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A Review on Electrospun Short Fiber Production

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Abstract: Nanotechnology has become the interest of researchers in recent years for their unique properties of submicron scale materials. Nanotechnology also consists of nanofibers made from natural or synthetic polymers which can be electrospun into ultra-thin continuous fibers. These nanofibers are versatile as it can be found in various applications such as in filtration, affinity membranes, tissue engineering, biosensors, scaffolds, drug delivery and fiber reinforcement. Over the years, many researchers have reported various methods used to produce short electrospun fiber by means of ultrasonication, mechanical cutting, UV cutting, precipitation method, microtome cutting, cryo-microcutting, cryogenic milling, ball milling, and razor blade cutting under liquid nitrogen. The aim of this paper is to provide a review on electrospun short fiber production which elaborates more on the scission methods of the continuous as-spun fibers. The literature shows that several methods have been proposed and utilized, with varying degrees of success. Overall, it can be concluded that further research is needed to fully understand the complexities of this area and to develop a more effective approach.

Keywords: Electrospinning, short fiber, scission, nanofiber

1. Introduction

Short polymer fibers with a diameter and length of submicron are intriguing the research community due to its unique attributes which provides opportunities for a various application. It can be used as reinforcements for brittle materials by altering the mechanical propeties of a composite material as well as ease of molding. Short fibers or more specifically, short nanofibers, can be applied even in the biomedical field such as drug delivery capsules, tissue engineering scaffolds, filtration devices, membranes, sensors[1].

Among various methods for fiber production, electrospinning is a relatively efficient way of producing continuous as-spun ultra-thin fibers with diameters down to submicron scales. The lengthy fibers requires a the secondary process to convert it into short fibers which is neither totally simple nor cost-effective and the electrospun ultrafine fibers' relatively low tensile strength[2] makes it very difficult to produce fibers with less than 200 aspect ratio by means of physical alteration [3]. Electrospinning can be used to produce fibers using natural or synthetic polymer such as collagen [4], gelatin [5], chitosan [6], poly(l-lactic acid) (PLLA) [7], poly(glycolic acid) [8], poly-ε-caprolactone (PCL) [9]. Electrospinning method requires an electric field with a high voltage to electrically charge viscous polymer solution in order to be jetted by electrical forces where the polymer will melt and the solvent molecules will evaporate prior to reaching the collector [10]. As it is then deposited on a collector, it is collected as a thin sheet of fiber mat. Further scissioning of these long thin fibers are then carried out by various methods but more predominantly, ultrasonication[11]–[16]. Among various methods available, some which are discussed in this literature include mechanical cutting [17], Ultra-Violet (UV) cutting [18], microtome cutting [19], micro cutting under liquid nitrogen [30], cryogenic milling [20], ball milling[21] and razor blade cutting under liquid nitrogen.

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