Investigation of spin-transfer properties in ferrimagnetic Mn_4N nanowires

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[Introduction] We have investigated Mn_4N ferrimagnetic thin films for the application to current induced domain wall motion (CIDWM). Made of only abundant and light elements, Mn_4N has a strong perpendicular magnetic anisotropy with K_u of 10^5 J/m^3 and small M_S of 110 kA/m [1]. We have already shown the prominent properties of domain wall (DW) in Mn_4N films grown on $SrTiO_3$ (001) with millimeter domain sizes [2]. So Mn_4N appears as a promising candidate to investigate CIDWM.

[**Experiment**] 10-nm-thick Mn_4N film was grown on $SrTiO_3$(001) substrate by molecular beam epitaxy, followed by fabrication process to 0.2-2-μm-wide wires. Each sample consists of two Hall crosses, a notch to pin the DW between crosses, and a nucleation pad on the left side of the wire shown as inset in Fig. 1, so that the DW always comes from left. We measured the coercive field H_C by Hall measurement under various direct current (DC) offsets j_{DC}. After pinning a DW at the notch, we injected the DC into the Mn_4N wire and showed that the DW can be moved without magnetic field assistance.

[**Result and discussion**] Figure 1 shows the j_{DC} dependence of H_C at the left/right Hall crosses of 1-μm-wide Mn_4N wire. Only positive currents affect strongly H_C. The analysis of this asymmetric behavior indicates the H_C increment is caused by STT, with a very large efficiency of 7.7×10^{-12} Tm^2/A. In addition, by injecting DC of 60 GA/m^2, we succeeded in trapping the DW at the notch. Figure 2 presents the Hall voltage of left cross. After a DC injection over 120 GA/m^2, the Hall voltage indicates DW motion towards the middle of the left cross. Preliminary experiments show pure CIDWM speed above 200 m/s at 500 GA/m².

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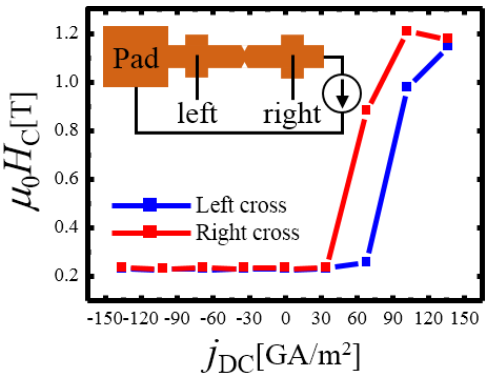

Figures 1 Current dependence of coercivity.

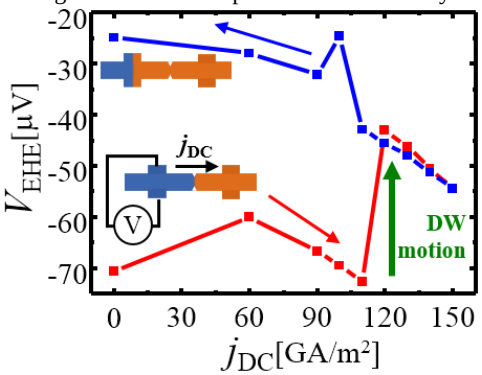

Figure 2 Hall voltage of left cross with sweeping DC.

[**References**]

1) K. Kabara *et al.*, J. Appl. Phys. **117**, 17B512 (2015).

2) Ext. Abstr. 61st JSAP Spring Meet., 2014, [5a-C18-6].