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THE EFFECT OF FLUENCE ON THE PENETRATION DEPTH OF COPPER TO TITANIUM SUBSTRATE UNDER ION TREATMENT

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Any production cycle of coating deposition usually includes the step of pretreating sample surfaces. For this purpose, a direct flow of inert gas ions generated by ion sources is used. Pre-ion nanostructuring of a metal substrate can be a promising way to increase adhesion strength of heat-shielding coatings [1,2]. We have shown that bombardment of a copper substrate by intensive ion beams of metals with the energy of 3 keV can lead to increased adhesion and crush the structure of the nanocomposite Si−Al−N coatings [3].

Ion-beam treatment does not only modify the structure of the surface layer of a substrate, but also changes its morphology, chemical and phase composition. It is of interest to identify the role of each of these factors [4]. In addition, the state of the substrate surface can significantly affect the formation of the structure and properties of the coating proper [4]. The purpose of this work is to study the structural-phase state of the surface layer of a titanium substrate modified by copper ions and special attention is paid to the effect of fluence on the penetration depth of copper during ion treatment by titanium.

The structure and phase composition of the ion-modified layers of the samples was researched by the TEM method using a JEOL-2100 device (Jeol Ltd., Japan). Foils for the TEM studies were prepared by the cross-section method using an Ion Slicer EM-09100IS (Jeol Ltd., Japan). The elemental composition of the coatings was determined by the energy dispersive X-ray analysis using a microanalyzer INCA-Energy (Oxford Instruments) with the built-in TEM JEOL-2100.

The surface bombardment by the copper ions leads to a change in the surface morphology of titanium substrate. First, small etching deepening appear in the surface layer, then they become deeper and finally, complex pores appear in the material of the surface layer of the substrate.

It has been shown by the X-ray and TEM that there are the intermetallide phases of the Cu-Ti system in the surface layer when titanium is treated by copper. With shorter times of the ionic treatment there are phases enriched with copper (Cu_3Ti). Under increased treatment duration there are phases such as Cu_4Ti_3 and Cu_4Ti. When the maximum treatment time is 7.5 min the reflexes of the CuTi phase become more intense than those of the copper substrate, i.e. almost the entire surface layer of the substrate turns into an intermetallic compound. The processes of ion etching, heating, radiation-stimulated diffusion in the surface layer of the metal substrate leads to a two-level micro- and nanoporous nanocrystalline structure.

It was established by energy dispersive X-ray analysis that the depth of penetration of copper into the titanium alloy at a processing time of 3 minutes is about 600 nm. At a treatment time of 6 minutes, the depth penetration copper to the titanium alloy is about 6 microns. A well-known long-range effect observed by the authors in is observed [4].

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