CONTROL OF ISOLATED FePt GRAINS FORMATION BY MULTIPLE NANO-PARTICLE NUCLEATION WITH RAPID THERMAL ANNEALING METHOD

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I. INTRODUCTION

For the fabrication of high density magnetic recording medium, we studied about fabrication of isolated FePt grains formation with Rapid Thermal Annealing and Rapid Cooling Process (RTA)[1],[2]. As one of the issues in this method, grains density and grain diameter depend on the thickness of pre-stacked metal thin films, so they can not be controlled independently in single RTA process. Generally, particle nucleation phenomena have important role during FePt grain formation process under RTA. Therefore, we focused that control of FePt grains formation by multiple particles nucleation procedure. In this report, it was shown that the multiple particles nucleation with RTA is effective for independent control of grain density and diameter, furthermore grains formation position.

II. EXPERIMENT

Metal thin films were fabricated using DC magnetron sputtering on flat thermally oxidized Si substrates. Fe and Pt layers were fabricated in 0.18 Pa pressure ArH (H_2: 3 vol. %) gas atmosphere. For particlize, metal films were annealed by RTA process in the vacuum chamber at 2.0×10^{-3} Pa with infrared lamp. At the end of RTA, metal films were quenched by RCP. The average temperature elevation rate was about 120 ℃ / sec. At the maximum temperature of 600 ℃, the optical pass was closed then N_2 gas was flowed for RCP. The size and the shape of isolated particles were observed by Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM).

III. RESULTS&DISCUSSION

Pt thin films {A: 1.0 nm, B: 1.88 nm} were particlized by RTA. Fig.1 shows SEM and TEM planer view images, number of particles (N_p) and particles average diameter (D_a) in each samples. Isolated Pt particles were emerged in both samples. Sample B was obtained as areal particles density of 10 T particles/ inch^2 over. Next, Pt (0.69 nm)/ Fe (1.31 nm) continuous multilayer thin film was additionally deposit on these samples and then RTA was performed. Fig.2 shows SEM planer view images of FePt grains. Sample B retained the particles density and particles formation position of Pt particles. Sample A is decreased areal particles density.

For fabrication of high density particles, it is favorable that metallic film is stacked as thin as possible. Fig.3 shows particles density is higher than FeCuPt particles formed with the same or thin film that already reported[3]. From These results, The first tiny grain formation is effective for control of grains areal density. Second grains formation is effective for grain growth. Therefore, multiple particles nucleation is effective for independent control of grain density and diameter, furthermore grains formation position. In same deposited amount of FePt, the particle density was increased with double nucleation procedure than single RTA process.

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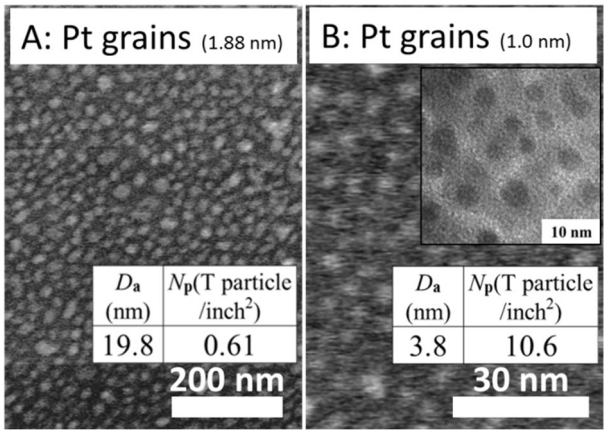

Fig.1 SEM and TEM planer view images, D_a and N_p in each samples. A: Pt thickness is 1.0 nm, B: Pt thickness is 1.88 nm.

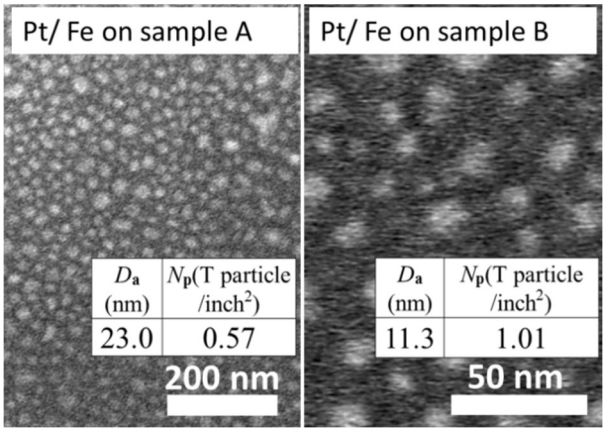

Fig.2 SEM planer view images, D_a and N_p in each samples. left: Pt/ Fe thin film on Sample A. right: Pt/ Fe thin film on Sample B.

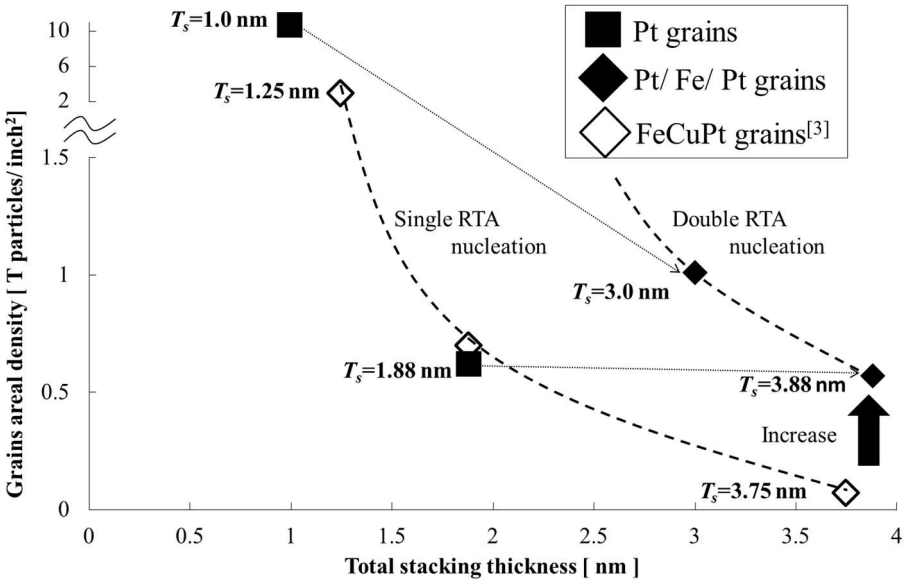

Fig.3 Dependence of total stack thickness on grain density.