Voltage-induced magnetic anisotropy change of Fe-4f-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 4f-metals since 4f metals have large orbital moment. In FeGd alloys, large anisotropy field change and magnetization-energy change ratio have been observed [3]. This suggests that 4f-metals are promising for voltage-induced spintronics devices. In this study, we investigated voltage-induced anisotropy change of FeTb(Nd)[MgO]-based magnetic tunnel junctions (MTJs).

Fe (30 nm)|Fe_{100-x}(Gd, Tb, Nd) | [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-4f metal alloy layer was prepared using co-evaporation of pure Fe and 4f 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).