Current-induced effects on domain wall motion in $SrRuO_3$

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Current-induced domain wall motion (CIDWM) has been attracting much attention as one of schemes for electrical magnetization reversal in spintronics devices, and for this purpose, reduction of the critical current density J_c to move DW has been desired. In a ferromagnetic oxide $SrRuO_3$, while efficient CIDWM with $J_c \sim 10^{10}$ A/m^2 was reported [1], its mechanism has been unclear yet. Here, we investigated current I dependence of the coercive field for DW motion in $SrRuO_3$ to understand the driving force.

A 21-nm thick $SrRuO_3$ film was grown on a slightly miscut (~2°) $SrTiO_3$ (001) substrate by pulsed laser deposition. Magnetotransport measurement showed that the $SrRuO_3$ film had uniaxial magnetic anisotropy whose magnetic easy axis was tilted out of the film plane and the in-plane projection along the miscut direction as reported previously [2,3]. The film was processed into Hall bar devices with a 5-μm wide channel, a pair of Hall probes, and a 2-μm wide Au/Cr line (Oersted field line) for generating a local Oersted field (Fig.(a)). After preparing a DW around the Oersted field line by applying a current pulse to it, we measured transverse resistance R_{yx}, reflecting the anomlous and the planar Hall effect, under various I values with sweeping out-of-plane external magnetic fields. The coercive field for DW motion $\mu_0 H_c$ extracted from the measurement increased linearly with decreasing I from positive to negative (Fig. (b)), where $+I$ ($-I$) was difined as a current flow from left (right) to right (left). The negative slope indicated that the DW was moved by I in the current flow direction and magnitude of the linear slope of 8×10^{-13} Tm^2/A was close to the previously reported ratio of depinning magnetic field to J_c [1]. The linear relationship strongly suggests that the effect of I on DW motion is equivalent to an effective perpendicular magnetic field H_{eff}. In view of negative spin polarization [4] and relatively large damping constant ~0.8 [5], the CIDWM in $SrRuO_3$can be related to nonadiabatic spin transfer torque caused by spin relaxation, which acts as H_{eff} on a DW.

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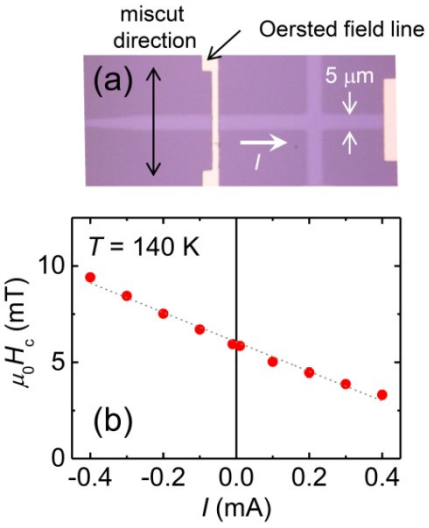

Figure: (a) A micrograph of the device. (b) Current I dependence of the coercive field $\mu_0 H_c$ after preparing a DW in the channel at 140 K.

References

[1] M. Feigenson *et al.*, Phys. Rev. Lett. **98**, 247204 (2007).
[2] L. Klein *et al.*, J. Phys. Condens. Matter. **8**, 10111 (1996).
[3] Q. Gan *et al.*, J. Appl. Phys. **85**, 5297 (1999).
[4] D. C. Worledge *et al.*, Phys. Rev. Lett. **85**, 5182 (2000).
[5] M. C. Langner *et al.*, Phys. Rev. Lett. **102**, 177601 (2009).