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Short Communication

Simulation of Corrosion Resistance of Nanocomposites Fe (Co)-W

N Sakhnenko*, T Nenastina, M Ved and M Volobuyev

Department of Higher Mathematics, Kharkiv, Ukraine

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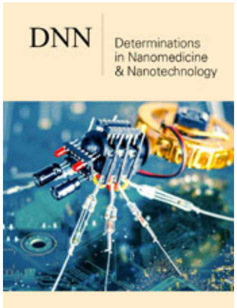

***Corresponding author:** N Sakhnenko, Department of Higher Mathematics, Kharkiv, Ukraine

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Introduction

The problem of the formation of functional coatings, combining such important consumer properties as corrosion resistance, hardness, wear resistance and catalytic activity, is key in the creation of new materials for modern instruments, devices and technologies. The great practical interest in Co-W and Fe-W alloys is explained by the prospect of their use in industry as thermo, wear and abrasion-resistant, magnetic-hard materials, possessing high microhardness and being an alternative to hard chrome coatings [1-6]. In addition, such materials can be used as the basis of catalytic systems in hydrogen energy, for the disposal of wastewater, toxic emissions of vehicles and industrial enterprises, reducing material costs and improving environmental safety [7,8].

Method

Coatings were deposited on rectangular samples made of steel from citrate electrolytes at direct and pulse current density of 3.0-4.5 A/dm^2 [9-11]. The chemical composition of the coatings was determined using the energy-dispersion spectrometer Oxford INCA Energy 350 with the integrated programming environment SmartSEM. The surface morphology of alloys was investigated using the scanning electron microscope ZEISS EVO 40XVP, and the topography was studied using the microscope NT-206 with the probe CSC-37. The structure of the deposits was examined by X-ray diffraction analysis using a diffractometer DRON-3.0 in monochromatic Co-Kα radiation. The corrosion properties of the binary deposits were determined by polarization resistance and impedance technique. The spectra of electrochemical impedance were measured on the Autolab-30 electrochemical module PGSTAT301N Metrohm Autolab in the frequency range 10^{-2}-10^{6}Hz. Vickers microhardness Hv of coatings with alloys not less than 30 microns thick was determined by after 24 hours of aging of the coatings at room temperature under a load of 0.05kg and a holding time of 10s.

Result

The common trends in the corrosion behavior of electrolytic Co (Fe)-W electrolytic alloys in an aggressive media is a decrease in the corrosion rate and opposite change in the open circuit potentials with an increase in the refractory metal content. The corrosion resistance of tungsten alloys significantly exceeds the resistance not only of steel substrates, but also of individual metals. To predict the corrosion resistance of the above alloys, thermodynamic functions of metals and their oxides, the energy and parameters of the crystal lattice, the binding energies of metals with oxygen and hydrogen and their differences, the specific electrical resistance of metals and oxides, etc., were used as input parameters for Artificial Neural Networks (ANN) analysis [12]. The output variable is the corrosion rate of the alloys in various environments. From the analysis of a large number of ANNs of various architecture, it was found that the minimal error in predicting the Co-W corrosion rate in aggressive solutions is achieved by a generalized regression ANN with two hidden layers. And a multilayer perceptron with two hidden layers exhibits the smallest error in predicting the corrosion rate for Fe-W coatings. The microhardness of coatings Co(Fe)-W of ω (W)=40-50 mas% rises up to 500-600 in comparison with alloying metals (Co-130, Fe-150, W-400) [13-15].

Conclusion

Corrosion-electrochemical behavior of coatings of iron (cobalt)-tungsten alloys in environments of different acidity depends on the content of the refractory component, and the increase in corrosion resistance in an acidic environment is due to the formation of acidic tungsten oxide on the surface. Simulation of the corrosion processes using ANN artificial neural networks show the most important parameters determining the corrosion resistance of alloys to be electrical conductivity of metals and their oxides; metal-oxygen binding energy; standard enthalpies of formation and entropy of oxides WO_3, Co_3O_4, Fe_3O_4. The microhardness of electrolytic alloys of tungsten with iron (cobalt) depends on its content and exceeds the characteristics of coatings with individual metals, which allows to recommend such materials as an alternative to hard chromium coatings.

References

1. Donten M, Cesiulis H, Stojek Z (2000) Electrodeposition and properties of Ni-W, Fe-W and Fe-Ni-W amorphous alloys. A comparative study. Electrochimica Acta 45(20): 3389-3396.
2. Ibrahim M, Rehim S, Moussa SO (2003) Electrodeposition of non-crystalline cobalt-tungsten alloys from citrate electrolytes. Journal of Applied Electrochemistry 33(7): 627-633.
3. Mukhamedova GSH, Sakhnenko ND, Ved MV, Yermolenko IY, Zyubanova SI (2017) Surface analysis of Fe-Co-Mo electrolytic coatings. IOP Conference Series: Materials Science and Engineering 213.
4. Feng JH, Jing TL, Xin L, Huang YN (2004) Friction and wear behavior of electrodeposited amorphous Fe-Co-W alloy deposits. Transactions Nonferrous Metals Society of China 14(5): 901-906.
5. Tsyntsaru N, Dikusar A, Cesiulis H, Celis JP, Bobanova Zh, et al. (2009) Tribological and corrosive characteristics of electrochemical coatings based on cobalt and iron superalloys. Powder Metallurgy and Metal Ceramics 48(7-8): 419-428.
6. Ved M, Sakhnenko N, Bairachnaya T, Tkachenko N (2008) Structure and properties of electrolytic cobalt-tungsten alloy coating. Functional materials 15(4): 613-617.
7. Ghaferi Z, Sharafi S Bahrololoom ME (2016) The role of electrolyte pH on phase evolution and magnetic properties of CoFeW codeposited films. Applied Surface Science 375: 35-41.
8. Weston DP, Harris SJ, Shipway PH, Weston NJ, Yap GN (2010) Establishing relationships between bath chemistry, electrodeposition and microstructure of co-w alloy coatings produced from a gluconate bath. Electrochimica Acta 55(20): 5695-5708.
9. Karakurkchi AV, Ved MV, Sakhnenko ND, Yermolenko IY, Zyubanova SI, et al. (2015) Functional properties of multicomponent galvanic alloys of iron with molybdenum and tungsten. Functional Materials 22(2): 181-187.
10. Yermolenko IY, Ved MV, Sakhnenko ND, Sachanova Y (2017) Composition, morphology, and topography of galvanic coatings Fe-Co-W and Fe-Co-Mo. Nanoscale Research Letters 12(1): 352.
11. Ved M, Glushkova M, Sakhnenko N (2013) Catalytic properties of binary and ternary alloys based on silver. Functional Materials 20(1): 87-91.
12. Himmelblau DM (2000) Applications of artificial neural networks in chemical engineering. Korean Journal of Chemical Engineering 17(4): 373-392.
13. Mukhamedova G, Ved M, Sakhnenko N, Nenastina T (2018) Electrodeposition and properties of binary and ternary cobalt alloys with molybdenum and tungsten. Applied Surface Science 445: 298-307.
14. Glushkova MO, Ved MV, Sakhnenko MD (2013) Corrosion properties of cobalt-silver alloy electroplates. Materials Science 49(3): 292-297.
15. Grabco DZ, Dikusar IA, Petrenko VI, Harea EE, Shikimaka OA (2007) Micromechanical properties of Co-W alloys electrodeposited under pulse conditions. Surface Engineering and Applied Electrochemistry 43(1): 11-17.