PhD seminar:
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Title:

Ptychography and Full Field Imaging with a Crossed Multilayer Laue Lens Setup

Abstract:

Multilayer Laue Lenses (MLL) are a relatively new kind of x-ray optics. They use the phenomenon of diffraction to concentrate incoming light to a focus of sizes down to 5 nm with current geometries or further to 1 nm with improved geometries as predicted by theory [1].
We have fabricated several multilayer coatings using Magnetron sputter deposition with layer thicknesses according to the zone plate law. Thin slices were cut from the deposited multilayer stack and partly machined by Focused Ion Beam milling (FIB) to obtain lamellas with an overall thickness of several micrometer. In Laue geometry an incident plane wave illumination results in a line focus if one lamella is used; in a setup with perpendicularly crossed lenses a point focus is obtained.
We have deposited up to 53 µm of layers and tested the focusing performance of the lenses at the P06 beamline of the PETRAIII synchrotron in Hamburg. With ptychography [2], a coherent diffraction imaging technique, we obtained a phase image of our test sample in addition to the complex wave field of the lenses. This information can be used to characterize the quality of the lens in terms of layer stress and deposition drift rates.
Besides of focusing x-rays the lamellas can also be used as imaging lenses for full field imaging in laboratory x-ray microscopy. In comparison to the zone plates currently used for imaging in the microscope we have achieved a comparable resolution, efficiency and background. This is promising considering that full field imaging was achieved for the first time using Multilayer Laue Lenses and originally predicted not to work at all with reasonable efficiencies and without abberations [3]. Considering the possible improvements there is still significant potential for further development.

[1] H.C. Kang, et al. “Nanometer Linear Focusing of Hard X Rays by a Multilayer Laue Lens”, Phys. Rev. Lett. 96, 127401 2006

[2] A. Schropp, et al. “Non-destructive and quantitative imaging of a nano-structured microchip by ptychographic hard X-ray scanning microscopy”, Journal of Microscopy 241 (2010)

[3] J. Maser, et al. "Multilayer Laue Lenses as High-Resolution X-ray Optics", Proceedings of SPIE Vol. 5539 (SPIE, Bellingham, WA, 2004)

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