Amorphous Borosilicate Bioactive Glass Scaffolds Processing and In-Vitro Dissolution

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Abstract

Sintering of commercially available bioactive glasses particles, such as 45S5 and S53P4, leads to porous scaffolds partially to fully crystallized with low mechanical properties. Crystallization is known to reduced, or even suppress in some cases, the material's bioactivity. Recently, Borosilicate bioactive glasses have emerged as a class of glasses highly interesting for tissue engineering applications. They have enhanced thermal properties, and faster conversion to hydroxyapatite (HA) in physiological conditions compared to the traditional silica-based bioactive glasses. Borosilicate glasses, that can be sintered into porous scaffold without adverse crystallization, have even been developed. One drawback of the developed glasses lies in their reduce cell attachment and proliferation when compared to typical silicate bioactive glasses. Here, we report on the processing of 3D porous scaffolds using Mg and Sr-containing borosilicate bioactive glasses. These glasses exhibit cell attachment and proliferation similar or superior to the typical silicate bioactive glasses. Scaffolds were produced using 3D printing and the porogen burn-off technique. All the scaffolds produced were amorphous in nature. Porosity was greater than 60-70% with interconnected pores larger than 200 μm in average. The Mg-containing glass have higher sintering ability as evidenced by the increased mechanical properties and further confirmed by μCT. Immersion of the scaffolds in simulated body fluids suggested that the scaffolds prepared by robocasting reacts at a slightly higher rate than those obtained using the porogen burn-off method. ICP-OES and FTIR was used to quantify the glass dissolution and probe the change in the glass structure. Presence of Sr and/or Mg led to a slower glass reactivity. However, the presence of Sr induced precipitation of a Sr-substituted hydroxyapatite layer at the scaffolds surface. The change in compressive strength, as a function of immersion time, were also measured for all processed scaffolds.

Keywords: Bioactive glass, Borosilicate, Scaffolds, Sr, HA

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