# New monochromator optics for tender X-rays

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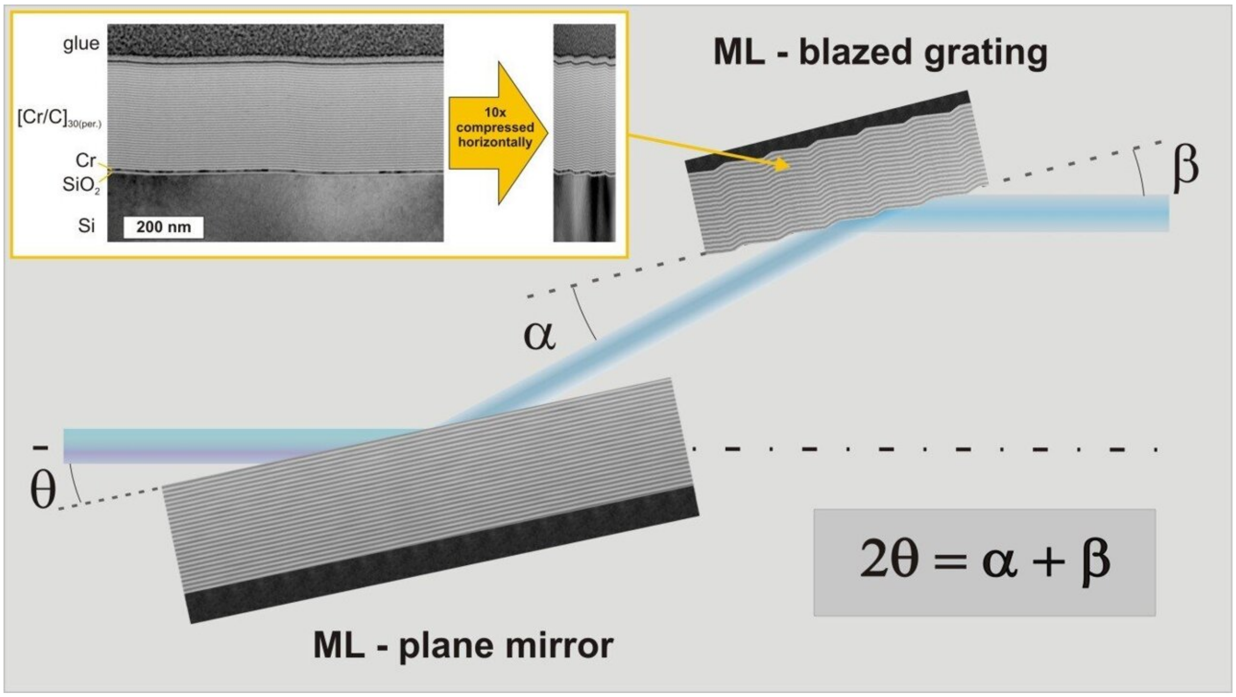


New monochromator optics for tender X-raysSchematic drawing of the novel monochromator concept at the U41-PGM1 beamline at BESSY-II based on a multilayer coated blazed plane grating and mirror to improve the photon flux in the tender X-ray photon energy range (1.5 – 5.0 keV). The inset shows a TEM image of the cross-section of the Cr/C multilayer blazed grating structures. For better visualization of the grating period, the image was horizontally compressed 10 fold.Schematic drawing of the novel monochromator concept at the U41-PGM1 beamline at BESSY-II based on a multilayer coated blazed plane grating and mirror to improve the photon flux in the tender X-ray photon energy range (1.5 – 5.0 keV). The inset shows a TEM image of the cross-section of the Cr/C multilayer blazed grating structures. For better visualization of the grating period, the image was horizontally compressed 10 fold. Credit: *Small Methods*

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A climate-neutral energy supply requires a wide variety of materials for energy conversion processes, for example catalytically active materials and new electrodes for batteries. Many of these materials have nanostructures that increase their functionality. When investigating these samples, spectroscopic measurements to detect the chemical properties are ideally combined with X-ray imaging with high spatial resolution at the nanoscale.

However, since key elements in these materials, such as molybdenum, silicon or sulfur, react predominantly to X-rays in the so-called tender photon energy range, there has been a major problem until now.

This is because in this "tender" energy range between soft and hard X-rays, conventional X-ray optics from plane grating or crystal monochromators deliver only very low efficiencies. A team from HZB has now solved this problem: "We have developed novel monochromator optics. These optics are based on an adapted, multilayer-coated sawtooth grating with a plane mirror," says Frank Siewert from the HZB Optics and Beamlines Department.

The new monochromator concept increases the photon flux in the tender X-ray range by a factor of 100 and thus enables highly sensitive spectromicroscopic measurements with high resolutions for the first time.

"Within a short time we were able to collect data from NEXAFS spectromicroscopy on the nanoscale. We have demonstrated this on catalytically active nanoparticles and modern microchip structures," says Stephan Werner, first author of the publication. "The new development now enables experiments that would otherwise have required months of data collection," Werner emphasizes.

"This monochromator will become the method of choice for imaging in this X-ray energy range, not only at synchrotrons worldwide, but also at free-electron lasers and laboratory sources," says Gerd Schneider, who heads the X-ray Microscopy Department at HZB. He expects enormous effects on many areas of materials research: Studies in the tender X-ray range could significantly advance the development of energy materials and thus contribute to climate-neutral solutions for electricity and energy supply.

The paper is published in the journal *Small Methods*.

**More information:** Stephan Werner et al, Spectromicroscopy of Nanoscale Materials in the Tender X-Ray Regime Enabled by a High Efficient Multilayer-Based Grating Monochromator, *Small Methods* (2022). DOI: 10.1002/smtd.202201382

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