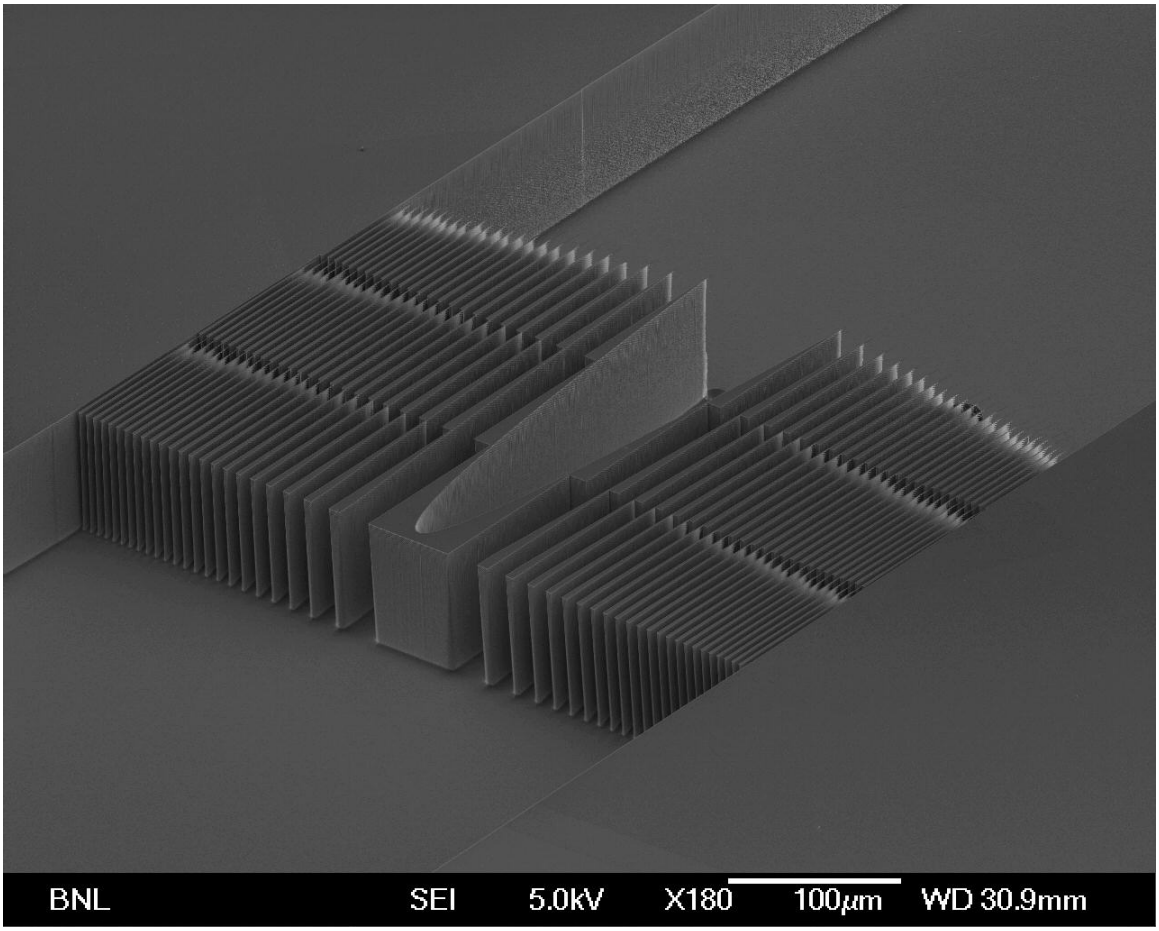
Fabrication of silicon kinoform lenses for hard X-ray focusing by electron beam lithography and deep reactive ion etching

Aaron Stein
Center for Functional Nanomaterials, Brookhaven National Laboratory, Upton, NY 11973
Kenneth Evans-Lutterodt
National Synchrotron Light Source, Brookhaven National Laboratory, Upton, NY 11973
Ashley Taylor
Alcatel-Lucent, 600 Mountain Ave, Murray Hill, NJ, 07974

The focusing of sub-nanometer wavelength x rays is limited by our ability to fabricate high quality optics. In general, the resolution is of the order of the smallest feature of the optic, so nanometer spot sizes are extremely difficult to achieve with lenses made by traditional fabrication methods. In addition, gains in resolution for a given lithography limit are often made at a sacrifice of focusing efficiency. Kinoform lenses offer a compromise position and point to a path for nanometer spots without a serious loss in x-ray flux[1]. Fabrication of these lenses is made easier by using higher order focusing and larger features. By combining 100 keV electron beam lithography and deep reactive ion etching we have fabricated cylindrical kinoform lenses in silicon. These lenses can be used in a crossed-pair to produce a 2-D focus, but to maintain a large aperture and high resolution this requires etch depths of up to 100 microns. Such large etch depths require careful consideration of lens design – feature sizes and densities can be changed with some latitude in the kinoform lens pattern without affecting the lens performance. Multiple lenses are fabricated in serial stacks to increase the resolution and provide a path forward to nanometer resolution. Fabrication and experimental results are presented.

[1] K. Evans-Lutterodt, J. M. Ablett, A. Stein, et al., Optics Express, **11**, 919 (2003)


BNL
SEI
5.0kV
X180
100µm
WD 30.9mm