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Abstract

Fabrication of Novel Electroconductive PAN/PEDOT:PSS Nanofibers for Osteochondral Tissue Regeneration †

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Osteochondral tissue (OCT) diseases, particularly osteoarthritis, are among the most prevalent in the adult population worldwide. Current clinical treatments have failed to properly address this issue, being often plagued by poor long-term efficacy. As a result, OC tissue engineering (OCTE) strategies emerged as a promising alternative to the current methods, aiming to develop scaffolds capable of replacing damaged OCT and promoting its regeneration. Although the electrical properties of OCT have been extensively reported in different studies, as well as their important effects on several cellular processes, they keep being neglected in the design of novel OCT scaffolds. Thus, in this work we developed novel heat-treated PAN/PEDOT:PSS-based conductive electrospun scaffolds capable of mimicking the electroconductive nature of OCT's fibrous extracellular matrix (ECM) and providing an advanced platform for applying exogenous electrical stimuli. Different polar solvents (DMSO and cyrene), as well as sulfuric acid, were used as doping agents to enhance the electrical conductivity of the fibrous scaffolds. Given the complex structural, compositional, and electrical gradients present within the OCT, the electroconductive scaffolds were optimized to replicate the subchondral bone region of the OCT. The nanofibers were functionalized through the addition of a mineral coating produced by incubation in simulated body fluid (SBF). The combined heat and sulfuric acid treatments were found to successfully generate electroconductive fibers, with peak conductivity being registered for the scaffolds constituted by DMSO-doped 1%wt PEDOT:PSS. Although these annealing and doping processes were found to significantly weaken the mechanical properties of the scaffolds, the resulting fibers exhibited high hydrophilicity. The post-processed fibers were also successfully mineralized in SBF. Moreover, the mineral apatite-like coating was found to significantly improve the biocompatibility of the electroconductive scaffolds, which translated to augmented proliferation of human bone marrow mesenchymal stem/stromal cells. The generated fibers could potentially be integrated in a novel hierarchical scaffold for OCT regeneration.

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