Ion implantation into ZrNb nanometric multilayers

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Zr/Nb nanometric multilayers deposited on Si substrate by magnetron sputtering, having a periodicity from 6 to 167 nm were subjected to room temperature irradiation by carbon, silicon and copper ions. The mechanical proprieties, ion profiles, and disordering behavior have been investigated by Secondary Ion Mass Spectrometry - SIMS, nanoindentation, X-ray diffraction - XRD, and scanning transmission electron microscopy - STEM. The damaged regions are clearly visible on STEM bright field micrographs of cross-section lamellae prepared by focused ion beam technique - FIB. Damage starts from the surface side of the multilayer, and the most damaged and disordered zone is located close to the maximum ion concentration. Near the substrate, no damage was observed. The C and Si concentration profiles detected by SIMS were not affected by the nanolayers periodicity. This agrees with the Stopping and Range of Ions in Matter - SRIM software simulations. Diffraction analyses – selective area electron diffraction, and XRD suggest a structural evolution in relation to the multilayer periodicity. For the multilayer with a periodicity of 6 nm, and 27 nm, Si, C and Cu-ion irradiation led to a tensile strain in Nb layers and compressive strain in Zr layers. In contrast, for periodicity higher than 27 nm, both Zr and Nb layers are subjected to compressive out-of-plane strain.

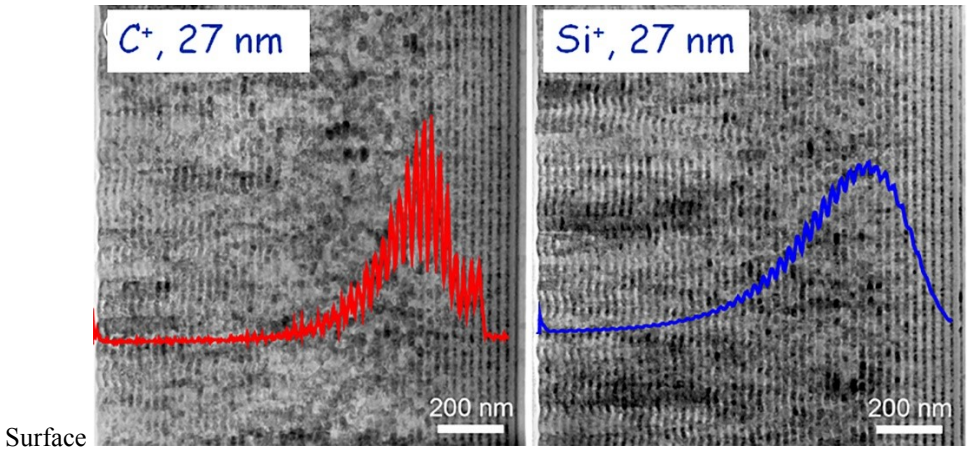

Figure 1. Highly damaged areas overlap with maximum ion concentrations detected by SIMS.

Keywords: Zr/Nb multilayers, ion irradiation, strain, XRD, SIMS