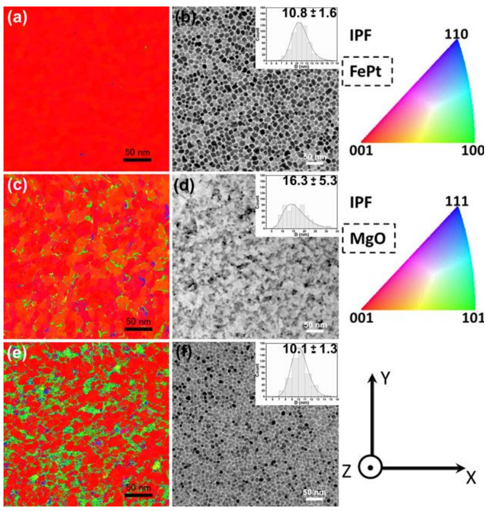

Fig.2 In plane orientation mapping (a, c and e) and virtual bright field TEM images (b, d and f) of Sample A (a & b); polycrystalline MgO (c & d) and Sample B (e & f).