Low spin-orbit torque efficiency at the Pt/Gd interface

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Spin-orbit torque (SOT) has been widely studied because it provides an efficient means of manipulating magnetization [1,2]. Moreover, rare-earth-transition-metal ferrimagnets, in which two magnetic moments of each sublattice are antiferromagnetically coupled, are attracting attention as materials with ultrafast magnetization switching by SOT [3]. However, there have been few studies that tried to evaluate the SOT efficiency on each sublattice. One of the most appropriate platforms for that topic is ferrimagnetic bilayer, whose sublattices are spatially separated. Using ferrimagnetic bilayers of Co/Gd with different stacking orders, we compared the SOT efficiency on each sublattice.

Thin films consisting of (A) Ta(2)/Gd(2)/Co(2.4)/Pt(6) and (B) Ta(2)/Co(2.4)/Gd(2)/Pt(6) (unit : nm) were deposited on Si/SiO_2 substrates using the magnetron sputtering. Then the films were fabricated into micrometer wires using the photolithography and Ar ion milling, and Ti(5)/Cu(80)/Au(20) (unit : nm) electrodes were attached to the wires by the lift-off process. Using the homodyne detection technique [4], we performed ferrimagnetic resonance (FiMR) measurements at 300 K. As shown in Figure 1, clear FiMR peaks were obtained for samples (A) and (B). From the line shape analysis of FiMR spectra [4], the spin conversion efficiency (ξ_{eff}) was calculated. Figure 2 shows the frequency dependence of ξ_{eff} for samples (A) and (B). We found that the SOT transmitted from Pt to Gd is considerably smaller than that transmitted from Pt to Co.

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[3] J. Yu *et al.*, *Nature Materials* **18**, 29-34 (2019), [4] L. Liu *et al.*, *Physical Review Letters* **106**, 036601 (2011)

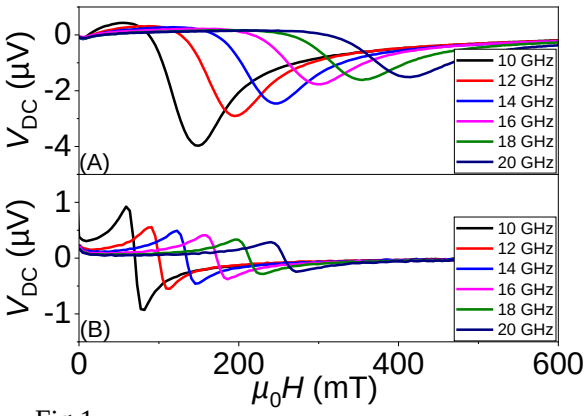

Fig.1
FiMR spectra for samples (A) and (B) at 300 K

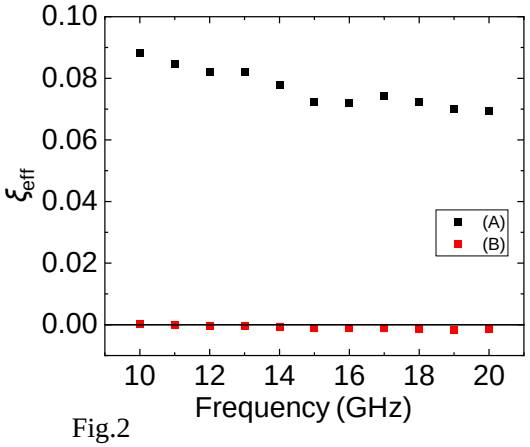

Fig.2
ξ_{eff} for samples (A) and (B) at 300 K