Nanocomposites and nanomaterials

Growth and structure of Zr/Mg multilayer x-ray mirrors

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Multilayer X-ray mirrors (MXM) providing a high level of reflectance in the wavelength range of 25-35 nm and 0.9-2.5 nm are of great interest for astrophysics and X-ray Spectroscopy. The first part of the spectrum is the most informative for the diagnostics of the Sun coronal plasma. The second one is used for controlling Mg, Na, F, O content in steel, aluminum and magnesium alloys.

In the mentioned wavelength ranges Mg-based MXMs are the most effective. In order to create mirrors with high reflectance it is important to diminish the imperfection (discontinuousness of layers, interlayer roughness, presence of mixed zones) in the multilayers. So the aim of this paper is to study growth features and the structure of the nanosized magnesium layers in the Zr/Mg MXMs.

Zr/Mg MXMs on glass substrates were fabricated by DC magnetron sputtering. The structure of the coatings was studied by X-ray diffraction methods. It is found that magnesium and zirconium layers grow epitaxially and have a texture with (002) plane parallel to the film surface. At thicknesses of magnesium layers more than 5 nm, Zr/Mg MXMs are characterized by a high level of periodicity, low level of interlayer roughness (σ <0.4 nm) and absence of interlayer interaction. At a thickness of less than 5 nm, the Mg layers are discontinuous. Several facts confirm this. The first one is the results of calculating the superstructural satellite intensity ratio on the coherent X-ray scattering patterns. The second fact is low intensity of the first Bragg satellite on the small-angle X-Ray diffraction in comparison with the theoretical one.

Studies show that a pair of materials Zr-Mg is promising for the creation of MXMs for of 25-35 nm wavelength range.

The possibility to analyze the coherent X-ray scattering pattern for obtaining information on the layer growth, in particular for plotting a concentration profile, was demonstrated for the first time.