Improved spectral purity of EUV multilayer mirrors with optimized SiO_2 top layer

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EUV Multilayer mirrors with high peak reflectivity and also high attenuation in a specific wavelength range are required for a large number of applications as High Harmonics Generation (HHG) sources, EUV lithography, x-ray analyses (XRF, EPMA), solar imaging telescopes… In fact, for all applications using a broadband source, one need to take care about the attenuation of unwanted wavelengths by the multilayer itself or by other optical components as filters. By using the multilayer itself instead of a filter, one can expect to improve the optical throughput of the system.

Concerning HHG sources, we have developed previously several kinds of narrowband multilayers in order to select efficiently one harmonics in the spectral range 30 nm to 50 nm [1]. Reflectivity higher than 20% and rejection of the neighboring harmonics near 10 have been obtained experimentally for harmonics 17 to 25 (wavelength range : 32 - 47 nm). Nevertheless, these multilayers present relatively high reflectance at higher wavelength (50-100 nm range) where low harmonics are generated with high intensities. We present here an approach for improving spectral purity of these multilayers by using optimized SiO_2 top layers on the multilayer stack. The goal is to minimize the reflectance of the mirror in the high wavelength range while preserving a high reflectivity and selectivity for the Bragg peak. Two examples of realization will be described: B4C/Si multilayers for selection of harmonic 25 at 32nm and Sc/Si multilayers for selection of harmonic 19 at 42 nm. In both cases, we have used SiO_2 top layers deposited by reactive magnetron sputtering and the thickness of these top layers has been optimized in order to get reflectance lower than 2% up to 100 nm. The study and the optimization of deposition parameters of SiO_2 thin films will be presented. Experimental results measured on ELETTRA synchrotron radiation source (BEAR beamline) will be compared with theoretical simulations.

Concerning EPMA application, there is a need to have multilayers for selection of low Z material lines (as N Kα emission line at 3.16 nm) with a good attenuation of the Si Lα emission line which is usually the main signal emitted from the sample. We have developped Cr/Sc multilayers working at 23° grazing angle with reflectivity of 40% at 3.16 nm. Unfortunatley, these multilayers reflect about 5% at the Si emission line. In this case, we have used SiO_2 top layer in order to minimize the reflectance of the multilayer for the Si Lα emission line. Reflectances of multilayers with and without SiO_2 top layer have been measured on ALS 6.3.2 beamline at the N Kα emission line and at the Si Lα emission line.

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