強磁性/重金属/強磁性多層膜を用いた非対称スピンオービットトルク磁化反転の観測

Observation of asymmetric spin orbit torque magnetization switching using ferromagnetic/heavy metal/ferromagnetic multilayer film

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Introduction：Magnetic Random Acsess Memory(MRAM) has attracted much attention as not only a novel nonvolatile memory for its low power consumption but also a high density memory. [1] In order to enhance the density of MRAM further, we propose a multi-level recordable MRAM by using two Tb-Fe free layers whose magnetization separately controled by different spin orbit torqe (SOT). In our films in cells, the magnetization state of the two magnetic layers independently by sandwiching a heavy metal layer as an intermediate layer between the two magnetic layers and generating an asymmetric Spin Orbit Torque (SOT).

Experiment：Ta(3.5)/Tb-Fe(6)/Pt(3)/Tb-Fe(6)/Ta(3.5nm)/Sub. multilayer film was deposited on a SiO_2 substrate by using DC magnetron sputtering. Since the upper Ta was mostly oxidized in an atmosphere, the SOT from the Ta layer can be ignored. The asymmetric SOT is generated from top and bottom surface of Pt layer because the injected spin angular momentum from top and bottom surface of Pt layer have opposite polarity. A Hall bar was fabricated by photolithography. The current-induced magnetization switching was observed by the change in Hall voltage under a constant in-plane magnetic field of 0.1T.

Result：Figure 1 shows the results of current-induced magnetization switching in an in-plane magnetic field where blue arrows denote the corresponding magnetization in the top and bottom Tb-Fe layer. The magnetization switching of each Tb-Fe layer was separately observed under the different current density, resulting four levels of the Hall voltage as shown by four kinds of color dot. Such a difference of switching current density was obtained because the SOT from the Pt layer gives the opposite torque in the top and bottom Tb-Fe layers.

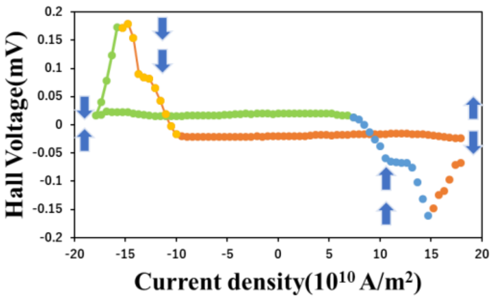

Fig. 1 Hall voltage in the sample as a function of current density under in-plane magnetic field H_x = 0.1T. Arrows show the magnetization direction in the top and bottom ferromagnetic layer.

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1) K L Wang, et al., J. Phys. D: Appl. Phys. 46 074003 (2013).