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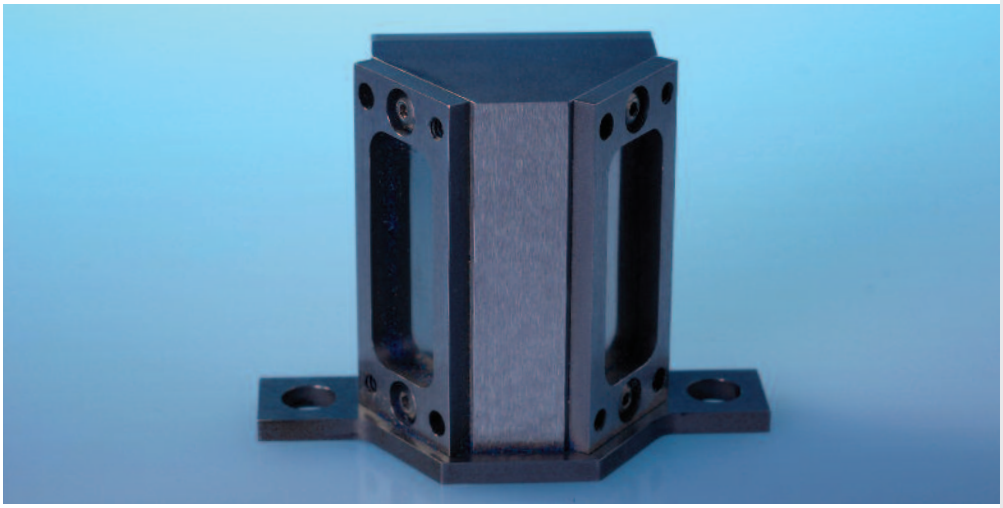
Doubly Curved Crystals

FOR MONOCHROMATIC MICRO X-RAY FLUORESCENCE AND X-RAY DIFFRACTION



Improved Performance with DCC Optics

Highly monochromatic X-ray beams focused in three dimensions can be obtained by using Doubly Curved Crystals (DCCs). Crystals of mica, graphite, Si, Ge, and others are used for an energy range of 1.5 to 58.KeV. Crystal optics reflects X-rays based on Bragg diffraction. The DCC accurately images micron-sized and large X-ray point sources.

Features:

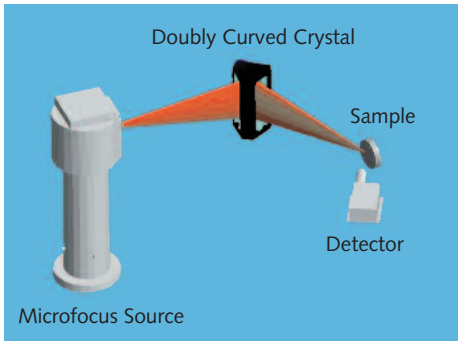
- 3-Dimensional point-to-point focusing of X-ray
- Asymmetric focusing magnification
- Highly monochromatic beam
- Large capture angle
- High flux density gain
- High angular uniformity of beam
- High spectral purity

Benefits:

- Extremely low background
- High detection sensitivity
- Detection limits in ppb range
- Large working distance
- Rapid data collection

Applications:

- Single crystal XRD
- Powder XRD
- Monochromatic µ-XRF
  - Evaluation of small features
  - Small particle analysis
- X-ray reflectometry (Metrology)
- Total reflection X-ray fluorescence
- Imaging: offers good P/B ratio to improve contrast for medical applications



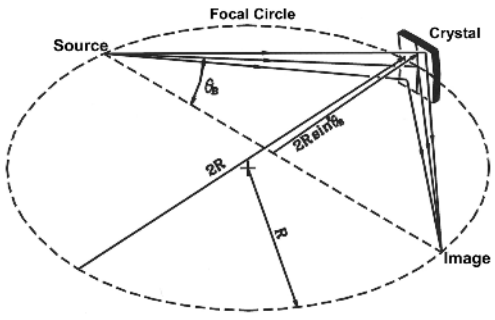
Typical flux and spot sizes

High-power rotating-anode sources:

- **Flux: 1x10^{11} photons per second at the spot**
- **Spot size: ~150µm x 150µm**

Microfocus sources:

- **50W**
- **Flux: 1x10^{9} photons per second at the spot**
- **Spot size: from 20µm up to 150µm (equivalent to source size)**

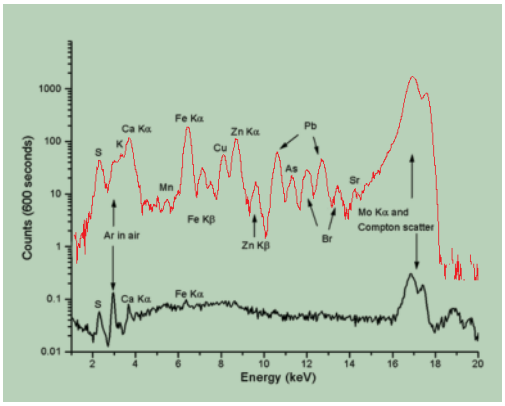


XRF and XRD with DCC Optics

Custom Solutions. In XRF applications, DCC offers intense monochromatic beam resulting in superior signal-to-noise ratio, more than two orders of magnitude higher than those provided by standard XRF technique. In diffraction applications, DCC optics provide incident beam with higher spectral purity e.g. Cu Ka/Kb>1000 and and Mo Ka/Kb >1000 enabling simplified diffraction spectra for qualitative analysis. Below are typical examples of DCC optics. XOS can customize DCC optics based on application requirements.

Table 1: Examples of Different DCC Optics

Focusing E (keV)	Bragg Angle (degree)	Focal Length (mm)	Collection Solid Angle (sr.)	Efficiency	Focusing Spot (µm)
2.3	55	100-150	0.1	5%	300
4.5	25	100-150	0.05	5%	300
5.4	20	100-150	0.05	5%	100-300
8	14	100-200	0.01-0.02	10%	50-300
17.5	10	150-200	0.01	10%	50-300
20.2	9	150-200	0.01	10%	80-300
22	8	170-250	0.01	10%	100-300



Pinhole, 50 micron diameter
DCC optic, 50 micron focal spot

Figure 1. Monochromatic Micro XRF

Comparison of a Mo DCC and a pinhole for elemental analysis of concentrated air particulates. Mo excitation (40kV, 20W, 200s).

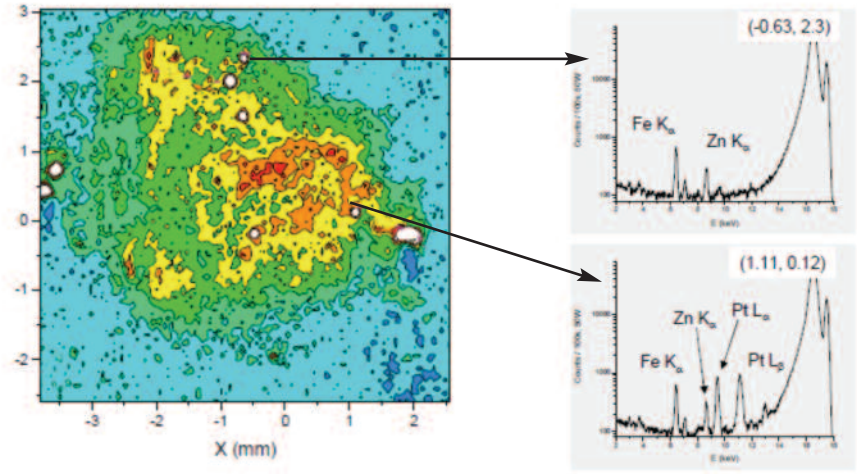


Figure 2. Tissue Mapping

Mapping of bioessential metal distributions in tissue samples for diagnosis of health disorders. Figure shows Neurodegenerative disease Fe map. Mo excitation (50Kv, 1mA, 60µm steps, 25 seconds per step)

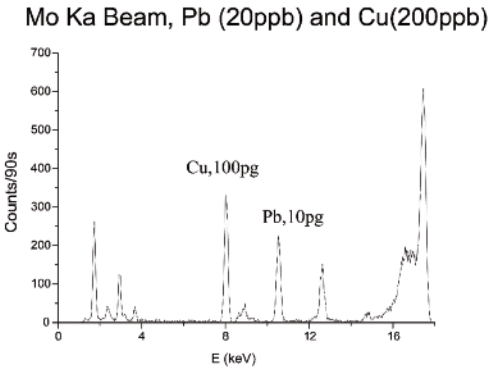
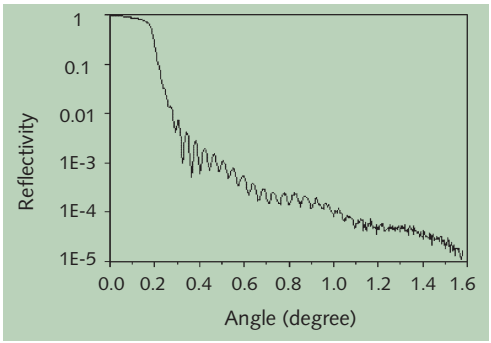
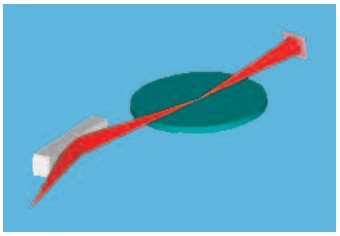


Figure 3. Total Reflection X-ray Fluorescence (TXRF)

Spectrum of a residue on the surface of a silicon wafer, showing 10pg Pb detection using Mo Kα excitation (50 kV, 50W, 90s, 1mA).





Schematic diagram of XRR geometry.

Figure 4. X-ray Reflectometry (XRR)

XRR data for 800Å TiN film on Si wafer using Tungsten L line. Tungsten source with 4µm spot source (3kV, 3.5W, 0.1mA, 100s).

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