



Technology Offer

High resolution full material Fresnel Zone Plate array and process for its fabrication

File no.: MI-0104-5259-GÖ-IT

Max-Planck-Innovation GmbH
 Arnulfstr. 58
 80335 Munich
 Germany

Phone: +49 (89) 29 09 19 - 0
 Fax: +49 (89) 29 09 19 - 99
 info@max-planck-innovation.de
 www.max-planck-innovation.de



Background

X-ray microscopy has been shown to be an important imaging technology. The resolution of a microscope is limited by the wavelength of the used radiation. In comparison to visible light, X-rays provide the advantage of a shorter wavelength, potentially allowing higher resolutions. However, refraction or reflection of X-rays by conventional lenses is very limited. Thus, the diffractive Fresnel zone plates have been established as the most popular and successful devices for focusing X-rays, especially in the soft X-ray energies. A (full material) Fresnel Zone Plate is a diffractive lens, composed of multilayers of at least two materials to act as the zones of the FZP.

Contact
 Gökçe Özyurt
 Phone: +49 (89) 29 09 19 - 18
 oezyurt@max-planck-innovation.de

Technology

We fabricate our multilayer Fresnel zone plates (ML-FZPs) by depositing alternating layers over focused ion beam (FIB) milled micro pillars or over glass fibers by using atomic layer deposition (ALD) technique. We then slice the deposited micro pillars by using the FIB again. This method allows to fabricate FZPs having outermost zone widths as small as 5 nm with extremely high aspect ratios compared to the FZPs fabricated by lithography techniques.

The micro pillar arrays can be fabricated with the desired tapering angle *via* the Plasma FIB, and allows ML-FZPs to be fabricated with zones tilted to the Bragg angle, paving the way for high efficient focusing to sub 10nm resolution.

Patent Information:

EP 3 282 294 B1 valid in DE, FR, GB
 Granted in China: ZL 2017 8 0049606 6
 Granted in Japan: Patent Nr. 6758480

Advantages

	Conventional Sputter Sliced	ALD ML-FZP
High Aspect Ratio	YES	YES
High Throughput	One FZP at a time	YES
Need for Rotation	YES	No
FZP Arrays	No	YES
Various Tilt angles	One angle at a time	YES

Unlimited number of FZP's can be fabricated from a single deposition

ALD is very conformal, allowing FZP arrays to be fabricated

With the PE-FIB, the tapering angles of micro-pillars can be controlled

Advanced Nano Fabrication

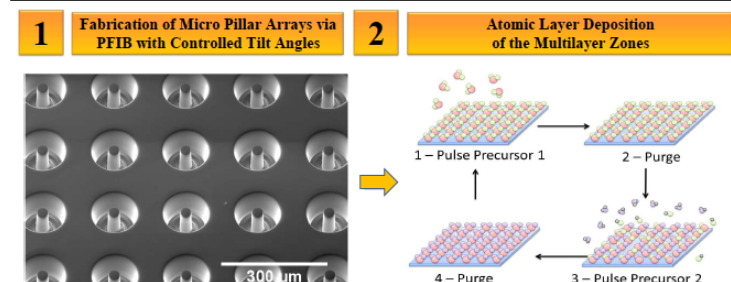


Fig 1. An array of micro-pillars fabricated via a Plasma Focused Ion Beam System

Fig 2. Atomic layer deposition complementary cycles

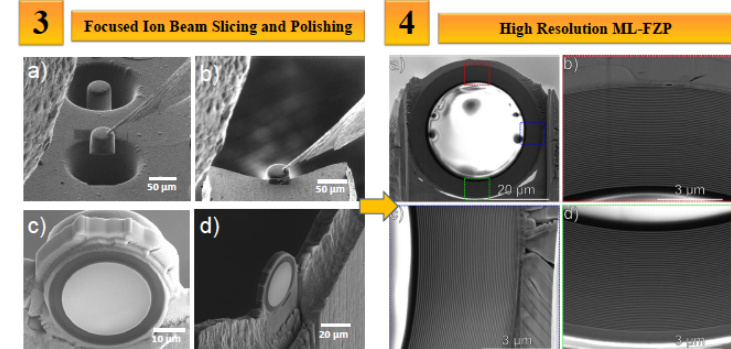


Fig 3. Focused ion beam slicing, transfer of the ML-FZP on a TEM Grid and surface polishing

*Multilayer Fresnel zone plates for high energy radiation resolve 21 nm features at 1.2 keV, Optics Express, 22, 18440-18453.

Fig 4. SEM images showing the zones of the multilayer