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EFFECT OF F-MWCNT ON STRUCTURAL AND MORPHOLOGICAL PROPERTIES OF PANI/F-MWCNT THIN FILMS

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Abstract

The Polyaniline/functionalization multiwall carbon nanotubes (PANI/f-MWCNT) thin films have been prepared successfully by the dip coating of slide glass during in-situ polymerization of PANI/f-MWCNT. The PANI/f-MWCNT thin films of thickness (200±20) nm have been prepared at different doped ratios of f-MWCNTs (0.34, 0.5, 1 W%). The films are characterized by X-ray diffraction to study the structure properties of films, the morphological characteristics of the PANI/f-MWCNT films were examined through scanning electron microscopy.

Key words: PANI/f-MWCNT, dip coating, structure properties.

1. Introduction

Polymers have emerged as one of the most important materials in the twentieth century. The twenty-first century will undoubtedly see the use of polymers move from primarily passive materials such as coatings and containers to active materials with useful optical, electronic, energy storage and mechanical properties[1]. Indeed, this development has already begun with the discovery and study of conducting polymers. Electronically conducting polymers possess a variety of properties related to their electrochemical behavior and are therefore active materials whose properties can be altered as a function of their electrochemical potential [2]. The importance and potential impact of this new class of material was recognized by the world scientific community when Hideki Shirakawa, Alan J. Heeger and Alan G. MacDiarmid were awarded the Nobel Prize in Chemistry in 2000 for their research in this field [3]. Although these materials are known as new materials in terms of their properties, the first work describing the synthesis of a conducting polymer was published in the nineteenth century. In the fabrication of high– equality polymer–carbon nanocomposites with predictable and optimal performance , a homogeneous dispersion of CNT in the polymer matrix is required. The polymer–CNT composite is expected to have good processability characteristics and excellent functional properties. The critical challenge, however is how to enhance the dispersion and alignment of CNT in the matrix. Enhanced dispersion and alignment of CNT in the polymer matrix will promote and extend the applications and developments of polymer/CNT nanocomposites[4,5].

In this paper, the in-situ chemical technique was used to prepare PANI and PANI/f-MWCNT, this method allow us to obtain PANI and PANI/f-MWCNT thin films. The effect of doped ratios of f-MWCNTs on their structure and morphology properties has been investigated.

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2. Experimental

One gram of MWCNT was first ultrasonically treated with a 3:1 mixture of concentrated H_2SO_4 and HNO_3 at 50°C for 4 h, the mixture was centrifuged and filtrated. The filtrated solid was washed by deionized water, then dried in a furnace at 80°C for 6h. The sample was abbreviated as f-MWCNT. The PANI and PANI/f-MWCNT nanocomposite was chemically synthesized by in-situ polymerization method, where using aniline monomer and ammonium persulfate (APS) as oxidant agent and hydrochloric acid (HCL) as protonic acid dopant, accordance to a method similar to the described by Jabbar 2018 [6]. The different doped ratios of f-MWCNTs (0.34, 0.5, 1 W%) were used. PANI and PANI/f-MWCNT films was deposited on glass slides. The slides are dipped in aniline/HCl solution then the oxidant agent (APS) was added under constant stirring to start the polymerization process, after 30 min, all the slides are removed from a flask. The obtained films were again immersed in aniline/HCl solution, then rinsed with 1 M HCl and acetone, finally left to dry in air at room temperature. The X-ray diffractrometer type SHIMADZU, power diffraction system with Cu-K_α X-ray tube (λ =1.54056 Å) is used. The X-ray scans are performed between 2θ values of 5 and 80°. The surface morphology of the prepared thin films was carried out by using field emission scanning electron microscopy (TESCAN- MIRA3 -FESEM).

3. Results and Discussion

The morphology and nanorod diameters of the produced PANI/f-MWCNT thin films were examined using FESEM. Figure (1) shows the FESEM images of PANI/f-MWCNT thin films with different weight ratios of f-MWCNT (0.34, 0.5, 1 W%). From the FESEM images it can be seen that the morphology of films have structure like nanorods, the diameters of this nanorods are affected by increasing the f-MWCNT weight ratio, it was found these diameters was decreased from 192 nm at 0.34 W% to 102 nm at 1 W%, see table (1), on the other hand the surface smoothness of nanorods was decreased but its length was increased with an increase in the f-MWCNT weight ratio. These results coincide with the results reached by F. Huang et al., 2010 [7].

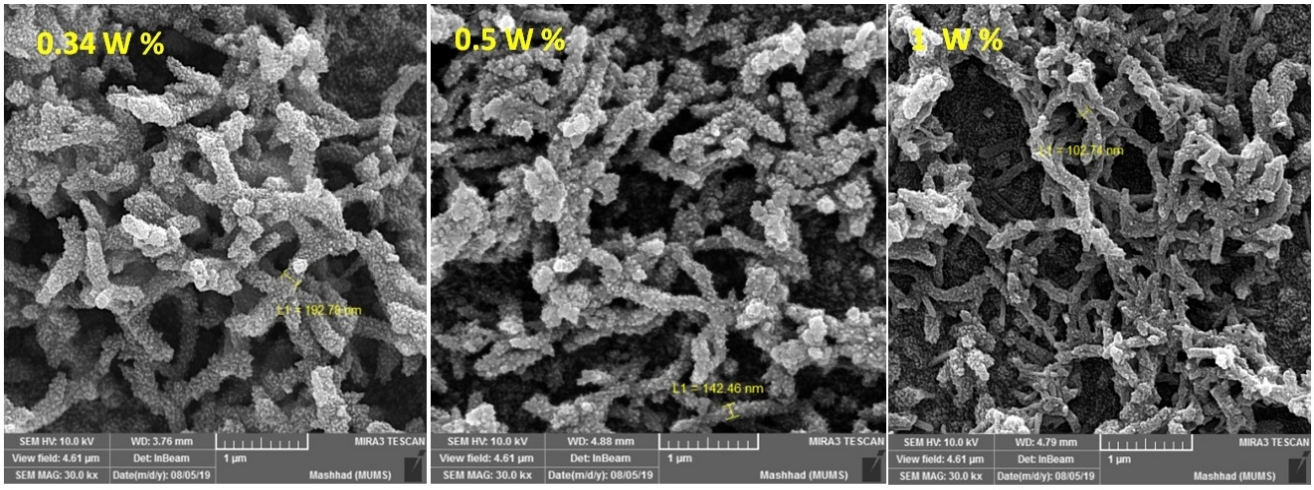

Fig 1. FESEM images for the PANI/f-MWCNT thin films.

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Table1. The values of the conductivity and nano rods diameters for PANI/f-MWCNT thin films

f-MWCNT Wight ratio (W %)	σ S/cm	Nano rods diameters nm
0.34	5.9	192
0.5	7.81	142
1	7.96	102

The XRD was used to examine the crystallinity properties of the PANI/f-MWCNT thin films as shown in Figure (2). The results show that the samples are highly disordered with a broad diffraction peak around $2\theta = 25^{o}$. The latter observation suggests that the amorphous structure of the PANI/f-MWCNT is not altered by f-MWCNT in PANI [8,9].

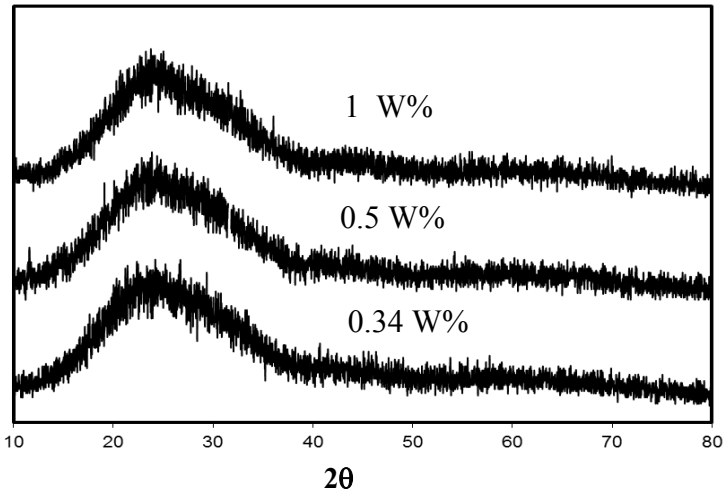

Fig.2. XRD spectra of the PANI/f-MWCNT thin films

Figure (3) show the FT-IR spectra for PANI/f-MWCNT thin films. From this figure one can notice that the spectrum presents similar peaks with the increase in the f-MWCNT in PANI and observe a small change in intensity of the bonds with increase the f-MWCNT ratio. Nevertheless, there are no additional vibrational bands as compared to spectrum of the all sample. Therefore the f-MWCNT does not effect on the bonds structure and the agreement with Sujith et. al., [10].

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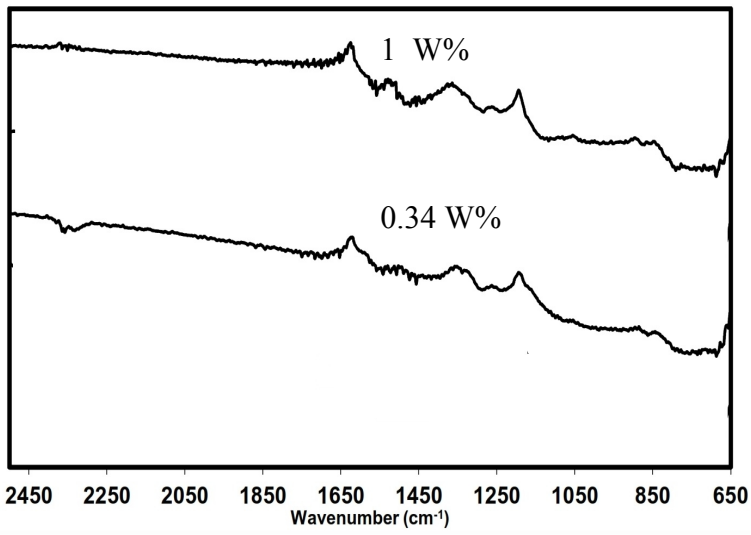

Fig.2. FTIR spectra of PANI/f-MWCNT thin films

Table1. shows the variation of electrical conductivity of PANI/f-MWCNT thin films with different f-MWCNT doped ratios at room temperature. The max conductivity is found at 1 W% f-MWCNT doped ratio, and it was about 7.96 $S.cm^{-1}$, in general the high conductivity in 1 W% f-MWCNT doped ratio compare with other two films may be attributed to the structure state of the films, it is important to note that the obtained values of conductivity in this work are close to those found in the literatures [11,12] .

Conclusion

The PANI/f-MWCNT thin films have been successfully prepared by the dip coating method for different f-MWCNT doped ratios, the systematic study was conducted for structure, morphology and electrical conductivity. The FESEM images show that the obtained films have a structure like nanorods with diameter up to 102 nm. The XRD shows the all samples have amorphous structure, and FT-IR spectra revealed that the f-MWCNT does not effect the structure of the bonds and function group of PANI/f-MWCNT thin films. From D.C conductivity we found the PANI/f-MWCNT thin films has best conductivity at 1 W% f-MWCNT.

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