HIGH-TEMPERATURE CREEP OF ZrB_2 - SIC - Cr_3C_2 CERAMICS

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One of the main service properties of ultra-hightemperature structural ceramics, to which the system under study belong, is the high temperature creep. Creep characteristics also directly determine the sinterability of ceramics during hot pressing. Therefore, at the development of high-temperature ceramics it is important to have a fast and efficient method of creep characteristics estimation. In this paper we tested a technique for investigation of creep regularities of [ZrB_2-SiC-Cr_3C_2] samples on laboratory setup for vacuum hot pressing. The method is based on determining of the high-temperature creep curve of the sample by the measurement its height during creep process in dependence on the temperature and (or) the axial pressure. Tests are conducted in a protective atmosphere or under vacuum in a graphite mold with a diameter D samples in the range 8…12 mm and a height of 1,5…2D. Between the matrix and the sample side surface is provided clearance for free deformation of the sample. Heating of the sample is performed by an indirect method. Initially the sample is fully loaded before turning on heating to eliminate the influence of deformation of the installation parts on the accuracy of measurement. Samples should be compact (or maximum dense) of equal height and density within the samples set under testing. Temperature is controlled by an infrared thermometer Thermix K, changing the height of the sample – by linear encoder, data is stored on the PC with a frequency of 1…10 seconds. The obtained kinetic curves include errors associated with the temperature expansion and additional shrinkage of the graphite tooling (negative values L in Fig. 1) and with heating of system parts at high temperatures. Therefore, to adjust the current values of sample shrinkage (reducing the height of the sample) the thermal expansion of the system and graphite shrinkage are experimentally determined for specific heating rates.

As an example, Figure 1 shows the kinetics of creep of the composition [80 vol.% ZrB_2 + 20 vol.% SiC]. The start of creep is recorded at T=1980°C. Reducing the height of the samples at temperatures of 2030°C, 2100°C and 2160°C was 8.8%, 13.3% and 54.4% respectively. Figure 2 shows a photo of samples after deformation. Similarly, the composition [(80 vol.% ZrB_2 + 20 vol.% SiC) + 5 wt.% Cr_3C_2] was studied. It was found that it creep begins at T=1820°C, and at temperatures 1830°C, 1900°C, 1980°C reducing of the samples height was 7.8%, 19.6% and 31.1% respectively.

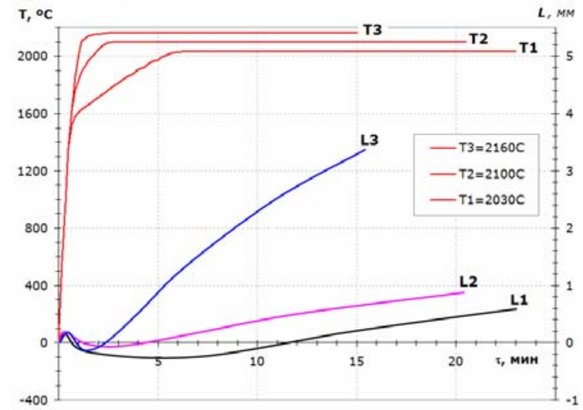
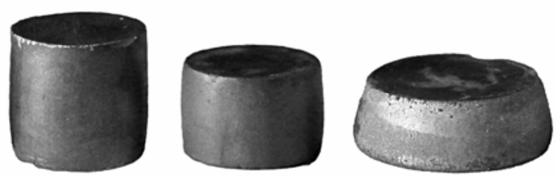


Fig. 1 Kinetic curves of samples height change at a pressure 48MPpa



L1 L2 L3

Fig. 2 View of the samples after the test. The composition is [80 vol.% ZrB_2 + 20 vol.% SiC]

This method allows to determine the creep threshold, the dependence of deformation on temperature and time, and perform assessment of the contribution of high-temperature deformation in the ceramic shrinkage at its sintering under pressure.

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