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RESEARCH ARTICLE

Synthesis of Polymers Containing 5, 5-Dimethylhydantoin and Study of its Optical Properties

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Abstract

In this research work, four aromatic polymers, known as 5,5-Dimethylhydantoin derivatives. 5, 5-dimethylimidazolidine-2,4-dione have been condensed with different dihalolkanes (1,2-dichloroethan and dichloromethane respectively) to give two different poly hetero aromatic polymers. Also 5,5-dimethylimidazolidine-2,4-dione have been treated with chloroacetic acid and polymerized with ethylene glycol and hydroquinone respectively to give two different polyester polymers. The prepared polymers have been identified using FTIR and 1HNMR instruments. All the prepared polymers have shown a high number average molecular weight (Mn) using Gel Permission Chromatography (GPC) technique. Where absorbance was measured by using a device (UV-Spectroscope).The optical properties of the prepared polymers have been studied. The transmittance, absorption coefficient, had been measured. Transmittance values of the four prepared polymers increases with increasing wavelength due to the decrease in absorption values because the transmittance is inversely proportional with absorbance. The absorbance values of the prepared polymers have been decreased with increasing the wavelength. The absorbance spectra of the polymer solution of the concentration (0.3 g/mL %) for polymer N2 and the concentration (0.2 g/ml %) for polymer N3 within the range (200-1100 nm).The highest absorbance value (310 nm) for polymer N2 and (330 nm) for polymer N3. the absorbance spectra of the polymer solution of the concentration (0.3 g/mL %) for polymer N4 and the concentration (0.2 g/ml %) for polymer N5 within the range (200-1100 nm).The highest absorbance value (310 nm) for polymer N4 and (330 nm) for polymer N5.

Keywords: *Absorption coefficient 5, 5-Dimethylhydantoin, Optical properties, Polymers.*

Introduction

Imidazolidine-Dione (hydantoin) find important applications as medicinal (anticonvulsant drugs in the treatment of epilepsy [1, 2], anticancer [3], anti-arrhythmic [4, 5] and antitumor [6] drugs) and so many industrial applications [7].

For the reason that polyester conjugated polymers has a good solubility and excellent processibility, polyesters attracting extra and extra consideration as new optical, electronic and magnetic provisions. Accordingly, actual altered properties are set up for the polyamides than their non branched complements [8-13]. Heterocyclic compounds

can be found in a huge amount of compounds which display manufacturing applications. The molecular structures of the heterocyclic compounds always determine the activity of it [14-17].

The learning of the optical belongings of polymers raises our information of the kind of polymer inside structure, nature of the bonds and increases the possible range of polymer application. Polymers offer notable benefits in optical applications over common

inorganic glasses, particularly in terms of their light weight, impact and smash resistance [18].

Absorbance (A) definite as the relation between absorbed light intensity (I_A) by material and the incident intensity of light (I_o).

$$A = \log \frac{I}{I_o} \quad \text{..... (1)}$$

Where absorbance was measured by using a device (UV-Spectroscope), the ratio (I / I_o) called (transmittance) (T_r), thus can be definite as the relation of the strength of the transmitting waves (I) through the film to the intensity of the instance waves (I_o) on it as follows and connected by absorbance as :

$$T_r = e^{-2.303A} \quad \text{..... (2)}$$

Experimental Work

Chemicals

Chemicals were bought from sigma-Aldrich Company.

Analysis Instruments

^{1}H NMR spectra were recorded on a Bruker AV500 spectrometer operating at 500 MHz. IR spectra were recorded as pellets (KBr) using a Perkin Elmer FT-IR or a Nicolet A 320 FT-IR spectrometer.

Preparation of Compound N

A (0.2 mol, 28.2 gm) bromoacetic acid and (0.1mol, 10 gm) of Imidazolidine-Dione have been melted for 1 hour .A (0.2mol, 8 gm) of NaOH dissolved in 20 ml cold water. The mixture has been refluxed for 5 hrs. The combination then decanted into 150 ml cold water and acidified with 10 % hydrochloric acid. The filtrate collected and recrystallized.

2,2'-(4,4-dimethyl-2,5-dioxoimidazolidine-1,3-diyl)diacetic acid (N), Mp 220–222 °C ; IR (v, cm^{-1}): 1,624 (C=N), 3,200 (NH), 3,550 (SH);1H-NMR (d-DMSO) δ (ppm): 9.85 (s, 2 H, COOH).

Preparation of Compounds N1

Compound N (0.05 mol) have been dissolved in 15 ml of thionyl chloride. The mixture has been refluxed for 3 hours. The excess thionyl chloride has been evaporated using rotary evaporator.

2, 2'-(4, 4-dimethyl-2, 5-dioxoimidazolidine-1, 3-diyl) di acid chloride N1

Preparation of Polymers N2 and N3

A (0.05 mol, 35.32 gm) of compound N2 have been dissolved in a mixture of (0.2 mol, 25 gm) hydroquinone for polymer N2 and (0.2 mol 12.4 gm) ethylene glycol for polymer N3 and 20 ml pyridine. The mixture has been stirred for 24 hours.

20 ml cold water has been added. The precipitate collected by filtration.

Polymer N2

Yield 67%, Mp 200–202 °C; IR (v, cm^{-1}): (3118 and 2891) (Aromatic CH), 2,987-2,848 (C-H aliph.). ^{1}H-NMR (DMSO) δ (ppm): 1.47 (s, 6H CH_3), 4.70 (s, 2H, CH_2 aliph), 6.50-7.10 (d, 4H, Ar-H).

Polymer N3

Yield 70%, Mp 217–219 °C; IR (v, cm^{-1}): 2,987-2,848 (C-H aliph.) ^{1}H-NMR (DMSO) δ (ppm): 1.47 (s, 6H CH_3), 3.60 (m, 2H, CH_2 aliph) 4.20 (m, 2H, CH_2 aliph), 4.80 (s, 2H, CH_2 aliph).

Preparation of Polymers N4 and N5

Polymers N4 and N5 were produced by dissolving sodium metal (0.84gm, 0.03 mol) in 25 ml of absolute EtOH. Imidazolidine-Dione (1.7 gm, 0.017bmol) added, and the solution was boiled up. Benzene was added (45 ml) and Dichloromethane (1.42 gm, 0.b017 mol) for polymer N5 and 1, 2-dichloroethan (1.59 gm, 0.017 mol) for polymer N4. Next the vigorous and spontaneous reaction moderated, 45 ml of benzene was added and the mixture was refluxed for 72 hours. After cooling the reaction mixture, it was filtered off. The solution was vaporized using vacuum pump to give the polymers.

Polymer N4

Yield 67%, Mp 226–228 °C; IR (v, cm^{-1}): 2,987-2,848 (C-H aliph.). ^{1}H-NMR (DMSO) δ (ppm): 1.47 (s, 6H CH_3), 3.60 (m, 4H, CH_2 aliph).

Polymer N5

Yield 70%, Mp 217–219 °C; IR (v, cm^{-1}): 2,987-2,848 (C-H aliph.) ^{1}H-NMR (DMSO) δ (ppm): 1.47 (s, 6H CH_3), 3.90 (m, 2H, CH_2 aliph).

The **polymer N2**and **polymer N3** solution was prepared by dissolving a known weight (0. 2 gm) of **polymer** powder in affixed volume (20 mL) of distil water under stirring at 30 °C for (45 min), until the solution mixture became a homogeneous.

Results and Discussion

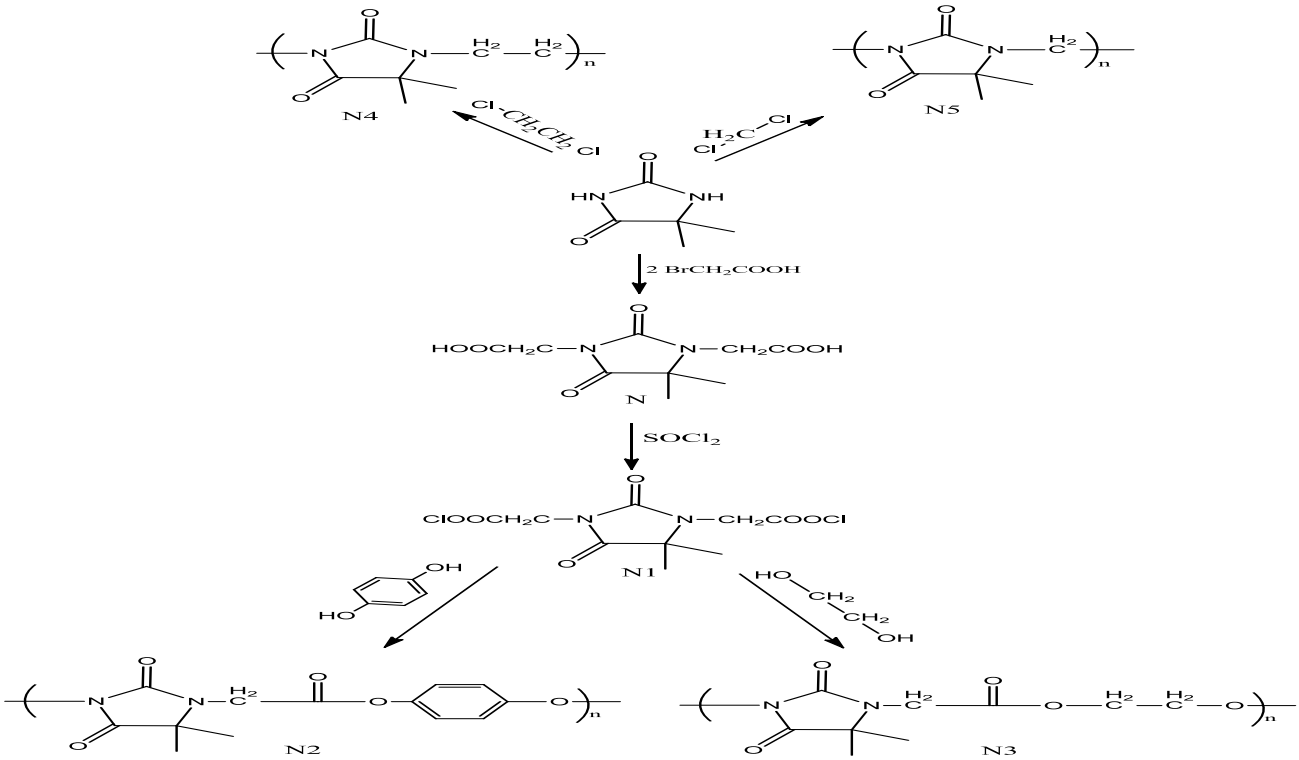
5,5-dimethylimidazolidine-2,4-dione have been treated with bromoacetic acid followed by thionyl chloride and polymerized with hydroquinone to give N2 polymer and ethylene glycol to give N3 polymer (Scheme 1). 5,5-dimethylimidazolidine-2,4-dione have been condensed with different 1,2-dichloroethan to give polymer N4 and dichloromethane to give N3(Scheme 1). All the prepared polymers have been identified using FTIR and ^{1}HNMR.

The number average molecular weight (Mn) of the polymers N2 and N3, measured by gel permeation chromatography (GPC), was found to be 10519 and 12432 respectively.

The number average molecular weight Mn determined by GPC for polymers N4 and N5 14321and 15651 respectively. Fig. (1 and 3) shows the absorbance spectra of the polymer solution where a graph is plotted between the wavelength and absorbance values of the concentration (0.3 g/ mL %) in Fig. (1) For polymer N2 and the concentration (0.2 g/ ml %) in Figure (3) for polymer N3 within the range (200-1100 nm).

The results are shown in Fig. (1 and 2) and it can be observed that the highest absorbance value (310 nm) for polymer N2 and (330 nm) for polymer N3.The wavelengths are higher then the polymer becomes light-emitting. This is due to the fact that by increasing the wavelength of the light, the light energy decreases and the absorbance decrease according to Planck's law [19-22].

Transmittance of the polymer was found by using equation (2) and the result shows transmittance values increase with increasing wavelength due to the decrease in absorption values because the transmittance is inversely proportional with absorbance. Fig (2 and 4) shows that the polymer has high permeability at high wavelength and decrease with low wavelength.



Scheme 1: Synthesis of compound A

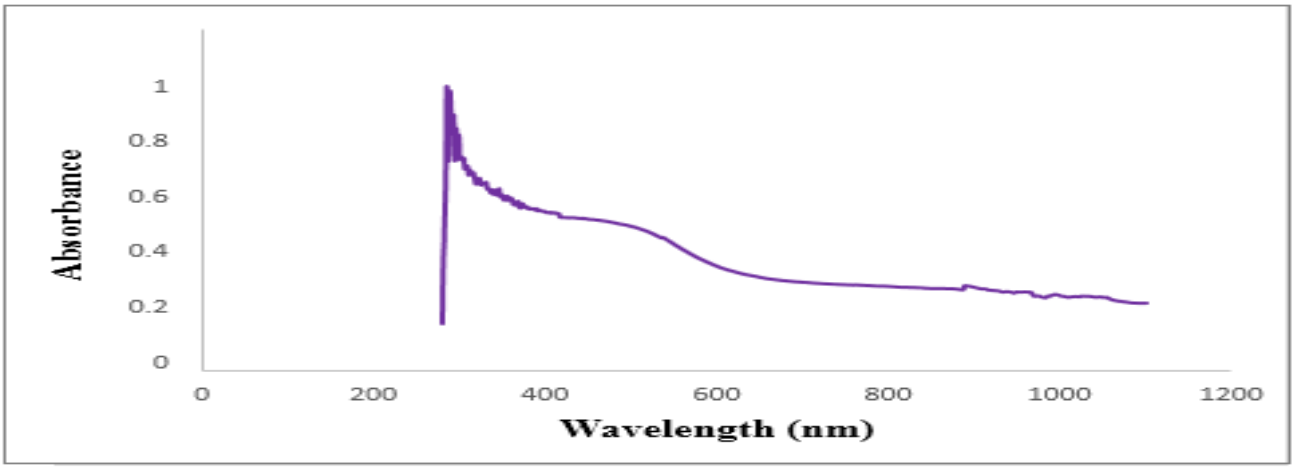


Figure 1: the Absorption verses the wavelength for polymer N2

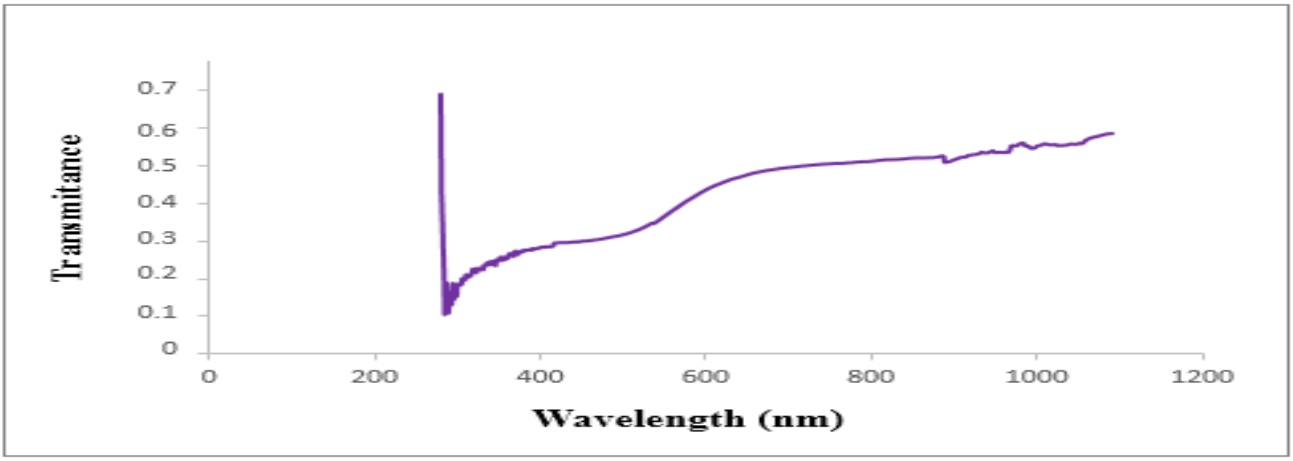


Figure 2: the transmission verses the wavelength for polymer N2

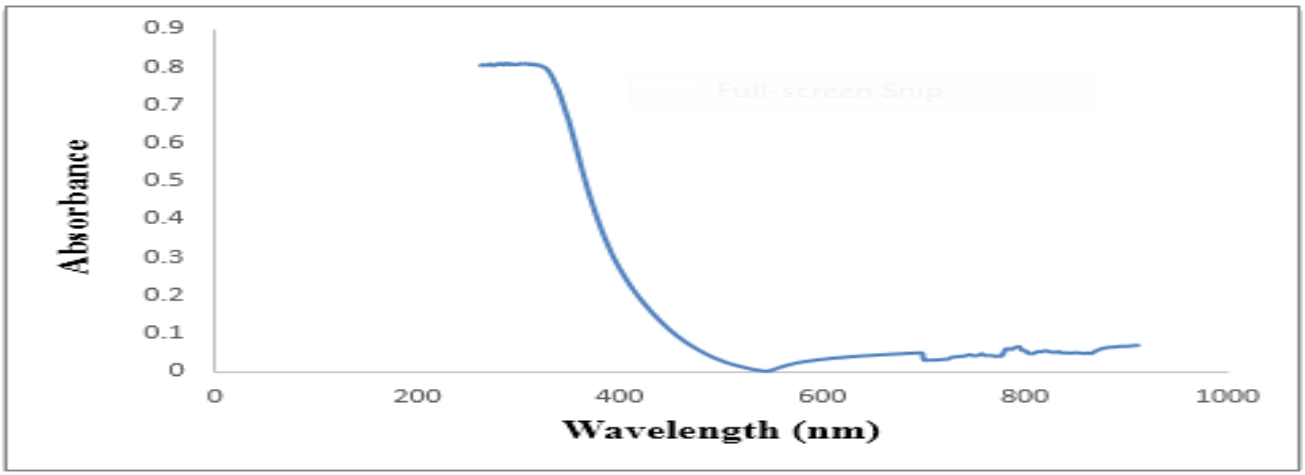


Figure 3: the absorption verses the wavelength for polymer N3

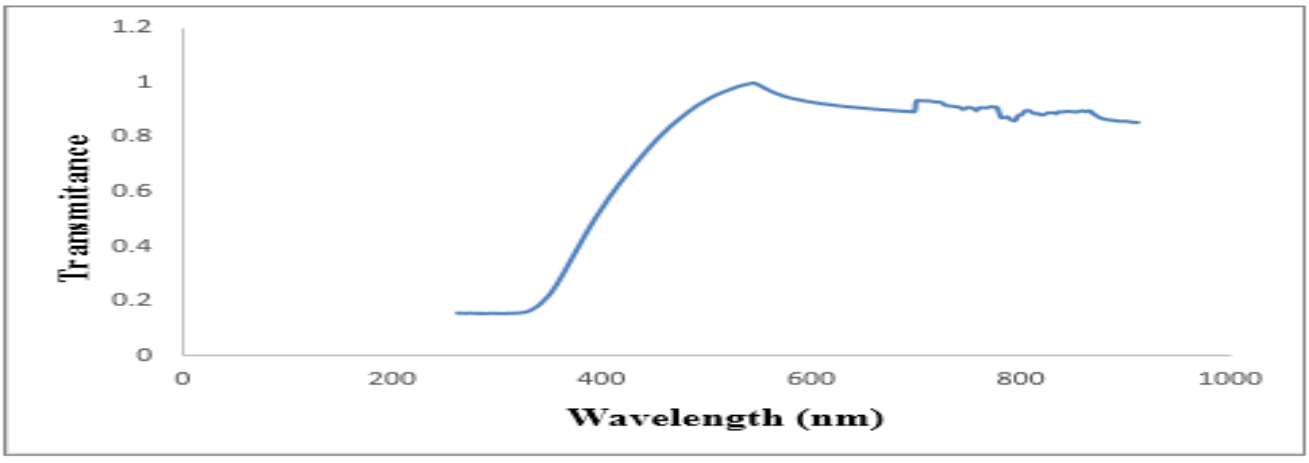


Figure 4: the transmission verses the wavelength for polymer N3

Figure (5 and 7) shows the absorbance spectra of the polymer solution where a graph is plotted between the wavelength and absorbance values of the concentration (0.3 g/mL %) in Figure (5) for polymer N4 and the concentration (0.2 g/ml %) in Figure (7) for polymer N5 within the range (200-1100 nm). The outcomes are shown in Fig. (1 and 2) and it can be observed that the maximum absorbance value (310 nm) for polymer N4 and (330 nm) for polymer N5.The wavelengths are higher than the polymer becomes light-emitting. This is due to the fact that by increasing the wavelength of the light, the light energy decreases and the absorbance decrease according to Planck's law. Transmittance of the polymer was found by using equation (2) and the result shows transmittance values increase with increasing wavelength due to the decrease in absorption values because the transmittance is inversely proportional with absorbance. From Figure (6 and 8) we can notice that the polymers have high permeability at high wavelength and decrease with low wavelength.

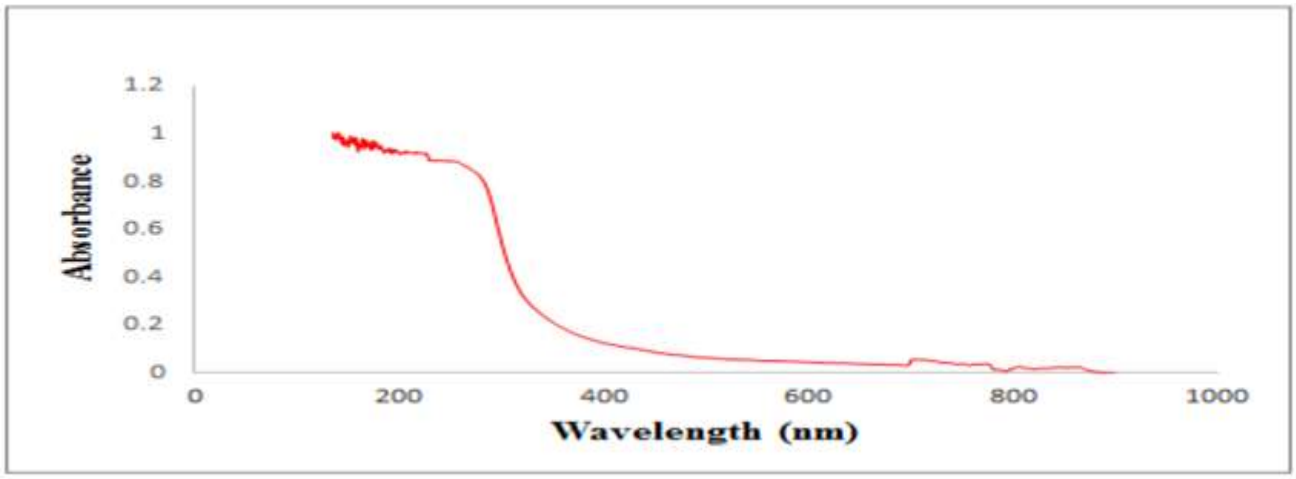


Figure 5: The absorption verses the wavelength for polymer N4:

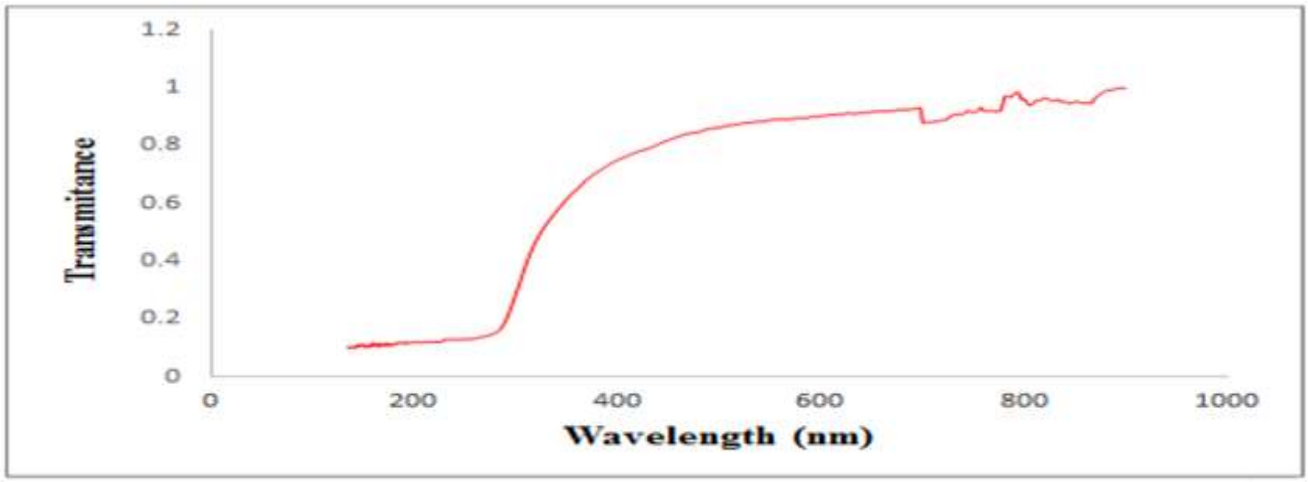


Figure 6: the transmission verses the wavelength for polymer N4

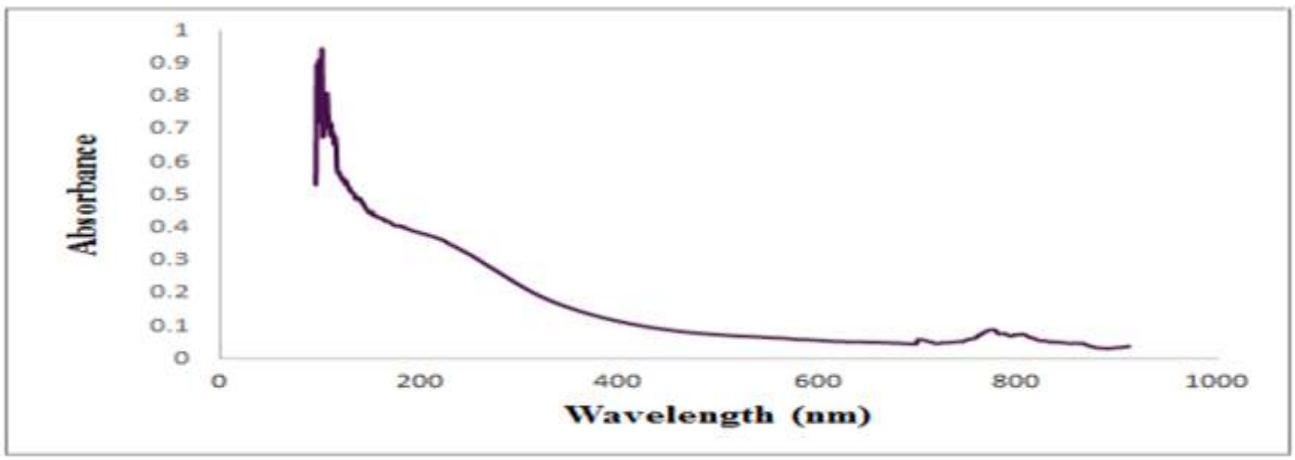


Figure 7: the absorption verses the wavelength for polymer N5

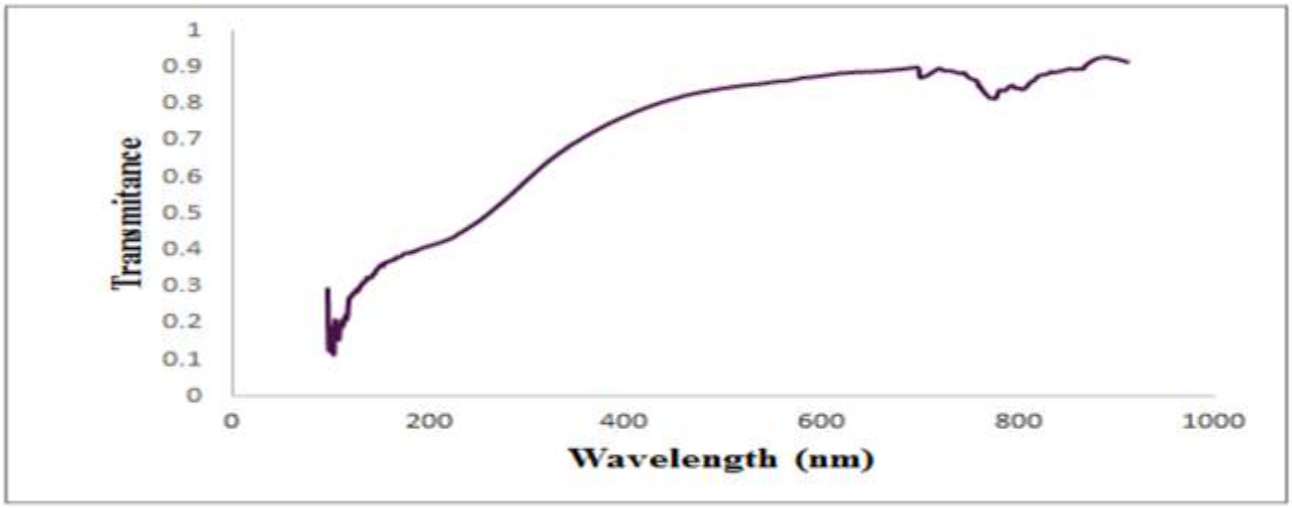


Figure 8: the transmission verses the wavelength for polymer N5

Conclusion

- The new semiconductor films prepared by drop casting method.
- Transmittance values increase with increasing wavelength.
- Properties are decreased values with wavelength values except the transmittance, it increases with increasing wavelength.

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