Effect of CoFeB Composition and Mg Interlayer on Perpendicular Magnetic Anisotropy in Hf/CoFeB/MgO Structures

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1. Introduction

The MgO/ CoFeB/ Ta structures is known to have a decent perpendicular magnetic anisotropy (PMA), and magnetic tunnel junctions (MTJs) based on this structure yield a high tunnel magnetoresistance (TMR) of over 120%[1]. It has been recently reported that the PMA at the MgO/CoFeB interface can be increased by inserting a Mg interlayer between CoFeB and MgO [2] or by replacing Ta to Hf underlayer [3]. Here we have investigated the influence of the CoFeB composition and Mg interlayer on the PMA in Hf/ CoFeB/ Mg/ MgO structures.

2. Experiment Method

We fabricated Hf/ $Co_4Fe_4B_2$/ MgO and Hf/ $Co_2Fe_6B_2$/ MgO structures. The samples were deposited using both DC and RF magnetron sputtering on the oxidized Si(100) substrates, and thereafter annealed at 300 ℃. The magnetic properties were characterized by vibrating sample magnetometer (VSM) and the anomalous hall effect (AHE).

3. Results and Discussion

A PMA is observed in both Hf/ $Co_4Fe_4B_2$/ MgO and Hf/ $Co_2Fe_6B_2$/ MgO structures, when the thickness of CoFeB is thinner than 1.4 nm. The Hf/ $Co_4Fe_4B_2$/ MgO structures show a higher PMA than the Hf/ $Co_2Fe_6B_2$/ MgO structures, since the $Co_2Fe_6B_2$ layer has been sizably oxidized during the MgO deposition. We find that the PMA has been enhanced by inserting a Mg interlayer between the CoFeB and MgO. The largest PMA is observed when the Mg thickness is 0.4 nm. It is believed that the insertion of Mg layer affect the Co-O and Fe-O bonding at the interface, which are crucial to obtain a high PMA.

4. Conclusion

We show that the variation of CoFeB composition and the insertion of a Mg interlayer affect the PMA in Hf/ CoFeB/ MgO structures. These results demonstrate that a slight difference in Co-O and Fe-O bonding at the interface influences the PMA significantly. The structures studied in this paper can be used for perpendicular MTJs and for other spintronics devices based on perpendicular magnetic layers.

Reference

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