Imaging Switching Behavior of Magnetic Nanostructures by resonant X-Ray Holography

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We report on magnetic imaging by x-ray spectro-holography. On the basis of a coherent scattering experiment, it is possible to image a specimen with high spatial resolution using a holographic approach.[1] A nanostructured mask makes it is possible to couple a reference beam to the object wave, thus allowing to solve the phase problem (and at the same time reducing the beamstop problem). We take advantage of multiple reference waves [2] and multiple objects [3] in a multiplexed experiment. An image is obtained directly by a Fourier transformation of the recorded scattering pattern, which constitutes a Fourier transform hologram. We exploit circular magnetic dichroism when scattering resonantly at the Co L edge in order to image the switching behavior of magnetic nanostructures with a spatial resolution of 40 nm.
We investigate the switching behavior and switching field distribution of magnetic multilayers on polystyrene spheres of 110 nm and 58 nm diameter. The magnetic caps on the spheres form exchange isolated magnetic islands with perpendicular anisotropy and are of interest for applications in magnetic data storage.[4] Magnetic contrast is generated by Co with an integrated thickness of 2.4 nm in the sample. The magnetic state of each nanosphere is imaged holographically as a function of applied field strength as well as of the direction of the applied field with respect to the anisotropy axis. On this basis, we draw conclusions on the microscopic switching mechanism and dipolar interactions between individual nanospheres, which are of importance in nanomagnetism and for data storage applications.

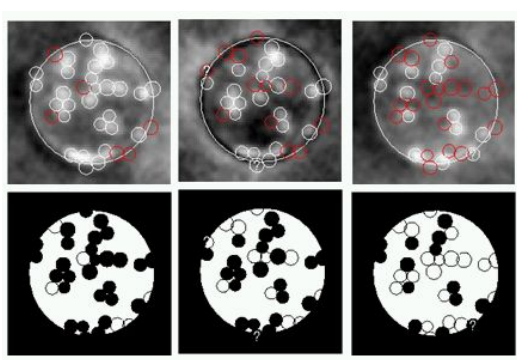

Figure 1. Example for the switching of 58 nm diameter spheres when the magnetic field is increased from 1.51 kOe to 2.16 kOe. From the magnetic image (top) we derive a model (bottom, inverted greyscale). The circular field of view is 500 nm in diameter.

[1] S. Eisebitt et *al*. *Nature*, **432**, 885 (2004).
[2] W. F. Schlotter et *al*., Applied Physics Letters **89**, 163112 (2006)
[3] W. F. Schlotter et *al*., in preparation. (see contribution of W. F. Schlotter)
[4] M. Albrecht et *al*., Nature Materials **4**, 203 (2005).