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Influence of a Hf interlayer on the perpendicular magnetic anisotropy of the MgO/Hf/CoFeB structure

Kyoung-Min Lee[1,2*], Taufik Bonaedy[1], Byoung-Chul Min[1], Junghyun Sok[2], and Jun Woo Choi[1]
[1]Spin Convergence Research Center, Korea Institute of Science and Technology, Seoul 136-791, Republic of Korea
[2]Department of Nano Engineering, University of Seoul, Seoul 130-743, Republic of Korea

Investigations to tune the perpendicular magnetic anisotropy (PMA) of MgO/CoFeB have attracted great interest due to its potential application to various spintronics devices [1-4]. Recent studies show that Mg or Fe interlayers can effectively control Fe-O bonding (Fe 3d-O 2p orbital hybridization) which subsequently control the interfacial magnetic anisotropy of the MgO/CoFeB structure [1, 2].

In this work, we have studied the PMA of a CoFeB//Hf/MgO structure in which Hf is inserted as an interlayer. The full sample structures were Ta(20 Å)/MgO(16 Å)/Hf(0.8 Å)/CoFeB(12~30 Å)/Hf(25 Å)/Pt(25 Å)/ Ta(50 Å)/ SiO2/ Si and Ta(20 Å)/MgO(16 Å)/CoFeB(12~30 Å)/Hf(25 Å)/Pt(25 Å)/ Ta(50 Å)/ SiO2/ Si, the difference between the two samples being the presence or absence of the Hf interlayer. The CoFeB having the composition ratio of 40:40:20 were used. The samples were annealed at 200 ~ 320 °C, and the magnetic hysteresis loops were measured by a vibrating sample magnetometer (VSM). The effective anisotropy and the coercivity was increased with the insertion an Hf interlayer, indicating the increase in PMA. The magnetic properties were also greatly influenced by the CoFeB thickness and annealing temperature. In order to verify the mechanism of the increase in PMA, x-ray photoelectron spectroscopy (XPS) measurements were performed to observe chemical states of the Hf, Fe, Co and Mg at the CoFeB/MgO interface. XPS data suggest that the increase in PMA is due to the change of the Fe-O bonding states by the formation of HfO.

References

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