Determination of magnetic domain-wall types via observing Dzyaloshinskii-Moriya interaction-induced domain expansion patterns

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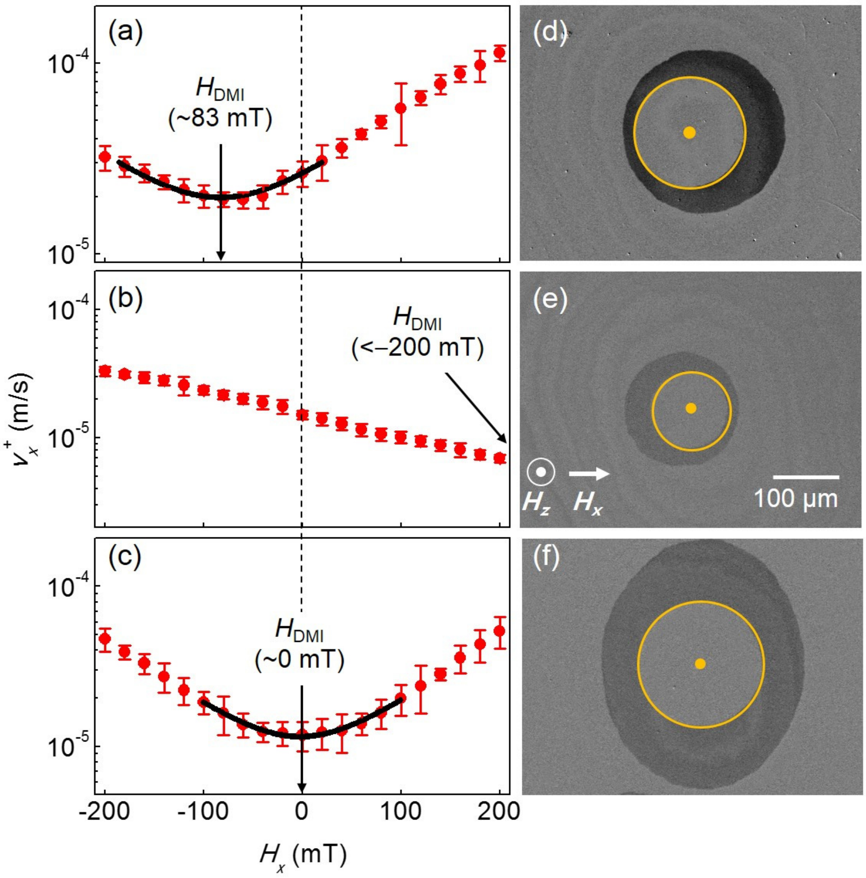
In materials with perpendicular magnetic anisotropy, current-induced domain-wall (DW) motion has been attracted a great attention for its technological application toward spintronic devices such as Magnetic magnetic Racetrack racetrack Memory memory [1]. Recently, the efficiency of the current-induced DW motion is found to depend on its DW type sensitively [2]. Since the DW type is determined by the Dzyaloshinskii-Moriya interaction (DMI) [3], here, we report that the DMI-induced asymmetric domain expansion pattern provides the information of the DW type: either Néel or Bloch. For this study, Pt/Co/Pt (Sample I), Pt/Co/Pd (Sample II), and Pd/Co/Pd (Sample III) films are were deposited on Si substrates with 100-nm SiO2 layer by use of dc magnetron sputtering. The DW expansion images are were then observed by use of a magneto-optical Kerr effect microscope and the DW speed is was measured from the sequential domain images. As shown in Fig. (a)-(c), the DW speed v_{DW} shows an inversion symmetry with respect to an offset, which is known to be a direct measure



of HDMI [3, 4]. It is clear from the figure that the samples exhibit distinct signs and magnitudes of HDMI, which finally induces different DW type: the right-handed-Néel-type (H_{DMI} = +85 mT) for Sample I, left-handed-Néel-type (H_{DMI}< -200 mT) for Sample II, and Bloch-type for Sample III (H_{DMI} ~ 0 mT), respectively. Interestingly, these samples also exhibit distinct domain expansion patterns as seen in Fig. (d)-(f): elongation to $+x$ direction for Sample I, $-x$ direction for Sample II, and y direction for Sample III, respectively. Such distinct domain expansion patterns is indicated to be accounted for that the spatial distribution of the DW energy on the circular domains under an external magnetic field H_x depends is related to the DW type. Detailed analysis will be discussed.

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