Structural analysis of ion polished W/Si soft X-ray multilayer reflectors

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We studied the effect of ion polishing in sputter-deposited W/Si multilayer mirrors with a period of 2.5 nm for X-ray fluorescence applications. 0.1 to 0.5 nm of Si were etched with 100 eV Ar+ ions. This process resulted in a pronounced reduction in diffused scattering, measured at wavelengths about 0.1 nm. However, soft X-ray specular reflectivity at 0.84 and 2.4nm did not show significant changes after the ion polishing as compared to the non-polished structures. Grazing incidence X-ray reflectivity analysis revealed that there was no pure W present in the deposited multilayers, with a WSix silicide being formed instead. As a result, it was concluded that the initial roughness in W/Si multilayers grown by magnetron sputtering is not the major factor in the reflectivity loss of W/Si multilayers compared to an ideal system. Nevertheless, the GISAXS analysis revealed that ion polishing significantly reduces the vertical propagation of roughness from layer to layer, as well as favorably affects the lateral correlation length and Hurst parameter. These improvements explain the reduction of diffused X-ray scattering at 0.1 nm by more than an order of magnitude, which is relevant for applications like high-resolution XRD analysis.