FC03

Vortex Dynamics in Submicron Exchange Biased Disks

Jung Hwan Moon[1], Woo Jin Kim[2], Taek Dong Lee[2], Kyung-Jin Lee*
[1] Department of Materials Science and Engineering, Korea University, Seoul, Korea
[2] Department of Materials Science and Engineering, Korea Advanced Institute of Science and Technology, Daejeon, Korea
*Corresponding author: kj_lee@korea.ac.kr, Phone: +82 2 3290 3289, Fax: +82 2 928 3584

Meiklejohn and Bean reported a new type of anisotropy at the interface of the ferromagnet (FM)-antiferromagnet (AFM) in 1956 [1-2]. The directional coupling between FM and AFM called the exchange bias has aroused a considerable interest because it is an indispensable part of magneto-transport devices.

Sort *et al.* reported that a reversal mechanism of magnetic domain in submicron exchange biased disks strongly depends on the angle between the external field and the exchange bias [3]. Recently, Waeyenberg *et al.* showed that the vortex core polarization is controllable by alternating magnetic field. Since the vortex core polarization can be used as data carriers like an in-plane spiral, it is one of powerful candidates for high density information device [4].

Here, we performed a micromagnetic simulation to understand the vortex dynamics in a submicron exchange biased disk. The diameter and the thickness of the ferromagnetic Permalloy disk is 500nm and 10nm, respectively. Without exchange bias, a vortex core was formed at the centre of disk. In the exchange biased system, the vortex core was shifted perpendicular to the direction of exchange bias (Fig. 1). An external field of 50Oe was applied along the direction of the exchange bias. The vortex core showed precessions around its equilibrium position. The precession frequency increased with the exchange bias field (Fig 2). We will discuss a correlation between the exchange bias and the vortex dynamics.

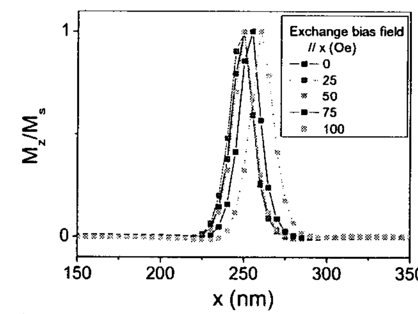

Fig 1. Cross sectional profile of out-of-plane component (normalized)

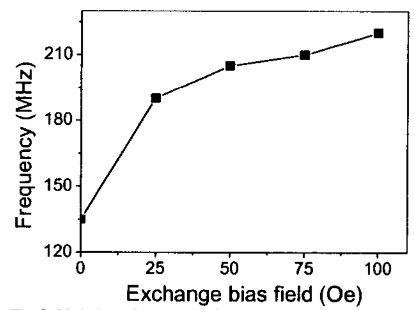

Fig 2. Variation of precession frequency

REFERENCES
[1] W.H. Meiklejohn, C.P. Bean, Phys. Rev. 102 (1956) 1413.
[2] W.H. Meiklejohn, C.P. Bean Phys. Rev. 105 (1957) 904.
[3] J. Sort *et al.*, Phys. Rev. Lett. 95 (2005) 067201.
[4] B. Van Waeyenberg *et al.*, Nature 444 (2006) 461-464

FC04

Size Dependence of Magnetization Reversal in Pac-man Shaped Ni80Fe20 Elements

Y. K. Hong*[1], J. Jabal[2], B. C. Choi[3], H. Han[1], G. Abo[1], S. H. Gee[1], G.W. Donohoe[4], B. C. Kim[1]
[1] Department of Electrical and Computer Engineering, University of Alabama, Tuscaloosa, AL 35487-0286, USA
[2] Department of Physics and Astronomy, University of Victoria, Victoria, BC, V8W 3P6, Canada
[3] Department of Materials Science and Engineering, University of Idaho, Moscow, ID 83844, USA
[4] Department of Electrical and Computer Engineering, University of Idaho, Moscow, ID 83844, USA
*Corresponding author: ykhong@eng.ua.edu, Phone: +1 205 348 7268, Fax: + 205 348 6959

The inherently non-volatile nature of magnetic random access memory (MRAM), allowing the storage of information without the need for periodic refreshing, along with the potential for faster writing speeds and lower power requirements make MRAMs very attractive. To make MRAMs a reality it is first necessary to understand the dynamics of the magnetization process and decide on the best mechanism, in terms of both speed and stability, for turning the bits on and off. To obtain the fastest magnetization reversal the ideal mechanism is a complete, coherent rotation of the magnetization. In our study the micromagnetic simulations were performed on elongated Pac-man (EPM) shaped element with size ranging from 1 μm×360 nm to 200 nm×72 nm in 200 nm steps of the elongated directions, while maintaining the same aspect ratio. The EPM element was chosen because of it's merits in terms of narrow switching field distribution and element selectivity compared to conventional element shape [1,2]. An in-plane magnetic field was applied along the 45° from the length direction of the EPM element to simulate the fully selection in device operation by simultaneously apply orthogonal easy and hard axis fields. The dynamic response was studied by apply magnetic field along the same direction having a field strength 20 Oe higher than the coercivity of each element. As the size shrinks to 1/5 of 1 μm ×360 nm, coercivity increases by 2.5 times, which can be seen in the hysteresis loops in Fig. 1(a). This is attributed to the increased demagnetization energy in smaller elements. A much narrow switching field distribution is obtained in the 200 nm length element. This is caused by the elimination of domain switching in the center area of element, while the edges lag behind observed in the 1 m size EPM element in Fig. 1(b), as compared to the magnetization configuration in Fig. 1(c). In conclusion, small EPM elements show fast switching compared to large element, but spin ringing happened right after the reversal process. For device applications, size shrinkage can increase the switching speed, but will cause unfavorable effect such as increased interlayer coupling when spin-ringing effect occurred in small elements switching speed.

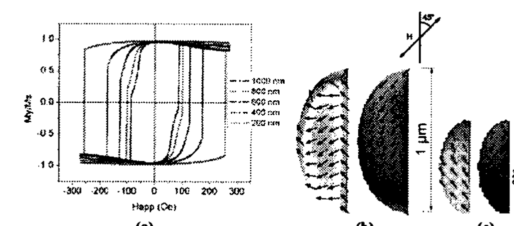

Fig. 1. (a) Hysteresis loops for varying element lengths (with aspect ratio of 2.8). Magnetization configurations before and after reversal for the sizes: (b) 1 μm ×360 nm, and (c) 200 nm × 72 nm.

REFERENCES
[1] M. H. Park, Y. K. Hong, S. H. Gee, D. W. Erickson, and B. C. Choi, Appl. Phys. Lett. **83**, 329 (2003).
[2] M. H. Park, Y. K. Hong, S. H. Gee, D. W. Erickson, T. Tanaka, and B. C. Choi. J. Appl. Phys. **95**, 7019 (2004).