GISAXS-based Optimization of La/B₄C Multilayer Mirrors for Soft X–ray FELs. Matej Jergel, Peter Siffalovic, Eva Majkova, Livia Chitu, Stefan Luby, Karol Vegso, Stefan Hendel, Maike Lass, Marco D. Sacher, Wiebke Hachmann, Ulrich Heinzmann, Andreas Timmann, S. V. Roth, Institute of Physics, Comenius University, Bratislava, Slovak Republic. 4Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava, Slovak Republic. 5Faculty of Physics, University of Bielefeld, Bielefeld, Germany. 6HASYLAB/DESY, Hamburg, Germany.

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Lanthanum based multilayer mirrors are a convenient choice for the soft X-ray energy range. In addition to conventional periodic mirrors, aperiodic (chirped) broadband multilayers are needed to process extremely short light pulses from free-electron lasers (FELs) or high harmonic laser radiation. Here, smooth and narrow interfaces are of primary importance. Ion beam polishing (IBP) proved to be an efficient way to enhance the interface quality in multilayers. UHV electron beam evaporation is one of the few techniques compatible with IBP. We studied the effect of IBP with Kr⁺ ions in UHV deposited La/B₄C multilayers. These multilayers are applicable in the 100-190 eV energy range which fits well the spectrum of FLASH facility in Hamburg. Periodic multilayers (nominal period 3.5 nm) were chosen for pilot studies to facilitate evaluations. Basic multilayer parameters were obtained from the specular X-ray reflectivity completed by high-resolution transmission electron microscopy. Grazing incidence SAXS (GISAXS) measurements were performed at HASYLAB BW4 beamline. Analyses of GISAXS patterns (Fig. 1) showed presence of vertically correlated and uncorrelated roughness with lateral periods of ~42 nm and ~13 nm, respectively. The ability to reveal coexistence of both types of roughness is a unique feature of GISAXS. The polishing of La layers brought about a reduction of both lateral and vertical roughness correlations starting from high frequencies and suppression of the diffuse scattering while the polishing of B₄C layers had negligible effect. The implications for preparation of chirped La/B₄C multilayers are straightforward.

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Keywords: magnetism; DFT; pseudopotential

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phases. We observe additionally, that moderate oxidation makes the surface oxide layer reconstruct in the form of $2\sqrt{3} \ (1\times1)$ – R30° which produces a unit cell that is 12 times larger than that of the unreconstructed hexagonal corundum structure. As the oxidation proceeds, the diffraction patterns are strongly modulated by the contribution of antiphase boundaries separating the domains. It is essential to keep the temperature around 700 K while oxidation in order to promote Al segregation to the surface that required for the formation of the oxide. We make attempts to understand these observations in terms of structural details of the quasicrystal-oxide interface. We also emphasize the possibility of using these well-ordered islands as substrates for generating quantum-wells [3]. Since the film thickness can easily be controlled, these interfaces help us investigate finite-size effects in quantum-well structures.


Keywords: oxide surfaces; low-energy electron diffraction; quasicrystals