Influence of the covalent grafting of bioactive polymers onto PCL fiber scaffolds for tissue enginnering: Surface characterization, intrinsic proprieties investigation and *In vitro* biological response

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Abstract

Electrospinning, an electrostatic fiber fabrication technique has evinced more interest in recent years due to its versatility and potential for applications in diverse fields especially in tissue engineering.[1] Polycaprolactone (PCL) polymer has been approved for biomedical application and offers excellent mechanical properties and slow biodegradation, making it an appropriate material for use as a scaffold for tissue engineering.[2] Previous studies carried out in our laboratory have shown that the covalent "grafting from" of polymers or copolymers bearing anionic groups such as sulfonate, carboxylate and phosphonate can favor cell adhesion and differentiation.[3-4] Various PCL fiber scaffolds (PFSc) with different microstructures were prepared by electrospinning. The grafting of bioactive polymers on PFSc was carried out using two "grafting from" techniques; (i) Thermal grafting which requires a surface activation by ozonation and (ii) UV grafting with or without surface activation.[5] Toluidine blue (TB) colorimetric method, Fourier-transform infrared spectra (ATR-FTIR), contact angle measurement, scanning electron microscopy with Oxford energy dispersive spectroscopy (SEM-EDS) and x-ray photoelectron spectroscopy (XPS) were applied to characterize the surfaces and confirm the successful grafting of ionic polymers onto the PFSc . In addition, possible changes in the intrinsic properties PCL have been studied using mechanical characterization, size exclusion chromatography (SEC), and differential scanning calorimetry (DSC). Finally, *In vitro* assay experiments were carried out to observe the L929 fibroblast cell behavior on these functionalized PFSc exhibiting different degrees of surface hydrophilicity (hydrophobic, hydrophilic and super-hydrophilic). This study shows the elaboration of various PCL fiber scaffolds, their functionalization by the grafting of various bioactive polymers and the appreciation of the mechanical and microstructural changes. The *in vitro* biological assays have shown that depending on the microstructure type of the PFSc, its surface functionalization by different polymers and its surface hydrophilicity, different cell behaviors can be observed.

Table 1. Grafting rates and contact angles for ungrafted and various grafted PCL fiber scaffolds.

	Grafting rate (mol.g^{-1})	Contact angle (°)
Ungrafted PCL scaffold	$(1.56 \pm 0.34) \times 10^{-6}$	123 ± 2.5
Thermal grafted 1 h – Oz 20 min	$(2.14 \pm 0.29) \times 10^{-5}$	68.4 ± 1.9
Thermal grafted 3 h – Oz 20 min	$(9.49 \pm 0.18) \times 10^{-5}$	0
UV grafted 1 h – Oz 20 min	$(1.06 \pm 0.15) \times 10^{-4}$	0
UV direct grafted 1 h	$(4.37 \pm 0.14) \times 10^{-5}$	34.3 ± 3.9

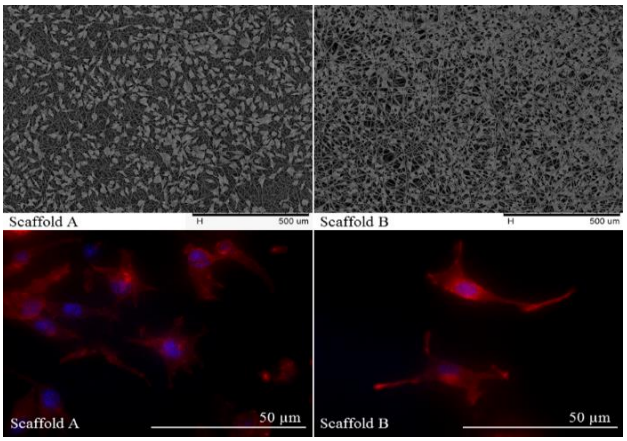


Fig. 1. SEM micrographs and fluorescent imaging at day 7 of fibroblast seeded 2 different PCL scaffolds (A: fiber diameter 0.72 µm ± 0.4, B: fiber diameter 3.28 µm ± 0.3) UV direct grafted 1 h.

References

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Gana Amokrane is graduated in Dental surgery at the faculty of medicine of Algiers (ALGERIA, 2014) and completed his master's degree in biomaterials at the University of Paris 13 (FRANCE, 2016). He is currently a third year PhD student in biomaterials science with the Laboratory of Biomaterials For Health (laboratoire de biomatériaux pour la santé LBPS) based at the University of Paris 13 (France). His work involves the elaboration of various polycaprolactone fiber scaffolds by electrospinning and their functionalization by the covalent "grafting from" of bioactive polymers bearing anionic groups in order to produce biodegradable functionalized scaffolds for use in tissue engineering applications. He has 2 published and 1 submitted journal articles and has ongoing projects on polymeric, metalic and ceramic dental biomaterials.
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