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Investigationsof Nanocrystalline Alloy Electrospark Coating Madeof Nanocrystalline Alloy Based on 5БДСР Ferrum

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Abstract. The article describes the properties of wear resistant electrospark coating made of nanocrystalline alloy of type 5БДСР (Finemet). It is proved that electrospark coating has nanocrystalline structure which is like amorphous matrix with nanocrystals α – Fe. Coating thickness is 33 µm, micro-hardness is 8461 - 11357 MPa, wear resistance is $0{,}55\times10^4$s/g. Coating ofnanocrystalline alloy of type 5БДСР can be used to increase wear resistance of machinery working surfaces.

1. Introduction
One of the promising directions of improving the wear resistance of working surfaces of details is their hardening due to the creation of surface layers with high physical-mechanical properties. Analysis of scientific and technical information showed that among the commonly used methods of hardening of working surfaces can distinguish heat treatment, chemical heat treatment, laser and plasma hardening and others. A promising method of hardening the working surfaces with complex geometric form, is an electro spark processing (ESP) [1]. There are many different ways to method development ESP. One of the ways is the use of new materials with nanocrystalline structure. The use of such materials will allow to obtain multifunctional electro spark coating, can improve wear resistance of working surfaces of parts [2-12].

2. Obiectiv.
Explore the properties of electric-reinforcing coating made of nanocrystalline alloy (NCA).

3. Methods.
As an electrode material 5BDSR nanocrystalline alloy was selected mark (Finemet) (Fe-70% B - 9.2%, Si- 6.3% Nb- 2.21%, 0.8% Cu-, Mo- 0,2%). The structure of the resulting coatings was investigated with a scanning electron microscope Hitachi TM - 1000. The reinforcing coating is applied to the samples of steel 65G install EDM brand BIG - 4 (mode: №2, K = 0.8). The thickness of

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the experimental electric-spark coatings was measured on transverse sections. The measurements were performed on a microscope MIM-8. Base surface served as the boundary between the coating and the substrate. Microhardness was measured at a load of 50 g indentation of diamond tips on a computerized Hardness PMT-3M-01.Protsess studied mass transfer was investigated by measuring geometric parameters of single erosion marks left electrode. Hardness measurements were performed PMT-3M. Microhardness was equipped with a screw ocular micrometer MOV-1-16H, and MA-25 lens (epiobektiv plan-achromatic F = 25,0 mm, A = 0,17) .Tribotehnicheskie tests performed on the machine friction MTU-01, at the outer load of 2.5 N, with relative sliding speed - 1.0 m / s. Material for manufacturing served kontrobraztsa steel grade 65G, hardened to HRC 58 ... 60. Depreciation is determined by gravimetric method using weights Sartorius Competence CP64 with an accuracy of 0.0001 g.

4. The results of the research.

Scanning electron microscopy made it possible to state that-tension coating obtained by treating the steel substrate electrode of the NCA brand 5BDSR, it has a homogeneous structure to the level of 1 micron. However, in the transition zone between the coating and the substrate are microcrystalline incorporating substrate material (Fig. 1). X-ray studies have shown that the coating alloy 5BDSR has a nanocrystalline structure, is an amorphous matrix with nanocrystals α - Fe. It can be seen from Figure 2, in which there is reflection from the crystal phases α-Fe [10].

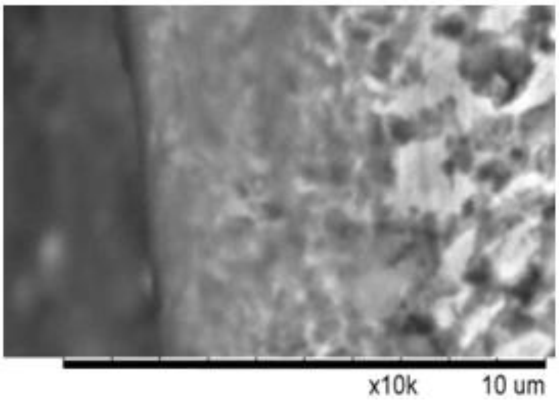

Figure1. Electrospark coating structure

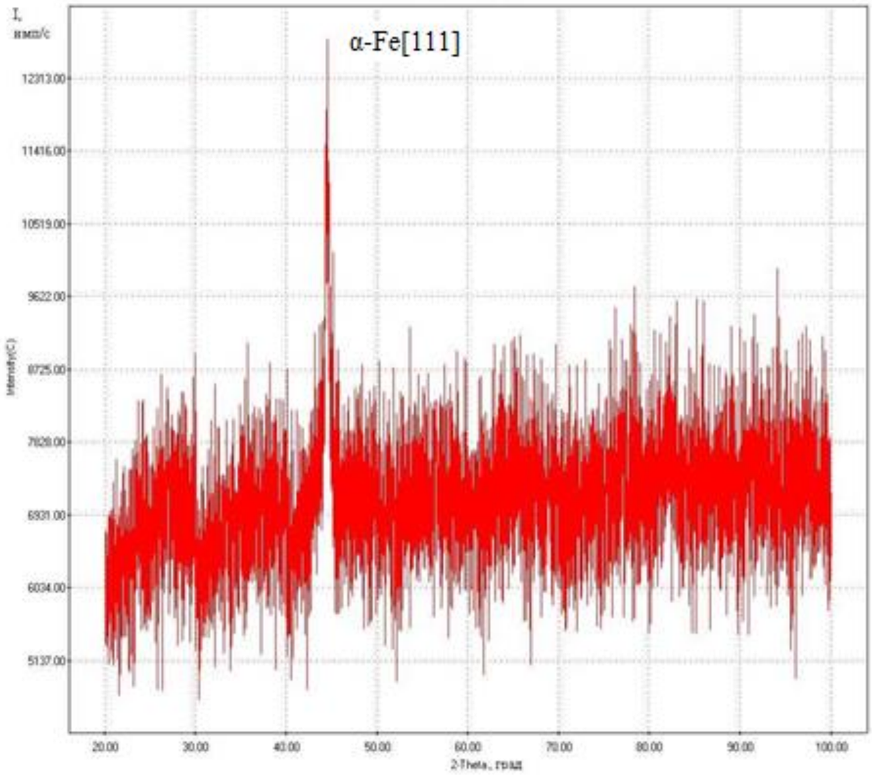

Figure2. Diffraction pattern of electric spark coating

The thickness of the electric-cover changes nonlinearly. The experimental dependence of the thickness of the specific processing time provided in Figure 3 As it set the threshold of brittle fracture is 2.1 min / sm2i critical threshold of brittle fracture is equal to 5.2 min / cm^2. In ESP at № mode 2, k = 0.8 of the maximum thickness of coating grade 5BDSR NCA - h = 33 m, which is approximately 1.5 times greater than the thickness of the alloy coating-grade VK6 OM obtained in a similar mode.

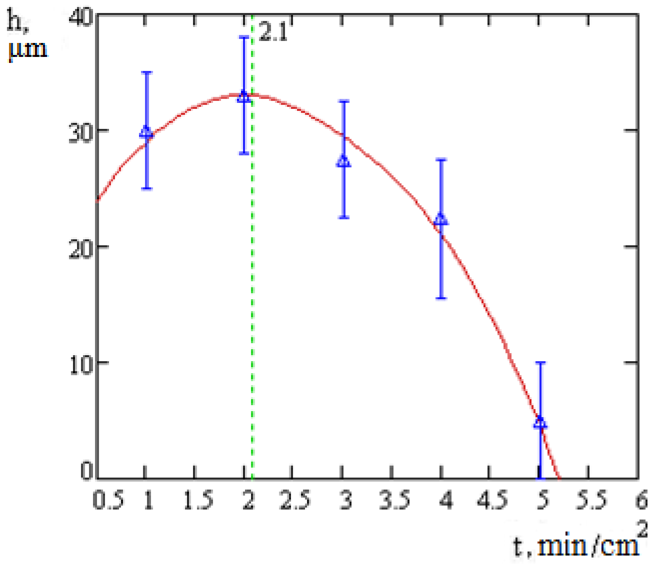

Figure3. The dependence of the film thickness h of the specific processing time t

Microhardness strengthening coating is largest dispersion. The maximum value of the microhardness of coatings NCA brand 5BDSR - $N_{\mu max}$ = 11357 MPa minimum - $N_{\mu min}$ = 8461 MPa. A characteristic feature indicative of plastic deformation of the coating is the presence of "crown" on the printout of the indenter [1, 8].

During the mass transfer studies have demonstrated the dependence of the mass of the electrode material transported from the anode to the cathode, the initial stress - one of the main technological parameters of ESP. Figure 4 shows the regression power law, which can be used to develop the process of hardening of details. Using the gravimetric method was established and mass transfer direction generally ESP efficiency. This method allowed us to determine a number of mass transfer parameters necessary for the process to ensure ESP process (Table. 1).

Table 1. Mass-transfer parameters

Mass-transfer average ratio	Threshold fragile destruction coatings, t_x, min/cm ^{2}	The critical threshold brittle fracture surfaces, $t_{кр}$, min/cm ^{2}
0,54	4,0	6,5

Endurance tests yielded dependence on wear test duration, represented as a function of logarithmic regression. After differentiation its wear rate dependence on the time (Fig. 5) was obtained.

Tribological tests found that the hardening electric spark coating NCA brand 5BDSR has wear rate Wsr = 18 × 10^{-5} g / s and wear resistance U = 0,55 × 10^4 s / g. Low wear rate and high wear resistance indicate that the considered electric spark coating should be used in hardening of working surfaces of parts.

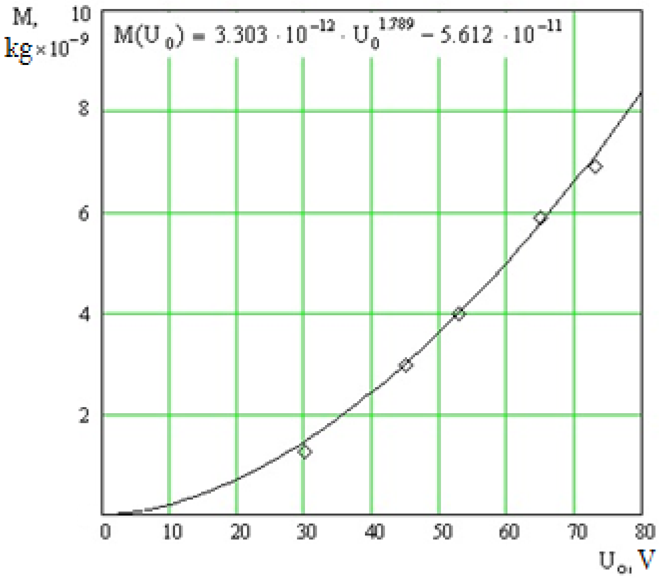

Figure 4. The dependence of the mass of the electrode material is transferred from the anode to the cathode, the initial voltage for ESP

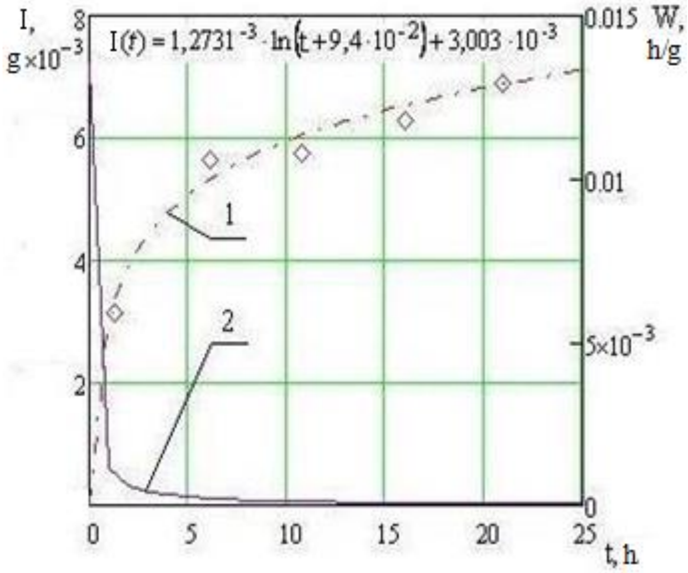

Figure5. Dependencies wear (1) and wear rate (2) electric spark coating on the duration of the test

5. Conclusion.

Dura-tension coating of nanocrystalline alloy brand 5BDSR a nanocrystalline structure, the thickness of 33 microns, the maximum microhardness of 11357 MPa, the wear resistance of 0.55×10^4 s / g. Coverage of this alloy can be used to improve the wear resistance of working surfaces of machine parts.

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