X-ray spectral analysis of sintered products made of electroerosive materials obtained from X17 alloy waste in lighting kerosene

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Abstract. The article presents the results of a study of the elemental composition of sintered products from alloy X17 electroerosive materials obtained in lighting kerosene. It is shown that the main elements on the surface of sintered products are chromium, iron and nickel.

1 Introduction

Steel X17 is called technical, although many of its properties are much higher than that of standard stainless steels. X17, containing a large percentage of chromium and a small percentage of carbon, is distinguished by a combination of ductility and high strength.

One of the important advantages of steel is passivity in sulfur-containing environments. X17 is also characterized by resistance to scale formation during operation at high temperatures (up to 759˚C).

Steel X17 is used for the manufacture of parts, the operation of which can lead to direct contact with dilute solutions of acids (nitric, citric, acetic) and salts. It is used for the production of pipeline products - pipes, fittings, tees, transitions, valves, gate valves and others, for the production of fasteners, bushings, elements of heat exchangers and furnaces.

The widespread use of X17 steel in various fields of industry leads to a large accumulation of its waste that requires processing. Currently, there are many ways to recycle metal waste for reuse. However, the disadvantages of the known methods are increased energy consumption, multi-stage technological process [1].

The most promising method for processing metal waste is the method of electroerosive dispersion (EED), which is distinguished by the environmental friendliness of the process and relatively low energy consumption.

To develop technologies for the practical application of powder materials obtained from X17 alloy wastes and to assess the efficiency of their use, it is necessary to carry out comprehensive theoretical and experimental studies.

The aim of the work was to study the elemental composition of sintered samples from alloy X17 electroerosive materials obtained in lighting kerosene.

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2 Materials and Methods

To implement the planned studies, wastes of alloy X17 (GOST 5632-72) were loaded into the reactor of an electrical discharge dispersion (EED) unit [2]. Lighting kerosene (GOST 4753-68) was used as a working fluid. The process was carried out with the following electrical parameters: capacity of the discharge capacitors 55 μF, voltage 120 ... 130 V, pulse repetition rate 95 ... 100 Hz.

As a result, particles were obtained with an average size of 28 μm.

The powder was consolidated by the method of spark plasma sintering using a spark plasma sintering system SPS 25-10 (Thermal Technology, USA) according to the scheme shown in (Fig. 1).

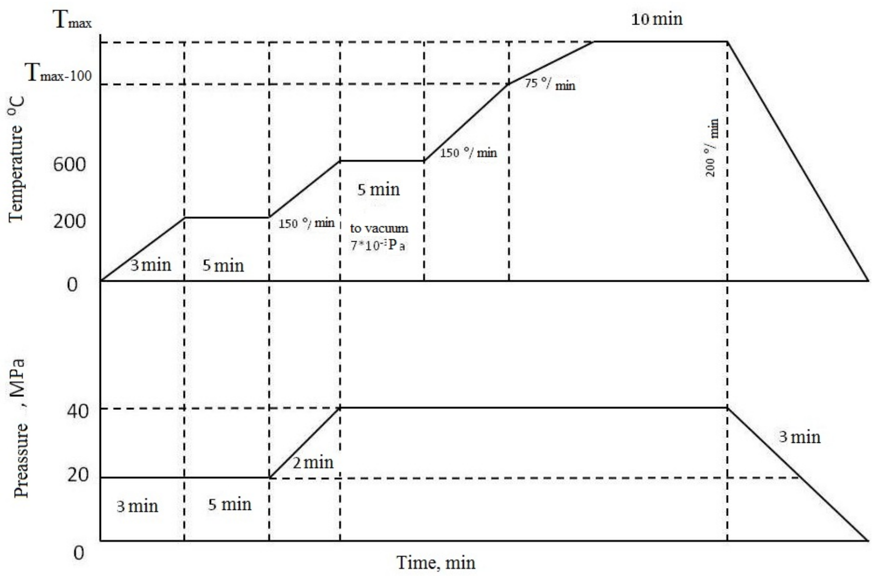

Fig. 1. Scheme of powder consolidation by spark plasma sintering

The starting material was placed in a graphite matrix placed under a press in a vacuum chamber. Electrodes, integrated into the mechanical part of the press, supplied an electric current to the matrix and created spark discharges between the sintered particles of the material, providing intense interaction.

The advantages of the spark plasma sintering technology are uniform heat distribution over the sample; high density and controlled porosity; no need for binders; uniform sintering of homogeneous and dissimilar materials; short cycle time; production of a part immediately in its final form and obtaining a profile close to a given one [3-14].

Using an EDAX energy-dispersive X-ray analyzer built into a Nova NanoSEM 450 scanning electron microscope (Fig. 2), characteristic X-ray spectra were obtained at various points on the sample surface.

Fig. 2. Scanning electron microscope Nova NanoSEM 450

X-ray spectral microanalysis is understood to mean the determination of the elemental composition of micro-objects from the characteristic X-ray radiation excited in them.

3 Results

On the presented spectrogram, a certain chemical element corresponds to each peak of a certain height (Fig. 3).

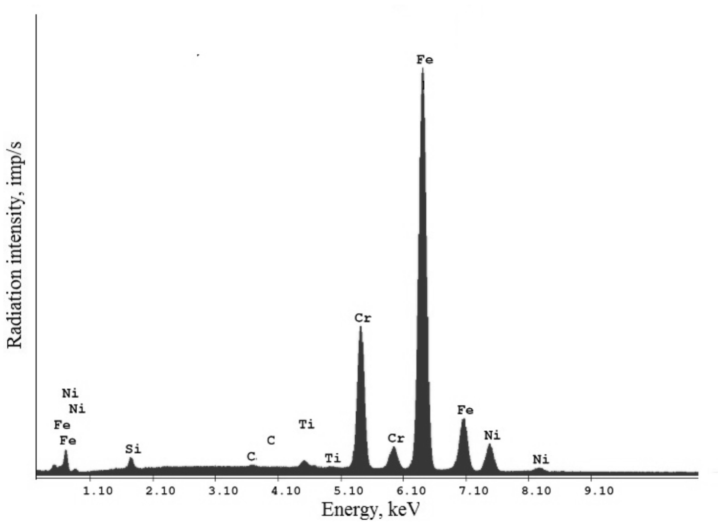

Fig. 3. Spectrogram of the surface of the sintered samples

The elemental composition obtained as a result of X-ray spectral microanalysis is presented in Table 1.

Table 1. Elemental composition of the studied samples

Element	Mass fraction, %	Atomic fraction, %
C	1,90	5,87
Si	1,83	3,40
Ti	0,65	0,70
Cr	15,62	15,67
Fe	72,4	67,61
Ni	7,61	6,76
Total	100,00	100,00

According to the data presented, it was found that the main elements in a sintered sample of X17 electroerosive materials obtained in kerosene are chromium, iron and nickel. The rest of the elements are distributed relatively evenly.

4 Conclusion

On the basis of the carried out experimental studies aimed at studying the elemental composition of sintered samples, it was found that the main elements in a sintered sample from electroerosive materials of X17 alloy wastes obtained in lighting kerosene are chromium, iron and nickel. The presence of free carbon on the surface is explained by the fact that the electroerosive materials were obtained in a carbon-containing liquid - lighting kerosene. The conducted research will determine the most relevant area of application of the samples obtained and will improve the quality of scientific and technical developments.

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