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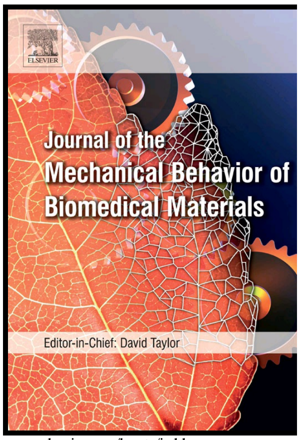

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Microstructure, mechanical characteristics and cell compatibility of β-tricalcium phosphate reinforced with biodegradable Fe-Mg metal phase

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Abstract

The use of beta-tricalcium phosphate (β-TCP) ceramic as a bioresorbable bone substitute is limited to non-load-bearing sites by the material's brittleness and low bending strength. In the present work, new biocompatible β-TCP-based composites with improved mechanical properties were developed via reinforcing the ceramic matrix with 30 vol.% of a biodegradable iron-magnesium metallic phase. β-TCP-15Fe15Mg and β-TCP-24Fe6Mg (vol.%) composites were fabricated using a combination of high energy attrition milling, cold sintering/ high pressure consolidation of powders at room temperature and annealing at 400°C. The materials synthesized had a hierarchical nanocomposite structure with a nanocrystalline β-TCP matrix toughened by a finely dispersed nanoscale metallic phase (largely Mg) alongside micron-scale metallic reinforcements (largely Fe). Both compositions exhibited high strength characteristics; in bending, they were about 3-fold stronger than β-TCP reinforced with 30 vol.% PLA polymer. Immersion in Ringer's solution for 4 weeks resulted in formation of corrosion products on the specimens' surface, a few percent weight loss and about 50 % decrease in bending strength. In vitro studies of β-TCP-15Fe15Mg composite with human osteoblast monocultures and human osteoblast-endothelial cell co-cultures indicated that the