Abstract

Porous ceramics are extensively utilized in various fields due to their desirable properties. Among the different fabrication methods for porous ceramics, thermo-foaming has emerged as a versatile, cost-effective, and environmentally friendly process suitable for mass production. In this study, two novel thermo-foaming techniques were developed to fabricate porous ceramic composites and ceramic foams, with a focus on achieving economic feasibility and easy adoptability. The first method involved the dissolution of alumina in aqueous acidified media, enabling green machining ability and the fabrication of complex porous shapes. The second method utilized sucrose dehydration through sulphuric acid, resulting in ultra-light ceramic foams with a gradient microstructure. Both techniques offer the advantages of low cost and simple processing, making them suitable for mass production applications.

Furthermore, in line with the development of these new techniques, this study aimed to contribute to "Waste Valorization" by utilizing industrial solid waste in the fabrication of porous ceramics. Coal Overburden waste, known for its harmful impact on the environment and ecology, was selected as the model material for porous composite fabrication. The developed techniques successfully processed coal overburden waste, demonstrating their efficacy and potential extension to other solid wastes. Additionally, for comparison purposes and to expand the porosity range and applicability of porous composites, a sacrificial method using rice husk was employed in conjunction with coal overburden.

The resulting porous composites and foams predominantly exhibited mullite and other aluminosilicate phases, offering porosity and mechanical strength in the ranges of 20-90% and 0.8-50 MPa, respectively. These porous composites displayed favourable thermo-mechanical properties, rendering them suitable for insulation applications. Overall, this study presents promising thermo-foaming techniques for the fabrication of porous ceramic composites and foam, while also contributing to waste valorisation by employing industrial solid waste materials.