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MECHANICAL BEHAVIOUR UNDER UNIAXIAL COMPRESSION OF ROBOCAST CALCIUM PHOSPHATE SCAFFOLDS

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INTRODUCTION: The mechanical behavior under compressive stresses of β-tricalcium phosphate (β-TCP) and hydroxyapatite (HA) scaffolds fabricated by robocasting technique is analyzed in this work. The effect of a three-week immersion in simulated body fluid (SBF) on the strength of the scaffolds is also analyzed. The experimental results are compared with predictions from finite element modeling (FEM) and existing literature data.

METHODS: Concentrated colloidal inks prepared from β-TCP and HA commercial powders were used to fabricate porous structures consisting of a 3-D square mesh of interpenetrating ceramic rods (Fig. 1).

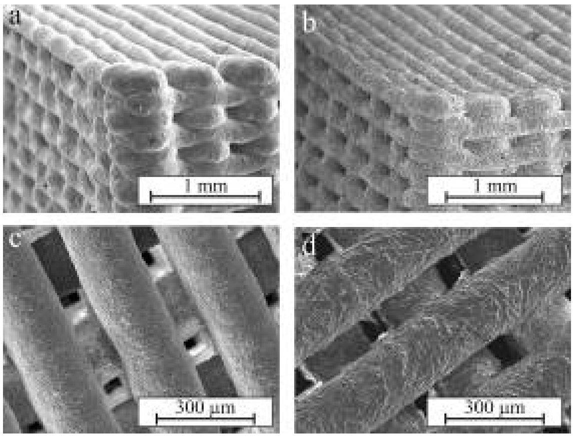

Fig. 1: SEM micrographs showing HA (a, c) and β-TCP (b, d) scaffolds morphology.

The compressive strength of these model scaffolds was determined by uniaxial testing to compare the relative performance of the selected materials. The results were then compared with predictions obtained from FEM simulations of the compression tests using ABAQUS software.

RESULTS: HA scaffolds exhibit a much higher compressive strength than β-TCP (more than two-fold) in all testing configurations, and this difference increase considerably after immersion in SBF (Fig. 2).

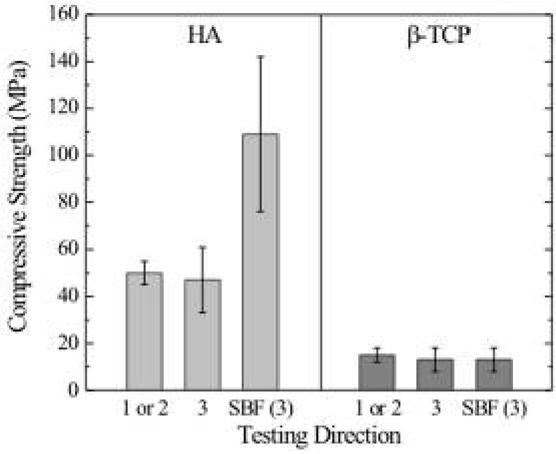

Fig. 2: Average compressive strength data obtained for each type of scaffold.

HA scaffolds double their compressive strength due to bone-like apatite growth on the surface of the HA rods, while β-TCP remains unaltered during this in vitro immersion. Experimental results were found to be in good agreement with FEM predictions.

DISCUSSION & CONCLUSIONS: According to our results, controlled immersion in SBF seems to be a simple and inexpensive means to improve the mechanical performance of complex 3D structures fabricated by robocasting (or other SFF techniques) from apatite-forming materials (like HA). Besides, FEM was shown to provide an excellent means to predict the compressive strength of these structures as a function of geometric variables, which paves the way to the optimization of the mechanical performance of robocast calcium phosphate scaffolds, for it possible use in load-bearing bone tissue engineering applications.

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