

Porous bioactive glass scaffold with high compression strength

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INTRODUCTION: Tissue engineering poses new challenges in the area of biomaterials. For bone and cartilage tissue engineering applications, in particular, there is a need for the development of better scaffold materials. Porous bioactive glass scaffolds have been manufactured by sintering bioactive glass fibres. The relative porosity of the scaffolds, size of the pores and compression strength can be controlled by altering the manufacturing parameters like fibre dimensions and sintering temperature and time ¹.

The aim of this study was to manufacture porous structures with high compression strength by sintering bioactive glass fibres.

METHODS: The composition of the bioactive glass used in this study was as follows; 12% Na₂O; 15% K₂O; 3% MgO; 13% CaO; 1% B₂O₃; 2% P₂O₅ and 54% SiO₂ (all in weight %). Glass fibres, with mean diameter of 100 µm, were manufactured from the glass by melt spinning. The fibres were further chopped either to a length of 1.3 mm or 2.0 mm. Porous scaffolds (height = 6 mm) were manufactured by sintering the fibre segments in a mould (with inside diameter of 15 mm) at 630 °C for time periods of 15, 20 or 30 minutes. Porosity and compression strength and compressive shear strength (as a maximum load) of the manufactured specimen were analyzed. The cross head speed of 5 mm/min was used in both testing methods.

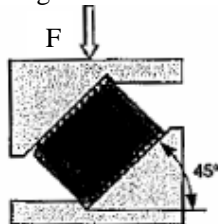


Figure 1. Schematic figure of setup of the compressive shear test.



Figure 2. Sintered porous scaffold.

RESULTS:

In Figure 3 porosity of the scaffolds as a function of sintering time and fibre segment length can be seen. The extended sintering time and shorter fibre length both decrease the scaffold porosity.

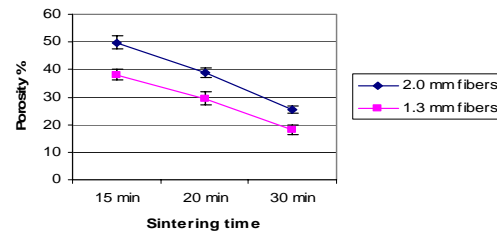


Figure 3. Porosity of the scaffolds as a function of sintering time.

Table 1. Compression strength and compressive shear strength of the sintered scaffolds.

Fibre length mm	Sint. time min	average scaffold diameter mm	Comp. strength (stdev) N	Comp. shear strength (stdev) N
2.0	15	11.6	1316 (378)	1038 (13)
2.0	20	10.8	2477 (685)	1855 (492)
2.0	30	10.1	4995 (288)	4527 (642)
1.2	15	12.2	3192 (946)	2269 (294)
1.2	20	11.5	3785 (486)	3316 (281)
1.2	30	11.3	7402 (1300)	6424 (633)

As seen in Table 1 the increasing sintering time does increase the compression strength of scaffolds, though the brittle nature of the scaffolds introduce uncertainty on the results (high standard deviations).

DISCUSSION & CONCLUSIONS:

Porous bioactive glass is proposed as a good materials choice to achieve repair in articular osteochondral defects². Bioglass® has also been shown to have the ability to support the growth of chondrocytes³. By using sintering technique porous bioactive glass scaffold with high compression strength are obtained. This type of networks may therefore prove useful as scaffold in applications, in which load bearing materials are required.

REFERENCES: ¹ E. Pirhonen (2003) *Porous Bioactive 3-D Glass Fiber Scaffolds For Tissue Engineering Applications*, Key Engineering Materials Vols. 240-242 pp. 237-240. ² H. Ylänen (1999) *Porous Bioactive Glass Matrix in Reconstruction of Articular Osteochondral Defects*, Annales Chirurgiae at Gynaecologiae 88: pp.237-245. ³ A. Asselin (2004) *The Modulation of tissue-specific gene expression in rat nasal chondrocyte cultures by bioactive glasses*. Biomaterials 25. pp 5621-5630.