COMBINATION OF 3D PRINTING AND SOLUTION BLOW SPINNING TO PRODUCE HYBRID PLA/PCL SCAFFOLDS

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SUMMARY

Scaffolds for tissue engineering are an interesting platform to drive tissue growth and regeneration [1]. These matrices must attend requirements such as porosity with interconnected pores, mechanical properties in the range of the natural tissue, biocompatibility and, biodegradability [2]. Moreover is an advantage for scaffolds to have a micro and nano environment that mimics the architecture of the extracellular matrix (ECM) of tissues. Fused deposition modeling (FDM) is a 3D printing technique widely studied to produce polymeric scaffolds for tissue engineering [3,4]. Despite having low cost, good accuracy, and allowing the production of complex geometries, scaffolds printed by FDM do not mimic the nanostructure of the ECM. To overcome this barrier, the combination of 3D printing with a technique to produce fibers, such as solution blow spinning (SBS), seems to be promising and works introducing micro and nanofibers on the surface and interior of the scaffold pores [5,6]. Furthermore, fibers produced by SBS can act as a platform for drug and biomolecules delivery. This work aimed to produce hybrid scaffolds by combining 3D printed polylactic acid (PLA) matrices with polycaprolactone (PCL) fibers produced by SBS, to create a highly complex structure to bone tissue regeneration. PLA scaffolds were designed with two different pore sizes (0.9mm and 1.1mm from top to bottom and 0.3mm on the sides) and printed from white PLA filament by FDM equipment (3D Cloner). To produce fibers,

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12% of PCL (w/v) was solved in a mix of acetic acid and acetone (50/50 % v/v). To produce the hybrid matrix, previously printed PLA scaffolds were placed in a target and the PCL solution was injected with a flow rate of 2 ml/h at 0.103 MPa of air pressure. PCL fibers and PLA scaffolds were characterized by morphological and physical-chemical properties. PLA scaffolds were efficiently produced and printed demonstrating accuracy and compatibility with the projected virtual model. Scaffolds designed with different pore sizes also demonstrated different degrees of porosity: 68 ± 2.1% for scaffolds with pores in the range of 0.9 mm and 75 ± 1.85% for scaffolds with pores in the range of 1.1 mm. Before covering the scaffolds with the fibers, a brief morphological characterization was performed to evaluate the morphology and diameter of fibers. The solvent system, as well as the chosen spinning parameters, made it possible to obtain continuous fibers, with a high degree of misalignment and average diameter around 187 ± 43 nm. It was possible to coat all the surfaces of PLA scaffolds with PCL fibers. PCL fibers penetrate approximately 600 µm in the inner structure of scaffolds regardless of pore size. Although the PCL fibers do not penetrate the entire structure of scaffolds, creating a fiber layer on the superficial region of scaffolds tends to upgrade its nanostructure. In addition to mimic the morphology of ECM, this layer also acts improving the colonization of scaffolds when seeded with cells. Additionally, these fibers can also serve as a platform to immobilize biomolecules and drugs, which gives an additional function to the hybrid matrix.

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