MgO/FeB/MgO 積層膜における磁気異方性の上部 MgO 層厚依存性

Top MgO layer thickness dependence of magnetic anisotropy in MgO/FeB/MgO stacks

Double CoFeB-MgO interface structure in magnetic tunnel junction (MTJ) showed higher thermal stability factor $\Delta$ without increasing intrinsic critical current $I_{C0}$ compared to single-interface CoFeB-MgO recording layer [1,2]. High effective perpendicular magnetic anisotropy energy density $K_{eff}$ [3] and high $\Delta$ with low $I_{C0}$ [4, 5] were also reported in similar structure using double ferromagnet-MgO interface. In this study, we investigated magnetic properties of the MgO/FeB/MgO stack structure with various FeB and top MgO layer thicknesses.

The stack structures of substrate/Ta(5)/MgO(1.0)/Fe$_{80}$B$_{20}$($t_{FeB}=2.4$)/MgO($t_{MgO}=0$-2)/Ta(5)/Ru(5) (in nm) were deposited by rf magnetron sputtering. These stacks were annealed at 300°C for 1 h under perpendicular magnetic field of 0.4 T. Magnetic moment per unit area versus magnetic field curves ($m$-$H$ curves) were measured by vibrating sample magnetometer.

$K_{eff}$ was determined by area encircled by in-plane and out-of-plane $m$-$H$ curves. The interface anisotropy energy density ($K_i$) was determined from the intercept of a liner fitting to dependence of $K_{eff}$ on $t^*$, where $t^*=t_{FeB}-t_d$ ($t_d$ is dead layer thickness determined by the same way used in ref. [6]). As shown in Fig. 1, $K_i$ increases from 1.4 mJ/m$^2$ to 2.3 mJ/m$^2$ with increasing $t_{MgO}$. The value of $K_i$ for MgO/FeB/MgO stacks does not reach twice of that for single-interface FeB-MgO stack. The result indicates that $K_i$ of top and bottom interfaces are different.

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Fig. 1 Top MgO layer thickness dependence of $K_i$ in the MgO/FeB/MgO stacks annealed at 300°C.