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Research Article

Tailoring the Morphological Properties of PVA Nanofibrous Mats by Manipulating Working Planes

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Despite the process, solution, and ambient parameters of the electrospinning technique have been intensely studied, the effects of different setup orientations have not been thoroughly investigated. In many research studies, the attempts on electrospinning of polyvinyl alcohol have been performed with a horizontal electrospinning or researchers have not even mentioned the setup orientation. This paper examines the morphological properties of polyvinyl alcohol-based fibrous mats electrospun with the same apparatus and identical process and solution parameters but with different working planes, namely, (x)-axis, (+y) axis, and (−y) axis. From the test results, it is concluded that the (−y) axis is the most versatile working plane because fibrous mats have the finest nanofiber diameters with the lowest diameter variation, the medium-level pore area with the smallest pore sizes. Besides, the highest packing density and highly deposited structure with the longest fibers with a high aspect ratio are constructed in this setup orientation. (−y) axis electrospinning is more favorable than that of other working planes for polyvinyl alcohol-based permeable membranes and biostructures.

1. Introduction

Electrospun surfaces have been widely used due to their lightweight and functional properties. The functionality of these surfaces is based on their complex structures resulted from fiber entanglement, and continuity of each individual fiber acts an important role in dispersion of desired functionality in the unit area. Electrospinning is a simple and versatile technique needing only a few apparatus for fibrous mat manufacturing. The basic components of an electrospinning setup are a collector for fiber deposition as an output material, a feeding unit for continuous flow of polymer solution/melt as an input material, and a high voltage source for supplying adequate electrostatic field to stretch polymer jet. With the help of continuous polymer solution/melt feeding and triggering of electrical forces, the polymer jet reshaping from a spherical to a conical configuration reaches the collector and fibers which are micro or nano in size are deposited on the collector as a fiber mat [1–4]. Many studies report that solution parameters, ambient conditions, and process parameters have important effects on the characteristic properties of the electrospun mat [3, 5–18].

In the electrospinning process, spinnability of polymer solution/melt can be possible if applied voltage overcomes the various forces affecting the fluid such as surface tension, gravitational force, and coulomb repulsion force [19, 20]. Among these forces, surface tension and Coulomb repulsion force are related to solution parameters and manipulated by the applied voltage and feeding rate because the surface area of an electrospinnable fluid is increased by repulsion force but unfortunately reduced by surface tension [21]. However, gravitational force is out of these aspects and can contribute or limit the spinnability with respect to the setup orientation.