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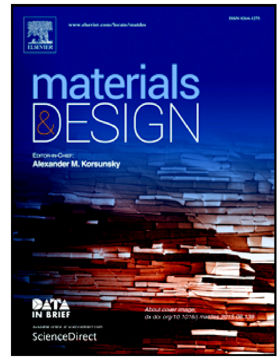

Combinational processing of 3D printing and electrospinning of hierarchical poly(lactic acid)/gelatin-forsterite scaffolds as a biocomposite: Mechanical and biological assessment

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Combinational processing of 3D printing and electrospinning of hierarchical poly(lactic acid)/gelatin-forsterite scaffolds as a biocomposite: Mechanical and biological assessment

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Abstract: In this research, hierarchical scaffolds including poly(lactic acid) (PLA) micro struts and nanocomposite gelatin-forsterite fibrous layers were developed using fused deposition modeling (FDM) and electrospinning (ES), respectively. Briefly, geometrically various groups of pure PLA scaffolds (interconnected pores of 230 to 390 µm) were fabricated using FDM technique. After mechanical evaluation, ES technique was utilized to develop gelatin-forsterite nanofibrous layer. To study these scaffolds, scanning electron microscopy (SEM), Fourier transform infrared spectroscopy, and uniaxial compression tests were performed. Furthermore, bioactivity of the scaffolds was evaluated by immersing in the simulated body fluid and apatite formation on the surface of the scaffolds was investigated. Results depicted that elastic modulus of PLA/gelatin-forsterite scaffolds, fabricated by a combinational approach, was significantly higher than that of pure one (about 52%). SEM images showed the formation of calcium phosphate-like precipitates on the surface of these scaffolds, confirming the effects of nanocomposite fibrous layer on the improved bioactivity of the scaffolds. Regarding the obtained biological as well as mechanical properties, the developed bio-composite scaffolds can be used as a biocompatible candidate for bone tissue regeneration.

Keywords: 3D printing; Electrospinning; Bio-composite scaffold; Poly(lactic acid); Gelatin; Forsterite

1. Introduction

Tissue engineering is a multidisciplinary field including the combination of engineering and life science in order to provide a suitable structural framework to restore, protect, or augment the tissue functions [1]. From tissue engineering point of view, three-dimensional (3D) biocompatible scaffolds needed for bone regeneration have to mimic both biological and mechanical properties of the extracellular matrix (ECM) in order to control the cell function, diffusive capability and induce bone regeneration [2]. Furthermore, high diffusivity is necessary for 3D scaffolds in order to facilitate the mass transport of oxygen and nutrients [3,4]. To access this approach, the average pore size of scaffolds should be in the range of 300-400 µm to allow growing of the osteons into the scaffold [5]. In this regard, a complete library for engineered scaffold structures and their features was reported by Cheah et al. [6,7].

There are several techniques applied to fabricate 3D scaffolds such as fiber bonding [8], particular leaching [9] and emulsion freeze-drying [10]. Despite the promising results from

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