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Electrospun PHA Fibrous Architectures for Localized Delivery of Photosensitizers

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Introduction

Photodynamic Therapy (PDT) is a promising alternative for the treatment of cancer, being a minimally invasive and localized therapy. PDT is based on the combined action of three agents, namely photosensitizers (PSs), light source and molecular oxygen, which will generate reactive oxygen species able to promote cell death [1].

Electrospinning is a versatile and feasible technique able to produce ultrafine continuous polymeric fibers. Electrospun nanofibers exhibit very interesting properties to act as localized and controlled release systems of PSs, thereby improving the efficiency of PDT and minimize its side effects. Polymeric nanofibers can be prepared from synthetic or natural polymers. Currently, the use of biopolymers has been increasingly researched for medical applications due to their inherent properties, such as biocompatibility and biodegradability [2]. Polyhydroxyalkanoates (PHAs) are natural and non-toxic biopolyesters produced by microorganisms with remarkable properties for the next generation of sustainable materials. Gelatin (Gel) is a natural, biodegradable polymer formed by the incomplete hydrolysis of collagen from animal skin, muscle and bone [3]. Furthermore, the use of biodegradable polymers to produce these drug delivery systems allows an effective drug release as well as avoids its surgical removal at the end of its therapeutic lifetime [2].

The main objective of this work is the development and optimization of solution and process parameters for the production of electrospun nanofibers, based on biodegradable polymers, to act as localized drug delivery systems for cancer PDT.

Methodology

In order to obtain defect-free nanofibers, different parameters of solution and process were evaluated, including the concentration of PHA, the solvents used, the applied voltage, the flow rate, the distance between the needle and the collector and the needle diameter. The optimized polymeric solutions were prepared according to the scheme in Figure 1.

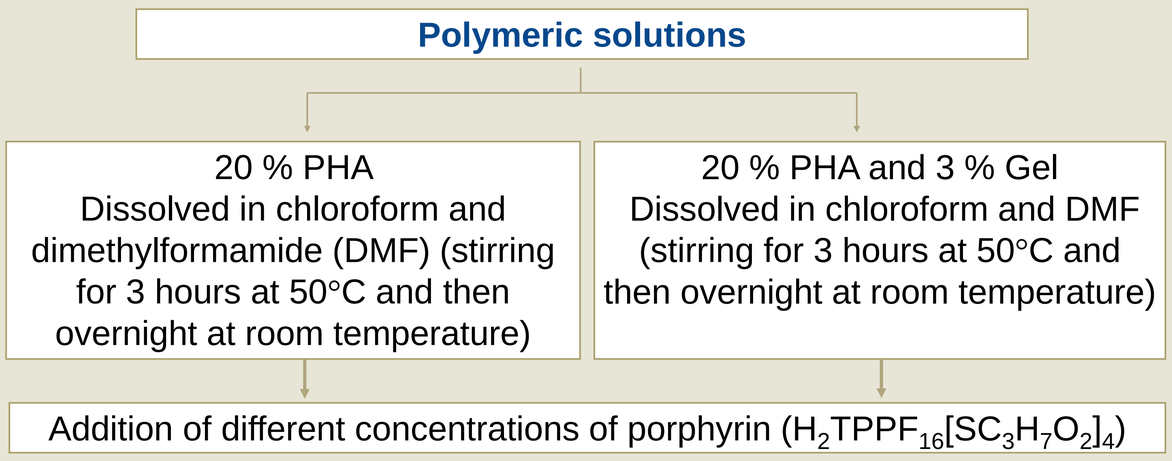


Figure 1: Polymeric solutions to be used in electrospinning.

The solutions were electrospun in an electrospinning NF 103 equipment from MECC.

Results

Both PHA and PHA-Gel solutions allowed the production of uniform and defect-free nanofibers (Figure 2). However, PHA nanofibers revealed a WCA of 155º, while the addition of Gel promoted a decrease in hydrophobicity, showing a WCA of 123º, which is beneficial for biomedical applications. Afterwards, porphyrin compound was incorporated into both nanofibers. As an example, Figure 2f demonstrates the GSDR spectra of PHA and PHA-Porphyrin nanofibers, where it was possible to observe the typical absorption bands of this compound (Soret and Q bands), confirming its successfully incorporation into the membranes.

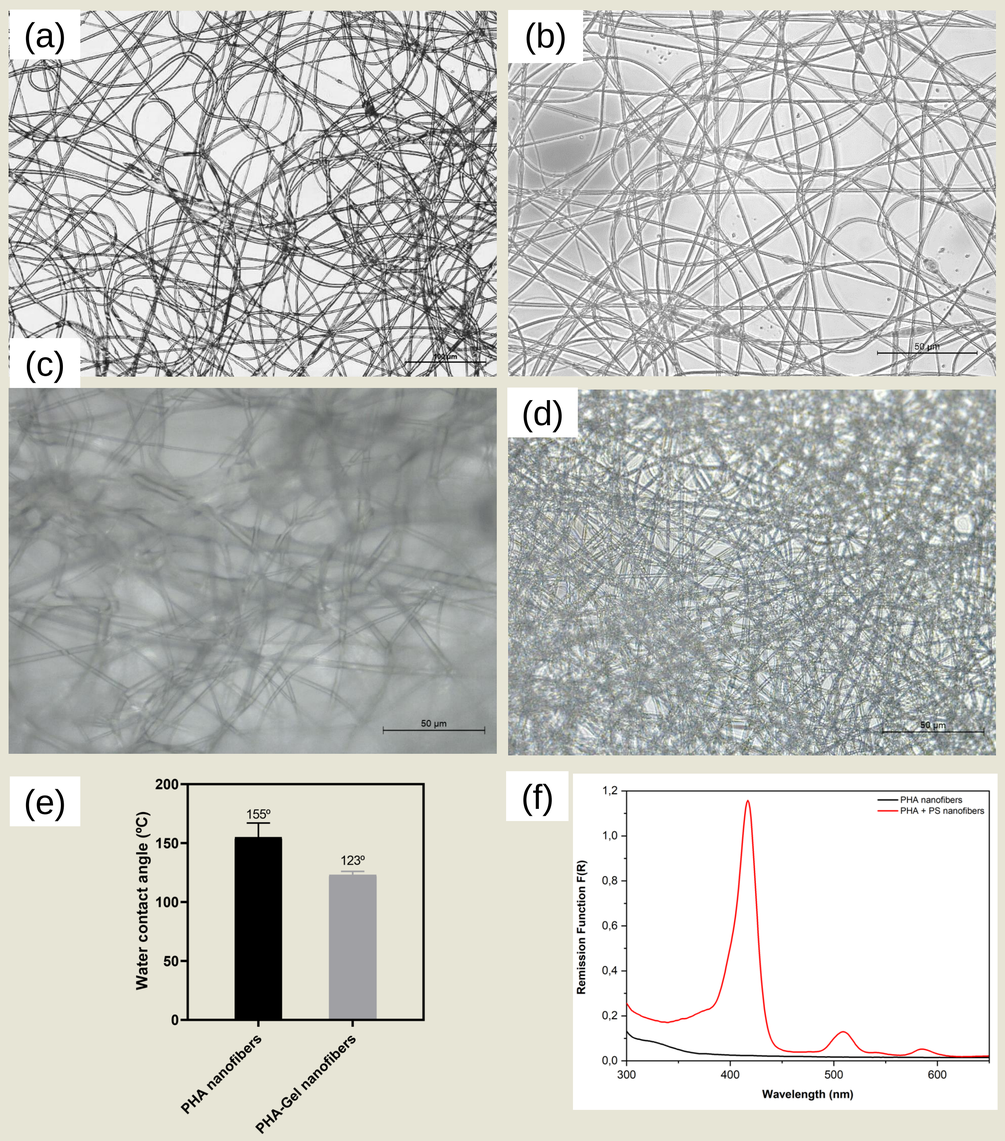


Figure 2: Optical microscopy images of **(a)** PHA, **(b)** PHA-Gel, **(c)** PHA+Porphyrin and **(d)** PHA-Gel+Porphyrin nanofibers. **(e)** Water contact angle of PHA and PHA-Gel nanofibers. **(f)** Ground State Diffuse Reflectance (GSDR) of PHA and PHA+Porphyrin nanofibers.

Conclusions

This study demonstrated the successfully production of defect-free nanofibers with PHA by electrospinning. The addition of Gel increased hydrophilicity of the membranes, which can be beneficial for cell compatibility. Moreover, the incorporation of porphyrin into electrospun nanofibers was also successfully performed. More tests will be performed in order to evaluate the potential of these membranes to act as DDS for PDT.

References:

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