

# The Effect of Sodium Fluoride on Optical Properties of Polyvinyl pyrrolidone

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## Abstract

The Composites Materials are important in many applications and industries. For the importance of these materials, this paper is aimed to study optical properties of (PVP-NaF) composites. The effect of sodium fluoride on optical properties of polyvinyl pyrrolidone has been investigated. The samples of (PVP-NaF) composites are prepared by using casting technique. The optical properties of (PVP-NaF) composites were measured in the wavelength range (200-800) nm. Results showed that the absorbance, absorption coefficient, extinction coefficient, refractive index and real and imaginary dielectric constants of polyvinyl pyrrolidone are increasing with increasing the sodium fluoride concentrations. The energy band gap of polymer is decreased with increasing of the sodium fluoride concentrations.

**Keyword:** sodium fluoride, optical properties ,polymer.

## Introduction

Polymers have relatively poor mechanical, thermal, and electrical properties as compared to metals and ceramics. Many types of polymers such as homopolymers, co-polymers, blended polymers and modified polymers are not sufficient enough to compensate various properties, which we have demanded. Alternative approaches to improve their properties are to reinforce polymers with inclusion of fiber, whisker, platelets, or particles. The choice of the polymers is usually guided mainly by their mechanical, thermal, electrical, optical and magnetic behaviors. However, other properties such as hydrophobic/hydrophilic balance, chemical stability, bio-compatibility, opto-electronic properties and chemical functionalities (i.e., solvation, wettability, templating effect, etc.) have to be considered in the choice of the polymers. The polymers in many cases can also allow easier shaping and better processing of the composite materials [1]. The doped polymers may present useful applications in integrated optics or in real time holography. In order to tailor materials with improved properties within the doped polymer class, it is necessary to understand and control the electronic mechanisms involved in the optical behavior[2]. The studies on optical properties of polymers have attracted much attention in view of their application in electronic and optical devices[3]. 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 [4]. This paper deals with effect of sodium fluoride on polyvinyl pyrrolidone.

## Materials and Methods

The materials which used in this paper are polymer and sodium fluoride. The polymer was dissolved in distill water by using magnetic stirrer in mixing process to get homogeneous solution. The concentrations of sodium fluoride are (0,5,10 and 15) wt.% were added and mixed for 20 minute to get more homogenous solution , after which solution was transferred to clean glass. The optical properties of composites are measured by using UV/1800/Shimadzu spectrophotometer.

The absorption coefficient ( $\alpha$ ) is defined [5] :

$$\alpha=2.303A/t \quad \dots\dots\dots (1)$$

Where A: is the absorbance of the material t: the sample thickness.

The energy band gap give by[3]:

$$\alpha h\nu = B(h\nu - E_g)^r \quad \dots\dots\dots(2)$$

Where  $h\nu$  is the photon energy, B is a constant,  $E_g$  is the optical energy band gap,  $r=2$ ,or 3 for indirect allowed and indirect forbidden transition.

The extinction coefficient (k) calculate by using the following equation[5]:

$$k=\alpha\lambda/4\pi \quad \dots\dots\dots (4)$$

The refractive index (n) of the specimens is defined [6]:

$$n=(1+R^{1/2})/(1-R^{1/2}) \quad \dots\dots\dots (3)$$

The real and imaginary parts of dielectric constants ( $\epsilon_1$  and  $\epsilon_2$ ) was calculated by using equations [6]:

$$\epsilon_1=n^2-k^2 \text{ (real part)} \quad \dots\dots\dots (5)$$

$$\epsilon_2=2nk \text{ (imaginary part)} \quad \dots\dots\dots (6)$$

## Results and Discussion

Figure (1): shows the absorbance spectra with wavelength for (PVP-NaF) composites of different concentration of filler. From the figure, the absorbance is decreased with the increasing of the wavelength which attributed to the absorbance of polymer which lies in UV- region. Also, the absorbance of (PVP-NaF) composites increases with the increase of the weight percentages of sodium fluoride, this behavior due to high absorbance of sodium fluoride compared with the absorbance of polymer[7].

The variation of absorption coefficient with photon energy of (PVP-NaF) composites is shown in figure(2). The absorption coefficient less than  $10^4 \text{ cm}^{-1}$  this mean the composites have indirect energy band gap as shown in figure(3) and figure(4) for allowed and forbidden indirect energy gap respectively. These figures show that the indirect energy gap is decreased with the increase of the sodium fluoride concentration which attributed to create local energy levels in the energy gap [8].

Figure (5): shows the variation of extinction coefficient of (PVP-NaF) composites with photon energy. The extinction coefficient (as shown in the figure) is increased with the increase of the concentration of sodium fluoride. The increase of extinction coefficient attributed to the sodium fluoride ions which absorb the incident light [9] (as shown in figure:1)

The relationship between the refractive index and photon energy of (PVP-NaF) composites of different concentration of sodium fluoride is shown in figure(6). The figure shows that refractive index of (PVP-NaF) composites increases with the increasing of the sodium fluoride concentration, this behavior due to the increase the density of polymer with the increasing of the sodium fluoride concentration [9].

Figures (7 and 8) shows the effect of sodium fluoride concentration and photon energy on real and imaginary parts of dielectric constant. The real and imaginary parts of dielectric constant are increasing with the increase of the weight percentages of sodium fluoride which attributed to the increase the reflective index and absorption coefficient as result for the increase the density and absorbance of (PVP-NaF) composites [10].

### Conclusions

The absorbance of polymer increases with the increasing of the weight percentages sodium fluoride. -1  
The optical constants (absorption coefficient, extinction coefficient, refractive index and real and imaginary dielectric constants) are increasing with the increasing of the weight percentages of sodium fluoride. -2

The energy band gap of polymer decreases with increasing of the weight percentages of sodium fluoride. -3

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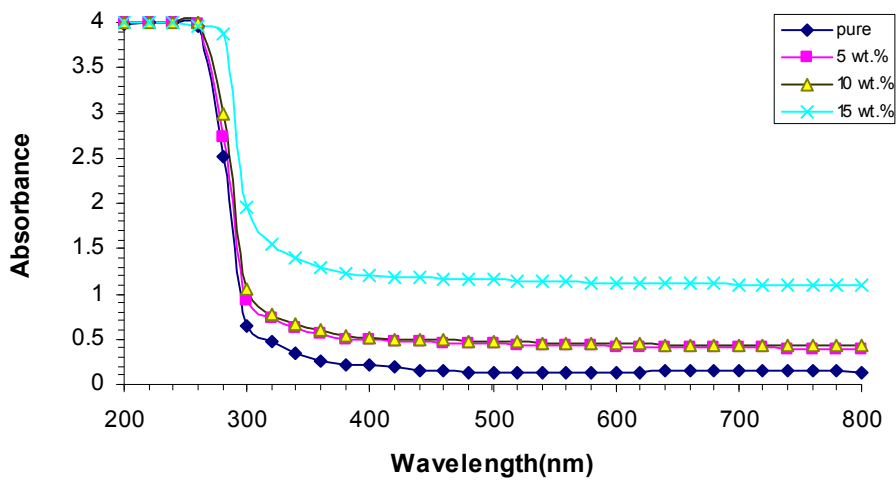


FIG.1

The variation of optical absorbance for composite with wavelength

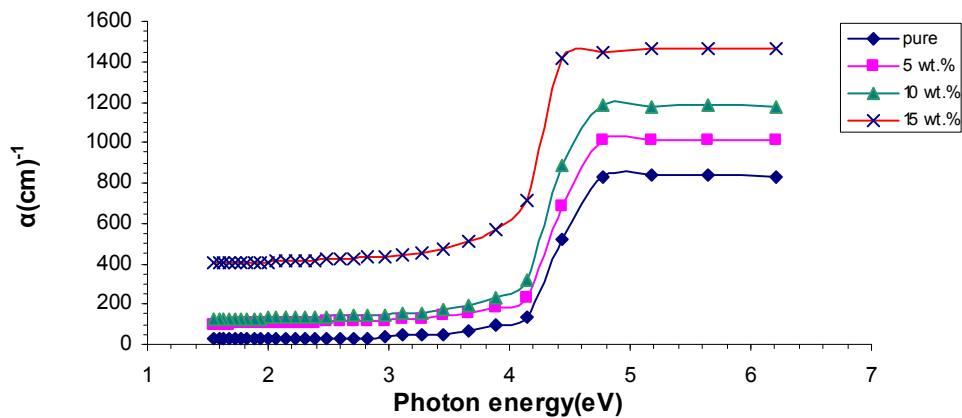


FIG.2

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

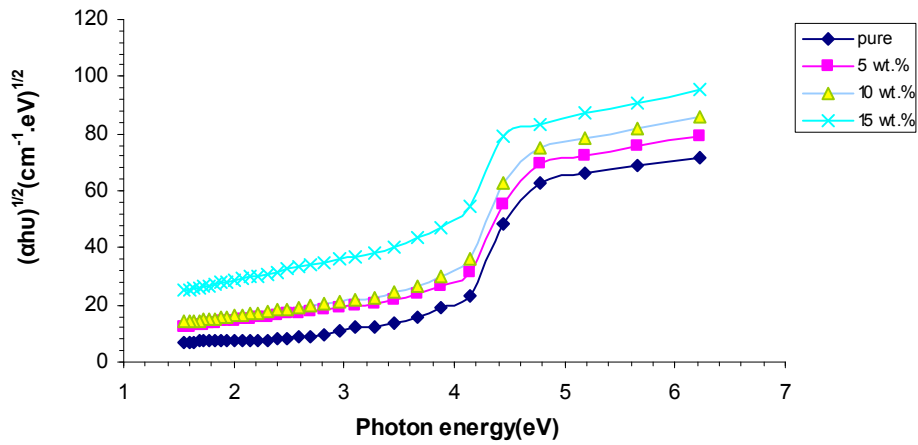


FIG.3

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

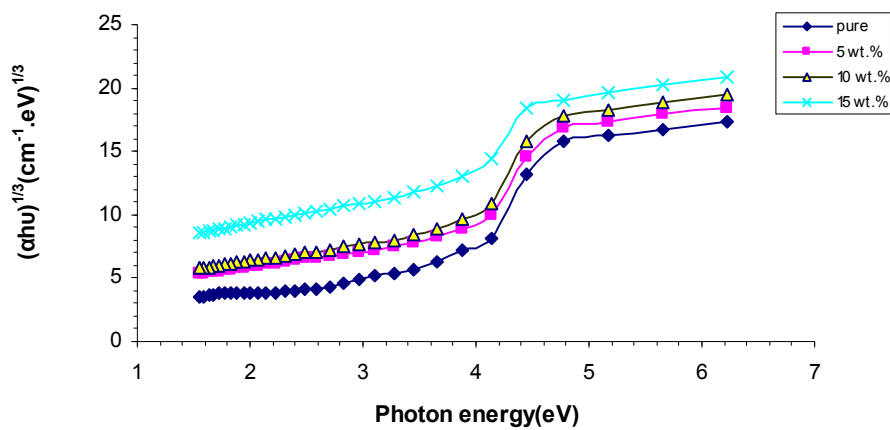


FIG.4

the relationship between  $(\alpha hu)^{1/3} (\text{cm}^{-1} \cdot \text{eV})^{1/3}$  and photon energy of PVP-NaF composites.

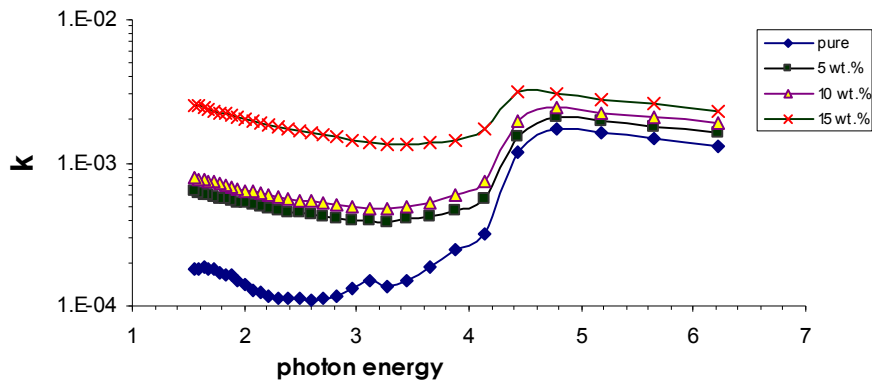


FIG.5  
The extinction coefficient for (PVP-NaF) composite with various photon energy

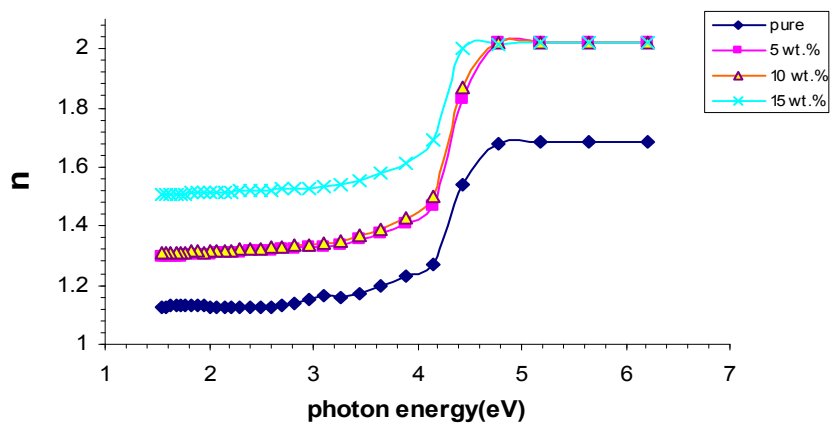


FIG.6  
The relationship between refractive index for (PVP-NaF) composite with photon energy

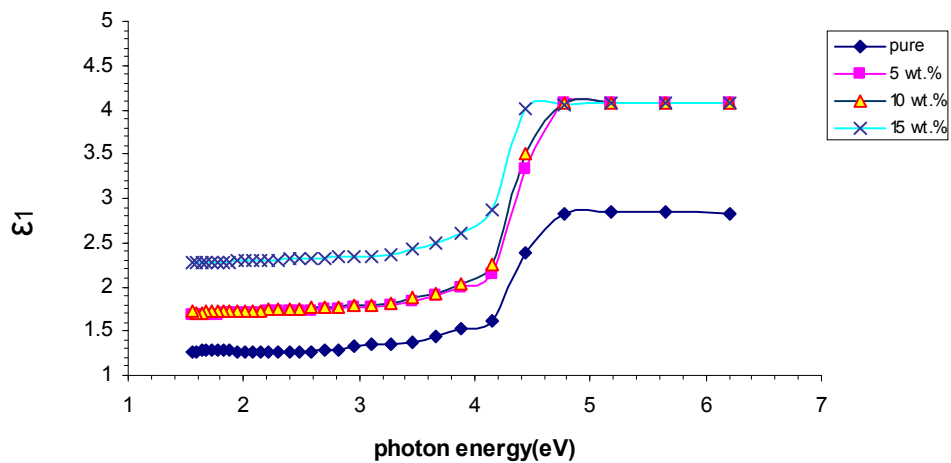


FIG.7  
The variation of real part of dielectric constant (PVP-NaF) composite with photon energy

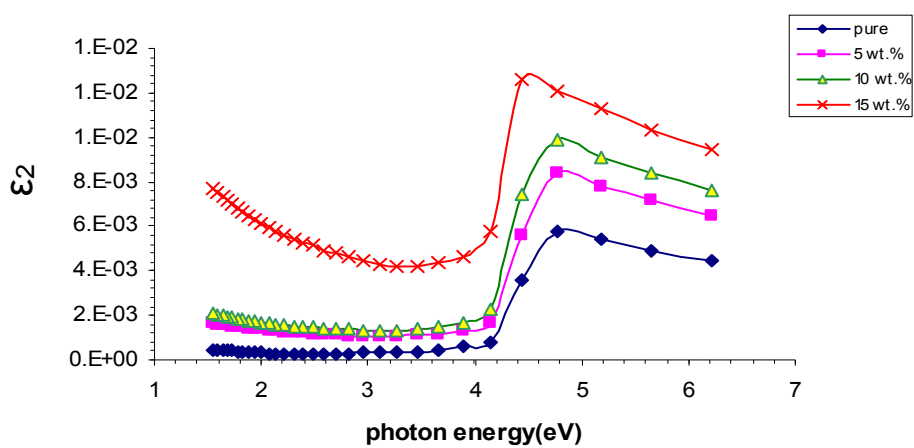


FIG.8  
The variation of imaginary part of dielectric constant(PVP-NaF) composite with photon energy

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