



Experiment title: Comparison of zone plates generated by different European groups	Experiment number: MI-307
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Beamline: ID21	Date of experiment: from: 29/3/99 to: 06/04/99	Date of report: Feb, 25, 2000
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Report:

The following description of the experiment is the abstract of a publication which as a result of the experiment MI-307 published in *Nature*, **401**, 895 (1999)

by *E. di Fabrizio, F. Romanato, M. Gentili, S. Cabrini, B. Kaulich, R. Barrett, and J. Susini*, entitled

High efficiency multilevel zone plates for keV X-rays

Abstract

The development of high brilliance X-ray sources coupled with advances in manufacturing technologies has led to significant improvements in submicrometer probes for spectroscopy, diffraction and imaging applications. The generation of small beam spot sizes is commonly based on three principles [1]: total reflection (as used in optical elements involving mirrors or capillaries), refraction (such as in refractive lenses [2]) and diffraction. The latter effect is employed in Bragg-Fresnel or Soret lenses, commonly known as Fresnel zone plate lenses. These lenses currently give the best spatial resolution, but are traditionally limited by their efficiency. Here we report the fabrication of high-efficiency, high-contrast gold and nickel multistep (quaternary) Fresnel zone plates using electron-beam lithography. We achieve a

maximum efficiency of 55% for the nickel plate at 7 keV. In addition to their high efficiency, the lenses offer the advantages of low background signal and effective reduction of unwanted diffraction orders. We anticipate that these lenses should have a significant impact on techniques such as microscopy [3], micro-fluorescence [4] and micro-diffraction [5], which requires medium resolution (500nm – 100nm) and high flux at fixed energies.

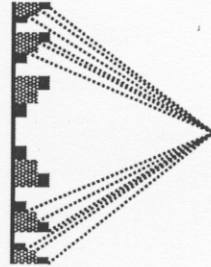
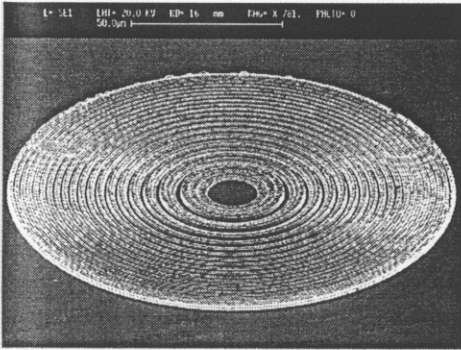


Fig.1: Left: SEM image of a quaternary Fresnel zone plate. The geometrical characteristics designed for 8 keV are: focal length of 1m, diameter of 150 μ m, number of levels is 4, and the outermost zone width of the fourth level is 500nm.

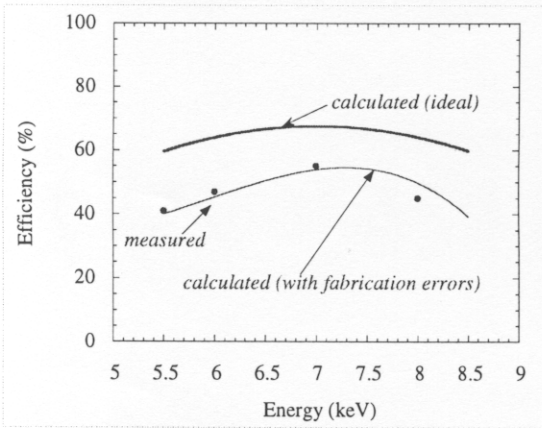


Fig.2: Theoretical and experimental efficiency of a Fresnel zone plate versus photon energy for the quaternary Ni zone plate. The difference is attributed to fabrication errors, such as electroplating growth, line-width errors and alignment errors

References:

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 [2] A. Snigirev, V. Kohn, I. Snigireva, and B. Lengeler, Nature **384**, 49 (1996)
 [3] J. Kirz, C.Jacobsen, and M. Howells, Q.Rev.Biophys. **28**, 33 (1995)
 [4] J. Wang, Phys.Rev.Lett. **80**, 1110 (1998)
 [5] W.Rodrigues et.al, in Proc. SRI (1997)