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DIGEST

## Porous alumina – mullite ceramic, structure and properties

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### Summary
Highly porous alumina – mullite ceramic with porosity 60-90% is produced from concentrated suspension. Porosity, mechanical strength and high temperature deformation depends on the grain size of raw materials, amount of the pore formation agent, rheological properties of suspension and sintering temperature. Mullite formation in materials is carried out in two ways: by using kaolin and by addition of milled silica with grain size 5-8μ. Location of mullite crystals in the structure of material influences properties of material. Shrinkage of material decreases by formation of mullite in result of reaction sintering by additive of silica.

### Introduction
Porous alumina – mullite ceramic via slip casting of suspension of raw materials such as alumina with different grain size and kaolin is obtained. Pore formation occurs in result of hydrogen formation in chemical reaction between aluminum powder and water and following solidification of green bodies. These materials have a quite large sintering shrinkage [1-3]. Additive of silica accelerates the process of transformation of γ-alumina to α-alumina [4] and at the same time drives the formation of mullite in reaction sintering process [5]. Infiltration of nano sized alumina powder increases mechanical strength of porous material, but infiltration of titania powder suspension gives photocatalytic properties.

### Materials and methods
Materials used: alumina (α-, $d_{50}$ 4μ and γ-, $d_{50}$ 80μ), Nabaltec, Germany; kaolin, MEKA, Germany; pure silica. Materials are sintered at the temperatures of 1650-1750°C. Investigation methods used: phase analysis (Rigaku Ultima+), shrinkage, pore size distribution (Pore Master, Quantachrome), bulk density, three point bending strength (ZwickBDO-FB020TN), SEM (Oxford instrument).

### Results and discussion
The properties of produced materials depend largely on the crystalline modification of alumina used. Materials produced from raw mix with α-alumina (with grain size $d_{50}$ 4μ) and 5% of kaolin have a higher bending strength but lower porosity. XRD analysis shows the presence of crystalline phase corundum and mullite. With a γ-alumina in the raw mix the bending strength decreases but porosity increases and XRD analysis shows only corundum. Shrinkage of all materials is within 12%. By replacing the kaolin with the 5 and 10wt% of silica in the raw mix, sintering shrinkage of material

decreases to 8.5 and 5.9% respectively in the prevalence of γ-alumina and to 7.5 and 3.5wt% in the prevalence of α-alumina.
Fig.1. shows a change in the bending strength of materials. Bending strength of materials obtained from raw mix with predominant fine grain α-alumina is on the average 3 times larger than materials produced from mix with predominant γ-alumina. Bulk density in the same time is almost constant, about 0.90 to 1.05 g/cm$^3$. Corundum and mullite coexists in the all these materials.

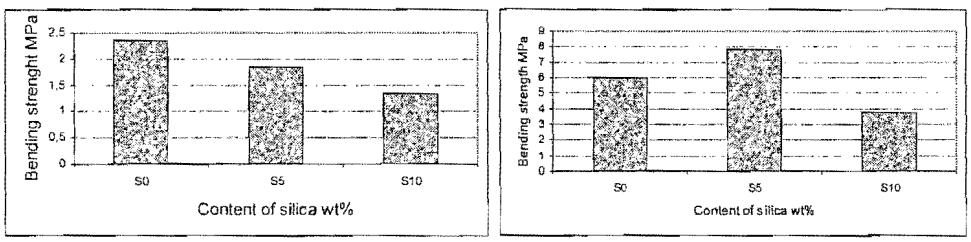


*Fig. 1.Bending strength of materials sintered at temperature 1750°C. a – by prevalence of γ-alumina, b – by prevalence of α-alumina in raw mix.*

## Conclusion

Investigation in the synthesis of highly porous alumina ceramic demonstrates that the main factors influencing the properties of material are: type of raw materials, additives, sintering temperature and sintering process. The 5-10 wt% additives of fine silica powder results in the formation of small crystals of mullite thus decrease sintering shrinkage and increase mechanical strength of sintered material. At the same time there is only a small change in the porosity. Also the small mullite crystals layer forms on the grain boundaries of alumina grains and increases adhesion. Materials with a photocatalytic activity are produced by infiltrating the porous mullite/alumina matrix with water suspension of fine titania powder and following sintering in high temperature.

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