Electrospun nanofibers of PLGA-EPE Blends: Influence of EPE on surface properties and degradation

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Introduction: Extracellular matrix mimicking electrospun nanofibers have been extensively studied as scaffolding systems for tissue engineering applications. The surface modification of such nanofibrous scaffolding systems is of significance as it can potentially enable the modulation of cell behavior on such scaffolding systems. Conventional surface modification techniques such as chemical treatment and high energy radiation enables the modification of surface but at the expense of bulk degradation especially so for electrospun nanofibers. Therefore, blending can be an effective way of engineering new nano- and micro-structured materials with improved properties. In this study a triblock copolymer poly(ethylene glycol) block-poly(propylene glycol)-block-poly (ethylene glycol) (EPE) (pluronic PE 6800) a non ionic surfactant was blended in small proportions (0.5-2.0 %) with PLGA/PLA for the synthesis of electrospun nanofiber with controlled surface hydrophobicities. This report focuses on understanding the influence of blended EPE into PLGA/PLA nanofibers on the in vitro degradation of these nanofibrous scaffolds.

Methods: Blends of PLGA (85:15 - *M*w 45000-70000) / PLGA (75:25 - *Mw* 90,000-126,000) (22-20% w/v) PLA (*Mw* 85000-160,000) (15%w/v) with varying content (0.5-2.0 %) of EPE (*Mn* 14,600) were electrospun into nanofibers. The surface morphology and diameter of nanofibrous scaffolds before and after degradation were characterized by scanning electron microscopy (SEM). The hydrophilicity of the nanofibrous scaffolds was characterized using a contact angle measuring goniometer. Fourier transform infrared spectroscopy (FTIR) and nuclear magnetic resonance (NMR) were used to study the polymer chain interactions between PLGA and EPE. In order to better understand the degradation behavior of the blended nanofibrous matrices, in vitro studies were conducted in cell culture media (with and without FBS) and PBS buffer for 120 days.

Result/Discussion: **N**anofibers of PLGA/PLA blended with EPE having diameters ranging from 200-800 nm were synthesized by electrospinning. The contact angle measurement demonstrated that the incorporation of EPE enabled a significant increase in hydrophilicity with increase in content from 0.5-2.0% w/w (data not shown). A major consequence of decrease in hydrophobicity could potentially influence protein adsorption. Therefore, selective agglomerations of fetal bovine serum (FBS) proteins were observed on fibers surface (EDAX study) (figure 2).

Figure 1: Purposed model of polymer chain interaction between PLGA and EPE

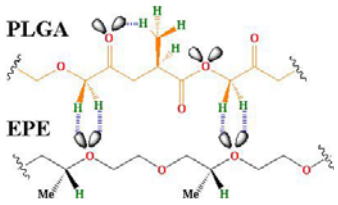

Figure 2: SEM of protein adsorption on PLGA-EPE 1% nanofiber in different media at day 7.

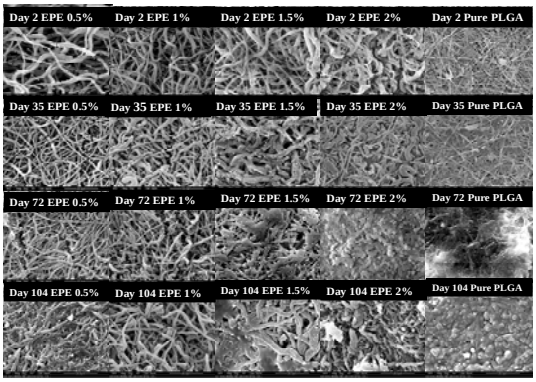

Figure 3: Degradation study of PLGA-EPE (varying concentrations) in FBS containing DMEM media

These results demonstrated that controlled hydrophobicity/hydrophilicity is probably a better choice for controlled protein adsorption. The degradation study was conducted in DMEM medium (with and without FBS) and PBS buffer for 120 days (figure 3). The results demonstrated slow degradation, fiber swelling (5 fold) and water holding capacity (110-240 %) of EPE containing PLGA matrixes. Further, FTIR and NMR analysis revealed the presence of inter-polymeric chain interaction between PLGA and EPE (figure 1) which could be speculated as the reason for change in conformation and as a consequence change in physical properties of the blended nanofibrous system.

Conclusion: These studies demonstrated that molecular interaction between PLGA and EPE can enable control on the surface properties of electrospun nanofibrous scaffolds. The control on the hydrophobicity/hydrophilicity in turn influences protein adsorption and water holding capacity and degradation behavior that can be of significance in tissue engineering applications.

References:

1. Zuwei Ma, Colloids Surf B Biointerfaces. 2007; 60:137-157.