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Magnetic and XRD Studies of FePt-Ag Nanoparticles Chemically Synthesized by a Nontoxic Process

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Chemically synthesized FePt magnetic nanoparticles have so much attention since the discovery by S. Sun and the co workers in 2000[1]. Because of their ultrafine particle size (3 4 nm), uniform size distribution, good chemical stability, and high magnetocrystalline anisotropy, the FePt nanoparticles are an idea material for ultrahigh density magnetic recording media. It is well known that the FePt nanoparticles are self assemble into highly ordering in films and maintain the ordering after annealing process to produce the $L1_0$ phase. Previous work has pointed out that the annealing temperature can be reduced by adding Cu, Ag, Co, or Au etc. on FePt nanoparticles in the synthesis process [2,3]. However, it has to be noted that some of the synthesis process involved the iron pentacarbonyl ($Fe(CO)_5$) as a precursor basically possesses toxicity and volatility. This is a disadvantage of synthesizing FePt nanoparticles for either research or mass production in industry. In this paper, the FePt Ag nanoparticles are synthesized by platinum acetylacetonate ($Pt(acac)_2$), iron acetylacetonate ($Fe(acac)_3$), and silver acetylacetonate (Ag(acac)) that all are the non toxicity and non volatility precursors. A series of FePt-Agx (x = 0, 0.125, and 0.25) nanoparticles were synthesized by chemical reduction processes. Their magnetic properties and XRD analysis which were studied by different annealing temperatures and treatments will be demonstrated in the paper.

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RA11

Chemical Synthesis and Annealing Procedures of FePt Nanoparticles

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Nowadays magnetic nanoparticles (NPs) have been received considerable attention due to their wide range research field such as biomedial and magnetic recording applications [1]. In this article, the hydrophobic FePt nanoparticles were chemical synthesized in an argon atmosphere by the reduction of 1 mmol $Pt(acac)_2$, from 1, 1.5, to 2 mmol $Fe(acac)_3$, and 1,2 hexadecanediol in the presence of oleic acid and oleyl amine stabilizers. The FePt NPs were then annealed at the temperature ranged from 400 °C to 600 °C for half hour surrounded with N_2 environment. A synthesis of partially ordered FePt NPs has been developed. For the case of 2 mmol $Fe(acac)_3$, the average diameter of as-prepared FePt nanoparticles was about 3 nm with the narrow size distribution and without significant aggregation as observed form the TEM image (Fig.1). Because of the small particle size, the as-prepared NPs are superparamagnetic at room temperature (R.T.) with a blocking temperature T_B of about 14 K from the temperature dependence of both field-cooled (FC) and zero-field-cooled (ZFC) magnetization. The surface modification of FePt NPs transferred form oil to water-soluble phase was prepared with the mercaptoacetic acid and 11-mercaptoundecanoic acid. From the XRD and SQUID measurements, the as-synthesized NPs with a chemically disordered fcc structure and can be transformed into partially ordered fct structure after annealing process at temperatures above 450 °C. The sample shows a coercivity of 100 Oe at R.T., and increased up to 1.25 Tesla after annealed at 600 °C as shown in Fig. 2. In spite of the presence of fct phase after annealing process, it was also due to the strong magnetostatic interaction between FePt NPs. Thus, the FePt NPs have to be dispersed for the application of magnetic recording media. In conclusion, the composition of the FePt nanoparticles with the chemical synthesis can be easily tuned. The as-prepared fcc FePt NPs with the completely water soluble property have been actively pursued for potential biological application. The room-temperature coercivity of FePt NPs ranged from 0.1 to 12.5 kOe, depending on the particle composition as well as the annealing temperature during synthesis procedures.

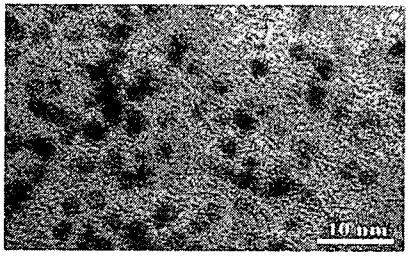

Fig. 1. TEM image of the as-prepared FePt nanoparticles.

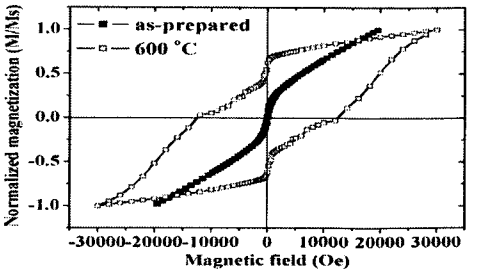

Fig. 2. Magnetization curves for the as-prepared and then annealed at 600℃ FePt nanoparticles.

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