Imaging Magnetic Domains by X-Ray Spectro-Holography

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While holography has evolved to a powerful technique in the visible spectral range, it is difficult to apply at shorter wavelength as no intrinsically coherent (soft) x-ray laser is yet available as a light source. The progression from visible light towards shorter wavelength is motivated by the increase in spatial resolution that can be achieved. Of equal importance is the possibility to exploit special contrast mechanisms provided by scattering in resonance with transitions between electronic core and valence levels. We demonstrate magnetic imaging by x-ray spectro-holography, exploiting x-ray circular dichroism as a contrast mechanism. Images of magnetic domain patterns forming in thin film Co-Pt multilayers with perpendicular anisotropy are presented. The images are obtained by direct Fourier inversion of the scattering pattern, without the need of phase retrieval or an iterative computing process. Currently, we achieve a spatial resolution of 50 nm at an x-ray wavelength of 1.59 nm. [1] Holography at this wavelength is made possible by combining the sample with a nanostructured mask. An advantage of this approach is that there are no severe space constraints around the sample, making it easy to realize extreme sample conditions such as high magnetic fields or low/high temperature. Here, we present domain images in an applied magnetic field for several magnetic multilayer systems and discuss future opportunities for single shot imaging experiments at free electron x-ray lasers.

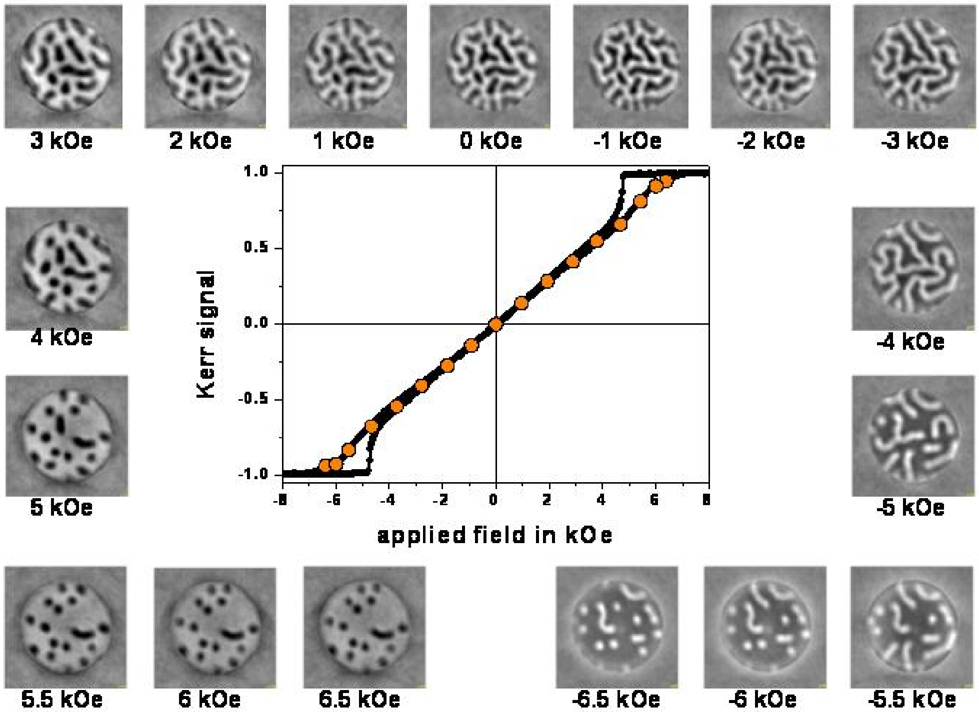

Figure 1: Spectro-Holography images of a reversal sequence during an external field sweep for a Co/Pt multilayer. The MOKE hysteresis loop of the sample is shown in the center.

Reference

[1] - S. Eisebitt, J. Lüning, W. F. Schlotter, M. Lörgen, O. Hellwig, W. Eberhardt, J. Stöhr, Lensless Imaging of Magnetic Nanostructures by X-ray Spectro-Holography, *Nature*, **432**, 885 (2004).