ADVANCES IN MATERIALS ENGINEERING

Volume 2

Edited By:
Md Abdul Maleque
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Effect of Composition on Phase Transformation of Iron-Platinum Nanoparticles

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Keywords: Iron-platinum, Microemulsions, Nanoparticles, Phase Transformation.

Abstract. Iron-platinum (FePt) nanoparticles were prepared by coreduction of H_2PtCl_6 and $FeCl_2$ with hydrazine in water/triton X-100/cyclohexane microemulsions. The as-synthesized FePt nanoparticles showed disordered face centered cubic (FCC) structure. After annealing at 700°C for 1 hour, Pt_3Fe phase was formed for samples with molar ratio of Fe: Pt of 1:1 and 1:3 while long range ordered $L1_0$ face centered tetragonal (fct) phase was formed for sample with molar ratio of Fe: Pt of 3:1. The crystallite sizes of annealed FePt nanoparticles were 53 nm, 61 nm and 22 nm for Fe: Pt molar ratio of 3:1, 1:1 and 1:3, respectively. The hysteresis loops measured by Alternating Gradient Magnetometer (AGM) revealed that the Pt_3Fe exhibited soft magnetic behavior while fct FePt was a hard magnetic material and had higher coercivity. The physical sizes estimated from Transmission Electron Micrograph (TEM) were similar to the crystallite sizes of FePt nanoparticles calculated from X-ray diffraction (XRD) data.

Introduction

Iron-platinum (FePt) nanoparticles have been investigated for several decades because of their importance as high-density magnetic recording media. Higher magnetic storage density media with low noise can be advised using smaller magnetic grain size and better magnetic isolation among the grains. Although, reduction of grain size increases areal density, it could be thermally unstable [1]. To avoid thermal instability, materials with much higher magnetic anisotropy are needed [2]. Depending of the Fe to Pt molar ratio, these alloys can display chemically disordered face centered cubic (fcc) phase or chemically ordered phases of iron-platinum compounds, such as Fe_3Pt, Pt_3Fe and face centered tetragonal (fct) [3]. These structural variations show dramatic effects on the magnetic properties of the FePt nanoparticles. For example, Fe_3Pt is paramagnetic, Pt_3Fe is antiferromagnetic, while fct FePt has large uniaxial magnetocrystalline anisotropy and strong ferromagnetic properties [4].

The magnetic properties of FePt nanoparticles generally depend on the structure, the size, the composition, and interparticulate interaction [5]. Fct phase of FePt can be formed in Fe_xPt_{x-100} nanoparticle system [6] within the composition of $40<x<60$. However, the formation of fct FePt requires adequate annealing to overcome the energy barrier for atomic diffusion and superlattice ordering. Concurrently, grain coarsening and sintering during the annealing process may occur if the particles are in close contact with each other which result in broad distribution of particle sizes and hence deterioration of magnetic properties.

Extensive efforts have been made to obtain monodisperse fct FePt particles. Monodisperse