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STRUCTRAL STUDY OF POLY(ETHYLENE TEREPHTHALATE) NANOFIBERS

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INTRODUCTION

In the past few years, a large amount of work has been reported on the preparation and characterization of electrospun nanofibers from a wide range of polymer materials. Nanofibers are produced by different ways and the most important way is electrospinning.

Several properties of the polymer solution and process parameters can be adjusted in order to control the final fiber characteristics.

Controlling these parameters is a criticial step to obtain electrospun fibers with characteristics that meet to specific applications needs.

This study describes the preparation and characterization of nano fibers obtained by electrospinning of poly(ethylene terephthalate) (PET) solutions in trifluoroaceticacid/dichloromethane (TFA/DCM). The purpose of this study is to understand the effect of the applied voltage and the linear velocity of the collecting drum on the final characteristics of the electrospun PET mats.

EXPERIMENTAL

PET pellets were kindly supplied by Polyacryl Company. Trifluroaceticacid (TFA) and dicholoro methane (DCM) was prepared from Merck as solvent.

Polymer solution with concentration 9 w/v% was prepared by dissolving PET in TFA: DCM (70:30).

Once, electrospinning processes were conducted at 11kV of applied voltage with a flow rate of 0.21ml/min. Fibers were collected as a nonwoven fibrous mat by a grounded rotating drum with variable rotational speed(from 90rpm to 810rpm) placed 10cm from the needle tip. Second electrospinning processes were conducted at variable voltage (from 7kV to 14.5kV) with a flow rate of 0.21ml/min.

After electrospinning, the fibrous mats were studied using some techniques such as SEM, FTIR, XRD and DSC.

Crystallinity of these fibers was determined using DSC and XRD methods and orientation of PET nanofibers was determined using FTIR method.

RESULTS

Based on the results, nanofibers diameter was decreased by increasing in rotational speed of drum and applied voltage.

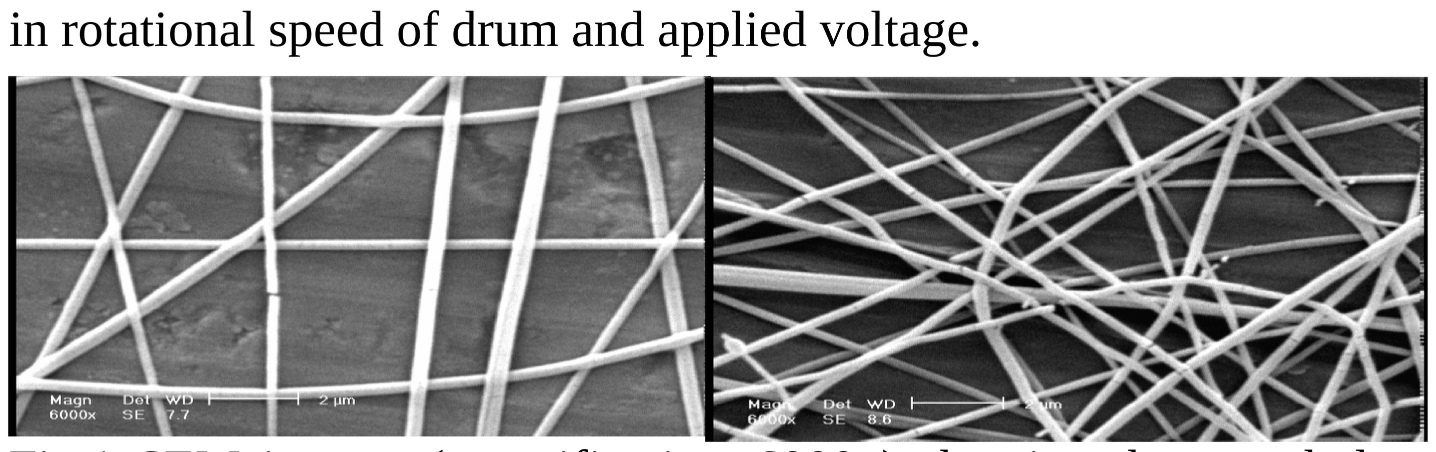

Fig.1 SEM images (magnification=6000x) showing the morphology of PET nanofibers a-rotational speed of drum 90RPM , b-rotational speed of drum 810RPM

The results in Table 1 show that increase in the rotation speed of the drum cause a decrease in the average diameter of nanofibers and also crystal dimensions. This also causes an increase in the crystallinity percentage and molecular orientation of the nanofibers. More increase in velocity causes the nanofibers to broken.

Table 1.Effect of rotational speed of drum on the structural properties of PET nanofibers

Sample	1	2	3	4
Rotational speed of drum (rpm)	90	450	630	810
Average diameter (nm)	310	303	291	241
Crystallinity (%) (XRD method)	41.5	44.7	-	51.3
Crystal dimension (°A)	65	62	-	51

The results in Table 2 show that the ratio of gauche to trans conformation increases with increase in rotational speed of the drum.This means that the molecular orientation of the nanofibers have been increased by increasing in rotational speed of drum.

Table 2 Trans/gauche ratio results obtained of FTIR

T/G	T/M	G/M	Rotational speed of drum (rpm)
0.49	0.66	1.34	90
0.76	0.84	1.11	270
0.79	0.93	1.19	450
0.84	0.94	1.12	630

G:gauche conformation

T:trans conformation

M:reference peak

The results show that with increase in applied voltage, average diameter was decreased. The effect of variation of applied voltage on fiber crystallinity and molecular orientation was not significant.

Table 3. Effect of applied voltage on the structure of PET nanofibers

Sample	1	2	3	4	5
Applied voltage(kV)	7	9	11	13	14.5
Average diameter (nm)	371	369	367	355	354
Crystallinity (%) (XRD method)	41.5	-	42.1	-	39.8
Crystal dimension (°A)	64	-	65	-	74

The Results of DSC and X-Ray diffraction measurements show that with increase in applied voltage, first crystallinity percentage increased and then it was decreased. Crystal dimensions first were almost constant but with more increase in voltage, the crystal dimensions increased. With increase in crystallinity percentage, crystal dimension was decreased. Totally, the effect of voltage variation was not significant on the fiber crystallinity and orientation. Effect of Linear velocity of drum was more significant on the properties of the electrospun mats.