Riga Technical University
Faculty of Material Science and Applied Chemistry

ABSTRACTS

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Riga Technical University

53rd International Scientific Conference

Dedicated to the 150th Anniversary and
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Material Science and Applied Chemistry

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Riga Technical University 53rd International Scientific Conference dedicated to the 150th anniversary and
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Porous Mullite Ceramics Doped with WO_3

Ludmila Mahnicka, Ruta Svinka and Visvaldis Svinka (*Riga Technical University*)

***Keywords* – Mullite-corundum, tungsten oxide, alumina, kaolin, porous refractory ceramics**

I. Introduction

Ceramics based on alumina (Al_2O_3) and silica (SiO_2) have such properties as high refractoriness, high bending strength and high creep resistance, good chemical and thermal stability. Mullite ($3Al_2O_3 \cdot 2SiO_2$) phase is the important stabile crystalline phase in the alumosilicate system. Therefore, mullite ceramics with high porosity serve as a heat insulator and filters, as well as can be used in constructional and thermal engineering. Our porous mullite ceramics were obtained by slip casting of suspension of raw materials. The metallic aluminium paste is used as pore forming agent [1]. The WO_3 additive influences on the properties of mullite ceramics [2].

II. Experimental Procedure

A. Raw materials and Characterization

Commercially available Al_2O_3 (*Nabalox, Germany*): α-Al_2O_3 (d_{50}=4 µm) and γ-Al_2O_3 (d_{50}=80 µm), kaolin (*MEKA, Germany*) (with SiO_2 -56.2 wt%, Al_2O_3-31.0 wt%, Fe_2O_3-0.29 wt%, kaolinite 72 wt%, quartz 21 wt%, illite 7 wt%), pure SiO_2 (d_{50}=6.94 µm), WO_3 (d_{50}=5 µm) powders were used as the starting materials. Aluminium paste (*Aquapor 9008*) was used as the pore former. Distilled water was needed for creation of raw materials suspension.

Mullite stechiometric compositions is $3Al_2O_3 \cdot 2SiO_2$, therefore Al_2O_3 and SiO_2 were in 2.57:1 ratio in all samples. In all compositions of samples α-Al_2O_3 and γ-Al_2O_3 were used in the ratio 1:3. The quantity of kaolin was 30 wt%. The weight percentage of WO_3 additive was 5% of dry raw materials mass. Water content in the suspensions was 38-40 wt%, aluminium paste was 0.18 wt% in all samples.

B. Preparation of the Samples and Testing Method

The technological method of the sample preparation included three main processes. First of them was preparation of suspension of raw materials with following adding of suspension of Al paste. Slip casting of final suspension in the mould, pore formations and solidification of the suspension were the second stage. The third process was the drying of the samples (24 hours, T=50°C) and sintering at the necessaries temperatures (1200°C, 1300°C, 1400°C and 1500°C, holding time - 1 hour).

Important moment of our method was the pore forming. It was achieved by hydrogen elimination as a result of the chemical reaction of Al with water [1, 5]. A more detailed process of obtaining of the samples described in the full version of article and represented on the Fig. 1.

In our work we analyzed phase compositions of samples, as well as such parameters as shrinkage, bulk density, porosity, thermal and mechanical properties of ceramics. For these we used the XRD analysis, differential thermal analysis, pore size distribution by Hg porosimetry, hydrostatic weighting and thermal shock by rapidly changes of temperatures (from 1000°C to 20°C). The elastic modulus of the samples after 1st, 2nd, 3rd, 5th, 6th, 8th and 10th cycle of thermal shock was measured with nondestructive acoustic method called the impulse excitation technique, also as destructive method was used three point bending strength.

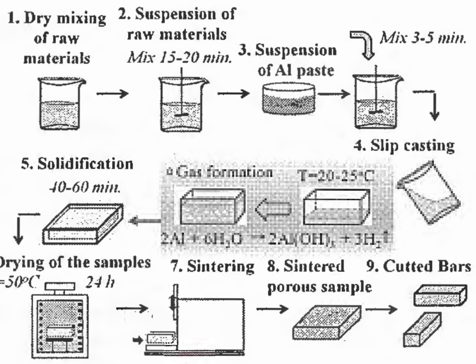

Fig.1. Scheme of technological process of ceramics preparation

III. Results and Discussions

The results of analysis and tests showed, that the exothermal DTA peak at 995.56°C corresponded to mullite formation. This temperature of mullite formation is lower compared to the samples without WO_3 additive, which were investigated in our previous works. The mullite was the predominant phase; corundum phase also was in these samples. Phase of aluminium tungsten oxide was in different quantities in all samples. Bulk density for all samples was about from 1.06 to the 1.24 g/cm^3. Shrinkage is 1% and 1.50% for samples fired at the 1200°C and 1300°C, but it increased after 1500°C and 1600°C, became 5.23% and 6.61%, respectively. Porosity and mechanical properties of samples also were determined in our work.

IV. Conclusions

The mullite is the main phase in all materials that were sintered at the different temperatures. Usage of WO_3 additive decreased the temperature of mullite's formation, the bulk density and shrinkage, but increased porosity of samples.

VI. References

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