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Short Communication

X-ray Diffraction Analysis of the Chromium-containing Electroerosion Powders of Micro - and Nanoparticles

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Presents the results of a study of x-ray analysis of the powder obtained by electro erosion dispersing of waste nichrome H15N60 brand in kerosene lighting. The major phases in Nickel-chromium powder obtained by electroerosion dispersion method in kerosene lighting are Ni and Si_2O.

Keywords: Electroerosion powders, Nichrome, X-ray analysis.

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1. INTRODUCTION

Nichrome – the basic material for the manufacture of heating elements for electric furnaces. Nichrome is specifically designed for this purpose and, therefore, to the greatest extent meets all requirements for such materials.

Nichrome – general name of the group of alloys consisting, depending on the brand of alloy from 55...78 % nickel, 15...23 % chromium with additions of manganese, silicon, iron and aluminum. The first group comprises the alloys consisting essentially of nickel and chromium, the iron content in them is small (0.5...3.0 %), which explains the name. The second group includes an alloys containing apart from nickel and chromium, also iron.

Nichrome, a further development of heat-resistant chromium-nickel steel, is very heat-resistant material, because it has an extremely durable protective film of chromium oxide Cr_2O_3, having a melting point higher than that of alloy, and well withstands periodic heating and cooling. In addition, it has good mechanical properties both at normal and high temperatures, creep resistance and sufficient ductility, so that it is easily handled and, in particular, well welded.

The electrical properties of Nichrome is also quite satisfactory, has a high resistivity, low temperature coefficient of resistance, and doesn't have effects of aging and growth. Binary alloys have the best electrical and at the same time good mechanical properties. These alloys have at the same time excellent heat resistance, so that they can operate up to 1100 °C.

The higher of chromium content in the alloy, the more content of Cr_2O_3 in its protective film, so it is more refractory and the material has a better oxidation resistance. But with increasing of chromium content, machinability deteriorates simultaneously, and when it reaches 30 % of chromium content, drawing and cold rolling becomes impossible. Therefore, usually, the content of chromium does not exceed 20 %.

The addition of iron into the alloy slightly improves its workability and resistivity increases, but its temperature coefficient of resistance decreases and the heat resistance is significantly reduced. Nevertheless, in those cases, when the working temperature exceeds 1000 °C, it is permissible to use triple alloy, because it is cheaper and less scarce comprises nickel.

Iron-rich nichrome (a term adopted abroad, where it is widely used, in our country we refer it as Cr25Ni20 alloy) is even cheaper, requires even less nickel, and has excellent mechanical properties, although its heat resistance is even lower. It can be used in ovens at a temperature not higher than 900 °C. All nichrome alloys are non-magnetic. Nichrome is produced in the form of wire and tapes.

Nichrome was first proposed in 1906 by Marsh. Currently abroad many companies produce it under different names. Double and triple alloys, in some brands molybdenum is added, are produced. In our country, a dual alloy produced with a chromium content of 20...23 % and nickel 75...78 % (Cr20Ni80) also a similar alloy with titanium is issued (Cr20Ni80Ti), but it is somewhat less heat-resistant and received only limited use. Ternary alloys are produced with a chromium content of 15...18 % and nickel 55...61 % (Cr15Ni60). The high cost and scarcity of nichrome led to methods of reuse its waste [1-5].

One of the advanced and industrialized not used methods to obtain a powder of any material conducting current, which is characterized by low cost of electricity and the lack of environmental pollution, is a method of the electroerosion dispersing (EED) [6-9].

The aim of this work was to perform X-ray diffraction analysis of the powders, obtained by the electroerosion dispersing of nichrome wastes brand Cr15Ni60 in a lighting kerosene.

2. MATERIALLY AND METHODS

For obtaining of the chromium powder setting for the EED of conductive materials and Nichrome wastes brand Cr15Ni60 were used. Nichrome wastes were loaded into reactor, filled with hydraulic fluid – kerosene lighting. EED process was carried out at the following electrical installation parameters: voltage across the electrodes 140...160 V, capacitance of discharge capacitors 65 uF, the pulse repetition frequency 170...175 Hz.

The research of the phase composition of the powders was carried out by X-ray diffraction on the diffrac-

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tometer Rigaku Ultima IV in Cu-Kα radiation (wavelength $\lambda = 0{,}154178$ nm) with Soller slits. Shooting of the diffraction spectrum for phase analysis carried out by the scheme θ-2Θ scanning with focusing according to Bregu-Brentano in the angle range 5...100 deg. 2Θ. Shooting was in the single spot mode with a step of scanning $\Delta(2\theta) = 0{,}02$ deg, a rate of 0,6 deg/min, the operating voltage of 45 kV, 200 mA. To clarify the profile of the experimental radiographs the software package PDXL RIGAKU was used. Subtraction of background was performed by the method of Sonneveld – Visser, smoothing of the experimental profile by the method of Savitsky - Golay, and the separation of components $k\alpha 1$ and $k\alpha 2$ by the method of Rachinger. For a description of the diffraction peaks superposition of the Gaussian function and the Lorenz function was used. Approximation of each of the reflexes in the diffractograms of investigated samples by the pseudo – Voigt function allowed to determine the position of reflections exactly, based on the displacement caused by the overlapping of reflections at half maximum of intensity (FWHM) and intensity. The phase composition of the coatings was determined by BD ICCD PDF-2 (2008).

3. EXPERIMENTAL RESULTS AND DISCATIONS

The XRD pattern of the powder under study is shown in Figure 1.

Table 1 lists the maximums of the XRD pattern of the nichrome powder.

Thus, according to the results of the research it was found that the main phases in the Ni-Cr alloy powders, produced by the electroerosion dispersion of nichrome wastes brand Cr15Ni60 in a lighting kerosene are Ni and Si_2O.

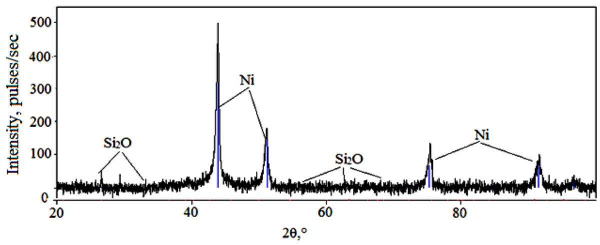

Fig. 1 – The XRD pattern of the nichrome powder

Table 1 – List of maximums nichrome of the powder radiographs

№	2θ, (degree)	Diameter, (Angstroms)	Height, (Hz)	Intensity, W (degree)	Asymmetry factor
1	26,547 (7)	3,3549 (9)	53 (7)	0,08 (2)	1,2 (8)
2	39,25 (16)	2,293 (9)	10 (3)	9 (4)	0,20 (4)
3	43,845 (9)	2,0632 (4)	319 (18)	0,75 (5)	1,62 (17)
4	51,149 (11)	1,7844 (4)	117 (11)	0,85 (9)	3,1 (5)
5	75,456 (6)	1,25883 (8)	83 (9)	0,87 (11)	5,0 (10)
6	91,671 (10)	1,07382 (9)	58 (8)	1,15 (19)	4,8 (10)
7	96,79 (5)	1,0301 (4)	16 (4)	0,9 (3)	1,8 (9)

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