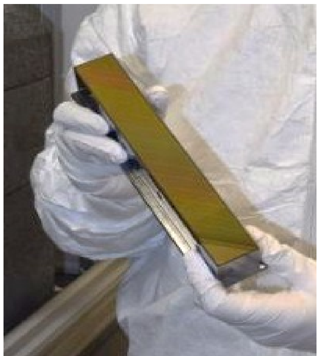
Free Electron Laser Applications



VLS DIFFRACTION GRATINGS for FEL Applications

Inprentus manufactures blazed diffraction gratings for x-ray and ultraviolet applications using a nano-scale, contact-mode lithography technique, a method of controlled mechanical deformation of metallic surfaces. This technology is particularly suited to x-ray and UV diffractive optics in which features must be shaped with 0.1 degree angular precision and positioned with nanometer precision over distances of tens of centimeters.

Mechanically Ruled VLS Blazed Diffraction Gratings

SPECIFICATIONS

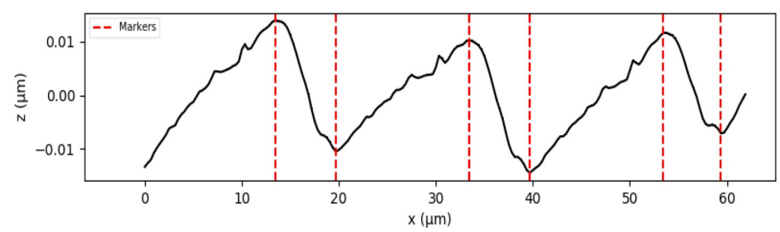
See Standard Diffraction Grating datasheet for other specifications

Parameter	Capability Range
Resolving power (λ/δλ):	Up to 30,000, over 30,000 at best effort
Blaze angle:	As low as 0.1°
Line Density:	50 - 5000 lines per mm
VLS law:	$N(w) = a_0 + a_1 w + a_2 w^2 + a_3 w^3$
Substrates:	Planar or curved single crystal silicon or fused silica
Dimensions (clear Aperature):	Up to 500mm long x up to 200mm wide
Coating:	Ti or Cr adhesion layer, Au ruling layer
Overcoating:	Ni, B_4C, Pt, etc. available through contracting of 3rd party vendors
Delivery:	Subject to project specifications
Warranty:	12 months after delivery

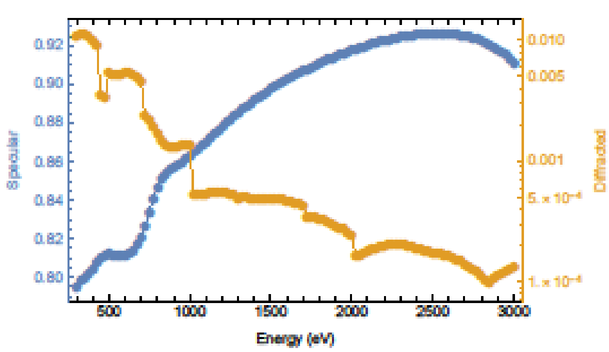
Blaze Angle Profiles

Ultra low blaze angles improve efficiency and can be manufactured by Inprentus.

Right: A single unsmoothed AFM trace of a 50 lines/mm grating with a blaze angle of 0.1°.



FEL Diagnostic Gratings



Diagnostic gratings can be custom designed to meet the needs of any FEL application.

Using the spectral reflection of the coated grating and various diffracted orders of the grating, the majority of photons may be passed downstream to beamlines, with a small fraction being directed into a spectrometer for in-situ diagnostics of pulse trains generated by the laser.

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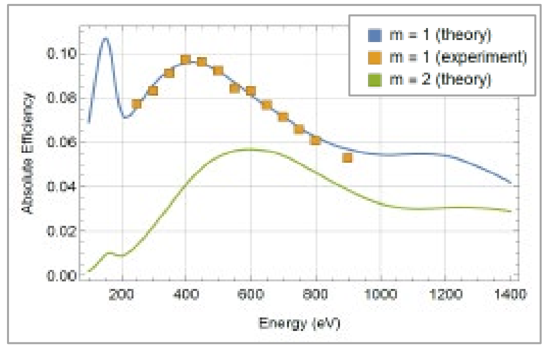
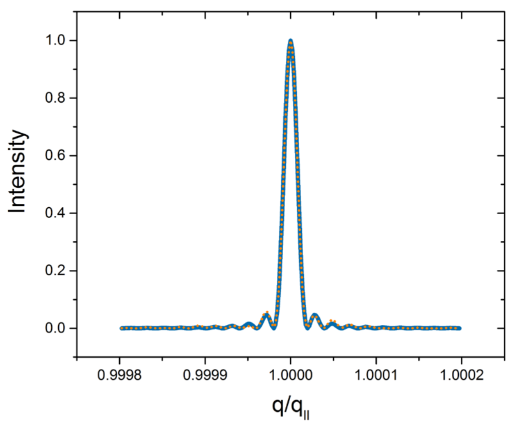
Efficiency Simulations

The 1st order diffraction of an Inprentus grating was measured and compared to Inprentus efficiency simulations. Efficiency simulations were conducted using real AFM data from blaze angle characterizations.

Inprentus simulation services are available with all grating purchases and provide reliable predictions of in-beamline grating efficiency.

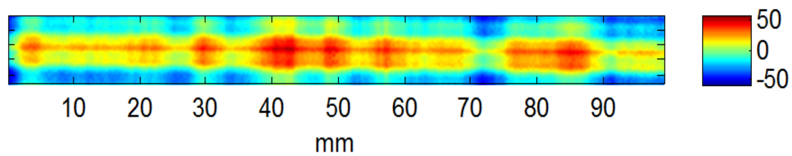


Resolving Power



Left: Resolution function, R(q), reconstructed from the Fizeau data below, showing a resolving power of E/ΔE = 50,400

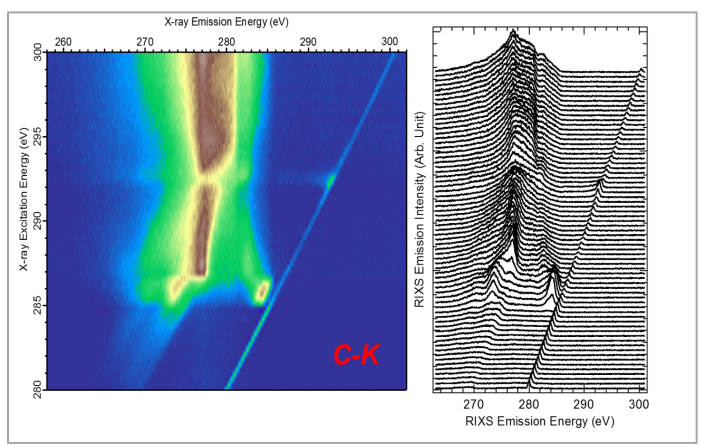
Bottom: Fizeau interferometry measurement in Littrow geometry of a uniform (non-VLS) 500/mm grating, taken by Brookhaven National Laboratory. The “height” in this image is a measure of the line density, showing the local variations.



Experimental Results from RIXS Applications

Right: Resonant Inelastic X-ray Scattering (RIXS) data from Beamline 8.0.1 at the Advanced Light Source at Lawrence Berkeley National Laboratory. The inclusion of an Inprentus grating into the RIXs endstation at Beamline 8.0.1 greatly enhanced the throughput of the experiment and increased the efficiency of data acquisition.

Related Publication: “High-efficiency in situ iRIXS endstation at the ALS” Qiao et al., Review of Scientific Instruments 88, 033106 (2017)



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