Study on Perpendicular Magnetic anisotropic properties of Amorphous Ferromagnetic CoSiB/Pd Multilayer with Various thicknesses

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1. Introduction

Materials with PMA have large anisotropy energies more than that with in-plane anisotropy (IMA). For the patterned device, in addition, the magnetization of materials with PMA does not suffer from thermal instability due to magnetization curling observed at the edge of in-plane case [1]. Moreover, the reverse of magnetization of a PMA free layer is easier than that of an IMA free layer. Based on these general theories, devices with PMA have lower switching currents than devices with IMA for the same magnetic field [2-4]. Multilayers based on crystalline materials, for example, Co, Fe, and CoFe show PMA for a certain range of thickness of layer and number of periods with noble metals like Pt, Pd, and Au [5-9]. Also, multilayers based on amorphous materials like CoSiB, and CoFeSiB show PMA. Both crystalline multilayers and amorphous multilayers show PMA, but amorphous multilayers have two strong advantages. There are no grain boundary and the less roughness of the amorphous than that of crystalline [10, 11].

Therefore, we studied the perpendicular magnetic anisotropic properties of amorphous ferromagnetic CoSiB/Pd multilayers as functions of the thicknesses of CoSiB and Pd layers. In order to investigate of the role of these amorphous multilayers, the magnetic properties were studied by a VSM and a XRD.

2. Experiments

The chamber's base pressure was up to 2.0×10^{-7} Torr, and the working pressure was 2×10^{-3} Torr after flowing Ar gas (46 sccm). All thin films were uniform in size, 1.4 cm x 1.4 cm, and were deposited at room temperature. The magnetic properties of the thin films were measured by a vibrating sample magnetometer.

3. Result

We found that the coercivity and the magnetization are strongly dependent on ferromagnetic material's thickness. In addition, the amorphous ferromagnetic CoSiB/Pd multilayer has larger squareness, lower coercivity, and lower magnetization than those of crystalline multilayer.

4. Discussion

Based on these results, the amorphous CoSiB multilayer system was proved to be beneficial for perpendicular magnetic tunnel junction (pMTJ) applications. Therefore, in the further study, we will propose an annealing effect of CoSiB system and insert this system as a free layer of MTJ.

5. Conclusion

We found that the coercivity and the magnetization are strongly dependent on ferromagnetic material's thickness. In addition, the amorphous CoSiB multilayer has larger squareness, lower coercivity, and lower magnetization than those of crystalline multilayer. This means that the amorphous is more beneficial than other crystalline which are known. In conclusion, the amorphous ferromagnetic CoSiB multilayer is more useful than other crystalline multilayer for pMTJ application.

6. Reference

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