Imaging Magnetic Nanostructures by X-Ray 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 imaging of non-periodic objects by x-ray spectro-holography at 50 nm spatial resolution. Magnetic domain patterns forming in thin film Co-Pt multilayers with perpendicular anisotropy are imaged using x-ray magnetic circular dichroism contrast at 778 eV photon energy. The images are obtained by direct Fourier inversion of the coherent scattering pattern, without the need of phase retrieval or an iterative computing process. Holography at this wavelength was made possible by combining the sample with a nanostructured mask. [1] This approach is particularly valuable for future single shot and/or single molecule imaging experiments at free electron x-ray lasers. At such sources, the coherent x-ray flux will be sufficient to record a coherent x-ray diffraction snapshot using a single x-ray pulse with a duration of a few femtoseconds.

[1] Eisebitt S., Lüning J., Schlotter W. F., Lörgen M., Hellwig O., Eberhardt W., Stöhr J., *Nature*, 2004, **432**, 885.

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