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Simultaneous fiber formation and surface modification of electrospun polymers with a bioactive peptide conjugate

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Surface modification of polymer nano/microfibers with bioactive functional groups has recently become a rapidly expanding research topic, since it provides for the possibility of bioactive materials designed for functional textiles, responsive membranes and biomedical devices (e.g., tissue engineering scaffolds). A novel single-step surface modification strategy has been successfully developed and implemented by co-electrospinning poly(ethylene oxide) (PEO) and a peptide conjugate that possesses a large polarizability. The resultant polarizability contrast enables the sequence-defined oligopeptide conjugate (C3PO) to carry bioactive species to the fiber surface during fiber formation, thereby precluding the need for post-fiber modification. The mobility of the conjugate is attributed to dielectrophoresis in the presence of a high electric field and electric field gradient. In order to improve the fiber properties, electrospinnability and surface modification, poly(methyl methacrylate) (PMMA) has been introduced into the system since it is partially miscible with PEO. Binary blends of PEO and PMMA, as well as ternary blends of PEO, PMMA and a Fluorescein-labeled conjugate (FC3PO), have been electrospun into fibers to elucidate the effect of composition on the extent of surface modification. X-ray photoelectron spectroscopy (XPS) measurements of nitrogen on the surface of the fibers confirms that, due to a larger dielectric constant difference and less hydrogen bonding, PMMA provides for greater surface enrichment of the peptide. Addition of PEO, however, improves electrospinnability and the mechanical properties of the resultant fiber mat. Optimization of surface modification, mechanical properties and electrospinnability has been achieved by systematically investigating the composition of the ternary blends. The surface modification strategy introduced here not only provides fundamental insight into the electrospinning process and its effect on polymer blends that can phase-separate in the presence of an electric field, but also renders a promising perspective for the expedient production of polymer nano/microfibers with bioactive surface species.

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