Fabrication of Bioactive Porous TiO_2 Nanotubes/PLGA Composite Scaffolds for Tissue Engineering Applications

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Statement of Purpose: Every day thousands of surgical procedures are performed to replace or repair tissue that has been damaged through disease or trauma[1]. The developing field of tissue engineering aims to regenerate damaged tissues by combining cells from the body with highly porous scaffold biomaterials, which have the potential to induce bone regeneration and are able to degrade after a certain period of implantation[2].

Poly(lactide-co-glycolides) (PLGA) are biocompatible, biodegradable and non-toxic copolymers. Because the biocompatibility of these polymers is well established, they have been extensively used in biomaterial applications. TiO_2 has the advantages of good biocompatibility, good dispersibility, non-toxic, and super hydrophilic, is currently one of the most popular materials in biomedical fields. TiO_2 nanomaterials have been recently proposed as attractive filler materials for biodegradable polymer matrices. TiO_2 nanotubes has a large specific surface area, can be used as drug carriers, tube wall has larger space for absorbing kinds of drugs.

Combined TiO_2 nanotubes with PLGA, which can be integrated the advantage of both, and made the biodegradable hybrid scaffold material with good biological compatibility, excellent mechanical properties; In addition, through TiO_2 nanotubes carry drugs, drugs can slow release along with the degradation of PLGA, achieving the purposes of adjuvant therapy. Thus giving the hybrid material with multiple functions.

Methods: In this study, We obtained the TiO_2 nanotubes/ PLGA hybrid materials by chemical graft-modification. The silane coupling agent (KH550) was grafted on the surface of TiO_2 nanotubes, and then reacted with high activity-terminated PLGA, the TiO_2 nanotubes bonded through the amide bond grafted onto the surface of PLGA and prepared the organic-inorganic hybrid nano-materials. Then prepared TiO_2 nanotubes/PLGA composite scaffolds using solvent casting/ particulate leaching technique for bone tissue engineering. The structure and morphology of the materials were characterized by FTIR, ^{1}H-NMR, TGA, FESEM and TEM.

Results: we analyzed the surface contact angle of the pure PLGA scaffolds and hybrid scaffold. The surface contact angle as shown in Fig. 1. The experiment results showed that the average surface contact angle of PLGA scaffolds is 100.02°, the hybrid scaffold average contact angle is 83.78°.

The pore size of the composite scaffold varied from 100 to 200 μm as measured by SEM in comparison to the pore size of 200–300 μm of control PLGA scaffolds (showed in Table 1). For tissue engineering scaffolds the ideal pore size range was 150–200 μm as reported earlier [3].

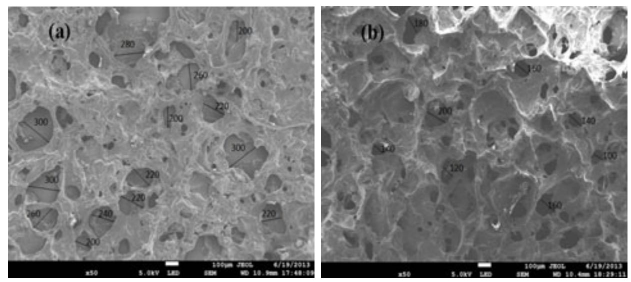
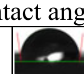
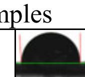
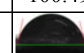
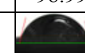
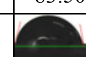
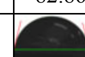


Fig. 1 FESEM images showing the morphology of (a) PLGA scaffolds and (b) TiO_2 nanotubes /PLGA scaffolds.

Table 1 Contact angles of samples

Pure PLGA	Photos					Average Value 100.02
	Angle	101.25	99.52	101.99	99.49	
	Photos					
	Angle	98.92	100.49	99.49	98.99	
PLGA/ TiO_2	Photos					Average Value 83.78
	Angle	83.50	82.99	82.86	83.50	
	Photos					
	Angle	84.80	84.50	83.52	84.64	

Conclusions:

The results showed that the TiO_2 nanotubes was grafted successfully on the surface of PLGA with 18% average grafting. The TiO_2 nanotubes/PLGA hybrid scaffolds materials are more conducive for calcium phosphate layers deposited and improve the surface hydrophilicity. In addition, through TiO_2 nanotubes carry drugs, drugs can slow release along with the degradation of PLGA, achieving the purposes of adjuvant therapy.

References:

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