

RESEARCH PAPER

MWCNT – PMMA as Thin Films

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ABSTRACT

Spin-coating technique has been used to fabricate the poly methyl methacrylate (PMMA)/multi-walled carbon nanotubes (MWCNTs) thin films. Optical characteristics of the refractive index, band gap and that of optical connectivity have been measured. an optical band gap of the films as calculated utilizing the UV-Vis spectra.to examine dispersion of the MWCNT in the polymer matrix, it was done with the help of atomic force microscope (AFM).

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INTRODUCTION

Polymer have universally been applied in many of the devices as insulation material and optoelectronic uses. This has been brought about by their unique nature, such as the high malleability, its light weight and ability to be contrived at low temperatures and at low rates. CNT are worthy of several varied uses, such as the gas sensors [1], electro-magnetic shielding [2], and electro-static discharges [3]. Such composites are usually produced by the help of using a range of the strategies, as follows: (a) CNT functionalization, (b) mixing strategies variation (melt, solution), (c) changing the mixing ratio of the CNT to the matrix, (d) changing the matrices or (e) changing CNT characteristics [4]. CNTs as such tend to be chosen due to their exceptional properties, including: thermal, electrical, optical and mechanical. However, the challenge to use the CNTs as the reinforcements in the composites

is connected to the fact, that they do not disperse and that they tend to agglomerate due to the tough inter-molecular Vander Waals and high characteristic ratio [5].

Consequently, the CNT/Polymer nanocomposite is the possible kind of nanomaterials with the perspective applications, namely the light emitting diodes (LED) , photovoltaic cells, and transport layers. The matrix polymer in this current work has been chosen, namely, the MMA due to its applicability to a wide range of production and processing methods and its non-crystalline nature (by which we would be deprived of the many difficulties encountered in dealing with the crystallization properties) accused of saintess, with his saintly spectacles [6].

MATERIALS AND METHODS

Preparation of PMMA/MWCNTs Thin films

Spin coated films of the PMMA/CNTs of the

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various concentrations are equipped. The material that has been used in the extant article is the polymethyl methacrylate, the PMMA solution were prepared by adding 26 mg of PMMA to 1ml of chloroform and put on the magnetic stirrer to mix it well after 30 s multi-walled carbon nanotube (MWCNTs) were added at varying rate (1%,3%,5). Lastly, thin films are spin coated at rotation speed of 3000rpm and rotation time of 10sec , layers

were dehydrated at 60° C.

RESULTS AND DISCUSSION

Optical properties

Enhanced PMMA transmittance spectra at the wave-length range of 200nm 1000nm have also been determined using a diversity of concentration levels. Figs. 1 and 2 shows spectra of the absorption and transmittance of different gradations of the

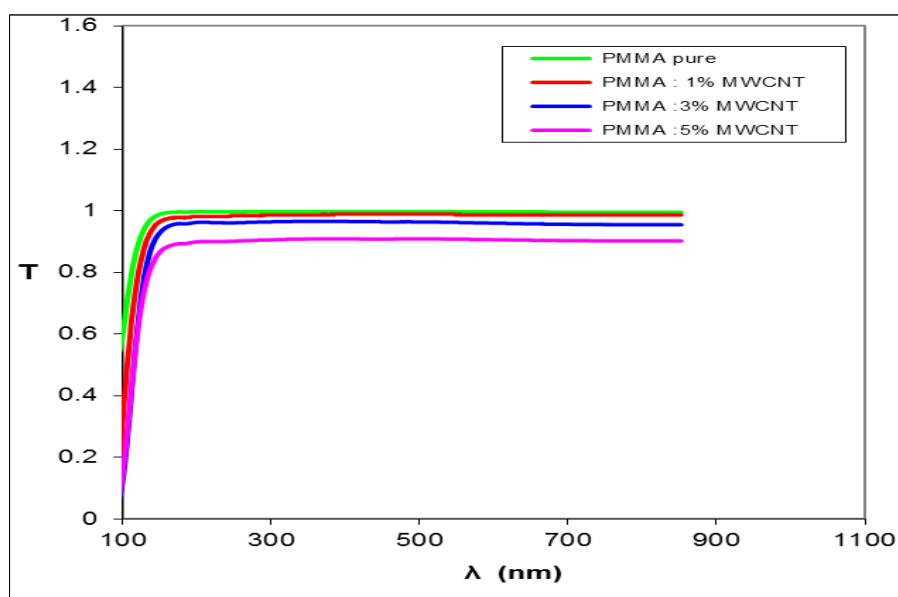


Fig. 1. transmittance of PMMA thin films at different MWCNTs doping ratio.

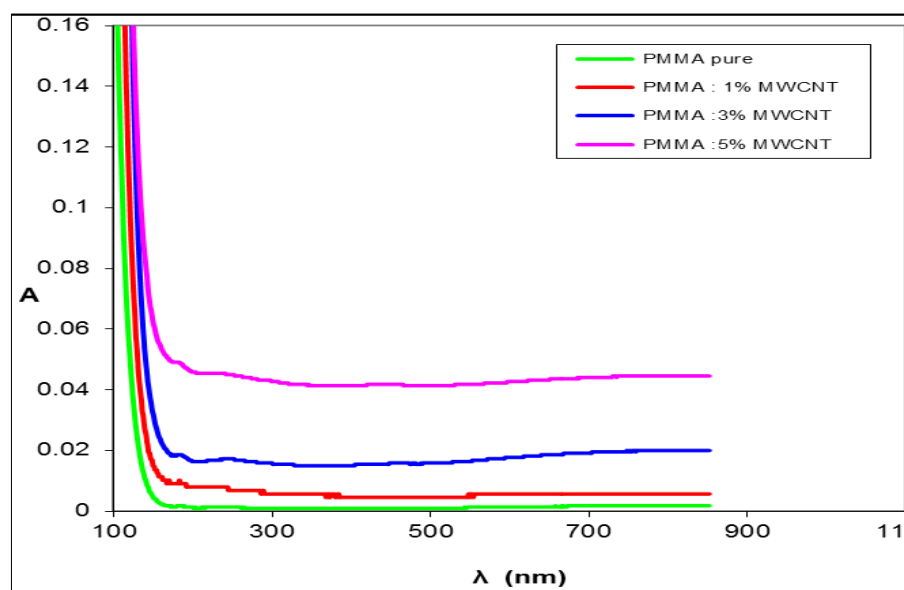


Fig. 2. Absorption spectra of PMMA thin films at different MWCNTs concentrations.

MWCNT concentration. It was revealed that that all the sections have been nearly clear in UV till the region of NIR. As the concentration is enhanced so the transparency of the sample is enhanced. That is why, it has been justified that all of the samples possess PMMA main characteristic which is high in transparency.

Optical band gap for the PMMA thin film when in differences in concentration with MWCNTs the UV-Vis spectra of PMMA/MWCNTs nanocomposite thin films have been also measured with the objective to determine the optical band gap depending on the result of the UV-Vis measurement through the plot $(\alpha h\nu)^2$ as against $h\nu$ of PMMA/MWCNTs nanocomposite. The value of optical band gap increased with the addition of MWCNTs into

PMMA can be varied to (3.8-3.5) eV. The result indicates that the 0 wt% MWCNTs produces the 3.8eV and 1 wt%, 5 wt% MWCNTs results in the decreasing value. band gap of the all samples is tabulated in (1) and schemed in Fig. 3.

It has been observed that the E_g has decreased with the upsurge of the concentration of the PMMA. The optical scattering of grain boundaries may be the cause of variations in optical band gap at different transport of different concentrations of the PMMA the reduction in the values of the light absorption as show in table 1 [7]. Generated in the thin film prepared at 30 mg might be owing to deficiencies in the films that have increased as the development beside the c-axis has decreased at the high concentrations. It has been considered that the eternal-effect of the grain boundaries that

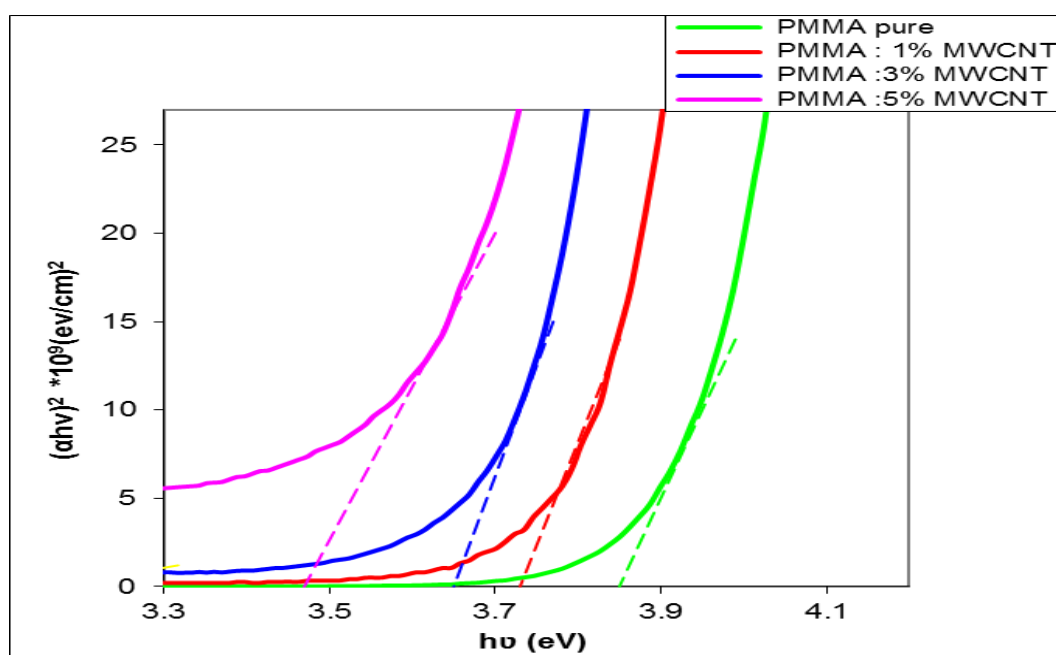


Fig. 3. $(\alpha h\nu)^2$ versus $h\nu$ of PMMA/MWCNTs thin films as dropped with different doping concentration.

Table 1. value of band gab via doping concentration.

Wt.% CNTs in PMMA/MWCNTs nanocomposite	Optical Band Gap (eV)
Pure	3.9
1 wt%	3.7
3 wt%	3.6
5 wt%	3.5

scatter light is minimized. Those values have been conflicting to those of that are 4.6eV [8, 9].

Fig. 4 demonstrates the shift of the optical conductivity on the deposit of the electrons in the range of the wave-lengths, where maximum conductivity in the range of the ultraviolet radiation, and decreasing of its value with the increase of the values of the wave-lengths, Using

the graph, it will be predictable that rising the amount of the MWCNTs material, the optical connectivity of the nanocomposites will be fluctuating not only between the pure PMMA and the pure MWCNTs when these materials are brought together. The MWCNTs and PMMA were successfully bonded in series where by drastic rise in the Optical Connectivity is observed when the

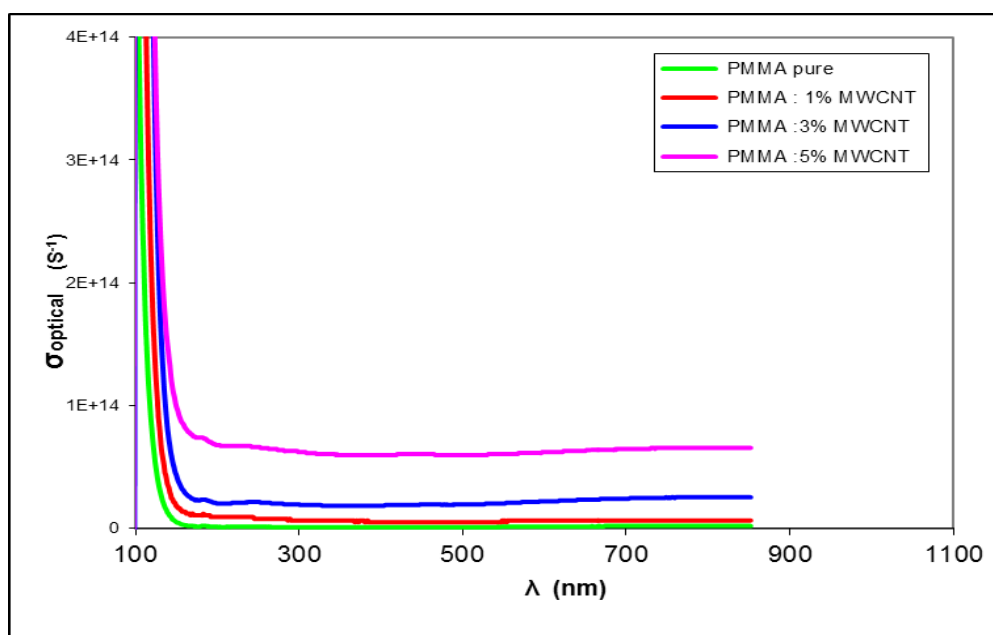


Fig. 4. PMMA/MWCNTs nanocomposites optical connectivity.

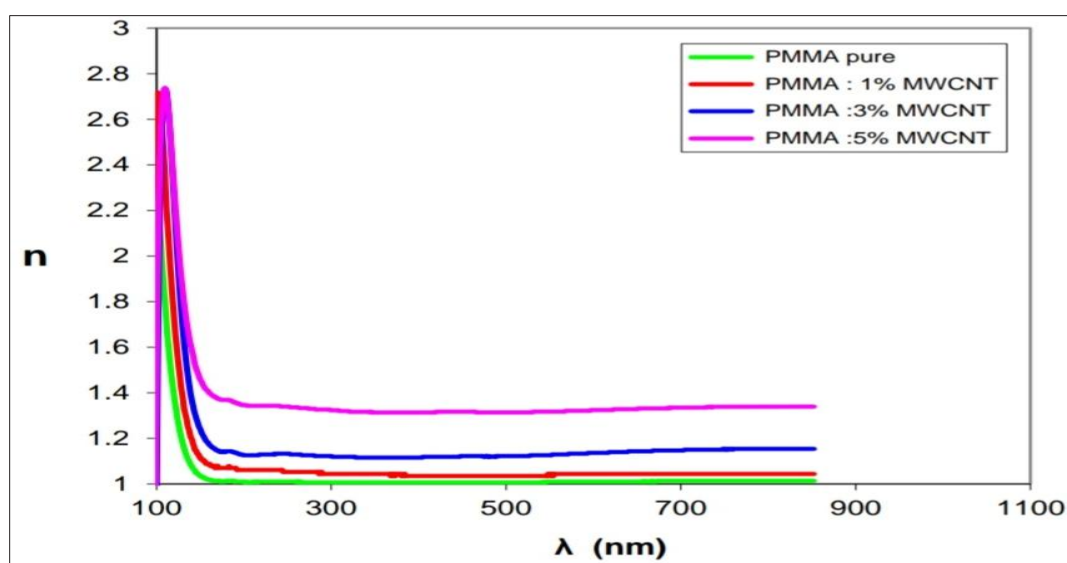


Fig. 5. value of refractive index with wavelength for pure and doped PMMA films.

MWCNTs is more than 2.0 wt.%. [11]

The refractive index (n) for all samples before and after being doped in Fig. 5, will we seen that the n and k values increase with accumulative the doping of MWCNTs [11].

Similar behaviors relate to the density of absorbing centers like layers absorption, singularity in excitation transition and other defects in the crystal lattice and are dependent on the conditions

of the sample preparation. The values of the dielectric constant increases as the wavelength also increases and the doping level of MW-CNTs. At the wavelength of 400 nm the corresponding values of the dielectric constant at 0, 1, 3, and 5 % MW-CNTs contents were 4,5,6 and 7, respectively, and 0.000045, 0.000223, 0.000377 and 0.000442, respectively, at the imaginary part (Figs. 6 and 7). In addition, this gain due to the variation of ϵ_1 chiefly

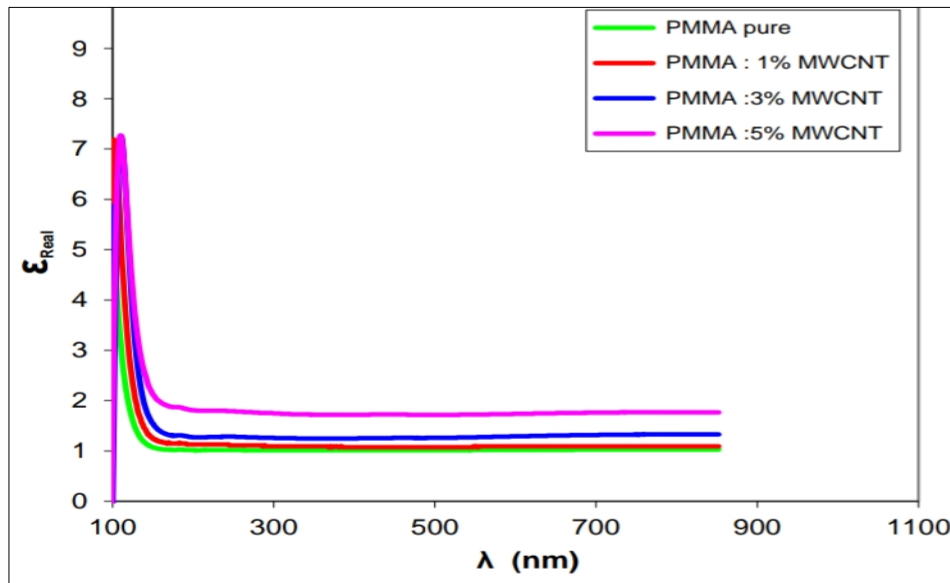


Fig. 6. The real part of dielectric constant via wavelength for pure and doped films.

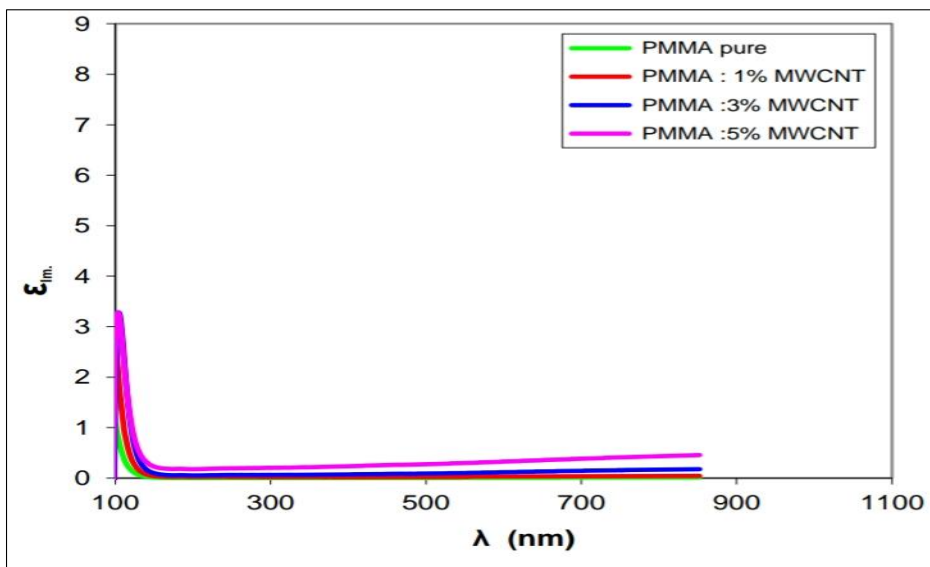


Fig. 7. The variation of imaginary part of dielectric constant with wavelength for pure and doped PMMA films.

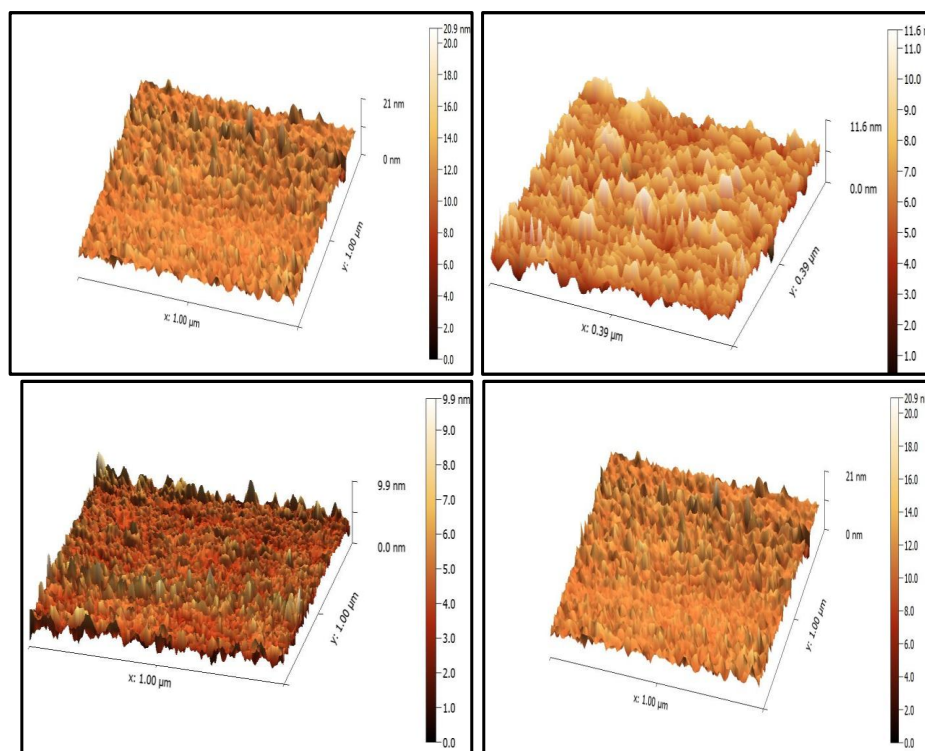


Fig. 8. 3D AFM descriptions of (PMMA-MWCNTs) with different doping concentrations (a) pure PMMA, (b) 1wt%, (c) 3wt%, (d) 5wt%.

relies on n^2 for the reason that of small values of k^2 while ε_2 which is proportionate to k value which is associated to the dissimilarity of absorption coefficients [13].

Surface Morphology of thin films MWCNT_s-PMMA

In line with the inquest into PMMA concentration effect on morphology, the surface topography of the films has been determined by following an AFM method as depicted in Fig. 8. The FS images demonstrated that all films are uniform with no deferent substantial limits across all the concentrations. The R_A with MW-CNT_s 0.75nm, 0.8nm, 10.11 nm and 7.47nm when 0,1, 3, and 5 percent added. The outcomes have demonstrated that the concentration of R_A has been raised in increase of concentration [14]. The viscosity of such a solution with increase in concentration of PMMA also leads to such an increase in surface roughness.

CONCLUSION

Our experiments examined shows MWCNTs are impacting optical properties of PMMA through the technique of spin coating technique.

It is depicted that the electrical conductivity is enhanced three orders of magnitudes when the MWCNTs are incorporated. This is supposed to be because of the creation of conducting ways on the polymer. As the content of MWCNTs on the ratio of 3wt.% to 5 wt.% are added the conductivity rises drastically as well. Hence, it can be said that the conductivity will rise with additions of higher content of MWCNTs. The optical band gap exhibits results that depict a downward trend in optical band gap values, except the two samples (3 wt.% and 5wt.%). This could be due to the absence of dispersion of MWCNTs in PMMA.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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