Granular Nanostructures and Magnetic Properties of FePt-C/FePt-SiO$_2$ Films

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The $L1_0$ ordered FePt is one of the most promising candidates for heat assisted magnetic recording (HAMR) media due to its high bulk magnetocrystalline anisotropy energy constant K_u of ~7 × 10^7 ergs/cc. For HAMR media, $L1_0$ FePt-X(segregant) thin films must have high coercivity and small, uniform and columnar shape FePt grains. Various segregants, such as C, TiO$_2$, SiO$_2$ and etc. [1-3)] have been doped to FePt film to obtain desired properties. By doping amorphous SiO$_2$ and TiO$_2$ can fabricate the (001) textured FePt films with columnar grains. However, these FePt films exhibited poor perpendicular anisotropy because their phase separation tendency is too weak to isolate FePt grains in the lateral direction[4)]. FePt-C granular films realize high K_u and well-isolated FePt grains with small grains. But the doped C easily diffused to the surface at the relatively higher fabrication temperature of FePt films. This resulted in second nucleation and the formation of double layer structure with increased media thickness[5)]. In this work, we successfully fabricated columnar structured FePt film with large coercivity by using FePt-C/FePt-SiO$_2$ bilayer structure. Granular nanostructures and magnetic properties of FePt-C, FePt-SiO$_2$ and FePt-C/FePt-SiO$_2$ films have been investigated.

Fig. 1(a) shows an XRD pattern of the FePt-C30*vol*%(4 nm)/FePt-SiO$_2$ 45*vol*%(4 nm) film. The wide background peak between 17° and 35° corresponds to the amorphous glass substrate. The (001) and (002) peaks of the $L1_0$ FePt structure are clearly observed with a missing (111) peak, indicating the FePt grains are strongly (001) textured. The high degree of chemical ordering of $L1_0$ FePt manifests itself as a large integrated peak intensity ratio $A(\mathrm{FePt}_{001})/A(\mathrm{FePt}_{002})$=2.2. Fig. 1(b) shows the magnetization curves of the film. Coercivity of the out-of-plane direction is about 28.5 kOe. Fig. 1(c) and (d) show the cross-sectional TEM bright field images of the film. It is evident that only one layer of well-isolated columnar FePt grains which are about 10 nm in diameter and 13 nm in height is epitaxially grown on the MgO intermediate layer. It can be seen that the FePt-SiO$_2$ layer is successfully grown on the FePt-C layer without forming the second layer. Note that the 8 nm thickness of FePt-C/FePt-SiO$_2$ is thicker than the critical thickness of FePt-C single-layer formation (4 nm). It means that the FePt-SiO$_2$ layer suppress the phase separation between FePt and C.

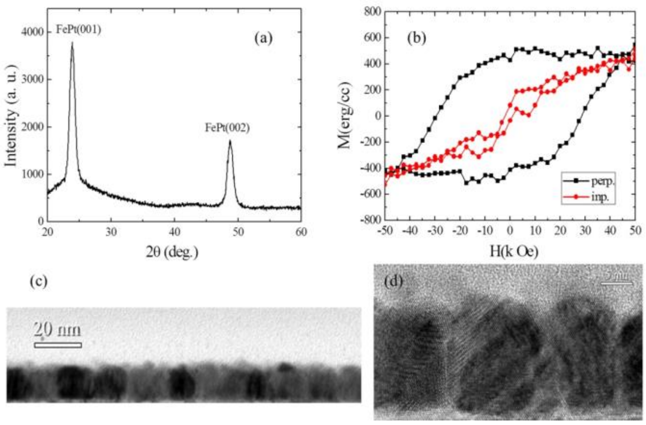

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Fig. 1. (a) XRD pattern, (b) magnetization curves and (c), (d) cross sectional TEM images of FePt-C30*vol*%(4 nm)/FePt-SiO$_2$ 45*vol*%(4 nm) film.