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STRUCTURE AND PROPERTIES OF GLASSY SURFACE LAYERS OF TINI SUBSTRATE FABRICATED THROUGH HIGH-DOSE ION IMPLANTATION*

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TiNi shape memory alloys (SMAs) are known to be smart materials utilized for fabrication of tiny medical instruments for small invasive surgery. This is due to the fact that TiNi SMA exhibits thermoelastic martensitic transformations, and its mechanical behavior is similar to the mechanical response of biological tissues. However, the issue of the assessment of biodegradation and corrosion properties of these alloys in the physiological environment is still under debate because release of toxic nickel ions could initiate inflammatory processes. Therefore, the formation of ultrastable oxide layers on the TiNi alloy surface, which prevents the nickel release into the biological environment, is an extremely urgent task. The method of ion implantation has a great potential for modifying the phase and chemical composition of TiNi SMAs [1–3] in order to improve corrosion properties and biocompatibility. In the current study, the approach of synthesis of barrier oxide layers on TiNi surface through ion-beam implantation of titanium was performed, and the detailed characterization of structure and electrochemical properties of the modified surface layers was given by means of high-resolution TEM/SEM and modern electrochemical methods.

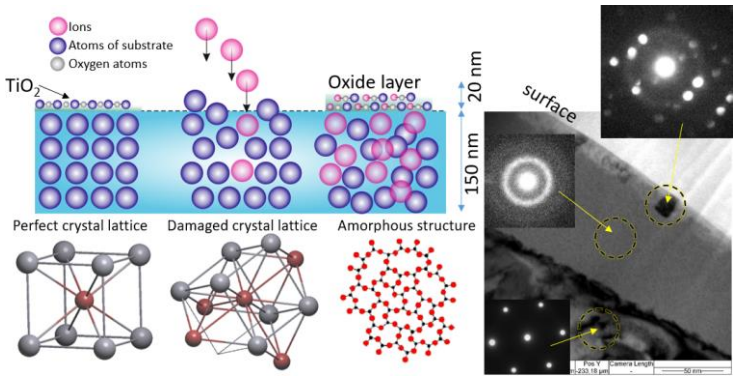

Fig.1. Scheme of ion implantation process of the TiNi alloy, leading to glass transition of a thin (up to 100 nm) surface layer. TEM images of the structure of the surface layer of the TiNi alloy after high-dose ($D=1\cdot10^{17}$ ion/cm^2) implantation with titanium.

The ion implantation of TiNi by titanium ions was carried out in the Laboratory of Plasma Sources (Institute of High Current Electronics, Tomsk) using a vacuum-arc ion source MEVVA-V.RU with a voltage of 30 kV, residual vacuum of $2\cdot10^{-4}$ Pa, at a pulse repetition rate of 10 Hz and an ion current density of 4.5 mA/cm^2. Material characterization was done in the center for the collective use «Nanotech» (Institute of Strength Physics and Materials Science, Tomsk).

The results (Fig. 1) have shown that ion implantation leads to the glass formation of a thin (100 nm) upper surface layer of TiNi substrate, when the dose of irradiation reaches $D=1\cdot10^{17}$ ion/cm^2. The nano-beam diffraction patterns indicate on the formation of a mixture of brookite TiO_2 and cubic TiO oxide phases on the sample surface. Data on corrosion properties (corrosion current, corrosion potential, breakdown potential, polarization resistance) demonstrate the advantage of ion implantation for improving the corrosion resistance.

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