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Research paper

The influence of the compounding process and testing conditions on the compressive mechanical properties of poly(D,L-lactide-co-glycolide)/α-tricalcium phosphate nanocomposites

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ABSTRACT

The enhanced biological and degradation properties of bioresorbable polymer matrix nanocomposites intended for use in orthopaedic applications have been demonstrated recently. However, at the moment there are only limited reports addressing their mechanical properties under physiological conditions, which is of central importance to the successful design of these nanocomposites. Here, we show that at room temperature in dry conditions, the incorporation of α-tricalcium phosphate nanoparticles into a matrix of poly(D,L-lactide-co-glycolide) increases the compressive strength and modulus. The values at room temperature obtained for nanocomposites compounded by a modified solvent evaporation method via attrition milling in acetone were similar to those from samples compounded by twin screw extrusion. The values for nanocomposites tested at 37 °C in phosphate buffered saline solution were significantly lower than those tested at room temperature in dry conditions, and lower still after two weeks of degradation in PBS at 37 °C. These effects can be related to hydration, degradation and interface effects in the nanocomposites.

1. Introduction

In vitro studies have demonstrated that bioresorbable polymer matrix nanocomposites (PMNCs) exhibit excellent biodegradation and resorption rates (Ehrenfried et al., 2008b, 2009; Zhongkui et al., 2005; Yang et al., 2009; Chen et al., 2007; Rezwan et al., 2006; Maiti and Yadav, 2008). Moreover, *in vitro* and *in vivo* studies with scaffolds have shown that these biodegradable PMNCs provide a biocompatible osteoconductive environment for growth of bone cells, and therefore may be suitable candidate materials for use as bone graft substitutes (Hong et al., 2007; Zhongkui et al., 2005; Jose et al., 2009). Bioresorbable PMNCs are engineered such that their bioresorption in the body completes only after the natural bone tissue has reformed. Despite numerous reports on the bioresorption rates and osteoconductivity

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