

Obtaining welding materials of various structures, fractional and chemical composition using plasma granulation

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Abstract. The article proposes the technology for producing fused welding fluxes grains of various structures, fractional and chemical composition using a highly concentrated heat source. Interaction processes between the highly concentrated heat sources and mineral raw materials are presented in the article. The necessary components for obtaining welding flux with various granule structures are determined. The proposed technology allows to obtain welding flux granules with a range from 0.1 to 3.0 mm that meets regulatory documentation requirements. It was found that during the process of plasma granulation there is a decrease in the concentration of alkali metals to the required content for welding fluxes. At the same time, there is an increase in the concentration of basic elements such as silicon, calcium, aluminum and other metals.

1. Introduction

Currently there is a number of studies to obtain welding flux granules with a spherical shape and a vitreous grain structure using a plasma arc. Expanding the possibility of obtaining granules of different morphology and grain structure using highly concentrated heat sources is an urgent task [1].

In this regard, the aim of this work is to develop technological foundations for obtaining fused welding fluxes with different grain structures, morphology and chemical composition produced by plasma-arc method.

These aims are achieved by choosing the right source of mineral raw materials, manufacturing samples for the granulation process and the subsequent production of fused welding flux using plasma granulation.

2. Plasma granulation technology

Plasma granulation process was carried out on modern welding equipment for plasma cutting. Due to the fact that compressed air was used as a plasma-forming gas in the direct-action plasmatron, a copper electrode was used for a stable granulation and arc burning process. The scheme and process of granulation of fused welding flux by plasma-arc method is presented in Fig 1.

Rocks of the gabbroid group of the Ural region were selected as mineral raw materials for producing welding materials. Hornblendite contains all the necessary elements for a slag base and chalk makes it possible to increase slag basicity to the desired value, silicon carbide increases stability of arc burning and provides high surfacing coefficient and fluidity of the bath [2-4].

For granulation process samples were made in the form of plates (Fig. 2, a), using a technology similar to manufacturing of coated electrodes and agglomerated or ceramic fluxes, where hornblendite and



chalk charge was mixed with sodium liquid glass to produce plates [5]. The surface of the plate is porous. This is possible due to the chemical reaction of the components with liquid glass (Fig. 2, b).

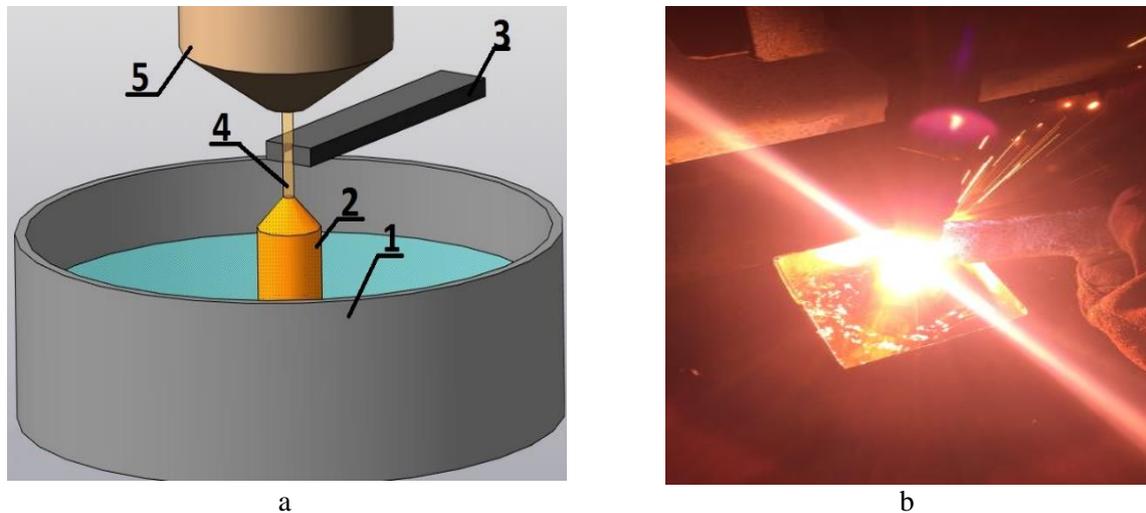


Figure 1. The scheme (a) and granulation process (b) of fused welding flux by plasma-arc method: 1 – granulation pool; 2 – copper electrode; 3 – granulated plate; 4 – plasma arc; 5 – plasmatron.

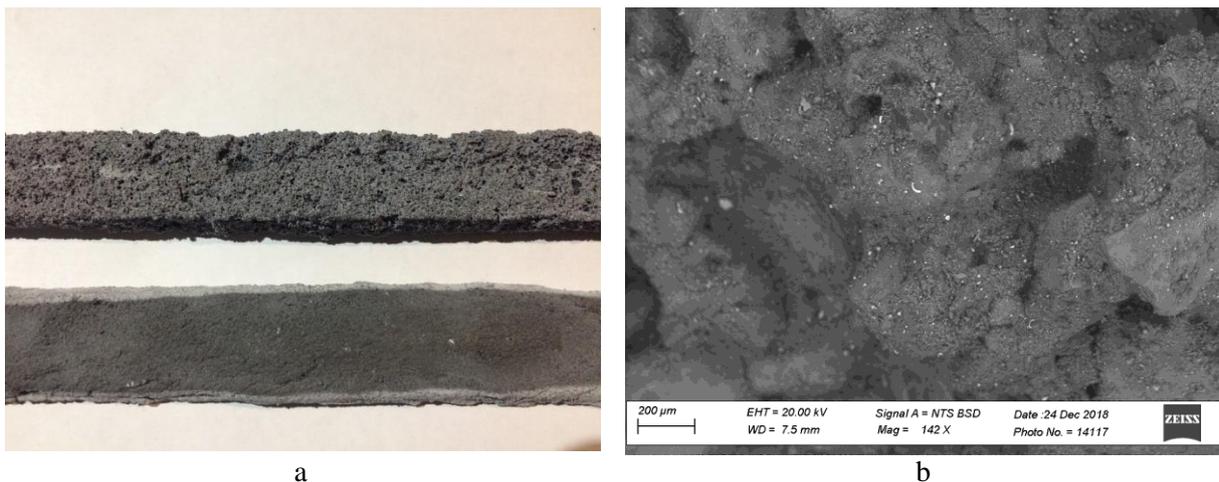


Figure 2. Samples for plasma granulation: a - general view of samples for plasma granulation; b - surface of samples, x150

Plasma arc 4 was ignited between the plasmatron 5 and a copper electrode 2 immersed into the granulation pool 1. Then, plates 3 were fed into the arc burning zone. Under dynamic and temperature action of the compressed arc the edges of the plates melted and fell into the granulation pool in the form of granules.

3. Experimental research

As a result, welding flux granules were obtained (Fig. 3), the morphology and size of these granules were examined using scanning electron microscopy with a ZEISS microscope. It was found that the granules have a particle size of 0.1 to 3 mm that corresponds to fractional composition for welding fluxes.

Figure 3 «a» shows general view of fused welding flux granules that have both spherical and fragmental form. The surface of the granules is porous because of the fact that chalk and partially silicon carbide form CaO , SiO_2 , CO_2 under the conditions of an oxidizing medium and therefore

bubbles and pores on the surface of the granules are formed [6]. The formation of a pumiceous grain structure occurs more intensively when granules fall into heated water.

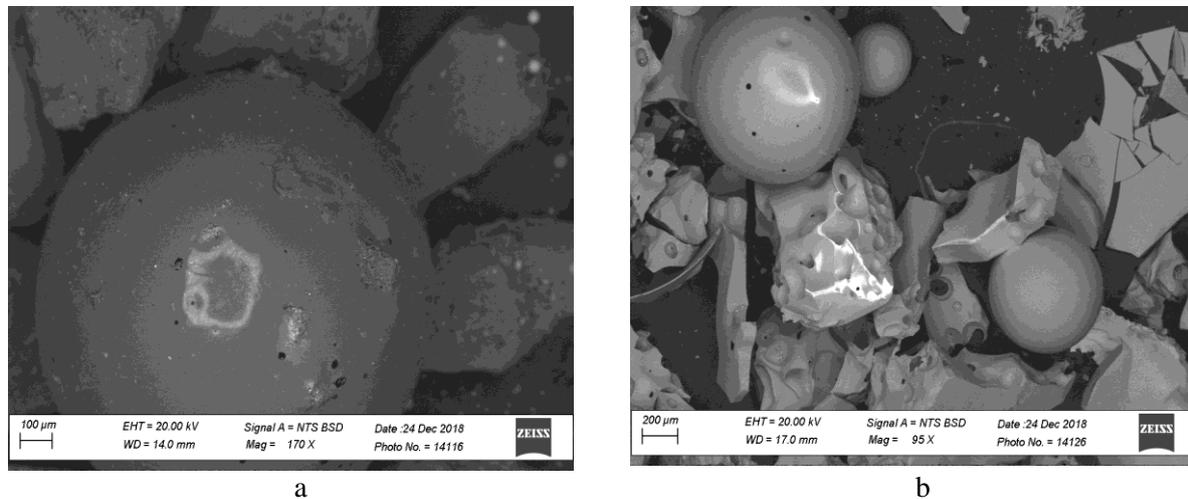


Figure 3. Fused welding flux granulated by plasma arc, a – general view of the granules, b – general view of glass-pumiceous grain structure flux granules.

Plates produced from the charge with a greater amount of added chalk led to formation of a fused welding flux with a glass-pumiceous grain structure during the granulation process (Fig. 3 b). Formation of such structures is explained by the fact that vitreous fluxes mainly consist of Ca^{2+} , Mg^{2+} , Fe^{2+} , Na^+ , K^+ cations and complex silicon-oxygen or aluminum-oxygen anions. Some examples of how your references should be listed are given at the end of this template in the ‘References’ section which will allow you to assemble your reference list according to the correct format.

Chemical composition of mineral raw materials before and after plasma arc granulation is shown in Table 1.

Table 1. Chemical composition of mineral raw materials before and after plasma granulation.

Material	Elemental chemical composition, mass. %									
	C	O	Na	Si	Ca	Fe	Al	Mg	K	Ti
Raw material	12.80	52.52	27.59	1.57	4.13	1.18	0.21	-	-	-
Formed granules	0.54	60.01	3.40	15.22	9.00	2.61	3.67	4.86	0.20	0.49

It was found that during plasma processing alkali metals are partially burned to the required concentration for welding fluxes, also there is an increase in the concentration of basic elements such as silicon, calcium, aluminum and other metals. In addition, proposed chemical composition and method of granulation of fused welding flux makes it possible to obtain granules of the required chemical and fractional compositions, with a degree of basicity of 0.7, as well as the required grain structure that corresponds to regulatory documentation [6].

4. Conclusion

In conclusion, it can be noted that grain structure, fractional and chemical composition during granulation of mineral raw materials of the Ural region using plasma-arc method is affected by changing chemical composition of the charge and methods of granules formation. The processes leading to a structure change, fractional and chemical composition are well studied and can be predicted in the development of welding materials for various purposes.

Acknowledgements

The reported study was funded by RFBR according to the research project № 18-33-00599.

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