Fabrication, characterization and application of large aperture multilayer Laue lenses

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Multilayer Laue lenses are an emerging type of X-ray lenses in hard X-ray microscopy at photon energies of 8 keV and beyond. Their application is related to beneficial properties in terms of efficiency and focus quality in comparison to Fresnel zone plates. The total thickness of the multilayer stack equals the size of the aperture of the resulting X-ray lens. Thus, the fabrication of multilayers with a total thickness of > 50 µm consisting of currently up to 12500 individual layers with a defined lateral and depth gradient is showed. Individual lenses are manufactured with micromachining methods and optionally bended to enhance the diffraction efficiency. The final assembly to a compact lens device allows a convenient integration in scanning and full-field X-ray microscopy instruments. Extensive characterization is performed during manufacturing in advance of the final measurement of the focusing properties using synchrotron radiation. A main application is point or line focusing of synchrotron radiation to dimensions well below 50 nm. Various methods such as nano X-ray diffraction, X-ray fluorescence and ptychography benefit from the small and intense X-ray focus. The status of the integration to a full-field X-ray microscope with a laboratory X-ray source is shown as well.