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Voltage-induced magnetic anisotropy change of Fe-4*f*-metal alloys

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Voltage-induced magnetic anisotropy change has been investigated because of its potential for non-volatile magnetic random access memories with low power operation. [1,2] Since spin-orbit coupling plays an important role in the voltage-induced anisotropy change, in our previous study, we tested 4*f*-metals since 4*f* metals have large orbital moment. In FeGd alloys, large anisotropy field change and magnetization-energy change ratio have been observed [3]. This suggests that 4*f*-metals are promising for voltage-induced spintronics devices. In this study, we investigated voltage-inducecd anisotropy change of FeTb(Nd)|MgO|-based magnetic tunnel junctions (MTJs).

V (30 nm)|Fe_{100-x}(Gd_x, Tb_x Nd_x) [x = 0-30]|MgO (1.6 nm)|Fe (10 nm) multilayer was fabricated by molecular beam epitaxy method on MgO [001] substrate as shown in Fig. 1. The Fe-4*f* metal alloy layer was prepared using co-evaporation of pure Fe and 4*f* metals. The film was patterned into MTJs by using electron-beam lithography and an Ar ion-milling. Fig. 2 shows the normalized magnetization curve of Fe (0.55 nm), $Fe_{90}Gd_{10}$ (0.60 nm) and $Fe_{90}Tb_{10}$ (0.64 nm) at 0.3 V (-0.3 V), which is calculated by magnetization curve. From this, the anisotropy field changes of $Fe_{90}Gd_{10}$ and $Fe_{90}Tb_{10}$ are larger than that of Fe.

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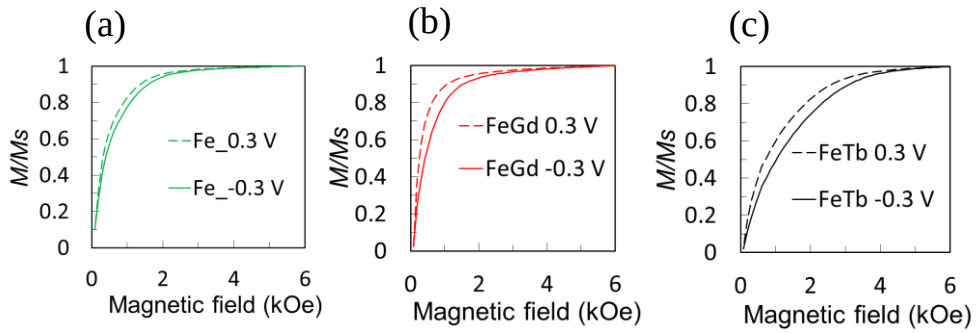

Fig.1 Normalized magnetization curves of
(a) Fe (0.55 nm), (b) FeGd (0.60 nm) and (c) FeTb (0.64 nm).

[1] M. Weisheit *et al.*, Science **315**, 349 (2007).

[2] T. Maruyama *et al.*, Nature Nanotechnol. **4**, 158 (2009).

[3] K. Tanaka *et al.*, Appl. Phys. Express *in press*.