Diffractive X-Ray Optics for Microscopy and Radiography Applications

C. David[1], *J. Vila Comamala*[2], *K. Jefimovs*[1], *T. Donath*[1], *C. Grünzweig*[1], *O. Bunk*[1], *and F. Pfeiffer*[1,3]

[1] Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland,
[2] Laboratori de Llum Sincrotró, E-08193 Bellaterra, Spain
[3] Ecole Polytechnique Federale de Lausanne, CH-1015 Lausanne, Switzerland.

We report on recent developments in the fabrication of diffractive x-ray optics and their application in microscopy and radiography experiments. These include Fresnel zone plates (FZPs) for full field transmission x-ray microscopy (TXM) and scnning transmission x-ray microscopy (STXM) applications in the soft and hard x-ray range: gold FZPs for the multi-keV range [1], silicon zone plates for high heat load applications at FEL sources [2], and beam shaping condensers to produce a square flat-top illumination in TXMs [3]. Moreover, a line doubling technique to produce ultra-high resolution FZPs has been developed [4]. These devices are capable of resolving 15nm lines and spaces in STXM mode.

In addition, an interferometric hard x-ray phase imaging technique is presented, which is based on diffraction gratings fabricated using microlithography techniques. Compared to other phase contrast imaging methods, the grating interferometer only has very moderate requirements in terms of coherence. It can accept a wide spectral band width, and virtually no spatial coherence is required when a third grating is placed close to the radiation source [5]. This makes it possible to use the method with standard x-ray tubes, which opens up a huge range of every-day applications such as medical imaging. In addition to phase contrast x-ray imaging, the scattering properties of the sample can be used for dark field x-ray imaging [6].

Moreover, phase contrast and dark field imaging experiments with other low-brilliance radiation sources are possible with grating based set-ups. We have developed the instrumentation to acquire neutron radiographies and tomographic reconstructions [7]. The method can be applied to visualize magnetic domain structures inside bulk ferromagnets.

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