Structural and reflective characteristics of Mo/Be multilayer with barrier layers

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Mo/Be multilayer structure (MLS) was actively studied in the late 90s, early 2000s in connection with work on the lithography in the wavelength range of 11.2-11.4 nm. In particular, [1] reported on achieved reflectance at a wavelength of 11.3 nm about 70.1% at normal incidence. The theoretical limit of the reflection coefficient for this pair of materials reaches about 76%. In succeeding years these studies almost not conducted perhaps because of the fact that the wavelength of 13.5 nm and a Mo/Si MLS have been chosen as the most promising for the lithography.

However, active researches in recent years to find a shorter wavelength for next generation lithography [2,3], as well as increased demands to the multilayer mirrors for solar studies in the spectral range of 11-13 nm [4] forced to turn again to this promising pair of materials .

Present work has the following objectives. The first goal is to find out the reasons why the experimentally obtained reflectance of Mo/Be MLSs is relatively low as compared with the theoretical limit. To solve this problem using methods of small-angle scattering of X-rays with a wavelength of 0.154 nm, precision laboratory and synchrotron radiation reflectometry in the spectral range of 11-13 nm, and atomic force microscopy we studied in detail the internal structure of Mo/Be MLSs. As the structural parameters we considered: the profile of the dielectric constant within the unit cell (period) of the MLS, the interfacial surface roughness (component of the transition layer), and the profile of the dielectric constant in the upper (outer) period. When reconstructing the dielectric constant profiles using the X-ray reflection data we used both a model and a model-free approach.

The second goal is the search for optimal materials and thicknesses of the barrier layers to reduce the interlayer transition areas. In this work, as the materials of the barrier layers Si and B_4C were studied.

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