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Plasma Modification of Pre-Electrospinning PCL Polymer Solutions

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Electrospinning is a versatile and reliable method to produce nanofibers. Nanofiber-based materials have several advantages compared to conventional textiles. In particular, these materials have an ultrahigh surface-to-volume ratio combined with excellent mechanical properties. As a result, electrospun nanofibers are expected to be promising candidates in various fields, such as filtration, drug release, tissue engineering,…To manipulate the electrospinning process, various parameters, such as voltage, humidity, solution flow rate,can be altered. The greatest challenge in electrospinning is the preparation of a suitable polymer solution because the system requires a balance of forces controlled by viscosity, conductivity and surface tension. In many cases, researchers have been using several additives in order to make polymer solutions compatible with the electrospinning process. Within this work, a non-thermal atmospheric pressure plasma jet generated directly in the polymer solution itself will be explored trying to improve electrospinnability and nanofiber quality. Such a plasma set-up allows a close, intense contact between the plasma jet and the polymer solution which could lead to a very efficient effect on the quality of the resultant fibers. Within this work, a 5% PCL solution in a mixture of Chloroform and N,N-dimethylformamide (DMF) in a ratio of 9:1 is used. Before plasma treatment, it was found that the solution conductivity is very low (around 0.5 μS/cm). During the electrospinning of the untreated solution the produced nanofibers were ultra-thin with a large amount of beads. After testing the untreated solution, different plasma modifications with varying exposure times (1-5 minutes) were conducted. It was found that after plasma treatment, the beads completely disappear obtaining more uniform fibers with a higher oxygen content. In addition, it was observed that solution conductivity and viscosity gradually increased with plasma exposure time. Chemical studies of the treated solutions are currently ongoing to unravel the plasma-polymer solution interactions. It can already be concluded that plasma treatment presents a very efficient method to improve the electrospinnability of polymer solutions, which can open the door to new possible applications of electrospun materials.

Keywords
Electrospun nanofibers
atmospheric plasma in-liquid