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The influence of under-layer for voltage-controlled magnetic anisotropy in CoFeB/MgO junctions

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Introduction : The voltage-induced magnetic anisotropy change in ferromagnetic metals is expected as an ideal method to control magnetization with low-power consumption [1-4]. However, the experimental results are often scattered between the research groups and often differ from theoretical predictions even in the sign of the effect. In this study, we investigated the voltage-induced magnetic anisotropy change in sputter-deposited-CoFeB/MgO junctions on Ru or Ta under-layer.

Experiment : Buffer/Ta(5)/Ru(0 and 5 nm)/Co₁₆Fe₆₄B₂₀(1.4 nm)/MgO(2 nm)/Co₁₆Fe₆₄B₂₀(10 nm) were deposited on thermally oxidized Si substrate by using DC and RF magnetron sputtering. Then, the films were micro-fabricated into magnetic tunnel junctions (MTJs) using electron-beam lithography and an Ar ion milling. The samples with Ta and Ru under-layers were annealed at 300°C and 200°C, respectively, to realize perpendicular spontaneous magnetizations in thin-CoFeB layers. We investigated the voltage-induced anisotropy change from magnetoresistance (MR) curves with in-plane field [4]. Sign of the bias voltage is defined with respect to the top thick-CoFeB electrode.

Result : Figure 1(a)(b) shows the normalized in-plane magnetization curve determined from MR curves under positive and negative bias voltages. The polarities of voltage-induced perpendicular magnetic anisotropy change are opposite between MTJs with Ta and Ru under-layers. In addition, magnitude of its change in the Ta under-layer is larger than that in the Ru under-layer. Therefore the different material of under-layer affects sensitively to CoFeB/MgO interface structures, which is one of the important factors about perpendicular magnetic anisotropy and its voltage effect.

Reference : [1] M. Weisheit *et al.*, *Science* **315**, 349 (2007). [2] T. Maruyama, Y. Shiota *et al.*, *Nature Nanotech.* **4**, 158 (2009). [3] M. Endo *et al.*, *Appl. Phys. Lett.* **96**, 212503 (2010). [4] Y. Shiota *et al.*, *Appl. Phys. Express* **4**, 043005 (2011)

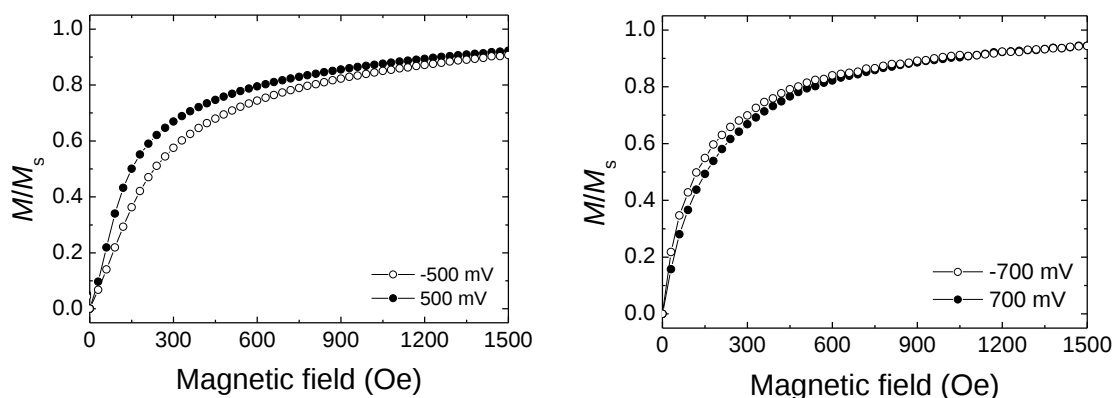


Figure 1 Magnetic field dependence of the normalized in-plane component of the magnetization estimated from MR curves under bias voltage in CoFeB/MgO junctions on (a) Ta under-layer and (b) Ru under-layer.