Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

Special Issue

MICROSCOPIC ANALYSIS OF ELECTROEROZYON CHROME-CONTAINING POWDERS

E. V. Ageev[1,*], A.Y. Altukhov[1], A.V. Shcherbakov[1], A. N. Novikov[2]

[1]South-West State University, Kursk, 94 50 years of October st

[2]Orel State University named after I.S. Turgenev, Orel, 77 Moscowskaya st.

Published online: 08 August 2017

ABSTRACT

The method of electro-erosive dispersion (EED) is characterized by relatively low energy costs and ecological purity of the process and allows to obtain powders from wastes of production and consumption. Nevertheless, the wide use of the method of electro-erosive dispersion is hampered by the lack of reference material for optimizing the powder formation regimes and the properties of the obtained copper powders. For wide use of this method, extensive theoretical and experimental studies are required. The purpose of this work is to study their shape and condition of the surface of powders, obtained by electro-erosive dispersion of chromium-containing waste. By the method of scanning electron microscopy (SEM) on the Nova NanoSEM 450 device particles of powders, obtained by electro-erosive dispersion of chromium-containing waste, were investigated. It was found that the shape of the powder particles is due to the way, in which the material is ejected from the well in the EED process. It can be seen, that particles having a regular spherical or elliptical shape prevail in a powder. They are obtained by crystallization of molten material (liquid phase). The particles, formed during the crystallization of the boiling material (vapor phase), have an irregular shape, the size of an order of magnitude smaller, than the particles, formed from the liquid phase, and usually agglomerate with each other and on the surface of other particles. In the EES process, such particles are most susceptible to chemical and phase changes.

Keywords: Chrome-containing waste, electroerosive dispersion, powder, form, surface.

Author Correspondence, e-mail: ageev_ev@mail.ru

doi: http://dx.doi.org/10.4314/jfas.v9i2s.89

1. INTRODUCTION

At the present time one of the main directions of the development of engineering technology is the improvement of existing and development of new waste-free, environmentally friendly, material-saving production processes, i.e. such processes that ensure the production of blanks with minimal allowances for subsequent machining, or without them at all, while reducing the consumption of scarce materials. In solving of this problem, a certain role belongs to powder metallurgy.

Progress in modern technology is inextricably linked with advances in the field of powder metallurgy. Powder metallurgy occupies a significant place in the creation of perspective modern materials having a high strength, heat resistance, hardness, wear resistance, low density, special magnetic and optical characteristics, and the like. The properties of powder materials are determined by the structure and composition, which in turn depend on the chemical composition, the technology of production and subsequent processing through mechanical, thermal, chemical, physical and other combined effects [1-5].

The properties of powder materials are largely determined by the properties of the original powders. Therefore, in the development and use of powder materials, the characteristics of the original powders, as well as the structure, the composition of the powder materials themselves, and, consequently, the methods of their investigation and evaluation, play an important role. Recently, for obtaining of metal powders, the electro-erosive dispersion method is of a great interest. The method of electroerosive dispersion (EED) is characterized by relatively low energy costs and environmental purity of the process and allows to obtain powders from production and consumption wastes. Nevertheless, the wide use of the method of electroerosive dispersion is restrained by the lack of reference material for optimizing the powder formation regimes and the properties of the obtained powders. To make wide use of this method, extensive theoretical and experimental studies are required [6-9].

The shape of the powder particles and the state of their surfaces have a great influence on the bulk density and compressibility, as well as on the density, strength and homogeneity of the compacts. Compacts from powders with a dendritic form of particles have the smallest bulk density and the greatest strength. On the contrary, powders with particles of spherical shape have a maximum bulk density, but are poorly compressed. To obtain compacts with sufficient strength from them, high pressures are required. Powders with a scaly form are very poorly pressed, and the compacts obtained from them are prone to cracking and delamination. Fibrous powders are poorly pressed and used mainly as reinforcing (strengthening) additives in the creation of fibrous materials.

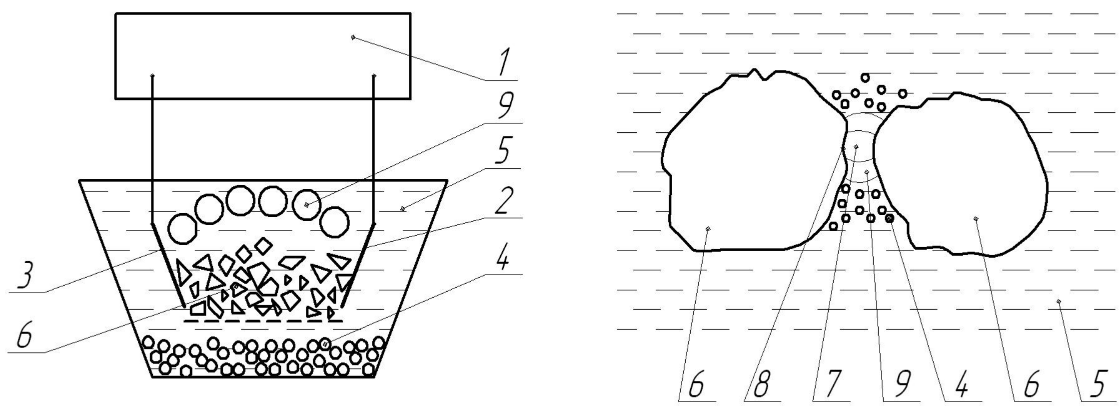
The shape of the powder particles is due to the way in which the material is ejected from the well in the EED process. Typically, particles obtained by crystallization of the molten material (liquid phase) are dominated in the powder. They have a regular spherical or elliptical shape.

2. PURPOSE OF RESEARCH

The purpose of this work was to carry out a microscopic analysis of powders, obtained by electroerosive dispersion of chromium-containing waste for study their shape and surface state.

3. OBJECT AND METHODS OF RESEARCH

The device for the EED of conductive materials, developed by the authors, was used to obtain the powder from the chromium-containing waste by the method of electro-erosive dispersion. As a result of the local impact of short-term electrical discharges between the electrodes, the material of the waste material was destroyed with the formation of dispersed powder particles (Fig. 1).



a) b)

Fig.1. EED process: a) device scheme; b) process scheme

The impulse voltage of the generator 1 is applied to the electrodes 2 and 3 and further to the plates of the alloy 6. When the voltage reaches a certain value, an electrical breakdown of the working fluid 5, located in the interelectrode space, occurs, forming a discharge channel 7. Due to the high concentration of thermal energy, the material at the point of discharge 8 melts and evaporates, the working fluid evaporates and surrounds the discharge channel with gaseous decomposition products 9.

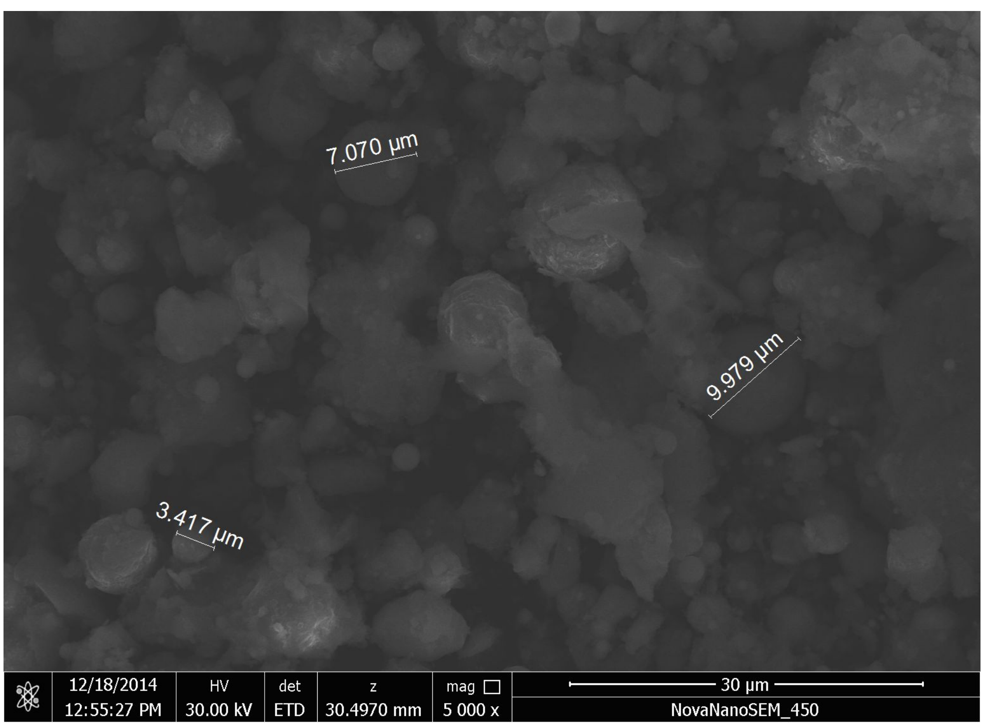
As a result of the development of considerable dynamic forces in the discharge channel and the products of the decomposition of the working fluid, the drops of molten material 4 are ejected outside the discharge zone into the working fluid surrounding the electrodes and solidify in it, forming drops-shaped particles.

Then, by the method of scanning electron microscopy (SEM) on Nova NanoSEM 450, particles of powders obtained by electroerosive dispersion of chromium-containing waste were investigated.

The microscopes of the NovaNanoSEM range differ by ultra-high resolution in high and low vacuum modes. This type of microscope is designed for research for non-conducting, easily charged materials and (or) gas samples at the nanoscale. Main advantages: field emission SEM with super-stable Schottky source with high current density, the world's only fully low-vacuum autoemission SEM with a true high resolution: 1.8 nm at 3 kV, current up to 200 nA for analysis in high or low vacuum, precision and stable subject table 150 x 150 mm with piezodrive (for Nova NanoSEM 650), immersion magnetic field, beam retardation mode, beam energy at sample surface up to 20 eV, retractable detector with unique ring segmentation.

4. RESULTS AND ITS DISCUSSION

The results of the investigation of powder particles, obtained by electro-erosive dispersion of chromium-containing waste on the Nova NanoSEM 450, are shown in Fig. 2.



a)

b)

Fig.2. SEM image of the powder particles with the scale bar:
a) 30 µm; b) 10 µm

It is shown that the shape of the powder particles is due to the way in which the material is ejected from the well in the EED process. It can be seen, that in the powder particles, having a regular spherical or elliptical shape, prevail. They are obtained by crystallization of molten material (liquid phase). The particles, formed during the crystallization of the boiling material (vapor phase), have an irregular shape, size an order of magnitude smaller than particles, forming from liquid phase, and are usually agglomerated with each other and on the surface of other particles. In the EED process, such particles are most exposed to chemical and phase changes.

5. CONCLUSION

Thus, based on the carried out experimental studies, aimed at studying the shape and state of the powder surface, obtained by the method of electroerosive dispersion from chromium-containing waste, it is established that the powder consists of particles of regular spherical shape (or elliptical) and irregular shape (conglomerates).

ACKNOWLEDGEMENTS

The work is executed at financial support of Russian science Foundation. Project number 17-79-20336.

REFERENCES

[1] Azarova E.V., Levashov E.A., Ralchenko V.G. // Metallurgist. 2010. Vol. 54. № 7-8. P. 523-529.

[2] Kirsanov S.V., Babaev A.S. // Russian Engineering Research. 2013. Vol. 33. № 3. P. 170-171.

[3] Ivanov V.V., Pryazhnikova A.A. // Russian Engineering Research. 2013. Vol. 33. № 1. P. 46-47.

[4] Uglov V.V., Kuleshov A.K., Remnev G.E. // Russian Journal of Non-Ferrous Metals. 2013. Vol. 54. № 4. P. 349-354.

[5] Valentov A.V., Konovodov V.V., Agafonova E.V. // Applied Mechanics and Materials. 2013. T. 379. C. 28-31.

[6] Ageeva E.V. // Journal of nano- and electronic physics. 2013. Vol. 5, № 4. P. 04038-1–04038-2.

[7] Ageev E.V. // Journal of nano- and electronic physics. – 2014. – Vol. 3. – P. 03001-1–03001-4.

[8] Ageeva E.V. // Journal of nano- and electronic physics. – 2014. – Vol. 3. – P. 03011-1–03011-3.

[9] Ageev E.V. // Journal of nano- and electronic physics. – 2014. – Vol. 3. – P. 03049-1–03049-3.

How to cite this article:
Ageev E V, Altukhov A Y, Shcherbakov A V, Novikov A N. Microscopic analysis of electroerozyon chrome-containing powders. J. Fundam. Appl. Sci., 2017, *9(2S), 1152-1157.*