Multilayers on sculptured surfaces

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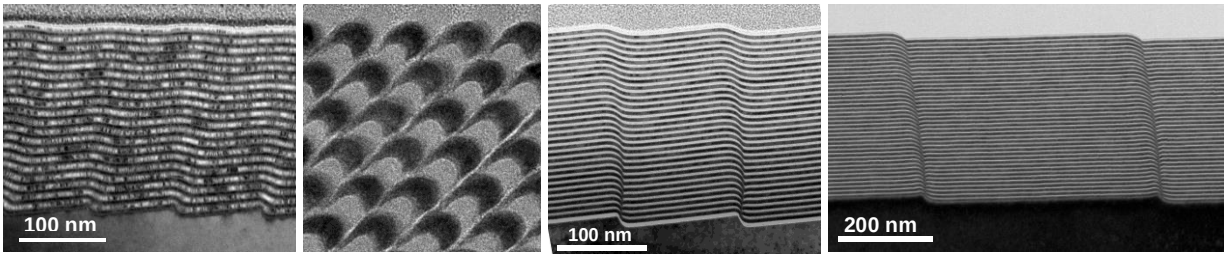
Multilayers grown on substrates with sculptured surfaces offer new functionalities and allow novel advanced x-ray optics and instrumentation. For example, multilayers deposited on saw-tooth substrates enable high efficiency Multilayer Blazed Gratings (MBG) which are a key component for high throughput and high resolution EUV and soft x-rays spectrometers. Understanding the fundamentals of x-ray diffraction in a sculptured multilayer stack and investigation of the growth of the multilayers on highly corrugated surfaces are of great importance for design optimization and performance of the MBGs.

We found by simulations and experiments that diffraction in MBGs corresponds to asymmetric Bragg diffraction of x-rays with specific refraction effects which depend on diffraction geometry and might significantly differ from the ones for the symmetrical diffraction in plane multilayers. The asymmetrical refraction alters the resonance wavelength, bandwidth, effective blaze angle, and diffraction efficiency of MBGs.

Investigation of the growth of the multilayers on sculptured substrates allows proper optimization of the deposition process to avoid excessive smoothing or shadowing effects dominating the multilayer stack (see TEM images below). The optimal growth regime provides almost perfect replication of the saw-tooth substrate by the multilayer interfaces and allows absolute diffraction efficiency close to the theoretical one. This work was supported by the US Department of Energy under contract number DE-AC02-05CH11231.



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