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Research Paper

Research of mechanical properties of the sintered samples from electro-erosion cobalt-chromium powder

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Abstract

The main requirement for powders for additive 3d technologies is the spherical shape of the particles. Such particles are most compactly packed into a certain volume and ensure the "fluidity" of the powder composition in the supply systems of the material with minimal resistance. Proceeding from the peculiarities of the methods for the production of spherical powders with the aim of obtaining spherical granules of regulated granularity, the technology of electroerosive dispersion is proposed, which is characterized by relatively low energy costs and ecological purity of the process. Based on the results of the studies aimed at investigating the mechanical properties of sintered samples from cobalt-chrome powders obtained for additive technologies by electroerosive dispersion, it was established that the average Vickers hardness of sintered samples is 14,63 Gpa; the porosity of the sintered samples is 6,15%.

Keywords: *Cobalt-Chromium Alloy; Electroerosive Dispersion; Powder; Spark Plasma Sintering; Sintered Sample; Hardness; Porosity.*

1. Introduction

At present, Russian organizations that have purchased expensive equipment for AT are dependent on a foreign supplier and are forced to purchase imported powder materials. Different companies-manufacturers of AT-machines prescribe work with a certain list of materials, usually supplied by this company. At the same time granules of limited compositions are delivered to Russia, which exclude high-temperature applications in the interests of rocket and space technology.

The main requirement for powders for additive 3d technologies is the spherical shape of the particles. Such particles are most compactly packed into a certain volume and ensure the "fluidity" of the powder composition in the supply systems of the material with minimal resistance. In addition, the powder should contain a minimum amount of dissolved gas. The microstructure of the powder must be uniform and finely dispersed (with a uniform distribution of phase constituents) [1-8].

Proceeding from the peculiarities of the methods for obtaining spherical powders with the aim of obtaining spherical granules of regulated granularity, the electroerosive dispersion technology is proposed, which is characterized by relatively low energy costs and ecological purity of the process [9-12].

The wide use of the EED method for processing metal waste into powders for the purpose of their reuse and application in additive technologies is hampered by the lack in the scientific and technical literature of full-fledged information on the effect of the initial composition, regimes and media on the properties of powders and technologies of practical application. Therefore, in order to develop technologies for the reuse of alloy powders obtained from nichrome waste and to evaluate the effectiveness of their use, complex theoretical and experimental studies are required.

The aim of this work was to study the mechanical properties of sintered samples from cobalt-chrome powders obtained for additive technologies by electro-erosive dispersion of metal wastes of KHMS alloy.

2. Materials and methods

For the implementation of the planned studies, the wastes of the cobalt-chrome alloy of the brand KHMS "CELLIT" were chosen. Isobutyl alcohol was also used as the working fluid. For the production of cobalt-chrome powders, a device for EED of conductive materials was used. Dispersion parameters: voltage 100 V, capacity 48 μF, repetition rate 120 Hz.

The powders are consolidated by the method of spark plasma sintering using the spark plasma sintering system SPS 25-10 (Thermal Technology, USA).

The surface hardness tests were carried out using an automatic micro-hardness analysis system DM-8 using the micro-Vickers method with an indentor load of 200 grams per ten prints with a free choice of the site of the injection in accordance with GOST 9450-76 (Measurement of microhardness by indenting diamond tips). The loading time of the indenter was 10 s.

The porosity was determined using an Olympus GX51 optical inverted microscope with software for quantitative image analysis. Prepared samples had no traces of grinding, polishing or dying of structural components. The slab was made by the cross section (fracture) of the whole product or part thereof with an area of <2 cm^2. The "SIAMS Photolab" software, which is equipped with a microscope, was developed taking into account the specific application of digital microscopy and image analysis methods for metallographic analysis of compounds. The digital image of a material in shades of gray looks like a set of objects that have

close color, brightness and morphometric characteristics. Accordingly, the automatic allocation of measurement information is associated with the inevitable capture of noise and interference. In order to ensure the reliability of the analysis results, the software has elements of the expert system: in an interactive mode, the operator is asked to select those of the automatically selected objects that, in his opinion, are microstructure defects. Since both individual pores and pore chains can be detected on the monitored surface, as well as microcracks, the operator with a continuous marker designates a pore chains, and single pores of creep and microcracks mark the marker as separate areas. The results of marking are used to form an expert conclusion and calculate the quantitative characteristics of microdamage. Based on the results of accumulated statistics, an automatic report is created in the automatic mode, which contains calculated data and information about the controlled area.

3. Results and discussion

The results of Vickers hardness measurements are given in Table 1.
The results of a study of samples porosity by the metallographic method are shown in Fig. 1.

Table 1: Vickers Hardness

Print number	Value HV	Print number	Value HV
1	1549	6	1606
2	1531	7	1361
3	1361	8	1302
4	1495	9	1425
5	1607	10	1393

The average hardness value of the sintered samples is 1463 HV.
The scatter of the microhardness values over the surface of the sample is due to the heterogeneity of the material.

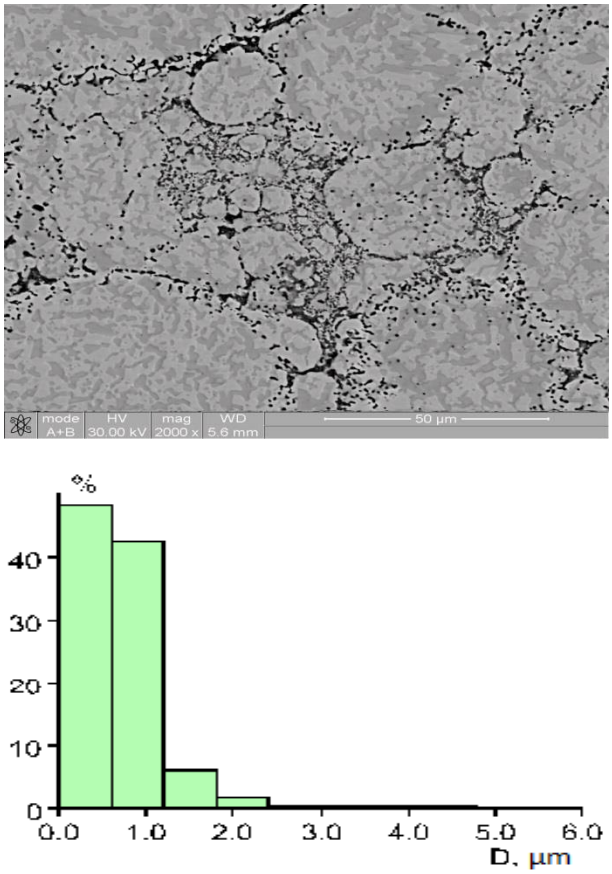

Fig. 1: Transverse Section of the Sintered Sample: A) Microstructure; B) Histogram of the Distribution of Pores by Size.

It has been experimentally established that the porosity of the sintered samples is 6, 15%.

4. Conclusion

Thus, based on the results of the studies carried out to study the mechanical properties of sintered samples from cobalt-chrome powders obtained for additive technologies by electroerosive dispersion, it was established:

- The average value of Vickers hardness of sintered samples is 14.63 Gpa;
- The porosity of the sintered samples is 6.15%.

The carried out researches will allow to define the most rational area of their practical application.

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