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X-ray focusing technique is essential for probing microscopic samples at high pressures. Compound refractive lens (CRL) is one of the most versatile devices that are capable of focusing and collimating x-rays in the high-energy range of 20－60 keV [1, 2]. The CRL offers many advantages: good efficiency for focusing, compactness, robustness, and easy alignment (in-line focusing element). At high-pressure x-ray diffraction beamline BL10XU of SPring-8, the x-ray focusing optics consisting two different types of CRL devices have been installed in tandem. The first CRL (16 m focal distance) made from glassy carbon (GC), which is situated at a distance of 42 m from the source, has been used incidentally to collimate the x-ray beam. The aperture of this CRL is about 1 mm, whose size matches the beam size of the undulator. Because of difficulty in focusing the x-ray beam size down to 10μm through the first CRL, a second focusing CRL device was placed at 0.5 m upstream to the sample. The second CRL is sets of planar cross-lenses with a quasi-parabolic profile for focusing in two directions, and were fabricated from SU-8 polymer by deep x-ray lithography at the ANKA in Germany [3]. The placement of the SU-8 CRL after the GC-CRL produces an x-ray beam with a spot size of less than 7 μm at 30 keV. The photon flux density at the focal point is approximately 10^{15} photons/sec/mm^2. This x-ray optics allow us to collect high-quality x-ray diffraction data on materials subjected to extreme pressures of up to 400 GPa, which exceeds the condition found at the Earth's center.

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Keywords: high-pressure X-ray diffraction, X-ray focusing optics, synchrotron radiation optics

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Total reflection and multilayer optics for synchrotrons and free-electron lasers

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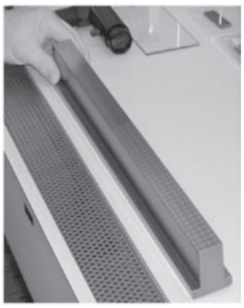
We will be presenting selected aspects of simulation, preparation and characterization of total reflection and multilayer X-ray optics. The optimum coating is found by calculating the optical properties. Sophisticated improvements in manufacturing technology allow the precise realization of the specified parameters. Our capabilities for the production of multi stripe optics as well as for very long mirrors will be shown. Two applications demonstrate our possibilities: First of all we will be showing results of the development of carbon coatings as total reflection mirrors for Free-Electron Lasers. Over the past years, we have developed optimized optics for the XUV range up to 200 eV. The investigations have shown that carbon coatings offer high reflectivity >95%, high radiation stability and good uniformity both in thickness and roughness. Secondly, we will be presenting some results of the production of multi stripe optics for the use at different energies. One example shows a three-stripe optics for a tomography beamline. A Ru/C multilayer was choosen for energies of 10-22 keV, a W/Si multilayer for energies of 22-45 keV and one stripe of the (111)-Si substrate remained uncoated.



Keywords: synchrotron optics, multilayer optics, total Reflection Optics

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Center of mass grain maps in 3D

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We would like to visualise the microstructure of crystalline materials. Diffraction based mapping techniques [1] offer a way to determine the position, orientation, size and strain state of multiple crystallites within a sample. Mixtures of different crystalline phases can also be treated, as each crystallite is indexed and fitted separately. Multiple crystallites can be indexed from a single dataset to give an orientation matrix for each one. Any small misalignment of each crystallite with respect to the diffractometer axis gives systematic shifts in the Bragg peak positions during rotation. The area detector geometry and axis direction can be fitted together with the positions of the crystallites using the ImageD11 software package [2]. The position, orientation and lattice parameters of each indexed crystallite are normally refined. Peak intensities give the volume of each grain that has been illuminated by the beam. We will show several examples of maps produced using high energy x-ray diffraction data collected on an area detector at beamline ID11 at the ESRF. Spatial resolutions for the center of mass grain position are typically somewhat better than the detector pixel size (50 micron) and cover an area as large as the beam size (up to 2 mm). Maps containing several hundred grains have been produced.

[1] Three dimensional X-ray diffraction microscopy, Mapping polycrystals and their dynamics. H F Poulsen (Springer, Berlin, 2004)
[2] http://fable.wiki.sourceforge.net/imaged11

Keywords: instrumentation and software, area detectors, crystallites

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Grazing-angle incidence hard X-ray nanoscope

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We consider in presented theoretical paper a possibility to overcome the limitations of the x-ray microscope and increase its resolution from tenth a micrometer to a nanometre or less. Proposed nanoscope would allow studies of the nanoscale structures. We foresee the