Nano-Dispersion Phase Components - Ratio Influence on Cr-Sio$_2$-C Nano-CEC Corrosion Resistance

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ABSTRACT

The report presents the results of experiments on introduction of nano-size particles of silicon dioxide SiO_2 (5-50 nm) and lamp soot C (11-100 nm) into chromium coatings and investigation of corrosion resistance in 3% NaCl solution. Nano-composition electrolytic coatings were received at the various density of current: 2, 3, 4, 5, 6, 7 kA/m^2, temperature 303-343 K and nano-dispersion phase components' ratio.

The microstructure was investigated by electron- and atom-force microscope before and after corrosion tests. It was established, that nanostructured composition electrolytic coatings, which were obtained in electrolytes containing 18-14 g/dm^3 SiO_2 and 2-6 g/dm^3 C, have the highest corrosion resistance.

Keywords: Nano-Dispersion Components, Ratio Influence, Corrosion Resistance

INTRODUCTION

The metals corrosion protecting problem is an actual not only in Kazakhstan, but all over the world [1-5]. Composite electrolytic coatings (CEC) showed oneself to advantage both for protection against corrosion and for increase of wear resistance, and also for the size renewal. Nano-particles of various compositions are more actively used as a disperse phase in recent years. It is known, that replacement of fundamental resistance of traditional materials by using nano-dispersion powders opens large-scale perspectives for creation of new materials and technologies [6-9]. So using nano-size powders in electroplating sphere gives possibility both for improving main parameters and for creation of composites with specific properties

CORROSION RESISTANCE OF CHROMIUM - SILICON DIOXIDE - LAMP SOOT NANO-CEC

The galvanic method has such doubtless advantages as: possibility of making CEC with demanded structure and properties; absence of thermal influence on a part and a coating; possibility of exception of the subsequent machining; the low net cost. In view of the aforesaid it is necessary to investigate chromium - silicon dioxide - lamp soot nano-CEC's physical and chemical special properties.

The aim of the work is research corrosion resistance of chromium - silicon dioxide - lamp soot nano-CEC for determining an optimum ratio of components and regimes for effective protecting coatings electro deposition.

Testing of Corrosion Resistance

For testing of corrosion resistance of chromium - silicon dioxide - lamp soot nano-CEC the experimental device for corrosion resistance determining by a weight method adjusted for coatings working conditions was developed, assembled and completed (Figure 1). The testing stand consists of peristaltic pump 1, boiler 2 for keeping constant temperature, distributor of water stream 3, communicating columns 4 for positioning tested samples; thermometer for corrosive medium 5 and buffer 6 temperatures control. In parallel columns the holders of samples are placed, due to this holders 8 coupons, placed for 4 samples per each shoulder of the stand, are simultaneously tested in identical conditions. The speed of stream done by the peristaltic pump is 40 vol/min. 3 % solution of sodium chloride was chosen as the corrosion medium because chlorine ions are high antagonists of chromium. Temperature of the corrosion medium was 293 K.

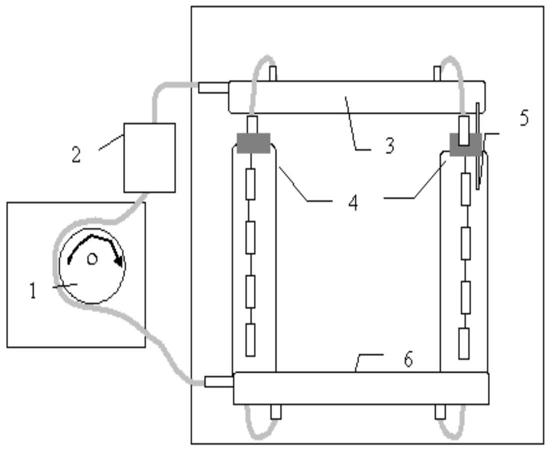

Figure 1. Corrosion testing equipment

Whereas nano-CEC was put onto steel St.3, efficiency of nano-CEC anticorrosive stability was estimated in comparison with corrosion stability of steel St.3 without coating. Therefore corrosion tests of samples from St.3 without coating were preliminary conducted by gravimetric method (table 1).

Table 1. Results of steel St.3 corrosion resistance investigations

t, h	$m_0, 10^{-3}$ kg	$m_1, 10^{-3}$ kg	$\Delta m, 10^{-3}$ kg	K, 10^{-3} kg /m^{2}h
5	17,2019	17,2041	0,0022	0,1989
10	17,2041	17,2058	0,0017	0,2672
15	17,2058	17,2048	0,0011	0,2455
20	17,2048	17,2019	0,0029	0,37395

The table's data show, that within 10 hours there is an intensive dissolution of steel, then the passivation film is formed and covers surface of the sample with a friable inhomogeneous layer, which is destroyed for the following 5 hours and carried away by a stream of corrosive medium. Then deeper layers of steel are further dissolved, continuously changing film of corrosion products is emerged.

The same method was used for estimation of corrosion stability of nano-CEC, obtained from electrolytes with concentration ratio of lamp soot and silicon dioxide

(g/ dm^3): 2/18, 4/16, 6/14, 8/12, 10/10, 12/8, 14/6, 16/4 and 18/2. In spite of a variety of sedimentation modes and nano-dispersion phases concentrations ratio in electrolyte, all coatings showed 15-36 time increase of corrosion resistance in comparison with St. 3 and 5-

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12 time increase in comparison with pure chromic electrolytic coating. The deep parameter of corrosion thus was 0, 005-0, 02.10^{-3} depending on modes of sedimentation and electrolyte composition.

We carried out research of corrosion resistance at specially developed stand on the basis of Wheatstone bridge use. In figure 2 change of corrosion resistance depending on time is presented, the figure shows, that the highest resistance has nano-CEC, obtained at 333 K ($28 \cdot 10^{-3}$ Ohm), and lowest at 303 K (12.10-3 Ohm). To find out the cause of corrosion stability increase, we had been studied nano-CEC microstructure by methods of raster electronic and atom-force microscopy.

In figures 3 and 4 atom-force microscopy pictures are presented, which show that nano-CEC, obtained at temperature 303 K has large-globular structure. Obviously more smooth structure of surface of Cr-SiO_2-C nano-CEC, obtained at temperature 333 K is the cause of high corrosion stability of these coatings.

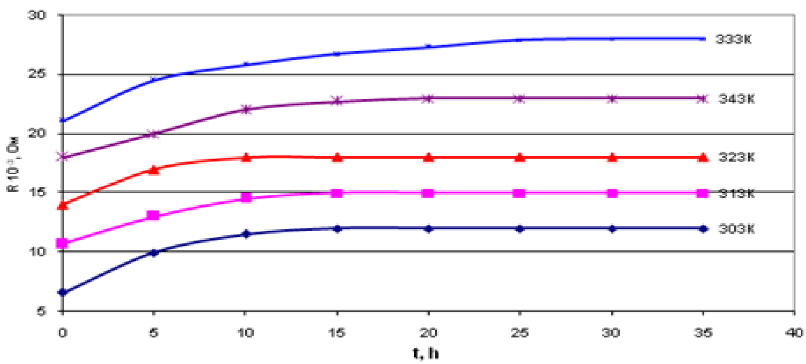

Figure 2. Dependence of electro resistance on duration of corrosion tests for nano-CEC, obtained from electrolyte with concentration 2 g/ dm^3C+18 g/ dm^3SiO_2

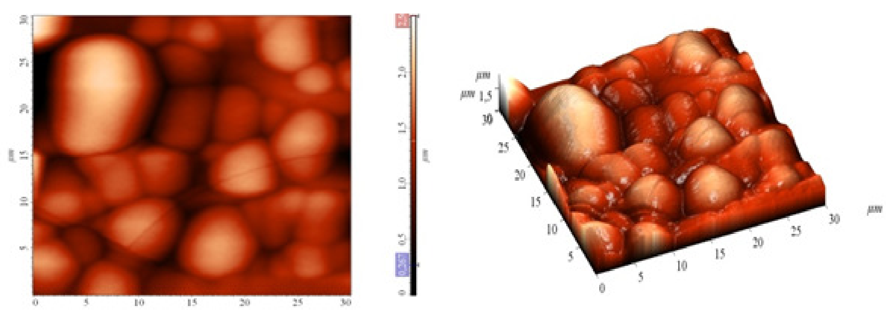

Figure 3. AFM image of nano-CEC Cr-SiO_2-C, obtained at temperature 303 K

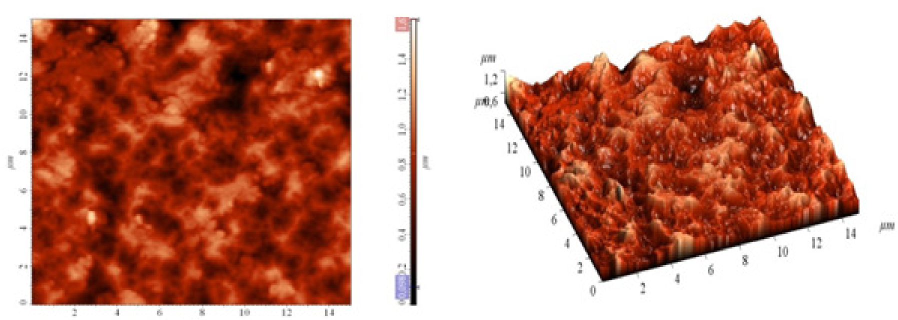

Figure 4. AFM image of nano-CEC Cr-SiO_2-C, obtained at temperature 333 K

RESULTS AND DISCUSSIONS

The results of carried out investigation are the following.

The experimental devices for corrosion resistance test by a weight method and a method of electric resistance measuring were developed, assembled and completed;

The technique for investigation of corrosion resistance of Cr-SiO_2-C nano-composition electrolytic coatings in 3 % NaCl solution was worked out by two methods. The microstructure of chromium - silicon dioxide - lamp soot nano-CEC before and after corrosion was studied by methods of an optical metallography, raster electronic and atom-force microscopy;

Influences of nano-CEC composition and regimes of their obtaining: current density; electroplating speed; microhardness, - on corrosion resistance of Cr-SiO_2-C coatings were investigated. It is established that nano-CEC 18 g/ dm^3 SiO_2-2 g/ dm^3 C, 16 g/ dm^3 SiO_2-4 g/ dm^3 C, 14 g/ dm^3 SiO_2-6 g/ dm^3 C, obtained at current density 4 A/dm^2 and temperature 333K have the highest corrosion resistance.

REFERENCES

[1] Bush et al. (1989). Problems encountered and protective measures. *Metals Handbook. 13.* Metals Park (Ohio). c. 1245-1259.

[2] Swidzinski, M. A. (1997). Offshore protection: painting for a 20-year. *J. Prot. Coat. and Linings, 14*(5), 46-53.

[3] Jackson, K. (1999). Recent advances in water-borne protective coatings. *Surface Coat. Int. 82*(7), 340-343.

[4] Yar-Mukhamedova, G. Sh. (1999). Internal adsorption of admixtures in precipitates of metals. *Materials Sciense, 35,* 598-600.

[5] Zhou X., & Shen, Y. (2014). Surface morphologies, tribological properties, and formation mechanism of the Ni-CeO_2 nanocrystalline coatings on the modified surface of TA_2 substrate. *Surface & Coatings Technology, 249,* 6-18.

[6] Yar-Mukhamedova, G. Sh. (2000). A Mathematical Model of Formation of the Structure of Composite Films by the Cut-Off Method. *Materials Sciense, 36*(4), 598-601.

[7] Perdomo, J. J., & Cawley, J. D. (2001). Chemical and electrochemical conditions on steel under disbonded coatings: Mathematical modeling of mass transport and chemical changes. *Corrosion Reviews, 19*(5-6), 419-434.

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