Q-18

Effect of the Relative thickness of Co Layers on the Bias Field in NiFe/Al_2O_3/Co/Ru/Co/FeMn MTJs by computer simulation

Korea Institure of Sci. and Tech.(KIST),
Y. R. Uhm, S. H. Lim, K. H. Shin, S. H. Han, and H. J. Kim

1. Introduction

High switching field is one of the most important issues in high density MRAM. Two factors of coercivity(H_c) and bias field are related to the switching field. In case of bias field, it related to the asymmetry of the switching field. Synthetic antiferromagnetic(AF) pinning layer is one efficient way to reduced the asymmetry bias field. In this work, we examined effect of the relative thickness of Co Layers on the Bias Field in NiFe/Al_2O_3/Co/Ru/Co/FeMn magnetic tunnel junctions(MTJs) by computer simulation

2. Model and Computation

The micro magnetic model used here considers demagnetization, anisotropy and exchange energy. The each magnetic layers were single domain model, meaning that the magnetization and anisotropy is uniform within a layer. The spin-valve modeled related in MTJs structure in this work is NiFe (7.5 nm)/ Al_2O_3 (0.7 nm)/ Co (6-y nm)/ Ru (3 nm)/ Co (y nm)/ IrMn (10 nm). The milti-layer with aspect ratio of 2.0 are size in $(\mu m)^2$ of 0.8 × 0.4, 0.6 × 1.2, 1.4 × 2.8, 2 × 4, 3 × 6, 4 × 8, 5.6 × 112 and 8 × 16. The down pinning field ($H_{pin-down}$) acting on antiferromagnetic(AF) layer layer is -1200 Oe. The AF exchange coupling is -1200 Oe between upper and down pinning layer. The magnetic induced anisotropy is 5.32 Oe in free layer, and exchange coupling of free layer with upper pinning layer is 33 Oe. The direction of all layers are parallel to the length direction. Magnetic layers are coupled through the magnetostatic and interlayer exchange interactions. The magnetic field is applied in the length directions of the cycled between +500 and -500 Oe.

3. Results and discussion

The change in the magnetic properties was investigated mainly by measuring M-H hysteresis loops. The coercivity is a function of size of MTJs. The difference bias fields depend on both of size and relative thickness of Co pinning Layers. The increase of the coercivity with the decrease of the size can be explained by the uniaxial shape anisotropy. Figure 1 represents interlayer magnetostatic field in free layer versus thickness ratio of upper/ down pinning layer Co (6-y nm)/ Ru (3 nm)/ Co (y nm) with size in $(\mu m)^2$ of 0.8 × 0.4, 0.6 × 1.2, 1.4 × 2.8, 2 × 4, 3 × 6, 4 × 8, 5.6 × 11.2 and

8 × 16. The interlayer magnetostatic field decreases with thickness ratio of upper/sown pinning layer increses. The magnetic properties as a function of different thickness ratio is due to the magnetostatic interaction of orange peel coupling. The interlayer magnetostatic field in free layer versus surface area(Width × Length) indicates that the optimum thickness ratio is Co (3 nm)/ Ru (3 nm)/ Co (4 nm) as shown in Fig. 2.

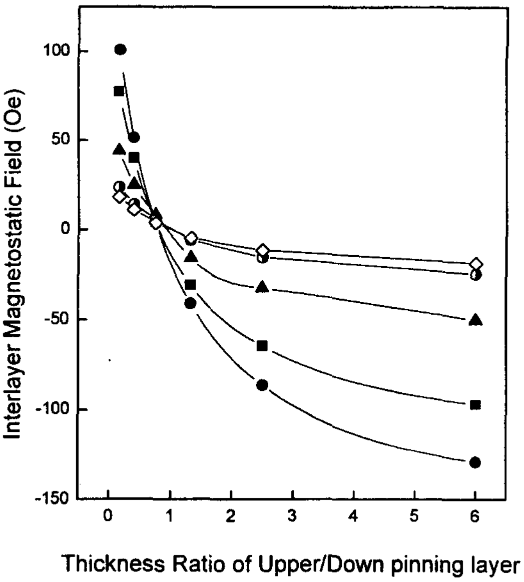

Fig. 1. Interlayer magnetostatic field in free layer versus thickness ratio of upper/ down pinning layer Co(6-ynm)/Ru(3nm)/Co(y nm) with size in (μm)^2 of 0.8 × 0.4, 0.6 × 1.2, 1.4 × 2.8, 2 × 4, 3 × 6, 4 × 8, 5.6 × 11.2 and 8 × 16.

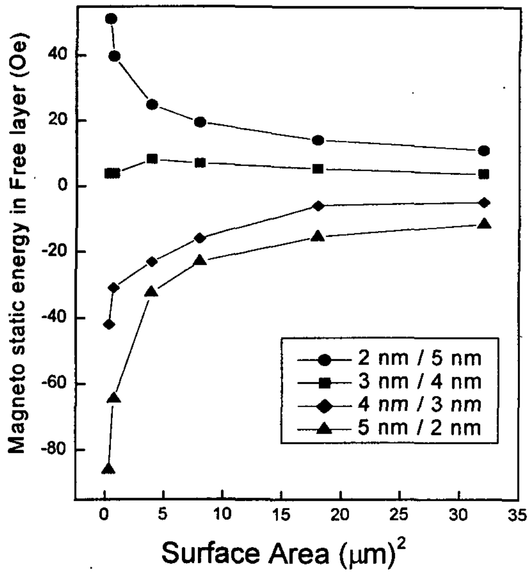

Fig. 2. The interlayer magnetostatic field in free layer versus surface area (W× L) (μm)^2

Reference

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