Fabrication and characterization of high efficiency multilayer-coated blazed gratings for EUV range*

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Abstract:

Multilayer coated blazed gratings with high groove density are the most promising candidate for high resolution EUV and soft x-ray spectroscopy. They combine the ability of blazed gratings to concentrate almost all diffraction energy in a desired high diffraction order with high reflectance of EUV and soft x-ray multilayers. The gratings however have to be of superior quality in order to realize their potential. Thus, the grating fabrication process should provide a perfect triangle groove profile and extremely smooth surface of the blazed facets. Here we report on recent progress in fabrication and characterization of the gratings designed for EUV applications. The gratings having groove density from 5000 to 10000 lines/mm were fabricated with scanning beam interference lithography or electron beam lithography followed by wet anisotropic etch of silicon wafers and multilayer deposition. The groove surface morphology was characterized with AFM and SEM, and evolution of the structure of the multilayer stack in the course of multilayer deposition onto the corrugated surface of the blazed grating was studied with TEM (Fig. 1). The grating diffraction efficiency measurements were performed at the ALS beam line 6.3.2. The grating coated with the Mo/Si multilayer composed of 30 bi-layers demonstrated diffraction efficiency more than 37% in the 3rd diffraction order (Fig. 2). An impact of groove profile imperfections and perturbations of the multilayer stack was also investigated via efficiency simulations with PCGrate 6.1 code. The results of the study show good prospects to extend the technology towards soft x-rays.

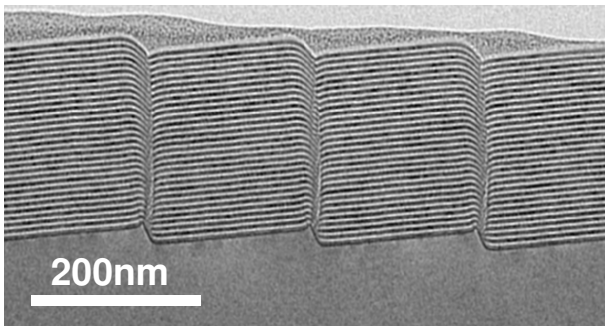

Figure 1: Cross-section TEM image of the 200 nm period blazed grating coated with a Mo/Si multilayer composed of 30 bi-layers.

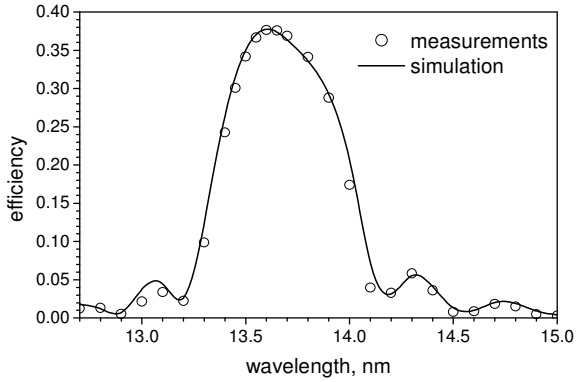

Figure 2: Efficiency of the 3rd diffraction order of the Mo/Si coated blazed grating versus the wavelength.