SH – SYNTHESIS OF CARBON – METALCARBIDE CRUCIBLES

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Introduction

The development of new constructional carbonaceous SHS – materials based on silicon and titanium carbides, which are suitable for thermal units fettling production as well as making the connection junction in graphite, carbon or carbon based composite materials, and also in units of modern engineering and highelectric heating devices application is a extremely urgency [1,2].

The purpose of this work was study of SH-synthesis in Al-TiO_2-C system for carbon metalcarbide composite material production, suitable as a flux and constructional material at operation temperature higher, than 2073 K and resistant to aggressive chemical attack [3,4].

Experimental

The combustion processes in Al-TiO_2-C(1) system was investigated.

$$4Al + 3\ TiO_2 + 3C = Al_2O_3 + 3TiC \qquad (1)$$

Pigmentary titanium oxide, which was used, consist of 97 wt. % rutile and 3 wt. % anatase. The sort of aluminium powder, which was used is PA-4, dispersity 90 μm. Graphite powder, obtained from electrode breakage, had dispersion less than 55 μm.

The samples were prepared by pressing in cylinders, 20 mm in diameter or in crucibles, external diameter is 50 mm and height 70 mm. The 40% silica was used as a binder.

Dried samples were placed in muffle furnace with a programmable heating. Control and thermometry in furnace provided with thermoregulator and thermocouple. The higher temperature in furnace, necessary for SH-synthesis in samples was less than 1373 K.

Results and discussion

We found, that ignition temperature of Al-TiO_2-C system is above 1470 K. Ignition temperature determined by temperature profiles, measured with a chromel-alumel thermocouples during linear heating rate 10 K/min. Figure 1 shows combustion wave profile in 6Al +3TiO_2 + C system.

The phase structure of SHS products depends on initial components ratio. In modify components ratio we can regulate phase structure for specific technical application. In our work we have pursued the reception aim to obtained the resulting product from chemical inert high temperature electroconductive element in one operation.

Such kind of goods are used us the electric heater, which works on resistance heat foundations and in inductive high frequency settings.

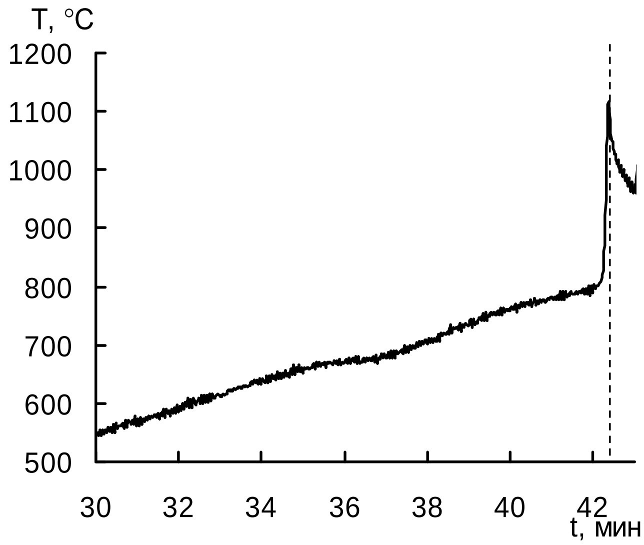

Fig.1 Temperature profile in 4Al+3TiO_2+3C system.

The products phase structure inside SHS – sample and near the graphite surface was determined for a combustion wave braking near inert high heat capacity surfaces was studied. Table1 is shows the results of this investigations.

Table 1. The results of the SHS products semi-quantitative X-ray analysis in the connection junction of carbonaceous titanium oxide system.

Substance	Phase structure of SHS products wt. %	
	Inside the sample	On graphite surface
Corundum	77,0	29,1
Silicon	-	1,9
Graphite	-	53,2
Titanium oxide (rutile)	-	2,9
Titanium carbide	22,9	2,0
Silicon carbide	-	10,1
Aluminium	-	0,5

X-ray analysis of combustion products, shown in table 1, made clear, that inside connection junction phase structure consists of products by reaction 1. Inside the sample near the graphite surface, at a distance of 0,1 – 0,5 mm, we found incomplete products of SHS synthesis.

The one of the claims to metalcarbide materials used us heating units is a resistivity and it temperature dependence. Figure 2 shows resistivity dependence on temperature for presenting samples.

This dependences shows the SHS products has a metal-like properties.

Developed by us composite SHS – material was used for producing of melting crucibles for melting and casting jewelry allows in inductive furnaces. The composition of crucibles, resulting SHS, consists of graphite filler, imbedded in metalcarbide matrix, based on titanium carbide, synthesized in the combustion wave.

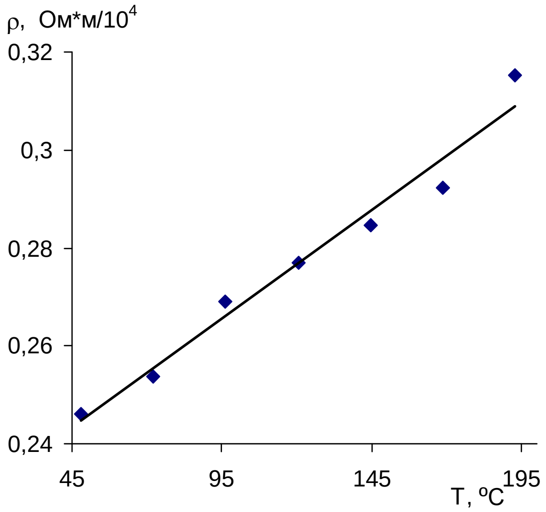

Fig.2 Resistivity dependence on temperature SHS products in $4Al+3TiO_2+3C$ system.

The useful capacity of melting crucibles, made by us, is 120 sm^3. They also has shape and size, similar to regular crucibles for jewelry casting machines, with the exception in bottom part. The regular crucible has a locked drain holes on bottom part automatically opened in the casting metal process. Drain holes in the bottom part of experimental crucibles were not.

The practical purpose of this investigation was to study possibility of using experimental crucibles as consumables in jewelry casting and interaction of crucible surface with the melted jewelry alloy.

Each test has 3 fusions. Destruction and limiting wear were not tested.

At tests we used SrM 925 and ZlSrNCM 585-80-8,2-2,5 alloys (State common standard of the CIS).

At tests pouring of alloys in the foundry form was not made.

We have found, that experimental crucibles are similar to regular graphite crucibles by servicing characteristics in heating, melting and stirring alloy processes.

Figure 3 shows experimental crucibles during testing in induction casting machine YASUI K-3.

Fig.3 Experimental carbonaceous metalcarbide crucibles during testing.

The results of testing are shown in table 2.

Table 2. The results of experimental crucibles testing in induction casting machine.

Parameter	Observations	
	Regular crucible	Experimental cruicible
Operating furnace atmosphere	Argon	Argon
Operating furnace pressure	100 kPa	100 kPa
Alloy temperature	1200 °C	1200 °C
Remelted ZlSrNCM 585-80-8,2-2,5 allow assay test	The alloy is corresponding to 585 assay	The alloy is corresponding to 585 assay
Remelted SrM 925 allow assay test	The alloy is corresponding to 925 assay	The alloy is corresponding to 925 assay

Conclusion

The dependences of combustion wave parameter**s** in $TiO_2 – Al – C$ systems are established.

Experimental composite crucibles, made by us, were made by original method [5]. They has physicochemical and servicing characteristics similar to crucibles, consists of pressed small-grained sintered graphite, delivered in the complete set of casting machines.

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