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OBTAINING OF HETEROMODULUS ZRC-BASED COMPOSITE MATERIALS, THEIR STRUCTURE AND PROPERTIES

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In the present study, the effect of carbon (C) addition on crack resistance of zirconium carbide (ZrC)-based ceramics was investigated. ZrC/C composites are classified as heteromodulus materials as elastic modulus of their components is significantly different [1-2].

X-ray diffractograms of the powders were presented only by ZrC patterns, any impurities were not detected. Coherent scattering region (CSR) was found at 35 nm, whith microdistortion at 2.3×10-3. ZrC crystal lattice parameter was found at 4.694 Å which is close to its stoichiometric composition [3-5]. Carbon addition had ambivalent effect on ZrC compaction during hot-pressing. Porosity of ZrC/C composites with concentration of free carbon at 1 and 3 % v./v. was found at 5±4%. Addition of carbon at concentration higher than 3 % v./v. resulted in porosity increase. In case of heteromodulus Zr/C composites with concentration of free carbon of 5 and 10 % v./v. the porosity was found at 18±4%. Obtained results on the compaction during the synthesis of heteromodulus ZrC/C ceramics by hot-pressing show complex effect of C concentration on ZrC sintering behavior. Removal of adsorbed oxygen from the powders particles has positive influence on ZrC compaction at low C concentrations. Increase of the porosity of ZrC/C heteromodulus composites with C concentration more than 3 % v./v. is most likely connected with the decrease of diffusion mass transfer intensity owing to filling of carbon vacancies.

Increase of the carbon concentration was accompanied with the decrease of materials strength and elastic modulus. Vickers hardness (Hv) got down from 15±2 to 5±1 GPa, while elasticity modulus decreased from 330±30 to 200±10 GPa with the rise of C concentration. Calculations of the critical stress intensity factor K_{IC} on length of the crack from Vickers indenter using Niihara formula [6] demonstrated that carbon addition provided increased crack resistance. K_{IC} of ZrC ceramics was found at 4.3±0.2 MPa*$m^{1/2}$, while crack resistance of ZrC/C composite with C concentration of 3 % v./v. – at 7±0,5 MPa*$m^{1/2}$. Crack resistance of ZrC/C composite with the highest C concentration (15 % v./v.) was found at 5±0,3 MPa*$m^{1/2}$ and was the least among ones for ZrC/C ceramics. However, this parameter was better than for ZrC ceramic without carbon addition. Crack resistance of the obtained ZrC/C heteromodulus composites is comparable with one for metal matrix composites and in some cases exceeds K_{IC} of multiphase ZrC-based ceramic composites.

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