PREPARED POLY AMIDE NANOFIBERS REINFORCED WITH ZnO NANOPARTICLES USING ELECTROSPINNING TECHNIQUE

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Abstract: Electrospun polyamide 66 nanofibers and poly amide 66 nanofibers reinforced with Zinc oxide nanoparticles were prepared in this search. 14% con. Of poly amide 66 dissolved in formic acid prepared and pumping through electrospinning system under : (25 kV HVPS , 15 cm electrospinning distance, 0.48 mm needle diameter, and 0.3 ml/hr electrospinning flaw rate. Some tests performed on prepared samples involve: contact angle, Scaning electron microscope (SEM), atomic force microscopy (AFM), and Foriour transfere analysis (FTIR).Results proved that, the polyamide 66 nanofibers has hydrophilic behaviour with contact angle about 57.113 ^{o} and it decreases with adding of ZnO nanoparticles to 43.3^{o}, also AFM results proved that the adding of ZnO nanopartiles leads to increase of surface roughness and decrease the contact angle. SEM results show the diameter of nanofibers about 90 nm but there are a beads present after adding of ZnO nanoparticles.

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1. Introduction

In terms of its behavior towards water, the material is classified into two main types, water-loving and water-repellent. A hydrophilic surface has strong alliance to water whereas hydrophobic surface repel water, this simple definition however, is too overall classification of a variety of diverse solids having different wettability [1]. The phrase of super hydrophilicity noted for the first time in the technical literature in 2000, in four researches published by three various research teams. The subject of wet ability received great benefit from both theoretical and experimental studies. It function a significant role in many industrial operations, such as, lubrication, spray quenching liquid coating and oil recovery [2]. Contact angle is a measurement of wettability of materials as in Fig. 1:

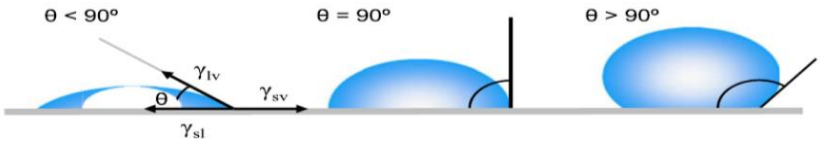

Fig. 1. Contact angle range.

If contact angle lower than 50 ^{o}, the surface has super hydrophilic properties and high wettability properties, while, if the contact angle lower than 90^{o}, the surface has a hydrophilic property. On the other hands, large contact angles (>>90°) correspond to low wettability. [3] 1n 1996 Onda et al. studied the contact angle of a liquid drop as a function to dimensions of surface , and the results shows the surface has super wettability properties [4]. Then, since 2000-2019, there are an enumerate of papers were published [5].

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2. Experimental part

2.1 Materials used

Polyamide 66 as a white powder with 114 g/cm^3 density China product used for prepared the polyamide nanofibers. Formic acid with 100.8 ^{o} C boiling boint India product used for dissolving of polyamide powder. ZnO nanoparticles with (50 nm) grain sizes, China product used as a reinforcement materials.

2.2. Electrospinning of nanofibers

(0.13 Con. %) wt% of (PA 66 + formic acid) solution was performed for electrospinning pump. This solution mixed with heating (50 -60 ^{o} C) for (6 hr). Two samples prepared by electrospinning technique, the first is pure poly amide nanofibers, and the second is the polyamide nanofibers reinforced by ZnO nanoparticles, table 1. Show the condition of electrospinning process.

Table 1. Shows the conditions of electrospinning technique.

Sample No.	Content	Conditions
1	PA + formic acid	HV= 25 kV E.D =15 cm N.d= 0.48 mm F.R = 0.3 ml/hr R.S = 300 rpm Con.%=0.13 g/ml Viscosity=8 Cp Surface tension = 24 mN/m
2	PA + formic acid + ZnO nanoparticles	

2.3. Tests

Surface morphology of electrospun nanofibers placed on aluminum surfaces investigated using Scanning electron Microscopy (SEM) and atomic force microscopy (AFM).

Hydrophilic Behavior Hydrophilic behavior tested by measuring of contact angle of surface by contact angle analyzer.

4. Results and discussion

4.1. Contact angles

Fig. 2 (a,b) show the contact angle of poly amide nanofibers and polyamide nanofibers reinforced by ZnO nanoparticles respectively. We notice from Fig. 2 (a) and (b) the contact angle is decreases from 57.113^o after adding of ZnO nanoparticles to 43.3^o, this is because the hydrophilic behavior of ZnO nanoparticles and increasing of the roughness of surfaces [6].

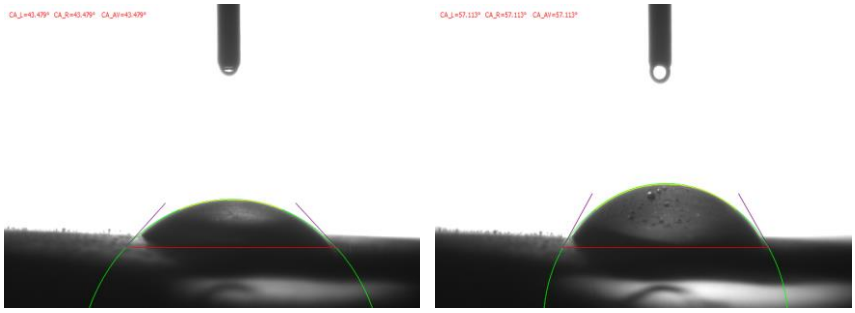


Fig. 2. (a) Contact angle of Poly amide nanofibers.
(b) Contact angle of (Polyamide + ZnONp) nanofiber

4.2. FTIR analysis

Fig. 3 shows the FTIR analysis of poly amide nanofibers and polyamide nanofibers reinforced by ZnO nanoparticles.

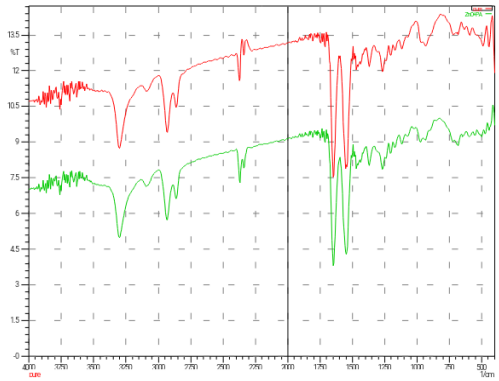
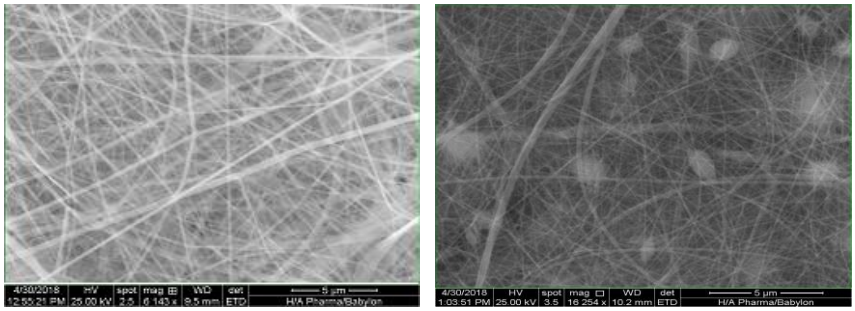


Fig. 3. FTIR analysis of analysis of poly amide nanofibers and polyamide nanofibers reinforced by ZnO nanoparticles.

We notice from Fig. 3. There are not any chemical reactions between PA nanofibers and ZnO nanoparticles, but there are physical reactions proved by the shifting of bonds after adding the ZnO Np., also there is an increasing of crystalline region after adding of ZnO Np [7].

4.3. SEM Images analysis

Fig. 4 a and b shows the SEM images of poly amide nanofibers and polyamide nanofibers reinforced by ZnO nanoparticles respectively.



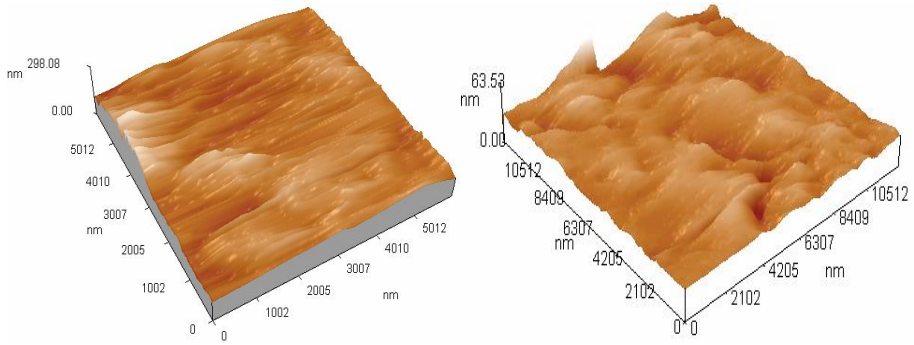
(a) *(b)*

Fig. 4 (a) SEM images of polyaimed nanofibers; (b) SEM images of polyaimed nanofibers reinforced with ZnO NPs.

We notice from Fig. 3 (a), there are a smooth nanofiber are great by electrospinning technique with about 90 nm diameter, while there are ab beads were appeared after adding of ZnO NP this is because un-instability of electrospinning process [8].

4.4 AFM analysis

Fig. 5 a and b shows the AFM analysis images of poly amide nanofibers and polyamide nanofibers reinforced by ZnO nanoparticles respectively.



a) b)

Fig. 5. (a) images of polyaimed nanofibers; (b) images of polyaimed nanofibers reinforced with ZnO NPs.

Notice the PA 6 nanofibers surface has roughness less than (PA 6 +ZnO) surface this is because the ZnO nanoparticles adding leads to increasing of roughness of surface [9].

Conclusions

The results of this work determined the activity of polyamide 66 nanofibers reinforced with Zinc oxide nanoparticles that made the surface becomes super wettability properties. Improve hydrophilic behavior of due to the addition ZnO nanoparticles and increasing of the roughness of surfaces. The FTIR analysis reveals physical reactions proved by the shifting of bonds after adding the ZnO NPs. Besides, the morphology and structure of polyamide nanofibers reinforced by ZnO nanoparticles by using SEM and AFM improved a smooth nanofiber are great by electrospinning technique with about 90 nm diameter as compared with poly amide nanofibers as well as PA 6 nanofibers surface has roughness less than (PA 6 +ZnO).

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