THE INVESTIGATION OF NANOSTRUCTURED COMPOSITE FE-CO-MOO$_X$ COATINGS BY AFM ANALYSIS

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The target electrosynthesis of the nanostructured Fe-Co-MoO$_x$ coatings are discussed. The Fe-Co-MoO$_x$ films were deposited onto a mild steel substrate from citrate iron (III) based electrolyte at direct current density of 2–3 A/dm^2 [1]. The elements composition was determined by X-ray fluorescence method. The surface morphology and topography was examined by an atomic force microscopy AFM using NT–206 microscope. Scanning was performed by contact probe CSC-37 with a cantilever lateral resolution of 3 nm.

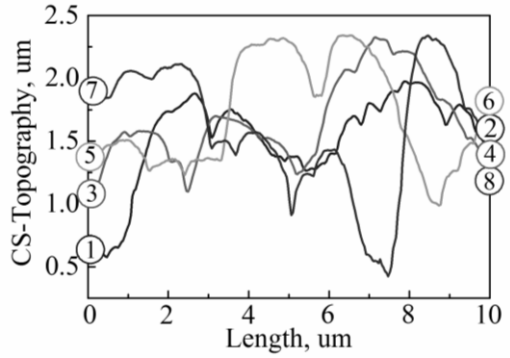

Fig. 1. 2D- maps of the surface (*a*) and cross sections (*b*) for Fe-Co-Mo coating.

According to the SEM analysis, the alloys are characterized by a high oxygen content both on the hills (21 Fe, 22 Co, 26 Mo and 31 O at. %) and valleys (16 Fe, 17 Co, 20 Mo and 47 O at. %). The high concentration of oxygen in the alloy composition is associated with the peculiarities of iron, cobalt and molybdenum co-reduction [2] and indicates incomplete reduction of molybdate-ions to molybdenum oxides MoO$_x$. The last makes it possible to attribute Fe-Co-MoO$_x$ coatings to composite materials.

The analysis of AFM data show that globular surface with the agglomerates sizes of 1–3 um is formed (Fig. 1). One can see a uniform distribution of hills and valleys over the coating surface (Fig. 1b). The roughness parameters R_a and R_q for Fe-Co-MoO$_x$ alloy were defined as 0.3 and 0.4 respectively that much higher than those for the polished mild steel substrate (R_a = 0.007 and R_q = 0.010) and shows substantial development of the surface. The fractal dimension was determined by the «slit-island method» (SIM). The scan research results at area of 48×48 um show that the fractal dimension D for Fe-Co-MoO$_x$ coating is of 2.64 with, which reflects three-dimensional nucleation during coating growth. Fractal dimension ranges from 2.42–2.48 with decreasing the scan area to 10×10 um and becomes lower D = 2.05 in the nanoscale relief (5×5 um). Above parameters indicates the 2D mechanism of coating grains nucleation.

The obtained results allow predicting high electrocatalytic activity of the deposited coatings in the redox reactions such as hydrogen evolution and methanol oxidation due to uniformly developed surface [3].

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