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Poly(L-Lactic Acid) Scaffolds for Bone Tissue Engineering

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Abstract : Biodegradable polymers have received significant scientific attention in tissue engineering (TE) application, in particular their composites consisting of inorganic nanoparticles. In the last 15 years, they are subject of intensive research by many groups, aiming to develop polymer scaffolds with defined biodegradability, porosity and adequate mechanical stability. The most important characteristic making these materials attractive for TE is their biodegradability, a process that could be time controlled and long enough to enable generation of a new tissue as a replacement for the degraded polymer scaffold. In this work poly(L-lactic acid) scaffolds, filled with TiO2 nanoparticles functionalized with oleic acid, have been prepared by thermally induced phase separation method (TIPS). The functionalization of TiO2 nanoparticles with oleic acid was performed in order to improve the nanoparticles dispersibility within the polymer matrix and at the same time to inhibit the cytotoxicity of the nanofiller. The oleic acid was chosen as amphiphilic molecule belonging to the fatty acid family because of its non-toxicity and possibility for mediation between the hydrophilic TiO2 nanoparticles and hydrophobic PLA matrix. The produced scaffolds were characterized with thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), scanning electron microscopy (SEM) and mechanical compression measurements. The bioactivity for bone tissue engineering application was tested in supersaturated simulated body fluid. The degradation process was followed by Fourier transform infrared spectroscopy (FTIR). The results showed anisotropic morphology with elongated open pores (100 µm), high porosity (around 92%) and perfectly dispersed nanofiller. The compression moduli up to 10 MPa were identified independent on the nanofiller content. Functionalized TiO2 nanoparticles induced formation of hydroxyapatite clusters as much as unfunctionalized TiO2. The prepared scaffolds showed properties ideal for scaffold vascularization, cell attachment, growth and proliferation.

Keywords : biodegradation, bone tissue engineering, mineralization, PLA scaffolds
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