$Fe_{40}Pt_{40}B_{20}$ Electrode for Perpendicular Magnetic Tunnel Junctions

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Perpendicular magnetic tunnel junctions (p-MTJs) with high crystalline anisotropy (K_u) materials can be used to improve the thermal stability of nano-scale magnetic memory elements. The L10 FePt alloy is one of promising candidates for the electrodes of p-MTJs because of its high crystalline anisotropy [1]. However, to be used as an electrode of MgO-based MTJs, a large lattice constant mismatch with an MgO barrier makes its application difficult. To reduce the structural mismatch during the deposition, we used amorphous $Fe_{40}Pt_{40}B_{20}$ (at %) alloy for the electrodes of p-MTJs. The perpendicular magnetic anisotropy (PMA) of the $Fe_{40}Pt_{40}B_{20}$ (at %) alloy can be recovered by the diffusion of boron and the crystallization of the alloy during a post annealing process. In this work, we show that a high degree of ordering of the $Fe_{40}Pt_{40}B_{20}$ layer can be achieved on a thin MgO barrier.

The sample consists of Si/ SiO_2 (300)/ MgO (2)/ Fe40Pt40B20 (10)/ Ti (5) (in nm), where the $Fe_{40}Pt_{40}B_{20}$ layer is deposited by co-sputtering of Fe66B34 and Pt. Actual composition of films were examined using Auger Electron Spectroscopy (AES), and sputtering power was manipulated to obtain an equal atomic composition of Fe and Pt at the deposited state. Post annealing has been conducted by rapid thermal annealing (RTA) at 600℃ for 30 min. The structural properties and magnetic properties are measured by an X-ray diffraction (XRD) and an Alternating Gradient Magnetometer (AGM).

Fig. 1 shows XRD results before and after an annealing process. At as-deposited state, there are no diffraction peaks, representing an amorphous state. However after 600℃ annealing, strong peaks of FePt (001) and (002) evolve, which indicate a high degree of ordering. Fig. 2 shows the magnetization hysteresis after 600℃ annealing. The magnetic properties have changed from a soft in-plane (not shown here) to a strong PMA property. These results show that a high degree of ordering of the FePtB layer can be achieved on a sputter deposited thin MgO barrier.

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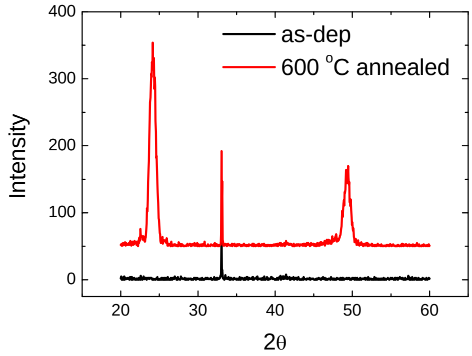

Fig. 1. XRD results of substrate/ MgO (2)/ FePtB (10)/ Ti (5).

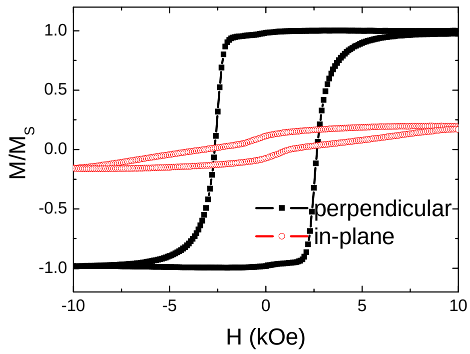

Fig. 2. Magnetization hysteresis of substrate/ MgO (2)/ FePtB (10)/ Ti (5) after annealing at 600℃.

Reference

[1] T. Shima et al, Appl. Phys. Lett., 85, 2571 (2004).