Guefoams: A new concept of filter media for water bacterial removal

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Abstract

Open-pore foams are utilized in numerous applications, including medical implantology, catalysis, contaminant retention, heat dissipation, and energy absorption, among others. [1-4].
The replication method is one of the most widely used manufacturing strategies to produce open-pore foams, as it provides a great deal of design flexibility for both the porous architecture and the foam material. This technique is widely employed in the production of metallic, ceramic, and polymeric foams [5-12]. The process involves infiltrating a porous preform with a liquid precursor and then removing by dissolution or chemical reaction the template preform. The use of packed NaCl particulate beds as a leachable template in the production of ceramic materials and polymeric foams is particularly attractive due to its abundance, low cost, and simple disposal. However, its general application for this purpose is limited for the following reasons: (i) due to the high solubility of NaCl in water, water-based ceramic slurries dissolve part or all of the NaCl preform during infiltration , and (ii) due to the high wettability of many polymers on NaCl, their infiltration on NaCl-packed particle or sphere preforms results in a total filling of the pore space in a way that makes it impossible to dissolve the NaCl and obtain a foam material.
In this work, a method is proposed for the fabrication of foams and Guefoams (foams with guest phases located within their porous cavities without any chemical or physical bonding) with ceramic and polymeric matrices. To achieve this, the replication technique was modified by combining two templating agents. The first templating agent is sodium chloride particles or spheres, which are coated with paraffin (second templating agent) and sintered at low temperature (Figure 1). As a result, a self-standing preform with paraffin bridging the particles is obtained. The fully paraffin-coated preform is infiltrated with ceramic slurries or low solubility polymers in paraffin. When the matrix has been consolidated, the two templates can be easily eliminated. This method permits the fabrication of open-pore foam materials with a high degree of design flexibility in terms of both the foam material and its pore architecture (shape, size, and pore size distribution). The application of certain polymer matrix materials as antibacterial water filters was tested. These materials consisted of epoxy matrix Guefoams and activated carbon guest phases coated with iodine. E. coli and S. aureus were used in the tests as the bacteria. More than 99% of the bacteria were inhibited in a single pass through the filter, with the added benefit that the pressure drop imposed by the Guefoam material is significantly less than that of a bed of compacted particles of similarly modified activated carbon. In the field of bacteriological water purification, the results suggest that these materials are among the most promising alternatives.

References

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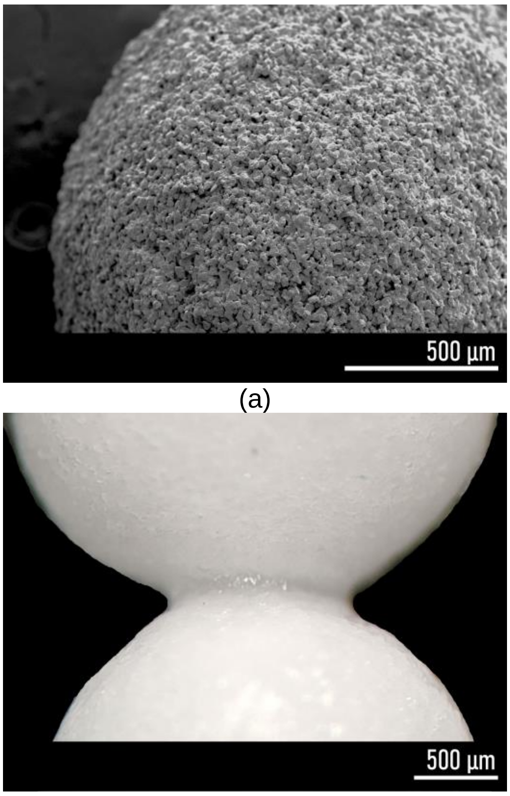
Figures



(a)

(b)

Figure 1. SEM image of the spherical NaCl particles prepared for the fabrication of leachable preforms; (b) photograph of the paraffin-coated NaCl spheres after the sintering process, showing the bonding bridges.