Silicon carbide patterned structures fabricated by robocasting

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Abstract

Cellular materials are an important kind of high-porosity solids comprising structures like certain foams, honeycombs or robocast scaffolds, cellular ceramics being widely use in applications like chemically inert filters, thermal storage systems, heat exchangers, catalytic supports, or as scaffolds for osteo-integration. As an exceptional example of structural ceramics, the family of silicon carbide (SiC) materials stands out for a combination of excellent properties, particularly their low density, high hardness, high stiffness, and high resistance to abrasion, corrosion and wear, even at high temperatures.

Here, the development of complex 3D-structures of SiC assembled by a colloidal printing method known as Robocasting is presented. This technique consists in a concentrated colloidal ink extruded through a nozzle forming a continuous filament, which is placed on a substrate to assemble the final 3D pattern in a succession of building layers. The grain size and specific surface area of the starting ceramic powders, the ink solids content, green porosity, amount of sintering additives and sintering temperatures are the main parameters taken into account for the production of these 3D-structures. In addition, SiC cellular skeletons have been used as a support to grow aligned carbon nanotubes (CNTs) within the cellular structure. The hybrid CNTs/SiC material retained water and allowed flowing oils and gasoline through the filter exhibiting superhydrophobic and superoleophilic properties. Interestingly, it also showed high electrical conductivity throughout the whole 3D structure that would enable recycling of the device by Joule heating after the filtration process.