Investigation of defect structure distribution in the multilayer nanoscale self-healing coatings based on Zr/Nb layers after proton irradiation

A. Lider,[1] R. Laptev,[1] A. Lomigin[1] , Yu. Bordulev[1*], K. Siemek[2], A. Kobets[2] , M. Syrtanov[1] and E. Kashkarov[1]

[1]Division for Experimental Physics, National Research Tomsk Polytechnic University, Tomsk 634050, Russia
[2] Joint Institute for Nuclear Research, Joliot-Curie 6, Dubna, 141980, Russia

Multilayer nanoscale coatings (MNC) with different crystal structures are considered as capable to self-healing after radiation damage due to the recombination of vacancies and interstitials. Most of the MNC studies are focused on the interrelation of the structural and strength characteristics [1, 2], but do not include investigation of defect structure. This work is focused on defects distribution study in MNC based on Zr/Nb layers (25/25 and 100/100 nm) after proton irradiation. Coatings with the total thickness of about 1-1.5 microns were irradiated by 900 keV protons using linear electrostatic particle accelerator with the ion current of 2 μA during the time of 30 to 120 minutes. The influence of irradiation effect on the overall and, in particular defect structure was studied by X-ray diffraction analysis, discharge optical emission spectrometry and positron spectroscopy with the varied energy of positrons. It was shown, that defects concentration of MNC after proton irradiation does not increase and, in some cases shifts to the lower values. This effect can be explained by the presence of an incoherent two-layer interface, which traps the defects. This effect is more evident in the samples with the larger number of such interfaces (25/25 nm samples, see Figure 1).

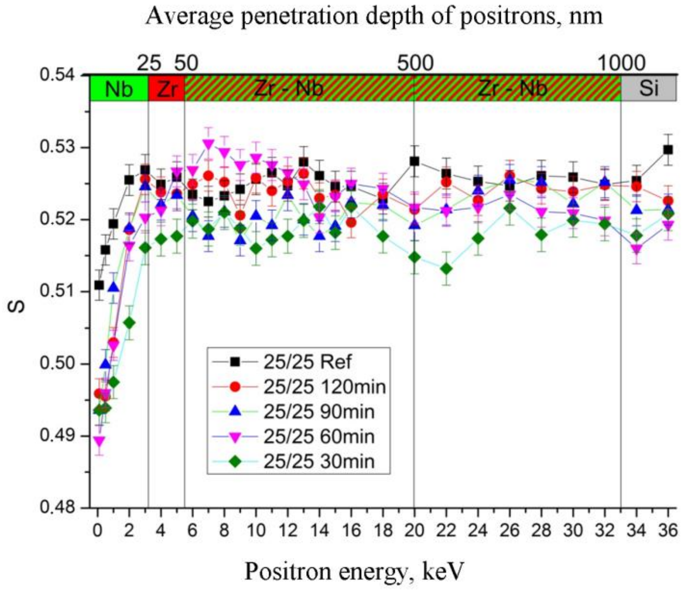

Figure 1 *Dependence of S-parameter on positron energy in multilayered Zr/Nb coatings with the layers thickness of 25 nm and different proton irradiation time.*

References
[1] M. Callisti, S. Lozano-Perez, and T. Polcar, *Materials Letters.* **163**, 138 (2016).
[2] M. Callisti, M. Karlik and M. Polcar, *ScriptaMaterialia*, **152**, 31 (2018).

*Corresponding author, Email: bus@tpu.ru