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SYNTHESIS OF TI-6AL-4V SURFACE LAYER ALLOYED WITH Ag BY COMBINED ION-PLASMA TREATMENT

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Titanium alloys (in particularly Ti-6Al-4V) are widely used in the manufacture of medical implants. It is widely accepted that post-operative implant-related infections are associated with biofilm, dense extracellular polymeric substances produced by adherent microbial aggregates [1]. One of the widely adopted strategies is to incorporate antimicrobial agents into the implants. Common methods for improving the antibacterial properties of the implants surface include plasma spray, magnetron sputtering, microarc oxidization [2], etc. It is known that Ag atoms are effective as a broad-spectrum bactericide even against drug-resistant strains [1, 3]. Thus improvement of antibacterial properties can be achieved by additional surface alloying of the Ti-6Al-4V alloy with argentum atoms.

The formation of a titanium-based surface alloy containing argentum was carried out by preliminary deposition of a argentum coating with a thickness of ~ 2 μm on samples of the Ti-6Al-4V alloy by the method of vacuum cathode-arc deposition and subsequent exposure to compression plasma flows (CPF). The samples were processed by three pulses of CPF generated in the nitrogen atmosphere. Energy density absorbed by the surface was varied from 26 to 43 J/cm^2 per pulse. The surface morphology of the samples was studied using scanning electron microscopy. The elemental composition of the samples was determined by X-ray spectral microanalysis (X-ray microanalysis) using Oxford X-ray detector coupled to a scanning electron microscope. The phase composition was investigated by X-ray diffraction analysis.

It has been established that the impact of the CPF on the Ag/Ti-6Al-4V system led to the formation a surface titanium layer alloyed by aluminum, vanadium, and silver with a uniform distribution of elements. The findings showed that plasma treatment resulted in the formation of α-Ti solid solution containing alloying elements in the surface layer and δ-TiN on the surface. The surface nitride film had a dendritic structure in all processing modes, which is associated with crystallization under conditions of a high cooling rate. The phase and elemental composition of the formed surface alloy depended on the energy absorbed by the surface layer. Growth of the energy absorbed by the surface led to decrease of silver concentration (from 20 to 7 wt.%).

The mechanisms and the reasons of the observed effects were discussed.

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