Ultra-dense multilayer-coated diffraction gratings for EUV and soft X-rays

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ABSTRACT

Diffraction gratings with high efficiency and high groove density are required for EUV and soft x-ray spectroscopy techniques (such as Resonant Inelastic X-ray Scattering**,** RIXS) designed for state-of-the-art spectral resolution and throughput. We report on recent progress achieved at the Advanced Light Source (ALS) in development of ultra-dense multilayer coated blazed (MCB) gratings.

In order to fabricate a high quality MCB grating, one should address two main challenges. The first one is to fabricate nano-period saw-tooth substrates with perfect groove profile and atomically smooth surface of the blazed facets. The second challenge relates to uniformed deposition of a multilayer on a highly corrugated surface of the substrates. We show that the required saw-tooth substrates with groove density up to 10,000 lines/mm can be fabricated using high resolution interference and e-beam lithography techniques followed by wet anisotropic etching of silicon. Peculiarities of growth on the saw-tooth substrates of a variety of multilayers, optimized to provide high diffraction efficiency in EUV wavelength range, are also under throughout investigation. With cross-sectional TEM we reveal a transformation of the structure of the multilayer stack, consisting in smoothing of the groove profile of a coated grating. The multilayer profiles measured with the TEM are used for diffraction efficiency simulations and investigation of the impact of the smoothing on grating performance. Thus, we show that a strong smoothing of the grating grooves results in deterioration of the blazing ability of the gratings. This work was supported by the US Department of Energy under contract number DE-AC02-05CH11231.

Key words: diffraction grating, multilayer coating, interference lithography, electron beam lithography, wet anisotropic etch, EUV, soft x-rays, TEM