УДК 666.7:620.193

ВИЗНАЧЕННЯ ЗАЛЕЖНОСТІ МЕХАНІЧНИХ ХАРАКТЕРИСТИК ZRO_2-3 мас%Y_2O_3 ВІД РЕЖИМУ СПІКАННЯ ПРИ ФОРМУВАННІ КЕРАМІКИ МЕТОДОМ ЕЛЕКТРОКОНСОЛІДАЦІЇ

THE DETERMINATION OF THE DEPENDENCE OF MECHANICAL CHARACTERISTICS OF ZRO_2-3 wt%Y_2O_3 ON THE SINTERING MODE OF CERAMICS MOULDING BY ELECTROCONSOLIDATION METHOD

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The operational properties of ceramic zirconia tools for industrial applications determine the requirements for the development and production of ceramic systems. Exposure to very high temperatures over long periods of time makes it challenging to produce high-strength materials. Products meeting these requirements can be obtained by developing composites consisting of nanoscale reinforcing particles and by selecting the most suitable sintering technique.

The aim of the study was to establish the regularities of dependence of some mechanical characteristics on the sintering modes of mixtures based on zirconium dioxide nanopowders

It is known that the sintering of composite materials depends on such process parameters as pressure, current and voltage, heating rate and time. All of this has a wide range of effects on the structure and properties of the formed samples. In contrast to conventional sintering, where the main driving force of shrinkage is surface tension, electroconsolidation, due to the heterogeneous temperature field, creates a heterogeneity of vacancies that causes mass transfer, which leads to the reduction of large pores at an accelerated rate [1].

Some mechanical characteristics of ZrO_2-3wt%Y_2O_3 composites synthesised by hot pressing with direct current flow were investigated in this work. To find the hardness and modulus of elasticity, the method of Oliver and Farr was applied [2].

Some mechanical properties of ceramics

Composite	Hardness, GPa	Elastic modulus, GPa	Referance	
ZrO_2–3 wt% Y_2O_3	6.24	198	[3]	
ZrO_2–3 wt% Y_2O_3	270±12	17,6±1	$T_{sint.}$	$t_{hold.}$
			1400	3
	446±15	30,6±2	1500	5
	348±29	19,5±3	1600	5
ZrO_2–8 wt% Y_2O_3	3.5 ± 0.9	87.5	[4]	
	3	60	[5]	

A study of the correlation between grain size and mechanical properties showed that the elastic modulus decreases with grain size.In the process of studying the effect of grain size on mechanical properties such as elastic modulus, yield strength and hardness for some ceramics, many models based on dislocation clustering approaches for composites have been developed to explain the changes in hardness and yield strength in the nanometre regime [3].

Based on the experimental data, it can be seen that the most optimal mode of sintering composites having the highest values of Young's modulus and microhardness is consolidation of ZrO_2-3 wt% Y_2O_3 powder at sintering temperature T= 1500°C and holding time t=5min.

To conclude, the study revealed the dependence of some mechanical characteristics on the sintering modes of mixtures based on zirconia nanopowders. Thus, the consolidation of ZrO_2–3 wt% Y_2O_3 ceramics at the sintering mode T= 1500°C, t=5 min allows to obtain high-strength products for tooling purposes.

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