Current-induced effects on switching magnetic field in $La_{0.67}Sr_{0.33}MnO_3/SrTiO_3$

RIES, Hokkaido Univ.[1], School of Engineering, Hokkaido Univ.[2]

○Michihiko Yamanouchi[1*], Tatsuro Oyamada[2], Takayoshi Katase[1], Hiromichi Ohta[1]

***E-mail: m-yama@es.hokudai.ac.jp**

Current-induced effective magnetic fields are attractive for electrical manipulation of magnetization direction in spintronics devices. The effective field generated by spin-orbit torques (SOTs) has been studied in ferromagnetic semiconductor [1] and ferromagnetic metal heterostructures [2, 3]. Ferromagnetic oxide is promising material for spintronics application because large magnetoresistance has been reported in magnetic tunnel junction based on ferromagnetic oxide [4], however the effective field has not been reported in it yet. Here, we investigate current-induced effective field in ferromagnetic oxide heterostructure $La_{0.67}Sr_{0.33}MnO_3/SrTiO_3$.

The 4−6 nm thick $La_{0.67}Sr_{0.33}MnO_3$ (LSMO) films are grown by pulsed laser deposition on a (TiO_2)-terminated $SrTiO_3$ (001) substrate. The LSMO films show biaxial magnetic anisotropy of the easy axes along <110> as reported in Ref. 5. The films are processed into devices with Hall bar electrode geometry of 10-μm wide channel along [100] by using conventional photolithography and wet etching as shown in Fig. After aligning magnetization direction with external magnetic field along $[\bar{1}\bar{1}0]$ at nominal temperature of 50 K, transverse resistance, reflecting planar Hall effect, is measured with various currents while sweeping external magnetic field in [010]. An abrupt reduction of transverse resistance, which corresponds to switching of magnetization direction from $[\bar{1}\bar{1}0]$ to $[\bar{1}10]$, is observed at a switching magnetic field as reported in $La_{0.84}Sr_{0.16}MnO_3$ [6]. The switching field becomes larger for negative current than that for positive current with increasing magnitude of current, where positive current is directed along [100]. These results suggest that effective magnetic field along [010] ($[0\bar{1}0]$) is induced by positive (negative) current.

This work was supported by JSPS KAKENHI for Young Scientists A (15H05517) and Grant-in-Aid for Scientific Research on Innovative Areas (25106007) from the Japan Society for the Promotion of Science.

References

[1] A. Chernyshow *et al*., Nature Phys. 5, 656 (2009).

[2] I. M. Miron *et al*., Nature Mater. 10, 419 (2011).

[3] L. Liu *et al*., Science 336, 555 (2012).

[4] M. Bowen *et al*., Appl. Phys. Lett. 82, 233 (2003).

[5] K. Steenbeck and R. Hiergeist, Appl. Phys. Lett. **75**, 1778 (1999).

[6] Y. Bason *et al*., Appl. Phys. Lett. 84, 2593 (2004).

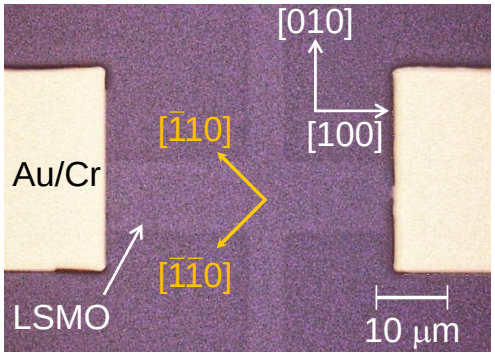

Figure: A micrograph of the device.