A.11:Development of high resolution multilayer mirror for soft x-rays

X-ray multilayer (ML) mirror based soft x-ray instruments require enhancement of their operating angles: (i) to increase numerical aperture and (ii) to provide a higher spectral selectivity. The motivation of the present work is to develop x-ray ML mirrors for applications in the soft x-ray region (800- 1500 eV). Indigenous development of such mirrors, is extremely important for applications at Indus-2 synchrotron beamlines and also have a large potential in future soft x-ray telescopes. Under optimized deposition conditions, multilayers of tungsten (W) and boron carbide (B_4C) have been made using magnetron sputtering system at RRCAT. Two main aspects have been studied in this work: a) the energy resolution of these ML mirrors, b) the stability of these mirrors with time.

W/B_4C ML mirrors have been fabricated with two different periods: d = 1.98 nm and 1.62 nm, with 300 layer pairs (N). Before soft x-ray performance testing, the MLs are characterized using hard x-rays (Cu K_α). The well defined successive higher order Bragg peaks indicates good quality of periodic structure in the MLs. The average high frequency interfacial rms roughness is ~0.35 nm. After one year of fabrication, the hard x-ray reflectivity indicates a drop in the reflectivity of the first order Bragg peak from 40% to 30% (ML with d = 1.98 nm) due to contamination at the top of ML and slight increase in its roughness. This indicates that these ML mirrors are very stable with time.

The soft x-ray optical performance is evaluated after around one year of fabrication of MLs. The soft x-ray measurements are done in the energy range ~654-1500 eV using BL-03, Indus-2 (Figure A.11.1). At an energy of 1489 eV, the measured resolution E/ΔE is ≈76 with reflectivity ≈10% for ML mirror with d = 1.98 nm (ML-1). Similarly, for ML mirror with d =1.62 nm (ML-2), the measured E/ΔE is ≈114 with reflectivity ≈4.5% at 1489 eV. Further, at E = ~1489 eV, the angular positions of the first order Bragg peak are 12.07 and 15, for MLs with periodicity 1.98 nm and 1.62 nm, respectively. The operating angles of the ML optics are significantly large and hence are suitable for applications in soft x-ray instruments.

For further details please see: *P. C. Pradhan, A. Majhi and M. Nayak, "Optical performance of W/B_4C multilayer mirror in the soft x-ray region", J. Appl. Phys., 123, 095302 (2018).*

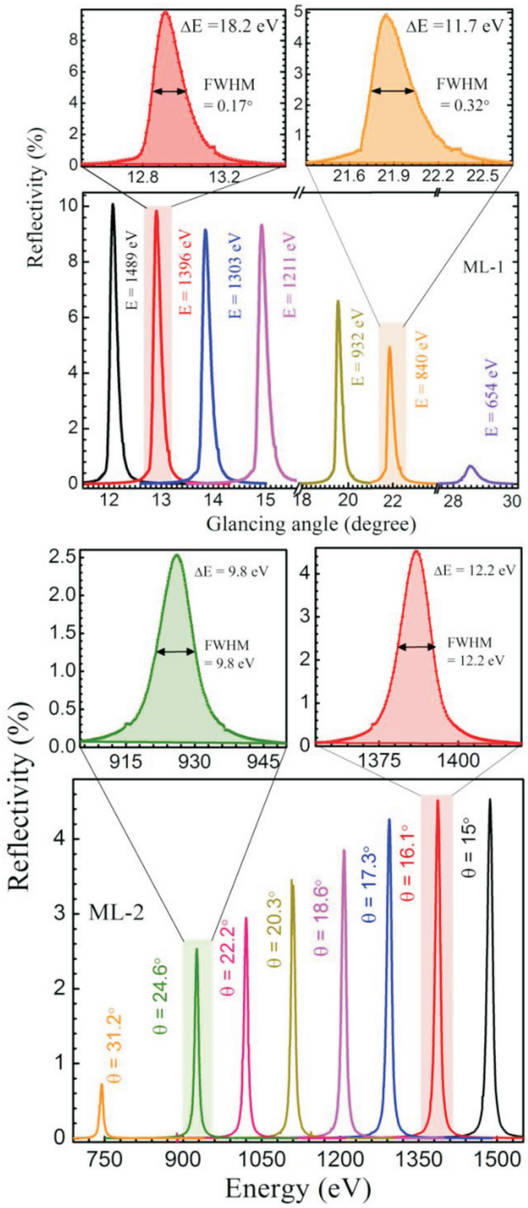

Fig. A.11.1: Measured soft x-ray optical performance of W/B_4C multilayer mirrors (ML-1 with N=300 and d = 1.98; ML-2 with N = 300 and d = 1.62 nm) using BL-3, Indus-2 synchrotron. For the clarity about resolution, the enlarged measured curve at selected energies and incident angles are given at the top.

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