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Stress optimization of multilayer Laue lens coatings

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Abstract

The application of thin film coating processes for the fabrication of diffractive X-ray optical elements like sputtered-sliced zone plates or multilayer Laue lenses (MLL) is a very promising approach for X-ray focusing down to spot sizes of < 10 nm. However, for practical useful focal length in the order of millimeters or decimeters, multilayer thicknesses of several 10 µm up to a few 100 µm are necessary in order to have large enough numerical apertures of the optical systems.

Currently one of the main challenges is to coat low-stress multilayers with large total thickness in the order of 100 µm. Usually sputter deposition results in thin films with significant compressive stress [1,2]. With increasing thickness of the coatings the risk for delamination, micro cracks and geometric deformation steeply rises. In order to avoid these problems, a new silicon-based multilayer system has been developed that shows low stress with absolute values < 50 MPa. This has been obtained in a broad bilayer thickness range between 5 and 50 nm necessary for multilayer Laue lens designs with focal length of about 10 mm. Additionally, the thermal stability, the change of the internal stress with temperature and the microroughness have been characterized for these multilayers.

[1] C. Liu et al.: „Film stress studies and the multilayer Laue lens project“, Proc. SPIE 63170J-1 (2006)
[2] K. MacArthur et al.: „Periodic variation of stress in sputter deposited Si/WSi_2 multilayers“, Appl. Phys. Lett. 99, 081905 (2011)

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