P-11

Junction Size Dependence of Magnetoresistance in Magnetic Tunnel Junctions with $IrMn_3$ antiferromagnet

YongKang Hu, CheolGi Kim, V. K. Sankaranarayanan*, Sangmin Yoon, Youngwoo Lee, Chong-Oh Kim

Department of Materials Engineering, Chungnam National University

*Research Center for Advanced Magnetic Materials, Chungnam National University.

Introduction

Magnetic tunnel junctions (MTJs), consisting of two ferromagnetic layers separated by an insulating layer, have been of interest because it can be applied in the magnetic random access memories (MRAM) [1]. MTJs can exhibit large tunneling magentoresistance (TMR) [2]. Junction size is one of many important factors influencing TMR. In this paper, we investigate the correlation of junction area with the parameters-MR, resistance, exchange bias field, coercivity of pinned layer, derived from the TMR measurements.

Experiment

Magnetic tunnel junctions with the structure of Ta (50 Å)/Cu (100 Å)/Ta (50 Å)/NiFe (20 Å)/Cu (50 Å)/ $Mn_{75}Ir_{25}$ (100 Å)/ $Co_{70}Fe_{30}$ (25 Å)/ Al-O (15 Å)/ $Co_{70}Fe_{30}$ (25 Å)/NiFe (600 Å)/Ta (50 Å), were deposited on thermally oxidized silicon wafer using DC sputtering with a base pressure of 3×10^{-9} Torr. The mixture of oxygen and the inert gas-Kr was introduced for the plasma oxidation. The junction size of MTJs was 180 μm, 250 μm, 320 μm and 380 μm, respectively. The specimens were annealed in a magnetic field of 1 kOe at 250 °C for 1 hour in a vacuum oven with the pressure of 5×10^{-6} Torr, followed by field cooling. In order to investigate magnetic transport properties of the specimens, MR measurement was carried out for as-deposited and post-annealed specimens.

Results and Discussion

Figure 1 shows the MR ratio as a function of junction area for as-deposited and post-annealed specimens. It is seen that MR increases up to a maximum, then decreases. For post-annealed samples, MR increases dramatically due to the improved quality of tunnel junctions. Fig. 2 shows the resistance as a function of junction area. It is found that the resistance almost scales inversely with the junction area. Fig. 3 shows the exchange bias field and coercivity of pinned layer as a function of junction area. The exchange bias field decreases with increasing junction area and the curve becomes flat for large junction sizes. But the coercivity of pinned layer is almost constant.

Conclusion

The post-annealed MTJs showed TMR of 16.66 % with the junction area of MR increases up to a certain value with increasing temperature. The resistance almost scales inversely with the junction area. The exchange bias field decreases with increasing temperature. However, the coercivity of pinned layer is almost constant.

Reference

[1] Parkin S.S.P., Roche K.P., Samant M.G., Rice P.M., Beyers R.B., Scheuerlein R.E.,. O'Sullivan E.J, Brown S.L., Bucchigano J., Abraham D.W., Lu Yu, Rooks P.L., Trouilloud M, Waner R.A. and Gallagher W.J., J. Appl. Phys. 85 (1999) 5828

[2] YongKang Hu, CheolGi Kim, Tomasz Stobiecki, Chong-Oh Kim and Kimin Hong, Journal of Magnetics 8(1), 32-35 (2003)

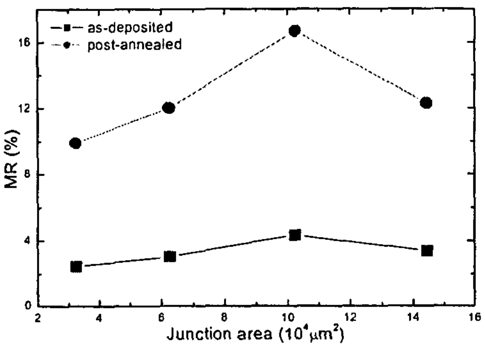

Fig. 1. MR ratio as a function of junction area.

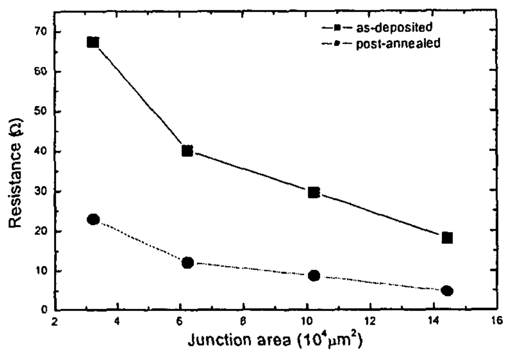

Fig. 2. Resistance as a junction area.

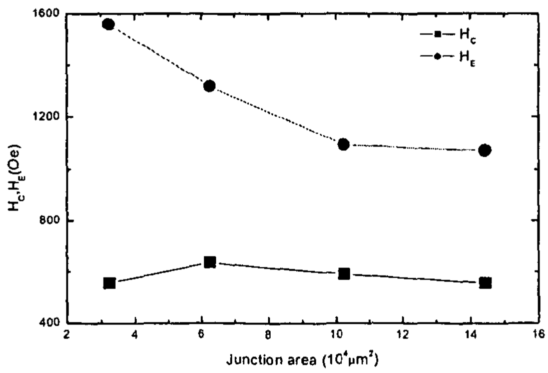

Fig. 3. Exchange bias field and coercivity of pinned layer as a function of junction.