



Calcium(II)-containing borosilicate aerogels as promising materials for application in regenerative medicine

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Hybrid aerogels in general are promising scaffolds for bone regeneration owing to the high porosity, nanostructured surface and versatile functionalization of this family of sol-gel materials. Our study focuses on the design, synthesis, in-depth structural characterization and in vitro biological testing of calcium(II)-containing hybrid borosilicate aerogels. Little is known about the behavior of nanostructured porous borosilicate materials in biological media (changing micro- and nanostructure, altered physical and chemical properties, reaction to environmental influences, etc.). Understanding the structure-property-function relationships in relation to biological systems is the most important objective of the present research.

Hybrid borosilicate aerogels were prepared by sol-gel synthesis using various molecular weight PVAs and different calcium sources (CaCl_2 , $\text{Ca}_3(\text{PO}_4)_2$, hydroxyapatite) as bioactive ingredients. The structural characterizations were done employing various techniques in terms of composition (FTIR, solid-state NMR), texture and morphological properties (N_2 -sorption porosimetry, small angle neutron scattering, electron microscopy). These studies reveal the interconnected mesoporous structure of the scaffolds with pore diameters of 20-45 nm and apparent surface areas of 540-1038 m^2/g . The synthesized materials were characterized employing various techniques in terms of composition, texture and morphological properties. Contrast-variated SANS has been used to describe the mesoporous structure of the scaffolds and their behaviour in aqueous environment. The suspensions of the aerogels were studied by dynamic light scattering and Zeta potentials were measured. Selected materials were submitted to in vitro experiments to determine their biocompatibility and bioactivity. Viability assays and time lapse video microscopy imaging of cell proliferation and scratch closure were performed using human mesenchymal stem cells. These experiments revealed the high affinity of the cells towards the hybrid borosilicate aerogels.

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