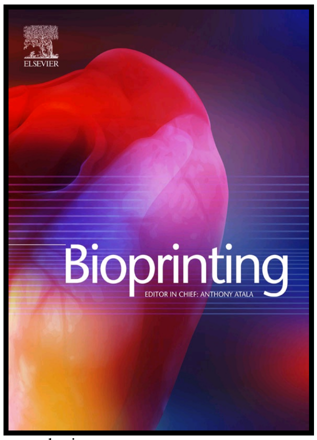
Author's Accepted Manuscript



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PII: S2405-8866(18)30034-4
DOI: https://doi.org/10.1016/j.bprint.2018.e00035
Article Number: e00035
Reference: BPRINT35

To appear in: *Bioprinting*

Received date: 29 August 2018
Revised date: 28 September 2018
Accepted date: 1 October 2018

An ink-jet printed electrical stimulation platform for muscle tissue regeneration

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Abstract

Conducting polymeric materials have been used to modulate response of cells seeded on their surfaces. However, there is still major improvement to be made related to their biocompatibility, conductivity, stability in biological milieu, and processability toward truly tissue engineered functional device. In this work, conductive polymer, poly(3,4-ethylene-dioxythiophene):polystyrene-sulfonate (PEDOT:PSS), and its possible applications in tissue engineering were explored. In particular PEDOT:PSS solution was inkjet printed onto a gelatin substrate for obtaining a conductive structure. Mechanical and electrical characterizations, structural stability by swelling and degradation tests were carried out on different PEDOT-based samples obtained by varying the number of printed PEDOT layers from 5 to 50 on gelatin substrate. Biocompatibility of substrates was investigated on C2C12 myoblasts, through metabolic activity assay and imaging analysis during a 7-days culture period, to assess cell morphology, differentiation and alignment. The results of this first part allowed to proceed with the second part of the study in which these substrates were used for the design of an electrical stimulation device, with the aim of providing the external stimulus (3V amplitude square wave at 1 and 2 Hz frequency) to guide myotubes alignment and enhance differentiation, having in this way promising applications in the field of muscle tissue engineering.

Keywords:

PEDOT; inkjet printing; muscle cells; electrical stimulation device; cell alignment, cell differentiation

1 - Introduction

Conductive polymers (CPs) have been one of the most attractive topics of biomedical research in recent years. CP-based materials can be effectively used as tissue scaffolds for the replacement or restoration of damaged or malfunctioning tissues since many of them respond to electrical stimulation [1]. The use of conductive polymers in tissue engineering and regenerative medicine is very promising due to the combination of good electrical and optical properties (similar to metals and inorganic semiconductors) with their mechanical properties. In fact, these materials provide better mechanical compatibility and structural tunability with cells and organs finding a variety of applications in bone, skeletal muscle, nerve, cardiac and skin tissue engineering [2]. CPs can be fabricated in several ways to produce scaffolds or substrate for tissue engineering: pure polymer films [3–5], blends or composite films [6][7], copolymer films [8][9], nanofibers