Microstructural, physical and mechanical analysis of RHA pore modified porous alumina with aluminum as reinforcement

ABSTRACT

Porous ceramics are being used in many industrial applications and processes that require extreme environment exposure due to its chemical inertness to corrosive medium and its ability to withstand high temperatures. Tailoring the porosity through pore modifier is one of the method available to ensure that the strength of ceramic is homogeneous. In order to improve the strength of the porous ceramic, the addition of aluminium powders was explored in this research. With the addition of agricultural waste source pore modifier and aluminium as reinforcement, the microstructure, linear shrinkage, porosity (open, closed and total), density, hardness and failure strength of this ceramic composite were examined. The ceramic composites were fabricated through powder metallurgy processing routes. Alumina, Al2O3 with the respective amounts of 0 to 10 wt.% (intervals of 10 wt.%) of RHA and 0 to 10 wt.% (intervals of 2 wt.%) of aluminum, Al, were mixed homogeneously with 12 wt.% of sucrose solution. The mixtures were compacted and heat-treated for 1 h at each of the soaking temperatures of 200°C, 600°C and 1000°C followed by full sintering at 1550°C for 2 h in a furnace. The results have shown that open and total porosity increases with increasing amounts of RHA and aluminum. Meanwhile, the linear shrinkage, close porosity, density, hardness and failure strength was reduced. In this research, the strength was expected to increase with the addition of aluminum. However, due to the increasing percentage of the total porosity with the increased addition of aluminum, the samples behave inversely. Phase transformations to mullite (3Al2O3. 2SiO2) were seen in this research with the addition of RHA. This phase formation helps to increase the overall strength of the ceramic composites, showing that 10 wt% addition of RHA have a positive impact, not only as a medium to modify the pore formation, but it also has a positive effect on the strength property of the ceramic composite.

Keyword: Alumina; Ceramic matrix composite; Mechanical properties; Microstructure; Powder metallurgy; Sintering process