# REVIEW OF RF PATENTS FOR REFRACTORY INVENTIONS

## Review prepared by the editorial staff of Novye Ogneupory[1]

Translated from Novye Ogneupory, No. 6, pp. 71 – 72, June, 2013

### A METHOD OF PRODUCING SILICON CARBIDE- AND SILICON-BASED REFRACTORY MATERIAL

*S. V. Digonskii and V. V. Ten*

Patent RU 2439032
IPC C04B35/565

A method of producing silicon carbide- and silicon-based refractory material that comprises filling a form of carbon-containing material with silicon carbide and silicon, imparting to the fill the configuration of an article, heating and heat treatment in a reducing atmosphere, and siliconizing by impregnation of silicon carbide first with a melt and then vapors of silicon is distinguished by the fact that heat treatment is performed at 2300 – 2500°C and higher right up to the boiling point of silicon for 2 – 3 h until complete dissolution of the silicon carbide into silicon is achieved. Silicon in the charge is prescribed with excess in a ratio not less than Si/SiC = 3/1, while the content of silicon in the resulting material is in the range from 15 to 50 wt.% under normal conditions. The technical result of the invention lies in an increase in the strength and refractoriness of articles. The complex of properties of the new SiC material defines its possible range of application, for example, for the fabrication of crucible materials that come into contact with smelt; the pipes of the nozzle inserts of high-temperature gas jet equipment; turbine blades that function under conditions of high temperatures and oxidative media; low-abrasive anti-friction parts of machines that rotate at high temperatures; low-abrasive electric brushes used in every imaginable type of electric motor; different types of valves that experience periodic impact loads; and high-temperature heaters that function under corrosive conditions.

*Inventions Bulletin: Utility Models,*[2] *No. 1, 332 (2012)*

[1] OOO Intermet Inzhiniring, Moscow, Russia.
[2] Subsequently we use the abbreviated name *Bulletin*.

### ZIRCONIUM-BASED REFRACTORY MATERIAL

*V. N. Antsiferov, S. E. Porozova, V. B. Kul'met'eva, B. L. Krasnyi, and V. P. Tarasovskii*

Patent RU 2440952
IPC C04B35/48

A zirconium-based refractory material that includes zirconium and yttrium oxide in the following ratio, wt.%: zirconium, 97.0 – 99.1 and yttrium oxide, 0.9 – 3.0 and is distinguished by the fact that the zirconium contains aluminum oxide at a rate of 1.0 – 1.2 wt.%. The invention makes it possible to obtain zirconium-based refractory ceramic possessing elevated density and resistance to thermal dissociation at high temperatures and may be used in the fabrication of refractory materials and articles in metallurgy, machine construction, and the electrical engineering industry.

*Bulletin, No. 3, 111 (2012)*

### A METHOD OF FABRICATING CERAMIC ARMOR MATERIAL BASED ON SILICON CARBIDE AND BORON CARBIDE

*E. F. Kharchenko, V. A. Aniskovich, V. V. Lenskii, I. S. Gavrikov, and V. A. Bykov*

Patent RU 2440956
IPC C04B35/56, C04B35/573, F41H5/00

A method of fabricating ceramic armor material based on silicon carbide and boron carbide in which a charge is formed from the following components, wt.%: grains of α-crystals of silicon carbide 50 – 100 mm in size, 40 – 60; grains of crystals of boron carbide ≤35 μm in size, 40 – 60; and a mixture of phenol-formaldehyde lacquer with isopropyl alcohol, 5 – 20.

A billet is compacted from the resulting charge, subjected to heat treatment to obtain pyrocarbon situated between grains of the carbides, the billet is roasted in a vacuum at 1450 – 1900°C accompanied by the formation of two networks from the reaction-bound grains of silicon carbide and the reaction-bound grains of boron carbide also situated between them. A bond between the grains of silicon carbide is realized by deposition of β-crystals on the α-crystals of silicon carbide until a grain of 80 – 150 μm is attained accompanied by the formation from the latter of cross-links between the grains of silicon carbide, while the bond between the grains of the crystals of boron carbide is realized by deposition of a shell of silicon, boron silicides, and a solid solution of silicon carbide in boron carbide accompanied by the formation of cross-links of the latter. Siliconizing of a billet of 120 – 130 wt.% of silicon metal on a 100 wt.% billet is also performed.

2. Ceramic armor material based on silicon carbide and boron carbide fabricated by the method of Part 1 comprises a double-network composite material of reaction-bound grains of α-crystals of silicon carbide measuring 50 – 100 μm and reaction-bound grains of crystals of boron carbide measuring ≤35 μm. The reaction bonds of the networks are realized by a reaction between the components in the course of siliconizing:

– for the grains of the α-crystals of silicon carbide, by deposition of β-crystals on the α-crystals of silicon carbide until a grain measuring 80 – 150 μm is attained accompanied by the formation of cross-links of β-crystals between the grains of silicon carbide;

– for the grains of crystals of boron carbide, by a shell of silicon, boron silicides, and a solid solution of silicon carbide in boron carbide accompanied by the formation of cross-links from the latter, moreover, the materials that is obtained consists of a double network of $B_4C$ – SiC with an intergranular Si phase.

*Bulletin, No. 3, 112 (2012)*

## A REFRACTORY ARTICLE CAST FROM A MELT

*R. Nilika and K. Zantovski*

Patent RU 2440953
IPC C04B35/484, C04B35/657

The invention pertains to zirconium dioxide-based refractory articles that may be used in glassmaking tank furnaces and in the steel casting industry as hollow-metal cylinders in continuous casting of steel, plates, and for slide gates and worn parts in zones that are subject to the action of especially high loads. The refractory article that is cast from the melt consists of zirconium dioxide, the crystals of which are stabilized with magnesium oxide and surrounded by at least one crystalline phase containing magnesium oxide. The fraction containing magnesium oxide in the crystalline phases ranges from 0.5 to 10 wt.% scaled on the basis of the total weight of the refractory article, while the fraction of magnesium oxide is from 1 to 10 wt.% scaled on the basis of the total weight of the refractory article. The crystalline phase containing magnesium oxide constitutes forsterite, enstatite, cordierite, or spinel. The technical result of the invention lies in the creation of articles possessing elevated corrosion stability and wear resistance without shrinkage cavities.

*Bulletin, No. 3, 112 (2012)*

## A CHARGE FOR THE PRODUCTION OF SHRINK-RESISTANT, POROUS REFRACTORY THERMAL-INSULATION MATERIAL

*V. S. Vladimirov, M. A. Ilyukhin, E. S. Moyzis, S. E. Moizis, S. Yu. Rybakov, E. S. Lukin, and N. A. Popova*

Patent RU 2442761
IPC C04B38/02

A charge for producing porous, shrink-resistant refractory thermal-insulation material, comprising aluminum as the bloater, periclase and electrocorundum as the mineral fillers, alumina-rich cement, a modifier, and phosphate binder, distinguished by the fact that it contains a mixture of powders of different brands as the electrocorundum, with the following fractional content of the powders, wt.%: F280 powder with mean particle size $d_{av}$ in the range 30 – 40 μm, 18 – 25; F150 powder with $d_{av}$ in the range 80 – 100 μm, 13 – 15; F80 powder with $d_{av}$ in the range 160 – 200 μm, 22 – 25; and F54 powder with $d_{av}$ in the range 300 – 400 μm, 7 – 10; as well as periclase in the form of PPTI-92 powder of a continuous granular composition with residue in a 05 mesh at most 15%, and as the modifier, mortar of MPKhV sintered periclase-chromite, with the following ratio between the components, wt.%: aluminum, 5.0 – 5.5; periclase, 15.0 – 28.0; alumina-rich cement at most 6.5; mortar of sintered periclase-chromite, 1.0 – 2.0; and the specified electrocorundum up to 100.

The phosphate binder is introduced at a rate of 47 – 82% above 100. Aluminoborophosphate or aluminophosphate is used as the binder, while highly dispersed powder with spherically shaped particles with maximal size of the particles not greater than 50 μm in diameter is used as the aluminum.

The technical result is a reduction of shrinkage of materials to a minimum and an increase in compressive strength with elevated service temperatures. The material that is obtained on the basis of the charge may be used to fabricate both the thermal-insulation and the working layers of the lining of high-temperature equipment used for different purposes and blast furnaces, in the production of light, heat-resistant, cellular, porous concrete as well as for replacement of fibrous corundum slab materials, moreover, it is significantly less expensive and significantly stronger.

*Bulletin, No. 5, 227 (2012)*