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Characterizing the microscopic switching behaviour of CoPt nanoparticles with high resolution magnetic X-ray microscopy

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Magnetic nanoparticles are currently attracting significant physical and technological interest as being potential candidates for high density magnetic storage media [1-3]. However, a thorough understanding of characteristic magnetic properties on a microscopic length scale is inevitably for future developments. Of particular interest is the switching behaviour and the switching distribution of individual nanoparticles located in a dense packed array of neighboring elements.

We utilized analysis techniques based on X-ray magnetic circular dichroism to determine these properties in CoPt nanoparticle systems (Co 0.3nm/Pt 1nm)x8 + 1nm Pt capping layer) with particles sizes below 250nm.

Element-specific in-situ hysteresis loops of the Co component were derived from magnetic absorption spectroscopy at the Co L3 edge measured in transmission mode at BL4 at the Advanced Light Source in Berkeley CA [4], which clearly indicate the onset of magnetization reversal already at very small applied magnetic fields.

Detailed studies of the underlying microscopic switching behaviour were obtained by recording high resolution images with magnetic transmission X-ray microscopy (MTXM) [5] at the XM-1 beamline at the ALS, Berkeley CA. The lateral resolution provided by Fresnel zone optics can be as low as 13nm [6] and the field of view extends up to about 20µm, thus allowing to record a large set of nanoparticles under identical conditions, e.g. external magnetic field. We observe the flipping of individual magnetic particles and are able to derive the switching field distributions and the stochastic character of the magnetisation reversal process by analysing the obtained images by correlation techniques.

Comparing the MTXM results with Magnetic force microscopy results indicates the influence of the magnetic stray field of the tip to the switching of individual particles.

In future X-MCD based analytical tools will contribute significantly to the understanding of magnetic nanoparticles providing non-ambiguous element-specific information on the nanometer length and sub-ns time scale.

[1] S. Sun et al, *Science*, **287** (2000) 1989

[2] S. Anders et al, *J Appl Phys* **93** (2003) 7343

[3] MH Kryder, *DIGEST Joint [NA]PMRC 2003 IEEE Piscataway, NJ USA* (2003) 68

[4] AT Young et al, *Surface Review & Letters*, **9** (2000) 549

[5] P. Fischer, *Current Opinion in Solid State and Materials Science* **7** (2003) 173

[6] W. Chao et al, (2004) to be published