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Optimisation of Aspect-Ratio-Limited Zone Plates

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Fresnel zone plates are widely used for nanofocusing in x-ray microscopy. The focusing performance is described in terms of the resolution, related to the width of the smallest outermost zones, and the efficiency, governed by the thickness of the zones and therefore the amount of phase shift imparted onto the x-ray beam. The ratio of zone thickness to width, or "aspect ratio,"is limited in all methods of zone plate fabrication, requiring compromises between efficiency and resolution.

We have developed a new zone plate design method [1] which optimizes focusing efficiency within a set of practical constraints. This phasor-based method is used to optimize - subject to a maximum aspect ratio constraint –the efficiency of binary, multilevel, and kinoform zone plates. A truncated zone plate profile is proposed, which focuses more efficiently than binary and kinoform zone plates, but with considerably higher manufacturability.

The approach is demonstrated through measurements of lenses manufactured by focused ion beam milling in gold. Relative efficiency was validated at a synchrotron hard x-ray beamline. Our phasor method provides rapid design optimization, producing the ultimate lens designs for a given manufacturing limit, and it is generalizable to incorporate any fabrication tolerances such as roughness, zone displacements, and zone wall inclination.

[1] C. M. Kewish, S. Gorelick, D. M. Paganin, M. D. de Jonge, Optimum design of aspect ratio limited x-ray zone plates. Optica 11(2), pp 251-262 (2024).

I plan to submit also conference proceedings

Yes

Primary authors: Dr KEWISH, Cameron (Australian Synchrotron - ANSTO); Prof. PAGANIN, David (Monash University); DE JONGE, Martin (Australian Synchrotron - ANSTO); Dr GORELICK, Sergey (Monash University)

Presenter: DE JONGE, Martin (Australian Synchrotron - ANSTO)

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