PHASE AND CHEMICAL COMPOSITION OF INTERLAYERS IN W/Si MULTILAYER X-RAY MIRRORS

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Multilayer X-ray mirrors (MXMs) are effective optical elements reflecting the X-ray radiation in the wavelength range from ~0.01 to ~70 nm. MXMs are used as deflecting, focusing, polarizing and dispersing elements in such areas of science and technology as material science, medicine, biology, astrophysics, physics of plasma, X-ray lithography etc. Tungsten/silicon MXMs are widespread to reflect waves in the range of 0.7-3.1 nm due to a possibility to utilize them in the chemical analysis of light elements. The real mirrors have different structure defects that reduce efficiency of mirrors. Their main defect is interlayers which are formed already at the stage of production. Therefore recognizing, taking into consideration and reducing the influence of such interlayers are actual to increase the efficiency of W/Si MXMs.

The purpose of this work is to determine parameters and structure of interlayers in W/Si MXMs.

W/Si MXMs with periods of 1.0-6.2 nm were deposited by direct current magnetron sputtering and studied at the X-ray diffractometer with Cu$K\alpha_1$ radiation (λ=0.154 nm). Analysis of wide angle diffraction curves was done in order to plot the radial distributions functions of atoms (RDFA) for all interlayers. The average densities of MXMs were determined by a respective critical angle in the region of total external reflection. The radii of the first coordination sphere and coordination numbers (N) were obtained from RDFA analysis.

It was established that during the deposition of W layers with a nominal thickness of t_W<0.9 nm on amorphous Si layers the amorphous hexagonal WSi_2 interlayers (N≈5) are formed. In samples with t_W>1.2 nm between top and bottom interlayers the layers of amorphous tungsten with a primary structure of β-W (N≈9) appear. Obtained data allows improving the X-ray optical characteristics of MXMs. In the result of calculations and findings it is possible to build an updated model of the MXM structure with t_W>0.4 nm (fig. 1).

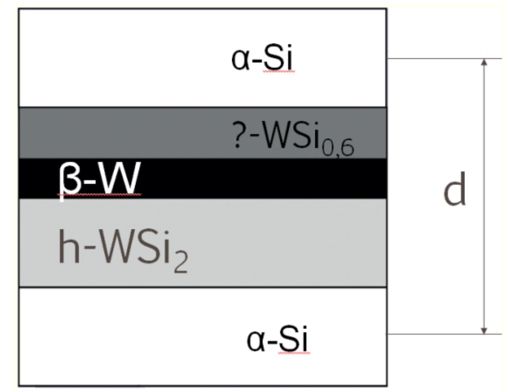

Fig.1 - Updated structural model of the W/Si MXM with t_W>1.2 nm.