X-ray standing wave study of barrier layers in ultrashort period multilayers

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Short-period multilayer mirrors are used as artificial crystals to detect fluorescent, element-specific radiation. In our research we are exploring W/Si multilayers with a period of 2.5 nm; optimized for the operation in 2.4 – 0.83 nm wavelength range. Previous research has shown that 0.5 nm thin W layer in these multilayers interacts entirely with Si to form a silicide, thereby lowering optical contrast with Si. To prevent W-Si interaction we have implemented sub-nm thick C and B_4C layers at the W-on-Si and Si-on-W interface – resulting in a significant reflectivity increase of 0.84 nm radiation. Although we have demonstrated the efficacy of sub-nm thin diffusion barrier layers on soft X-ray reflectivity, the exact mechanism behind this reflectivity increase is not known.

The goal of the performed experiment is the structural characterization of changes induced by C and B_4C barriers by the analysis of the distribution of C and B atoms in W/Si multilayers. To achieve this, we have measured X-ray standing wave fluorescence (XSW-F) of C and B_4C elements along with X-ray reflectivity (XRR) of the multilayers using the Elettra X-ray fluorescence beamline. Here we will present measured XSW-F data of C and B along with qualitative data analysis. A preliminary analysis seems to indicate the distribution of C inside the W absorber layer, suggesting strong C-W intermixing in barrier multilayers.