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COMPOSITION OF CATALYTIC LAYERS PREPARED BY ION BEAM ASSISTED DEPOSITION OF DYSPROSIUM AND PLATINUM FROM A PULSED ARC DISCHARGE PLASMA ONTO CARBON CATALYSTS CARRIERS [1]

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The aim of this work is to study the composition of the catalytic layers prepared on special carbon carriers of catalysts in the process of ion beam assisted deposition from plasma generated in metal vapors of a vacuum arc discharge, platinum as the main catalytic metal and dysprosium as an activating additive.

As substrates for the preparation of the studied layers we used special carbon materials: Toray Carbon Fiber Paper TGP-H-060 T and AVCarb® Carbon Fiber Paper, which are used as material of diffusion layers of the membrane electrode assemblies for low temperature fuel cells with a polymer membrane electrolyte. The plasma produced in metal vapors of a low-voltage vacuum arc discharge between two metal electrodes at their periodic contact was used to preparation surface catalytic layers by ion beam assisted deposition (IBAD) of dysprosium and platinum onto carbon fiber catalysts carriers. Formation of layers in IBAD mode, by means of the deposition of metal and mixing of precipitating layer with the substrate by accelerated (U = 5 kV) ions of the same metal, was carried out. Investigation of the composition of prepared layers was carried out by EDX, SEM, RBS and WD-XRF methods.

According to EDX (Fig. 1), RBS (Fig. 2) and XRF data, the atoms of deposited metals (Pt, Dy), carrier components (C, and F in the case of Toray Carbon Fiber Paper TGP-H-060 T hydrophobized with Teflon), and oxygen as an impurity is included in the composition of the layers. At the same time, the surfaces contain deposited metals inclusions with sizes of the order of a micrometer (Fig. 1), which arise from the precipitation of metal droplets from the arc discharge of the ion source. The distribution of oxygen over the surface correlates with the distribution of dysprosium (Fig. 1), which may indicate the formation of rare earth metal oxide.

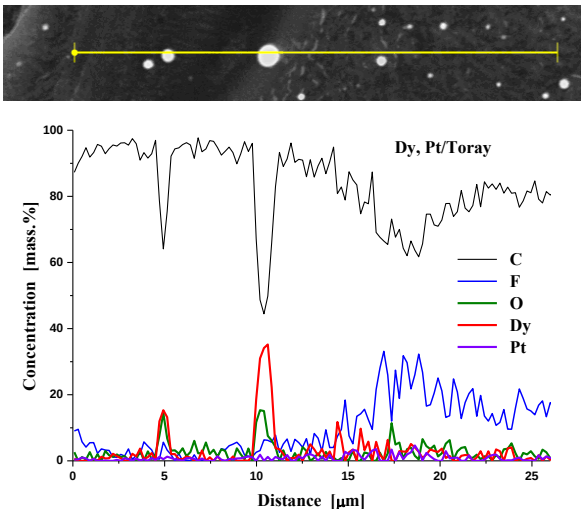

Fig. 1. Distribution of atoms of elements across the scanning line over the surface of Toray Carbon Fiber Paper TGP-H-060 T carrier with layer formed by the IBAD of dysprosium and platinum according EDX analysis.

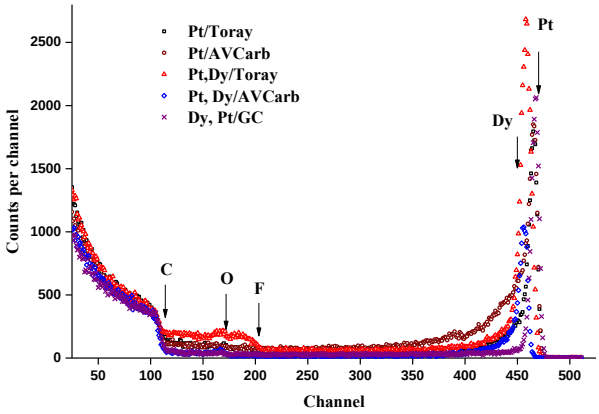

Fig. 2. RBS spectra of ^{4}He ions scattered by atomic nuclei of elements that make up layers obtained by IBAD of metals on Toray Carbon Fiber Paper TGP-H-060 T and AVCarb® Carbon Fiber Paper P500 T carriers, and dense carbon material – glassy carbon (GC).

The thickness of the prepared layers is ~50 nm; content of each of deposited metal atoms in the layers – ~(1–2) × 10^{16} cm^{-2}. In the maximum distribution located near the surface, the concentration of each of the deposited metals is about several atomic percent.

In the process of IBAD of metals in the proposed mode, ionic mixing of all components of the layer being formed takes place. Electrocatalysts with the prepared layers are active in the oxidation of methanol and ethanol reactions, which are the basis of the principle of operation of low-temperature fuel cells.

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