DOPING EFFECT ON OPTICAL CONSTANTS OF POLY-VINYL CHLORIDE (PVC)

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ABSTRACT

In the present work, the effect of silver acetic ((CH_3COO) Ag) addition on some optical properties of poly-vinyl chloride has been studied. For that purpose, many samples has been prepared by adding ((CH_3COO) Ag) to the poly-vinyl chloride with different weight percentages from ((CH_3COO) Ag) 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, real and imaginary dielectric constant and optical conductivity have been determined.

Keyword: Composites, optical properties

INTRODUCTION

Vinyl chloride monomer and its polymers occupy a unique place in the history of plastics. Arriving early in technology of synthetic resins, they have not been displaced by newer polymers. To the contrary, they have become increasingly important [1].

Vinyl chloride had its beginning in the laboratory of the French chemist Regnault [2]. In 1835, he produced vinyl chloride by mixing ethylene dichloride with an alcoholic solution of potassium hydroxide. The material remained laboratory curiosity, however, until Ostromislensky [3], investigated vinyl chloride chemistry in 1912.

The First World War resulted in heavy demands on German's chemical industry. Because of a rubber shortage, German chemists again investigated Regnault's work, and in 1917 Klatte and Rollet [4], developed the first practical method of polymerizing vinyl chloride. The polymer was called poly (vinyl chloride), which is abbreviated PVC, and it is found wide acceptance as substitute for rubber as well as building materials.

In the United Kingdom PVC was not produced on commercial basis until the outbreak of the Second World War [1].

This copolymer is produced by addition polymerization of the monomer vinyl chloride, figure (1), [5]: -

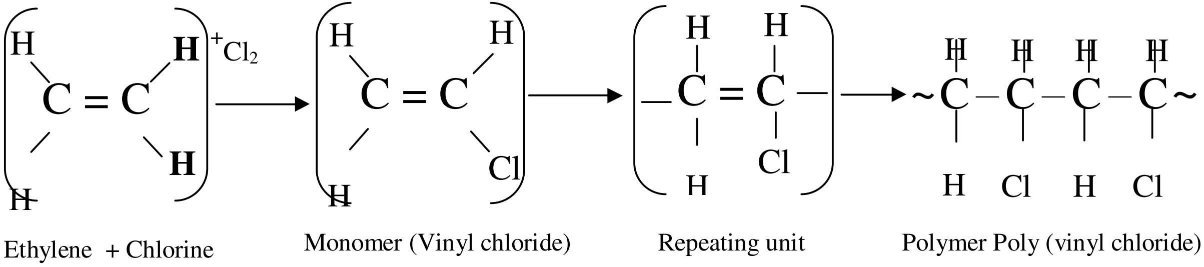

Figure 1. Polymerization of poly (vinyl chloride)

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Poly (vinyl chloride), PVC, is a linear - chain polymer figure (1) with bulky chlorine side-grubs which prevent crystalline regions occurring normally. PVC is hard and rigid material at room temperature [6].

Straight Poly (vinyl chloride) is colorless rigid material. It has relatively high density and low softening point [7].

The presence of the chlorine atom causes an increase in the inter chain attraction, hence an increase in the hardness and stiffness of the polymer is recognized. PVC is also polar polymer because of C-Cl dipole. These properties make PVC polymers as good candidate in the application involving high frequencies because of high dielectric constant and high power factor values higher than polyethylene owing to the polar carbon- chlorine bond [7, 8].

Ploy (vinyl chloride) has very limited solubility. The most effective solvents are those which appear to be capable of some form of interaction with the polymer. It has been suggested that ploy (vinyl chloride) is a weak proton donor and effective solvents are proton acceptor [9]. Thus the PVC polymer is soluble at room temperature in oxygen - containing solvents such as ethers e.g. dioxane, tetrahydrofuran; ketones, e.g. cyclohexanone, methyl isobutyl ketone and nitro compounds, e.g. nitrobenzene [10].

The importance of PVC in the field of plastics, in rigid form of PVC, can be extruded into pipe, conduit, or sheet. While in flexible form it can be substituted for rubber in low-voltage cables and house wiring [7]. This polymer may be regarded as the most widely used plastic material important applications from high volume construction related products to simple electric wire insulation and coatings [11].

EXPERIMENTAL WORK

The materials used in this paper are poly-vinyl chloride as matrix and silver acetic ((CH_3COO) Ag) as filler.

The electronic balanced of accuracy 10^{-4} have been used to obtain a weight amount of ((CH_3COO) Ag) powder and polymer powder. The weight percentages of ((CH_3COO) Ag) are (0, 2, 4, and 6) wt%. The transmittance & absorbance spectra of (PVC -((CH_3COO) Ag)) composites have been record in the wavelength range (190-890) nm using double-beam (CICEL) spectrophotometer .

RESULTS AND DISCUSSION

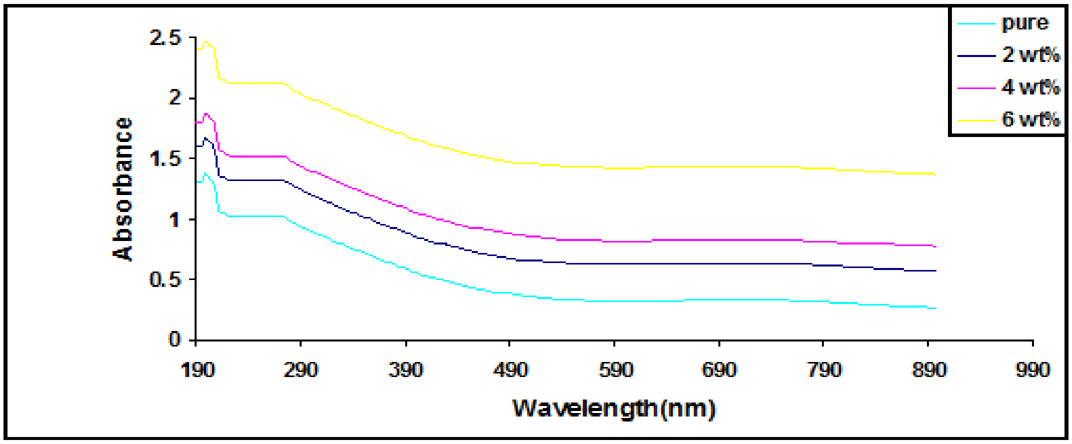

Figure 2. The absorbance spectra of PVC-((CH_3COO) Ag) composites as function of incident light wavelength

Figure (2) shows the absorption spectrum of (PVC-((CH_3COO) Ag)) composites as a function of the wavelength of the incident light. It is shown that the adding of the filler to the polymer leads to increase the intensity of the peak.

So, there is no shift in the position of the peak for all amounts of filler adding to the polymer. Chemically that means this addition do not change the structure of the (PVC-((CH_3COO) Ag)) composites .The increase of absorbance with the increase of weight percentage of the added silver acetic can be explained by the fact ((CH_3COO) Ag)) ions absorbed the incident light on them ,in other words ions absorb the incident light by the free electrons .Consequently ,by the increasing the weight percentage of added ((CH_3COO) Ag)), absorbance increase [12].

Figure (3) shows the optical transmittance spectrum as a function of wavelength of incident light on ((PVC-((CH_3COO) Ag))) films by adding different rate of the added ions .The figure shows that transmittance decrease with the increase of the added ions concentration ,this is caused by the added ((CH_3COO) Ag))contains electrons in it is outer orbits can be absorb the electromagnetic energy of the incident light and travel to higher energy levels, this process is not accompanied by emission of radiation because the traveled electron to higher levels have occupied vacant positions of energy bands ,thus part of the incident light is absorbed by the substance and dose not penetrate through it ,on the other hand, the pure Ploy(vinyl chloride) has high transmittance because there are no free electron (i.e .electrons are linked to atoms by covalent bonds) ,this is because the breaking of electron linkage and moving it to the conduction band need to photon with high energy [12].

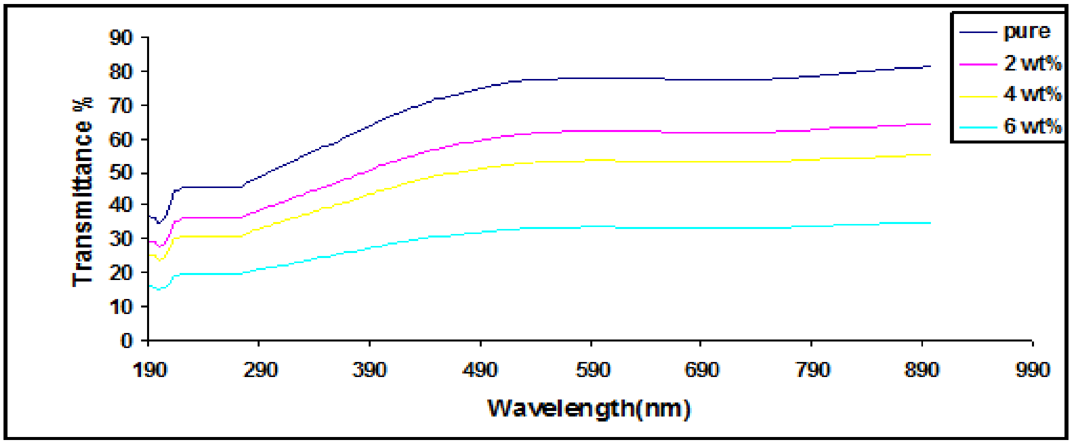

Figure 3. The transmittance for ((PVC-((CH_3COO) Ag))) composites as a function of incident wavelength

The absorption coefficient (α) was calculated in the fundamental absorption region from the following equation [13]:

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

Where: A is absorbance and d is the thickness of sample.

Absorption coefficient α as a function of photon energy for the ((PVC-((CH_3COO) Ag)))composites are shown in figure(4) its shown that the change in the absorption coefficient is small at low energies which is indicates that the possibility of electronic transitions is a few. The absorption coefficient helps to conclude the nature of electronic

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transitions, when ($\alpha<10^4 cm^{-1}$) at low energies we expected in this case indirect electronic transitions, the momentum of the electron and photon preserves by phonon helps [14].

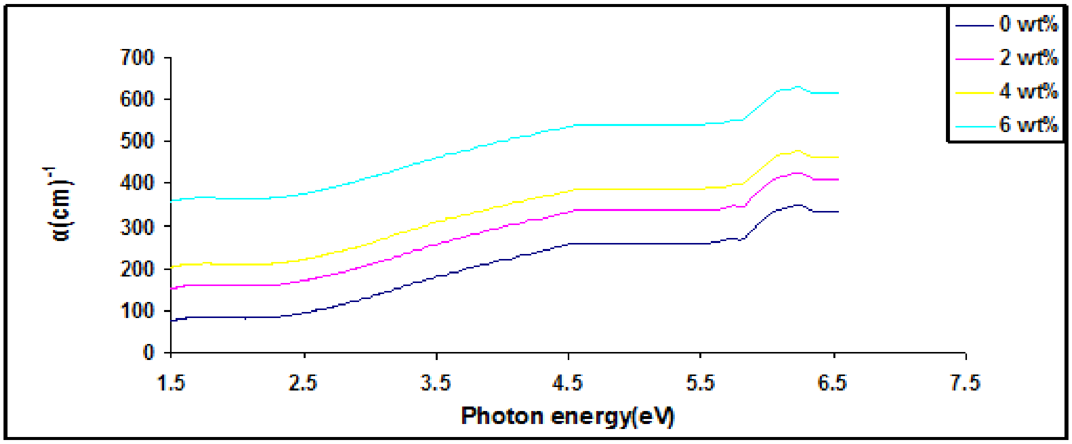

Figure 4. The relationship between the absorption coefficient and photon energy of the ((PVC-((CH_3COO) Ag))) composites

Figure (5) shows the variations of extinction coefficient ($k=\alpha\lambda/4\pi$) with wave length for pure and doped PVC with ((CH_3COO) Ag). This figure shows that, k value increases with increasing of doping concentration. The behavior of extinction coefficient (k) can be ascribed according to high absorption coefficient. This result indicates that the doping atoms of ((CH_3COO) Ag) will modify the structure of the host polymer. An interesting result is ((CH_3COO) Ag) doping increases the absorbance in the visible region [15].

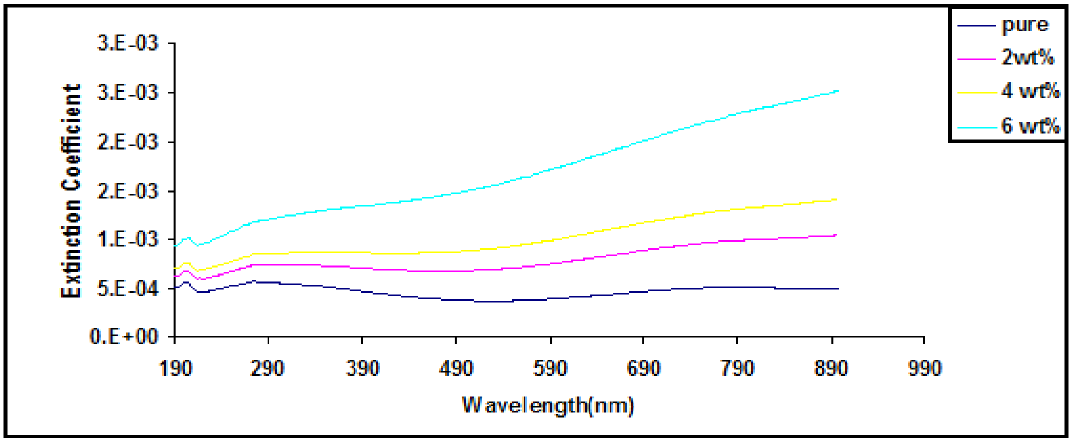

Figure 5. The variation of the extinction coefficient (k) with wave length of the PVC-((CH_3COO) Ag) composites

The variation of the refractive index for PVC-((CH_3COO) Ag) composites for various different concentrations as a function of wavelength at 30°C is shown in figure (6). The figure shows that the refractive index increase as a result of filler addition, this behavior can be attributed to the increasing of the packing density as a result of filler content.

The real and imaginary parts of dielectric constants ($\varepsilon 1 = n^2 - k^2$ and $\varepsilon_2 = 2nk$) of pure and doped PVC with ((CH_3COO) Ag) with different concentrations are depending on λ are shown in Figures (7, 8) [Ahmed R., 2008]. It is concluded that the variation of ε_1 mainly depends on (n^2) because of small values of (k^2), while ε_2 mainly depends on the (k) values which are related to the variation of absorption coefficients.

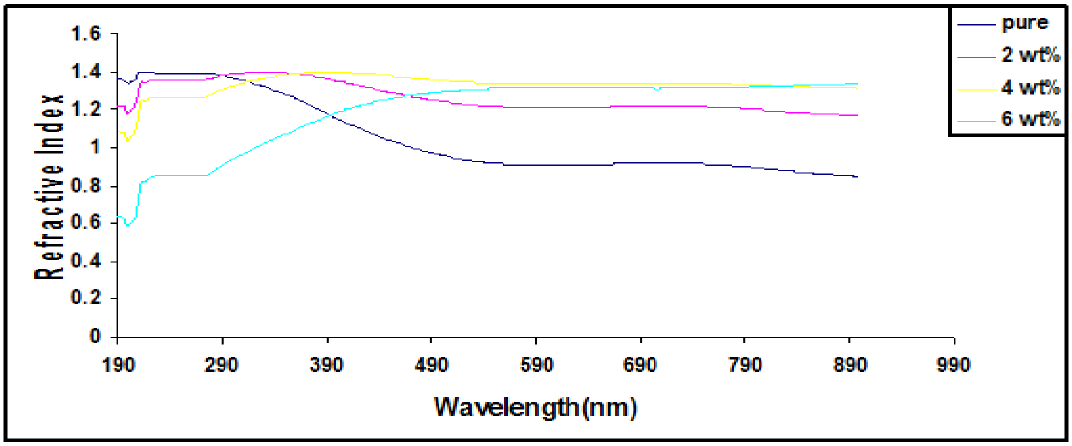

Figure 6.The variation of refractive index for (PVC-((CH$_3$COO) Ag) composites wavelength

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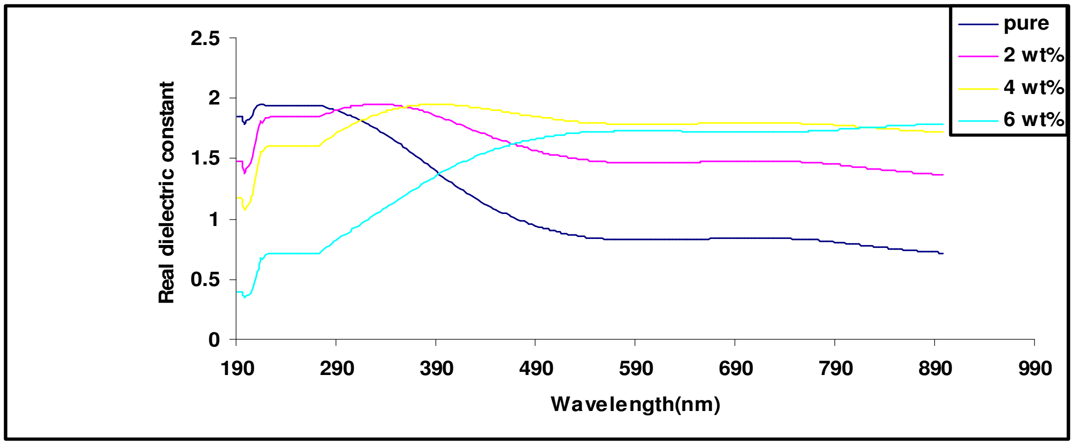

Figure 7. The real dielectric constant for PVC-((CH$_3$COO) Ag) composites as a function of incident wavelength

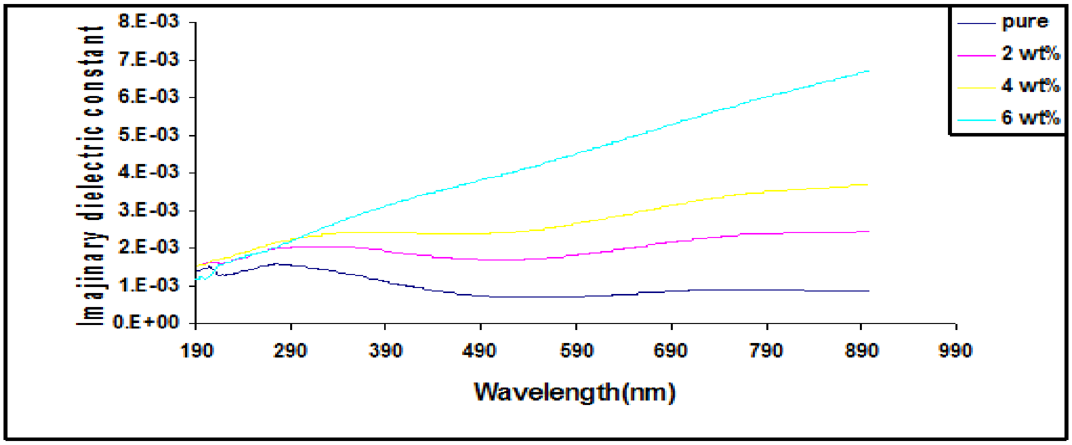

Figure 8. The imaginary dielectric constant for PVC-((CH$_3$COO) Ag) composites as a function of incident wavelength

Figure (9) shows the variation of optical conductivity with incident photon energy. The optical conductivity is determined by using the relation($\sigma=\alpha nc/4\pi$ where c is the speed of light), the optical conductivity directly depends on the absorption coefficient and was found

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to increase sharply for higher energy values due to the large absorption coefficient for these values[16].

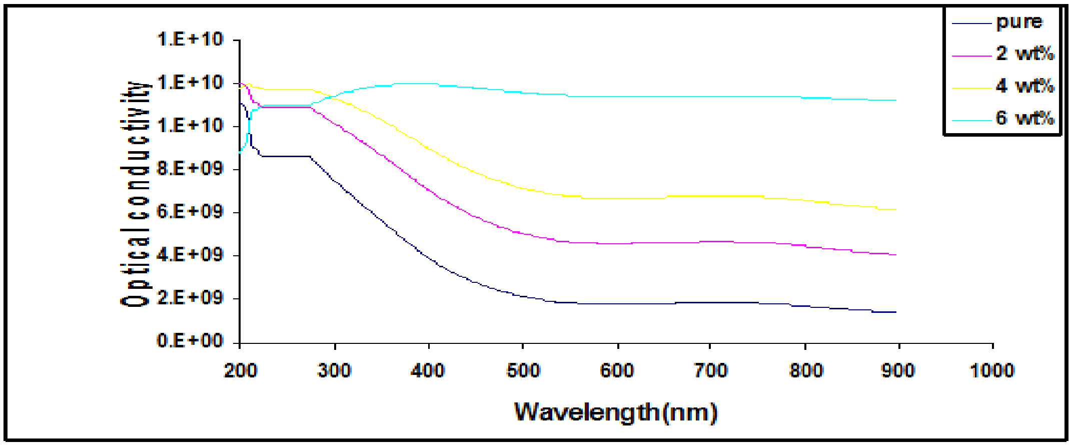

Figure 9. The optical conductivity for PVC-((CH_3COO) Ag) composites as a function of incident wavelength

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 extinction coefficient, real and imaginary dielectric constants and optical conductivity are increasing with increase the concentration of silver acetic

REFERENCES

[1]. Leonard, E. C. (1971). *Vinyl and Diene Monomer*, New York.

[2]. Regnault, V. (1835). *Ann. Chem. Phys,* 2(59), P.(538).

[3]. Ostromislensky, I. (1980). *Chem. Zentr.*(1)

[4]. Klatte, F. & Rollet, A. (1918). *Chem. Astr.* (12), P. (231)

[5]. Misra, G. S. (1993). *Introductor Polymer Chemistry*, New York.

[6]. Kernsears, J. & Darby, J. R. (1982). *The Technology of Plasticizers*, USA.

[7]. Koleste, J. V. & Wariman, L. H. (1969). *Poly (Vinyl Chloride),* London.

[8]. Mogorkiswicz, R. (1970). *Engineering Properties of Thermoplastic*, London.

[9]. Small, P. A. (1953). *J. Appl. Chem.* (3), P. (71).

[10]. Saunders, K. J. (1988). *Organic Polymer Chemistry,* 2ndedition, New York.

[11]. Titow, W.V. (1984). *PVC Technology,* UK.

[12]. Dahshan, M. (2002). *Introduction to Material Science and Engineering*, 2nd Ed.

[13]. Majdi, K., Zeedan, K. & Attar, H. (1997). Optical properties of poly thiophene/ PVC conducting polymer alloy films, *Iraqi J. of polym.,* 1(1),155-162.

[14]. Thangaraju, B., Kalianna, P. (2000). *Cryst. Res. Techon*., 35(71).

[15]. Ahmed, R. M. (2008). Optical study on poly (methyl methacrylate)/poly (vinyl acetate), Zagazig Uni., Zagazig, Egypt, E-mail-rania8_7@hotmail.Com

[16]. El-Gohary, Z. & E-Nahass, M. (2003). Optical dispersion parameters with different orientation for SrLaAlo single crystals, *J. matter. Sci. Technol.,* 19(1)**.**