Cr/Sc/B_4C multilayer mirrors with enhanced reflectance in “water window”

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Cr/Sc multilayer mirrors (MLSs) are widely used in microscopes for the “water window” range, mainly as radiation collectors paired to the Fresnel zone plate, which plays the role of a lens. Recently, it was shown in [1] that a full-mirror microscope based on the Schwarzschild objective, due to its small depth of focus, has significant advantages over the Fresnel zone plate based microscope and allows reconstruction of the 3D cell structure with a resolution better than 40 nm using simple z-tomography. Since in the scheme of the microscope there are three multi-layer mirrors, the result strongly depends on their reflectivity. In Ref. [2], a reflection coefficient of 23% at 3.12 nm wavelength using Cr/Sc MLS with B_4C barrier layers is reported, which is of interest.

This paper is devoted to a systematic study of the effect of B_4C interlayers on the reflection, X-ray scattering and interfaces in Cr/Sc MLS. It is shown that B_4C interlayers reduce interlayer roughness. In contrast to [2], the maximum of the reflection coefficients is reached when applying the interlayers on Sc. Fig. 1 illustrates this effect. Figure 1 a) shows the angular dependences of the Cr/Sc MLS reflectance measured on a laboratory reflectometer at a wavelength of 3.14 nm (line Ti Lα). The lower curve corresponds to MLS without interlayer, the upper curve – with B_4C interlayer. The reflection coefficient was about 20%. Taking into account the spectral resolution of the reflectometer, at the level of 0.014 nm, as well as a strong dispersion of the optical constants Sc when approaching the L-absorption edge, one can expect a significantly larger reflection coefficient at a wavelength of 3.12 nm. Figure 1 b) shows the indicatrices of diffuse scattering of radiation with a wavelength of 0.154 nm from Cr/Sc, Cr/B_4C/Sc and Sc/B_4C/Cr MLSs. As can be seen, Sc/B_4C/Cr MLS has a maximum reflection, and scattering is almost an order of magnitude less than that of Cr/Sc.

The report will present the results of measurements made on the BESSY II synchrotron with high spectral resolution and in the vicinity of 3.12 nm. Also, the results of studies of the continuity of Cr films depending on their thickness will be presented.

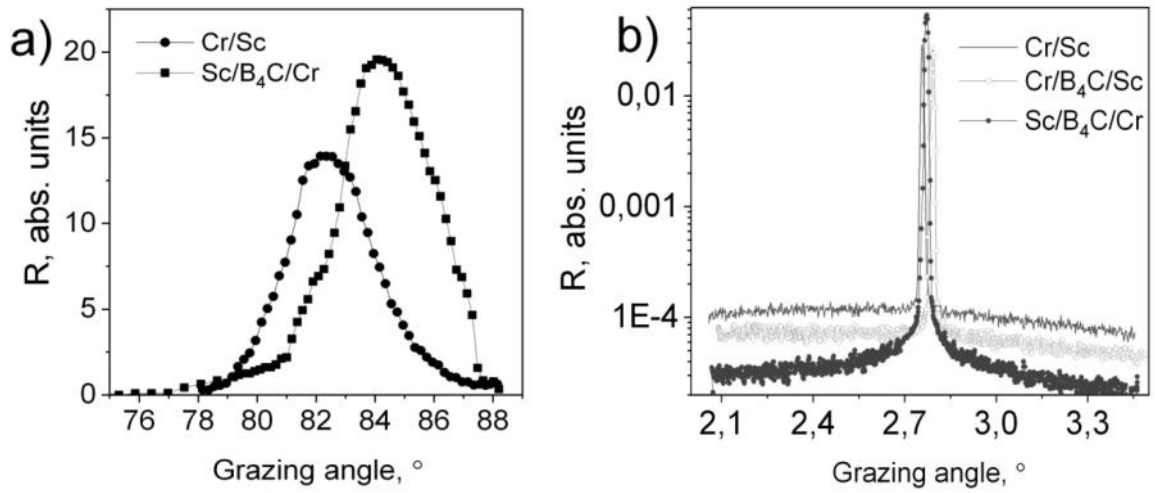

Fig. 1. Reflectance at λ=3.14 nm - a) and diffusion scattering at λ=0.154 nm - b) of MLSs with B_4C interlayers as compared with pure Cr/Sc.

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