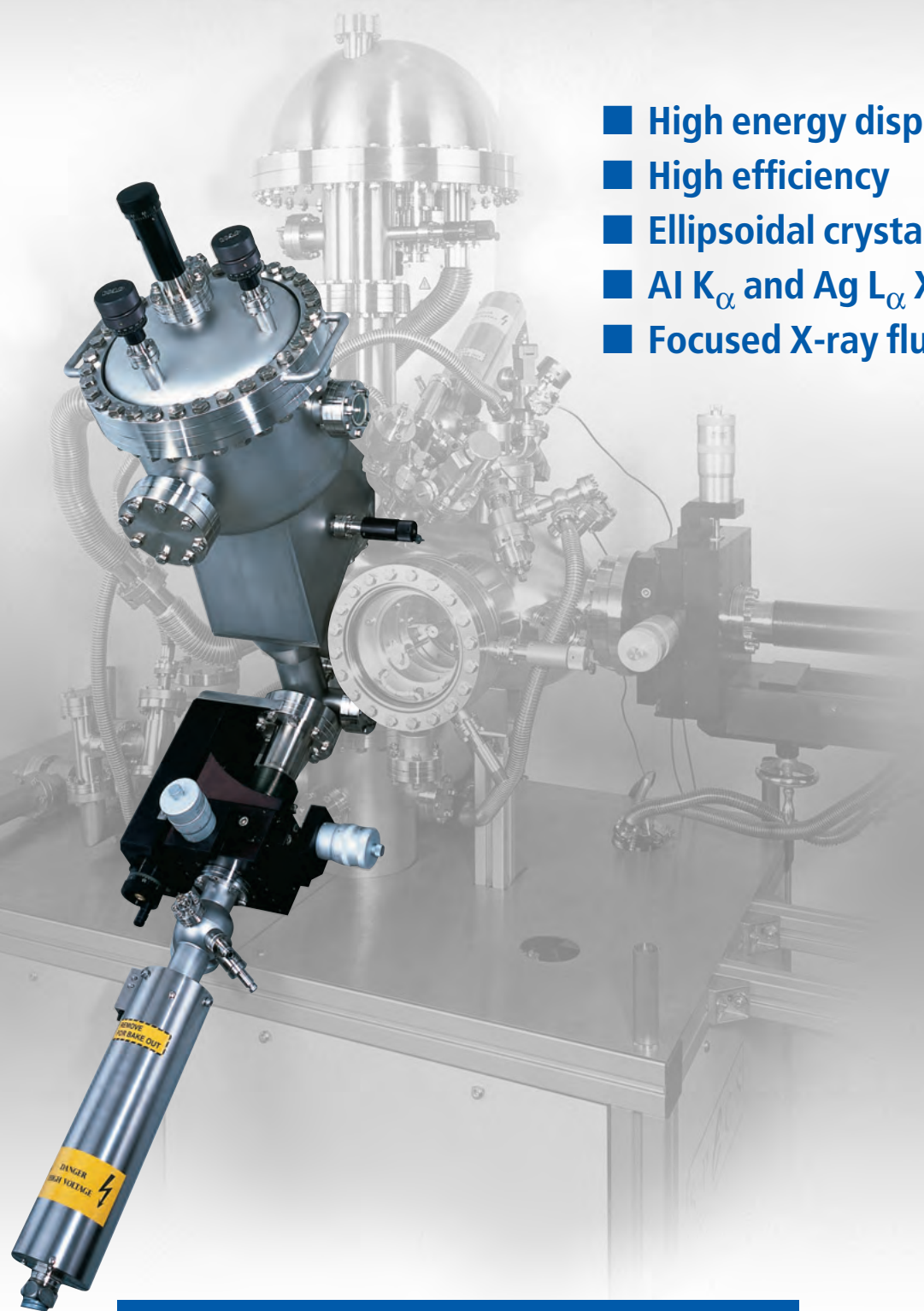


COMPONENTS FOR SURFACE ANALYSIS

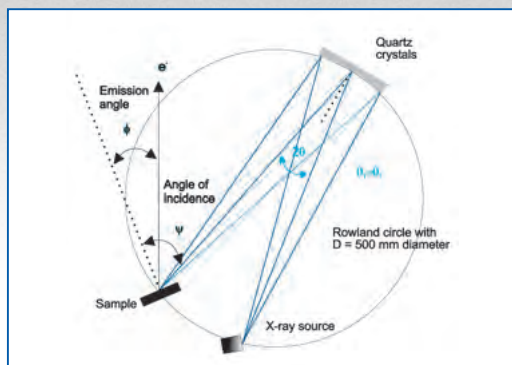
X-ray Monochromator **FOCUS 500**

- High energy dispersion
- High efficiency
- Ellipsoidal crystal design
- Al K_{α} and Ag L_{α} X-rays
- Focused X-ray flux



Monochromator

The ellipsoidal monochromator FOCUS 500 operates according to Bragg's Law of X-ray diffraction. A single wavelength of X-rays is reflected from a quartz single crystal mirror at a specific angle of reflection.



ELLIPSOIDAL GEOMETRY

The ellipsoidal mirror images a point source located at the ellipsoidal mirrors focus on the sample perfectly.

An X-ray monochromator provides the following advantages:

- Higher resolution
- Higher sensitivity
- Lower background
- No satellites
- Reduced sample damage
- Focused X-ray spot

The FOCUS 500 utilizes an ellipsoidal X-ray mirror. The mirror is composed of a monolithic backing support with precisely oriented atomic bonded crystal plates. The mirror has a 500 mm Rowland circle diameter which offers a high X-ray energy dispersion.

The large surface area of the quartz crystals defines a solid angle of 0.08 sterad for X-ray diffraction and hence leads to an intense X-ray flux from the monochromator for high efficiency.

A manipulator with precision temperature compensated drives provides three degrees of motion (two directions of tilt and one of translation, completely decoupled from each other) for accurate mirror positioning.

A moveable aluminized polymer window (shutter) is provided on the monochromator housing for differential pumping or to shield the crystal assembly during sputtering.

The monochromator can be used to perform Bremsstrahlung Isochromat Spectroscopy (BIS) with a retrofittable attachment to the standard equipment.

BIS

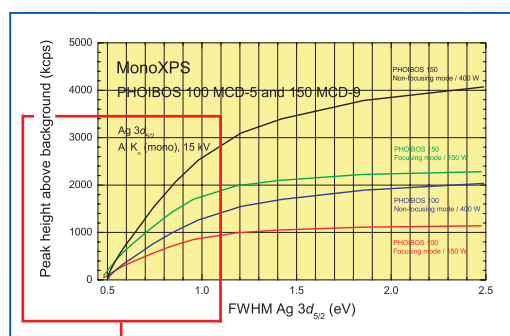
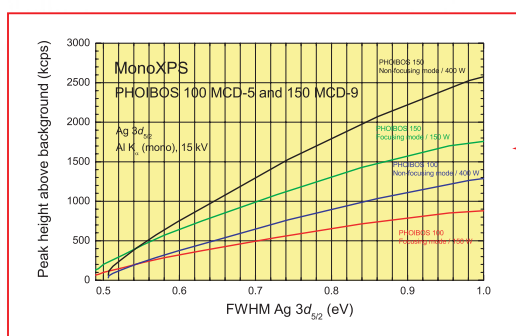
Using BIS the sample is irradiated by an electron beam with a narrow energy distribution.

The interaction between the incident electrons and the solid involves the direct deceleration of the incident electron with the simultaneous emission of Bremsstrahlung. The electron then occupies a previously empty state above the Fermi level. The probability of Bremsstrahlung emission is related to the density of unoccupied states.

The FOCUS 500 provides the capability to measure the intensity of a single X-ray wavelength while scanning the energy of the electron beam.

Typical Performance

The lens modes of the PHOIBOS analyzer series are optimized to give unsurpassed resolution and intensity performance with the FOCUS 500 X-ray monochromator.



Zoom

In the non-focusing mode some line broadening occurs due to the finite width of the X-ray spot. In the focusing mode the broadening due to the source is negligible.

X-ray Source

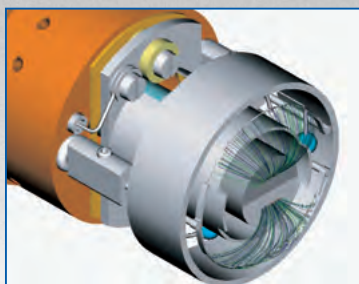
The X-ray source XR 50 M is specially designed for use with the monochromator. The power supply features high power operation up to 600 W.

With the FOCUS 500 the Bragg condition for $\text{Ag } L_{\alpha}$ X-rays is satisfied in second order. The twin anode (Al/Ag) allows a changeover from monochromatized $\text{Al } K_{\alpha}$ to $\text{Ag } L_{\alpha}$ excitation with only minor adjustments and without breaking the vacuum.

The $\text{Ag } L_{\alpha}$ photon energy of 2984.3 eV means that the FOCUS 500 can excite higher energy core levels and Auger series. In addition, the higher electron energy increases the analysis depth.

Each anode can be operated in a focusing or non-focusing mode. Due to the small source size in the focusing mode the mono-

chromator resolution is limited by the rocking curve width of the quartz crystals only.



ELECTRON OPTICAL SIMULATION

The figure above shows an electron optical simulation of the focusing lens in the X-ray source XR 50 M.

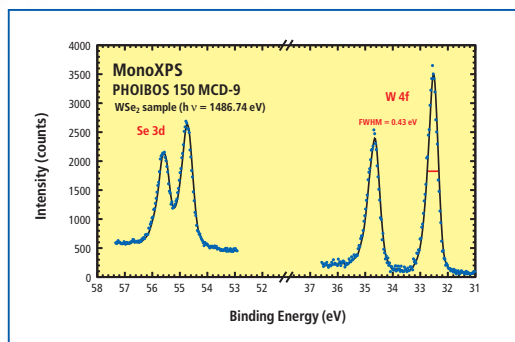
This lens can focus the electrons that impinge on the anode and produce a variable X-ray spot size. Both anodes (Al/Ag) can be operated in focusing or non-focusing mode.

ROCKING CURVE

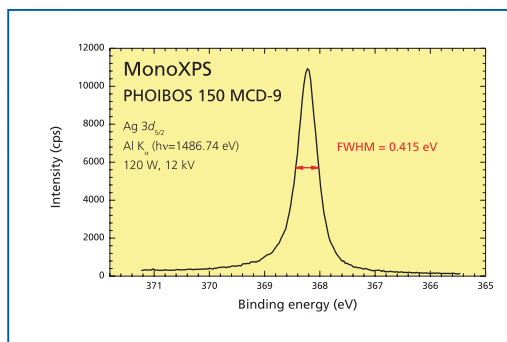
The reflected intensity versus the angle of incidence of the X-rays for a given crystal type is known as the rocking curve.

For quartz crystals the rocking curve width is about 160 meV.

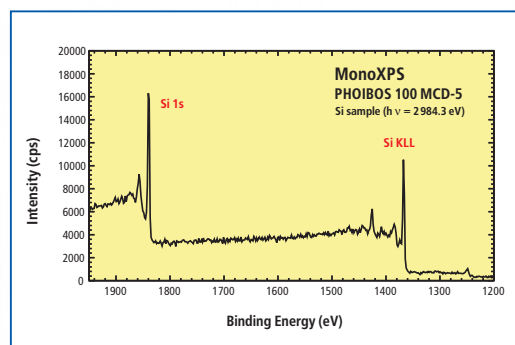
Spectral Data



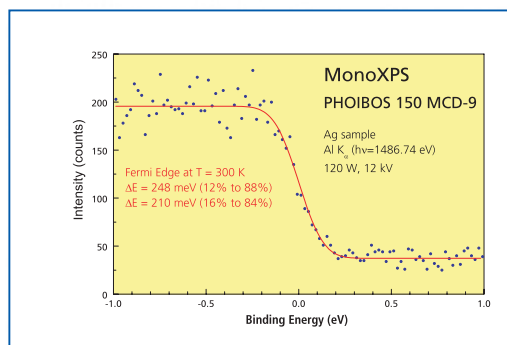
The main core levels of a layered crystal of WSe_2 are shown. The resolution is limited by the quality of the uncleaned sample surface.



The diagram shows the $\text{Ag } 3d_{5/2}$ peak. The inherent electron energy resolution was about 220 meV. The X-ray source was run in focus mode.



With the photon energy of 2984.3 eV $\text{Ag } L_{\alpha}$ new core levels can be excited for Al, Si, P, S, Cl, Br to Ru, Tm to Pt, Au, Hg, Pb and Bi.



This spectrum shows the Fermi edge of Ag at T = 300 K. The widths of the edge is 210 meV (16 % to 84 %).

UNSURPASSED RESOLUTION

The width of the Fermi edge demonstrates the high resolution capability of the FOCUS 500 monochromator.

Technical Data

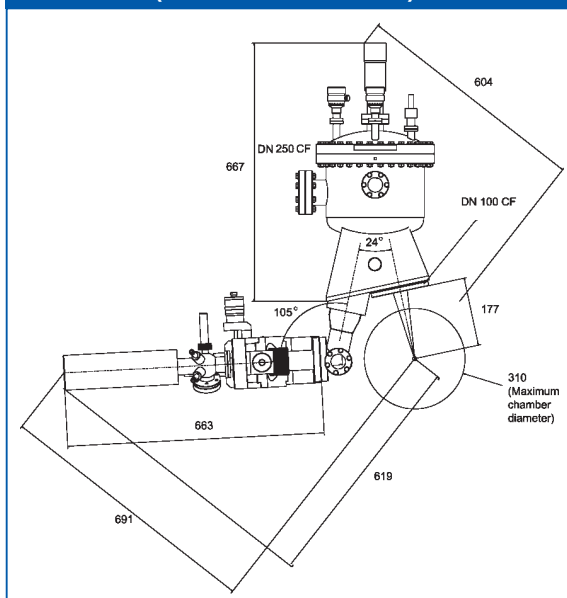
Monochromator

Single crystal	Quartz (10 $\bar{1}0$)
Crystal area	100 × 200 mm ²
Crystal manipulator	independent roll, pitch and focus
Rowland circle	Ø 500 mm
Port length	177 mm
Chamber diameter	< 310 mm
Shutter	Moveable X-ray window
Bakeout temperature	150° C (monochromator remains outside the blanket)
Mounting	DN 100 CF
Differential pumping	optional
BIS	optional
Weight	40 kg

X-ray source

Anode material	Dual anode (Al/Ag)
Modes of operation	Focusing and non-focusing mode
Spot size on anode	Focusing 0.5 × 3.5 mm ² Non-focusing 4 × 3.5 mm ²
Voltage	Up to 15 kV
Power Al	150 W / focusing mode 400 W / non-focusing mode
Power Ag	260 W / focusing mode 600 W / non-focusing mode
Manipulator	3-axis, micrometer drives
Weight	17 kg

FOCUS 500 (all dimensions in mm)



Resolution	SCD	MCD-5	MCD-9
Al Kα, 15 kV, 400 W, non-focusing mode			
0.60 eV	60,000	300,000	600,000
0.85 eV	120,000	600,000	1,200,000
Al Kα, 15 kV, 150 W, focusing mode			
0.50 eV	15,000	75,000	150,000
0.60 eV	60,000	300,000	600,000
Ag Lα, 15 kV, 600 W, non-focusing mode			
0.9 eV	200	1,000	2,000
1.4 eV	2000	10,000	20,000

COUNT RATE SPECIFICATION

The PHOIBOS analyzer series will exceed with the FOCUS 500 monochromator the values specified in the table (values are given in cps for the Ag 3d_{5/2} signal above the background). Values are specified for optimal geometric conditions (Emission angle $\phi=30^\circ$ and X-Ray angle of incidence $\psi=70^\circ$).

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