Effects of Interface Layers for the Heusler Based Current-perpendicular-to-plane giant Magnetoresistance Junctions

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Current-perpendicular-to-plane (CPP) giant magnetoresistance (GMR) junctions are of the interests for applications which require low junction resistance, e.g. reading head elements for hard disk drives [1]. Half-metallic Heusler alloy is one of the developed material classes for realizing a large resistance change of CPP-GMR junctions. The tailoring effects for the magnetic/nonmagnetic layer interfaces are interesting for modulating CPP-GMR, which drastically enhances MR effects in some cases (e.g. results in reference [2]). In our previous work, we reported a relatively large CPP-GMR in Heusler alloy based CPP-GMR junctions including $Co_2(Fe_{0.4}Mn_{0.6})Si$ (CFMS)/Ag_3Mg/CFMS structure [3]. The objective for the present study is to investigate the interface tailoring effects for the CFMS-Ag_3Mg based CPP-junctions from view points of MR effects at low bias and the bias current dependence.

Samples were prepared by magnetron sputtering technique. Fe or Mg was used for the inserts in this study. The stacking structure is as follows: MgO substrate | Cr (20) | Ag (40) | CFMS (20) | Fe or Mg ($t_{Fe\ or\ Mg}$) | Ag_3Mg (5) | Fe or Mg ($t_{Fe\ or\ Mg}$) | CFMS (7) | Ag (2) | Au (5), (unit in nanometer). The inserts thickness, $t_{Fe\ or\ Mg}$ was changed from 0 to 0.60 nm with increments of 0.15 nm. All layers were deposited at room temperature and post-annealing was carried out at 550ºC after the deposition of the upper CFMS layer. Structural property of the surface of the upper CFMS layer was characterized by using reflection high energy electron diffraction (RHEED) images. MR measurements were carried out using 4-probe method at room temperature.

Epitaxial growth of the layered structure was confirmed by the RHEED observations for all samples. MR ratio decreased with increasing the inserts' thickness, which were similar trend for both Fe- and Mg-insert junctions. From the bias current dependence of CPP-GMR, output voltage (ΔV) of the junctions was evaluated. Despite of the reduced MR ratios at the low bias current, ΔV nearly independent of the insertion thickness, and the values were of the order of 4 mV. Relatively high ΔV for junctions with inserts possibly originates from the reduced spin-transfer torque for the CFMS layer [4]. The temperature dependence of CPP-GMR will be discussed for the junctions with inserts, at the presentation.

References

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