Synthesis and characterization of sodium-reduced silica bioactive glasses via sol-gel approach

Synthetic bone substitutes such as bioactive glasses (BG) have gained importance concerning the surgical treatment of bone defects (1). In this context, the 45S5-BG (composition in mol%: 46.1, SiO_2, 24.5 CaO, 24.5 Na_2O, 6.0 P_2O_5) represents the most investigated BG and functions as a standard in order to compare newly developed BG compositions (2-5). A variety of advantageous properties, such as adherence to the surrounding tissue in-vivo and the induction of osteogenic differentiation in bone precursor cells imparted by liberation of bioactive ions were identified (1, 6-8). Besides these favorable properties, 45S5-BG generates by a burst release of sodium-ions (Na) mediated by its high initial bioreactivity a potential cytotoxic environment: besides a dramatic pH-shift and an alkalization of the local environment the presence of Na also plays a role in the induction of apoptosis (9-14).

In order to reduce alkalization of the BG-cell interface to a non-toxic extend, we propose within this work the preparation and characterization of 45S5-BG with different Na contents ranging from the original composition (with 100% of sodium) to 0% of the original content in 45S5-BG composition via sol–gel synthetic approach. The as-synthesized compositions will be characterized by means of x-ray diffraction, infrared and Raman spectroscopies and, electron microscopy before and after socking in body fluids during different times. The aim of the work will be to assess the impact of sodium reduction on i) the physicochemical properties of the materials and ii) the bioactivity (ability of the glass to develop hydroxyapatite its surface upon exposure to body fluids to different time spans).

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Preparation and characterization of Silicon oxycarbide (SiOC) based 3D scaffolds for bone regeneration applications

Silicon oxycarbide (SiOC) based materials are of interest due to their unique properties, including high-temperature resistance, mechanical strength, chemical durability and corrosion resistance. Due to their good hemocompatibility, silicon oxycarbides were shown to be promising materials for biomedical applications, such as blood contact materials. Recently, metal- (i.e. Ca2+, Mg2+) and/or boron- modified SiOC glass and glass ceramics have been shown promising bioactive behavior and then, eligible materials for bone tissue substitution. According to the final clinical application, metal-, boron-modified SiOC materials have to be processed as porous three-dimensional (3D) scaffolds.

This work aims the preparation and characterization of porous Ca/B-modified SiOC 3D scaffolds through the sponge replication techechnique. The physicochemical and the mechanical properties of the as-prepared materials under different conditions will be extensively investigated.

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