Thermal Activation of Reversal Process in Amorphous CoSiB/Pd Multilayers with Perpendicular Magnetic Anisotropy

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1. Introduction

For multilayer films of alternating ferromagnetic and nonmagnetic layers, the broken symmetry at the interface can induce the strong perpendicular magnetic anisotropy (PMA). Multilayer systems based on Co/Pt, Co/Pd are (111) textured, the grain boundaries act as pinning sites, and it causes irregular switching behaviors. In this research, we investigate the PMA of CoSiB/Pd multilayer system by replacing Co with amorphous CoSiB. The thermal reversal domain processes such as domain wall motion and the nucleation of reverse magnetization at grain boundaries are confirmed by the magnetic optical Kerr effect (MOKE) microscopy and sweep rate measurements.

2. Experiments

The samples were deposited by DC magnetron sputtering system at room temperature with Ar gas pressure of 2 mTorr from $Co_{75}Si_{15}B_{10}$ target. The multilayers consist of SiO_2 (100)/Ta (5)/Pd (3)/[CoSiB (t_{CoSiB})/Pd (1.3)]$_5$/Ta (5) with various thickness, t_{CoSiB} = 0.2, 0.3, 0.4, 0.5, and 0.6, (unit is nm). The domain wall (DW) motion due to thermal activation is confirmed with MOKE microscopy measurement. The sweep rate dependence of coercivity was observed by using a vibrating sample magnetometer (VSM).

3. Results and discussion

For t_{CoSiB} = 0.2, 0.3, 0.4, and 0.5 nm, the PMA is clearly observed. The maximum coercivity (261 Oe) was found for CoSiB thickness of 0.3 nm. Figure 1 shows the MOKE image of [CoSiB (0.3 nm)/Pd(1.3 nm)]$_5$ multilayer with waiting time (30 and 180 sec) at -150 Oe. It is described the DW motion related to thermal activation [1, 2]. The fluctuation field, H_f, is useful parameter to understand the thermal reversal process [3, 4]. The sweep rate dependence of coercivity of CoSiB/Pd multilayers with various thickness are shown in Fig. 2. H_f is obtained from fitting to the equation deduced by Bruno *et al*. [5]. In results, the coercivity is larger with smaller H_f.

4. Conclusion

We investigate the thermal activation related to time dependence of magnetization reversal process in CoSiB/Pd multilayers with PMA. The coercivity is intimately associated with the fluctuation field. More detail

analysis including thermal activation energy and the nucleation energy barrier will be discussed.

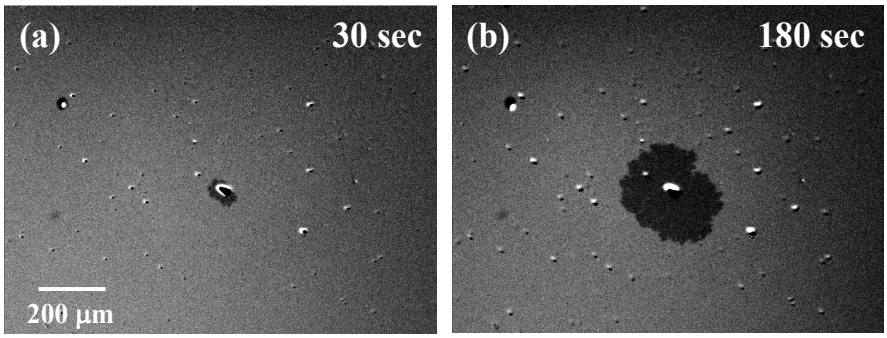

Fig. 1 Magnetic optical image for [CoSiB (0.3 nm)/Pd (1.3 nm)]$_5$ multilayer after (a) 30 sec and (b) 180 sec at -150 Oe.

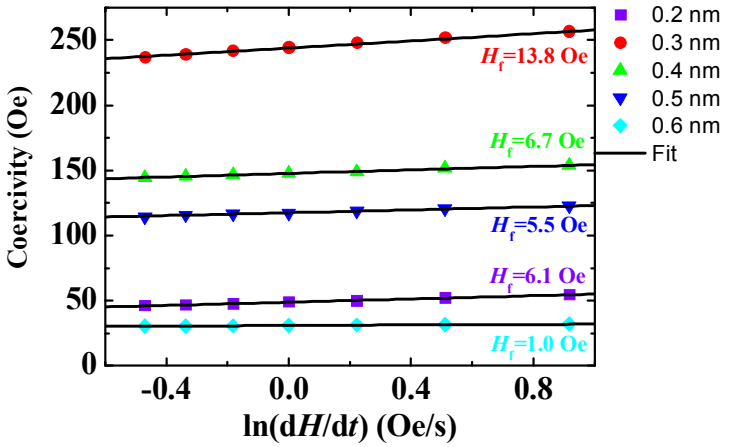

Fig. 2 Sweep rate, ln(dH/dt), dependence of the coercivity of [CoSiB (t_{CoSiB} nm)/Pd (1.3 nm)]$_5$ multilayer with various thickness, t_{CoSiB} = 0.2, 0.3, 0.4, 0.5, and 0.6 nm. The solid lines represent fit curves to the fluctuation filed, (H_f).

5. Reference

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