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Investigation of process for producing carbide-containing welding fused fluxes using plasma granulation

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This article proposes a technology for producing fused welding fluxes using plasma granulation. The developed technology enables producing welding flux granules with carbide-containing additives. This is possible due to high dynamic and temperature effects of plasma arc on mineral raw materials that stops refractory additives from melting and thus remaining in welding materials composition. Using petrographic analysis, it was found that silicon carbide particles remain unchanged in granules of fused welding fluxes composition. Plasma granulation technology makes it possible to obtain both finished products such as welding fluxes and a charge ready for manufacturing cored wire and coated electrodes.

1. Introduction

Expanding the use of mineral raw materials, especially gabbroid and basaltoid groups of the Ural region becomes an urgent task, since there are sufficiently large reserves of both natural and technogenic raw materials in the Ural region. One of the directions for obtaining new types of products from mineral raw materials is producing welding materials (fused flux, cored wire, coated electrodes) using plasma granulation technology that helps to reduce energy and material costs and increase welding properties in general [1-3].

Welding materials are an integral part of modern welding production. Therefore, using high-quality welding materials with high welding-technological properties is required during welding and repairing (surfacing) critical and building structures of general purpose. To this end, the chemical composition of welding materials is improved for arc burning stability and the favorable course of physical and chemical reactions during welding (surfacing). Mineral-based welding materials with various additives (e.g. carbides) are in particular demand.

In this regard, the aim of this scientific work is to obtain welding materials on oxide-silicate basis with the addition of silicon carbide. The main task of the study on the identification of silicon carbide in welding fused flux granules composition is to carry out a petrographic analysis of welding flux granules obtained by plasma granulation.

2. Experimental research

The experiments on plasma granulation of welding flux from mineral raw materials with carbide-containing additives were carried out on modern HyperTherm Powermax 45 air-plasma cutting equipment. This equipment allows to programmatically control heat input into the material by changing the arc parameters, as well as changing the speed and trajectory of the plasmatron.

Rocks of oxide-silicate base of the gabbroid group of the Ural region were used to study plasma granulation process. Aforesaid mineral raw materials have all the necessary components for a slag basis of fused flux and a low content of harmful impurities. Such rocks of the gabbroid group as hornblendite possess good fusibility, required melting point, and homogeneity in chemical and phase composition. Silicon carbide (SiC with a grain size of F60, 0.2-0.3 mm) was used as an additive that increased arc burning stability and ensured high deposition coefficient and fluidity of the bath [4].

Sections from synthesized flux granules obtained under action of high dynamic and temperature

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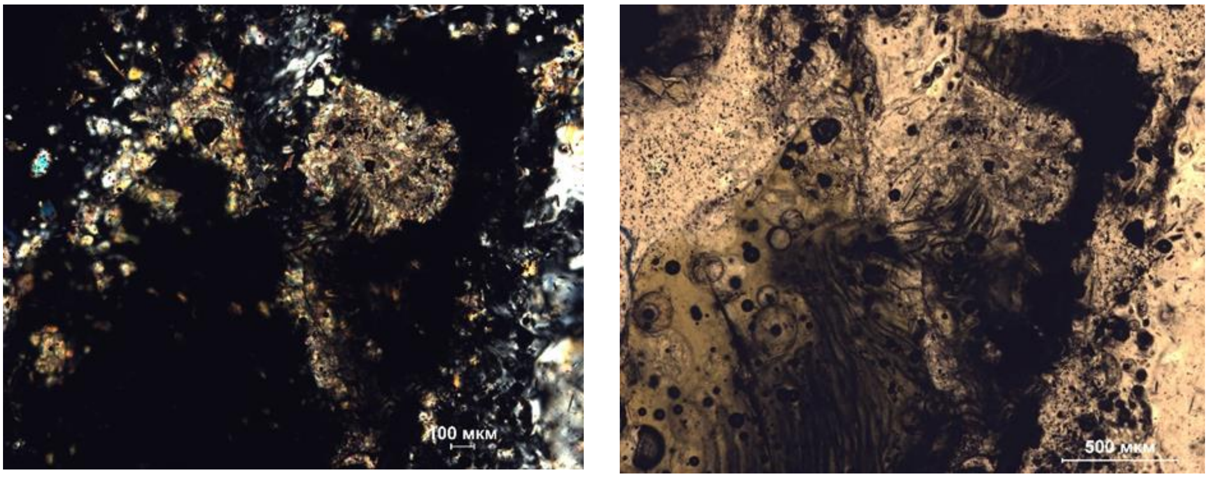
effects of the plasma arc underwent petrographic analysis using a Nikon Eclipse E 600 POL polarizing microscope.

Petrographic analysis showed that composition of the granules is similar in structure to hornblende. Hornblende is characterized by absolute cleavage in two directions, where the cleavage angle is 124 ° and 56 °, but there is no such cleavage observed in this section, since cracks are technogenic in nature [5].

In this section a hornblende has brown and green color with a clear pleochroism (pleochroic from pale green to green or pale brown to dark brown) without an analyzer. With the analyzer, the grains are isotropic, although the hornblende crystallizes in monoclinic system, and it must be anisotropic.

In this section, there are inclusions of silicon carbide, where the grain size is 0.08-0.12 mm. These clusters are located unevenly on the periphery (Figure 1, a) or inside (Figure 2, a) of single hornblende grains. Carbides in the section are colorless (without analyzer Figure 1, 2 b) and have birefringence (with analyzer-photo Figure 1, 2, a), that is characterized by bright pearly interference coloring.

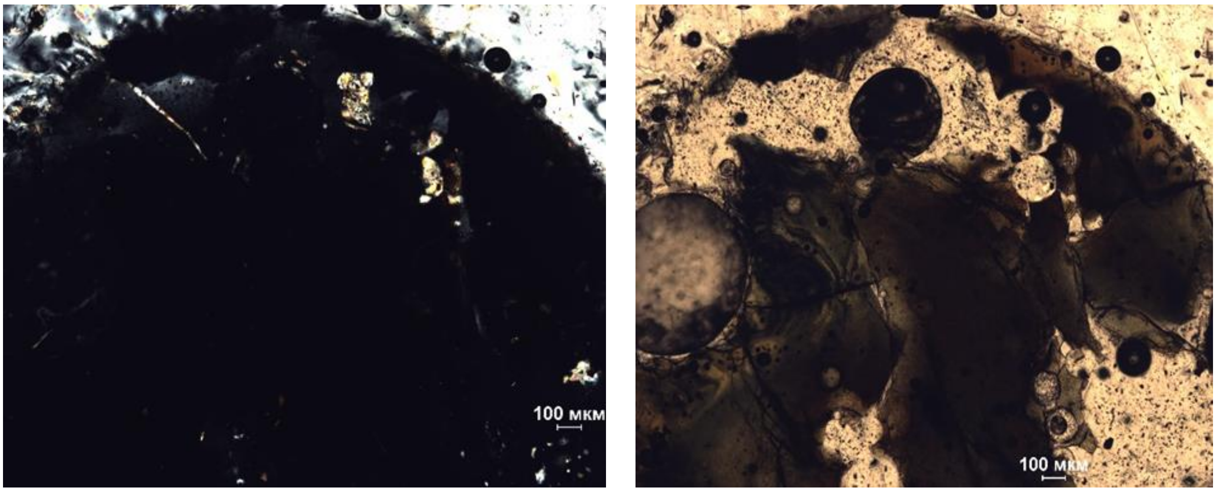


a b

Figure 1. Petrographic analysis of welding fused flux granules with SiC particles on the periphery: a - with analyzer-photo, 50x, b –without analyzer, x50.

It is possible that reduction in particle sizes of silicon carbide is associated with thermal decomposition. The oxide-silicate base affects the particles of silicon carbide, since an acidic medium causes thermal decomposition and a decrease in concentration and size of particles in welding flux granules. To prevent a decrease in concentration of carbides in the oxide-silicate base, it is possible to use a calcium fluoride base [6].

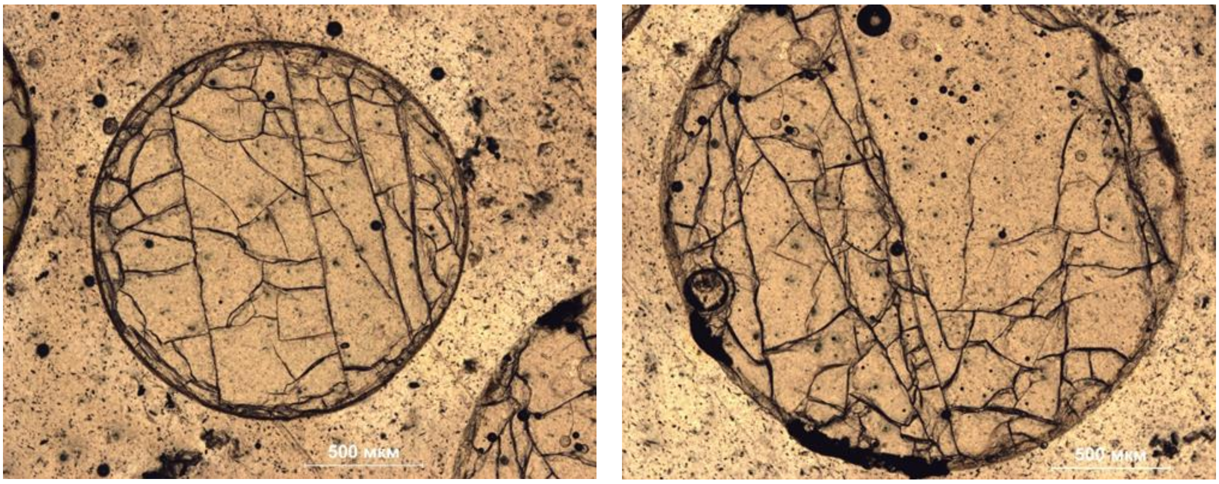
Using a calcium fluoride base, silicon carbide will be less susceptible to thermal decomposition. Fluorite can be such a calcium fluoride base. Fluorite-based granules obtained by plasma granulation are shown in Figure 3.



a b

Figure 2. Petrographic analysis of welding fused flux granules with SiC particles inside the section: a - with analyzer-photo, 50x, b –without analyzer, x50.

Fluorite-based granules have absolute cleavage in four directions; therefore, the crystal can split along the octahedron. The figure shows two out of four directions, the angle between the cleavage is ~ 90 ° (Figure 3, a). Partial cleavage is also observed in the granule part due to its technogenic origin (Figure 3, b). Since cubic system is characteristic of fluorite, it lacks one of the main optical properties - birefringence. Under a microscope in a section, fluorite without an analyzer is most often colorless, with an analyzer it is isotropic.



a b

Figure 3. Petrographic analysis of welding fused flux granules on fluorite base: a – granule with absolute cleavage, x50, b –granule with anisotropic cleavage, x50.

It is assumed that during formation of such granules after plasma granulation carbides will be located along the cleavage boundaries of fluorite that indicates uniform distribution of such particles.

3. Conclusion

Plasma granulation of fused welding flux technology is proposed that allows to obtain granules from mineral raw materials of the Ural region with the addition of silicon carbide, that later in the welding process participate in metallurgical processes that favorably affect modification of the weld. It has been established that silicon carbide particles up to 0.12 mm in size are located both inside and on the periphery of the granules. The synthesis of such composite granules will expand the range of welding materials.

Acknowledgements

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