17p-S2-43

Structural and Magnetic Properties of $L1_0$-MnAl/Co Multilayer

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To realize Gbit-class Spin-RAM, improvement of thermal stability and reduction of switching current density are necessary in magnetic tunnel junctions (MTJs). To satisfy these demands, MTJs with perpendicularly magnetized ferromagnetic electrodes (*p*-MTJs) are useful. However, the anti-parallel magnetic configuration is unstable due to the stray field from pinned layer in *p*-MTJs. In previous works, synthetic anti-ferromagnetic (AF) structure was used as pinned layer to suppress the stray field. However, the AF coupling was not so strong in the synthetic structure. In this study, we focus on strong AF coupling[1] between $L1_0$-MnAl[2] and Co and fabricated the MnAl/Co multilayers with low stray field which is applicable to the pinned layer of *p*-MTJs.

Films were prepared by RF magnetron sputtering system. The film stacking structure was MgO(001)-substrate/Cr(40)/[MnAl(2)/Co(t_{Co})]$_6$/Ta(5) (in nm). t_{Co} was varied from 0 to 0.8 nm. The postannealing temperature (T_a) was varied from 300 to 400℃. The crystal structure and magnetic properties were measured by X-ray diffraction (XRD) and vibrating sample magnetometer (VSM), respectively.

XRD (θ-2θ) patterns show a (001)-orientation and the existence of the $L1_0$-MnAl in all prepared films. Figure 1(a) shows magnetization curves for the as-deposited film with t_{Co}= 0.4 nm applying both in-plane and out-of-plane magnetic field. This indicates the film possessed a perpendicular magnetic anisotropy, small remanent magnetization (M_r) of 150 emu/cc and a large coercive field (H_c) of 10 kOe. This MnAl/Co multilayer is useful for pinned layer of *p*-MTJs. Figure 1(b) and 1(c) show the M_r decreased and the H_c increased with increasing t_{Co}. These results suggest the existence of AF coupling between MnAl and Co.

This work was partially supported by the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program) and JSPS KAKENHI (24226001). [1]G.Lauhoff, *et al.*, Phys. Rev. Lett. **79**, 5290 (1997), [2]H.Saruyama, *et al.*, J. Appl. Phys. **52**, 063003 (2013)

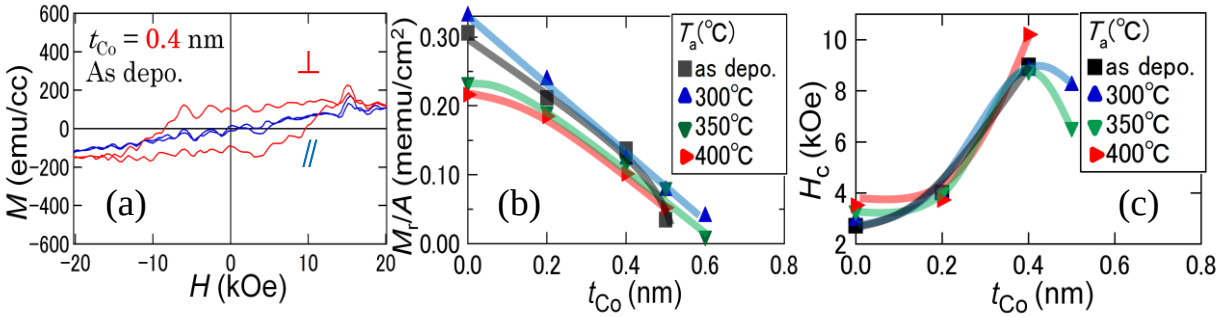

Fig. 1. (a) Magnetization curve for the as-deposited film with t_{Co}=0.4nm. (b) Co thickness dependences of remanent magnetization. (c) Co thickness dependences of coercive field.