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Galvanic Formation of the Triple Composition Coatings with Improved Functional Properties

HAPON Yuliana[1,a*], TREGUBOV Dmytro[1,b], SLEPUZHNIKOV Yevhen[1,c], KHARLAMOV Mykhailo[1,d]

National University of Civil Defence of Ukraine, 94, Chernishevska str., Kharkov, Ukraine, 61023

[a]yuliano4kah21@gmail.com, [b]cxxttregubov1970@nuczu.edu.ua, [c]slepuzhnikov@nuczu.edu.ua, [d]mike1982kharlamov@gmail.com

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Abstract. The article deals with the pulse electrolysis energy parameters effect on the current efficiency, phase composition and morphology of the cobalt with refractory metals – tungsten and molybdenum galvanic alloys surface. Synthesized coatings corrosion resistance and synthesized coatings catalytic activity testing results in various acidity media are presented. The obtained experimental data for the various composition alloy Co-Mo-W are compared with respective indicators for individual metals. The synergy effect presence due to the alloying elements mutual influence is experimentally established.

1 Introduction

The advances in technology need improvement in metals technological properties, which can only be achieved by the new alloys development, coatings on their bases and their production methods [1, 2]. Thus, coatings with nanosized films are used to organize air pollution sensors, create multilayer film elements for solar panels, oxidize titanium implants and others [3–5]. The decisive way in creating the novel progressive materials is the technologies introduction for the synthesis of multifunctional coatings that combine a large amount of advanced technological properties, namely: corrosion resistance, hardness, durability and catalytic activity. However, direct synthesizing of the required for modern products amorphous alloys, nanosized, nanocrystalline and nanolaminate structures, increased magnetic reluctance or high-temperature superconductivity thin-layer materials, multiferroics, etc., based on the trivial bimetal compositions turned out to be impossible. Electrochemical deposition is one of the most effective ways to obtain such coatings with a predetermined composition. This initiated introduction in the galvanotechnics technologies of a non-alternative shift from mono-coatings to multicomponent ones, first of all, ternary (triple) and synergistic alloys, which are peculiar to a superadditive increase in functional properties depending on the alloying components mass ratio [6, 7].

There are many significant differences not only in the alloys (obtained metallurgically or galvanically) structure and properties but in their components concentration ratios as well [8,9]. During the electrolytic deposition, possibilities for alloys formation that are essentially different in the phase composition and properties from those obtained metallurgically arise, which significantly broadens the range of these alloys technical applications. The electrolytic deposition technology allows creating an interrelated chain: electrolytic deposition process parameters → alloy composition → morphology → functional properties → range of application [10].

2 Main Part

It is known to use the electrochemical regimes selection for the process of the single-crystal gallium arsenide nanowires formation with the specified density and porosity (in an acidic medium) [11, 12]. This technology is promising for nanostructured semiconductors and nanosized gas sensors creation [13, 14]. But the relevant technologies are characterized by the dangers number presence [15,16]. Scientists consider the problem of increasing the electrodes corrosion resistance for work in

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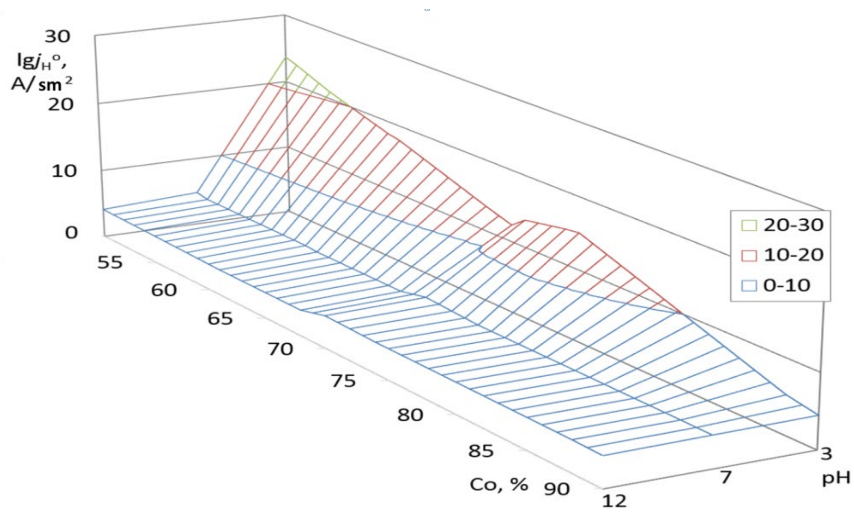

Fig. 4. Dependence of exchange current density for Co-Mo-W alloy coating on component composition at different acidity of solution (pH = 3; 7; 12)

Table 2. Hydrogen evolution in alkaline medium overvoltage empirical equations

Composition of the alloy, mas. [%]			Empirical equation of hydrogen overvoltage
Co	Mo	W	
74.3	10.6	15.1	$\eta = 0.609 + 0.167 \lg j$
70.1	16.1	13.8	$\eta = 0.682 + 0.15 \lg j$
68.3	18.8	12.9	$\eta = 0.691 + 0.159 \lg j$

5 Conclusion

Dependencies of the ternary alloy Co-Mo-W electrolysis pulse mode influence on the current efficiency and refractory components, deposited from a complex polyligand electrolyte content are obtained. The coatings obtained exhibit a higher corrosion resistance in various acidity environments compared to the base material (steel 3). The corrosion rate depth values allow attributing alloys to resistant materials in acidic media (pH = 3, k_h = 0.001–0.01 mm/year when a refractory metals content from 30 mas. %) and to extremely resistant ones in neutral and alkaline media (pH = 7 and 10.5, k_h = 0.01–0.08 mm/year) as well as considering them as prospective corrosion protection materials. The best performance was demonstrated by the coating samples of $\omega(Mo+W)_{tot}$ ~ 30 mas.% compositions.

A superadditive increase in the alloy electrocatalytic activity compared to some alloying components as electrode material in the reaction of hydrogen electrolytic evolution is experimentally established. The highest catalytic activity is shown by alloy in an acidic medium, which is evidenced by the exchange current density values that virtually do not differ from the platinum electrode values and even slightly exceed them: $\lg j_H^0$ ($Co_{71}Mo_{16}W_{13}$) = -3.07–3.24 and ($\lg j_H^0$(Pt) = -3.3).

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