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Synthesis of Low-Cost Porous Silicon Carbide Foams from Renewable Sources

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Abstract : Highly porous carbon-based foams are used in a wide range of industrial applications, which include absorption, catalyst supports, thermal insulation, and biomaterials, among others. Particularly, silicon carbide (SiC) based foams have shown exceptional potential for catalyst support applications, due to their chemical inertness, large frontal area, low resistance to flow, low-pressure drop, as well as high resistance to temperature and corrosion. These properties allow the use of SiC foams in harsh environments with high durability. Commonly, SiC foams are fabricated from polysiloxane, SiC powders and phenolic resins, which can be costly or highly toxic to the environment. In this work, we propose a low-cost method for the fabrication of highly porous, three-dimensional SiC foams via template replica, using recycled polymeric sponges as sacrificial templates. A sucrose-based resin combined with a Si-containing pre-ceramic polymer was used as the precursor. Polymeric templates were impregnated with the precursor solution, followed by thermal treatment at 1500 °C under an inert atmosphere. Several synthesis parameters, such as viscosity and composition of the precursor solution (Si: Sucrose molar ratio), and the porosity of the template, were evaluated in terms of their effect on the morphology, composition and mechanical resistance of the resulting SiC foams. The synthesized composite foams exhibited a highly porous (50-90%) and interconnected structure, containing 30-90% SiC with a mechanical compressive strength between 0.01-0.1 MPa. The methodology employed here allowed the fabrication of foams with a varied concentration of SiC and with morphological and mechanical properties that contribute to the development of materials of high relevance in the industry, while using low-cost, renewable sources such as table sugar, and providing a recycling alternative for polymeric sponges.

Keywords : catalyst support, polymer replica technique, reticulated porous ceramics, silicon carbide
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