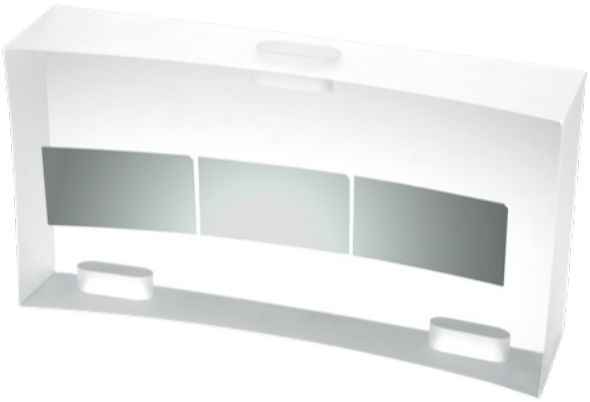
Inradoptics
A Luxium Solutions Company

X-ray Monochromators



X-ray monochromator featuring tiled silicon crystals.

OVERVIEW

X-ray monochromators, a type of bent single crystal component, efficiently focus x-ray emissions. The properties of bent crystal have been known and used for many years for focusing and analyzing x-rays. Fundamentally, these optics work by diffracting x-rays that satisfy the Bragg condition,

$$n \lambda = 2 d \sin (\theta_B)$$

where n is an integer, λ is the wavelength, d is the spacing between adjacent crystal lattice planes, and θ_B is the Bragg angle referenced to the plane of the crystal.

A variety of 2d spacings suitable for diffracting x-rays of different energies are attainable by varying the crystal orientation and diffraction orders. By bending the crystal planes in two directions to form a toroidal surface, it is possible to focus in both the sagittal and tangential directions with minimal aberration. Applications for these assemblies include high energy-resolution analyzers for synchrotron beamlines, analytical chemistry instruments, and spectroscopy and imaging of hot dense plasmas—most commonly for target diagnostics at nuclear fusion research facilities.

FEATURES

- Optically contacted crystals guarantee no outgassing
- Precision polished curvatures with low slope error and highly conformal crystals
- Crystal orientation verified to < 2 arcsec
- Dislocation, strain, and subsurface damage identified and rejected via x-ray topography

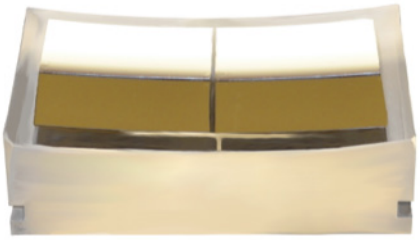
ADVANTAGES

- Vacuum compatibility
- Small spot sizes
- Efficient diffraction and high x-ray flux
- Uniform diffraction intensity profiles

FABRICATION & METROLOGY

Modern crystal growth techniques have enabled the growth of ultra-high purity and low dislocation single crystal materials, in particular silicon, germanium, and quartz. Inrad Optics employs x-ray imaging metrology to verify the quality of crystals used in x-ray assemblies and orients crystals to specified crystallographic planes to arcsecond precision. High-quality crystals, typically thinned to less than 100 µm, are readily bent and affixed to the shape of a precision polished backing.

Thinned crystals when optically contacted to curved backings conform tightly to the polished surface's curvature. As such, the x-ray focusing accuracy of the finished optic is far less susceptible to error introduced by the assembly process than other methods. Using proprietary optical polishing techniques and interferometric verification of the backing irregularity and slope error, Inrad Optics can ensure high performance x-ray monochromators.



Germanium (422) crystals, 35x60mm each, tiled on an ellipsoidal backing suitable for a 500mm Rowland circle geometry

Large single crystals can undergo excessive deformation when bent to a tight radius. To achieve large area coverage without the accompanying lattice distortion, a set of smaller crystals can be tiled onto the backing. Inrad Optics has developed specialized processing techniques which make it possible to produce these multi-crystal mosaics with excellent orientation accuracy.

ORDERING INFORMATION & SPECIFICATIONS

All toroidal and spherical x-ray crystals are manufactured at Inrad Optics according to a customer-supplied print or detailed specifications. Many different sizes, geometries, and specifications are possible.

SPECIFICATIONS	
Diffraction Crystals	Quartz, Silicon, Germanium, Lithium Niobate, InAs, KAP, and others on request
Surface Shapes	Toroidal, ellipsoidal, aspheric, cylindrical, conical, and spherical
Substrate Materials	N-BK7, Pyrex, and Aluminium
Assembly Dimensions	Diameters up to 250 mm
Assembly Features	Notches, grooves, and inserts for easy integration and alignment
Orientation Accuracy	Absolute to ± 10 arcsec ; Relative to ± 2 arcsec
Slope Error	To λ/4 per inch @ 633 nm
Radius Tolerance	Accurate to within 1%, Rv/Rh ratio controlled for toroids to several decimal places.

For more information or to speak with a sales engineer about your application's requirements, contact us at sales@inradoptics.com or call at 201-767-1910

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