Coaxial fibers of poly(styrene-co-maleic anhydride)@poly(vinyl alcohol) for wound dressing applications: Dual and sustained delivery of bioactive agents promoting fibroblast proliferation with reduced cell adherence

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Abstract

The prevalence of chronic and acute wounds, as well as the complexity of their treatment represent a great challenge for health systems around the world. In this context, the development of bioactive wound dressings that release active agents to prevent infections and promote wound healing, appears as the most promising solution. In this work, we develop an antibacterial and biocompatible wound dressing material made from coaxial electrospun fibers of poly(styrene-co-maleic anhydride) and poly(vinyl alcohol) (PSMA@PVA). The coaxial configuration of the fibers consists of a shell of poly (styrene-co-maleic anhydride) containing a variable concentration of silver nanoparticles (AgNPs) 0.1–0.6 wt% as antibacterial agent, and a core of PVA containing 1 wt% allantoin as healing agent. The fibers present diameters between 0.72 and 1.7 µm. The release of Ag^+ in a physiological medium was studied for 72 h, observing a burst release during the first 14 h and then a sustained and controlled release during the remaining 58 h. Allantoin release curves showed significant release only after 14 h. The meshes showed an antibacterial activity against Pseudomonas aeruginosa and Bacillus subtilis that correlates with the amount of AgNPs incorporated and the release rate of Ag^+. Indeed, meshes containing 0.3 and 0.6 wt% of AgNPs showed a 99.99% inhibition against both bacteria. The adherence and cell viability of the meshes were evaluated in mouse embryonic fibroblasts NIH/3T3, observing a significant increase in cell viability after 72 h of incubation accompanied by a reduced adhesion of fibroblasts that decreased in the presence of the active agents. These results show that the material prepared here is capable of significantly promoting fibroblast cell proliferation but without strong adherence, which makes it an ideal material for wound dressings with non-adherent characteristics and with potential for wound healing.

Author keywords
Allantoin; Coaxial fibers; Electrospinning; Silver; Wound dressings