Short Period (< 3 nm) Multilayers of BN/Ni and Si/W For X-Ray Applications.

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Increased effort is currently directed toward producing smaller d-spacing x-ray multilayer optics with high reflectivity. Although inherent atomic roughness and interface diffusion are intrinsic limitations, optics with bilayer periods less than 3 nm with well defined structure and optical properties have been reported [1]. Of several material combinations (BN, B4C, C, Si, Cr, Fe, Co, Ni, Ag, and W) that we have attempted to use for optics with these repeat distanc es, BN/Ni and Si/W have yielded the best results to date and are the focus of this report.

In our work, dual ion beam assisted deposition (DIBAD) methods at low ambient pressure (~ 10-4 Torr) were used to produce short-period multilayer optics with good results. The optical elements produced were 20 to 100 layer pair structures on high quality float glass, silicon wafers, and superpolished fused silica substrates. In the DIBAD technique, material is sputtered from source target to sample substrate by an argon beam with energies up to 1200 ev and currents up to 100 mA. Simultaneously, a second argon beam, directed at the sample, smoothes the surface and densifies the layered materials. Computer controlled deposition parameters provide excellent run-duration stability and day-to-day reproducibility. Resulting d-spacings throughout the multilayer stacks are within 0.01 nm and day-to-day targeted d- spacings are within a 0.1 nm.

High resolution x-ray reflect ometry at 8.05 keV (λ = 0.154 nm) was used to measure the specular and diffuse reflectivity for these multilayers. Structure, optical properties, interface roughness, and density are determined from these data. Data from a series of similar depositions gave d-spacing deviations from projected values allowing measurement of the development of interface layers. Results from diffuse x-ray scattering measurements provided estimates of interface roughness. At-wavelength performance was evaluated using selected optics as monochromators in 1 keV (λ ~ 1 nm) x-ray applications.

[1] Fedorenko, A. I., V. V. Kondratenko, Yu, P. Pershin, O. V. Poltseva, E. N. Zubarev, L. L. Balakireva, V. V. Didyk, V. V.Burtsev, Structure and Optical Properties of Multilayer X-ray Mirrors for Long Wave Part (3.1-4.4 nm) of Water Window, Cryst. Res. Technol. 29, 8, 1139-1147, 1994.