INFLUENCE OF THE RAW POWDERS TREATMENT PARAMETERS ON THE TRANSMITTANCE OF IR-TRANSPARENT Y_2O_3 CERAMICS

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Y_2O_3 ceramics has various applications. Choosing raw powders and control of their properties is crucial for obtaining full transparency. In this research, the influence of the milling conditions of Y_2O_3 powders on the characteristic of vacuum-sintered ceramics was studied. The milling was performed at a rate of 80-300 rpm for 1-22 h. It was found that milling at 300 rpm for 1 h gives the most promising nano-sized Y_2O_3 powder. The highest transmittance among obtained samples is 78.3% (1100 nm).

Keywords: yttrium oxide, transparent ceramics, powder processing, microstructure, vacuum sintering

Introduction. Y_2O_3 ceramics are actively used as a multifunctional material because of their excellent mechanical properties, transparency in the 0.2-8 μm range, and chemical and thermal stability [1]. The high density of ceramics and the absence of defects are significant to ensure high transmittance and good mechanical properties. In this regard, the choice of raw materials and the study of the influence of their processing methods play a significant role in the process of ceramics obtaining [2]. The aim of the work is to study the influence of raw powders and their processing conditions on the optical properties of Y_2O_3 ceramics obtained by vacuum sintering.

Experimental part. In this research morphology of two commercial Y_2O_3 powders (Nippon and Stanford, further denoted as N and St, respectively) after milling at 80-300 rpm rate for 1-22 h was investigated. 3 mol. % of ZrO_2 was used as a sintering aid. The samples were obtained by uniaxial pressing and CIP followed by vacuum sintering at 1700…1735°C for 24…32 h.

Results. Firstly, both Y_2O_3 powders were milled at 80 rpm for 22 h (further marked as NR and StR). NR-powder exhibits a uniform morphology, smaller and softer agglomerates compared to hard irregular agglomerates of StR-powder. Specific surface area (SSA, BET) is 4.08 and 19.22 m^2/g and an average agglomerate size (DLS) is 0.3 μm and 1.8 μm for NR and StR, respectively. Furter, both raw powders were milled at 100-300 rpm for 1 h to study the influence of the milling rate on powder characteristics. All obtained Nippon powders show similar morphology. The same is for St-powders. N-powders are more homogeneous with smaller agglomerates and higher SSA in contrast with St-powders. For N-powders, an increase in the milling rate leads to a slight

decrease in SSA due to deagglomeration as a result of interactions between small primary particles. These data show that N-powders are optimal for obtaining transparent ceramics. Thus, N-powder was chosen for milling at 200-300 rpm for 10 h to study the dependence of its morphology on milling time. It was found that particle size decreases by almost 2 times (DLS) in comparison with milling for 1 h with increasing of milling time, which indicates efficiency of the process.

Vacuum sintering was performed at 1700°C for 24 h. Among obtained Y_2O_3-ceramics only N-samples were transparent while St-samples were opaque. St-samples are characterized by low relative density and non-uniform microstructure with large (1-3 μm) interconnected pores formed due to the presence of large irregular-shaped hard agglomerates in powder. N-samples have a uniform microstructure and high density since powders are finer and less agglomerated. Therefore, Nippon samples were chosen for sintering at 1735°C for 32 h. An increase in sintering time and temperature leads to an improvement in microstructure and an increase in relative density. According to the SEM, obtained samples have uniform almost pore-free microstructure. It was found that milling at 300 rpm for 1 h gives the best sample since this powder has optimal parameters, which is proved by SEM, DLS and SSA data. This ceramics have uniform defect-free microstructure, 100% density and the highest optical transmittance among all analysed samples, which is 78.3% at 1100 nm (Fig. 1).

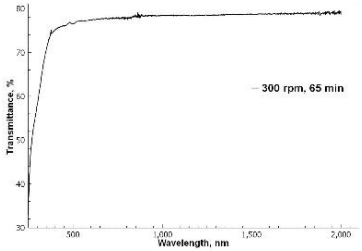

Fig. 1. In-line transmittance of Y_2O_3 ceramics obtained by vacuum sintering at 1735°C for 32 h.

Conclusions. It was found that ball milling at 300 rpm for 1 h is optimal for obtaining highly-sinterable nanopowders for transparent Y_2O_3 ceramics. The ceramics was obtained from this powder by vacuum sintering at 1735°C have the highest optical transmittance among other samples (78.3% at 1100 nm).

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