STUDY THE OPTICAL PROPERTIES OF POLYVINYLPYRROLIDONE (PVP) DOPED WITH KBr

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Abstract

The pure polyvinylpyrrolidone (PVP) and (PVP-KBr) composite with different weight percentage of KBr were prepared using solution casting technique. The optical properties of randomly mixed system consisting of PVP and KBr powders were studied. The effect of KBr concentration on the optical properties of (PVP-KBr) composites have been investigated.

The experimental results show that the optical constants (Refractive index, Extinction coefficient, Real and Imaginary parts of the dielectric constant) showed clear changes with increasing the doping concentrations.

1-Intoduction

The stability of polymer thin films on solid substrates is of great technological importance in applications ranging from protective coatings to paintings, semiconductor ,and micro-and optoelectronic[1,2]. The polyvinylpyrrolidone (PVP)has good film-forming and adhesive behavior on many solid substrates and its formed films exhibits good optical quality (high transmission in visible range),and mechanical strength (easy processing)required for application [3] In order to fulfill the requirements of polymer industry many develops usually blend polymers together in order to reach an optimum balance of properties. This paper deals the effect of KBr on the some optical properties of polyvinylpyrrolidone (PVP).

2.Experimental Part

The polymer was dissolved in distill water by using magnetic stirrer in mixing process to get homogeneous solution at 90^0C , then the solution was cooled at room temperature. The weight percentages of KBr are (0,5,10 and 15) wt.% were added and mixed for 10 minutes to get more homogenous solution , after which solution was transferred to clean glass petri dish of (5cm) in diameter placed on plate form. The dried film was then removed easily by using tweezers clamp. The polymer systems were evaluated spectra photo metrically by using UV/1800/Shimadzu spectrophotometer.

3.Results and Discussion

3-1The transmission of composites

The transmission spectra of the (PVP-KBr) composites with different concentrations are presented in Fig 1. The composite films are transparent in the visible range . it is clear from Fig 1. as the concentration of the KBr component in the polymer composition decrease the transmission with increase.

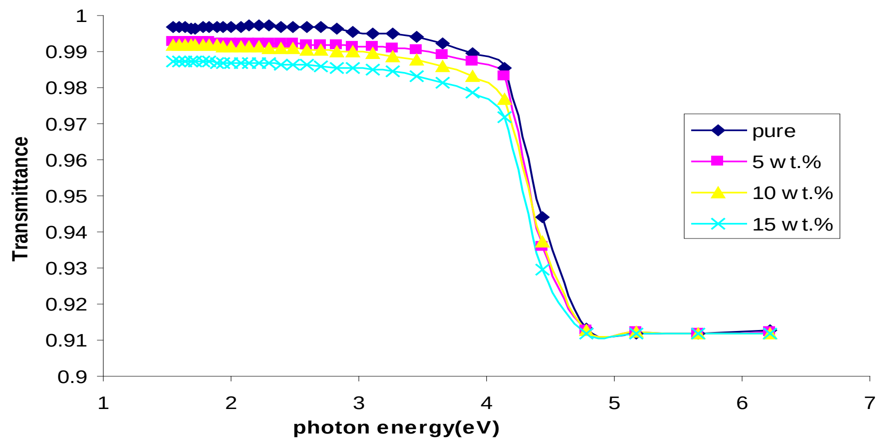

FIG.1
The variation of transmittance for (PVP-KBr) composite with wavelength

3.2 The absorbance of composites

Fig.2 shows the relationship between absorbance of (PVP-KBr) composite with wave length, from the figure it was appeared that the absorbance tends to decrease with the wavelength increasing. It clear From the Fig.2 that as the concentration of the KBr component in the polymer composition increase the absorbance increase this increasing may be refer to consist a new energy level between the valance band and conduction band .

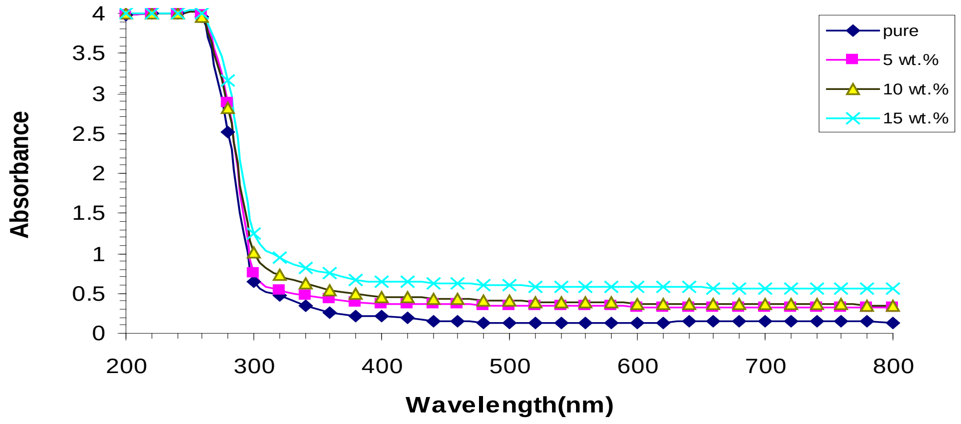

FIG.2
The variation of optical absorbance for (PVP-KBr) composite with wavelength

3.3The Absorption coefficient and energy gap of composite

The absorption coefficient (α) was calculated in the fundamental absorption region from the following equation[4]:

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

Where : A is absorbance and (d) is the thickness of sample

Fig.3 shows the optical absorption spectrum of composite for different impurities quantities, it was found that the composite have a low absorption coefficient at a small photon energy then increase at different rates dependence on the composite structure. The pure sample had low absorption coefficient this may be as a result of low crystalinity.

The optical energy gap E_g of the films has been determined from absorption coefficient data as a function of photon energy according to the non-direct transition model [5]:for higher values of absorption coefficient where the absorption is associated with interband transitions.

$\alpha h\upsilon = B(h\upsilon - E_g)^2$ …………….(2)

Where: $h\upsilon$ = The energy of the incidence photon ,h = The Planck constant

E_g = The optical energy band gap ,B = a constant known as the disorder parameter which is nearly independent of the photon energy.

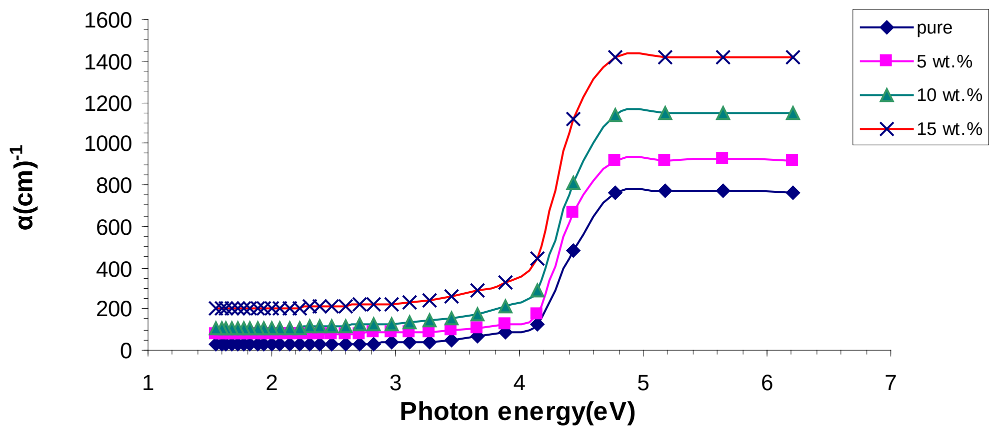

FIG.3

The absorption coefficient for (PVP-KBr) composite with various photon energy

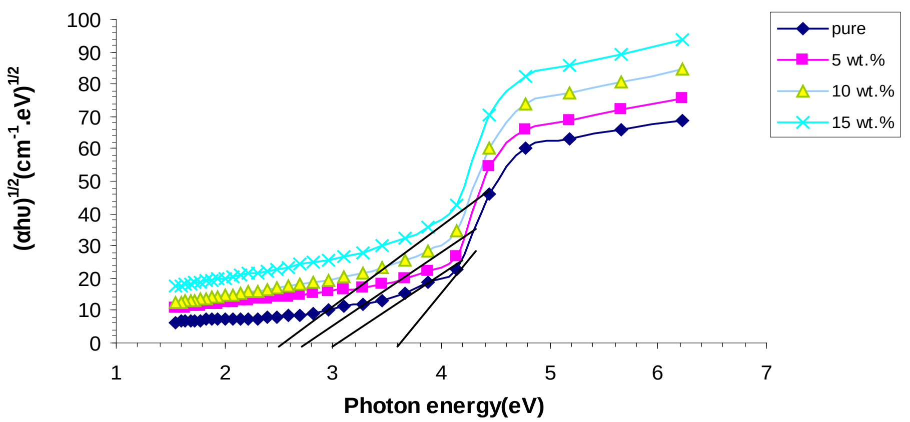

FIG.4

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

The indirect optical band gap can be evaluated from the linear plots of $(\alpha h\upsilon)^{1/2}$ versus $h\upsilon$ as illustrated in Fig.4 represented the indirect transition , the energy gab values dependence in general on the crystal structure of the composites and on the arrangement and distribution way of atoms in the crystal lattice . from Fig(4) the energy gab shift to lower energy with increasing the concentration of (KBr) compare with the pure (PVP). .

3-4 Refractive Index and Extinction Coefficient

The refractive index (n) and extinction coefficient (k) are important parameters characterizing photonic materials. The refractive index (n) as a function of wavelength can be determined from the reflection coefficient data R and the extinction coefficient K using equation:

$$n = \left(\frac{4R}{(1-R)^2} - K^2\right)^{1/2} - \frac{(R+1)}{(R-1)} \quad ....(3)$$

Fig. 5 shows the variation of refractive index (n) of the composite with a given photon energy.

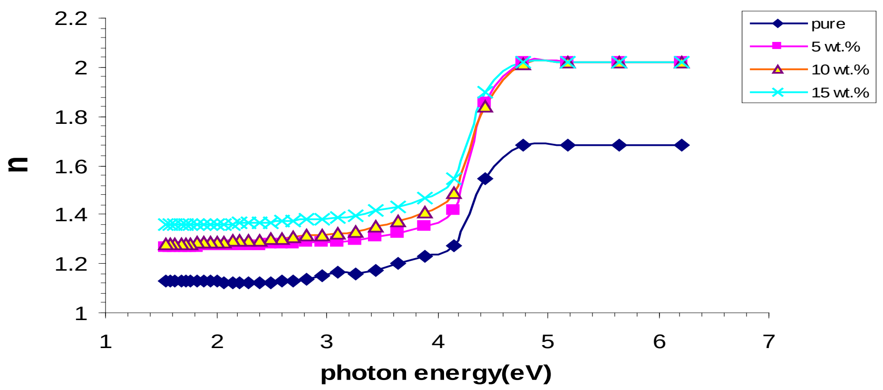

FIG.5
The relationship between refractive index for (PVP-KBr) composite with photon energy

The extinction coefficient (k) was calculated using the following equation:
K=αλ/4π ……….. ……………………(4)
Where (λ) is the wavelength and (α)the absorption coefficient .

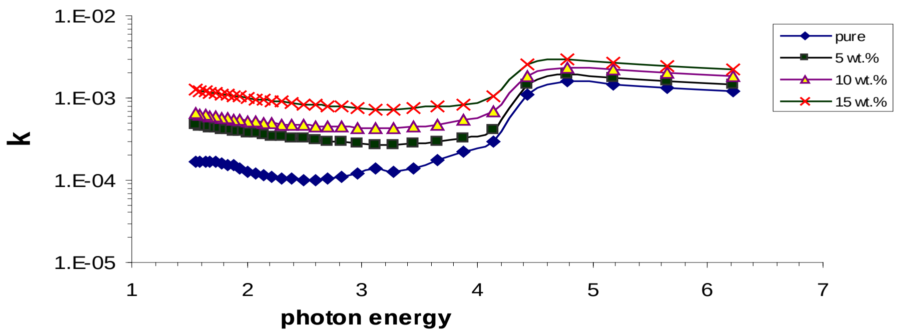

FIG.6
The extinction coefficient for (PVP-KBr) composite with various photon energy

The fraction of light lost due to scattering increase with the concentration of KBr therefore the extinction coefficient increase as shown in Fig.6 .

3.4 dielectric constant

The dielectric constant of compound (ε) is divided into two parts real(ε_1), and imaginary (ε_2).The real parts of dielectric constant is associated with the term that shows how much will slow down the speed of light in the material and the imaginary parts shows how a dielectric absorbs energy from an electric field due to dipole motion . ($\varepsilon_1$and ε_2) can be calculated by using equations [6,7]:

$\varepsilon = \varepsilon_1 - i\,\varepsilon_2$ ……….................... (5)
$\varepsilon_1 = n^2 - k^2$ ……............................. (6)
$\varepsilon_2 = 2nk$ ………..………………. (7)

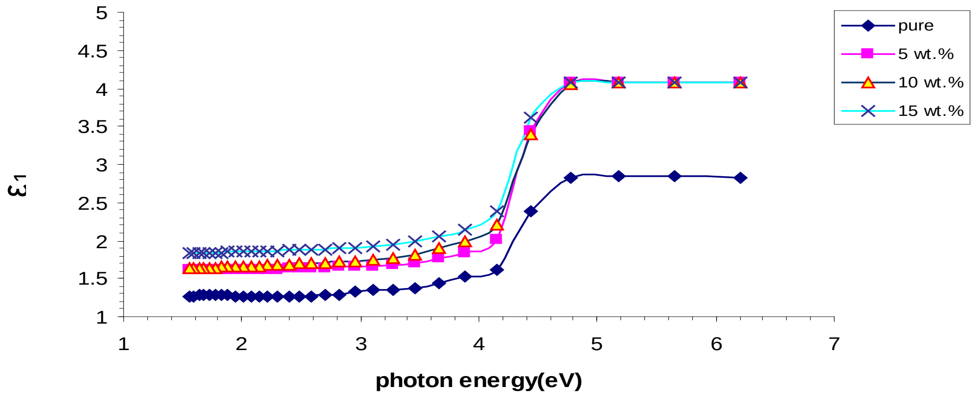

FIG.7
The variation of real part of dielectric constant (PVP-KBr) composite with photon energy

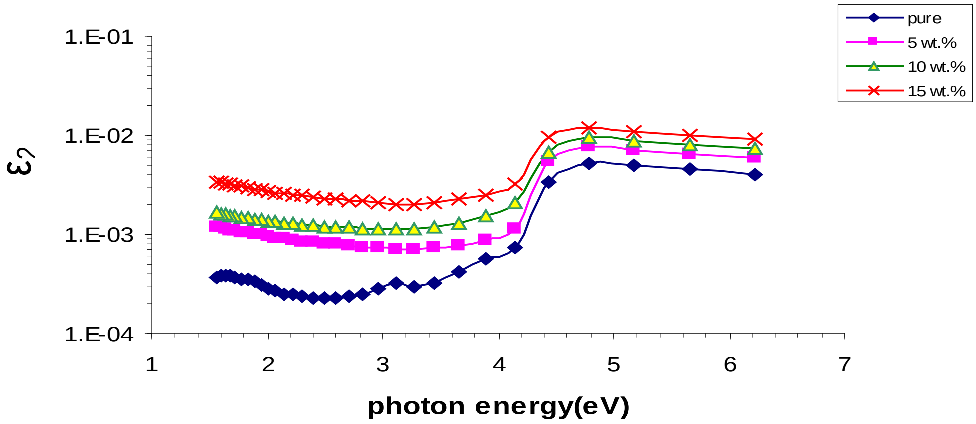

FIG.8
The variation of imaginary part of dielectric constant (PVP-KBr) composite with photon energy

4.Conclusions

Optical properties of PVP-KBr composite films were studied in the spectral region 200-800 nm .the composite showed high transmittance in the visible region making it suitable for using in window coatings .the interband transitions were found to be indirect type . the optical energy gap has been found to decrease with increasing the concentration of KBr . the refractive index has been found to increase with the increase the concentration of KBr .The real and imaginary dielectric constant increase with increasing the incident photon energy and the concentration of KBr. it will contribute to produce a new material that might potentially be used as an alternative or substitute material for many other application.

References

1. Oslance,R,;Costa,A.C.;Composto,R.J.Macromolecuels 2000,33,P .5505-5512.
2. Reiter,G.Macrolecules 1994,27,p .3046-3052.
3. Kothapalle,S.; Koramala, N. K.; V, Naresh, S. B. Materialessciences Application,2011,2,p.1688-1696.
4. BaoLi O., DuXin L., 2007, Preparation of Polystyrene/silica Nanocomposites by Radical Copolymerization of Styrene with Silica Macromonomer. Sci. China. Ser. B-Chem., 50(3): p. 385-391.
5. New York ,Plenum J.Tauc 1974 .Amorphous and Liquid Semiconductors P.159.

6. Dr.Nahida, J.H. 2011, Study of the Optical Constants of the PMMA/PC Blends Eng. & Tech. Journal ,Vol.29, No.4.
7. R Tintu, K. Saurav, K.Sulakshna,Vpn.Nampoori,Pradhakrishnan and Sheenu thomas 2010..” Ge28Se60Sb12 /PVA composite films for photonic application”. Journal of Non-Oxide Glasses Vol. 2, No 4, , p.167- 174,