Shift of magnetic hysteresis loop by Dzyaloshinskii-Moriya interaction in laterally asymmetry microstructure

Dong-Soo Han[1], Nam-Hui Kim[2,3,4], June-Seo Kim[1], Yuxiang Yin[1], Jung-Woo Koo[1], Jaehun Cho[2], Sukmock Lee[2], Mathias Kläui[3], Henk J. M. Swagten[1], Bert Koopmans[1], and Chun-Yeol You[2,4*]

[1]Eindhoven University of Technology, PO Box 513, 5600 MB Eindhoven, The Netherlands

[2]Inha University, Incheon 22212, Republic of Korea

[3]Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

[4]DGIST, Daegu 42988, Republic of Korea

*Chun-Yeol You, e-mail: cyyou@dgist.ac.kr

Recently, Dzyaloshinskii-Moriya interaction (DMI) has been heavily investigated by using many experimental techniques such as Brillouin light scattering (BLS) [1-2], asymmetric domain-wall expansion [3], and non-reciprocal spin wave velocity [4]. In this study, we would like to introduce unique technique to straightforwardly observe the DMI by shift of magnetic hysteresis loop arising in DMI in laterally asymmetric microstructures [5]. We prepared two types of thin films of Si(sub.)/Ta(4 nm)/Pt(4 nm)/Co(1.2 nm)/Ir(4 nm) and Si(sub.)/Ta(10 nm)/AlO_X(2.5 nm)/Co(1.15 nm)/Pt(4 nm) with perpendicular magnetic anisotropy (PMA), respectively. The first one has bottom Pt, while the second has top Pt layer, so they are expected to have opposite DMI. All samples are deposited by dc-magnetron sputtering, especially, we fabricated well-defined microstructure of triangle in order to introduce lateral asymmetry, and squares with lateral symmetry by using electron beam lithography and Ar^+ ion milling technique. In order to obtain asymmetry hysteresis properties and extract DMI energy density, we carried magneto optical Kerr effect (MOKE) measurement with microscopic imaging technique by applying positive and negative biased magnetic field [5]. For triangular-shaped microstructures of Pt/Co/Ir and AlO_x/Pt/Co, we found a shift of the hysteresis loop by applying additional in-plane magnetic field ($+H_x$, $-H_x$). On the other hands, for the case of square-shaped microstructure, there is no shift of loop. Consequently, we establish a unique, simple, and reliable approach to quantify the DMI in thin film structures and observe a shift in magnetic hysteresis loops arising from the DMI, by introducing a lateral asymmetry in microstructures and applying additional in-plane bias field.

References

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