BL-9C/2010G661

Disorder-order transformation of FePt nanoparticles by annealing

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1 Introduction

Equiatomic FePt nanoparticles are transformed from the fcc disordered structure to the large magnetic anisotropic $L1_0$-type ordered structure by annealing. Such transformation has been extensively investigated in the context of their application in advanced magnetic recording media [1]. To suppress sintering of nanoparticles during annealing, lowering of the ordering temperature is important.

Recently, we have succeeded in the synthesis of equiatomic FePt nanoparticles at a relatively low reaction temperature such as 383 K by adding hydroxyl ions, which promote the reduction reaction, to the glycol solution [2]. The FePt nanoparticles exhibited disorder-order transformation by heat treatment at temperatures above T_a = 573 K in a mixture of 5%H_2 in Ar. In addition, the sintering of FePt nanoparticles during heat treatment was suppressed below T_a = 673 K [3]. In this study, the local structure of the FePt nanoparticles synthesized at 383 K was investigated by using X-ray absorption spectroscopic technique.

2 Experiment

FePt nanoparticles were synthesized from hydrated $FeCl_2$ and $Pt(C_5H_7O_2)_2$ as precursors. Ethylene glycol was used as the solvent and reducing agent. NaOH was added in order to introduce hydroxyl ions to the reaction solution. The reaction time was 1 h and the reaction temperature was set at 383 K. Annealing for ordering transformation was conducted in Ar-5%H_2 for 1 h.

The XAS measurements were carried out at Fe K (7112 eV) and Pt L_3 absorption edges (11562 eV). The X-ray absorption spectra (XAS) of the as-synthesized specimen were measured at the beam line station BL-9C in the Photon Factory (PF) of the Institute of Materials Structure Science (IMSS), High Energy Accelerator Research Organization (KEK), Tsukuba, Japan. The XAS experiments of the heat-treated specimens were performed by a laboratory X-ray absorption spectrometer (Rigaku R-XAS Looper). The white radiation emitted from the X-ray tube with molybdemum target and LaB_6 filament was used. The measured data were analyzed by using the software REX2000 (Rigaku Corporation).

3 Results and Discussion

Figure 1 shows the radial structure function of Fe and Pt atoms obtained by Fourier transform calculation of the extended X-ray absorption fine structure (EXAFS) spectra. The Fe-O and Fe-Pt (or Fe) correlations are observed in the as-synthesized specimen. In addition, the as-synthesized specimen exhibits both the Pt-Fe (or Pt) correlation and the Pt-O correlation. It is suggested that the as-synthesized specimen contains both the crystalline FePt alloy phase and the poorly crystallized Fe- and Pt-oxide phase. Since the Pt-O correlation is not so strong, the Pt content in the poorly crystallized Fe- and Pt-oxide phase is considered to be relatively low. It should be noted that the Fe-O and Pt-O correlations disappear and the Fe-Pt and Pt-Fe correlations become intensive by heat treatment at T_a = 568 K. Therefore, the disorder-order transformation in FePt nanoparticles synthesized by the polyol process is accompanied by the reduction of the poorly crystallized Fe- and Pt-oxide phase with relatively low Pt content.

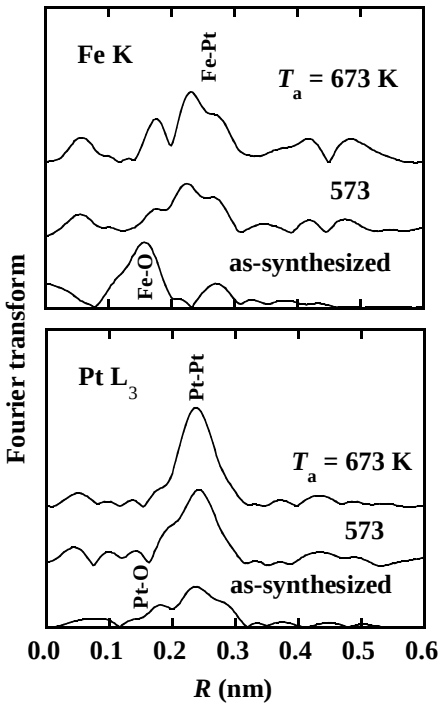

Fig. 1: Radial structure function around Fe and Pt atoms of the FePt nanoparticles synthesized at 383 K and those heat-treated at T_a = 573 and 673 K.

References

[1] S. Sun, Adv. Mater., **18** (2006) 393.
[2] K. Fukuda, S. Fujieda, K. Shinoda, S. Suzuki and B. Jeyadevanet, J. Phys.: Conf. Seri., **352** (2012) 012020.
[3] S. Fujieda, K. Shinoda, S. Suzuki and B. Jeyadevan, IEEE Trans. Magn. **49** (2013) 3303.

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