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Electrospun Fibre Networks Loaded with Hydroxyapatite and Barium Titanate as Smart Scaffolds for Tissue Regeneration

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Abstract : The field of tissue engineering has expanded its potential due to the use of composite biomaterials belonging to increasingly complex systems, leading to bone substitutes with properties that are continuously improving to meet the patient's specific needs. Furthermore, the development of biomaterials based on ceramic and polymeric phases is an unlimited resource for future scientific research, with the final aim of restoring the original tissue functionality. Thus, in the first stage, composite scaffolds based on polycaprolactone (PCL) or polylactic acid (PLA) and inorganic powders were prepared by employing the electrospinning technique. The targeted powders were: commercial and laboratory synthesized hydroxyapatite (HAp), as well as barium titanate (BT). By controlling the concentration of the powder within the precursor solution, together with the processing parameters, different types of three-dimensional architectures were achieved. In the second stage, both the mineral powders and hybrid composites were investigated in terms of composition, crystalline structure, and microstructure so that to demonstrate their suitability for tissue engineering applications. Regarding the scaffolds, these were proven to be homogeneous on large areas and loaded with mineral particles in different proportions. The biological assays demonstrated that the addition of inorganic powders leads to modified responses in the presence of simulated body fluid (SBF) or cell cultures. Through SBF immersion, the biodegradability coupled with bioactivity were highlighted, with fiber fragmentation and surface degradation, as well as apatite layer formation within the testing period. Moreover, the final composites represent supports accepted by the cells, favoring implant integration. Concluding, the purposed fibrous materials based on bioresorbable polymers and mineral powders, produced by the electrospinning technique, represent candidates with considerable potential in the field of tissue engineering. Future improvements can be attained by optimizing the synthesis process or by simultaneous incorporation of multiple inorganic phases with well-defined biological action in order to fabricate multifunctional composites.

Keywords : barium titanate, electrospinning, fibre networks, hydroxyapatite, smart scaffolds
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