MACRO AND MICROPOROUS SCAFFOLDS THROUGH A POWDER CASTING TECHNIQUE

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Introduction

Glass-ceramic Apatite/Wollastonite (A/W) has been used as a material for bone scaffold fabrication due to its biological and material properties. A/W has a good combination of bioactivity, bioresorbability, biodegradability, osteoconductivity and mechanical robustness [Kokubo, 1991]. A/W has been used successfully for bone scaffold fabrication in previous work [Dyson, 2007; Xiao, 2008]. This project aims to fabricate a 3D bone scaffold with tailored architecture, enhanced interconnectivity and macroporosity.

Methods

(1) A/W glass was produced by GTS, Sheffield, UK as reported by Kokubo [1991]. A/W powder was milled in a ball mill and then sieved to separate the particle fractions of <20µm, 20-53µm and 54-90µm. (2) Negative PLA cores (shown in Figure 1) were fabricated using a fused deposition modelling (FDM) machine. (3) To fabricate scaffolds the A/W powder was poured in platinum tubes (height 25mm, and diameter 10mm). When macroporous scaffolds were being made a PLA core was placed inside the platinum tube prior to the powder being poured into the tubes. The powders were then sintered in the tubes at 1150ºC for 1 hour.

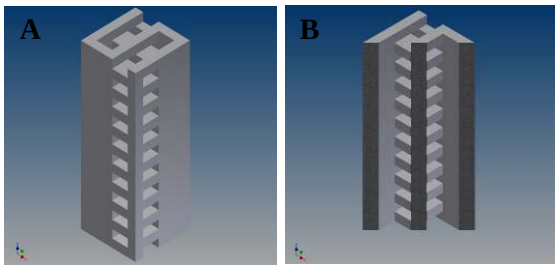

Figure 1: Computer aided design of PLA core: whole scaffold (A), cross section view (B)

Results

For samples made without a core the overall porosity levels were around 30%, with the porosity in the range 31.5- 35.8%. Young's modulus was assessed by the means of compressive test using Tinius Olsen; Instron machine at a 1.0mm/min, with results between 0.6 and 1.2 GPa. The post sintered A/W scaffolds that were made using the PLA core have very complex, detailed architecture with large channels (shown in Figure 2), and the scaffolds retained their structural integrity.

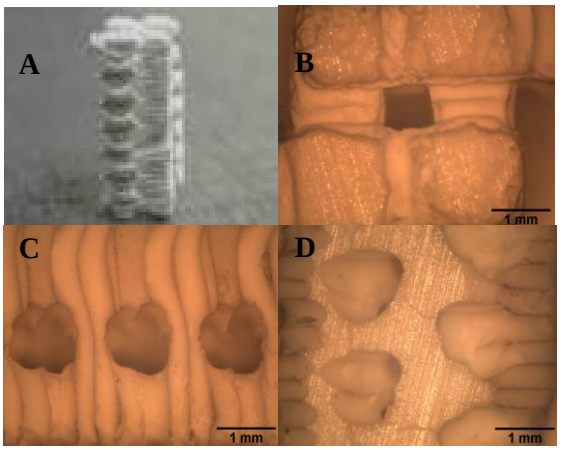

Figure 2: Post sintered macroporous A/W scaffold using PLA negative mould. Photograph of scaffold (A). Brightfield microscopy images of top view (B), longitudinal section view (C) and quarter section view (D).

Discussion

Scaffolds fabricated by casting dry loose powder into moulds are porous with high mechanical properties. The combination of PLA negative mould and loose powder; post-sintering can produce interconnected porous scaffolds with a designed macroporous structure.

References

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