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Characterization of (PVP-KCl) Composites

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Abstract

The polymers have uses in many industries. The addition of electrolytes to the polymers are produced a new materials use in many applications. Hence, in this paper study the effect of potassium chloride on the optical properties of polyvinyl pyrrolidone. The potassium chloride was added to polymer with different concentrations. The samples were prepared by using casting technique. The optical properties were measured in the wavelength range (200-800) nm. The experimental results showed that the absorbance (A), absorption coefficient (α), extinction coefficient (k), refractive index (n), real and imaginary dielectric constants (ε_1 and ε_2) of polyvinyl pyrrolidone are increasing with the increase of the potassium chloride weight percentages. The energy gap (E_g) of polyvinyl pyrrolidone decreases with the increase of the potassium chloride weight percentages.

Keyword: optical properties , potassium chloride, polyvinyl pyrrolidone.

1. Introduction

Polymer material is widely being used in various devices as insulating material and for optoelectronic applications. This is due to their unique properties such as light weight, high flexibility, and ability to be fabricated at low temperature and low cost **(Lyly Nyl Ismail, 2012)**. The development of polymer systems with high ionic conductivity is one of the main objectives in polymer research. This is because of their potential applications as electrolytes in solid-state batteries, fuel cells, electrochemical display devices/smart windows, photo electrochemical cells etc., due to their high conductivity, high energy density, wide electrochemical stability and easy process ability. The main advantages of polymer electrolytes are their mechanical properties, ease of fabrication of thin films of desirable sizes and their ability to form proper electrode/electrolyte contact in electrochemical devices **(U. Sasikala, P. 2012)** Polyvinyl pyrrolidone (PVP) is known to have a growing pharmaceutical importance and possesses good electrical properties. PVP has drawn a special attention amongst the conjugated polymers because of its good environmental stability, easy process situation and excellent transparency. PVP is a potential material having a good charge storage capacity and dopant dependent electrical and optical properties. Chemically PVP has been found to be inert, non-toxic and interestingly, it displays a strong tendency for complex formation with a wide variety of smaller molecules **(A. Rawat, H. Mahavar, 2012)**.

2. Materials and Methods

The materials used in this paper are polyvinyl pyrrolidone (PVP) as a matrix and potassium chloride as filler. The polyvinyl pyrrolidone was dissolved in distill water and the potassium chloride was add to polyvinyl pyrrolidone by different concentrations are (0,5, 10 and 15) wt.% . The mixture was mixed for 20 minute to get more homogenous solution. The casting technique was used to preparation the samples. The optical properties are measured by using UV/1800/Shimadzu spectrophotometer.

3. Results and Discussion

The absorbance spectra of (PVP-KCl) composites with wavelength of incident light are shown in figure (1). The absorbance of polyvinyl pyrrolidone increases with the increase of the potassium chloride concentration which attributed to potassium chloride ions which absorb the incident light greater than the polyvinyl pyrrolidone **(Ahmad A.H., Awatif A.M. 2007)**.

The absorption coefficient was calculated by following equation[5]:

$$\alpha=2.303\ A/d \qquad \text{……….} (1)$$

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

Figure(2) shows the variation of absorption coefficient of composites with photon energy. The figure refer to the increase of the absorption coefficient with the increasing of potassium chloride concentration because increase the absorbance. Also, absorption coefficient increases with the increase of the photon energy which due to the absorbance of the polyvinyl pyrrolidone **(Nahida. J. H. 2011)**. The absorption coefficient of (PVP-KCl) composites less than 10^4 cm^{-1} which refer to the composites have indirect energy band gap which calculate by equation [6]:

$$\alpha h\upsilon = B(h\upsilon - E_g)^r \text{................................}(2)$$

Where: $h\upsilon$ is the photon energy, B is a constant, E_g is the energy band gap, r=2 and 3 for allowed and forbidden indirect transition as shown in figures 3 and 4.

The width of mobility edge depends on the degree of disorder and defects present in the amorphous structure. Such defect produces localized states in the forbidden gap. So the increase of potassium chloride to polymer host increases the localized state which directly affects the decrease in the optical energy gap **(Hamed M. Ahmad, 2012)**.

The extinction coefficient (k) was calculated by the following equation [7]:

$$k=\alpha\lambda/4\pi \qquad \text{…………} (3)$$

The refractive index (n) of the specimens is defined **(Tariq J. Alwan, 2010)**:

$$n= (1+R^{1/2})/ (1-R^{1/2}) \qquad \text{………} (4)$$

Where R is reflectance

Figures (5) and (6) show the variation of refractive index and extinction coefficient of the composites with photon energy. The refractive index increases with the increasing of the photon energy, this behavior attributed to the electromagnetic radiation passing through the material is faster in the low photon energy. The extinction coefficient depends on the values of absorption coefficient. The refractive index and extinction coefficient are increasing with the increase of the concentration of potassium chloride which due to the increase of the density of composites **(Tariq J. Alwan, 2010)**.

The real (ε_1) and imaginary (ε_2) parts of dielectric constant are calculated by following equations **(Nahida. J. H. 2011)**:

$$\varepsilon_1=n^2-k^2 \qquad \text{…....} (5)$$

ε_2=2nk …… (6)

Figures (7) and (8) show the relationship of real and imaginary parts of dielectric constants (PVP-KCl) of composites. The variation of real (ε_1) part depends on refractive index because of small values of extinction coefficient, while imaginary part depends on the extinction coefficient values which related to the variation of the absorption coefficient **(Nahida. J. H. 2011)**.

4. Conclusions

1- The absorbance of polyvinyl pyrrolidone is increased with the increasing of the potassium chloride concentration.

2- The absorption coefficient, extinction coefficient, refractive index and real and imaginary dielectric constants are increasing with the increasing of the weight percentages of potassium chloride.

3- The indirect energy band gap of polyvinyl pyrrolidone is decreased with the increasing of the weight percentages of potassium chloride.

5. References

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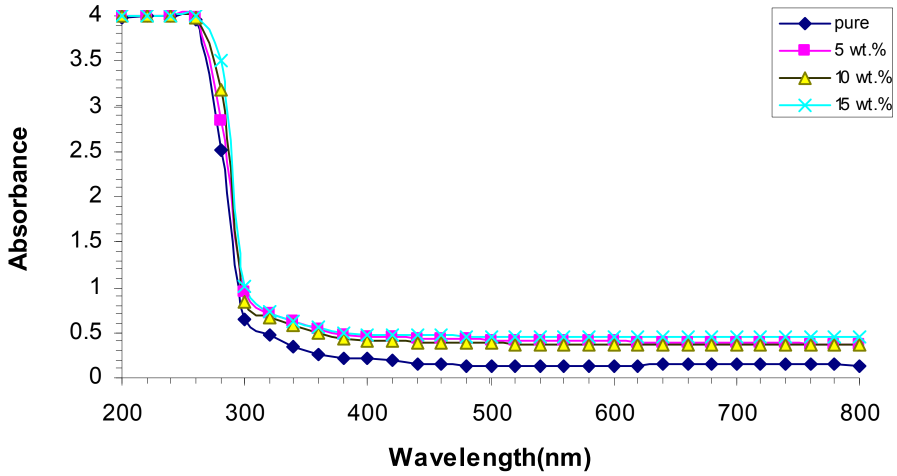

FIG.1
The variation of optical absorbance for (PVP-KCl) composite with wavelength

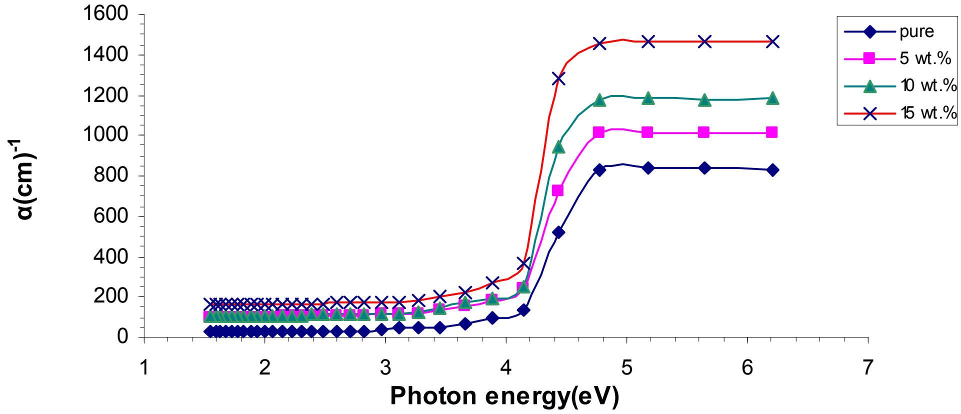

FIG.2
The absorption coefficient for (PVP-KCl) composite with various photon energy

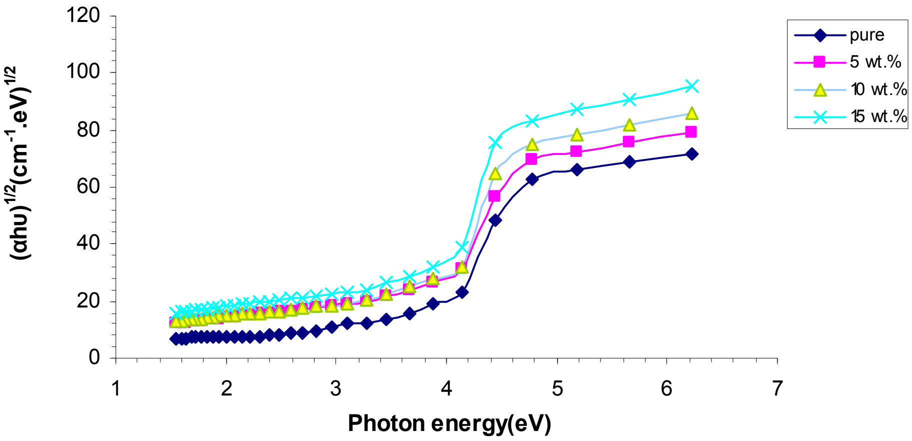

FIG.3

The relationship between $(\alpha h\upsilon)^{1/2}(cm\text{-}1.eV)^{1/2}$ and photon energy of composites.

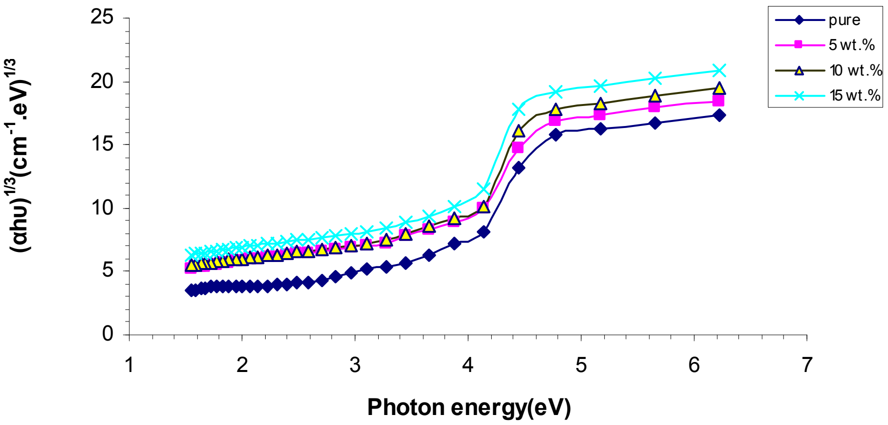

FIG.4

the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of composites.

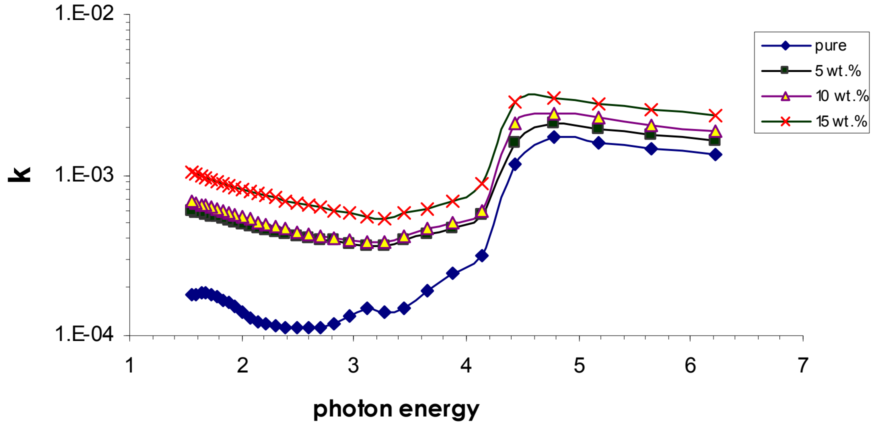

FIG.5
The extinction coefficient for (PVP-KCl) composite with various photon energy

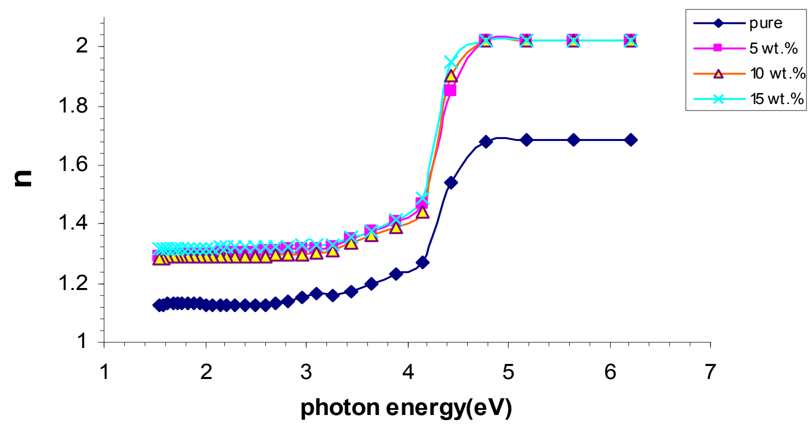

FIG.6
The relationship between refractive index for (PVP-KCl) composite with photon energy

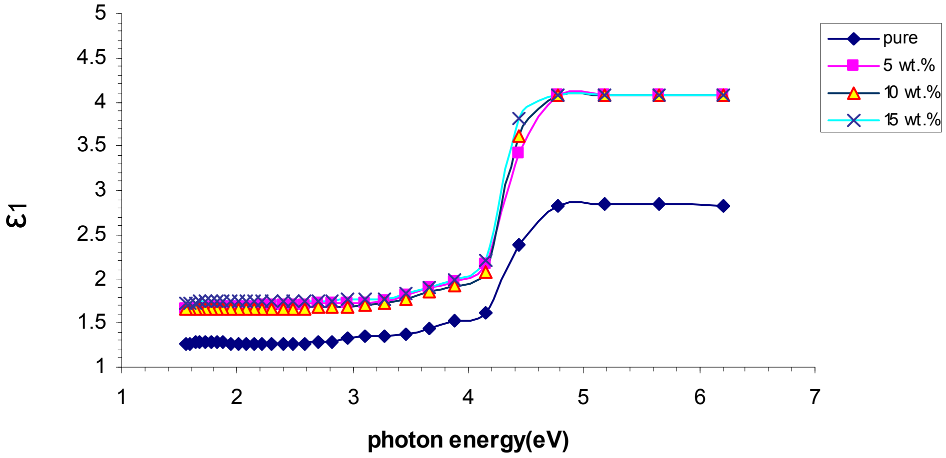

FIG.7
The variation of real part of dielectric constant (PVP-KCl) composite with photon energy

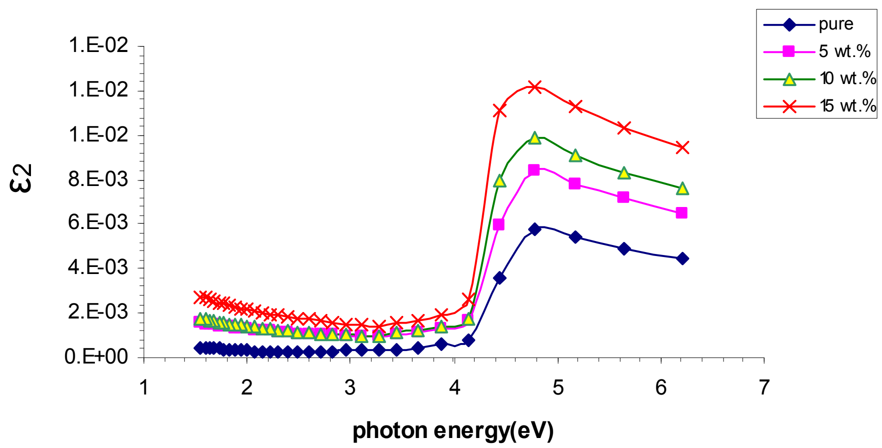

FIG.8
The variation of imaginary part of dielectric constant(PVP-KCl) composite with photon energy