17a-S2-8

Tunnel magnetoresistance in lattice-matched Co_2FeAl/Mg-Al-O/CoFe junctions

Thomas Scheike[1,2], Hiroaki Sukegawa[2], Takao Furubayashi[2], Zhenchao Wen[2], Koichiro Inomata[2], Seiji Mitani[1,2]

[1] Graduate School of Pure and Applied Sciences, University of Tsukuba, Japan; [2] NIMS, Tsukuba, Japan

E-mail: Scheike.thomas@nims.go.jp

Magnetic Tunnel Junctions (MTJs) with Co-based Heusler alloy electrodes are considered good candidates for future applications due to their high spin polarization, high magnetic moment and Curie temperature. MgO is usually used for the barrier, and tunnel magnetoresistance (TMR) ratios of around 2000% in Co_2MnSi/MgO/CoFe MTJs at low temperatures were obtained [1]. However, improvement of TMR ratio at room temperature (RT) is needed for practical application. The lattice mismatch between Co-based Heusler alloys and MgO is generally large (3~5%) which leads to dislocations at the Heusler/barrier interface. In addition, it has been suggested that suppression of an inelastic tunneling process at the interface might be necessary to enhance the RT TMR ratio [2]. To avoid both problems, it is promising to use an $MgAl_2O_4$ spinel barrier with cation-disorder (Mg-Al-O) [3] and to insert a thin CoFe(B) layer between the Heusler layer and the barrier [4]. Using the Mg-Al-O barrier, enhancement of TMR ratios due to the strong coherent tunneling effect and achievement of small interfacial dislocation density are expected. In this study, we investigate *B*2-ordered Co_2FeAl (CFA) Heusler alloy/Mg-Al-O/CoFe(001) epitaxial MTJs and the effect of CoFe insertion between the CFA and the barrier.

MTJ multilayers were fabricated by magnetron sputtering on an MgO(001) substrate. The stacking structure is as follows: MgO substrate//Cr (40)/CoFe (5)/CFA (5)/CoFe (d_{CoFe})/Mg (0.45)/$Mg_{19}Al_{81}$ (d_{MgAl} = 0.9)/oxidation/CoFe (5)/IrMn (12)/Ru (12), (thickness in nm). The CFA films were sputtered from a Co-Fe-Al target. The barrier was formed by oxygen plasma oxidation. To tune the CFA/Mg-Al-O interface structure, CoFe layers (d_{CoFe} from 0 to 1.5 nm) were inserted. TMR and resistance area (RA) were characterized using dc four probe method at RT.

The TMR and resistance area (RA) values as a function of d_{CoFe} for all microfabricated junctions are displayed in Fig. 1. For d_{CoFe} = 0 nm (no insertion), we successfully observed a relatively large TMR ratio of 228%, which was attributed to the large spin polarization of the CFA and the coherent tunneling through the Mg-Al-O barrier. TMR ratio increases with d_{CoFe} and shows a maximum for d_{CoFe} = 1 nm (275%), while RA decreases monotonically with the d_{CoFe}. This behavior may mean that the CoFe insertion reduced the damage for the CFA layer during oxidation. Increasing the d_{CoFe} to 1.5 nm leads to a reduction of the TMR, indicating a possible reduction of the contribution from the highly spin polarized CFA layer. The increase of TMR shows the effectiveness of CoFe insertion to tune the interface structure. Because the lattice mismatch between CFA and the spinel is much smaller than that for MgO, further optimization of the interface will lead to higher RT TMR ratios.

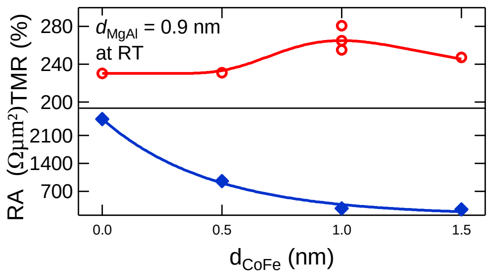

Fig. 1: TMR ratio (top, red) and RA (bottom, blue) vs. d_{CoFe} at RT

References:

[1] H. Liu *et al.*, Appl. Phys. Lett. **101**, 132418 (2012).
[2] A. Sakuma, Y. Toga and H. Tsuchiura, J. Appl. Phys. **105**, 07C910 (2009).
[3] H. Sukegawa *et al.*, Phys. Rev. B **86**, 184401 (2012).
[4] S. Tsunegi *et al.*, Appl. Phys. Lett. **94**, 252503 (2009).