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Compositional Dependency of Isolated FePt Grains Formation on Nano Silica Particle Substrate with Rapid Thermal Annealing Method

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To high-density magnetic recording medium, we already reported that isolated $L1_0$ - FePt grains were fabricated on Self-Assembled nano Silica Particle (SASP) substrate by Rapid Thermal Annealing (RTA) [1]. In addition, we reported that magnetic properties of FePt grains were changed by deposited composition ratio of Pt_{100-x} / Fe_x (x = 50 to 62) on flat SiO_x substrate [2]. In this reports, we found that high density FePt grains on SASP substrate indicated high coercive force. Also, number of density and magnetic properties of FePt grains changed depending on composition ratio.

1. Introduction

For high-density magnetic recording medium, we were reported high areal density isolated $L1_0$ - FePt grains were fabricated on Self-Assembled nano Silica Particle (SASP) substrate by Rapid Thermal Annealing (RTA) method [1]. In addition, hard magnetic like properties of FePt grains were changed by as-deposited composition ratio of Pt_{100-x} / Fe_x (x = 50～62) on flat SiO_x[2]. We focused on variation magnetic properties and number of density of FePt grains by changing as-deposited composition ratio of Pt / Fe on SASP substrate. Therefore, to investigate FePt grains formation on SASP substrate by changing as-deposited composition ratio of Pt / Fe, we fabricated Fe_xPt_{100-x} (x = 50, 62, 64) grains on SASP substrate.

2. Experimental method

SASP substrate was fabricated by the dip-coating method. The Mass concentration of Silica particles in solution is 5.8× 10^{-3} [wt. %]. The pulling up speed was 10 μm / sec. After the dip-coating, SASP substrate was formed through an annealing process (150 ℃, 10 minutes). After this process, Pt_{100-x} / Fe_x (x = 50, 62, 64) films were deposited by DC magnetron sputtering in 0.18 Pa pressure ArH (H_2: 3 vol. %) gas atmosphere. Total Fe and Pt film thickness of all samples were 1.88 nm. Fig. 1 shows these schematic diagram. These sample were rapidly annealed by using infrared lamp with a heating up rate of 20 to 30 ℃ / sec. Reaching at the maximum temperature of 600 ℃, the optical pass was shut out by shutter then N_2 gas introduced annealing chamber for rapid cooling. The base pressure of the annealing chamber was 3.0 × 10^{-3} Pa. The FePt grains were observed by Scanning Electron Microscope (SEM). The magnetic properties were measured by Superconducting Quantum Interference Device Vibrating Sample Magnetometer (SQUID-VSM). The crystal structure was evaluated by X-Ray Diffraction (XRD).

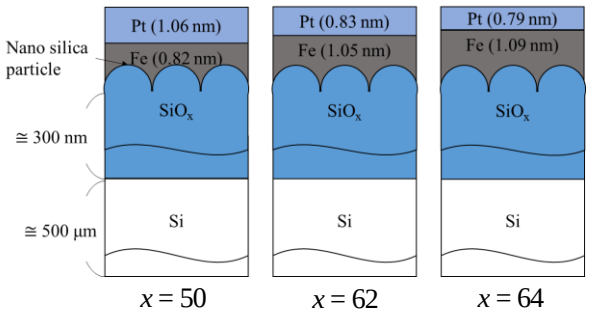

Fig. 1 Schematic diagram of as-deposited Pt / Fe on SASP substrate.

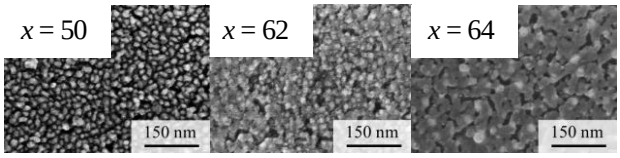

Fig. 2 SEM images of Fe_xPt_{100-x} grains on SASP substrate

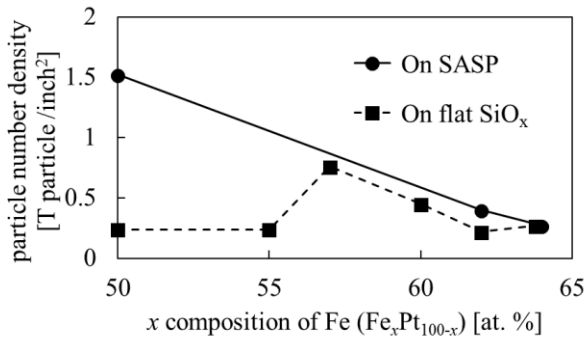

Fig. 3 Compositional dependency of particle number density for fabricated isolated Fe_xPt_{100-x} grains on SASP substrate and flat SiO_x [2].

3. Experimental result and discussion

Fig. 2 shows SEM images of Fe_xPt_{100-x} grains (x = 50, 62, 64). Fig. 3 shows compositional dependency of particle number density(N_p) of these isolated FePt grains on SASP substrate and flat SiO_x [2]. In FePt grains on SASP substrate confirmed that increasing of N_p according to decrease in composition ratio. It is larger than FePt grains on flat SiO_x. In addition, N_p of FePt grains fabricated on SASP substrate was nearly equal to the case of FePt grains on flat SiO_x with increasing composition ratio of Fe.

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The perpendicular magnetic properties of Fe_xPt_{100-x} grains on SASP substrate were as shown in Fig. 4. These magnetic properties of FePt grains has changed with composition ratio. In x = 62 and 64 obtained the "two-shoulder" hysteresis loops and high coercive force in this experiment. These results are considered to FePt grains with hard magnetic like properties by $L1_0$ crystal structure and soft magnetic like properties is present on SASP substrate. Fig. 5 shows compositional dependency of coercive force of these isolated FePt grains on SASP substrate and flat SiO_x [2]. In x = 62, coercive force of FePt grains on SASP substrate was confirmed a high coercive force at similar composition ratio as compared to FePt grains on flat SiO_x.

The crystalline structure of fabricated Fe_xPt_{100-x} (x = 62, 64) grains were analyzed by XRD, as shown in Fig. 6. In x = 62, $L1_0$ – FePt (001) and (111) peaks were confirmed. In x = 64, $L1_0$ – FePt (111) only peak was confirmed. These results considered to cause high coercive force in x = 62 and 64. Furthermore, from (001) peak was not observed at x = 64, therefore the coercive force may be reduced compared with x = 62.

From these result, composition ratio variation is effective scheme same with FePt grains fabricated on flat SiO_x to increase number of density and hard magnetic properties of FePt grains on SASP substrate.

4. Conclusion

We changed as-deposited composition ratio of Pt_x / Fe_{100-x} on SASP substrate to clarify composition ratio dependency of magnetic properties and number of density of FePt grains on SASP substrate. The number of density and magnetic properties of FePt grains on SASP substrate changed with composition ratio. In FePt grains formation using SASP substrate, increase of particle number density was confirmed in case of changing composition ratio. Especially, $Fe_{62}Pt_{38}$ and $Fe_{64}Pt_{36}$ grains indicated high coercive force. these results are similar to the case of FePt grains on flat SiO_x. Thus, FePt grains fabricated using SASP substrate has been suggest that magnetic properties and especially number of density of FePt grains responds to composition ratio variation.

5. Acknowledgement

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6. Reference

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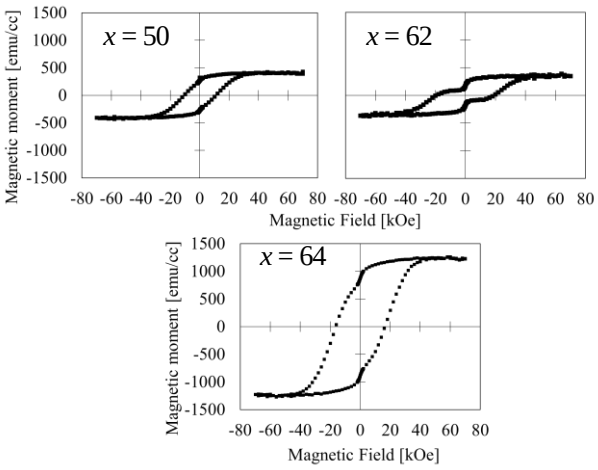

Fig. 4 Perpendicular Magnetization curves for Fe_xPt_{100-x} grains on SASP substrate measured by SQUID VSM at room temperature.

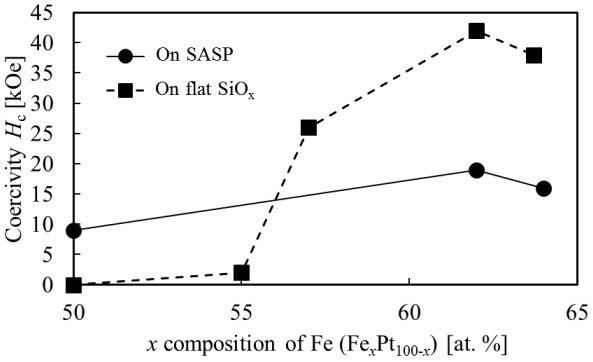

Fig. 5 Compositional dependency of coercive force of isolated Fe_xPt_{100-x} grains on SASP substrate and flat SiO_x [2].

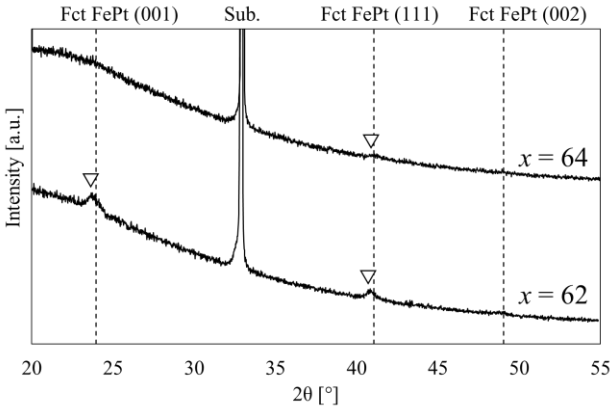

Fig. 6 Out of plane XRD profiles for Fe_xPt_{100-x} grains.