Preparation and Characterization of (Pva-$Sncl_2$) Composites

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ABSTRACT

In the present work, the effect of tin chloride SnCl2 addition on some optical properties of poly-vinyl alcohol has been studied. For that purpose , many samples has been prepared by adding $SnCl_2$ to the poly-vinyl alcohol with different weight percentages from $SnCl_2$ with polymer and by different thickness .The absorption and transmission spectra has been recorded in the wavelength range (190-890)nm . The absorption coefficient, refractive index, extinction coefficient and energy gap of the indirect allowed transition have been determined.

Keyword: Composites, optical properties

INTRODUCTION

Polymers have traditionally been considered as insulating materials by chemists and physicists alike. A conducting polymer is chewable and desirable. A light weight ready moldable, desirable conductive material has long been recognized as a worthwhile goal to work for [1, 2].Researches, generally, have demonstrated that conductive polymers can be used as energy storage element in: [3, 4]

1. Capacitors and Secondary batteries.
2. As semiconductor material in Schottky diode.
3. Insulated gate field effect transitions (FET) and light emitting diodes.
4. As conductive layer for electromagnetic shielding (EMI) a ndelectrostatic protection.

In the recent years conjugated conducting polymers have been the main focus of research throughout the world. Since the discovery led by 2000 chemistry Nobel winners, Shirakawa, MacDiarmid and Heeger, the perception that plastic could not conduct electricity has changed Nowadays, conducting polymers also known as conductive plastics are being developed for many uses such as corrosion inhibitors, compact capacitors, antistatic coating, electromagnetic shielding and smart windows; which capable to vary the amount of light to pass [5, 6].

EXPERIMENTAL WORK

The material used in this paper is poly-vinyl alcohol as matrix and tin chloride $SnCl_2$ as filler. The electronic balanced of accuracy 10^{-4} have been used to obtain a weight amount of $SnCl_2$ powder and polymer powder. The weight percentages of $SnCl_2$ are (0, 1, 2, and 3) wt%. The transmittance & absorbance spectra of (PVA- $SnCl_2$) composites have been record in the wavelength range (190-890) nm using double-beam (CICEL) spectrophotometer.

RESULTS AND DISCUSSION

Figure (**1**) shows the absorbance spectra as function of the wavelength of the incident light for different filler concentration. As it is shown in figure, the adding of the filler to the polymer lead to increase the peak intensity, and there is no any shift in the peak position for all amounts of the added filler to the polymer.

Chemically, that means this addition do not change the structure of the (PVA- $SnCl_2$) composites .The increasing of the absorbance values with the increasing of weight percentage of the added tin chloride can be explained by the fact that the tin chloride ions absorbed the light incident on them [7, 8].

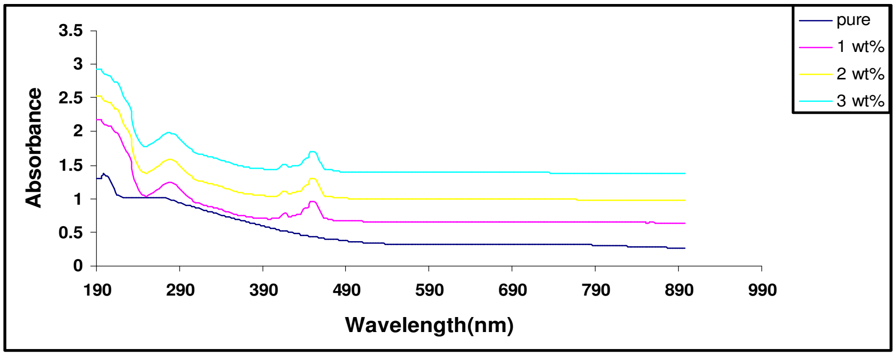

Figure 1. The absorbance spectra of (PVA- $SnCl_2$) composites as function of incident light wavelength

Figure(2) shows the optical transmittance spectra as function of wavelength of incident light for several concentration of the added ions , the polymer transmittance decrease with the increasing of the added ions concentration ,this is due to the added Tin Chloride molecules that contains in it is outer orbits, these electrons absorb the electromagnetic energy of the incident light ,then, as a result electrons excited to higher energy levels, this process is not accompanied by emission of radiation because the electron that moved to higher levels have occupied vacant positions of energy bands, thus part of the incident light is absorbed by the substance and does not penetrate through it ,on the other hand the pure poly-vinyl alcohol has high transmittance because there are no free electron (i.e .electrons are strongly linked to them atoms through covalent bonds) ,i.e. the breaking of electron linkage and moving to the conduction band need photon with high energy [7].

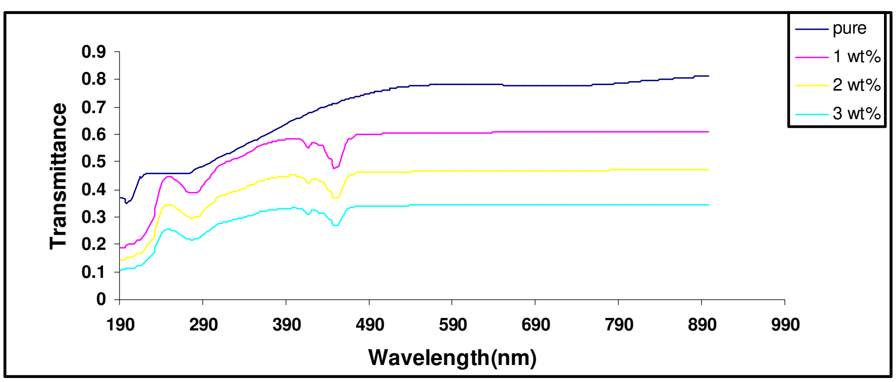

Figure 2. The Transmittance spectra of (PVA-$SnCl_2$) composites as a function of incident light wavelength

The absorption coefficient (α) was calculated in the fundamental absorption region from the following equation [9]:

$$\alpha = 2.303\frac{A}{d} \qquad (1)$$

Where: A absorbance and d the thickness of sample.

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Figure (3) shows the relationship between the absorption coefficient and photon energy of the ($PVA-SnCl_2$) composites we note the change in the absorption coefficient is small at low energies this is indicates the possibility of electronic transitions is a few. At high energy, the change of absorption coefficient is large this is indicates the large probability of electronic transitions are the absorption edge of the region [10]. The absorption coefficient helps to conclude the nature of electronic transitions, when the high absorption coefficient values ($\alpha>10^4 cm^{-1}$) at high energies we expected direct electronic transitions, and the energy and momentum preserve of the electron and photon, when the values of absorption coefficient is low ($\alpha<10^4 cm^{-1}$) at low energies we expected in this case indirect electronic transitions, the momentum of the electron and photon preserves by phonon helps. The results showed that the values of absorption coefficient of the $PVA-SnCl_2$ composites less than $10^4 cm^{-1}$ which indicates to the indirect electronic transition. The forbidden energy gap of indirect transition calculated according to the relationship [11]:

$$\alpha h v = A(hv - E_g)^m \quad ....(2)$$

Where: hv the energy of photon, A proportionality constant, Eg forbidden energy gap of the indirect transition.

If the value of (m=2) indicates to allowed indirect transition. When the value (m=3) indicates to forbidden indirect transition.

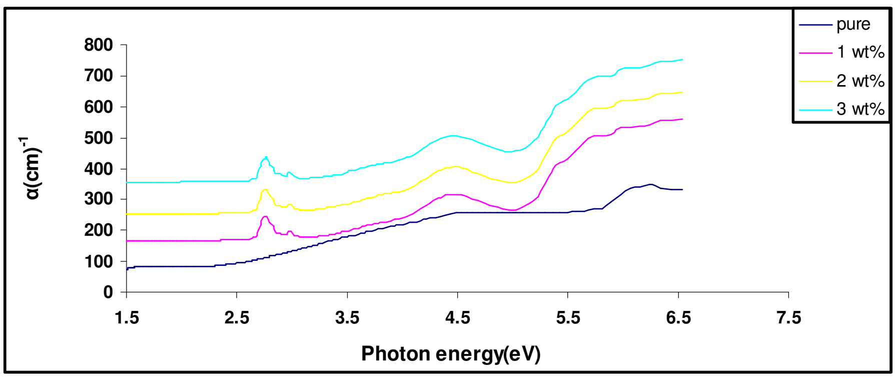

Figure 3. The relationship between the absorption coefficient and photon energy of the ($PVA-SnCl_2$) composites

Figure (4) shows the relationship between $(\alpha hv)^{1/2}$ $(cm^{-1}.eV)^{1/2}$ and the photon energy of pure polymer (PVA) , with take over part of the straight cut oriented axis at the point $(\alpha hv)^{1/2}$ =0 will get the value of forbidden energy gap of the allowed indirect transition , which equal (4. 8eV).

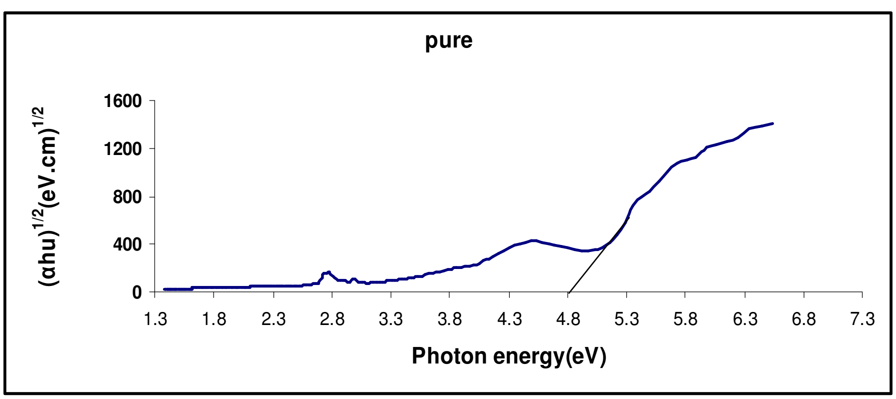

Figure 4. The relationship between $(\alpha hv)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of pure polymer (PVA)

Figures (5, 6 and 7) represents the same relationship but to the polymer filled with ($SnCl_2$) with weight percentages of $SnCl_2$ are (1 , 2,3) wt% , the same way we can be obtained on the value of forbidden energy gap of allowed indirect transition which equal (4.3eV) for 1 wt% $SnCl_2$, and (3.7eV) for 2 wt.% $SnCl_2$ and (3.3 eV) for 3 wt% . we note that the value of the forbidden energy gap decreases with increasing $SnCl_2$ concentration

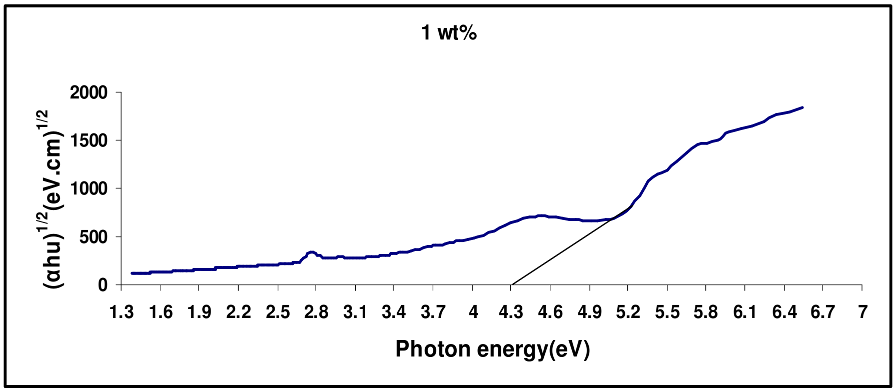

Figure 5. The relationship between $(\alpha h\nu)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PVA-$SnCl_2$ composites for 1 wt% $SnCl_2$

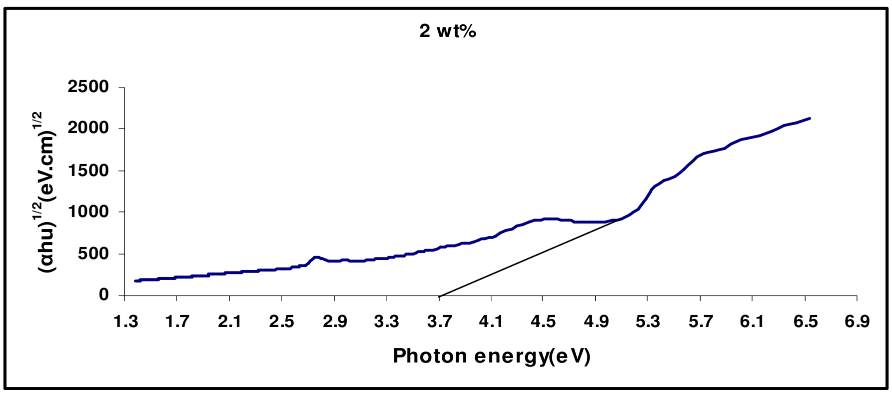

Figure 6. The relationship between $(\alpha h\nu)^{1/2}$ $(cm^{-1}.eV)^{1/2}$ and photon energy of PVA-$SnCl_2$ composites for 2 wt% $SnCl_2$

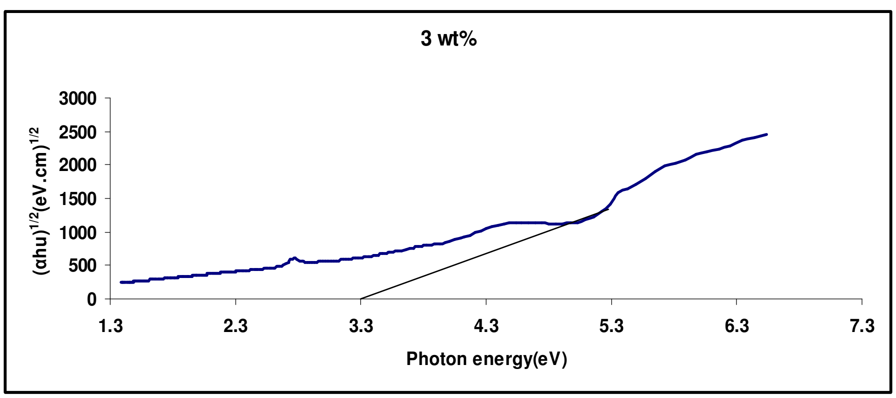

Figure 7. The relationship between $(\alpha h\nu)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PVA-$SnCl_2$ composites for 3 wt% $SnCl_2$

Figure (8) shows the variations of extinction coefficient (k) with wave length for pure and doped PVA with $SnCl_2$. This figure shows that, k value increases with increasing of doping concentration. The behavior of extinction coefficient (k) can be ascribed according to high

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absorption coefficient. This result indicates that the doping atoms of $SnCl_2$ will modify the structure of the host polymer. An interesting result is $SnCl_2$ doping increases the absorbance in the visible region [12].

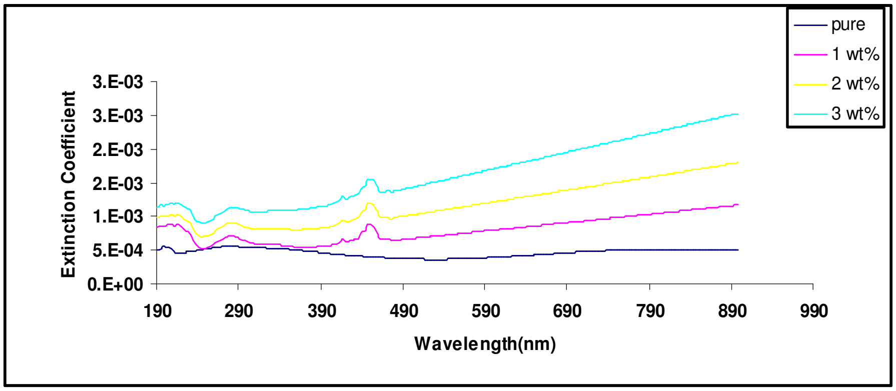

Figure 8. The relationship between the extinction coefficient (k) and wave length(λ) of the PVA-$SnCl_2$ composites

Figure (9) shows the variation of refraction coefficient of PVA- $SnCl_2$composites as a function of the incident light wavelength. From the figure we can see that the refractive index increase with the increasing of the weight percentage of the added $SnCl_2$ to the PVA. The reason of this result is because of the increased intensity of the resulting composite, in other words, due to the increasing of the free electrons number. Figure (9) also shows that the pure poly-vinyl alcohol has low refractive index because poly-vinyl alcohol is amorphous crystalline substance with low density.

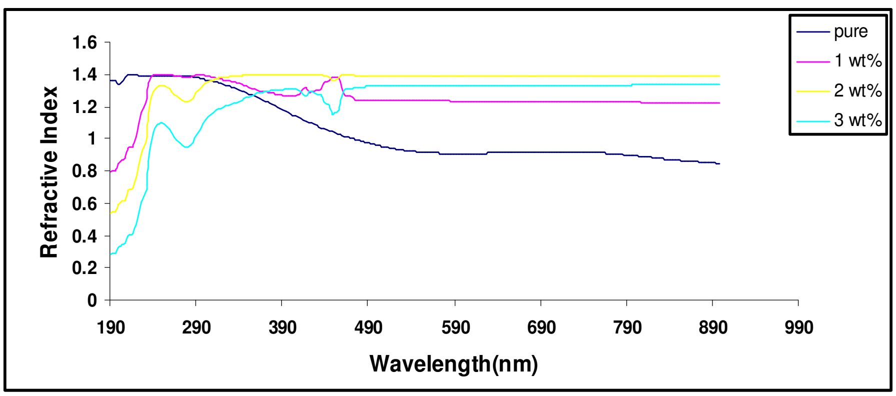

Figure 9. The imaginary dielectric constant of PVA-$SnCl_2$composites as a function of incident light wavelength

CONCLUSION

1. The absorption coefficient is increasing with increasing of the filler wt. % content.
2. The absorption coefficient less than $10^4 cm^{-1}$ this is indicates to forbidden and allowed indirect electronic transitions.
3. The forbidden energy gap is decreasing with increasing of the filler wt. % content.
4. The extinction coefficient and refractive index are increasing with increasing of the filler wt. % content.

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