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Femtosecond laser-induced modification of PLLA/hydroxypatite composite

K. Szustakiewicz[1,2], B. Stępak[3,4], A.J. Antończak[3], M. Maj[5], M. Gazińska[1], B. Kryszak[1], J. Pigłowski[1]

[1]Polymer Engineering and Technology Division, Wrocław University of Science and Technology (WrUST), Wyb. Wyspiańskiego 27; 50-370 Wrocław, Poland,
[2]Advanced Polymeric Nanostructured Materials Engineering, Graduate School of Engineering, Toyota Technological Institute, 2-12-1 Hisakata, Tempaku, Nagoya 468-8511, Japan
[3]Laser and Fiber Electronics Group, Faculty of Electrical Engineering, (WrUST), Wyb. Wyspiańskiego 27, 50-370 Wroclaw, Poland
[4]Faculty of Microsystems Electronics and Photonics, WrUST, 50-370 Wrocław, Poland
[5]Tissue Engineering Department, L. Rydygier Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Karłowicza 24, 85-092 Bydgoszcz, Poland

Abstract

In the article, we present the surface modification method of poly(L-lactide)/hydroxyapatite hybrid material using ultrashort pulse/femtosecond laser for tissue engineering application. Using femtosecond laser ablation we obtained 3D grooved structures at the composite surface with precisely controlled dimensions having 50 to 100 µm in width and a depth of 20 µm with porous bottom. Differential scanning calorimetry and XRD showed no significant influence of laser process on the supramolecular structure of the polymer in composite after modification. ATR analysis revealed partial surface "amorphisation" due to extremely high temperature gradient provided by laser pulses and relatively long crystallization time of PLLA. GPC revealed decrease in molecular weight of PLLA in the composite after laser modification. In addition biological tests were conducted. Human osteoblasts ATCC CRL-11372 were cultured on the laser-modified surface. Cytotoxicity and real time cell growth experiments showed no toxic effects of laser treated material on cells. This implies that femtosecond laser surface treatment is a promising method which potentially can be used in tissue engineering for scaffold modification and facilitating integration of bioresorbable implant and bone.

1.Introduction

Poly(L-lactide) (PLLA) and hydroxyapatite (HA) based hybrids are widely investigated materials by scientists from around the world [1]. One of the most interesting purposes of both materials are medical applications. Special interests of PLLA resins are caused by its specific properties, among other they are thermoplastic, biodegradable, bioresorbable, biocompatible and can be used as a materials for surgical suture, implants, screws and as carriers in drug delivery systems [2,3]. Polymeric materials are often doped with various kinds of additives or fillers to create desired material with particular parameters or new functions.

Among the fillers, HA is particularly important. Hydroxyapatite with formula $Ca_{10}(PO_4)_6(OH)_2$ is the main component of the vertebrates' bones. Moreover, it is relatively