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Injection of Domain Walls in Nanowires with Perpendicular Magnetic Anisotropy

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Current-driven domain wall motion in magnetic nanowires has attracted much research interests due to its basic physical mechanisms involved and its potentials in applications such as magnetic logic [1] and high-density storage devices [2]. Compared to conventional magnetic devices using external magnetic field for the encoding of information, domain wall motion or magnetization reversal by electrical currents can be a promising alternative encoding method because of lower power consumption, reduction of magnetic interference, and simple device structures. However, for the realization of magnetic devices utilizing domain wall motion, the underlying theory on current-driven domain wall motion needs to be understood and further reduction of the critical current density for domain wall motion should be achieved.

According to the report by Tatara and Kohno [3], the threshold current density is expected to show different characteristics depending on the thickness of domain walls. So far, the most studies have been done on materials with thick domain walls (usually permalloy) where the demagnetizing field confines the magnetization to the sample plane, and little experimental attention has been paid on the materials with perpendicular magnetic anisotropy (thin domain walls). Because the magnetization of permalloy can be easily controlled by shape anisotropy of nanowires, the techniques of domain wall nucleation, propagation and positioning in materials with longitudinal magnetic anisotropy have been well established. But, the techniques do not extend to materials with perpendicular magnetic anisotropy because in-plane demagnetizing effects no longer play a role. Thus, alternative methods are needed to control wall injection and propagation in nanowires with perpendicular magnetic anisotropy (PMA).

In this presentation, the methods for nucleation and propagation of domain walls in materials with PMA will be reported. For the controlled domain wall nucleation, Ga ion irradiation was conducted by using Focused Ion Beam (FIB) system. Domain wall injections in nanowires and processes in Hall bar geometries have been studied by MFM and extraordinary Hall effect measurements.

References

[1] D. A. Allwood et al., Science 309, 1688(2005).sol. (a), 1, 1 (1999).
[2] S. S. P. Parkin, U. S. Patent No. US 6834005 (2004).
[3] Gen Tatara and Hiroshi Kohno, Phys. Rev. Lett., 92, 086601 (2004).