Fabrication and Characterization of Porous Mullite Ceramics
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ABSTRACT

Porous mullite was fabricated from kaolin and alumina using naphthalene as a pore-former. For different wt.% of naphthalene addition, the apparent porosity (%) was analysed. The mechanical strength was estimated through flexural strength and diametrical tensile strength. Fabricated pellets were sintered at 1400°C, 1500°C, 1600°C to study the effect of pore former on phase formation and porosity distribution through X-Ray diffraction study and FESEM microstructure analysis. The analysis showed 39.79% of porosity in the case of 20wt.% naphthalene addition with flexural strength of 21.93MPa. This pointed towards the application of this product as a membrane support material.

INTRODUCTION

Porous mullite ceramics are attracting interest due to wide range of application in thermal insulators, catalytic supports, gas/liquid filters, separation membranes, high temperature structural materials, and kiln furniture etc.
To achieve porous ceramic with a tailorable porosity and tuneable pore size, several methods like ice-template spray drying, emulsification technique, sacrificial template etc. have been developed in the past years.
Here sacrificial templated method is implemented, due to the easiness of the process. In this method sacrificial agents like graphite, naphthalene etc. are used to tune the pore size and porosity of the structure
Here, kaolin (Al2O3.2SiO2.2H2O) is used as primary raw material. But despite from the chemical formulae of mullite (3Al2O3.2SiO2), kaolin has deficiency of alumina to form stoichiometry mullite structure. Hence required amount of boehmite is added from outside to make it stoichiometric

MATERIALS AND METHODOLOGY

KAOLIN

MIXTURE OF BOEHMITE AND KAOLIN

THE MIXTURE IS POT MILLED UNDER 6 HOURS AND STORED OVERNIGHT

DISSOLVING BOEHMITE

DIFFERENT PERCENTAGES OF NAPOTHEALNE IS ADDED (i.e. 0 to 40%)

THE PREPARED PELLETS WERE SINTERED AT 1400°C, 1500°C, 1600°C WITH SOAKING PERIOD OF 2 HOURS

CONCLUSION

Porous mullite from clay and boehmite is formed using naphthalene as a pore former. The sample sintered at 1600°C with 20wt.% naphthalene exhibited apparent porosity of 39.79% with flexural strength of 21.93MPa and diametrical tensile strength of 20.72MPa. From XRD and microstructure analysis it was evident that increase in sintering temperature favours the formation of mullite structure whereas addition of pore former delayed the mullitization process. Microstructural analysis also indicated the presence of distributed pores with increasing naphthalene content.

RESULTS AND DISCUSSION

The XRD analysis of the 1400°C and 1600°C sintered samples are shown in Figure 1(a) and (b). As per Figure 1(a) most of the peaks are corresponding to mullite phase along with some prominent peaks of α-alumina.

Here with the addition of pore former, alumina peak intensity increases i.e., mullite phase formation is hindered by the addition of pore former. For 1600°C sintered sample complete mullite phase formation is observed with negligible existence of α-alumina phase (Figure 1(b)).

From the Figure 2 it is evident that as the temperature is increasing the apparent porosity is decreasing due to sintering effect and as the naphthalene (wt.%) increases the apparent porosity increases.

Figure 3(a), (b), (c) shows the microstructure of the samples sintered at 1600°C containing different weight percentages of pore former. Here, better densification is observed in batch 1 compared to batch 3 and 5. The higher amount of pores present in batch 3 and batch 5 effect mullite phase formation because in presence of pores contact area between silica and alumina decreases which causes less diffusion and effect mullite phase formation.

REFERENCES

G. Ruan, Z. Zhang and M. Yin, Rare Met. 30, 506-510 (2011).