Dependence of dynamic magnetic properties on the Co-Fe-B layer thickness for Ta/Co-Fe-B and Ta-O/Co-Fe-B bilayers

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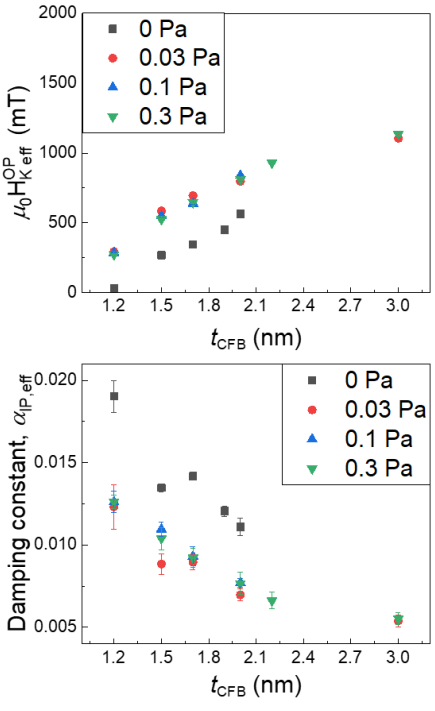
Spin-orbit torque (SOT) induced magnetization switching in non-magnetic (NM)/ferromagnetic systems has attracted much attention for applications in spintronic devices [1]. A high SOT efficiency for the magnetization switching in these systems was as-well known to be realized as the NM layer took in the oxygen [2]. On the other hand, how the dynamic magnetic properties in these systems change with the oxygen incorporation has not been fully investigated. Until now, we reported that dynamic magnetic properties such as the effective in-plane damping constant $\alpha_{IP,\,eff}$, the effective perpendicular anisotropy $H^{OP}_{K,eff}$ and so on, of Ta/Co-Fe-B bilayers markedly changed as the Ta layer took in the oxygen [3]. Herein, to further understand the effect of oxygen incorporation on the dynamic properties of Ta/Co-Fe-B bilayers, we investigate on the dependence of these properties on the Co-Fe-B layer thickness (t_{CFB}) for Ta/Co-Fe-B and Ta-O/Co-Fe/-B bilayers by a broadband ferromagnetic resonance (B-FMR) measurement technique, which is performed under an in-plane magnetic field in detail.

Figure 1 shows the t_{CFB} dependence of $H^{OP}_{K,eff}$ and $\alpha_{IP,\,eff}$ for Ta(-O) (1 nm)/Co-Fe-B (t_{CFB})/MgO (1.3 nm)/Ta (1nm) prepared at various oxygen pressure P_{Oxygen}. In each P_{Oxygen}, $H^{OP}_{K,eff}$ increases as t_{CFB} increases, indicating that the perpendicular magnetic anisotropy becomes weak as t_{CFB} increases. $H^{OP}_{K,eff}$ values for $P_{Oxygen} \geq 0.03$ Pa are higher than that for $P_{Oxygen} = 0$ Pa, which may be attributed to the reduction of perpendicular magnetic anisotropy by the oxygen incorporation [4]. On the other hand, in every P_{Oxygen}, $\alpha_{IP,\,eff}$ decreases linearly as t_{CFB} increases up to approximately 2.2 nm, and further almost keeps constant for $t_{CFB} \geq 2.2$ nm. $\alpha_{IP,\,eff}$ values for $P_{Oxygen} \geq 0.03$ Pa are lower than that for $P_{Oxygen} = 0$ Pa, which would be attributed to the decrease of spin-pumping effect by the oxygen incorporation. These results mean that the dynamic properties of these bilayers can be controlled by the slight oxygen incorporation.



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