OBTAINING NANODISPERSED PRODUCT OF TITANIUM DIBORIDE IN AN ARC DISCHARGE OF MAGNETOPLASMA ACCELERATOR

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Titanium Diboride (TiB_2) is a promising material for using it in many industrial applications. TiB_2 has combination of thermal, mechanical and electrical properties such as high thermal conductivity, extreme melting point, high hardness, elastic modulus and fracture toughness, good electrical conductivity, chemical stability and excellent wear resistance [1-5]. These outstanding properties can be used in different engineering applications, such as impact-resistant armour, cathodes in Hall-Heroult cells, solar thermal absorbers and cutting tools [6-8].

Nowadays there are a lot of ways to synthesize TiB_2: in situ, sol-gel reduction, mechanical alloying, gas phase method, carbon/boron thermal reduction method, self-propagating high-temperature synthesis, chemical vapor deposition [1, 6, 9-11]. However, there are some problems in synthesize nano-dispersed powders TiB_2: obtaining unsatisfactory size and dispersal of the product, high time and energy costs.

In this paper, a new method of synthesis is proposed – plasma dynamic synthesis in a hypersonic plasma jet using titanium electrodes. The installation called a coaxial magnetoplasma accelerator (CMPA). The main part of it consists of a coaxial electrode, a central electrode, isolators and a plasma formation zone.

In order to initiate an arc discharge it is necessary to put an amorphous boron powder into a plasma formation zone and stretch between coaxial and central electrode conductors. Different ways of initiation an arc gas discharge can be suggested for obtaining TiB_2 powdered products using titanium conductors, carbon fibers or graphite aerosol (graphitization). Depending on the method of initiation of the arc discharge, a different output of titanium diboride is obtained. The higher the content of titanium diboride in the product, the better and higher will be the properties of the ceramics obtained on the basis of the powder. The content of TiB_2 in the experiment using Ti-conductors is 26,8 %, using carbon fibers is 62,1 % and with graphitization is 93,2 %. All experiments were implemented with the argon atmosphere, which filled the volume of the reactor chamber. The time of the process of initiation an arc discharge is various and depending on the using conductors: with Ti-conductors t = 110 ms, with carbon fibers t = 150 ms, graphitization t = 160 ms. The faster the process of exploding the conductors, the less boron powder warmed up and interacted further with titanium eroded from the surface of the electrode of the trunk. So in the experiment with graphitization the highest yield of TiB_2 is 93,2 %.

Based on the obtained powder, ceramics was synthesized by the method of spark plasma sintering. This method is one of the perspective method due to the speed of the process (5 min), high temperature (1800 ˚C) and pressure (60 MPa). Obtained ceramics showed high value of hardness. The values of the obtained hardness were: 1) Ti-conductors P = 24,7 GPa; 2) Carbon fibers P = 28,3 GPa; 3) Graphitization P = 30,3 GPa. The higher the content of the TiB_2 the harder the ceramic samples.

REFERENCES

[1] Rabiezadeh A., Hadian A. M., Ataie A. //Ceramics International. – 2014. – V. 40. – №. 10. – P. 15775-15782.
[2] *Chao S., Goldsmith J., Banerjee D. //International Journal of Refractory Metals and Hard Materials. – 2015. – V. 49. – P. 314-319.*
[3] *Sahoo S., Singh S. K. //Ceramics International. – 2017. – V. 43. – №. 17. – P. 15561-15566.*
[4] *Sani E. et al. //Solar Energy Materials and Solar Cells. – 2017. – V. 169. – P. 313-319.*
[5] *Andrievski R. A. //Russian Chemical Reviews. – 2015. – V. 84. – №. 5. – P. 540.*
[6] *Ma L. et al. //Ceramics International. – 2018. – V. 44. – №. 4. – P. 4491-4495.*
[7] *Wu N. et al. //Ceramics International. – 2019. – V. 45. – №. 1. – P. 1370-1378.*
[8] *Mahaseni Z. H. et al. //Ceramics International. – 2018. – V. 44. – №. 11. – P. 13367-13372.*
[9] *Ping L. et al. //Rare Metal Materials and Engineering. – 2016. – V. 45. – №. 6. – P. 1381-1385.*
[10] *Fu B. et al. //Transactions of Nonferrous Metals Society of China. – 2015. – V. 25. – №. 7. – P. 2206-2213.*
[11] *Huang X. et al. //Materials Letters. – 2018.*