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COMPOSITION AND PROPERTIES OF PROTECTIVE LAYERS FORMED BY ION-PLASMA TREATMENT OF TITANIUM ALLOY[1]

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In this paper we investigated the possibility of obtaining chromium-containing layers on the surface of a BT1-0 titanium alloy using ion-plasma deposition, which contribute to increasing the resistance of the material to electrochemical corrosion. Titanium alloys can be used as a material for the manufacture of current collectors of fuel cells. In fuel cells of direct methanol and ethanol oxidation (DMFC and DEFC) the ion exchange membrane Nafion is used as an electrolyte, which is a fluorocarbon polymer containing sulfogroups. Under the operating conditions of the fuel cell, the surfaces of current collectors in contact with the membrane electrode assembly are subjected to electrochemical corrosion due to the high aggressiveness of the medium containing SO_4^- и F^- anions.

Chromium-containing layers on samples of titanium BT1-0 and current collectors made of it were obtained by two methods: ion-plasma deposition and ion beam assisted deposition. Ion-plasma formation of coatings was carried out by deposition from cathode arc erosion plasma generated by an arc source with a chromium cathode in a nitrogen medium – to obtain coatings from chromium nitride and carbon dioxide – to obtain coatings from chromium oxycarbide. The formation of surface layers using ion beam assisted deposition (IBAD) technology was carried out by deposition of chromium, as well as chromium and tin from a vacuum electric arc discharge plasma in a mode in which accelerated (U = 10 kV) ions of the deposited metal are used as assisting the deposition process.

The microstructure and composition of the obtained layers were studied using SEM, EDX and RBS (Fig. 1) methods. The corrosion resistance of titanium alloys with a surface modified in ion-plasma treatment processes to electrochemical corrosion in a solution of 1 M $H_2SO_4 + 2\times10^{-6}$ M HF at a temperature of 70–80°C, modeling the operating conditions of current collectors of fuel cells with a polymer membrane electrolyte Nafion is investigated (Fig. 2).

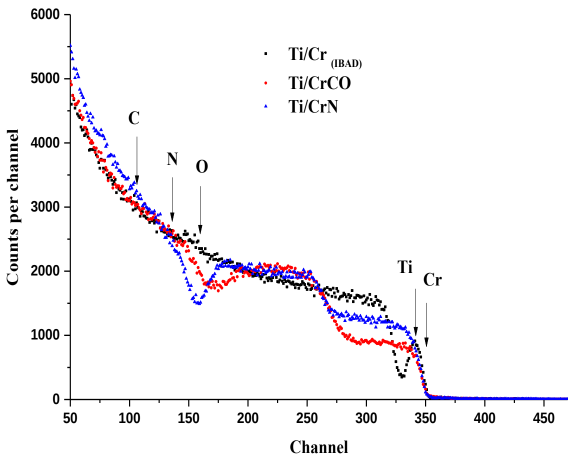

Fig. 1. RBS spectra of ^{4}He ions scattered by atomic nuclei of elements that make up titanium surfaces with layers formed by: chromium IBAD (Ti/Cr$_{(IBAD)}$); ion-plasma deposition of chromium oxycarbide (Ti/CrCO) and chromium nitride (Ti/CrN).

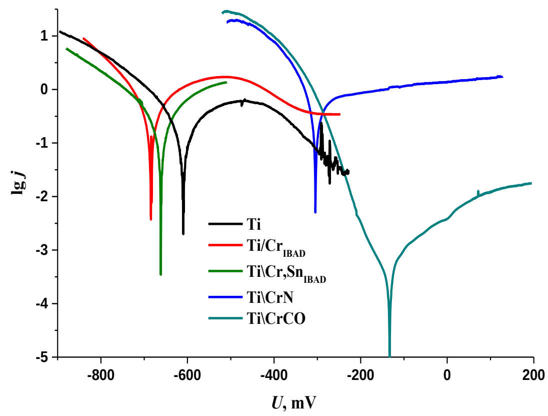

Fig. 2. Polarization curves of the investigated titanium samples in 1 M $H_2SO_4 + 2\times10^{-6}$ M HF solution.

IBAD of metals from vacuum arc discharge plasma ensures the formation of nanosice multicomponent layers and is characterized by one-stage operation, it does not lead to a significant increase in corrosion resistance, which may be due to the low chromium content and the small (~30 nm) thickness of the layers. A significant (by more than two orders of magnitude) decrease in the corrosion current density occurs for titanium with a coating formed by ion-plasma deposition of chromium oxycarbide (Ti\CrCO).

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