X-ray Magnetic Circular Dichroism Studied of Fe_3O_4 Magnetic Nanoparticles

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The design and synthesis of magnetite nanoparticles with controlled size has long been of scientific and technological interest. Some of the attractive properties reported are superparamagnetism, enhanced coercivity quantum tunneling of magnetization and giant magnetoresistance. Moreover, carried out to control the particle size and the size distribution during the synthesis of various nanosize materials become important because of their technological applications in modern industries. Most of these applications require the nanoparticles to be chemically stable, uniform in size and well dispersed in liquid media. Up to now, numerous works have been reported to prepare nanosized Fe_3O_4, such as: chemical precipitation in the presence of polyvinyl alcohol, chemical reduction of α-Fe_2O_3 and chemical coprecipitation, etc. Among these methods, the chemical coprecipitation is most promising one due to its simplicity and productivity.

There are several techniques to measure the magnetic properties of materials. Most of them are sensitive to the total magnetization of the measured sample. Unfortunately, these techniques cannot differentiate the contribution from different elements and the contribution from orbital and spin moments. In contrast, X-ray Magnetic Circular Dichroism (XMCD) is an element specific and a powerful tool for the measurement of local magnetization and the spin and orbital components.

In order to study magnetic nanoparticles by both a technological and theoretical interest connected with the possibility of developing a better understanding of magnetic phenomena related to size effects. Here, we report magnetic property measured by XMCD of pure Fe_3O_4 nanoparticles synthesized by chemical coprecipitation.

The Fe $L_{2,3}$-edge XAS and MCD spectra of nanosized Fe_3O_4 are plotted in Figure 1. It is well know that the MCD asymmetry ratio $(\sigma^+ - \sigma^-/\sigma^+ + \sigma^-)$ is proportional to the magnetic moment averaged over different sites, a quantitative estimation of the asymmetry ratio can give direct information on the Fe relative average moment. In Figure 2, the XMCD spectra of nanosized Fe_3O_4 and bulk Fe_3O_4 samples are plotted. The results show that the XMCD intensity of bulk Fe_3O_4 is higher than that of nanosized Fe_3O_4. It indicates that the average magnetic moment of nanosized Fe_3O_4 is smaller than that of bulk Fe_3O_4.

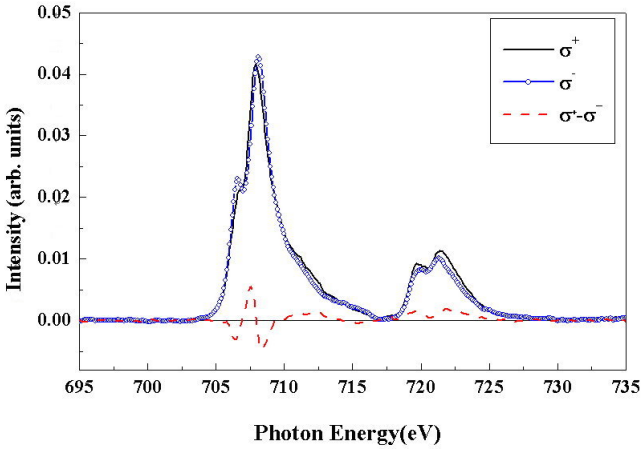

Figure 1. Fe $L_{2,3}$-edge XAS and MCD spectra of nanosized Fe_3O_4.

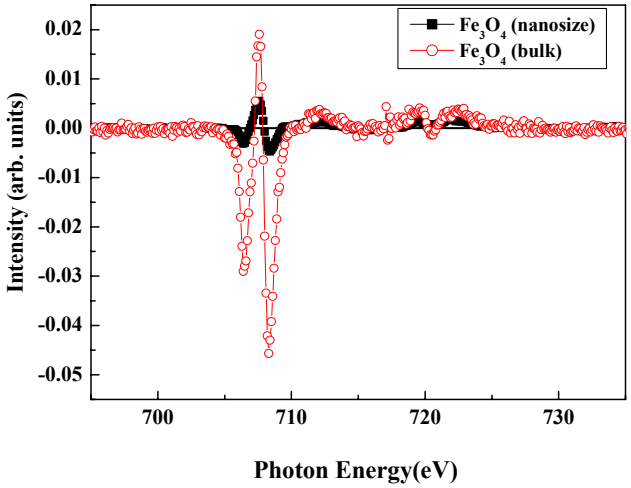

Figure 2. MCD spectra of nanosized Fe_3O_4 and bulk Fe_3O_4 samples.