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LARGE MAGNETIC INFLUENCE OF INTERFACIAL Fe WITH SiO_2 SUBSTRATE IN FeCuPt GRAINS

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We already reported that isolated several tens of nano-meters $L1_0$-FeCuPt and $L1_0$-FePt grains were fabricated by Rapid Thermal Annealing (RTA) and Rapid Cooling Process (RCP)[1][2][3]. In this fabrication process, we showed that interface between the SiO_2 substrate and the metallic layer had important role of the isolated FeCuPt grain formations and magnetic properties. Fe nearby interface didn't crystallize for $L1_0$-FeCuPt. Oxidization of the interfacial metallic layer was considerable factor to fabricate $L1_0$-FeCuPt grains.

1. Introduction

For high density Thermally Assisted Magnetic Recording (TAMR), we already reported that isolated several tens of nano-meters $L1_0$-FeCuPt and $L1_0$-FePt grains were fabricated by RTA and RCP for Pt / Cu / Fe and Pt / Fe multilayered ultra-thin films on the SiO_2 substrates. In this fabrication process, we focused that interface between the SiO_2 substrate and the metallic layer might have important role of the grain formations and magnetic properties. Therefore, to investigate the influence of interfacial condition, (a) We executed excimer substrate surface treatment with several irradiation times and fabricated of FeCuPt multilayered films with different sequences. More detail, (b) We deposited Pt / Fe double layers with changing composition of Fe_xPt_{100-x} (x = 50 to 63.7) on the SiO_2 substrate[4].

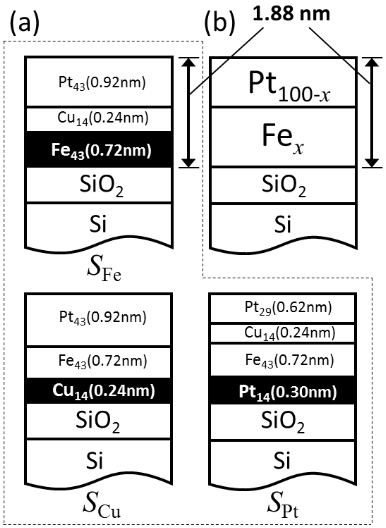

Figure1 Layer designs of (a) FeCuPt and (b) FePt thin films.

2. Experimental method

We experimented two methods. As for the layer design of Figure1 (a), for the gradual change of the SiO_2 substrate surface condition, the SiO_2 substrate was irradiated by excimer light with times (T_i) of 0, 5 and 30 s. After this process, the Fe_{43} Cu_{14} Pt_{43} multilayered films shown in Figure1 (a) were fabricated by DC magnetron sputtering in 0.18 Pa pressure ArH (H_2: 3 vol. %) gas atmosphere. Total film thickness of all samples were 1.88 nm. These films were annealed by RTA process in the vacuum chamber at 3.0×10^{-3} Pa. The heating up rate was about 90 ℃ / s. Reaching at the maximum temperature of 600 ℃, the optical pass was shut out by shutter then N_2 gas was introduced for RCP. As for the layer design of Figure1 (b), we deposited Pt / Fe double layers with changing composition of Fe_xPt_{100-x} (x = 50 to 63.7) on the SiO_2 substrate by DC magnetron sputtering in same as (a) condition. The RTA process was also executed in same as (a) condition. The isolated grains were observed by Scanning Electron Microscope (SEM). The magnetic properties were measured by Superconducting Quantum Interference Device - Vibrating Sample Magnetometer (SQUID-VSM).

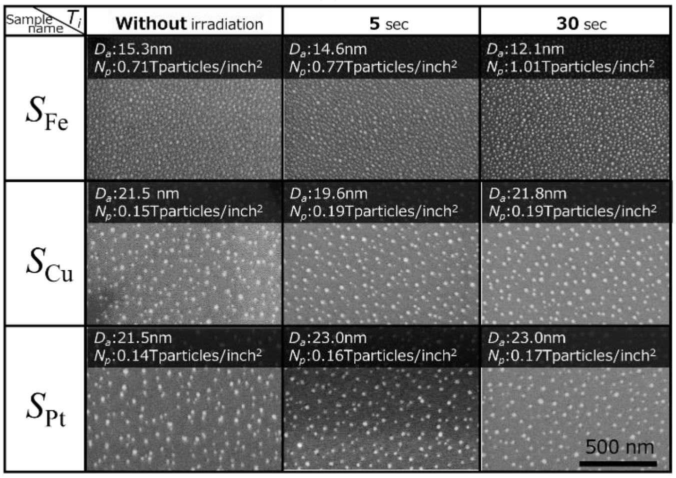

Figure 2 SEM images, D_a and N_p of the FeCuPt grains made on each condition.

3. Result

3–(a). Interface condition dependence of grain formations and magnetic properties

Figure 2 shows the SEM images, number density of grains (N_p) and average grain diameter (D_a) in each sample. If the first deposited metallic element was A, we defined the sample name as S_A. As for the N_p, the values were S_{Fe} >> S_{Cu} > S_{Pt}. Furthermore,

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substrate surface treatment much affected to increase N_p in S_{Fe} that had active metallic first deposited layer. These results suggest that substrate surface treatment by irradiating excimer light affect oxidization to interfacial metallic layer. N_p depends on metallic grains newcreation point of oxide. Figure 3 shows magnetic properties in each sample. About S_{Fe} and S_{Cu}, coercivity (H_c) was decreased by excimer light irradiation. On the other hand, H_c of S_{Pt} was almost not changed. It means oxidization of interfacial metallic layer affect crystallization.

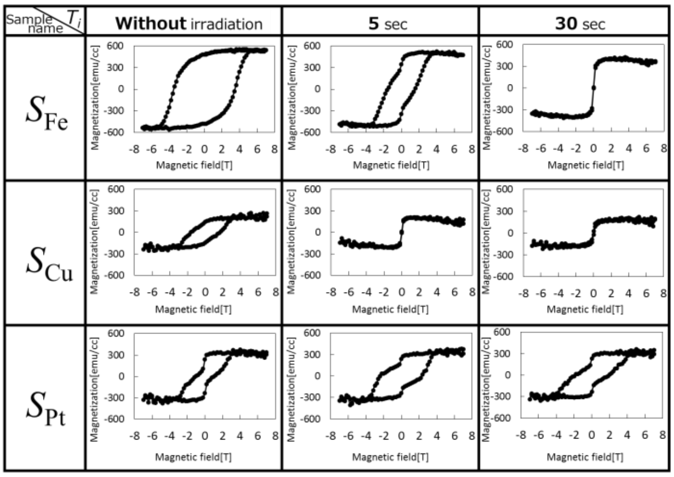

Figure 3 Magnetization VS Magnetic field of the FeCuPt grains made on each sample measured by SQUID - VSM at R.T..

3–(b). Composition ratio dependency of magnetic properties

To investigate interfacial influence in more detail, we deposited Pt / Fe double layers with changing composition of Fe_xPt_{100-x} (x = 50 to 63.7) on the SiO_2 substrate. These double layer films were simpler design than FeCuPt multilayered films. Figure 4 shows magnetic properties on applying magnetic field in each sample. Relations between each composition and H_c were {x,H_c} = {50, ≈ 0 T}, {55, < 0.2 T}, {57, 2.6 T}, {62, 4.2 T} and {63.7, 3.8 T}, respectively. In the case of x = 57, 62 and 63.7, large values of H_c were appeared. For x = 62, simple hard magnetic hysteresis loop was observed. However, in x = 57 and 63.7, characteristics like soft magnetic properties also were observed below ±1 T. These results suggest that Fe nearby interface didn't crystallize for $L1_0$-FeCuPt.

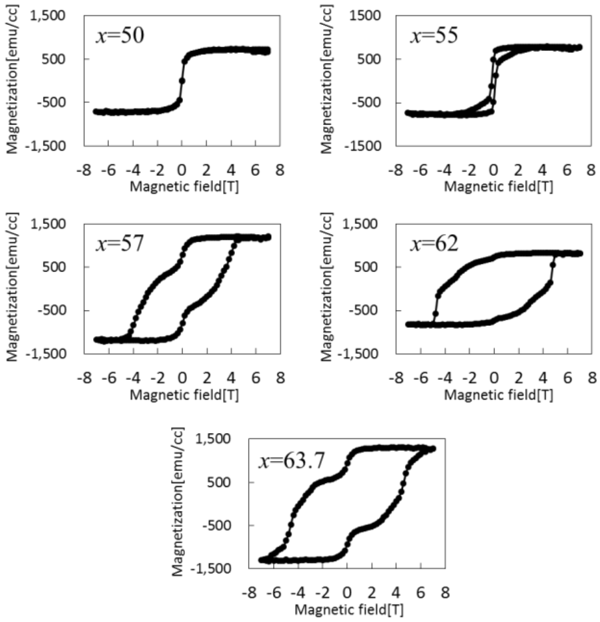

Figure 4 Magnetization VS Magnetic field of the FePt grains made on each condition measured by SQUID - VSM at R.T.[4].

5. Summary

In the RTA process of fabrication FeCuPt and FePt grains, we focused that interface between the SiO_2 substrate and the metallic layer might have important role of the grain formations and magnetic properties. As for the N_p, the values were the S_{Fe} >> S_{Cu} > S_{Pt}. Substrate surface treatment much affected to N_p and H_c in S_{Fe}. These results suggest that oxidization of interfacial metallic layer affect grain formations and magnetic properties. Furthermore from the relation between x and H_c, H_c couldn't appeared in the case of x < 50. These results suggest that Fe nearby interface didn't crystallize for $L1_0$-FeCuPt. Oxidization of the interfacial metallic layer was considerable factor to fabricate $L1_0$-FeCuPt grains.

Acknowledge

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