20a−S2−2

Current and field induced domain wall creep in Ta/CoFeB/MgO/Ta wire

Laboratory for Nanoelectronics and Spintronics, RIEC, Tohoku Univ.[1], CSIS, Tohoku Univ.[2], CIES, Tohoku Univ.[3], WPI-AIMR, Tohoku Univ.[4]

°S. DuttaGupta[1], S. Fukami[2, 3], M. Yamanouchi[1, 2], C. Zhang[1], H. Sato[2, 3], F. Matsukura[1,2,4], and H. Ohno[1,2,3,4]

E-mail: sdg@riec.tohoku.ac.jp

Domain wall (DW) motion in materials with perpendicular easy axis has been intensively studied in recent years because of its potential to realize fast magnetization reversal with a low current. In case that magnetic field (*H*) or current (*I*) much less than the threshold is applied to a DW, the DW is moved by thermal activation while interacting with the disorder in the material [1]. This sub-threshold phenomenon called "creep" has gathered considerable interest because of rich information about the mechanism for the DW motion. Since Ta/CoFeB/MgO is a promising material system for DW applications [2], we study the DW creep motion in Ta/CoFeB/MgO wires driven by both *H* and *I*.

The stack structure is Si/SiO_2 sub/ Ta (0.5 nm)/ CoFeB (1.2 nm)/ MgO (1.5 nm)/ Ta (1 nm). The stack is patterned into 5 μm wide wires by photolithography and Ar ion milling. The DW motion is observed by magneto-optic Kerr effect (MOKE) microscope after applying *H* or *I* pulses.

Figure 1 shows the DW velocity (*v*) *vs.* applied current density (*J*) or *H*. The non-linearity of the curve implies that the motion is in the creep regime. In the creep regime, *v* follows a scaling relation with respect to the *H* or *I*: $v = v_0 \exp\left[-\frac{U}{kT}\left(\frac{f_C}{f}\right)^{\mu}\right]$, where *U* is the energy barrier, *f* is the applied *H* or *I* and f_C is their critical value. The exponent μ reflects the mechanism of DW motion [3,4]. From the fitting shown in the insets in Fig. 1, μ is determined to be ~ 0.27 for the *H* driven case while it is ~ 0.6 for the *I* driven case. This is the first report of different μ for the *H* and the *I* driven case observed for a metallic system. The result can possibly be interpreted in terms of the nature of the disorder and the torque acting on the DW.

This work was supported by JSPS through its FIRST program, R&D for Next Generation IT of MEXT and R&D Subsidiary Program for Promotion of Academia-industry Cooperation of METI. The authors thank J. Ieda for fruitful discussion. SD acknowledges MEXT, Govt. of Japan for financial support.

[1] P. Chauve *et al.*, PRB **62** 6241 (2000).
[2] S. Fukami *et al.*, APL **98** 082504 (2011).
[3] M. Yamanouchi *et al.*, Science **317**, 1726 (2007).
[4] J.-C. Lee *et al.*, PRL **107** 067201 (2011).

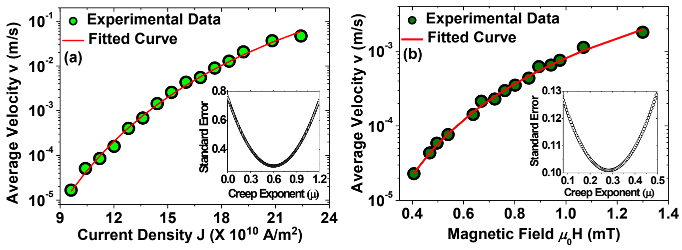

Fig. 1: DW velocity (*v*) as a function of current density (a) and magnetic field (b). Insets show standard error curve for determination of creep exponent.