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Practical approaches to energy efficiency improvement in SiC-based ceramics processing

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Statement of the Problem: Glass and ceramic industries fall into the category of energy-intensive industries and since 2014 when Integrated Pollution Prevention and Control was introduced in Russia these sectors have been closely monitored with regards to resource efficiency and environmental performance. Methodology & Theoretical Orientation: Traditional sub-sectors including tile and brick manufacturing in 2003-2013 participated in pilot projects intended to evaluate possibilities of implementing Best Available Techniques (BATs) in Russian industries. Based on the results of these projects BATs have been identified and national Information and Technical Reference Books developed. In manufacturing technical ceramics existing sector-specific BATs comprise mostly emissions control. However, considering materials for advanced applications such as alumina, zirconia or carborundum, where these levels are determined by strict process parameters, a generally accepted practice is to reduce energy consumption by adjusting firing temperature. This allows to suggest candidate BATs: batch composition adjustment, the use of eutectic sintering aids, and liquid-phase sintering. Findings: The present research addresses a combination of these techniques in production of SiC-based structural ceramics including selection of additives based on their physico-chemical properties (melting point, surface interaction) and the use of pre-fabricated sintering aids with enhanced reactivity. The effects of the additives on sintering behavior, phase composition, microstructure, and mechanical properties were studied. Conclusion & Significance: The combination of ultrafine SiC with 25 vol. % of a eutectic sintering aid in $MgO\text{-}Al_2O_3\text{-}Y_2O_3$ system allowed to produce ceramics with bending strength of 450 MPa, fracture toughness of 4.0 $MPa{\cdot}m^{1/2}$, and elasticity modulus of 380 GPa. Sintering temperature for this material didn't exceed 1900°C, which makes this technique practically suitable to reduce emissions and the impact on the environment. This research was carried out with financial support from the Ministry of Education and Science of the Russian Federation under State order, contract No. 10.6309.2017/BCh.

Recent Publications

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Biography

Maria Vartanyan is an expert in ceramics manufacturing, energy efficiency and environmental performance in production of ceramics materials based on oxide and non-oxide compounds.

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