Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7149

ALUMINA DOPING FOR IMPROVING PROPERTIES OF ZIRCONIA CERAMICS

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ABSTRACT

This work is devoted to the study of the properties of ceramics based on a ZrO_2 - 3mol% Y_2O_3 nanopowder doped by different Al_2O_3 contents. The effect of Al_2O_3 additives on the sintering kinetics, density, porosity and the amount of the monoclinic phase of zirconia is studied.

Keywords: nanopowders, zirconia, alumina, ceramics, properties.

INTRODUCTION

Ceramics based on zirconia nanopowders have a unique set of properties in comparison with other ceramic materials, in particular, high strength, wear resistance, chemical inertness, ionic conductivity and biocompatibility. Such qualities already allow the use of zirconia in industry, medicine, etc. However, zirconia ceramic requires further study and improvement of properties. In this paper, the influence of alumina oxide doping on the sintering kinetics and the physical properties of ceramics based on ZrO_2-3mol% Y_2O_3 is investigated (Biamino, 2006).

RESULTS AND CONCLUSIONS

It is known that tetragonal zirconia has a significant disadvantage, namely the property of degradation under hydrothermal conditions in the temperature range 120-300°C with a change in the phase composition, which can lead to the destruction of the material (Figure 1). This is due to a substantial increase in the amount of monoclinic phase, the specific volume of which is greater than the tetragonal phase (Danilenko, 2014) ($V_m > V_t \approx 4\%$).

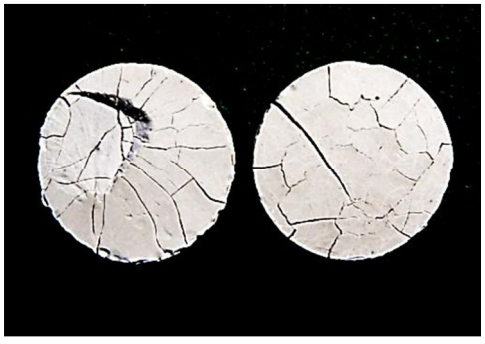

Fig. 1 - Degradation of ceramics based on zirconia in condition T=250°C.

The results of our studies show that doping with a small amount of Al_2O_3 can prevent the formation of a large amount of monoclinic phase and, accordingly, not lead to the destruction of ceramics (Figure 2).

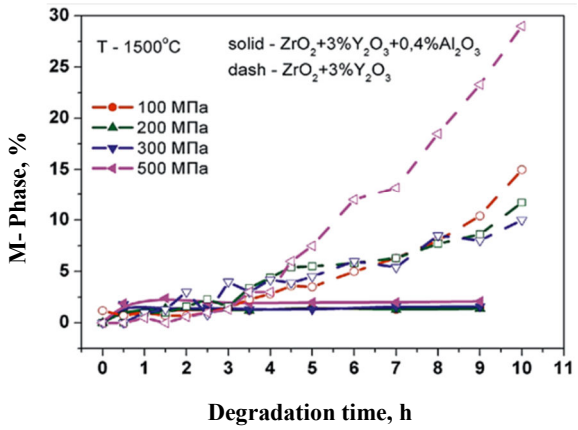

Fig. 2 - Amount of M-phase from the degradation time

The obtained sintering curves showed a substantially greater shrinkage of samples doped with 2% Al_2O_3, which provided an increase in density and a decrease in porosity (Figure 3).

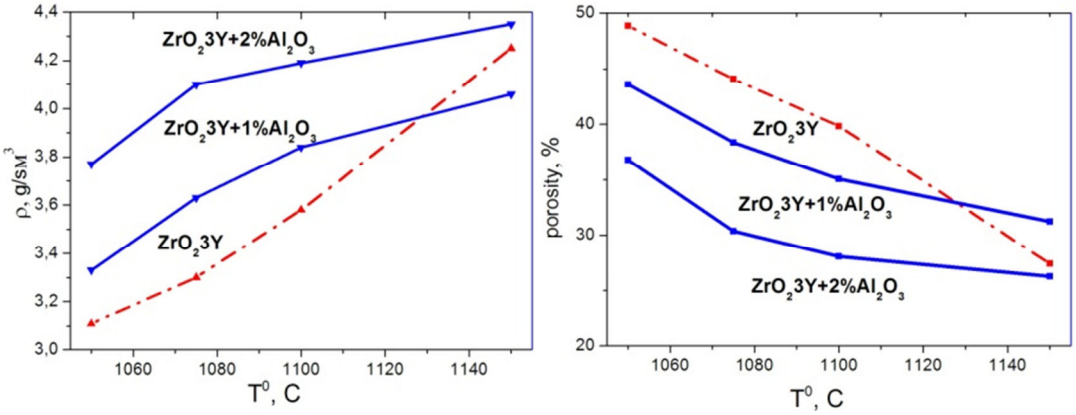

Fig. 3 - Density and porosity of ceramics

In this way, the alloying by Al_2O_3 of zirconia ceramics positively affects the kinetics of sintering of these materials. Used additives can prevent the formation of M-phase, and leads to an increase in density and monolithization of ceramics. The consequence of this is the hydrothermal stability of the material at a temperature of 120-300°C, which was not observed in the starting material, as well as an increase in the hardness and elastic properties of ceramic materials.

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