A.5: Commissioning of higher order suppressor system at soft x-ray reflectivity beamline BL-03 of Indus-2

Grating based monochromator system in soft x-ray beamline of any synchrotron sources suffer with presence of higher harmonic contents, which comes along with the primary monochromatic beam. Therefore, to improve the spectral purity at the soft x-ray reflectivity beamline (BL-03) of Indus-2 synchrotron source, a three mirror based higher order suppressor (HOS) system is custom designed, fabricated and commissioned. The three mirrors of the HOS setup move simultaneously in a synchronized way in ultra-high vacuum environment of the beamline, such that the beam exit remains fixed while the HOS is operated. All the three mirrors are coated with stripes of Ni, Cr, Si and C, which are used to suppress the higher harmonics coming from the varied line spacing plane grating monochromator of the beamline in 100-800 eV photon energy range. The HOS setup provides soft x-ray monochromatic beam with high spectral purity better than 1%. Optical layout of three mirror HOS setup is shown in the Figure A.5.1. The mirrors M1 and M3 operate at a grazing angle θ and simultaneously can be moved from 0° to 7° angle. The mirror M2 is set at an angle 2θ and moves in transverse direction in 0-30 mm range such that the exit beam remains fixed during the angular movement of the mirrors M1 and M3. In order to efficiently suppress the higher harmonics in 100-800 eV range, different coating materials are used for different energy regime. All the three mirrors have a stripe coating of four different materials i.e., Ni, Cr, Si and C. During the operation of the HOS, all the three mirrors can be set in the beam path with similar coatings on respective mirrors. Figure A.5.2 shows an inside view of ultra-high vacuum (UHV) compatible HOS system, where stripe coatings on mirrors M1 and M3 are clearly visible, whereas the face of mirror M2 is on other side.

The HOS performance has been checked using different samples by performing photon energy dependent reflectivity measurements. Due to the initial vacuum conditions in the beamline, the HOS was set for harmonic suppression in 50-225 eV energy range for initial experiments, where the stripe of carbon was used for higher harmonic suppression. In limiting vacuum environment, the carbon stripe is not expected to be affected by the surface contamination occurring due to hydrocarbon cracking in presence of synchrotron radiation (SR) beam, if any.

In Figure A.5.3, energy dependent soft x-ray reflectivity of a 40 nm thick B_4C thin film sample measured with and without HOS is shown. The reflectivity spectra measured without HOS shows clear signature of higher harmonics, which are distinctly visible at multiple of boron K-edge energy of ~184 eV. All these features of higher harmonics of boron K-edge are marked in the figure. These higher harmonic features disappear in the reflectivity spectra, when it is measured with HOS setup. The HOS setup improves the spectral purity and reduces the harmonic components below 0.1%.

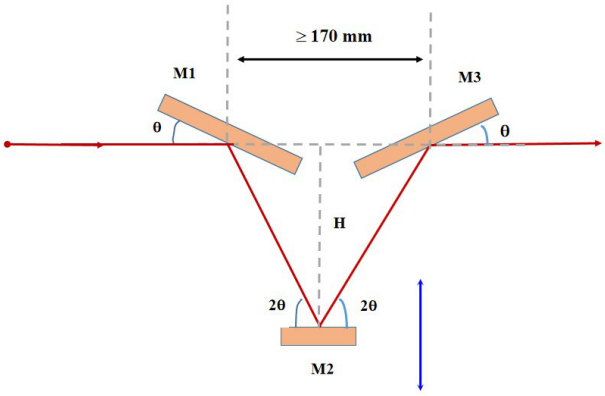

Fig. A.5.1: A schematic of three mirror assembly for higher order suppressor (top view).

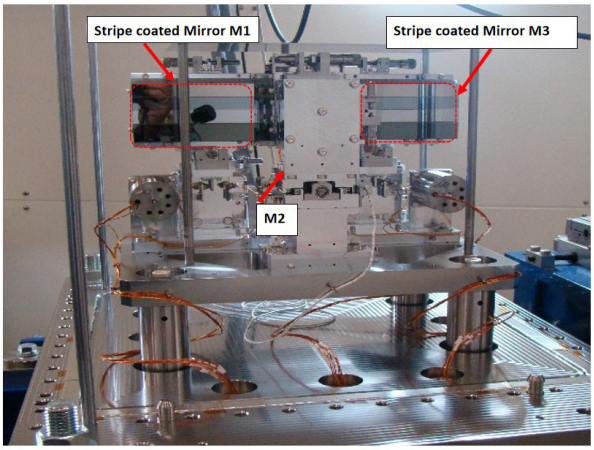

Fig. A.5.2: Inside view of UHV compatible HOS system, where stripe coated mirrors mounted on precision mirror mechanism are visible.

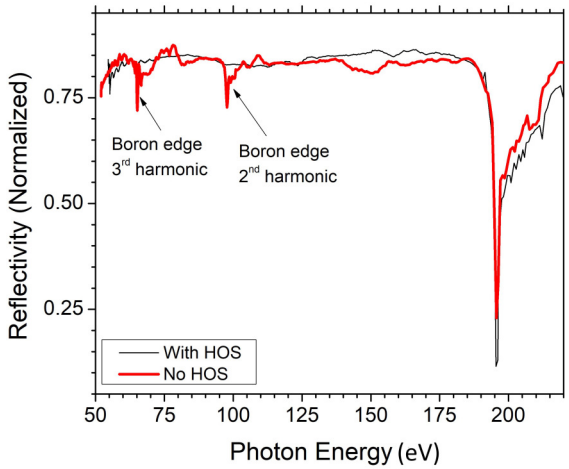

Fig. A.5.3: Soft x-ray reflectivity of 40 nm thick B_4C thin film measured at 1.5° incidence angle with and without HOS setup.

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