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Soft X-ray and UV Optics

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Custom-designed multilayer monochromators, beam-shaping mirrors and collector optics can be manufactured by AXO DRESDEN for photon energies ranging from several keV (hard X-rays) down to the tender and soft X-ray regime below 1 keV. Even applications in the UV, EUV (incl. 13.5 nm) and XUV range can be addressed with tailored multilayer systems. These optics are ideally suited for advanced laboratory and synchrotron applications, laser-produced plasma sources, as well as free-electron lasers (FEL).

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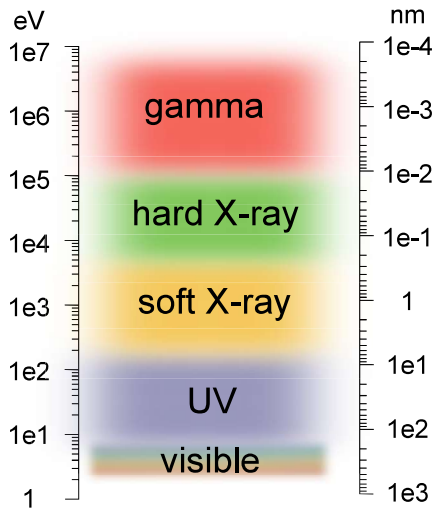
X-ray energy regions

Electromagnetic radiation spans a wide spectrum of wavelengths and energies. Radiation with wavelengths shorter than visible light (about 400 nm to 10 nm / 3 eV to 120 eV) is classified as ultraviolet (UV). Beyond that, the X-ray region begins with soft X-rays (until 250 pm / 5 keV) and extends to hard X-ray (until 10 pm / 120 keV) and gamma-ray domains.



Optics for the tender X-ray region

The energy range from 1 keV to a few keV is also called tender X-ray region, lying between the hard and soft X-ray regimes. In this energy region you can find many fluorescence lines of elements from the 3rd row in the periodic system of elements interesting in steel and ceramics production as well as oil analysis. Multilayer X-ray optics can improve excitation and detection of those elements in XRF analysis. Due to the low energy optics geometries and Bragg angles can become rather large and precise mirror fabrication and coating is challenging. Various mirror shapes and multilayer systems are available at AXO DRESDEN to achieve the best results for each application.

Soft X-ray references and applications

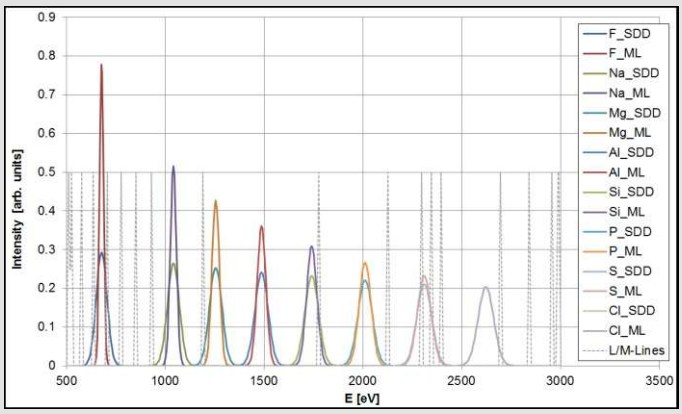
AXO DRESDEN has develpoed and fabricated numerous multilayer mirror solutions for the soft X-ray range, including...

- EUV/XUV monochromators (e.g. 0.02-0.04 keV)
- Plane & spherical concave EUV reflectors (0.09 keV (13.5 nm) and others, e.g. 0.2 keV)
- Broadband mirror for laser plasma XUV source (0.28-0.33 keV) at LLG Göttingen
- Lateral gradient multilayers for divegent FEL beams (0.4-0.8 keV)
- Large deflection angle mirrors for FEL (0.5-0.9 keV)
- Soft X-ray polarizer synchrotron mirror (0.8 keV)
- Focusing mirrors for LPS (1.1 keV)

Front page: Toroidal multilayer mirror at a laser plasma X-ray source (LPS) at the Technical University of Berlin.

Energy resolution

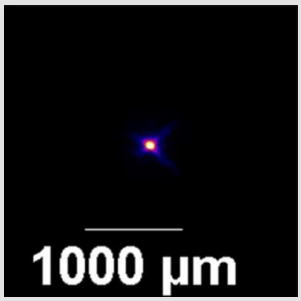
Even though energy bandwidth of silicon drift detectors (SDDs) decreases with lower photon energy, the so-called Fano noise has an opposing effect. Multilayer monochromators can provide better resolution to separate X-ray fluorescence lines here.

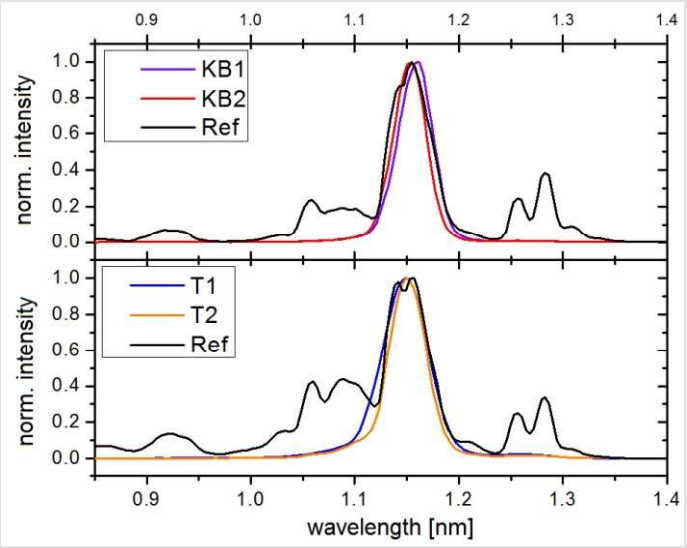


Calculated energy resolution for silicon drift detectors (SDDs) and multilayers for K emission lines from F to Cl. Several L- and M-lines of heavier elements are shown, too.

CCD image of a 1078 eV (1.15 nm) X-ray beam emitted from laser plasma source (spot size 70 µm) focussed to 75 µm FWHM using a multilayer coated toroid segment mirror.

(Image courtesy of BLiX, Berlin, Germany)





Spectrum emitted from a laser plasma source (LPS) before ("Ref") and after reflection from different multilayer mirrors such as a 1-dimensonally focussing mirrors in a KB arrangement and single toroid segments.

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