

Modified cenospheres as non-sacrificial pore-forming agent for porous mullite ceramics

ABSTRACT

Porous mullite ceramics were produced using mullite precursor and modified cenospheres as a non-sacrificial pore-forming agent. The cenospheres used are aluminosilicate hollow spheres with high silica and alumina content, which are obtained from coal-fired power plant. In this study, the cenospheres were modified using aluminum trichloride hexahydrate ($\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$), alkali/acid leaching and heat treatment. Various types and amounts of the modified cenospheres were mixed with mullite precursor to produce porous mullite ceramics for subsequent firing at 1500 °C. Graphite powder, as sacrificial pore-forming agent, was also used to prepare porous mullite ceramics by the same processing conditions for comparison. The study found that the use of graphite powder was unable to increase the porosity of the mullite ceramics as a result of excessive shrinkage. It acted more as a sintering aid rather than as sacrificial pore-forming agent. On the other hand, addition of modified cenospheres as non-sacrificial pore-forming agent leads to the increment of both total porosity and closed porosity, with the reduction of open porosity. The results showed that with the addition of 40 wt% of modified cenospheres to the mullite precursor, the resultant porous mullite ceramic has a total porosity of 50.2%, thermal conductivity of $1.28 \text{ Wm}^{-1}\text{K}^{-1}$, linear shrinkage of 4%, and biaxial flexural strength of 45.9 MPa. Porous mullite ceramic with majority closed pores has potential application for high temperature thermal barrier.

Keyword: Cenospheres; Non-sacrificial; Pore-forming agent; Porous mullite