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XMCD study of spin and orbital states of FePt nano-particles coated by SiO_2

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1 Introduction

$L1_0$ ordered FePt nano-particles coated by SiO_2 have a great attention as a material to be used in high density magnetic storage memory devices because this particles possesses a high magneto-crystalline anisotropy. The FePt nano-particles made by gas phase preparation method [1] have some problems to apply manufacturing process. Recently, on the other hand, FePt nano-particles coated with SiO_2 were found for practical realization and were investigated. FePt nanoparticles prepared by this method have a gigantic magnetic coercive force much larger than gas phase preparation. Since the orbital magnetic moment determines magneto-crystalline anisotropy, to obtain information about the orbital magnetic moment is important. In the present work, we have applied the XMCD technique to the SiO_2-coated FePt nanoparticles to characterize their magnetic properties.

2 Experimental conditions

FePt nano-particle samples were prepared by the wet chemical preparation method [2]. For the XMCD measurements, the nanoparticle samples were mounted on a sample holder using silver paste. After the preparation of the samples, they were kept in an Ar atmosphere in order to prevent oxidation until the XMCD measurements.

XAS and XMCD measurements were performed at the helical undulator beam line BL23SU of SPring-8. The highest applied magnetic field was 9 T. The measurements were performed under an ultra-high vacuum of ~4.8×10^{-9} Pa at room temperature (~300 K) with the total electron-yield (TEY) mode. The magnetic field dependence of the XMCD intensity at the peak of the Fe L_3 edge was measured in the range of -9 T ≤ H ≤ 9 T.

3 Results and discussion

Figures 1 (a) and (b) show the Fe 2p-3d XAS and XMCD spectra of FePt nano-particles, respectively. One can see Fe-oxide spectra overlapping on the high energy side of the main L_2 and L_3 XAS peaks. In XMCD spectrum in applied 9 T magnetic field, we have observed Fe^{3+} signal which is absent in the XMCD with 0 T magnetic field. This means that this peak is a paramagnetic component derived from Fe_2O_3. Since the samples were kept in Ar atmosphere to prevent oxidization just before the measurements, oxidization may have occurred between the SiO_2-coat and the Fe component. By applying optical sum rules [3, 4] to the measured XMCD spectrum, the ratio μ_L/μ_S is found to be 0.08, where μ_S and μ_L are the spin and orbital magnetic moments of Fe 3d electrons, respectively. Figure 2 shows hysteresis loops of the XMCD intensities at the Fe L_3 edge of the SiO_2-coated FePt nano-particle sample at room temperature. The magnetization measured by Fe L_3-edge XMCD was saturated around 6 T and the coercive force was as large as 1.7 T, consistent with the result of SQUID measurement [5].

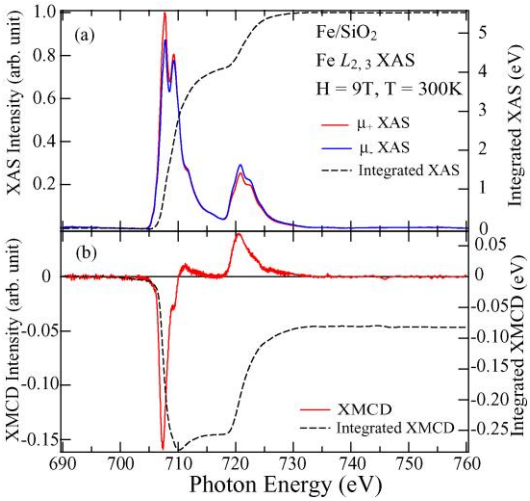

Figure 1 : (a) XAS spectra of Fe component in FePt nano-particles, (b) XMCD spectrum of Fe component at applied magnetic field 9 T.

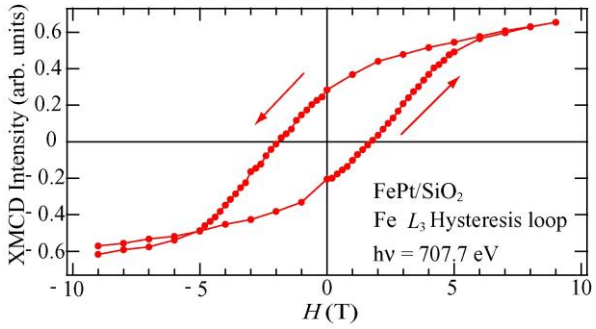

Figure 2 : Hysteresis loop of the XMCD intensities at the Fe L_3 edge of the SiO_2-coated FePt nano-particles.

References

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