IrMn cap layer を用いた GdFe 垂直磁化膜でのスピンオービットトルク磁化反転の観察

Observation of spin-orbit torque magnetization switching in Gd-Fe perpendicular magnetized wire with IrMn cap layer

九大シス情[1] 九大理[2] 九大スピンセ[3] ○(M1)若江 将和[1], 伊藤 正裕[1], 黒川 雄一郎[1], 大西 紘平[2,3], 湯浅 裕美[1]

Grad. Sch. & Fac. of Info. Sci. & Elec. Eng., Kyushu Univ.[1], Dept. of Phys., Kyushu Univ.[2], Res. Ctr. for Quant. Nano-Spin Sci., Kyushu Univ.[3] , °Masakazu Wakae[1], Masahiro Itoh[1], Yuichiro Kurokawa[1], Kohei Ohnishi[2,3], Hiromi Yuasa[1]

E-mail: wakae@mag.ed.kyushu-u.ac.jp

[Introduction] Magnetization switching using spin orbit torque (SOT) has attracted significant attention because it can be applied for Magnetic Random Access Memory (MRAM). The SOT is considered to have the higher potential for manipulating magnetization than conventional spin-transfer torque (STT) for two reasons. One is the small power consumption due to the faster magnetization switching than that using STT. The other reason is the small bit error rate owing to three terminals of SOT, which enable to separate the writing and reading paths. However, it is necessary to decrease the critical current density (J_C) for CIMS to realize a memory device using the SOT. Recently, a large spin Hall effect in IrMn have been reported although it is typical antiferromagnetic material, because it has a Ir. In this study, we investigate CIMS in Gd-Fe wire with the IrMn layer to decrease the J_C.

[Experiment] The Ta/Gd-Fe/IrMn and the Ta/Gd-Fe multilayer films were deposited on a thermally oxidized Si substrates by using DC magnetron sputtering. The 5-μm-wide Hall bars were fabricated by electron beam lithography. The SOT-CIMS was observed by using anomalous Hall effect in the in-plane magnetic field.

[Result] We observed the shifted Hall loop in Gd-Fe wire with IrMn layer although it has perpendicular anisotropy. It means that the magnetization in Gd-Fe layer was pinned perpendicularly by the IrMn layer.

We observed SOT-CIMS in Gd-Fe wires under various in-plane magnetic field (H_X). The SOT-CIMS was obtained in the Gd-Fe wire with IrMn layer with applying the out-of-plane magnetic field to cancel the exchange bias field. We found that the J_C in the Gd-Fe wire with IrMn layer was smaller than that without IrMn layer as shown in Figure 1.

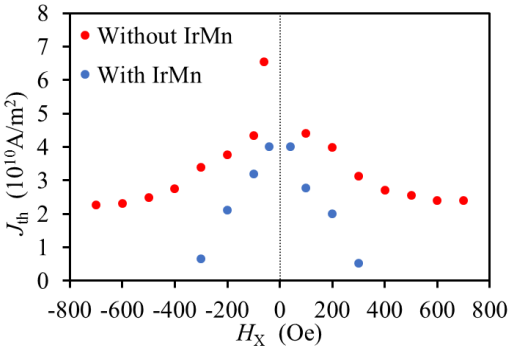

Fig. 1 Hx dependence of J_C

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