X-Ray Holography

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In x-ray holography, coherent scattering with short wavelength radiation ($\lambda \approx 1$ nm) is used to obtain a high resolution image of a specimen. To turn the coherent scattering pattern into a hologram, a suitable reference beam has to be coupled in. This is achieved by combining the sample with a nanofabricated x-ray mask. As a result, a Fourier Transform Hologram of the object can be recorded, which can be inverted into a high resolution image by a single Fourier transformation.[1]

By combining this lensless imaging approach with x-ray magnetic dichroism as a contrast mechanism, we are able to study the switching behavior of nanomagnets and thin magnetic films in external magnetic fields. Material science studies in the context of the development of patterned perpendicular magnetic storage media for high density recording are presented. The combination of high spatial resolution, specific contrast mechanisms (here: magnetic) and flexible sample environment (here: variable B,T) enables investigations of the structure-function relationship in nanoscale materials science. More complex object/reference structures allow multiplexed experiments and the introduction of geometrical time ramps in pump-probe experiments.[2,3]

A major motivation for femtosecond single-shot imaging at Free Electron X-ray Lasers is the hope to record a “movie” of a dynamic object with femtosecond time resolution and nanometer spatial resolution. As a complementary approach to time-delay holography,[4] we present proof-of-principle 2-beam experiments carried out at the FLASH free electron laser facility. Here, a soft x-ray split-and-delay unit in conjunction with a suitably designed Fourier Transform Holography mask is used to record two independent images of the same object at variable time delay between 15 fs and 15 ps, i.e. we take the step from a “still picture” to a “two frame movie”.[5]

References

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