Poster Presentations

[MS34-P01] Extreme X-ray beam compression for high-resolution GISAXS studies.

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Channel-cut V-shaped monochromators allow the beam footprint control. However, poor overlap of the rocking curves of the two diffractors due to refraction reduces severely their output intensity for the compression (expansion) factor larger than 10. While previous efforts to overcome this problem were driven by the need for beam expansion and X-ray imaging, the present work is devoted to a pilot utilization of the V-channel monochromators for extreme beam compression below 100 _m. Two monolithic compressors with different solutions to eliminate refraction were used. While V21 GeSi (220) uses slightly different lattice constants due to Si doping, V15 Ge (220) has different asymmetry angles of the diffractors. The compression factors were verified experimentally at CuK_ line by a CCD camera (Photonic Science). A 1 mm wide beam (FWHM) of 0.5 mrad divergence was delivered by a microfocus X-ray source I_S (Incoatec) with Montel optics. The compression factors of 18 and 23 found for V15 and V21, respectively, are even larger than the theoretical values which can be attributed to a small compressor acceptance, not matched to the Montel optics divergence. The beam divergence measured behind each compressor is reduced to _0.1 mrad while the source -2 -3 spectral bandwidth of 5.3_10drops to 1.6_10.The photon flux measured in single photon counting regime by Pilatus 100K detector (Dectris) behind the compressor decreases by 2 orders of magnitude to 10^6 cps. It can easily be recognized from geometrical optics considerations that it is not possible to obtain similar output divergence, output flux and beam size reduction at the same time with a two-slit collimator traditionally used in GISAXS/SAXS setups. For example, considering the same output divergence of 0.1 mrad as that of the compressor, a 1 m long evacuated collimator with 100 _m slits has a comparable flux attenuation of 1.6_10^{-2} but the beam size reduction factor is only 10 for 1 mm wide primary beam. On the other hand, keeping the 0.1 mrad output divergence and decreasing the slit size to 50 _m enhances the beam size reduction factor to 20 and shortens the collimator length to 0.5 m but the flux attenuation is doubled. Moreover, the compressor acts as monochromator and delivers a geometrically and spectrally very clean beam that is produced at much shorter length than in a collimator. This allows space saving and compact design of a high-resolution table-top GISAXS setup. The potential of such a setup with V21 compressor was tested on an ion-beam etched silicon wafer with periodical ripples with typical amplitude of _1 nm. The GISAXS pattern exhibits well resolved lateral truncation rods suggesting lateral periodicity of 58.63±0.01 nm. The instrumental resolution found from FWHM of the central truncation rod reaches 480 nm which is comparable to the value of 520 nm obtained on the same sample at BW4 synchrotron beamline at HASYLAB/DESY. This work was done during implementation of the project Research and Development Centre for Advanced X-ray Technologies, ITMS code 26220220170, supported by the Research and Development Operational Programme funded by the ERDF, and the COST action MP1203.

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