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Study of Some Optical Properties of Polyaniline Polymer

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Abstract : Some of optical properties of polyaniline (PA) dissolves in dimethylformamide (DMF) had been studied at different concentrations (0.1, 0.2, 0.3 and 0.4) g./mL %. The optical properties had been measured which included measuring absorbance and refractive index and from these two properties other properties were calculated such as: transmittance, reflectance, molar reflectance, coefficient of fineness, critical angle and Brewster angle. The results show that all these properties are increased values with increased concentration except the transmittance and the critical angle, it decreases with increasing concentrations.
Key words : Polyaniline, Optical Properties, Transmittance.

Introduction

Polyaniline is an inherently conductive polymer (ICP) and is polymerized from the monomer aniline and exists in three stable oxidation states which are shown in figure(1)[1]:

leucoemeraldine- white/clear poor conductivity

emeraldine- green or blue good conductive if doped

pernigraniline- blue/violet poor conductivity

The leucoemeraldine state is fully reduced when the pernigraniline state is fully oxidized and in the emeraldine state there is an equal amount of reduced and oxidized repeating units.

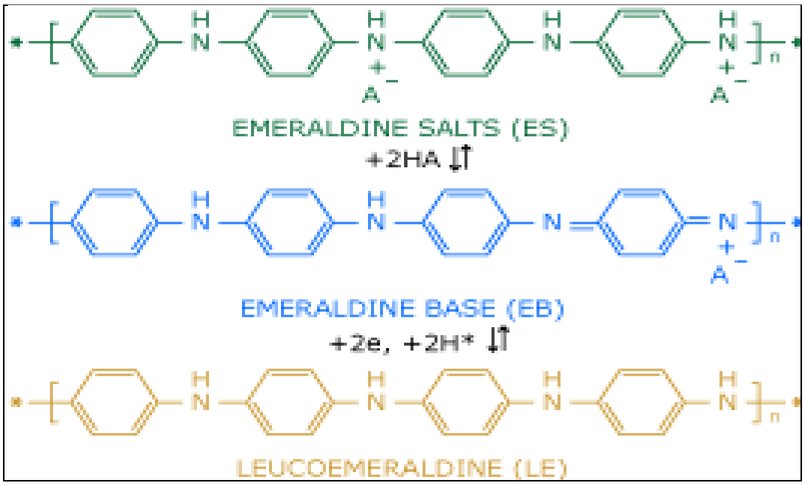

Figure (1) Three stable oxidation states of the monomer aniline [1]

The emeraldine state that is also called as the emeraldine base (EB) is the most useful state of these three, because of its stability at room temperature and conductivity. emeraldine base can be either neutral or doped with to achieve conductivity. Doping EB with an acid (dopant) results in an emeraldine salt (ES) that is electrically conductive figure(1). The leucoemealdine and pernigr aniline states are poor conductors even when doped[2].

Oxidation polymerization with the oxidant ammonium persulfate is probably the most common synthesis of polyaniline. The monomer and the oxidant is first dissolved in hydrochloric acid and after that they are slowly added to each other. This is a highly exothermic reaction. The reaction product is an unstable dispersion, with micronscale particules.

Application based on conductivity[2]

Dissipative/antistatic films, coatings, adhesives, plastics, rubbers, fibers , electromagnetic shielding, printed circuit board, artificial nerves, piezo ceramics, diodes, transistors, aircraft structures and switches.

Application based on electroactivity

Chemical, bio-chemical and thermal sensor, solid electrolytes, rechargeable batteries, electrolytic and super capacitors, drug release systems, molecular electronics, electric displays, optical computer, 'Smart' structures, electromechanical activators and ion exchange membranes[3].

Aim of the research is to prepare different concentrations of polymer polyaniline and study the optical properties of the prepared concentrations of polymer polyaniline.

1- Theoretical Part

The study of the optical properties of polymers increases our knowledge of the type of polymer internal structure,nature of the bonds and expands the potential scope of polymer application. Polymers provide remarkable advantages in optical applications over common inorganic glasses,especially with respect to their light weight, impact and shatter resistance [4,5].Absorbance (A) defined as the ratio between absorbed light intensity (I_A) by material and the incident intensity of light (I_o) [6].

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

Where absorbance was measured by using a device (UV-Spectroscope), the ratio (I / I_o) called (transmittance) (T_r), so can be defined as the ratio of the intensity of the transmitting rays (I) through the film to the intensity of the incident rays (I_o) on it as follows and connected by absorbance as [7]:

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

Refractive index is defined as the ratio between the speed of light (c) in a vacuum to the speed (v) of any center of a certain length and a certain wavelength, gives the following equation [8]:

$$n = \frac{c}{v} \quad \text{......................................} (3)$$

Reflectance known as the ratio of the reflected light energy into light energy falling. Reflectance given value for the fall when the vertical angle of falling the following equation [9,10]:

$$R = \left[\frac{n-1}{n+1}\right]^2 \quad \text{..........................} (4)$$

We can also calculate the Reflectance of the following relationship [11]:

$$R = 1 - A - T_r \text{ ....} (5)$$

It called the relationship between the density and molecular weight Reflectance molar which is measured in units (m^3 / mol) and is given by [12,13]:

$$R_m = \frac{n^2 - 1}{n^2 + 1}\frac{M_v}{\rho} \text{ ....} (6)$$

Coefficient of fineness is defined as a measure of the sharpness of interference fringes, calculated from the equation [14]:

$$F = \frac{4R}{(1-R)^2} \text{ ....} (7)$$

The critical angle is defined as angle which provides an angle of reflection of (90^o), is given to the equation [15]:

$$\theta_c = \text{Sin}^{-1}(1/n) \text{ ....} (8)$$

It is the angle of incidence at which light with particular polarization is perfectly transmitted through a transparent dielectric surface, with no reflection. When unpolarization light is incident at this angle, the light that is reflected from the surface is therefore perfectly polarized. This special angle of incident is named after the Scottish physicist Sir David Brewster (1781-1868), and given by follow equation [16]

$$\theta_B = \tan^{-1}(n) \text{ ....} (9)$$

2- Results and Discossions

In this paragraph will be illustrate the results obtained and discuss all the results that have been obtained scientific discussion and clear.

3-1- Absorbance

Absorbance change with the changing concentrations of (PA) shown as figure (2). Through it we can observe the increasing Absorbance values due to the steady increase of the concentration where it is directly proportional to the absorbance according to Lambert Beer law, and the reason for this is due to the increased concentration within the same volume of the solution, the number of particles increases it exposed to absorb the incident light and thereby increasing the value of absorbance and this applies with Lambert Beer law[17,18].

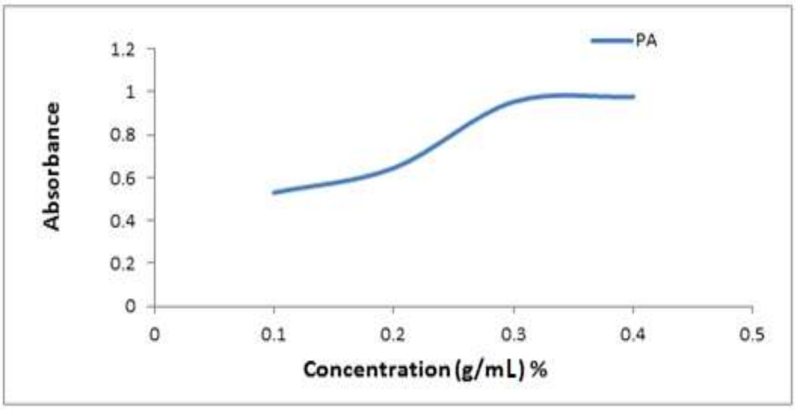

Figure (2) Absorbance as a function of concentration

3-2- Transmittance

It has been found transmittance of the (PA) using equation (2) and the results showed increased the polymer concentration of the transmittance begins decreased because an inverse relationship between the absorbance and transmittance. From figure (3) we note that the polymer is a record high[19].

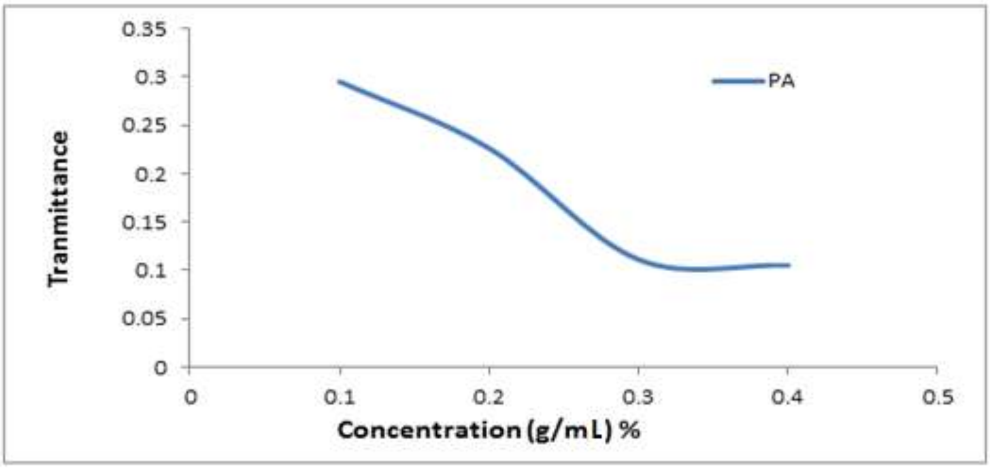

Figure (3) Transmittance as a function of concentration

3-3- Refractive Index

Was measured refractive index practically all polymer solutions using to measure the refractometer and the results illustrated in figure (4), it shows that the refractive index values increase with increasing concentration of polymer (PA). The reason for this is due to that when you increase the concentration increases the value of density and density are important function to calculate the refractive index so increasing the refractive index values greater concentration[20].

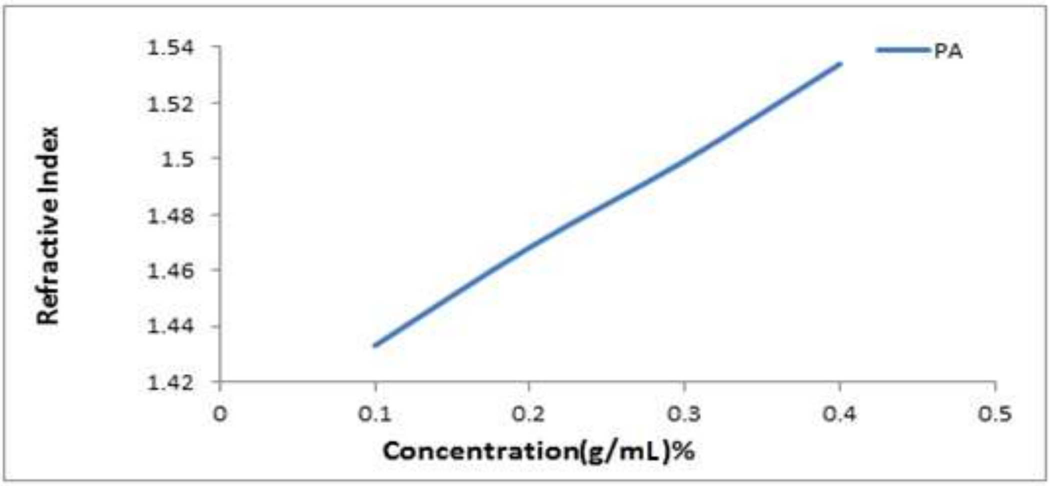

Figure (4) Refractive index as a function of concentration

3-4- Reflectance

Reflectance values been found for all polymer solutions of the equation (4) and these values increase with increasing concentrations reason for this is due to the increased number of polymer molecules in solution, thereby increasing the density of the solution as the reflectance totally dependent on the density .

The figure (5) shows that the values of reflectance varies linearly with increasing concentration and can be explained on the basis of reflectiveness depending on the refractive index as the relationship (4) Therefore, the reflectance behave similar to the refractive index before and after the addition [20].

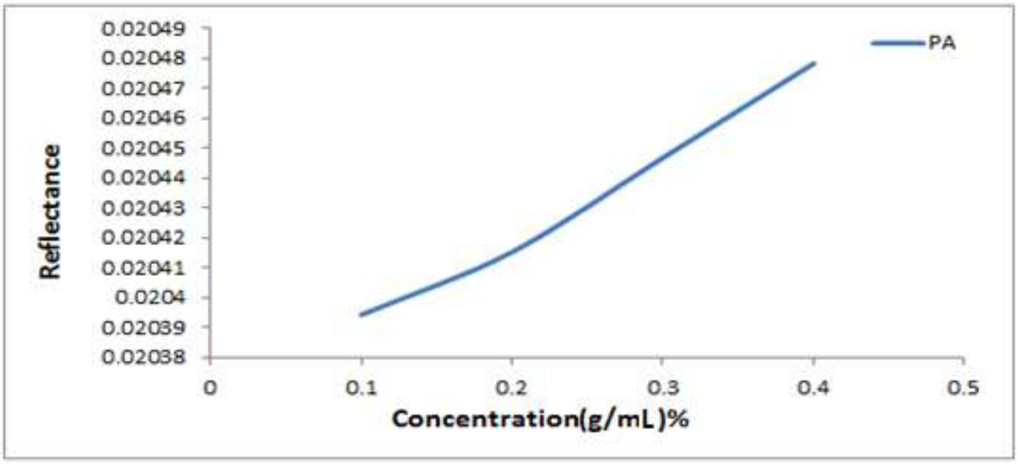

Figure (5) Reflectance as a function of concentration

3-4- Molar Reflectance

Has been found molar reflectance from relationship (6), the figure (6) showed increased molar reflectance values with an increased concentration reason for this is due to the increase in the values of a number of polymer molecules, thereby increasing molecular weight, where the molar reflectance proportional to the molecular weight [21].

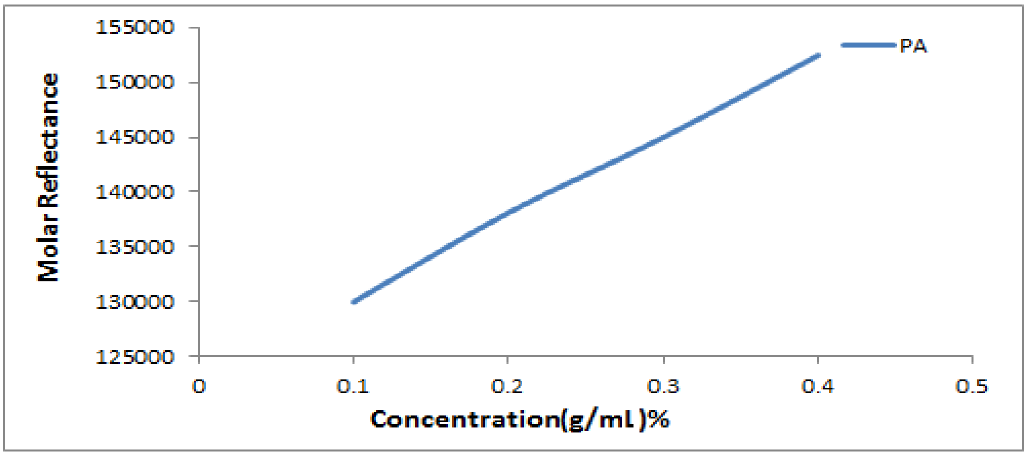

Figure (6) Molar reflectance as a function of concentration

3-6- Coefficient of Fineness

It has been found coefficient of fineness values of polymer solutions through the equation (7) and the results of increased coefficient of fineness with increasing emphasis as shown in figure (7)[21].

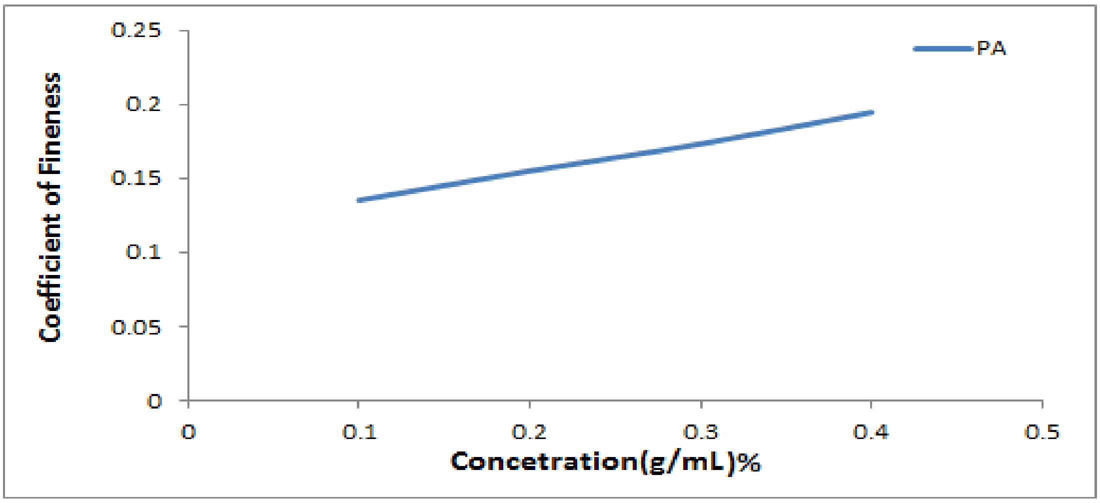

Figure (7) Coefficient of fineness as a function of concentration

3-7- Critical Angle

It has been found critical angle values of the relation (8) and the results are shown in figure (8). When the fall of the rays from the center of the highest density (solution) to the center of lower density (air) will happen reflection of internal total if the fall is greater than the critical angle. This means that any increase in the center density lead to increased refractive index, and as the critical angle related reverse with refractive index, any increase in the refractive index causes a decrease in the critical angle[17].

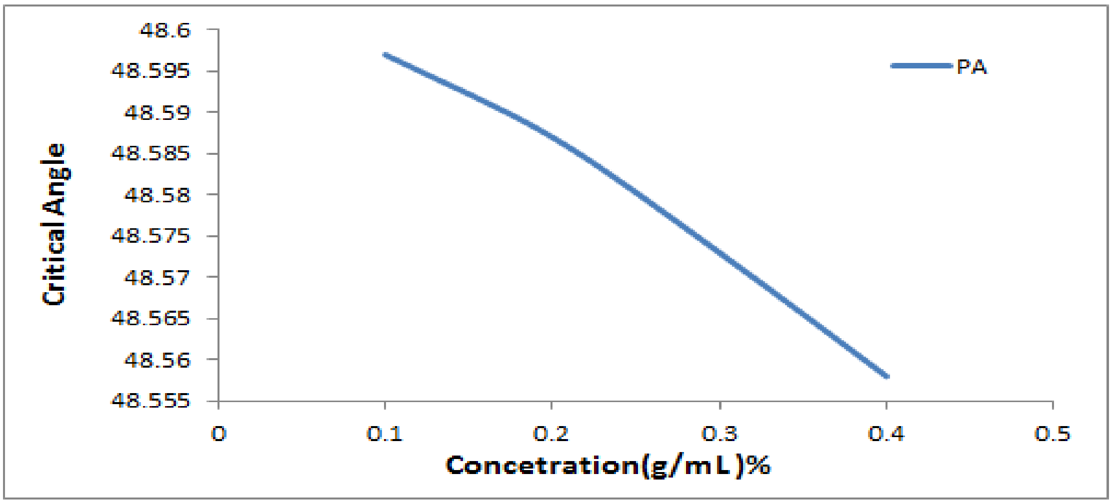

Figure (8) Critical angle as a function of concentration

3-8- Brewster Angle

Brewster angle has been found from the relationship (9) and the results of increasing the values of the Brewster angle with increased concentration as shown in figure (9). It Brewster angle values mainly depends on the values of the refractive index as be of a positive relationship with a refractive index[21].

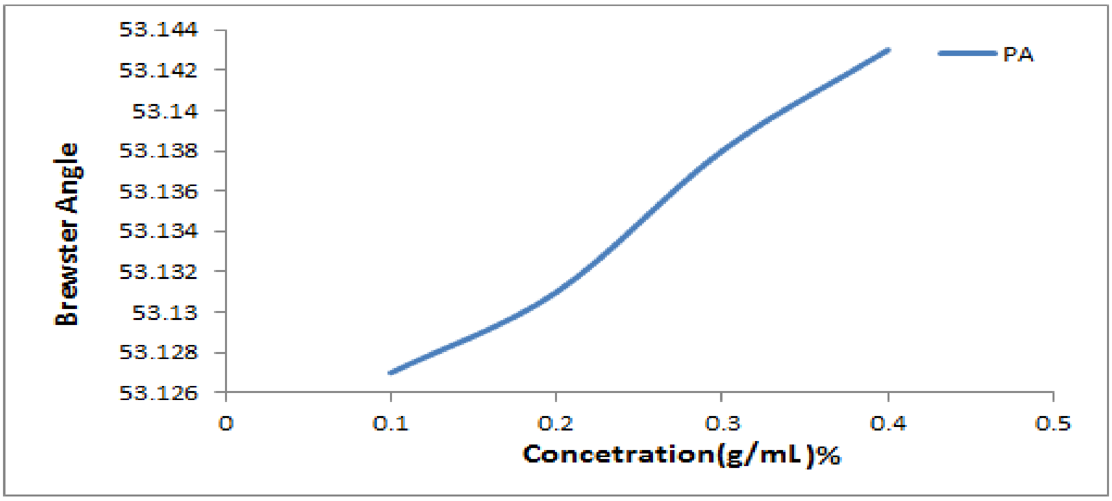

Figure (9) Brewster angle as a function of concentration

4- Conclusions

1. The concentrations prepared by dissolved polyaniline by (DMF).
2. The results show that all these properties are increased values with increased concentration except the transmittance and the critical angle, it decreases with increasing concentrations.

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