International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 09 | Sep -2017 www.irjet.net p-ISSN: 2395-0072

Experimental Study of Electrospun TiO_2 Nanofibers

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Abstract– *Presently, Electrospun TiO2 Nanofibers has potential application in various fields. In this paper, we present the fabrication and characterization of TiO_2 nanofibers by electrospinnig technique. The mixed anatase and the rutile phases of the nanofibers are confirmed by the XRD measurement. FTIR analysis showed the peaks from 800-500 cm^{-1} corresponding to the stretching of Ti-O.*

Keywords: TiO_2, nanofibers, sol-gel, electrospinning, anatase and rutile phase.

1. INTRODUCTION

Titanium dioxide (TiO_2) and its composite Nanofibers has innumerous application in various fields such as sensors, solar cells, membranes and biomedical [1]. TiO_2 nanofibers are widely used in biomedical application due to non-toxic and compactable to human anatomy. It exists in three polymeric phases such as rutile, anatase and brookite. However the rutile and anatase phase TiO_2 has good anti-microbial activity [2].

Various fabrication methods are available to fabricate TiO_2 nanostructures such as the hydrothermal method, template growth, thermal evaporation and electrospinning [3]. Among these methods, electrospinning method is a simple process one and can be produce continuous nanofibers with controlled diameter size from several nanometers to sub-micrometers [4]. By controlling process parameters various structural features of the electrospun fibers such as diameter of fibers, porosity, surface morphology, volume ratio, electrical and mechanical properties can be attained [5]. Beside these, external parameters such as humidity and temperature are mainly influence the fiber diameter and the stability of the jet.

In this paper, we present the fabrication of TiO_2 nanofibers by using sol-gel method and electrospining techniques. The prepared sample is found to be as high crystallinity and with large surface area.

2. Experimental Details

The fabrication of TiO_2 nanofibers involves two steps: 1) solution preparation by sol-gel methods and 2) fiber preparation by electrospinning process.

2.1 Preparation of solution by sol-gel method

The sol-gel method is chemical process in which solution are prepared into the gel form. It is a simple process and able to produce good nano-materials when compare to other method [6]. The size of nano-materials are depend on the precursor, solvent, polymer concentration and period of aging. Here, the details of chemicals and processes are as follows. First, 0.5 ml of Titanium tetraisopropoxide, TIP, Ti(OCH(CH3)2)4, (supplied by Sigma-Aldrich) was dissolve in a mixed solution of 10 ml of methanol and 4 ml of Acetic Acid solution. The stirring was maintained at room temperature for half an hour. The resultant solution was mixed with 1.0g of poly (vinyl pyrolidone) (PVP) (C6H9NO)n (Mw=1,300,000 supplied by Sigma-Aldrich) under vigorous stirring for 3 hours. Later, solution was turn into gel form with good transparent in color.

2.2 Electrospining Process

Electrospining is a simple technique to prepare the nanofibers with the desired diameters ranging from 50 to 500nm. The prepared solution was loaded into the syringe pump which is containing a needle (stainless steel 0.5 mm diameter) with vertically attached electrospinning device. The high voltage was applied to the needle and the solution was purged towards the grounded drum with controlled voltage and flow rate to the TiO2 nanofibers. The nanofiber sample war prepared and characterized by XRD,SEM,EDAX and FTIR [7].

3 Result and discussion

The surface morphology of the prepared sample was studied by the SEM measurement.

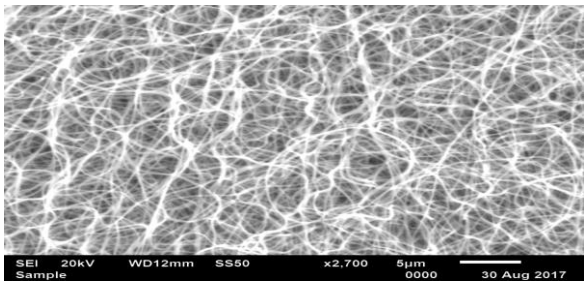

Figure 1. SEM image of calcined TiO2 nanofibers.

The average diameter of the prepared nanofibers was found to be 167 nm .

The EDS spectra TiO2 nanofibers shown in figure 2. depicts the required elemental peaks in the sample.

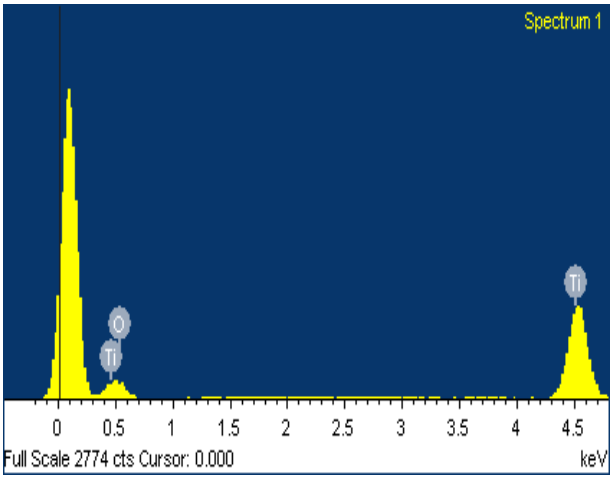

Figure 2. EDS spectra of TiO2 nanofibers

FTIR measurement was done to study the sample's quality. As shown in figure 8, the FTIR transmission bands of calcinated TiO2 nanofibers shows broad band between 3416 cm^{-1} is linked to hydrogen bonded O-H stretching vibration and 2927 cm^{-1} indicates the C-H groups in nanofibers. The vibration band at 2358 refers to C=C stretching of Alkyne group.

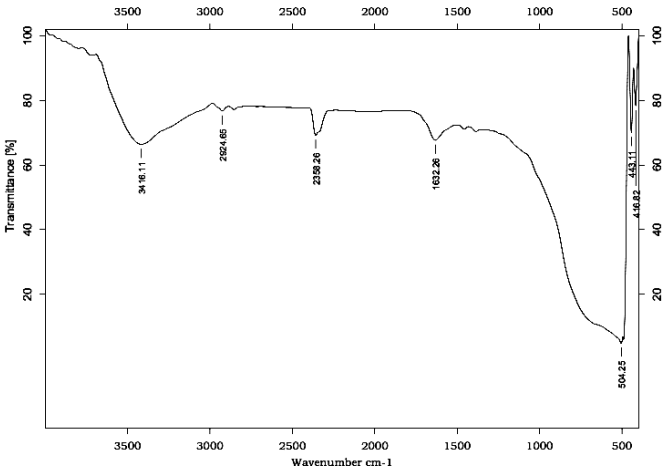

Figure 3. FTIR spectrums of calcined TiO2 nanofibers.

However, the peak at 1632 cm^{-1} shows that C=O stretching of Alkene group. The vibration bands at 504 cm^{-1} is related to binding energy of titanium metal reacted with oxygen (Ti-O) shows the formation of TiO2 nanofibers

To study the phase of the nanofibers, XRD measurement was carried out which is shown in figure 4.

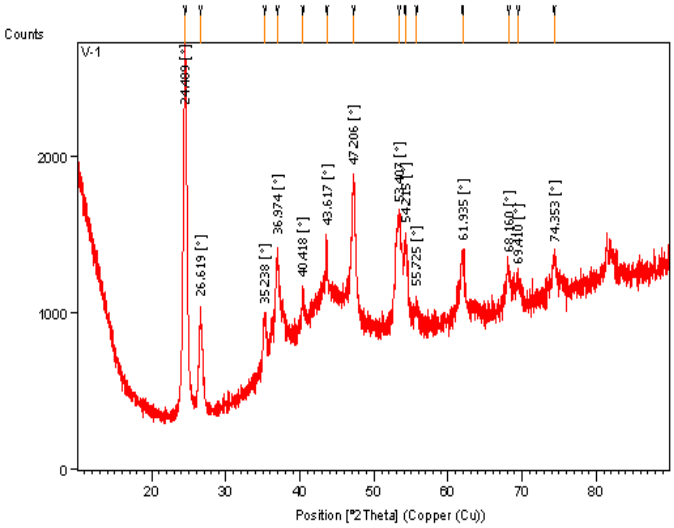

Figure 4. XRD pattern of calcined TiO_2 nanofibers.

XRD patterns of TiO2 nanofibers shows the presence of both anatase and rutile phases of the TiO_2 at approximately 2Θ=24.42 and 26.61 respectively.

3. CONCLUSIONS

In summary, TiO2 nanofibers were fabricate by combine sol-gel and electrospinning process. By SEM measure the dian were found 167 nm. by XRD mearement mixed anatase and rutile were observed. The qualitative peaks were conformed by FTIR.

By tuning electrospinning process parameter the desired diameter of the nanofibers can be fabricated for the specific application.

ACKNOWLEDGEMENT

D. Pradeep is thankful to the faculty of Department of Nanotechnology for their co-operation during the project work.

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