Fabrication of uniaxially aligned electrospun nanofibre using a rotating collector

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ABSTRACT – This paper is about the fabrication of aligned electrospun nanofiber based on Polyvinyl Alcohol (PVA) by using electrospinning technique with rotating collector. PVA solution was prepared by dissolved PVA powder into distilled water. This experiment was conducted at various speeds of rotating collector. PVA based nanofiber have been fabricated and characterized. The morphology of the fibres was analysed by using a Scanning Elec
tron Microscope (SEM) and ImageJ software. Form the results, 900 RPM achieved the most aligned electrospun nanofiber.

1. INTRODUCTION

Electrospinning is a simple technique to fabricate electrospun nanofiber from a polymer solution[1]. The outstanding small scale of fiber size make the nanofibers as the best applications in manufacturing sensors, military equipment, filtration, smart material, fuel cells and drug delivery [2]. The common electrospinning setup consists of high voltage power supply, syringe, needle, syringe pump and rotating collector as shown in Figure 1.1.

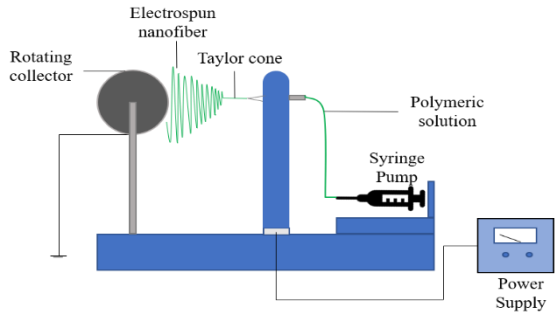

Figure 1.1 A schematic diagram of an electrospinning setup with rotating collector

The problem that occur in common electrospinning with flat plate collector is formation of random nanofiber. Electrostatic interaction of the charge causes the whipping instability during the electrospinning process. Thus, formation of aligned nanofiber can be generated by using rotating collector with suitable speed. Nowadays, medical applications are highly on demand due to its rate of healing wound efficiency. Aligned nanofibers has highly potential as efficient cardio-inductive implant for cardiac tissue [3]. Futhermore, aligned nanofiber can also heal wound due to its rapid oxygen exchange in the nanofiber. The aim of this study is to fabricate aligned nanofiber and investigate the suitable speed of rotating collector to get an aligned nanofiber.

2. METHODOLOGY

Polyvinyl Alcohol (PVA) electrospun nanofiber was produced by using electrospinning machine fabricated by UTeM students. The PVA polymer solution was prepared by dissolved 8wt% of PVA in distilled water and stirred for 4 hours by using magnetic stirrer model C-MAG HS7 (Ika Works, Malaysia). For electrospinning process, the voltage was set at 15 kV and the distance between the spinneret to the rotating collector was set at 10 cm. The speed of rotating collector was at 100, 200, 300, 400, 500, 600,700, 800, 900 and 1000 RPM for 7 minutes to each corresponding speed. Scanning Electron Microscope (SEM) Model JSM-6010PLUS/LV (Jeol Ltd., Japan) was used to examine the morphology of the fiber. ImageJ version 1.51s software (National Institutes of Health, USA) was used to analyse the degree of oriented under SEM micrograph. The degree of oriented was measure from bottom line of the SEM image as datum as shown in Figure 2.1. The average value of the degree oriented was took as the result.

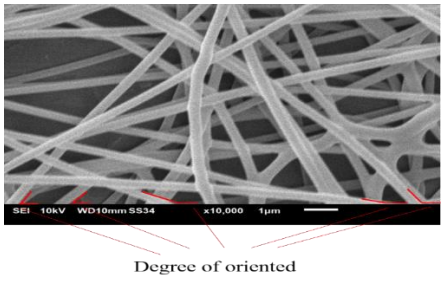

Figure 2.1 Measurement of degree of oriented

3. RESULTS AND DISCUSSION

Figure 3.1 shows a graph between degree of oriented and speed of rotating collector. The lowest degree of oriented nanofiber was 200 RPM which 73.77º while the highest degree of oriented was 500 RPM which 96.22º. The main finding of this study is to obtain an aligned nanofiber which is the nearest to 90º. Based on the result, degree of oriented electrospun nanofiber at 900 RPM was the nearest to 90º which is 90.05º. However, the random oriented were still seen on the SEM image as shown in Figure 3.2.

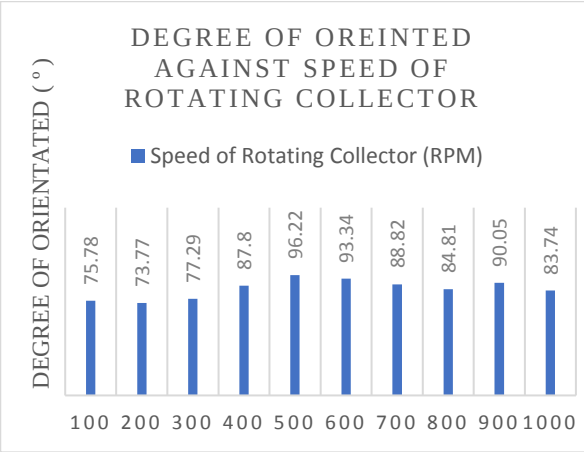

Figure 3.1 A graph between degree of oriented and speed of rotating collector

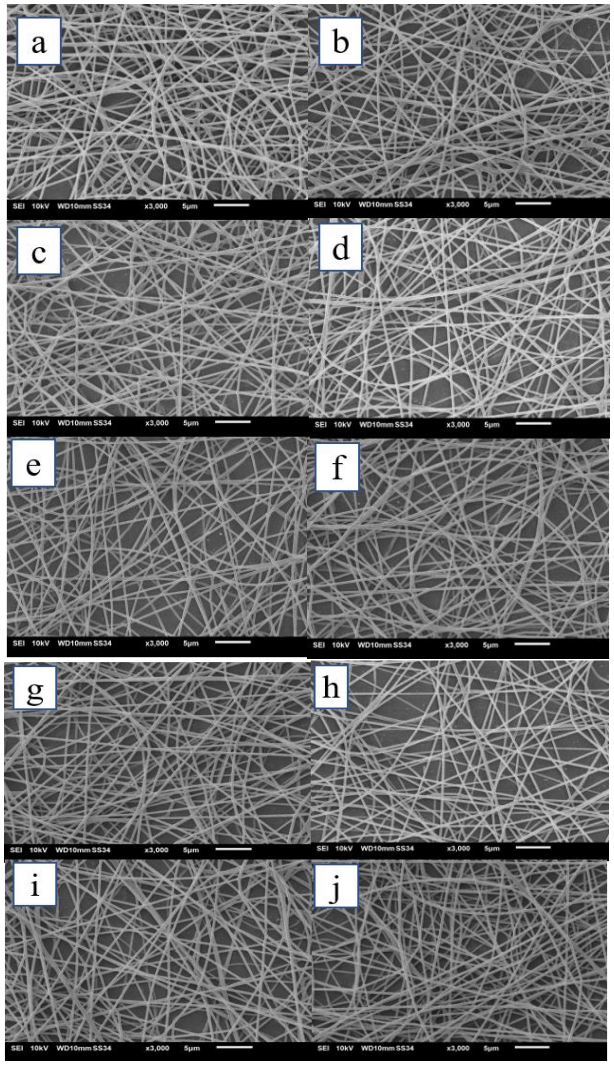

Figure 3.2 Micrograph under SEM
(a) 100 RPM (b) 200 RPM (c) 300 RPM (d) 400 RPM
(e) 500 RPM (f) 600 RPM (g) 700 RPM (h) 800 RPM
(i) 900 RPM (j)1000 RPM

H. Pan et al. stated that the rotating collector need to be at high speed in order to obtain aligned electrospun nanofiber, [4]. Thus, this study is complying from the previous research. However, 600 RPM it starts decreasing in degree of oriented. This problem occur probability from the accumulation of charge that increases at the collector as the speed of rotating collector increases. Accumulation of charge might cause interruption of the degree of oriented and deposition of nanofiber.

4. SUMMARY

In this study, the aligned nanofiber was successful fabricated from PVA polymer by using electrospinning process with rotating collector. SEM and Image J software was used to scan the electrospun nanofiber and measure degree of oriented nanofiber. Based on the result, it shows that speed of rotating collector at 900 RPM is the most suitable speed to obtain aligned electrospun nanofiber as its degree oriented was nearly to 90º.

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