Tailoring the direction of current-driven domain-wall motion in Pd/Co/Pd films with insertion of thin Pt layer at the Pd/Co interface

Sang-Cheol Yoo[1,2*], Duck-Ho Kim[1], Soong-Geun Je[1], Byoung-Chul Min[2] and Sug-Bong Choe[1]

[1]Department of Physics and Astronomy, Seoul National University, Seoul 151-747

[2]Center for Spintronics Research, Korea Institute of Science and Technology, Seoul 136-791

Current-induced domain-wall motion (CIDWM) in ferromagnetic nanowires has been predicted theoretically [1, 2] and demonstrated experimentally in recent years [3, 4]. However, in several materials such as Pt/Co/AlOx [3] and Pt/Co/Pt [4] thin films, the domain wall (DW) moves along the direction of the current that is opposite to the prediction of the spin transfer torque (STT) theory [1, 2]. To explain such peculiar behavior, several origins including the spin orbit torques (SOTs) combined with the Dzyaloshinskii-Moriya interaction (DMI) and a negative polarization (or nonadiabaticity) have been proposed [5, 6], but it is still under debate mainly due to the lack of experiments.

Here, we report that a series of the Pd/Pt/Co/Pd films exhibit an interesting behavior useful for this kind of experiments, since the DW-motion direction in this series samples is systematically reversed depending on the Pt layer thickness t_{Pt}. The DW moves along the electron in the films with $t_{Pt}<1$ monolayer, whereas the DW moves along the current in the films with $t_{Pt}>1$ monolayer. From a quantitative analysis on the DW speed [4], the effective magnetic field induced by the current is estimated to change gradually across zero (at $t_{Pt}\sim1$ monolayer). To quantify the contributions of the STT and SOT in these series samples, the effective fields induced by the DMI and the SOT are measured from the asymmetric DW expansion under an in-plane magnetic field [7] and the shift of the out-of-plane hysteresis loop under current injection, respectively. From these measurement results, the magnitude of the pure STT is determined and the correlation with the DW-motion direction will be discussed.

References

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