Rapid thermal annealing effect on magnetic property of thin-films consisting of amorphous CoSiB

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1. Introduction

Magnetic materials have been investigated in order to apply for high-density spin-transfer-torque magnetic random access memory (STT-MRAM) device and other next-generation magnetic recoding media [1, 2]. In order to realize high-density, perpendicular magnetic anisotropy (PMA) and high coercivity are required [3, 4]. In 1975, the phenomenon of PMA had been first investigated by Iwasaki and Takemura in the Co/Cr films. And then Carcia, Meinhaldt and Suna established the importance of interfaces in the multilayer as the driving mechanism for PMA in 1985 [5, 7]. In particular, magnetic tunnel juctions (MTJs) with PMA have attracted great research interest for the high-density device (such as STT-MRAM)'s realization. Because the phenomenon of STT causes the current-induced magnetization. This current-induced magnetization switching (CIMS) occurs at a smaller critical current density in perpendicular MTJ (pMTJ) than that in in-plane MTJ [6-11]. PMA has two strong advantages for the next-generation devices (such as STT-MRAM): low J_c (current density) and high thermal stability. Both the low J_c and the high thermal stability are important issues for application of STT-MRAM. Moreover, amorphous materials has higher saturation magnetization than crystalline materials. This chracterization is particularly usuful for improving of capavility of devices. Therefore, we studied magnetic and thermal properties of multilayers consisting of amorphous $Co_{75}Si_{15}B_{10}$ with PMA. In this study, we prepared CoSiB/Pd multilayers and investigated their magnetic property and the annealing temperature dependence of the magnetic property.

2. Experiment

The chamber's base pressure was up to 2.0×10^{-7} Torr, and the working pressure was 2×10^{-3} Torr. All films were uniformed in size, 1.4 cm × 1.4 cm, and were deposited by ultra high-vacuum system at room temperature. The magnetic properties (M_s and H_c) of all thin-films were measured by a vibrating sample magnetometer. For studying the thermal property of multilayers, we annealed the multilayers with various temperatures (300, 400, and 500℃) for 1 hour.

3. Result and discussion

In this study, we investigated the magentic properties (the coercivity and saturation magnetization) of the CoSiB/Pd multilayers and found the annealing temperature dependecne of the magnetic properties in these multilayers. When the thickness of CoSiB is 3Å, the coercivity has sevenfold increase at 300℃ and this multilayer has no PMA after 400℃. In the $[CoSiB\ (5\ Å)/Pd\ (14\ Å)]_5$ multilayers, the coervivity shows the highest value at 300℃. Both two saturation magnetizations of two multilayer systems have the highest values at 300℃. Finally, we note that the coercivity and the saturation magnetization of the CoSiB/Pd multilayer system have a

close association with the annealing temperature. Moreover, the coercivity especially shows a sudden increasing at the specific annealing temperature.

4. References

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