Easily replicable large aperture Fresnel lenses of highly regular structure for the micro-focusing of hard x-rays

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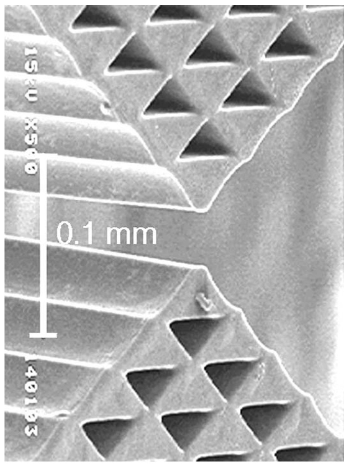
The object shown in the SEM picture shows the central part of a new refractive transmission lens for x-rays. This lens is composed of segments of almost identical shape, i.e. two large prisms, which are each composed of many smaller prisms or prism like objects of the same shape.



The parameters for the first prototypes of these lenses were adjusted for their production and replication by deep x-ray lithography (DXRL) in photo resists [1]. This results in focal length, which are very similar to those used in other concave refractive lenses for the focusing of x-rays. The lens belongs to the category of Fresnel lenses or kinoform lenses, as in it optically passive material, which will change the phase of the passing wave field by integer multiples of 2pi, has been removed. The average amount of the remaining absorbing material grows linearly with distance from the optical axis of the lens.

This contribution will discuss the limitation in the lens aperture due to the absorption and due to the state-of-the-art for the structure depth. The latter will have to match the lens aperture in a crossed configuration for bi-dimensional focusing. In addition the effect of the spherical abberations on the image size and the photon energy tunability will be discuss. The results of the latter discussion are applicable for all forms of Fresnel lenses.

The performance of the first lenses of this concept for 8 keV photon energy was:

- an image size of 2.8 microns could be measured for an expected image size of 1.75 microns with prism heights of 18.34 microns and rather careless lens alignment.
- a lens with a geometrical aperture of 1.5 mm showed an average refraction efficiency of 40%. This results in an effective aperture of 0.6 mm, which is identical to what can at best be achieved with linear concave lenses of the same focal length even if made in the less absorbing beryllium.
- structure depth of 0.4-0.6 mm, i.e. about 25 times the prism size, and 50% of the theoretically expected refraction efficiency can be achieved routinely.

[1] W. Jark et al, J. Synchrotron Rad. **11,** 386-392 (2004)