CoFeSiB/Pt Multilayers with Perpendicular Magnetic Anisotropy

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1. Introduction

A magnetic multilayer exhibiting perpendicular magnetic anisotropy (PMA) is one of the most attractive materials promising for high storage density MRAM [1]. In this study, we investigated the perpendicular magnetic behavior of CoFeSiB/Pt multilayers. This multilayer exhibits excellent soft magnetic characteristics compared with traditionally used PMA multilayer materials such as Co/Pt and Co/Pd [2].

2. Experiment

All CoFeSiB/Pt thin films were deposited on thermally oxidized Si wafers using dc magnetron sputtering system under base pressure lower than 5×10^{-8} Torr. The stacking structure of the samples is Si / SiO_2 / Ta(5) / Pt(0.4) / [Pt (t_{Pt}) / CoFeSiB (t_{CFSB})]N / Ta(5) (unit in nm), where t_{Pt} and t_{CFSB} indicating the thicknesses of Pt and CoFeSiB, respectively. The magnetic properties of the $[CoFeSiB / Pt]_N$ thin films were characterized by a vibrating sample magnetometer (VSM).

3. Results

Fig. 1 shows the hysteresis loops of the $[CoFeSiB(0.3) / Pt(0.8)]_5$ and the $[Co(0.3) / Pt(0.8)]_5$ multilayers for comparison. The coercivity of Co/Pt multilayer is 180 Oe, while CoFeSiB/Pt multilayer shows only 30 Oe.

Further, the thickness effects of CoFeSiB and Pt were investigated with same repetition structure, where the results are shown in Fig 2. With a CoFeSiB layer thickness change, the coherent switching was kept until the thickness increased to 0.6 nm.

4. Discussion

After that, the loops become a little rounded as the CoFeSiB thicknesses surpassed 0.8 nm, and sheared when it reached 1 nm, showing typical reversal behaviors for PMA films with strip domains caused by the competition between out-of-plane and in-plane shape anisotropy [3]. The in-plane anisotropy became dominant for a sample with CoFeSiB thickness reaching 1.2 nm.

5. Conclusion

We have designed and fabricated new perpendicular magnetic anisotropy multilayer with amorphous CoFeSiB ferromagnetic later. This new multilayer has low coercity compare with other multilayer system. And it also shows the low saturation magnetization and high perpendicular magnetic anisotropy. We point out that these multilayer system could promise applications for high density memory devices.

6. Reference

[1] N. Nishmura, T. Hirai, A.Koganei, T. Ikeda, K. Okano, Y. Sekiguchi, and Y. Osada, J. Appl. Phys. 91, 5246 (2002).

[2] C. Liu, E. R. Moog, and S. D. Bader, Phys. Rev. Lett. 60, 2422 (1988).

[3] V. Gehanno, A. Marty, B. Gilles, and Y. Samson, Phys. Rev. B 55, 12552 (1997).

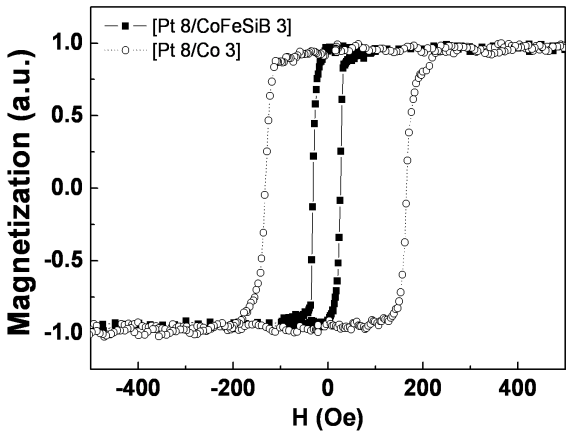

Fig. 1. Comparison of magnetic hysteresis between $[Co(0.3) / Pt(0.8)]_5$ and $[CoFeSiB(0.3) / Pt(0.8)]_5$ multilayers.

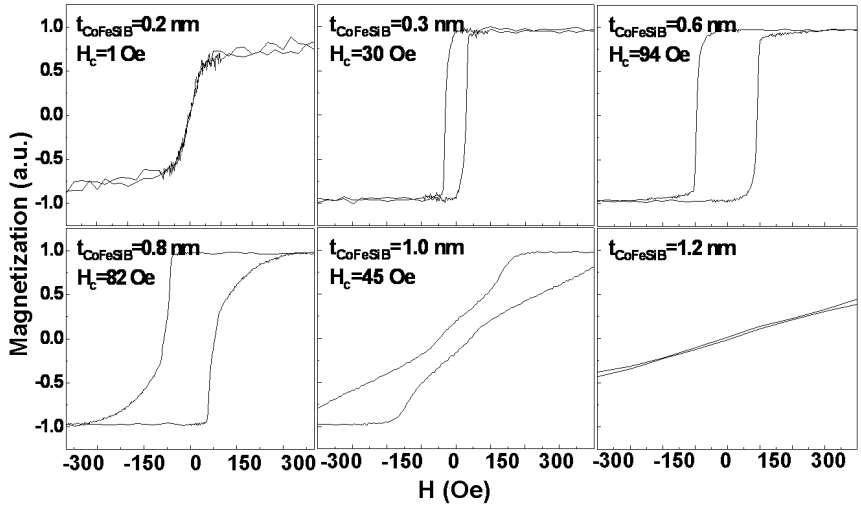

Fig. 2. Evolution of hysteresis loops as a function of CoFeSiB thickness while Pt thickness was fixed at 0.8 nm.