B-5

Magnetic-Optical AuFe Alloy Nanoparticles

Hong Ling Liu[1], Jun Hua Wu[1]*, Ji Hyun Min[2], Young Keun Kim[2]
[1]Institute for Nano Science, Korea University, Seoul, South Korea
[2]Department of Materials Science and Engineering, Korea University, Seoul, South Korea

Abstract

Smart nanoparticles (NPs) of multiple components offer exciting opportunities in fundamental studies and highly multidisciplinary nanotechnology that has rapidly grown with tremendous applications in many areas including medicine, life science, materials science, environment, electronics, and energy. Metallic alloy NPs have been extensively investigated for various purposes such as magnetic recording, drug delivery, bioseparation, medical diagnosis, and catalysis, particularly magnetic and optical properties of materials are widely pursued. Since fusion of the magnetic and optical elements in one single entity promises multifunctionality and potential applications, so a great deal of effort is instilled to prepare such nanoparticles containing Au and Fe. We have investigated a variety of functional nanoparticles via an efficient, scalable and non-toxic synthesis approach [1]. In this work, we report the preparation and characterization of multifunctional magnetic-optical AuFe alloy nanoparticles, integrating the optical functionality of Au composition and the magnetic properties of iron. The nanoparticles were synthesized by a modified polyol process using iron acetylacetonate ($Fe(acac)_3$) and gold acetate ($Au(ac)_3$) in the presence of surfactants at high temperature[1].Three compositions of AuFe nanoparticles, $Au_{0.25}Fe_{0.75}$, $Au_{0.5}Fe_{0.5}$, and $Au_{0.75}Fe_{0.25}$, were formed and investigated on the structure and properties as a function of composition by TEM/HRTEM, XRD, UV-vis, XPS and VSM/SQUID. It is found that the fusion of the two materials into one nanostructure entity retains the optical and magnetic properties of the individual components (Figs.1,2). The XRD and TEM analysis confirms the formation of the alloy nanostructure and provides the detailed structural arrangements, with a narrow distribution of particle sizes in the range of 5~10 nm (Figs.34). X-ray photoelectron spectroscopy reveals the binding energies of Au and Fe in the state of the AuFe alloy nanoparticles. The magnetic characterization shows the superparamagnetic or soft ferromagnetic behavior (Fig.1) of the nanoparticles at room temperature, while the thermal response to different external fields was obtained from the M~T measurements in the FC and ZFC modes, respectively. The UV-vis spectra display the variation of the absorption bands at ~560nm with composition (Fig.2), which is characteristic of nanostructured gold. These AuFe nanoparticles are water soluble after thiolation.

Reference

[1] Hong-Ling Liu, Seung Pil Ko, Jun-Hua Wu, Myung-Hwa Jung, Ji Hyun Min, Ju Hun Lee, Boo Hyun An, Young Keun Kim, J. Magn. Magn. Mater. 310 (2007) e815.

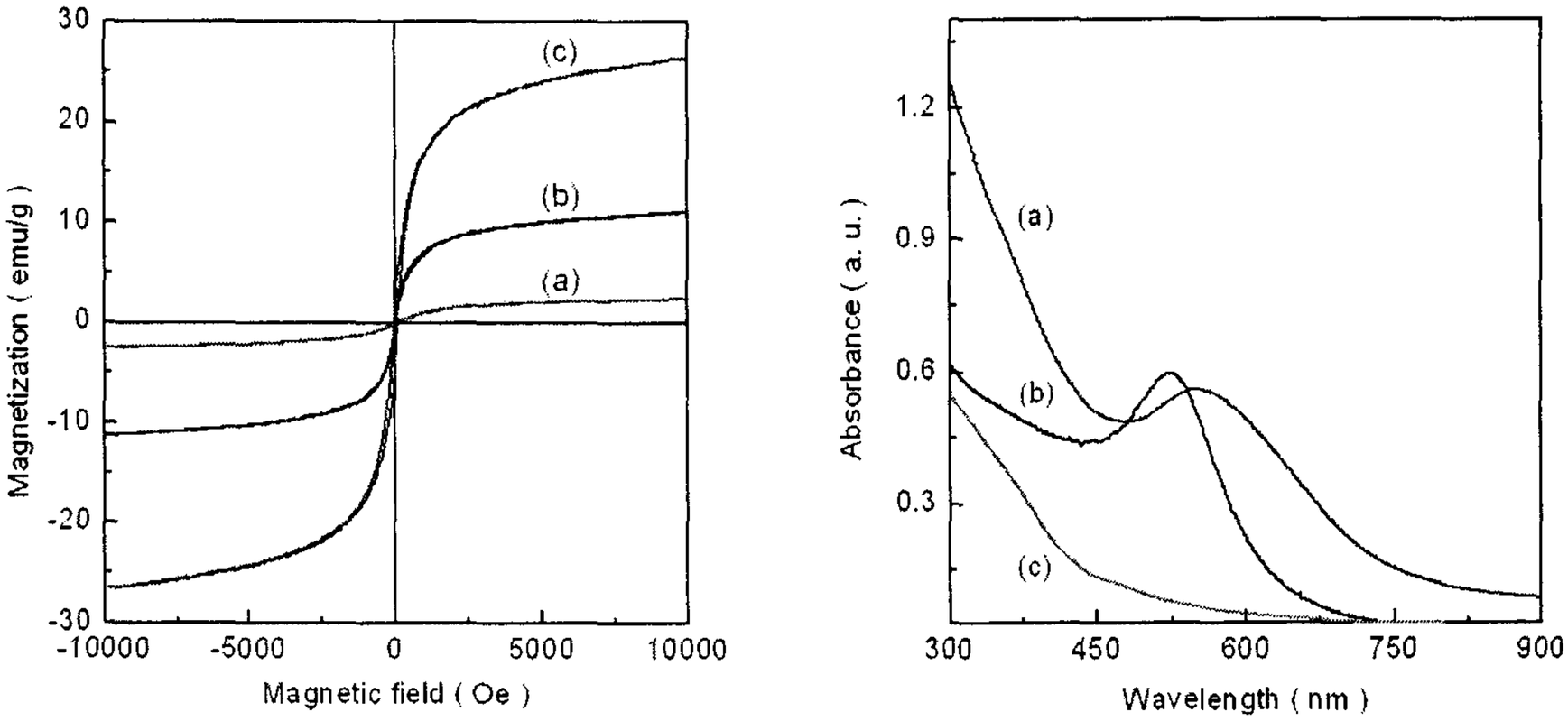

Fig. 1. M-H hysteresis loops of the AuFe nanoparticles with three compositions of (a) Au0.75Fe0.25, (b)Au0.5Fe0.5, and (c)Au0.25Fe0.75, respectively.

Fig. 2. UV-Vis absorption spectrum of the Au0.5Fe0.5 nanoparticles in hexane (a), compared to that of (b) Au and (c) Fe3O4 NPs.

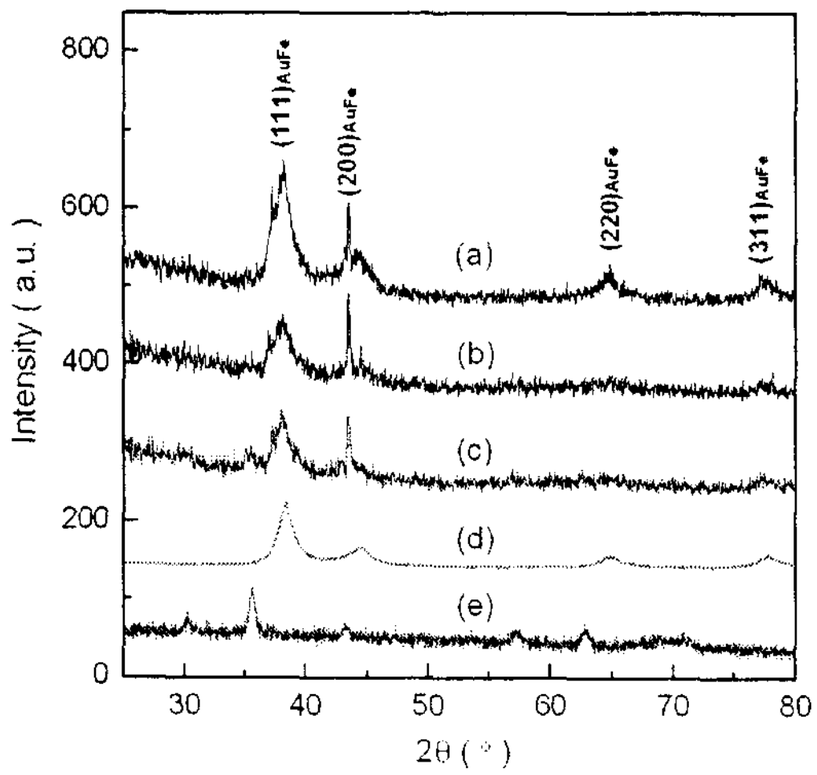

Fig. 3. XRD patterns of the AuFe nanoparticles with three compositions of (a) Au0.75Fe0.25, (b) Au0.5Fe0.5, and (c) Au0.25Fe0.75, respectively, in addition to (d) Au and (e) Fe3O4 obtained from the same way. The curves are shifted for clarity.

Fig. 4. HRTEM morphology of the AuFe nanoparticles with three compositions of (a) Au0.75Fe0.25, (b) Au0.5Fe0.5, and (c) Au0.25Fe0.75, respectively.