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Effect of Conduction Gaps and Increased Collector Rotation Speed on Electrospun PCL Matrices

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1 Introduction

Electrospinning is a technique that can produce fibers in the nanoscale range. The slow degradation of PCL provides suitable mechanical stability that allows an implant to withstand physiological levels of strain [1]. Several studies have revealed a correlation between the mandrel rotation speed, fiber alignment, and tensile moduli [1]. Studies have also shown conduction gaps affect alignment, but the interaction of the two has not yet been studied [1].
The aim of this study is to examine how the conduction gaps on the collector and its combination with higher rotation speed affect the mechanical and physical properties and the fiber morphology of the resulted PCL electrospun matrices [2].

2 Methods

Sample preparation.
Two different electrospinning conditions were used.
PCL (Mw 80.000) polymer pellets were dissolved in $CH_3OH:CHCl_3$ + 0.04 % NaCl overnight at room temperature to create 11 % w/v solution. The electrospinning was set to a flow rate of 1.62 ml/h, with a 20 cm working distance. A 10 ml glass syringe with 20G needle was used to spin the solution onto the rotating collector. In the fully conductive collector condition (FC), a mandrel rotation of 200 RPM was used; in the conduction gapped collector condition (CG), electrical tape was placed across the mandrel to create gaps in conduction and a mandrel speed of 800 RPM was used.
Fiber physical characterization.
The porosity (P) of FC and CG matrices was measured using the apparent density of each sample and the density of PCL (1.145 g/cm3) [3].
Mechanical properties.
The scaffolds were cut into rectangular shapes (4.5 cm x 1.5 cm) for testing, and a uniaxial tensile test was performed under quasi-static conditions (0.1mm/s) until a strain of 150% was reached.

3 Results

Matrices consisting of nanofibers between 350 nm and 850 nm in diameter were fabricated.
There was no noticeable difference in fiber diameter obtained from the two collector conditions (p>0.05). The fibers from CG showed higher directionality than the fibers from FC (Fig 1).
The mean porosity of CG and FC samples were 92.3% and 91.0%, respectively (non-significant difference, p > 0.05).
The CG samples showed a higher tensile E-Modulus (3.74 MPa) than FC samples (3.07 MPa), p = 0.032.

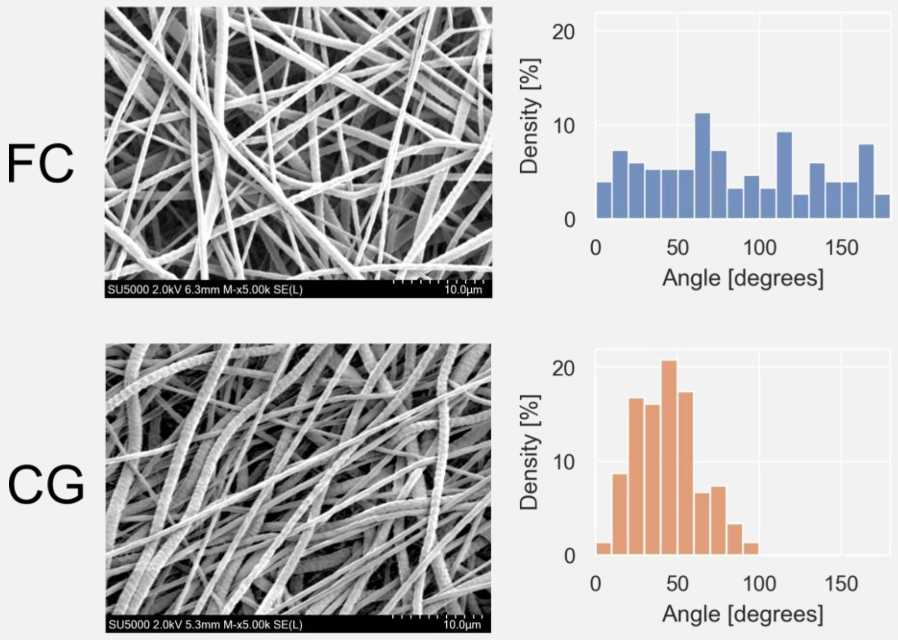

Figure 1: Fiber morphologies (Left). Distribution of fiber angles (Right).

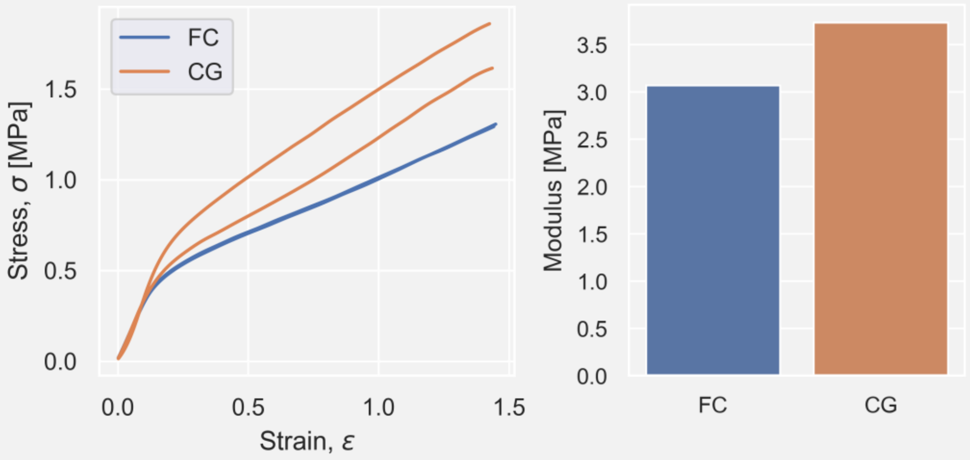

Figure 2: Left: Stress-strain curves of FC and CG samples. Right: Elastic modulus of FC and CG samples.

4 Discussion

- The introduction of conduction gaps on the collector represents a simple method to positively affect the properties of the resulting electrospun scaffolds.
- CG fibers were much more aligned than FC. This is reflected in the lower variance observed in fiber orientations (Fig 1).
- An increase in alignment yields a higher modulus for CG compared to FC.
- In contrast to other methods for enhancing fibre alignment, porosity was not decreased with CG, thus preserving favourable conditions for cell infiltration.

References

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Partner/Sponsor: ScopeM BioTrib

This work is funded by the European Union’s Horizon 2020 Research and Innovation programme under the Marie Skłodowska-Curie grant agreement No. 956004