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ORIGINAL PAPER

# Mechanical and structural properties of polylactide/chitosan scaffolds reinforced with nano-calcium phosphate

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**Abstract** In this study, chitosan/polylactide scaffolds reinforced with nano-calcium phosphate (average crystallite size of 16.5 nm) (CP) were fabricated to create a material with excellent properties for bone tissue engineering applications via freeze-casting method. The structural and mechanical properties of nanocomposite scaffolds were studied by increasing amount of chitosan/poly lactide ratio and nano-CP content in both dry and hydrate states, which reflected the exact status of scaffolds in a real biomechanical environment. The morphologies of the nanocomposite scaffolds were viewed using scanning electron microscopy (SEM) and all the scaffolds exhibited a high porosity (up to 92 %) with open pores of 38–387 μm average diameters, which decreased with increased chitosan/polylactide ratio and nano-CP content. Also, SEM photograph of the cross-sectional area of the scaffold showed nano-CP was dispersed all over the polymer matrix thoroughly. The results of mechanical tests showed that the compressive modulus ($E$) and compressive stress ($\sigma$) enhanced, when chitosan and nano-CP increased. X-ray diffraction analysis indicated typical chitosan, polylactic acid and nano-CP peaks and showed that the increase in nano-CP weight percentage increased its peak intensities. In addition, the effect of pore-size distributions of the scaffolds with the same composition was studied in relation to mechanical properties. The results showed substantial differences in the pore-size distributions of scaffolds with the same composition prepared, which have no effect on their dry states.

**Keywords** Polylactide · Chitosan · Nano-calcium phosphate · Porous scaffold · Mechanical properties

## Introduction

Today, nanocomposites have been used for application in tissue engineering and a wide range of these composites have been studied for use as porous scaffolds [1, 2]. In order to have a better interaction between the bioactive inorganic phase and the organic phase, creating a tough material, the nanocomposites are made. This nanoscale interaction should allow bone cells to come into contact with both phases at one time, and the material should degrade at a single rate. Since natural bone consists of organic and inorganic materials, significant attention is paid to polymer/ceramic composites [3].

Poly(*L*-lactic acid) (PLLA) is one of the most widely used synthetic, biocompatible and biodegradable polymers for fabrication of scaffolds. Most synthetic biodegradable polymers such as PLLA have good mechanical strength [4, 5]. But, it decreases the local pH as a consequence of its hydrolytic degradation and elicited undesirable inflammatory and allergenic reactions [6–10].

Beside, natural polymers exhibit good cell adhesion than synthetic polymers. Hence, the combination of a natural

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