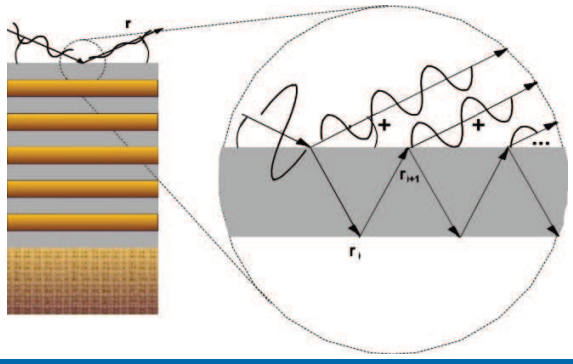
Synchrotron optics



Monochromatization of X-rays by reflection on a periodic nanometer multilayer stack.

Synchrotron monochromator optics
Typical synchrotron monochromators consist of periodic multilayer stacks on superpolished flat substrates. The reflected wavelength can be adjusted by selecting the corresponding Bragg angle for a given multilayer period thickness.
Multilayers can be made as high resolution, high flux or broadband versions as well as optimized for polarization experiments near the Brewster angle for low energy X-rays.
2- or 3-stripe mirrors can provide a selection of different multilayer types available with simple stage movement without the need to open the optics hutch.

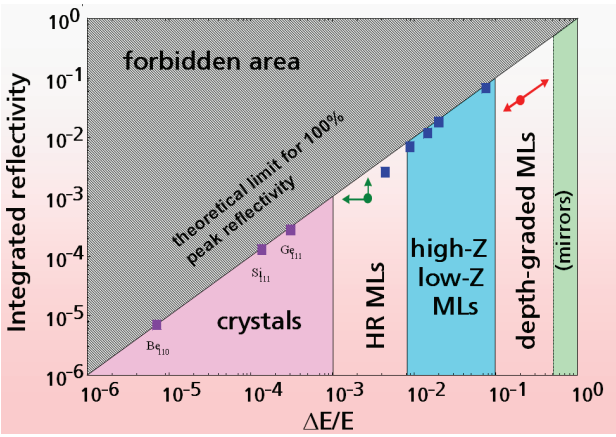
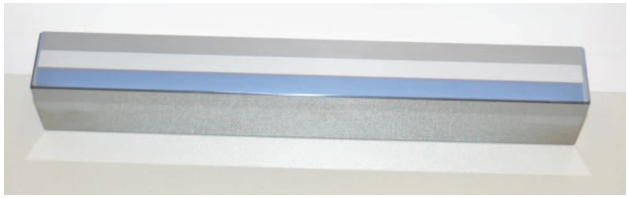


Illustration of integrated reflectivity (total flux) versus energy resolution of crystals, high-resolution, standard and depth graded multilayers.
Graph courtesy of C. Morawe, ESRF, France.



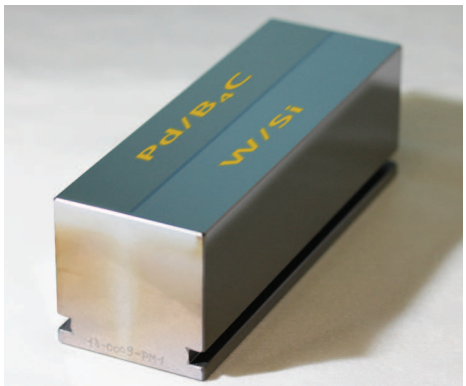
3-stripe multilayer monochromator for applications at synchrotron beamlines between 5 keV and 80 keV.
Development in cooperation with G. Falkenberg, HASYLAB/DESY, Hamburg, Germany.

Synchrotron optics features

Spectral range	<50 eV - 100 keV
Material system	multilayer coating optimized for wavelength or on customer's request
Typical size	up to 8" diameter or 1000 mm length
Energy resolution	0.25% < ΔE/E < 2% (periodic multilayer) ΔE/E > 5% on request (aperiodic multilayer)
Thickness homogeneity	Δd/d < 0.02%

Applications

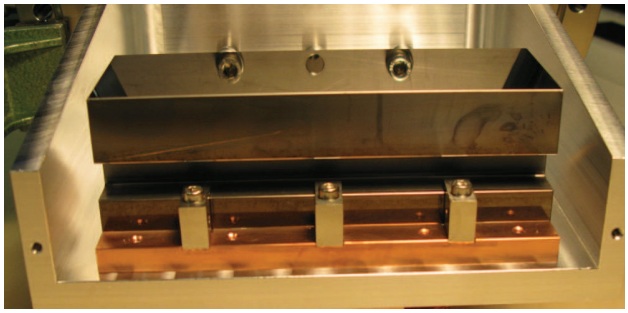
monochromators	optimized for high R or tailored bandwidth ΔE
polarizers	for soft X-rays (O-K, Fe-L, Ni-L)



2-stripe multilayer monochromator with harmonic suppression working between 6 keV and 15 keV.
Development in cooperation with S. Fiedler, EMBL/DESY, Hamburg, Germany.

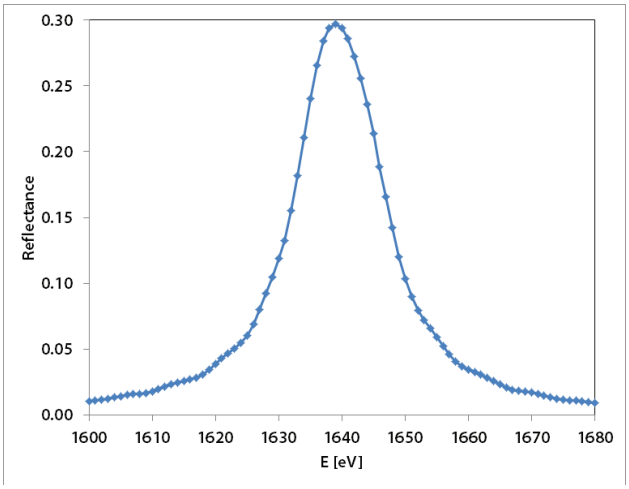
AXO DRESDEN GmbH
Applied X-ray Optics
Röntgenoptik und Präzisionsbeschichtung
Gasanstaltstr. 8 b
01237 Dresden · Germany
phone +49 (0)351 250897-20
fax +49 (0)351 250897-66
contact@axo-dresden.de
www.axo-dresden.de

Applications of synchrotron optics

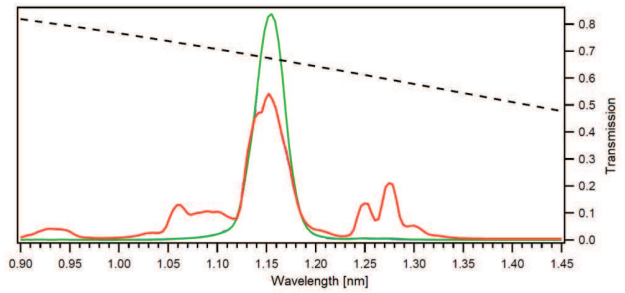


Toroidal multilayer mirror for soft X-rays in the set-up at beamline XPBF 2.0 in the PTB laboratory at BESSY II.
Development in cooperation with M. Krumrey, PTB, Berlin, Germany.

Synchrotron optics upgrade of XPBF
For the upgrade of the X-ray pencil beam facility (XPBF) of PTB at BESSY II to XPBF 2.0 toroidal, multilayer coated synchrotron mirrors were manufactured. A toroidal mirror was milled and polished from monocrystalline silicon and coated with a Mo/B_4C multilayer for best reflectance around 1.6 keV.
The monochromatized and focussed beam of this new optics system will be used to characterize a Wolter telescope of the ESA mission ATHENA+ (Advanced Telescope for High ENergy Astrophysics).

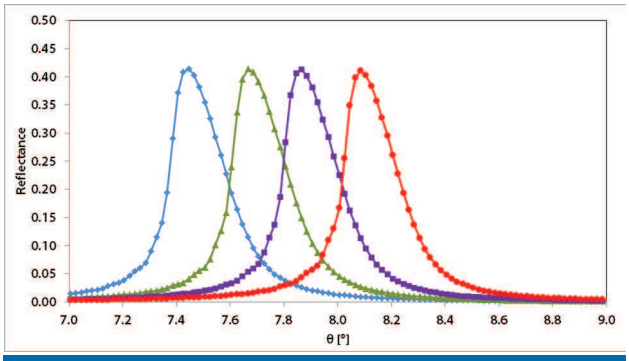


Reflectance versus photon energy measured at BESSY II for a multilayer coated toroidal mirror.
Measurements courtesy of M. Krumrey, PTB, Berlin, Germany.



Emission from a laser plasma source before (red) and after (green) reflection from a multilayer mirror (arbitrary units of detector intensity). The black dashed line shows the filter transmission of 0.9 µm Mylar + 1.5 µm Al.
Measurements courtesy of A. Jonas, TU Berlin, Germany.

Low energy optics for laboratory and special sources
Multilayers can be designed and optimized for arbitrary photon energies available at synchrotrons as well as uncommon energy regions.
The Berlin Laboratory for innovative X-ray technologies (BLiX) uses - amongst others - a laser-produced plasma source for the energy range between 100 eV and 1300 eV. Multilayer optics developed for this region can help to improve lateral resolution, performance and detection limits in fields like µ-XRF, XAFS, XANES and GEXRF.



Reflectance at different positions (25 mm steps) of a multilayer mirror at the target photon energy 1078 eV. (Curves shifted in angular direction for clarity.)
Measurements courtesy of J. Baumann/A. Jonas, TU Berlin, Germany.

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01237 Dresden · Germany
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fax +49 (0)351 250897-66
contact@axo-dresden.de
www.axo-dresden.de