

## ABSTRACTS

UDC 621.928.6:519.28

### **Modes of motion of the medium and universal curves for gravity separation processes**

Barskiy E. M. // *New Refractories*. — 2020. — No 2. — P. 3–6.

The separation curves for gravitational separation processes have the property of affinity. This means that with a certain transformation of the coordinate axes, all the experimental values of fractional extraction form a single curve in these coordinates. The values of the ordinates when obtaining such universal curves are called similarity criteria for separation processes. Similarity criteria have been determined for obtaining universal separation curves during separation for particles of different sizes in flows of a mobile medium for different modes: laminar, transient, and turbulent. However, it remains unclear in what boundaries one or another criterion should be applied in specific separation conditions. The article provides an analysis of the physical foundations of the interaction of a solid phase and a mobile flow in different modes of its movement. It is proved that the entire range from laminar to developed turbulent is covered by two similarity criteria. Ill. 3. Ref. 5. Tab. 2.

**Key words:** separation, affinity, separation curves, modes of motion of the medium, particle size, scope of the criterion.

UDC 621.762.4:669-492].004.052.42

### **Experimental verification of new compaction equations for fine materials of the mining & metallurgical complex. Part 2. Stage compaction equation**

Khudyakov A. Yu., Vaschenko S. V., Bayul K. V., Semenov Yu. S. // *New Refractories*. — 2020. — No 2. — P. 7–13.

The effectiveness of the new stage compaction equation in identifying and analyzing individual stages of compaction has been assessed. It was found that the newly developed equation correctly and with high accuracy describes the experimental compaction curves, taking into account the periodic nature of the process and allowing us to distinguish the characteristic transition points between stages, while the determination coefficient is close to unity. Based on the use of the basic and stage compaction equations, methods have been developed for determining the stabilizing pressure, briquetting and stiffness of the batch. A new feature is proposed for the energy classification of briquetted materials. Ill. 7. Ref. 18. Tab. 1.

**Key words:** fine materials, briquetting, modeling, stages of the compaction process, stage compaction equation, stabilizing pressure, briquetting, batch stiffness, energy classification.

UDC 666.762.14+666.762.52]:66.046.44

### **Stimulation of plasma-spark sintering of mixtures of oxide-non-oxide components by adding a solid solution TaB<sub>2</sub>-NbC and through a nickel melt in mixtures of metal powders**

Hmelov A. V. // *New Refractories*. — 2020. — No 2. — P. 14–29.

The article shows the effect of powders mixtures of Ni and Ta, Ni and Zr in relation with sintered solid solution TaB<sub>2</sub>-NbC during spark plasma sintering of compositions at pressing loading of 60 MPa in the range 1200–1600 °C on the phase composition, percentage content of Ti, Ta, Zr in the sialon, microstructure, grain sizes of crystalline phases, relative density, linear shrinkage, physical-mechanical properties, linear correlation of modulus of Elasticity and fracture toughness of mullite-β-

SiAlON-TiC, mullite-β-SiAlON-c-ZrO<sub>2</sub> samples in this work. Synthesised powders of β-SiAlON and TiC are characterized by intensive crystallization of β-SiAlON and TiC. Sintered by spark plasma method c-ZrO<sub>2</sub> at 1400 °C and solid solution TaB<sub>2</sub>-NbC at 1800 °C show intensive crystallization of c-ZrO<sub>2</sub> and (Nb, Ta)C,B phases. Microstructure of solid solution TaB<sub>2</sub>-NbC is crystalline, partially nonuniform and almost completely sintered. Sintered samples with additive of Ta and Zr show intensive mullitization, active crystallization of β-SiAlON, (Nb,Ta)C,B, Ni(Nb,Ta), different crystallization of NiTi, NiTa, NiZr and NiZr<sub>2</sub> phases in the range 1200–1600 °C. Microstructures of ceramic phases of samples with additive of Ta more uniformly and densely sintered, particles of NiTi and NiTa are uniformly and densely packed of samples with additive of Ta unlike the variously packed particles of NiTi and NiZr, NiZr and NiZr<sub>2</sub> of samples with additive of Zr. Sintering of compositions with additive of Ta form polydisperse grains compositions of crystalline phases, processed uniformly and intensively. Samples with additive of Ta show active growing and larger values of physical-mechanical properties, higher resistance to the cracking, larger linear correlation of modulus of Elasticity and fracture toughness in the range 1200–1600 °C. Ill. 14. Ref. 18. Tab. 3.

**Key words:** mullite-β-SiAlON-TiC, mullite-β-SiAlON-c-ZrO<sub>2</sub>, solid solution TaB<sub>2</sub>-NbC, powders mixtures of Ni and Ta, Ni and Zr, spark plasma sintering, properties.

UDC 666.3:546.822'261

### **Influence of synthesis parameters on density and phase composition of materials based on Ti<sub>3</sub>SiC<sub>2</sub>**

Bykova A. D., Semenova V. V., Perevislov S. N., Markov M. A. // *New Refractories*. — 2020. — No 2. — P. 30–34.

Various mixtures of the initial Ti/Si/C, Ti/Si/TiC, Ti/SiC/C, Ti/SiC/TiC, Ti/TiSi<sub>2</sub>/TiC and TiH<sub>2</sub>/SiC/C powders were used to synthesize Ti<sub>3</sub>SiC<sub>2</sub> by sintering at temperatures of 1300 and 1400 °C for 1–5 h. Ti/Si/TiC and Ti/TiSi<sub>2</sub>/TiC powders are the best among all powder mixtures for Ti<sub>3</sub>SiC<sub>2</sub> synthesis. The amount of the synthesized Ti<sub>3</sub>SiC<sub>2</sub> phase for the compositions of these components reaches 98,3 and 90,3 vol. %, at a sintering temperature of 1400 °C for 1 h. Ti<sub>3</sub>SiC<sub>2</sub> is synthesized and grows in the form of elongated grains. The influence of the time and temperature of sintering on the formation of the MAX-phase Ti<sub>3</sub>SiC<sub>2</sub> from the initial Ti/Si/C powders has been determined. Titanium carbide and a small amount of silicon carbide as intermediate phases are always present in the final products. An excess of silicon contributes to the highest formation of the Ti<sub>3</sub>SiC<sub>2</sub> phase. Ill. 3. Ref. 32. Tab. 1.

**Key words:** MAX-phases, synthesis of Ti<sub>3</sub>SiC<sub>2</sub>, phase composition.

UDC 544.45,53.091,53.092

### **Production of ceramic plates based on Al<sub>2</sub>O<sub>3</sub>-TiB<sub>2</sub> by free SHS compression**

Chizhikov A. P., Konstantinov A. S. // *New Refractories*. — 2020. — No 2. — P. 35–39.

Ceramic plates with dimensions of 90×40×7 mm and a density of 3,41 g/cm<sup>3</sup> were obtained by the method of free SHS-compression. The resulting plates consist of three phases: aluminum oxide, titanium diboride, and mullite. The plates have a composite structure: a matrix based on Al<sub>2</sub>O<sub>3</sub> with titanium diboride particles distributed in it. Also, in

the structure of the obtained plates, whiskers of titanium monoboride with a thickness of about 100 nm were observed. The results of high-temperature tests of plates in the range of 900–1200 °C for 10 h are presented, the dependences of the true rate of weight gain and specific weight gain of samples during the tests are obtained. Ill. 5. Ref. 27. Tab. 2.

**Key words:** self-propagating high-temperature synthesis, free SHS-compression, composite material.

UDC 669.713.7:621.3.036.5]:658.583

### **Selection and development of a masonry composition for the installation and repair of the lining of a magnesium diaphragm electrolyzer made of potassium fluoroflogopite**

Ignatova A. M., Yudin M. V. // *New Refractories*. — 2020. — No 2. — P. 40–44.

The effectiveness of refractory products made of new improved refractory materials is achieved if, during their installation and repair, a masonry composition is used, the properties of which provide a similar level of heat resistance in the aggressive environment of the electrolyzer as the material of the products. The article establishes the optimal component composition of the masonry mixture for the installation of the lining of a magnesium diaphragm electrolyzer made of potassium fluoroflogopite. It has been proved that the ratio of the mass fraction of fluorine-containing components to the rest of the mass is an indicator that allows characterizing the suitability of masonry mixtures for the installation and repair of products made of potassium fluoroflogopite. Ill. 4. Ref. 8. Tab. 4.

**Key words:** refractory silicate, electrolysis, fluoroflogopite, masonry composition.

UDC 691.54:66.063.8.086.4

### **Investigation of mineral hydraulic binders based on the slag-cement system obtained with the use of vortex electromagnetic homogenization**

Khaidarov B. B., Suvorov D. S., Lysov D. V., Luchnikova G. G., Druzhinina M. E., Kuznetsov D. V., Bychkov A. V., Burmistrov I. N., Mamulat S. L. // *New Refractories*. — 2020. — No 2. — P. 45–50.

Samples of mineral hydraulic binder and artificial stone based on it were obtained from granulated blast furnace slag and Portland cement M500 using vortex electromagnetic homogenization. The physicochemical characteristics of mineral powders have been investigated: phase and chemical composition, specific surface area, particle size distribution, mechanical properties of artificial stone based on binders of the slag-cement system. It is shown that when introducing into the composition of the developed materials from 10 to 50 wt. % Portland cement, the ultimate compressive strength of the samples varies from 50 to 90 MPa, the density is from 2,1 to 2,5 g/cm<sup>3</sup>. At the same time, these materials have a low cost due to the use of blast-furnace slag as a raw material, as well as due to the use of an energy-efficient grinding technique. Ill. 5. Ref. 14. Tab. 3.

**Key words:** granulated blast furnace slag, cement, hydraulic binders, vortex electromagnetic homogenization.

UDC 658.565:666.76]:548.734

### **Application of X-ray diffraction techniques to quality control of refractories and raw materials**

Ivanova T. I., Maslov V. N., Gershkovich S. I., Iksanov F. R., Kovalenko A. A., Tsunaeva A. V., Markelov S. A. // *New Refractories*. — 2020. — No 2. — P. 51–59.

The majority of refractory materials and raw minerals used for their production are crystalline substances. X-ray diffraction techniques can be successfully applied for qualitative and quantitative determination of their mineral composition and for analysis of those structural features, which are most important in technological process. The paper considers most common types of refractories studied with full-profile Rietveld refinement to reveal the parameters to be controlled during their production. It was concluded that structural properties of mineral phases should be taken into account to affect mechanical properties of the refractory materials. Ill. 9. Ref. 5. Tab. 1.

**Key words:** crystalline refractories, raw minerals, X-ray diffraction, qualitative and quantitative phase analysis, Rietveld structural refinement.

UDC 666.3:546.28'171].017:543.57+539.375

### **Combined analysis of stress-strain state of surface layer of ground Si<sub>3</sub>N<sub>4</sub>-TiC ceramics**

Kuzin V. V., Grigor'ev S. N., Volosova M. A. // *New Refractories*. — 2020. — No 2. — P. 60–66.

The main regularities of the stress state of the surface layer of ground Si<sub>3</sub>N<sub>4</sub>-TiC ceramic under the combined load are established. The specificity of formation of structural heterogeneity of stress and microstructural stress concentrators, which lead to changes in the structure of ceramics due to the formation of discontinuities, is revealed. Ill. 4. Ref. 26. Tab. 2.

**Key words:** Si<sub>3</sub>N<sub>4</sub>-TiC ceramics, surface layer (SL), stress state, combined load, stress intensity, microstructural stress concentrator, discontinuity, computer engineering.

UDC 533.6:628.511.2

### **Reduced dust generation when loading hoppers with powdered material. Part 1. Research methods**

Semenenko A. S., Logachev K. I., Goltsov A. B., Averkova O. A. // *New Refractories*. — 2020. — No 2. — P. 67–72.

The expediency of fan loading of bunkers with powdery bulk material by calculation is shown. The design of an annular charging device using the Coanda effect to reduce dust formation is proposed. The rational design and technological parameters of the developed device are numerically and experimentally determined. Ill. 8. Ref. 21. Tab. 2.

**Key words:** dedusting, bulk materials, Coanda effect, loading device.

#### **ПОПРАВКА**

В журнале «Новые огнеупоры» № 10 за 2020 г. на с. 66 в левой колонке последнее предложение перед разделом «Результаты исследования» следует читать так: «Например, коэффициент  $K_{212}$  определяет значение отношения  $\sigma_{\text{мин}}$  при **КА** к  $\sigma_{\text{мин}}$  при **СА** в поверхности **С2**».