Local Magnetic Field Generated at the Junction between Ferromagnetic Nanowire and Electrode

Kyoung-Woong Moon[1]*, Jae-Chul Lee[1,2], Kyung-Ho Shin[2], Sug-Bong Choe[1]
[1]Center for Subwavelength Optics and School of Physics, Seoul National University, Seoul, Korea.
[2]Center for Spintronics Research, Korea Institute of Science and Technology, Seoul, Korea.

1. Introduction

Current-driven magnetization dynamics due to the spin transfer torque (STT) [1] becomes a major topic in magnetism [2]. Besides the STT effect, the current also generates the Oersted field, which induces noticeable effect for some specific geometry such as the electric contacts. In this study, we examine experimentally the strength of the local magnetic field generated by the electric contact geometry.

2. Experimental Procedures

For this study, ferromagnetic nanowires were fabricated on 5-nm Ti/20-nm Py/5-nm Ti films deposited on SiO_2/Si substrate by e-beam lithography and ion milling processes. The width of the wire was 600 nm and the length was 17 μm. At the both ends of the wire, 100-nm Au electrodes were deposited for transport measurement as shown by the SEM image in Fig. 1(a). Current pulses were then injected into the wire under an external magnetic field slightly smaller than the coercive field at an angle to the nanowire. Above a threshold current density J_{TH}, it was observed that the magnetization reversal was triggered by the local magnetic field generation at the junction between the nanowire and the electrode.

3. Results and Discussions

Figure 1(b) shows J_{TH} with respect to ΔH. ΔH denotes the difference between the applied field and the coercive field. When ΔH is small, the magnetization of the wire approaches to the vicinity of the energy barrier for magnetization reversal. By injecting current pulses through the electrode, a small magnetic field generated beneath the electrode triggers the magnetization reversal of the nanowire. It is clearly seen from the figure that J_{TH} is proportional to ΔH. The proportional coefficient is estimated to be 6.5×10^{-11} Oe・m^2/A. It might cause a significant effect for the current-induced domain-wall motion experiments, since the critical current density for the domain-wall motion, known as in the order of 10^{12} A/m^2 [2] generates the local magnetic field more than 65 Oe beneath the electrodes.

4. References

[1] M. D. Stiles and A. Zangwill, *Phys. Rev. B* **66**, 014407 (2002).
[2] S. S. P. Parkin, M. Hayashi, and L. Thomas, *Science* **320**, 190 (2008).

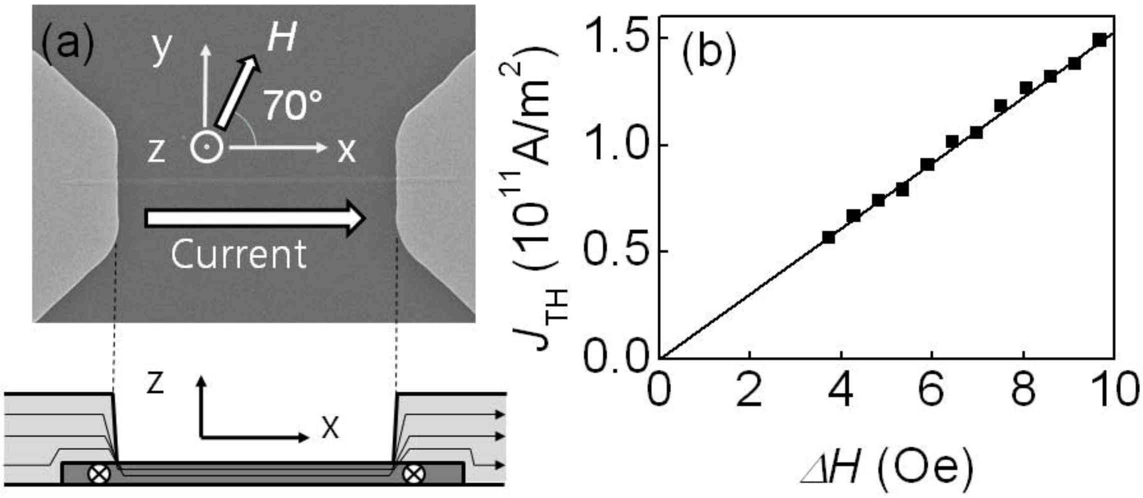

Figure 1. (a) SEM image of the Py nanowirestructure with electrodes (upper image). Schematic diagram of the current path and local magnetic field generation (lower image). (b) Threshold current density with respect to ΔH.