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Ceramics in the system ZrO_2-Al_2O_3 with eutectic additives

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Statement of the Problem: The ZrO_2-Al_2O_3 system is key for the synthesis of various structural materials; in particular, it is promising for manufacturing of wear-loaded items like friction pairs, cutting tools, etc. One of the most important issues in zirconia ceramics technology is that ZrO_2 is subject to intensive recrystallization at temperatures exceeding 1100-1200°C. This phenomenon leads to a martensitic transformation, accompanied by a significant drop in mechanical strength.

Methodology & Theoretical Orientation: An effective way to prevent recrystallization is to affect the grain of zirconia with an external compressive load, since in the stressed state the tetragonal solid solution does not decompose. It is possible to create an external load by introducing a second phase into the material, the role of which is taken up by alumina. The aim of the work is to create ceramic materials in the ZrO_2-Al_2O_3 system, with predominant zirconium dioxide, having a sintering temperature of 1400-1550 °C, and high mechanical properties. An attempt was made to reduce sintering temperature by the addition of eutectic aids to the batch. The influence of various types of alumina (commercial, obtained by chemical precipitation) on the structural properties, mechanical strength and microstructure parameters was analyzed. Zirconia was obtained by chemical precipitation, partial stabilization was carried out using yttrium chloride. To control the structure and properties of ceramics, modifiers were used in CaO-Al_2O_3-SiO_2 and MnO-TiO_2 systems.

Findings: It was found that ceramics with eutectic additives CaO-Al_2O_3-SiO_2 and MnO-TiO_2 in the ratio 1: 1 possesses the greatest mechanical strength - 750 ± 35 MPa. Conclusion & Significance: This ceramic material is characterized by the highest mycrohardness of 1200 N/mm^2. The material is promising for use as elements of stop valves, mill bodies, cutting tools; wear-resistant structural parts, etc.

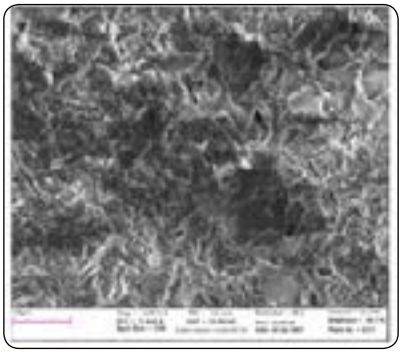

Figure 1: Microstructure of samples from partially stabilized zirconia and alumina with eutectic additives in CaO-Al_2O_3-SiO_2 and MnO-TiO_2 systems

Recent Publications:

1. Makarov N.A. Composite material in the alumina-zirconia system (2007) Glass and Ceramics. 4:12-15 (in Russian).
2. Makarov N.A. (2006) Features of sintering corundum ceramics, modified with eutectic additives. Glass and Ceramics. 4:16-18 (in Russian).
3. Lukin E.S., Anufrieva E.V., Makarov N.A., Popova N.A. (2008) New generation of oxide ceramics and the field of its application. Glass and Ceramics. 10:27-31 (in Russian).
4. Lukin E.S., Kozlov A.I., Makarov N.A., Popova N.A. (2009) Nanopowders for the production of oxide ceramics of the new generation. Refractories and Industrial Ceramics. 11:29-34 (in Russian).
5. Makarov N.A., Sverdlikov V.L. (2005) Composite material of the corundum - zirconia system - sintering additive. Glass and Ceramics. 11:16-18 (in Russian).

Biography

N. Makarov's scientific activity is dedicated to the creation of new types of ceramic materials, the study of their properties and makes a significant contribution to the development of the physic-chemistry of the processes underlying the technology of ceramics for special purposes, including nanomaterials. Scientific interests lie in the field of chemistry and technology of materials with a controlled structure and given properties based on aluminum and zirconium oxides, as well as oxygen-free compounds; directed control of the formation of the structure of ceramics from oxides and anoxic compounds; development of the theory and mechanism of sintering of ceramic materials modified by additives of various nature; development of energy- and resource-efficient technologies of ceramic materials possessing a high level of physic-mechanical properties and a low temperature of sintering.

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