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Determination of Production Parameters of Pan Nanofibers Produced by Electro-Spinning Method

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Abstract: ***In this study, the effect of nanofibers composed of polyacrylonitrile / dimethylformamide (PAN / DMF) with the speed of collecting the voltage fluid was investigated. Electrospin process was used in the production of PAN nanofibers. For this purpose, the best production parameters (with SEM analyzes) were determined for the blend ratio of 8% by weight consisting primarily of polyacrylonitrile / dimethylformamide (PAN / DMF). Nano particle nanofibers were produced by electrospin process. Morphological structures of these nanofibers were investigated.***

Keywords: Electrospinning process, Electrospun nanofibers, Polyacrylonitrile (PAN) nanofibers

1. Introduction

Fiber diameter of nanofibers are one micron or less. Fibers obtained from the polymer solution and the polymer flux in very small sizes, ie micro-meters, are called nanofibers [6]. Nanotechnology has been used widely today in many areas, some of these sectors; There are many fields of application in various fields of defense industry, materials and manufacturing sector, electronic and computer technologies, medicine, pharmacy, aerospace, space science and environment, energy applications. Fibers below 100 nm in diameter are called nanofibers. With the development of nanotechnology, active surface areas of nanomaterials are increasing. Nano materials have advantages in many respects such as mechanical properties, thermal conductivity, electrical conductivity, density, thermal stability according to macro materials.

Nowadays, nanofiber production from polymer and ceramic materials can be achieved with many production methods. The method of drawing, phase separation, melt spraying and electro-spinning are the main methods of nanofiber production. In the drawing method, micropipettes with a micrometer radius of several micrometers are dipped into the polymer droplet with the micro-manipulator and nanofiber production is performed by retracting at a rate of about 10-4 m / s [6]. In phase separation, a polymer is first mixed with a solvent prior to gelling. The main mechanism in this process - as the name implies - is the separation of phases due to physical incompatibility. One of the phase of the solvent is then removed by leaving behind the other remaining phase [6]. The meltblowing method has recently been widely used in small diameter fiber production.

Fiber production is obtained by dissolving the polymers from the eight molds by blowing hot air at high speed and then thinned with the help of cold air blown out [2]. Today, the most preferred method in nanofiber production is electro-spinning. The method is patented by [Formhals (1934)]. Electro-spinning is a method used in the production of nanofibers of various composition and diameter, with long lengths, solid and hollow structure [5]. The main reasons for using the electro-spinning method are that it is fast, suitable for mass production and is reproducible [1]. The electro-spinning method permits the production of nanofibers with very different polymers using relatively less energy and less raw materials than other methods [1].

1.1. Aim of study

- Investigation of the effect of nanofibers on the morphological structures of the production parameters by SEM analysis.
- Polyacrylonitrile / Dimethylformamide (PAN / DMF) nanofibers test parameters are easily controlled and produced by electrospin method.
- Determination of nanofiber production parameters in uniform structure (PAN / DMF) produced by electrospin device.

1.2. Context of study

The aim of this study is to determine the change in the morphological behavior of composite nanofibers (PAN / DMF) by SEM analysis of composite nanofibers (PAN / DMF) composite nanofibers.

1.3. Method of study

Polyacrylonitrile (PAN) is an extensively studied polymer with a high dielectric constant desired for electrospinning and easy carbonization [8]. PAN nano fibers can be used as direct electrode materials after stabilization and carbonization which cannot be carried out by many other polymers [4]. Polyacrylonitrile (PAN) is a synthetic and semi-crystalline organic polymer resin represented by the chemical form (C3H3N) [7].

Polyacrylonitrile (PAN) has properties including low density, thermal stability, high strength and elasticity modulus. These unique properties make Polyacrylonitrile (PAN) an important polymer in high technology. Polyacrylonitrile (PAN) is a material commonly used in the production of carbon nanofibers [3]. Dimethylformamide (DMF) was preferred as the solvent in this study. The main reason for choosing this material is the high solvent

properties of DMF. Therefore, it is an industrial chemical commonly used in electrospin method. Dimethylformamide (DMF) is generally used in the production of acrylic fibers and polyurethane products [7].

The production parameters of PAN / DMF nanofibers are shown in Table 1.

Table 1: Production parameters of PAN / DMF nanofibers

Exp. No	PAN/DMF	Voltage (kV)	The optimum distance between the needle tip & collector (cm)	The transmit rate of the fluid to collectors (mL/h)
1	PAN/DMF 1	10	13	1.5
2	PAN/DMF 2	10	13	2.0
3	PAN/DMF 3	10	13	2.5
4	PAN/DMF 4	10	13	3.0
5	PAN/DMF 5	10	13	3.5
6	PAN/DMF 6	15	13	1.5
7	PAN/DMF 7	15	13	2.0
8	PAN/DMF 8	15	13	2.5
9	PAN/DMF 9	15	13	3.0
10	PAN/DMF 10	15	13	3.5
11	PAN/DMF 11	20	13	1.5
12	PAN/DMF 12	20	13	2.0
13	PAN/DMF 13	20	13	2.5
14	PAN/DMF 14	20	13	3.0
15	PAN/DMF 15	20	13	3.5
16	PAN/DMF 16	25	13	1.5
17	PAN/DMF 17	25	13	2.0
18	PAN/DMF 18	25	13	2.5
19	PAN/DMF 19	25	13	3.0
20	PAN/DMF 20	25	13	3.5

The preparation of the solutions for the production of PAN / DMF nanofibers is the same, and the preparation of the PAN / DMF 1 coded sample, which is one of the preparation methods, before the start of the nanofiber production by the electro-spinning method, is as follows. The weighed PAN / DMF was mixed in an ultrasonic mixer until homogeneous, then the mixture was allowed to cool to room temperature for about half an hour.

Figure 1: Devices Used in PAN / DMF Nanofiber Production ((a) Electrospin Device (b) Precision Weighing (c) Ultrasonic Mixer)

Electro-spinning processes applicable to PAN + DMF then withdrawn into the syringe according to the parameters in Table 1 are nanofibers into production. In these parameters, our variables were determined as voltage (kV) and the rate at which the fluid was sent to the collector (mL / h).

2. Results

As a result of the experiments performed when all SEM analyzes are evaluated, at the 15 kV high voltage PAN / DMF solution, the collector rotates around its axis at a speed of 15 revolutions / minute, the distance between the collector and the needle tip is 13 cm and the rate at which the fluid is sent to the collector of the sample is 3 mL per hour. diameter is 143.05 nm. The resulting nanofiber has a uniform structure and a structure without pilling.

The beads were observed in the structures obtained in the other experiments and the fibers obtained were not uniform. The SEM image of the nanofiber obtained in experiment No. 9 is shown in figure 2.

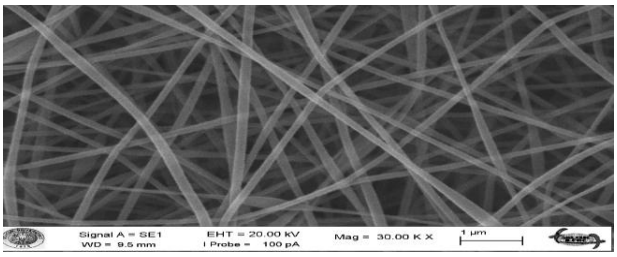

Figure 2: SEM image of PAN / DMF solution

3. Conclusion

In this study, the changes in the structure of voltage and fluid flow rate were investigated in nanofiber structures obtained by using electro spinning method. According to the results obtained from the SEM images, the average value of the nanofiber cap and a uniform structure was found to be 15 kV and 3 mL / h fluid flow rate.

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