PRODUCING TiC-Al CERMET BY COMBUSTION SYNTHESIS OF TiC POROUS SKELETON WITH SPONTANEOUS INFILTRATION BY ALUMINUM MELT*

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The ceramic-metal composite materials (cermets) possess unique properties, first of all, high hardness and heat resistance, and are of great interest for the application in metallurgy, mechanical engineering, aircraft and rocket science, nuclear energy [1, 2]. However, existing technologies for their production are energy-intensive and are implemented with the use of sophisticated expensive equipment, and the achieved level of properties is not always sufficient for the application of cermets. The use of a simple energy-efficient process of combustion synthesis or self-propagating high-temperature synthesis (SHS) for producing ceramic skeletons with increased strength followed by impregnation with molten metals can become the basis of a new technology for economically viable production of cermets and contribute to the creation of new materials for modern technics. The experience has been gained in obtaining the skeleton cermets with the simultaneous use of the SHS process for synthesizing a ceramic skeleton and melting a metal for infiltration (impregnation) of the synthesized skeleton [3, 4]. But at the same time, due to the heat of SHS reaction, a small amount of metal can be melted, which limits the size of the synthesized cermet. In addition, for complete impregnation and production of non-porous cermet, the application of excess pressure is required, which greatly complicates the process. In the present work, we study a new simple method for producing TiC-Al cermet based on the application of the SHS process of TiC porous skeleton followed by spontaneous infiltration with an aluminum melt prepared previously by heating from an external source, which makes it possible to use a melt mass sufficient to completely impregnate the ceramic skeleton without application of the excess pressure [5].

The results of theoretical estimates of both the temperature of the synthesized TiC porous skeleton necessary for spontaneous infiltration by an aluminum melt due to the phenomenon of thermosmosis, and the depth of spontaneous infiltration are presented.

In an experimental study, a stoichiometric mixture of powders of titanium Ti and graphite C was pressed into briquettes with a diameter of 23 mm and a height of 10-12 mm and burned using various melt infiltration schemes: in a sand backfill in contact with a molten aluminum with a temperature of 900 °C and vertical or horizontal directions of infiltration, also when the hot TiC skeleton is immersed in the molten bath, and when the hot skeleton is poured with aluminum melt. Full melt impregnation of vertically arranged briquettes with a height of 48 mm and horizontally arranged briquettes with a length of 130 mm was obtained via unidirectional mode of combustion and infiltration, and an infiltration depth of 60-70 mm of horizontal briquettes in the case of counter directional mode. The density, structure, phase composition, and mechanical properties of the obtained samples of TiC-Al cermet were studied.

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