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Functionally Modified Melt-Electrospun Thermoplastic Polyurethane (TPU) Mats for Wound-Dressing Applications

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Abstract : A wound dressing material is designed to facilitate wound healing and minimize scarring. An ideal wound dressing material should protect the wound from any contaminations of exogeneous microorganism. In addition, the dressing material should provide a moist environment through extraction of body fluid from the wound area. Recently, wound dressing electrospun nanofibrous membranes are produced by electrospinning from a polymer solution or a polymer melt. These materials have a great potential as dressing materials for wound healing because of superior properties such as high surface-to-volume ratio, high porosity with excellent pore interconnectivity. Melt electrospinning is an attractive tissue engineering scaffold manufacturing process which eliminated the health risk posed by organic solvents used in electrospinning process and reduced the production costs. In this study, antibacterial wound dressing materials were prepared from TPU (Elastollan 1185A) by a melt-electrospinning technique. The electrospinning parameters for an efficient melt-electrospinning process of TPU were optimized. The surface of the fibers was modified with poly(ethylene glycol) (PEG) by radio-frequency glow discharge plasma deposition method and with silver nanoparticles (nAg) to improve their wettability and antimicrobial properties. TPU melt-electrospun mats were characterized using SEM, DSC, TGA and XPS. The cell viability and proliferation on modified melt-electrospun TPU mats were evaluated using a mouse fibroblast cell line (L929). Antibacterial effects of theirs against both Staphylococcus aureus strain and Escherichia coli were investigated by disk-diffusion method. TPU was successfully processed into a porous, fibrous network of beadless fibers in the micrometer range (4.896±0.94 µm) with a voltage of 50 kV, a working distance of 6 cm, a temperature of the thermocouple and hot coil of 225–230ºC, and a flow rate of 0.1 mL/h. The antibacterial test indicated that PEG-modified nAg-loaded TPU melt-electrospun structure had excellent antibacterial effects and cell study results demonstrated that nAg-loaded TPU mats had no cytotoxic effect on the fibroblast cells. In this work, the surface of a melt-electrospun TPU mats was modified via PEG monomer and then nAg. Results showed melt-electrospun TPU mats modified with PEG and nAg have a great potential for use as an antibacterial wound dressing material and thus, requires further investigation.

Keywords : melt electrospinning, nanofiber, silver nanoparticles, wound dressing
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