Reduction of interlayer thickness by low-temperature deposition of Mo/Si multilayer mirrors for X-ray reflection

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Abstract

Thin interlayers are essential for high-quality multilayer optics. The influence of cooling the substrate, with liquid nitrogen during the deposition, on the formation of interlayers of Mo/Si multilayer structures has been investigated using Grazing Incidence X-ray Reflection (GIXR), Wide Angle X-ray Diffraction (WAXRD) and X-ray Photoelectron Spectroscopy (XPS) depth profiling. Remarkably, even after warming up the samples to room temperature prior to analysis, the interlayers that formed upon cryogenic deposition were found to be nearly 60% thinner compared to those formed during deposition at room temperature. This reduction can increase the reflectivity of a Mo/Si multilayer mirror significantly from typically 69 % to 71 %. The thickness reduction at low temperature and its preservation upon warming up are attributed to the crystallization of Mo, a lower mobility of adatoms and/or reduced surface segregation of Si during Mo-on-Si growth. Although investigated only for Mo/Si multilayer structures, cryogenic deposition is promising for any (multilayer) application where thin interlayers are desirable.

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