Spin-orbit torque magnetization switching in a perpendicularly magnetized full Heusler alloy Co_2FeSi

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As one of the next-generation memory technologies, magnetic random access memory (MRAM) is of great research interest because of its non-volatility, high access speed, large integration density and low power consumption. Current-induced spin-orbit torque (SOT) magnetization switching has been proposed for improving the writing performance of MRAM. Meanwhile, it has been demonstrated that the Co-based full Heusler alloys show potential for increasing the magnetoresistance ratio and achieving efficient reading due to their relatively large spin polarization[1]. Therefore, achieving the SOT magnetization switching in full Huesler alloys will be promising for optimizing both the reading and writing performance of MRAM devices.

Here, we report a successful full SOT magnetization switching in a perpendicularly magnetized full Heusler alloy Co_2FeSi[2] by using Pd as a spin current generating layer. A pulse current with a pulse width of 0.1 ms (Fig. 1a) is applied to induce the magnetization switching as shown in Fig. 1b. With the assistance of the external magnetic field of ±500 Oe, the magnetization can be fully switched with a switching current density of 3.7×10^7 A cm^{-2}, which is in the same order of magnitude as that required in the conventional heavy metal (HM)/ferromagnet system even though the Pd shows a relatively smaller spin Hall angle than that of HM[3]. The damping-like and field-like effective fields (H_{DL} and H_{FL}) are quantified to be 70 Oe and 49 Oe, respectively by using harmonic Hall measurements as shown in Fig. 1c,d. Our finding will advance the development of MRAM with both better reading and writing performance.

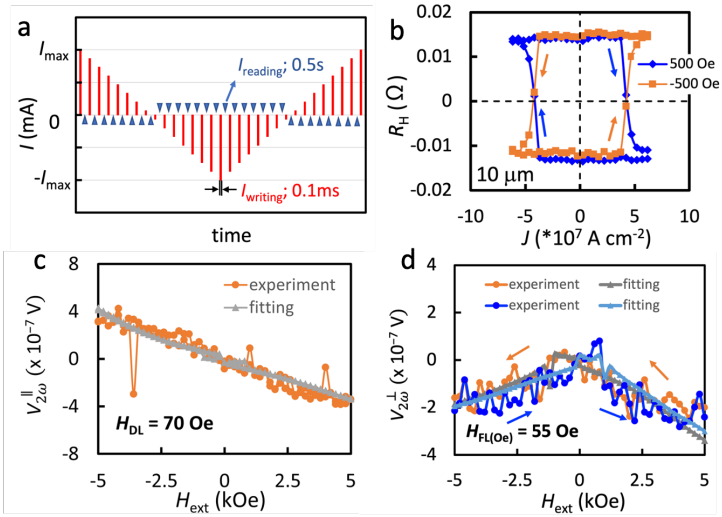

Fig. 1. SOT switching in a Heusler alloy Co_2FeSi and quantitative characterization of the SOTs.

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[1] Z. Wen *et al., Adv. Mater.* **26**, 6483 (2014).
[2] Y. Takamura *et al., J. Magn. Soc. Jpn.* **43**, 120 (2019).
[3] L. Liu *et al., Phys. Rev. Lett.* **109**, 096602 (2012).