COMPARISON OF THE COLLECTING HEADS EFFICACY USING ELECTROSPINNING METHOD

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Abstract

Nowadays nanofibers become an integral part of any field of science. One of the most popular methods for producing nanofibers is electrospinning. In our research work, we also used this method. Traditional static collector was replaced with rotating consisting of several metal bars which have been placed in a circle [3]. In these way metallic elements catches nanofibers like tradition collector and wounds it. In the end we eventually obtained layer consisting of parallel directed nanofibers. Further the material is collected and sent to the post-processing. It is planned to be used in medicine, in particular for producing implants for treating glaucoma disease.

Experimentally it was revealed that the shape, size, material of which the rods of the collecting head play an important role on the fiber collection efficiency. This article describes an experiment in which several different types of collecting heads were used. The experiment was conducted at the same temperature and humidity. Polyvinyl alcohol was used as the polymer solution.

Keywords: Electrospinning, nanofibers, oriented structure, efficacy

1. INTRODUCTION

Electrospinning is a technology to produce nanofibers. This technology allows the production of various nanofibers or microfibers. The electrostatic forces acting on the polymer solution causes the production of nano or micro fibers [1].

This article deals with the production of parallelized nanofibers by the electrospinning technology from the polymer solution. To achieve an oriented structure of the resulting layer, it is necessary to use special collector. Using the rotating carousel is very simple and recognized method [2].

However, experimentally it was revealed that the shape, size, material of which the rods of the collecting head play an important role on the fiber collection efficiency.

2. EXPERIMENTAL PART

We have produced 6 different rotating heads to conduct this experiment. Various kinds and various forms of metal rods have been used. The experiment was conducted at the same temperature and humidity. On the **Figure 1(a - f)** are shown six heads which were used for our experiment.

Functional prototype was tested in the laboratory with different types of collecting heads. Oriented structures were obtained from polyvinyl alcohol polymer solution.

(a): Cylindrical brass bars 4mm diameter

(b): Rectangular aluminium bars 20mm width; sandblasted; rounded tops

(c): Rectangular aluminium bars 20mm width; sandblasted; rounded tops; sharpened edges

(d): Rectangular aluminium bars 20mm width; sandblasted

(e): Cylindrical aluminium bars 10mm diameter; sandblasted

(f): Cylindrical aluminium bars 10mm diameter

Figure 1(a-f) Different types of collecting heads

2.1. Material

Polyvinyl alcohol (PVA; Mw:130 000 g/mol) was obtained from Sigma Aldrich. Polymer solution was prepared from PVA dissolved in hot distilled water (90°C) for 24 hours to achieve complete dissolution. Concentration of solution was 12wt.%. Before electrospinning, the solution was cooled to the room temperature.

2.2. Electrospinning

Electrospinning was carried out from 12wt.% PVA polymer solution. The solution was pushed from the syringe by linear pump (KDS 100, KD Scientific) to an opposite charge rotation collector with different types of head (**Figure1** different types of collecting heads) for 20 minutes. To achieve the electrospinning process, the solution was subjected to DC high voltage, using source SL 150 Spellman. Collector was powered by DC Regulated Power Supply (model RXN-302D-3). Electrospinning conditions are shown in **Table 1.**

Table 1 Electrospinning conditions of polymer solutions

Material	12wt.% PVA in H2O
Voltage on the needle [kV]	+27
Voltage on the collector [kV]	-4
Electrode distance [mm]	110
Dosing of polymer [ml/h]	0.8
Speed ofrotationofthecollector[rev./min]	200
Temperature [°C]	25
Relative air humidity [%]	40

2.3. Characterization

Electrospun fibers were studied by scanning electron microscopy (SEM; Tescan Vega 3SB Easy Probe). Fibers were coated with a layer of gold. Thickness was 7nm to ensure their conductivity before using of microscope.

3. RESULTS

Electrospun parallelized layers were studied for their productivity, depending on the type of used collecting heads. After 20 minutes of electrospinning process, all the material was removed on black paper (**Figure 2**) and produced layer was weighed on the scales with a precision of ten-thousandth of a gram, each layer was weighed ten times. Productivity is shown in **Table 2**. Image analysis from scanning electron microscopy are shown on **Figure 3**.

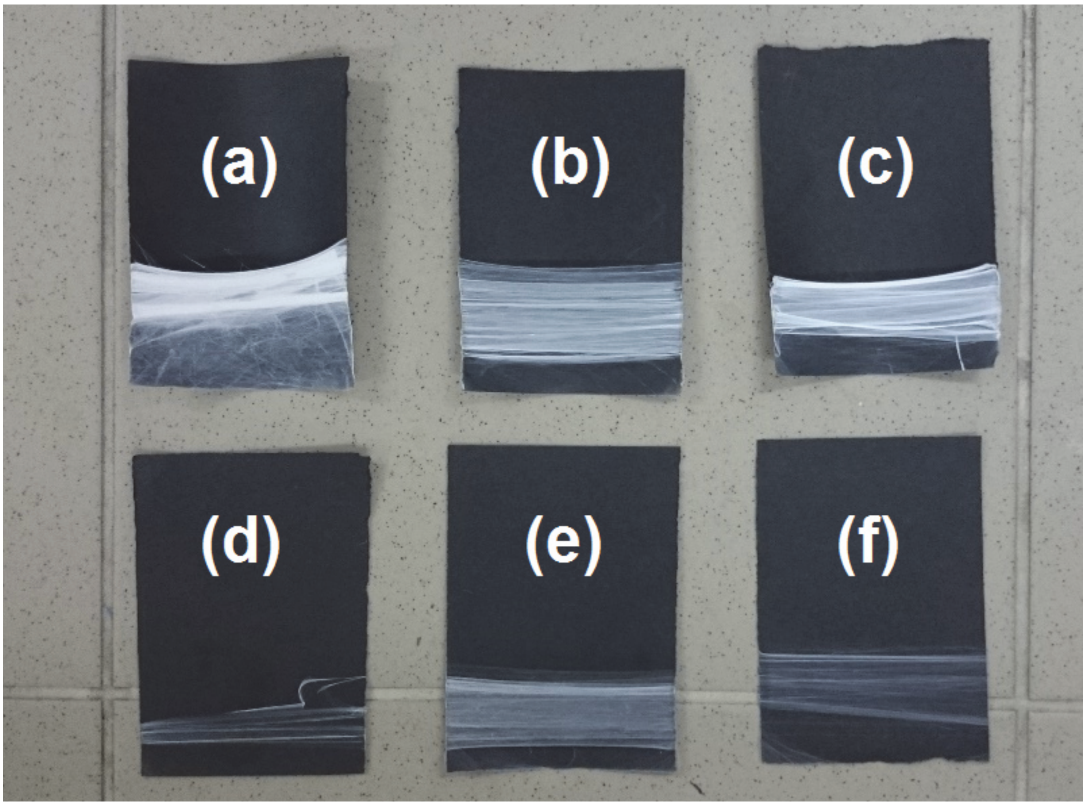
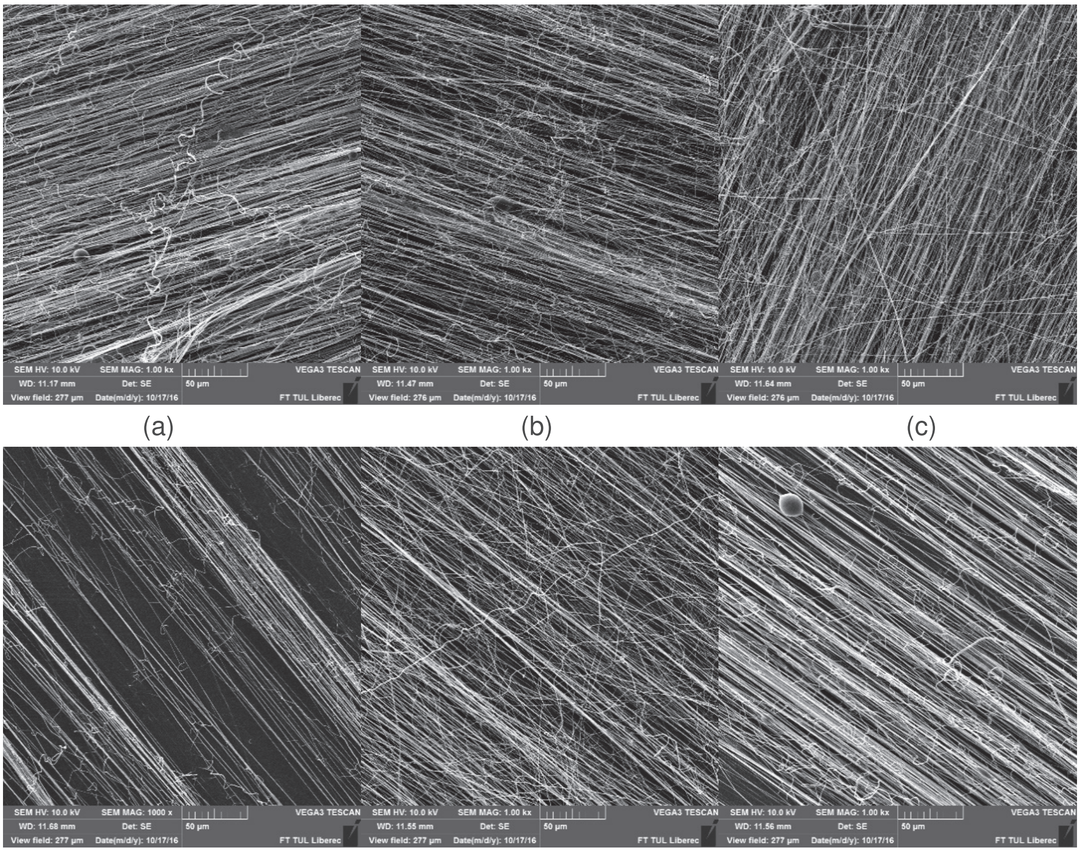


Figure 2 Images of productivity of electrospun layers

Table 2 Productivity of layers depending on types of arms

Types of collecting heads	Productivity (grams)
(a): Cylindrical brass bars 4mm diameter	0.0367
(b): Rectangular aluminium bars 20mm width. Sandblasted. Rounded tops.	0.0032
(c): Rectangular aluminium bars 20mm width. Sandblasted. Rounded tops. Sharpened edges.	0.0046
(d): Rectangular aluminium bars 20mm width Sandblasted.	0.0011
(e): Cylindrical aluminium bars 10mm diameter. Sandblasted.	0.0026
(f): Cylindrical aluminium bars 10mm diameter.	0.0007



(a) (b) (c)

(d) (e) (f)

Figure 3 Image analysis from scanning electron microscopy

The averages electrospun fibers diameters and parallelized percent age of fibers are summarized in **Table 3**.

Table 3 The averages electrospun fibers diameters and parallelized percent age of fibers

Sample	Fiber diameter [nm]	% of parallelized fibers
Cylindrical brass bars 4mm diameter	580±183	86±4
Rectangular aluminium bars 20mm width. Sandblasted. Rounded tops.	562±170	85±5
Rectangular aluminium bars 20mm width. Sandblasted. Rounded tops. Sharpened edges.	402±166	90±7
Rectangular aluminium bars 20mm width Sandblasted.	455±148	88±6
Cylindrical aluminium bars 10mm diameter. Sandblasted.	526±206	78±8
Cylindrical aluminium bars 10mm diameter.	531±158	91±3

The average fiber diameter was measured by image analysis software - Nis Elements. Percent age of parallelized fibers were similar. However, the best results shown head with cylindrical aluminium bars 10mm diameter, but this type of arms shown the lowest productivity. The best productivity shown collecting head with cylindrical brass bars 4mm diameter. Also worth noting is that the sharp edges gives good results.

4. CONCLUSION

We have produced 6 different rotating heads to conduct this experiment. Various kinds and various forms of metal rods have been used. The best productivity was got using collecting head with cylindrical brass bars 4mm diameter. However, the best results shown head with cylindrical aluminium bars 10mm diameter, but this type of arms shown the lowest productivity. Experiments using different types of materials and forms for collecting heads will continue to achieve the optimum combination of productivity and in parallel fibers.

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