Poly (octanediol citrate)/Gallium-containing bioglass microcomposite scaffolds

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Statement of Purpose: Bone defects caused by tumor reconstruction, chronic infection or traumatic bone loss create a major surgical problem [1]. In recent years development of bioresorbable tissue engineering scaffolds has advanced due to their ability to support the formation of newly grown tissue. Gallium compounds have utility in the treatment of diseases characterized by accelerated bone loss [2]. This paper describes a novel composite scaffold fabricated from poly (octanediol citrate) (POC) and gallium-containing bioglass.

Methods: Composite scaffolds were prepared by employing a salt-leaching method. The POC pre-polymer was dissolved in dioxane to obtain a 20% solution. Then, different concentrations (10, 20 and 30 wt%) of melt derived bioactive glass ($0.48SiO_2$-$0.12CaO$-$0.32ZnO$-$0.08Ga_2O_3$, molar fraction) with particle size below 45 µm were added to the solution. Following that, sieved NaCl (200-300 µm) was added and the mixture was stored at 80°C for one week. Then, NaCl was washed for 4 days in distilled water. Once the washing was completed, the resultant scaffolds were frozen at -80 °C and lyophilized using a freeze-dryer. Scaffold morphology was investigated by field emission scanning electron microscopy (FESEM, Zeiss-Auriga laser, Germany). The samples were placed on aluminum stubs (8 mm diameter) and images were recorded at various magnifications using an accelerated voltage of 15 kV. The cylindrical scaffolds were subsequently evaluated mechanically using an Instron 5544 (USA) mechanical tester. fitted with a 2 KN load cell. Samples were compressed to 50% of initial volume.

Results: Table 1 reports the compression modulus (E_c) of the scaffolds which were seen to increase with the addition of bioglass. Figure 1 shows the porous structure of the scaffolds.

Table 1: Compression modulus of POC-BG scaffolds.

Property	POC	POC-BG-10%	POC-BG-20%	POC-BG-30%
Ec (MPa)	0.31 ± 0.10	2.60 ± 0.69	4.00 ± 1.00	6.78 ± 1.62

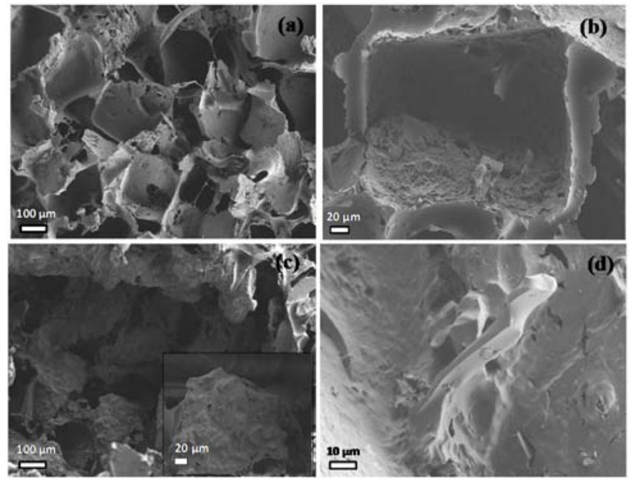

Figure 1: Microstructure of scaffolds observed by FESEM: (a) POC; (b) POC-BG-30%; (c) POC-BG-20%; and (d) POC-BG-10%.

Conclusions: The objective of the study was to fabricate gallium-containing composite scaffolds for potential scaffolding applications in human bone.

The observation of the porous structure of the scaffolds by FESEM demonstrated the glass particles were well-dispersed and the scaffolds had interconnected pores with pore size ranging from 200-300 µm suitable for cell migration and tissue growth [3]. However large particles were not fully embedded into the matrix which can be readily debonded and consequently reduce the composite strength [4].

Addition of bioglass to the polymer had a significant influence on the compression moduli as a result of enhanced physical crosslinks (metallic carboxylic bonds).

Although stiffness of materials increased by addition of bioglass, it is still lower than natural cancellous bone. Thus, the composite scaffolds have only potential to be used as filling in hard tissue surgery where there is an external support [5].

References:

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