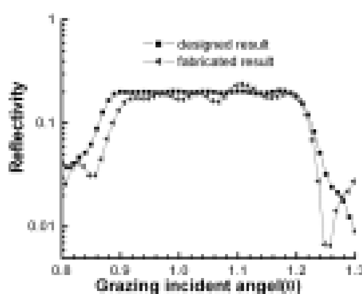
Fabrication and characterization of Depth-graded X-ray multilayers

Wang Zhanshan, Wang Fengli, Zhang Zhong, Wang Hongchang, Chen Lingyan

Institute of Precision Optical Engineering, Physics Department, Tongji University, No 1239 Siping Road, Shanghai, 200092, China
Tel and Fax: 021-65984652, e-mail: wangzs@mail.tongji.edu.cn

Depth-graded X-ray multilayer structures (also called supermirror), including nanometer scale layers, have currently been developed to provide broadband reflectivity for a variety of applications including synchrotron radiation and medical optics, and in particular for space-borne astronomical hard X-ray telescopes above 20keV. In the depth-graded X-ray multilayer, the layer thicknesses vary with depth into the film (in contrast to a periodic X-ray multilayer), so that the incident wavelength will penetrate deeply into the stack with minimal loss and reflect efficiently from as many interfaces as possible. The aim that we design depth-graded W/B_4C multilayers is to have a high and flat reflectivity in the grazing incident angle range of 0.9-1.2° at the wavelength of 0.154nm by using the Kozhevnikov's design method. The depth-graded W/B_4C multilayers were fabricated by using a high vacuum DC magnetron sputtering coater model JGP560C6 made in China. The base pressure is less than 8×10^{-5}Pa in the process of deposition. The working gas is Ar gas, the purity of which is larger than 99.99%, and the working pressure is 0.27Pa. The distance between targets and substrates is 80mm. The power of W and B_4C target are 20W and 130W respectively. The deposition rate of W is 0.47nm/s，and the one of B_4C is 0.32nm/s at above condition. According to the deposition rate, the computer controls the time needed to stay over each target for making depth-graded multilayers. The depth-graded X-ray multilayers fabricated by us were characterized by X-ray reflectivity measurements on a laboratory X-ray diffractometer . The angular resolution of the diffractometer is ~0.004°. Figure 1 shows the specular reflectivity around the first Bragg maximum of the samples as a function of the incident angle at the wavelength of 0.154nm. The Figure shows how the experimental result is close to the design.



Keywords: depth-graded multilayers, magnetron sputtering, X-ray diffractometer