Improvement in magnetic properties of ultrathin Fe and Co layers grown on MgO(001) by inserting an ultrathin Fe oxide layer

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An MgO-based magnetic tunnel junction (MTJ) is a core device structure for present spintronic, e.g. for a spin-transfer torque-MRAM and a spin-torque oscillator. Since the driving current density of these devices is proportional to the free layer thickness, formation of a high-quality thin ferromagnetic layer is a crucial technical challenge. Generally, it is difficult to form a thin and flat layer of 3d transition metal on MgO with keeping good magnetic properties due to the island growth. This feature comes from the fact that the surface energy of 3d transition metal is much higher than that of MgO. In this presentation, we report a novel approach to improve the crystalline quality and magnetic properties of an ultrathin Fe and Co layer grown on MgO by inserting an ultrathin Fe oxide layer.

Multilayer structure of Cr buffer / MgO / Fe oxide (0-0.4 nm) / ultrathin Fe or Co (0-1.5 nm) / MgO / ITO was deposited on MgO(001) substrate by the combination of MBE and sputtering techniques. Fe oxide layer was grown by evaporating metal Fe by a fusion cell in an atmosphere of thermally cracked atomic oxygen. Improvement in the crystalline quality and flatness was confirmed by reflection high energy diffraction (RHEED) and cross-sectional scanning transmission electron microscopy (STEM) observations. Magnetic properties were measured by magneto-optical Kerr effect.

Figure 1 shows the comparison of in-plane hysteresis curves for 1 nm-thick (a) Fe and (b) Co grown on MgO or on the Fe oxide layer. The insertion of the ultrathin Fe oxide of 0.4 nm causes the drastic improvement in magnetic properties and ferromagnetic hysteresis curves with high remanent magnetization was obtained [1]. This technique can provide a new way to fabricate the MTJ with an ultrathin top free layer.

[1] T. Nozaki *et al*. Appl. Phys. Exp. **6**, 113004 (2013).

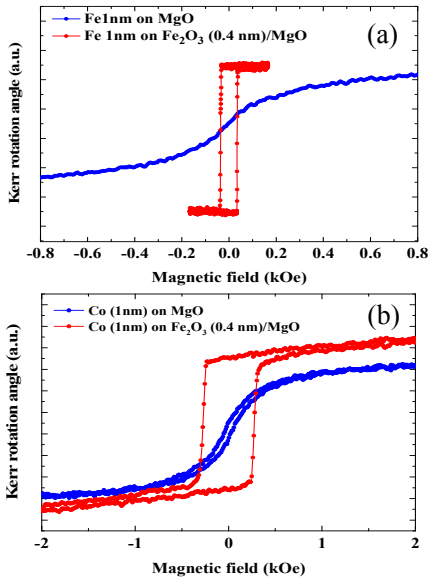

Figure 1 In-plane hysteresis curves of 1 nm-thick (a) Fe and (b) Co layer grown on MgO or Fe oxide insertion layer of 0.4 nm.