Plug-in MLL optics with long working distances for X-ray Nanodiffraction experiments

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MLLs for high resolution X-Ray Nanoprobes

MLLs (Multilayer Laue Lenses) are diffractive focusing and imaging optics made using thin film deposition and micromechanical preparation techniques such as magnetron sputter deposition and focused ion beam milling, respectively [1]. Two linear focusing MLLs can be combined to a point focusing and imaging device.

In recent years MLLs have shown their potential to achieve resolutions significantly better than 10 nm in hard x-ray microscopy and nanoprobes setups as well as relatively large efficiencies for the hard X-ray regime [2, 3]. A significant motivation of current MLL development is to make these optics feasible for experimental setups with bulky sample environments. This requires to make lenses with working distances of several millimeters. However, large working distances can be achieved only with long focal lengths, which reduce the numerical aperture and thus degrade the potential resolution. Furthermore, a reduction of the complexity of adjustments needed for MLL installation at beamlines is a major goal in recent developments.

We have developed a low stress multilayer system for MLL, based on Molybdenum, Carbon and Silicon. This system allows the multilayer deposition with a thickness of more than 100 micrometer and large diffraction efficiency [4]. A crossed MLL setup was assembled as an easy-to-install plug-in device, which achieved a sub 25 nm resolution in horizontal and vertical directions combined with a measured working distance of more than 100 micrometer and large diffraction efficiency [4].

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In-situ Measurements

µMechanical tests are used to study deformation mechanisms in individual micro-structural features of complex nanomaterials. In this experiment deformation fields were evaluated at different loads by nano X-ray diffraction measurements. In-plane stress distributions in CrNi and Cr sublayers reveal the stress concentrations induced especially by wedge indenter in CrNi sublayer and by notch in Cr sublayer. It is interesting to observe in-situ that the interfaces between the sublayers induce stress concentrations blunting.

References: