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Porous Mullite Ceramics Doped with ZrO₂

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Keywords – mullite-corundum, zirconia, alumina, kaolin, porous refractory ceramics.

INTRODUCTION

Mullite (3Al₂O₃·2SiO₂) phase is an important stable crystalline phase in the aluminosilicate system. Mullite ceramics with high porosity serves as a heat insulator and filter, as well as it can be used in construction and thermal engineering [1]. Zirconia ceramics is also an excellent candidate for high temperature applications, because of high melting point (2715 °C), good corrosion resistance and high mechanical properties. The glass phase of Al₂O₃-SiO₂-ZrO₂ system begins to form only from 1750 to 1850 °C, which is higher than, for example, that of Li₂O, Na₂O and MgO [2]. Therefore, ZrO₂ is used as a modifying additive and influences the properties of mullite ceramics.

EXPERIMENTAL PROCEDURE

A. Raw Materials and Characterisation

As mullite stoichiometric composition is 3Al₂O₃·2SiO₂, the ratio of Al₂O₃ (*Nabalox*, Germany) and pure SiO₂ (d₅₀=6.94 μm) was 2.57:1. The α-Al₂O₃ (d₅₀=4 μm) and γ-Al₂O₃ (d₅₀=80 μm) were used in the ratio 1:3. The amount of kaolin was 30 wt%, (*MEKA*, Germany with SiO₂–56.2 wt%, Al₂O₃–31.0 wt%). The weight percentage of used ZrO₂ stabilized with MgO additive was 5% of dry raw material mass. Distilled water content in the suspensions was 38–40 wt%, aluminium paste (*Aquapor 9008*) was 0.18 wt% and it was used as the pore former.

B. Preparation of the Samples and Testing Method

The porous mullite ceramics was prepared by direct foaming, when the formation of pores occurred as a result of hydrogen formation in a chemical reaction between aluminium paste and suspension of raw materials with pH>7 [1]. The preparation of the samples included three main processes: 1) the preparation of suspension of raw materials with the addition of Al paste suspension; 2) slip casting of final suspension in the mould, pore formation and solidification of the suspension; 3) drying of the samples (for 24 h at 50 °C) and sintering at the necessary temperatures (1650 °C, 1700 °C and 1750 °C, holding time – 1 hour).

The phase compositions of samples and such parameters as shrinkage, bulk density, porosity, thermal and mechanical properties of ceramics were analysed in our research. To assess the above-mentioned parameters, we used the XRD analysis, differential thermal analysis,

pore size distribution by Hg porosimetry, hydrostatic weighting and three-point bending test. The ten cycles of thermal shock test were implemented by rapidly changing temperatures (from 1000 °C to 20°C). The elastic modulus of the samples after each cycle of thermal shock was measured with the *Buzz-o-sonic* non-destructive acoustic method called the impulse excitation technique. Advantage of this method is that the same sample is measured after all cycles, which reduces the probability of occurrence of the error.

RESULTS AND DISCUSSION

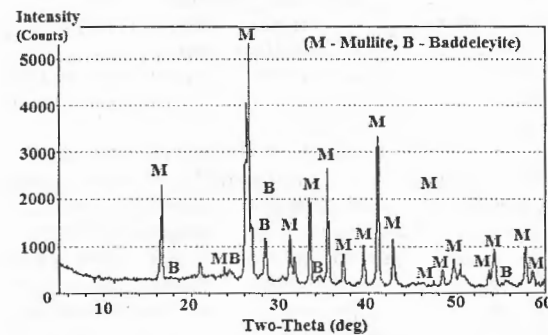


Figure 1. XRD patterns: phases of ZrO₂ (5 wt%) doped samples

Mullite is the dominant phase of samples with 5 wt% of ZrO₂ additive (Figure 1). The baddeleyite phase is from ZrO₂ and it is not so intensively expressed as mullite. The corundum phase is not observed. Phase of mullite is more intensive in the samples with ZrO₂ after sintering at 1650 °C than in the samples without ZrO₂ additive that were sintered at 1750 °C. The bulk density of doped samples is 1.68 g/cm³. ZrO₂ additive decreases the porosity of samples.

CONCLUSIONS

ZrO₂ additive influences mullite formation and its intensity, as well as properties of samples, decreases the sintering temperature and increases the sintering ability of samples.

REFERENCES

- [1] L. Mahnicka, R. Svinka, V. Svinka. Influence of kaolin and firing temperature on the mullite formation in porous mullite-corundum materials. *Mater. Sci. Eng.* 2011, 25 (1): 012008.
- [2] C. Zanelli, M. Dondi. Phase composition of alumina-mullite-zirconia refractory materials. *J. Eur. Ceram. Soc.*, 2010, 30, pp. 29–35.