Photo-Chemical Treatment of Electrospun Nano/Micro-Fibrous Scaffolds for Generation of Functionalized Surfaces

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Statement of Purpose: Electrospun nano/micro-fibers of synthetic polymers have been extensively explored as extracellular matrix mimicking fibrous scaffolding systems in tissue engineering applications. Further, it is well understood that the surface properties of biomaterial-based scaffolds can significantly influence the cellular response to these biomaterials. Therefore, surface engineering of electrospun nano/micro-fibrous scaffolds to enable favorable cell response would be highly desirable. Conventionally used chemical and high energy radiation methods when applied to polymeric nano/micro-fibers are not limited to the surface of nano/micro-fibers and lead to mass degradation of the scaffold. Hence, in this work we have employed controlled photo-chemical treatments for the surface modification of 3-D polymeric nano/micro-fiber-based scaffolds that enables the chemical as well as physical surface modification of nano/micro-fibers while preserving their overall structure.

Methods: Poly(lactide-co-glycolide) (PLGA) (85:15 - *M*w 45000-70000) was used to synthesize three dimensional nano/micro-fibrous scaffolds using the electrospinning technique for photo-chemical treatment. The PLGA nano/micro-fiber matrices were dipped in hydrogen peroxide (30%) then irradiated with UV light generated from a high pressure mercury lamp (200W, 254 nm) for controlled surface erosion[1]. The photo-chemically treated matrices were analyzed by Scanning Electron Microscopy and the duration of treatment was optimized so as to enable controlled surface erosion. An aqueous acrylic acid solution (10%) was used for graft polymerization to enable functionalization of the nano/micro-fibers with a –COOH functionality under UV radiation (210 nm). Atomic force microscopy (AFM) was used to characterize surface morphology, Fourier transform infrared spectroscopy (FTIR) and Toluidine Blue absorbance assay was used for detection and quantification of functionality and contact angle measurement was used for characterization of surface hydrophobicity / hydrophilicity.

Results: As shown in **figure 1**, the scanning electron micrographs of the photo-chemically treated PLGA nano/micro-fibers demonstrated an increase in surface roughness as well as diameter as compared to the untreated PLGA nano/microfibers. The results were further corroborated by the AFM analysis that also demonstrated an increase in surface roughness post functionalization (data not shown). The FTIR study (**figure 2**) shows increased presence of free –OH group as a consequence of acrylic acid grafting. Further, the –COOH functionalities were quantified using the toluidine blue absorbance assay and the results demonstrated that the acrylic acid grafted nano/micro-fiber surfaces showed a three to four fold increase in –COOH as compared to ungrafted PLGA nano/micro-fibers. The presence of free –COOH groups on the surface of nano/micro-fibers also led to a significant decrease in surface hydrophobicity which was studied using a contact angle measuring goniometer (data not shown). The functionalized matrices demonstrated an almost instantaneous spreading of the water droplet while the untreated control (PLGA nano/micro-fibers matrices) did not show a spreading in the water droplet for a duration of 30 minutes which further corroborates the previous result of increased –COOH functionality (i.e. improved hydrophilicity).

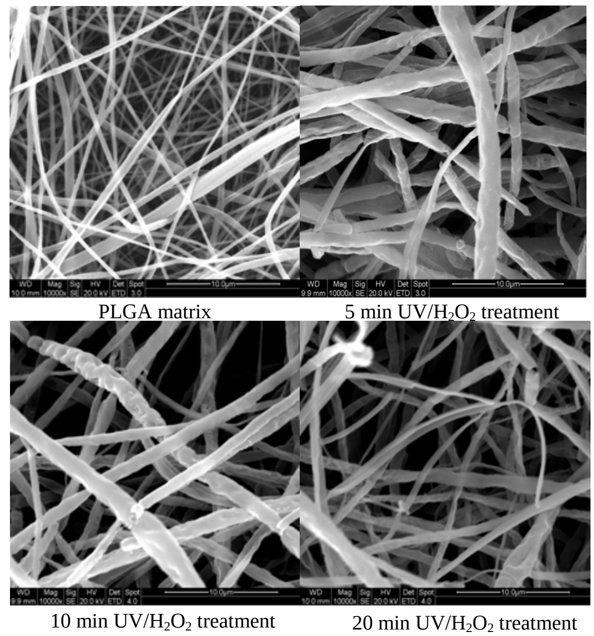

Figure 1: Scanning Electron Micrographs of photo-chemically treated and untreated electrospun PLGA nano/micro-fibrous matrices

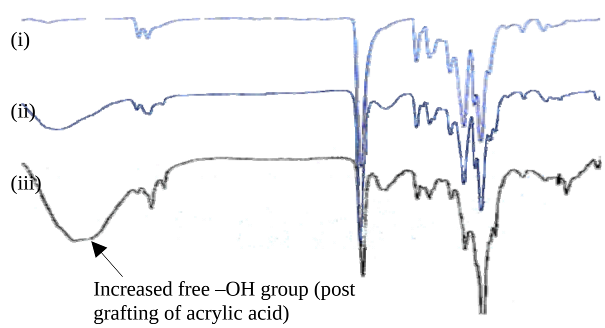

Figure 2: FTIR Spectra of (i) Pure PLGA, (ii) UV/H_2O_2 treated PLGA, and (iii) PLGA-Acrylic acid

Conclusion: From these studies we can conclude that controlled photo-chemical treatment can be effectively used for the functionalization/surface modification of 3-dimensional nano/micro-fibrous scaffold. Further, these functionalized scaffolds can potentially be used for immobilization of proteins that can have implications in tissue engineering applications.

References: [1] Ma Z. Euro Polym J 2002;38:2279-2284.