Abstract No. Evan0596

Fabrication and Focussing of a Linear Bragg-Fresnel Lens

K.Evans-Lutterodt,A.Stein,D.Tennant,F.Klemens,L.Ocola,C.Y.Kim, (Agere Systems, SUNY-SB, Lucent Technologies)

Beamline(s): X16C

Introduction: In the pursuit of high quality focussing optical elements for hard X-rays, a wide variety of optical elements have been evaluated. Unlike photons with lower energies, hard X-ray photons can be perfectly reflected from a crystalline lattice. In order to take advantage of this alternative optical channel we have fabricated and tested a linear Bragg-Fresnel lens in single crystal silicon. A typical optical amplitude zone plate has a transmission profile such that alternate Fresnel zones that interfere constructively at the focal point are allowed to pass through the zone plate, and the destructively interfering zones are blocked. Usually the functional form is of the form $x(n)=\sqrt{(Focal\_Length*Wavelength*n)}$, where n is the zone number. A Bragg-Fresnel lens simply writes this profile on a single crystal material; one has both Fresnel interference and Bragg diffraction.

Methods and Materials: Using planar micro-electronics technology we have fabricated Bragg-Fresnel lenses for hard X-rays in single crystal silicon. A linear Fresnel zone profile is transferred to a resist coating of UV113, using a JEOL electron beam writer (JBX-9300FS). The resist profile is subsequently transferred to a 500nm thick oxide hard mask, using an AMAT 5200 magnetically enhanced reactive ion etching tool, with an EMAX plasma source.

Results: Shown below in Figure 1 is a cross-section of the physical implementation of Bragg-Fresnel optic. In Figure 2 we show a typical knife edge scan, with a sharp focussed spot and a broad un-focussed background from the unpatterned silicon below the optic, and from the zero order of the zone plate.

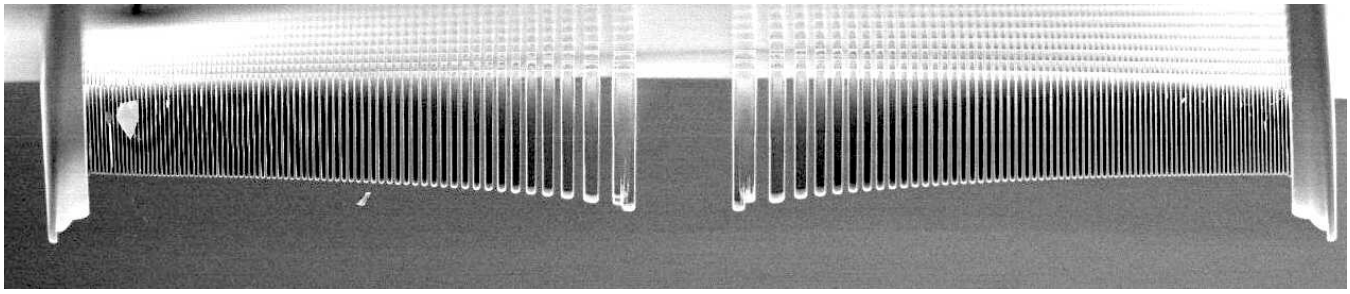

Figure 1: Side view of Linear Bragg-Fresnel optic, showing Fresnel profile etched into crystalline silicon.

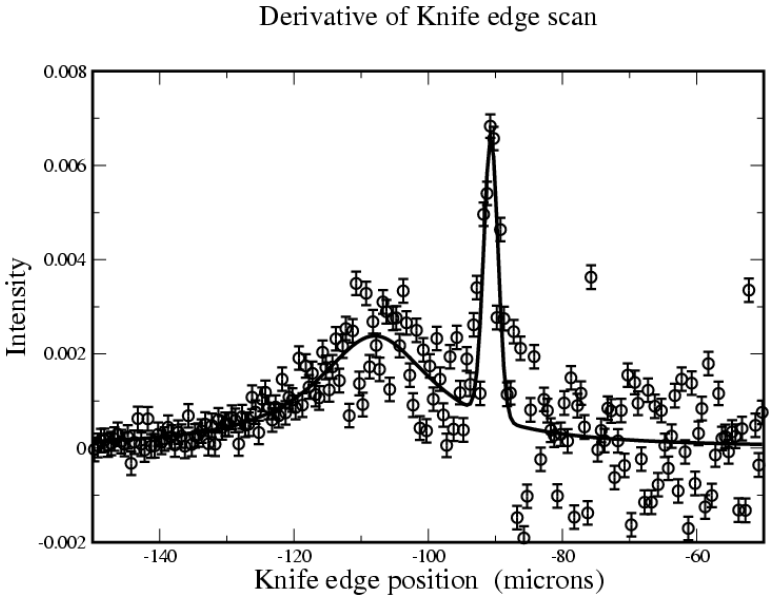

Figure 2: A Fit of a typical derivative of a knife edge. FWHM of the sharp component is 2.1 microns.