Small d-spacing Mo/B_4C multilayers: stress study

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Recent developments at FLASH (Free Electron LASer at DESY in Hamburg, Germany) required overlapping pulsed THz (pump) and soft X-ray (probe) beams on the sample for pump-probe experiments. FLASH's beam of 7 nm wavelength had to be reflected, focused and monochromatized at the same time. For this application we developed a narrow bandwidth multilayer for normal incidence geometry consisting of Mo/B_4C with period thickness of about 3 nm. The final optic was a 1" diameter spherical mirror with 2 m focal length.

The multilayers were coated using magnetron sputtering sources in multilayer laboratory at DESY (Deutsches Elektronen-Synchrotron). High energy resolution of this optic was of the uttermost importance with desired value of $\Delta E/E = \sim 3 \times 10^{-3}$. Smooth interfaces, stable deposition rates and high quality substrates are prerequisites to achieve this resolution. In addition, we optimized the number of bilayers and Γ (thickness of Mo/period thickness) value. The multilayer design required very small Γ (<0.1). Such multilayers had stress > 2 GPa, which limited the number of bilayers we could deposit without peeling or cracking the multilayer from the substrate. To reduce stress we studied the effect of post-deposition thermal annealing on these multilayers. We'll present and discuss results from stress, small angle XRD, microstructure and synchrotron reflectivity measurements as a function of annealing temperature and time.