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ORIGINAL RESEARCH PAPER

Feasibility of Fabricating PAN/TiO_2 Electrospinning Nanofibers with UV Protection Property

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ABSTRACT

Introduction: The skin, can be exposed to harmful factors like ultraviolet radiation (UV). Exposure to this physical hazardous agent could be contributed to pigmentation, erythemas, early aging, skin cancer, and DNA damage. The aim of this study, therefore, was to fabricate the polyacrylonitrile (PAN) nanofibers with the UV protection property by the use of various concentrations of titanium dioxide (TiO2) nanoparticles.

Material and Methods: The PAN nanofibers (10%wt) containing 0, 1, 5, 10 and 15% wt of TiO_2 nanoparticles were produced using electrospinning method. The morphological propertis of nanofibers were studied by scanning electron microscopy (SEM) and the functional groups were investigated by Fourier transform infrared spectrophotometer (FTIR). The UV protection property of nanofibers was studied by measuring UV transmittance as well as calculating UV protection factor (UPF).

Results: The results showed that the diameter and morphological characteristics of nanofibers are different at various concentrations of TiO_2 and increasing the concentration of TiO_2 has resulted to an increase in nanofibers diameter. The analysis of FTIR results showed that TiO_2 nanoparticles have been successfully loaded on nanofibers for UV protection purposes. The findings clarified that nanofibers loaded with TiO_2 could increase the UV protection property up to 15%.

Conclusion: Totally, our findings show the successful fabrication of UV-protective nano webs using TiO_2 nanoparticles. the new combination used in nano matcould protect employees from UV radiation.

Keywords: *Electrospinning; Poly acrylonitrile; Titanium dioxide; Ultraviolet radiation; Ultraviolet protection factor; Occupational protection*

1. INTRODUCTION

The skin, as the largest organ in the human body, can be exposed to many harmful factors in the workplace. One of these harmful factors is ultraviolet radiation (UV). Exposure to UV in outdoor environments can be 2 to 9 times higher than that of indoor workplaces. Exposure to this physical hazardous agent is contributed to pigmentation, erythemas, early aging, skin cancer, and DNA damage. The fabrication of appropriate textiles could be considered as one of the practical solutions eaither to avoid or reduce the exposure to UV as well as preventing its adverse effects such as skin cancer, etc. . Ordinary clothes provide inadequate protection for the skin. The efforts made in order to manufacture and to improve the textiles are required to increase protection against UVR. In the meantime, the application of nanomaterials in the field of textiles has attracted a great deal of attention due to the widespread interest and applicability of nanotechnology. The main reason for this interest is that the features added to the textiles through conventional techniques not only have no continual effects but also lose their functions after washing or wearing them. Using

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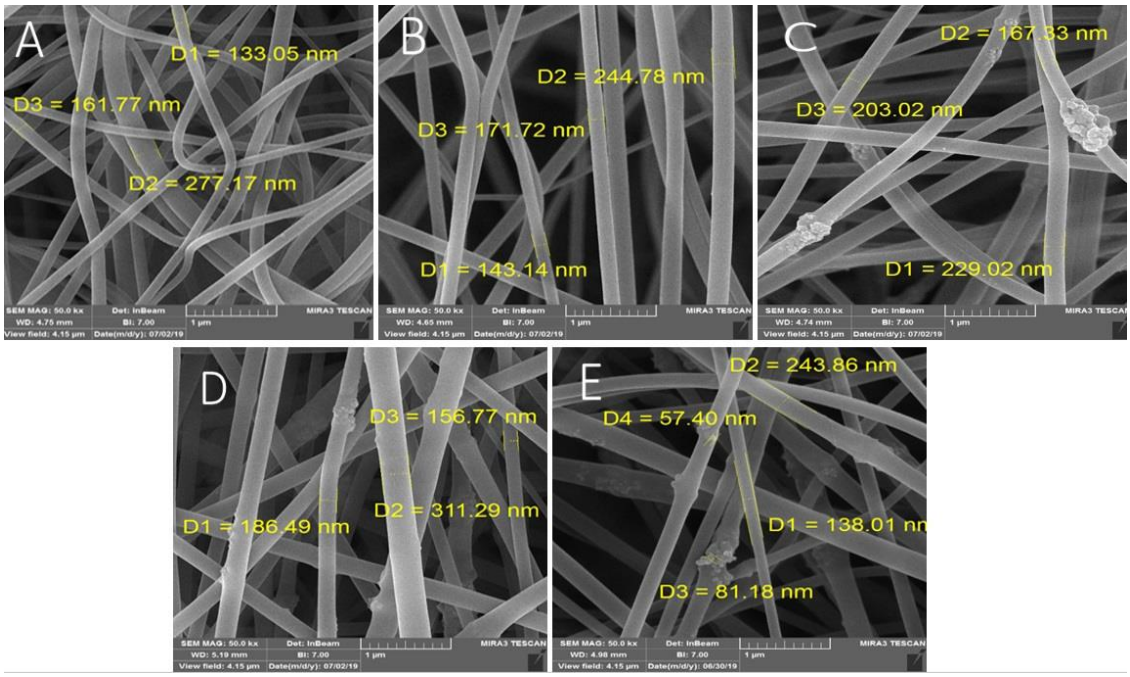

Fig 1. SEM images of A: PAN, B: PAN/TiO_2(%1), C: PAN/TiO_2(%5), D: PAN/TiO_2(%10), E: PAN/TiO_2(%15)

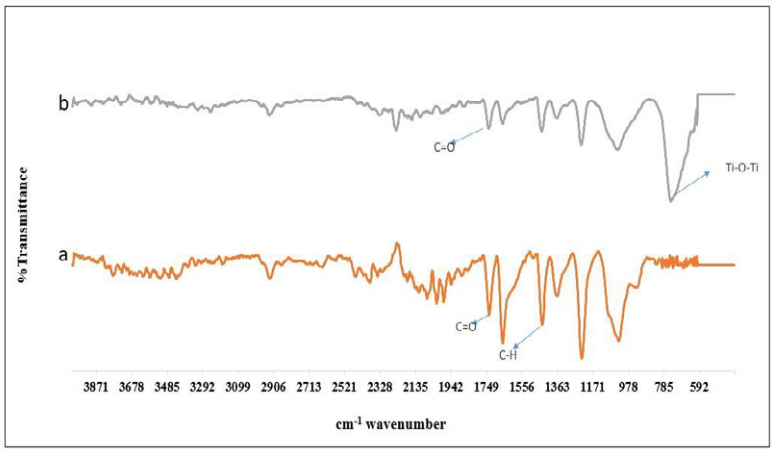

Fig 2. FTIR of a: PAN , b: PAN/TiO_2 nanofibers

nanoparticles, however, the applied modifications on fabric are durable due to the greater surface area and energy. The aim of this study, therefore, was to fabricate the Polyacrylonitrile (PAN) nanofibers with the UV protection property through using various concentrations of Titanium dioxide (TiO_2) nanoparticles.

2. MATERIALS AND METHODS

The PAN nanofibers (10%wt) containing 0, 1, 5, 10 and 15% wt of TiO_2 nanoparticles were produced using electrospinning method. The electrospinning process was performed at the following conditions: needle gauge: 21, 15 cm distance between the needle tip and collector, 20 KV voltage, 250 RPM drum rotation, and 1.2 ml/h feeding rate. The morphological property of nanofibers was studied by scanning electron microscopy (SEM) and the functional groups were investigated by Fourier transform infrared spectrophotometer (FTIR) to

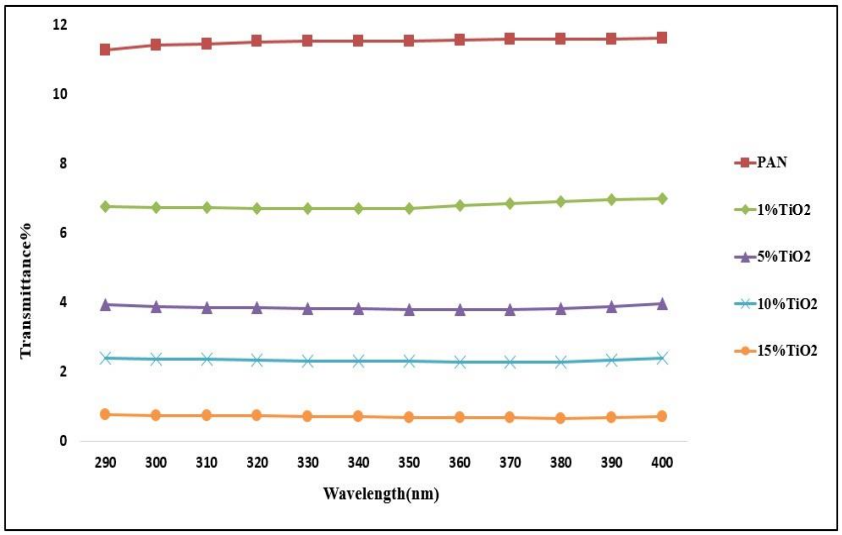

Fig 3. UV transmittance of electrospun nanofibers

Table 1. The Transmitter and UPF of Nanofiber Webs

Protection level	UPF	Average transmittance(%)	sample
Not ratable	8.72	11.53	PAN
Good protection	15.01	6.65	1%TiO_2
Very good protection	26.71	3.75	5%TiO_2
Excellent protection	42.31	2.33	10%TiO_2
Excellent protection	133.34	0.71	15%TiO_2

ensure the successful load of TiO_2 nanoparticles on nanofibers. The UV protection property of nanofibers was studied by measuring UV transmittance according to the method BS EN 13758-1:2002 as well as calculating UV protection factor (UPF) according to AS/NZ 4399:1996 standard.

3. RESULTS AND DISCUSSION

The results showed that the diameter and morphological characteristics of nanofibers are different at various concentrations of TiO_2 and increasing the concentration of TiO_2 has resulted to an increase in nanofibers diameter. The comparative study of functional groups in PAN and PAN/TiO_2 nanofibers showed that TiO_2 nanoparticles have been successfully loaded on nanofibers for UV protection purpose. The findings clarified that nanofibers loaded with TiO_2 are attributed to have more UV protection property and even increases with TiO_2 concentration up to 15%.

4. CONCLUSIONS

Our findings show the successful fabrication of UV-protective nano webs using TiO_2 nanoparticles which could be used to protect employees from UV radiation as nano mats.

5. ACKNOWLEDGEMENT

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