Suppression and Enhancement of Current-Induced Domain wall motion due to Spin Hall effect

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Here we report the suppressed and enhanced current-induced domain wall motion due to spin Hall effect induced effective field in Pt/Co/Pt stripes. The presence of effective field considered which is caused by spin Hall effect was observed in Pt/Co/AlO_X [1,2] and Ta/CoFeB/MgO[3] with perpendicular magnetic anisotropy(PMA). The effective field can result in perpendicular magnetization switching under an in-plane magnetic field. Recently, the perpendicular magnetization switching was also observed in Pt/Co/Pt[4] and we studied the influence of the effective field on the current-induced domain wall motion. For this study, 500 nm-wide nanowires made from Pt(1.5 nm)/Co(0.3 nm)/Pt(2.5 nm) and Pt(2.5 nm)/Co(0.3 nm)/Pt(1.5 nm) films, which may have opposite directions of net spin Hall effect, were prepared. The magnetization switching and domain wall motion induced by in-plane current were studied with applying in-plane magnetic field $H_{\parallel}$, parallel to the current direction, to tilt the magnetization of magnetic domain and domain walls. The nanowires shows purely current-driven domain wall motion at the current density of few 10^{11} A/m^2[5]. By applying $H_{\parallel}$, the domain wall speed is found to be either increased and decreased compared to the $H_{\parallel}$=0 case depending on the polarity of $H_{\parallel}$. As the current density and $H_{\parallel}$ increases, the effective field becomes stronger(Fig. 1), and finally it overcomes the driving force by current, the direction of domain wall motion is reversed surprisingly. Basically the same behavior is observed for the two films which have different Pt-layer configurations but the magnetization switching sign and the sign of effective field were opposite to each other. It signals the influence of spin Hall effect induced effective field in domain wall dynamics and more details of the effective field will be discussed.

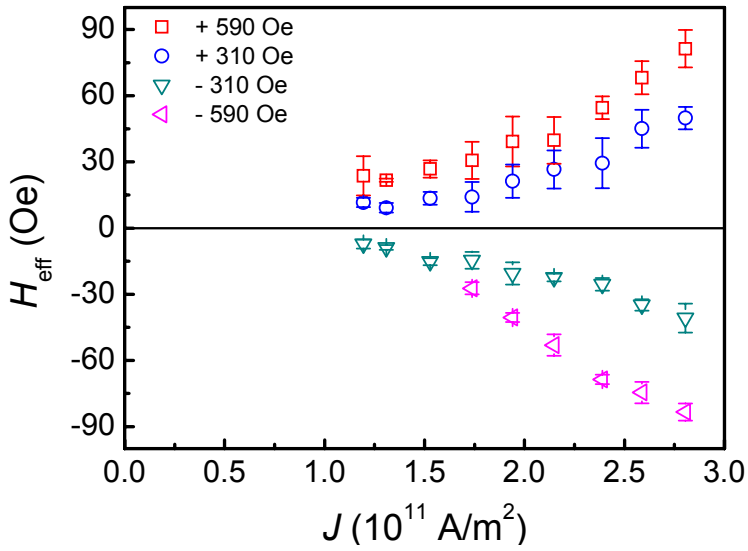

Fig. 1. Effective field induced by spin Hall effect.

참고문헌

[1] I.M. Miron *et al.*, Nature 476,189(2011).

[2] L. Liu *et al.*, Phys. Rev. Lett. 109,096602(2012).

[3] L. Liu *et al.*, Science 336,555(2012).

[4] P.P.J. Haazen *et al.*, Nature Matt. 12,299(2013).

[5] J.-C. Lee *et al.*, Phys. Rev. Lett. 107,067201(2011).