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Authors: I.V. Iatsyuk, Yu.S. Pogozhev, E.A. Levashov, A.V. Novikov, N.A. Kochetov, D.Yu. Kovalev

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COMBUSTION SYNTHESIS OF HIGH-TEMPERATURE ZrB_2-SiC CERAMICS

I.V. Iatsyuk[1*], Yu.S. Pogozhev[1], E.A. Levashov[1], A.V. Novikov[1], N.A. Kochetov[2], D.Yu. Kovalev[2]

[1]- National University of Science and Technology "MISIS", SHS Research and Education Centre MISIS-ISMAN, Leninsky prospect, 4, Moscow, 119049, Russia

[2]- Institute of Structural Macrokinetics and Materials Science, Russian Academy of Sciences, ul. Academica Osipyana, 8, Chernogolovka, Moscow Region, 142432 Russia

*ivansvoy@mail.ru

ABSTRACT

The work is dedicated to researching into combustion kinetics and mechanism as well as the stages of the chemical transformations during self-propagating high-temperature synthesis of ZrB_2-SiC based ceramics. Dependences of the combustion temperature and rate on the initial temperature (T_0) have been studied. It has been shown that the stages of the chemical reactions of ZrB_2 diboride and SiC carbide formation do not change within the range of T_0 = *298–700 K*. The effective activation energy of the combustion process amounted to 170–270 kJ/mol, from which it has been concluded that chemical interaction through the melt plays a leading role. The stages of the chemical transformations in the combustion wave have been studied by dynamic X-ray diffraction. First, ZrB_2 phase forms from Zr-Si melt saturated with boron, and SiC phase is registered later. The SHS method has successfully been used in order to obtain ZrB_2-SiC composite powders and compact ceramics with a silicon carbide content of 25-75 %. The ceramics are characterized by a residual porosity of 1.5 %, hardness up to 25 GPa, the elastic modulus of 318 ± 21 GPa, elastic recovery of 36 % and thermal conductivity of 54.9 W/(m×K) at T_{room}.

Keywords: combustion, kinetics, ceramics, zirconium diboride, silicon carbide.

1. Introduction

Zirconium diboride ZrB_2 has a unique complex of properties [1,2]: a high melting temperature (3245 °C), thermal conductivity (60–140 W/(m·K)), hardness (20–24 GPa), high elastic modulus (400–500 GPa and higher), resistance to abrasive wear and aggressive environments. Structural