Enhancement of heat controlled magnetic anisotropy by a MgO | tungsten | MgO capping layer

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Magnetic tunnel junctions (MTJs) have attracted great attention for realizing a next-generation spintronic devices such as microwave devices. To obtain higher microwave properties, large spin-torque is significant. Recently, it has been reported that the large spin-torque is obtained by a temperature change thanks to a heat controlled magnetic anisotropy (HCMA) effect [1]. The temperature change is enhanced by the suppression of heat dissipation due to high interfacial thermal resistance at a metal | insulator interface [2]. This implies that increasing the number of interfaces enhances the effect, however, there has been little study on thermal design in MTJs utilising an interfacial thermal resistance. Here, we have investigated a HCMA of MTJs with various capping layers to understand the effect of metal | insulator interface.

Film structure is buffer layer | IrMn | CoFe | Ru | CoFeB pinned layer | MgO barrier (1 nm) | FeB free layer (2 nm) | capping layer | metal electrode. We prepared two types of the capping layer: MgO (with thickness of 0.3 nm, 0.4 nm, 0.5 nm, 0.7 nm) and a composite of MgO (0.3 nm) | W (2 nm) | MgO (0.4 nm). The perpendicular magnetic anisotropy and its change were measured through the spin-torque ferromagnetic resonance measurement [3]. Figure 1 shows the magnitude of HCMA defined as the magnetic anisotropy energy change by DC power. HCMA increases as the thickness of the MgO capping layer increases, which indicates an enhancement of the interfacial thermal resistance at the FeB | MgO capping layer interface [4]. The increase in the interfacial thermal resistance may be attributed to roughness at the FeB | MgO capping layer interface. Moreover, the HCMA with a MgO (0.3 nm) | W (2 nm) | MgO (0.4 nm) capping layer is higher than that with a MgO (0.7 nm) even though the total MgO thickness is same. This result suggests that the HCMA is enhanced by the interfacial thermal resistance at a tungsten | MgO interface. This project was supported by JSPS and VAST under the JSPS-VAST Joint Research Program, JSPS KAKENHI Grant Number JP19K15435, and JP20H05666.

[1] M. Goto *et al.*, Nat. Nanotechnol. **14** 40 (2019), [2] T. Böhnert *et al.*, Phys. Rev. B **95** 104441 (2017), [3] A. A. Tulapurkar *et al.*, Nature **438** 339 (2005), [4] R. Okuno *et al.*, J. Phys. Condens. Matter, **32**, 384001 (2020)

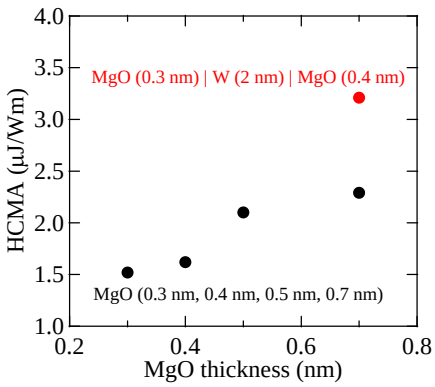

Figure 1 MgO thickness dependence of HCMA.