Efficient heat induced magnetic anisotropy change by a multiple interfacial cap layer in a magnetic tunnel junction

Osaka Univ.[1], CSRN-Osaka[2]

°R. Okuno[1], Y. Yamada[1], M. Goto[1,2], H. Nomura[1,2], and Y. Suzuki[1,2]

E-mail: okuno@spin.mp.es.osaka-u.ac.jp

Magnetic tunnel junctions (MTJs) have attracted great attention as a next generation microwave emitter. One of the driving methods of MTJs is changing the magnetic anisotropy of the free layer by the temperature change due to Joule heating [1]. In this system, the enhancement of the temperature change is significant. Because the temperature change is enhanced by the suppression of the heat dissipation due to high interfacial thermal resistance at a metal layer / insulation layer interface [2], increasing the number of interfaces may enable to enhance the heat induced magnetic anisotropy change through the temperature change. In this study, we stack a W / MgO film on the exsisting MgO barrier / FeB free layer / MgO cap structure in the MTJ [1], and investigate heat-controlled magnetic anisotropy (HCMA) of the MTJ with a multiple interfacial cap layer.

Film structure is buffer layer / IrMn (7) / CoFe / Ru / CoFeB pinned layer / MgO barrier (0.95) / FeB free layer (2) / MgO(0.3)|W(2)|MgO(0.4) cap / metal cap (units of nm). Figure 1 shows the measurement circuit. The measurement of the spin-torque diode effect [3, 4] of the MTJ under the out-of-plane magnetic field provides the perpendicular magnetic anisotropy field. The inset of Fig. 2 shows the magnetic anisotropy energy of the FeB free layer by the Joule heating due to the DC bias voltage. The magnetic anisotropy energy changes linearly to the Joule heating, and the slope is the efficiency of the HCMA. As shown in Fig. 2, the HCMA value of the MTJ with the MgO / W / MgO multiple interfacial cap is higher than that of the MTJ with only the MgO cap.

This project was supported by JSPS and VAST under the JSPS – VAST Joint Research Program and JSPS KAKENHI Grant Number JP19K15435.

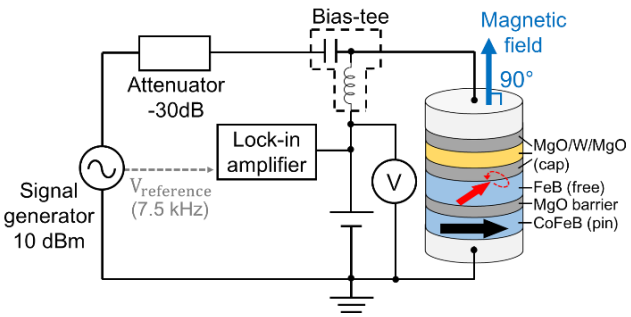

Fig. 1 Measurement circuit

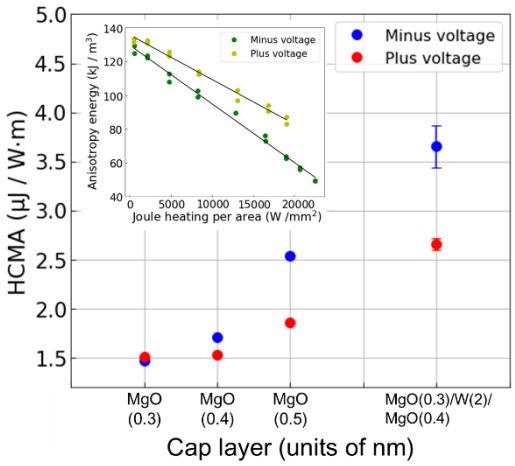

Fig. 2 HCMA values of MTJs with various cap layers

[1] M. Goto *et al*., Nat. Nanotechnol. **14**, 40 (2019) [2] T. Bohnert *et al*., Phys. Rev. B **95**, 104441 (2017)
[3] A. A. Tulapurkar *et al*., Nature **438**, 339 (2005) [4] S. Miwa *et al*., Nat. Mater. **13**, 50 (2014)