

Effect on switching characteristics of free layer thickness in magnetic tunnel junction

W. C. Lim, J. Y. Bae, B. G. Park, T. D. Lee

Department of Materials Science and Engineering, Korea Advanced Institute of Science and Technology, Daejeon, Korea

*Corresponding author: e-mail: wclim@kaist.ac.kr, Phone: +82 42 869 5336, Fax: +82 42 869 5310

Magnetic tunnel junctions (MTJs) attracted significant interest in recent years for magnetoelectronic applications. To make MTJs usable as low-field/low-power device application, it is critical to have small switching field and uniform switching field distribution.[1] In this study, to make the MTJs which have small switching field and uniform switching field distribution, we fabricated MTJs with three kinds of free layer, NiFe, CoFe, and NiFe/CoFe, and investigated effect of thickness of the free layer on magnetic properties. NiFe free layer showed lower MR ratio than CoFe free layer at as deposited state, although they have almost the same spin polarization, and lower switching field than CoFe. After annealing at 250 °C in vacuum, MR ratio increased due to the redistribution of excess oxygen at the interface between the barrier and the free layer, and the fact that MR ratio is independent of the free layer thickness in CoFe and NiFe indicates spin dependent scattering is dominated by interface scattering than bulk scattering. Because NiFe layer is more easily contaminated during vacuum break, the annealing effect is more effective with NiFe free layer. At 77K, both switching field and MR ratio increased. The increase of the switching field is due to reduced nucleation of magnetization reversal by thermal fluctuation, and the increase of MR ratio was due to the increase of spin polarization of magnetic layer and the decrease of spin independent tunneling at the lower temperature. There was a critical thickness for free layers, below which no MR ratio was detected. The MTJs with NiFe free layer shows no MR ratio below 1.5 nm of NiFe thickness, and the case with CoFe free layer shows no MR ratio below 1 nm of CoFe thickness. It is caused by the difference of the wettability of a free layer material on the AlO_x surface.

References

- [1] S. Tehrani, B. Engel, J. M. Slaughter, E. Chen, M. DeHerrera, M. Durlam, P. Naji, R. Whig, J. Janesky, and J. Calder, *IEEE Trans. Magn.* **36**, 2752(2000)