

## **BREAKING THE 10NM NANOFOCUS SPOT SIZE BARRIER WITH NEW APPROACHES FOR FRESNEL ZONE PLATES**

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Fresnel zone plates have been in routine use for focusing of x-rays for more than two decades. As diffractive elements they elegantly circumvent the problem of focusing x-rays by means of refraction. Due to the short wavelength of x-ray radiation, the ultimate resolution limit in imaging and scanning applications should be at or below the nm range if lens fabrication would not run against engineering limits in nanofabrication. Resolution below 20nm has been reported in the literature already utilizing novel fabrication approaches that overcome the limit of traditional fabrication methods.

To break the 10nm barrier for zone plate based focusing, several approaches are being pursued. In particular frequency doubled zone plates based on atomic layer deposition technology, and multi-step zone plates operating in higher diffraction orders are promising techniques that in principle should be able to achieve resolutions in the single digit nanometer range. Both methods address also the issue of keeping a practical focusing efficiency through adequate zone height or optimization of higher order efficiency.

Drivers for these high-resolution optics are soft and hard x-ray microscopy techniques. At resolutions below 10nm, new important application areas open up. For example the mapping of trace elements and markers in single cells and the cell nucleus at relevant length scales.