Fabrication and characterization of EUV multilayer mirrors with a small spectral reflection bandwidth

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EUV multilayer mirrors for small spectral bandwidth of the reflection peak have been produced by UHV electron beam deposition by varying the thickness ratio gamma between the absorber layer thickness and the bilayer thickness. These multilayers are designed for spectral selection of individual high harmonics of a fs-laser driven coherent EUV source of photon energies below 70eV. A seperation of adjacent harmonics requires a multilayer reflection bandwidth of ΔE_{FWHM}* 3eV.

The deposition process is controlled by in situ soft X-ray reflectometry which allows a variation of the individual layer thicknesses in between 1.9 nm and 23 nm by choosing two different emission lines and by varying the incident angle of the X-rays on the sample. Low-gamma (Γ * 0.2) multilayers have been fabricated by switching the evaporators in each maximum(Mo) and every second minimum(Si) of the in situ reflectivity curve. Ion polishing and heating methods are applied to reduce the interface roughness.
The properties of the Mo/Si multilayer mirrors prepared have been characterized by hard and soft X-ray reflectometry and cross sectional transmission electron microscopy. From the experimental data the characteristics of the ML structure like multilayer period, individual layer thickness and effective roughness of the multilayer interfaces are quantitatively extracted. It has been demonstrated experimentally by means of higher harmonics in fs-laser frequency mixing that two of the EUV multilayers with the small spectral reflection bandwidth in series are capable of selecting a single higher harmonic (e.g. the 45th of 69.8eV).