

Preparation of $[Co(NH_3)5Cl]Cl_2$ Complexes and Characterization of (PVA- $[Co(NH_3)5Cl]Cl_2$]) Composites

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Abstract
In this paper , preparation of $[Co(NH_3)5Cl]Cl_2$ complexes and study the effect of addition $[Co(NH_3)5Cl]Cl_2$ complexes on optical properties of polyvinyl alcohol. The samples have been prepared by casting technique and different thickness. . The absorption and transmission spectra has been recorded in the wavelength range (200 – 800) nm. The experimental results show that the absorption coefficient, energy gap of the indirect allowed and forbidden transition, extinction coefficient, read and imaginary dielectric constant and refractive index are changing with increase the of $[Co(NH_3)5Cl]Cl_2$ concentration.
Key words: polymer, optical properties, complexes.

Introduction

Conducting polymers can exhibit significant levels of electrical conductivity suitable for use in electronic devices, batteries, functional electrodes, electrochromic devices, optical switching devices, sensors, and so on [1]. Conjugated polymers have been the subject of intensive research during the last two decades mainly because of their semiconductor-like optical and electronic properties. These organic materials can be used in optoelectronic devices such as organic light-emitting diodes (OLEDs), light-emitting electrochemical cells, photovoltaics, image sensors, waveguides, and lasers [2].
Per last years composite materials attract the rapt attention both in industry applications and in science. In these materials there is the possibility to combine mechanical, electric and optical properties of constituent components in one sample. From optical point of view, several fascinating properties of these composites can be obtained [3].

Experimental Part

- **Preparation of $[Co(NH_3)5Cl]Cl_2$**

In the fume hood, completely dissolve 6 g of NH_4Cl in ~40 mls of concentrated ammonia in a 400 ml beaker. With continuous stirring, add 12 g of cobalt(II) chloride-hexahydrate in small portions. With continued stirring of the resulting brown slurry, slowly add 10 mls of 30% H_2O_2. After the effervescence has stopped, slowly add ~30 mls of concentrated HCl. With continued stirring, heat on a hot plate and maintain 85 o C for 20 minutes. Cool mixture to room temperature in an ice bath and filter (using a Buchner funnel) the crystals of $[Co(NH_3)5Cl]Cl_2$.

- **Materials and Methods**

PVA as a matrix and $[Co(NH_3)5Cl]Cl_2$ as a filler. The electronic balanced of accuracy 10^{-4} have been used to obtained a weight amount of polymer and complex. The samples were prepared using casting technique thickness ranged between (205-655)µm. The transmission and absorption spectra of composites have been recording in the wave length range (200-800) nm by using double – beam spectrophotometer (UV- 210Ashimedza)

The absorption coefficient(α) is calculated by using the following equation [4]:

$\alpha = 2.303A/t$ ………………… (1)

where A is absorption and t is the thickness of film .

The refractive index is calculated by using the following formula :

$n= [4R/(R-1)^2- (R+1/R-1)]^{1/2}$ …………(2)

The extinction coefficient is obtained by the relation :

$K= \alpha\lambda/4\pi$ …………….(3)

Real and imaginary dielectric constant is calculated from the equations :

$\varepsilon_1= n^2- k^2$ …………….(4)

$\varepsilon_2= 2nk$ ……………(5)

Results and discussions

The absorbance :

Figure (1) shows the relationship between the absorption and the wavelength. The value of absorption is exponentially decreased ,by comparing the four curves in the high absorption region i.e.(in the UV region the absorbance is increased by increasing the ratio of nickel nitrate, while in the visible region the absorbance decreased to the minimum value and be stable at the longest wavelengths. The absorbance is higher in the case of high concentration because high absorbance of nickel nitrate[5].

The absorption coefficient

The absorbance depends on the type and the nature of the chemical and crystalline of the composite and the type of the impurities which is found in the structure . variation of the absorption coefficient with the variation of the concentration of the added material and will be with constant values as shown in figure(2).
when the material is pure , a few concentration and the absorption coefficient will increase by increasing the photon energy (more than 5 ev).The high values refer to probability of occurring the indirect electronic transition.

Direct and indirect transitions :

To be sure that the composite has a direct allowed transition we use different values of the power. from the figures (3and 4) there is a variation in the energy gap values due to the mechanism of preparation, where the energy gap and its type depends on the crystal structure of the material and atoms distribution in the crystal lattice and the concentration of the energy levels, this means the variation of the structural properties and other parameters[6].

Extinction coefficient:

It refers to the amount of the attenuation which occurs in the electromagnetic wave when it passes the any medium in the figure (5) the extinction value is high in the region of high energies as a result to high absorption and this is affected by the structural formation of the composite the deviation increased at the increasing point of the chemical equilibrium the minor increasing occur in the lowest energies .
the extinction coefficient represent the imaginary part of the refractive index it is the loss of the energy due to the interaction between the light with the charges of the medium[7] .

The refractive index :

It is the function of the spectral reflectivity , so that the results of the refractive index will be affected by the spectral reflectivity and its variation with the wave lengths from figure 6 the refractive index increased with the deviation from the chemical equilibrium also the refractive index is increasing with the increase different concentrations of nickel nitrate ,this because of increase of the density of composite.

Dielectric constant

In the figures (7)and(8) the real and the imaginary parts of the dielectric constant can be calculated from the refractive index and the extinction coefficient ,so the real and the imaginary parts of the dielectric constant show a behavior similar to that of refractive index and extinction coefficient . in the real part at the low energy region the curves still nearly constant, while it increases rapidly at the high region. For the imaginary part the behavior is differ may be because the polarization is the main parameter.

Conclusions

From this study(optical properties of polyvinyl alcohol-chloro pentaammine cobalt(III) chloride composite), the addition of $[Co(NH_3)5Cl]Cl_2$ to Polyvinyl alcohol lead to increase the absorbance, on the other hand, absorption coefficient, extinction coefficient, real and imaginary dielectric constant and refractive index increase by increasing of $[Co(NH_3)5Cl]Cl_2$ concentration for all samples.

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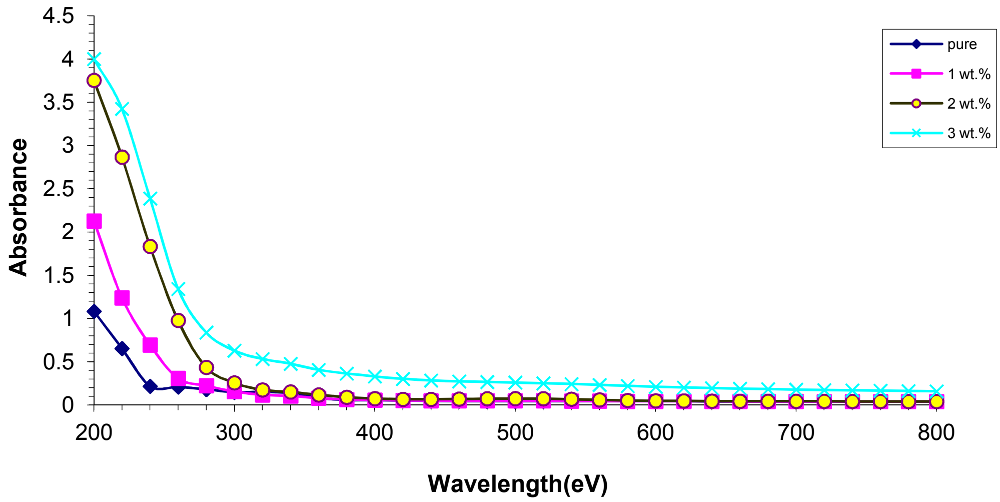

FIG.1
The variation of optical absorbance for composite with wavelength

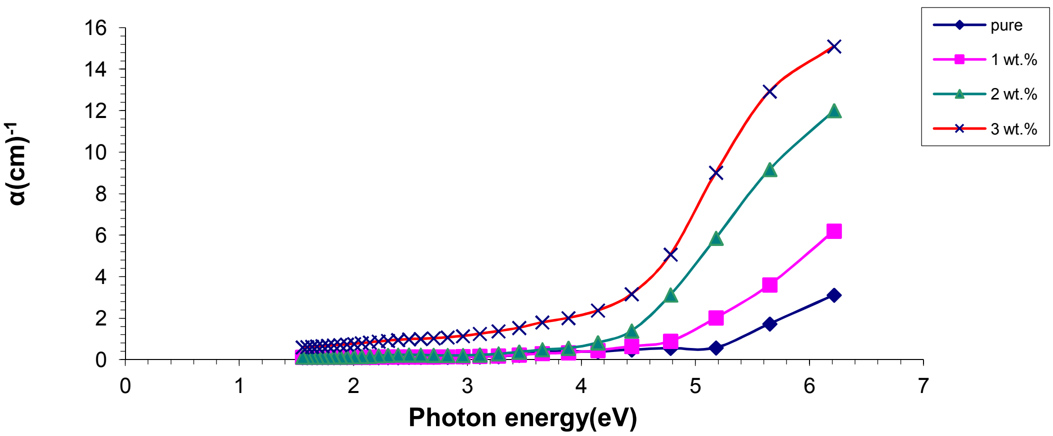

FIG.2
The absorption coefficient for (PVA-[Co(NH_3)5Cl]Cl_2) composite with various photon energy

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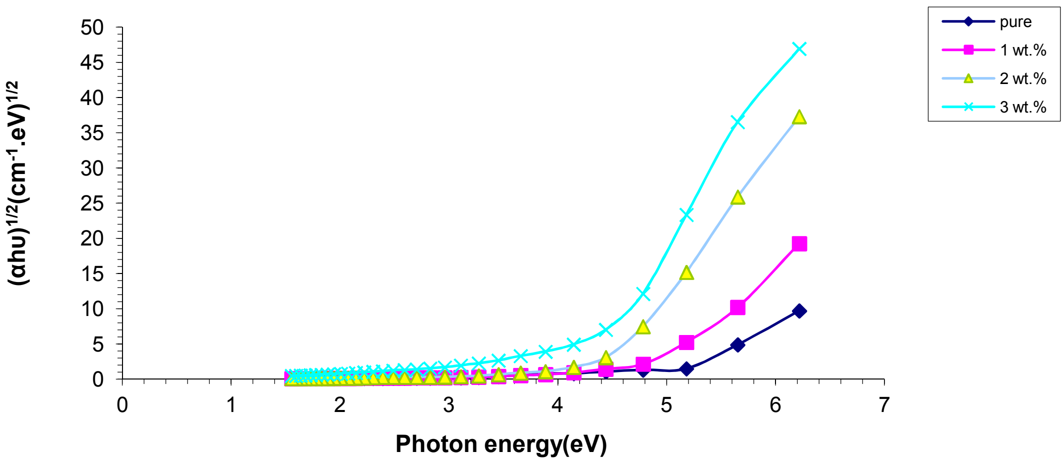

FIG.3
The relationship between $(\alpha h\upsilon)^{1/2}(cm\text{-}1.eV)^{1/2}$ and photon energy of composites.

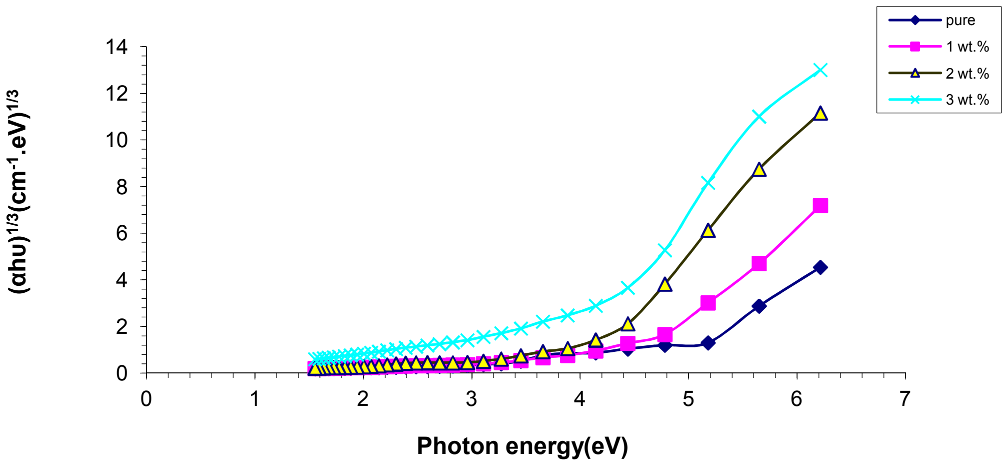

FIG.4
the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of composites

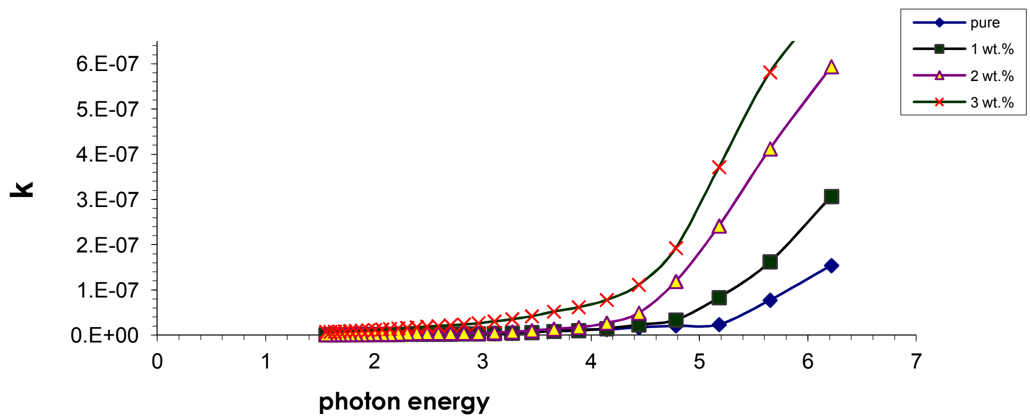

FIG.5
The extinction coefficient for composite with various photon energy

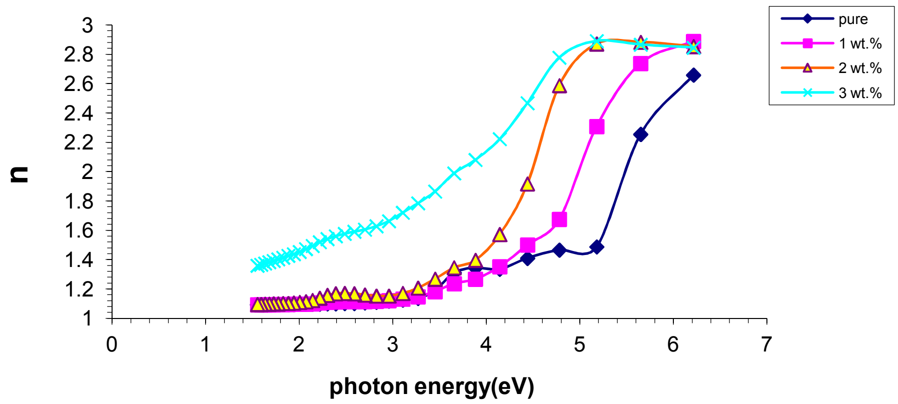

FIG.6
The relationship between refractive index for composite with photon energy

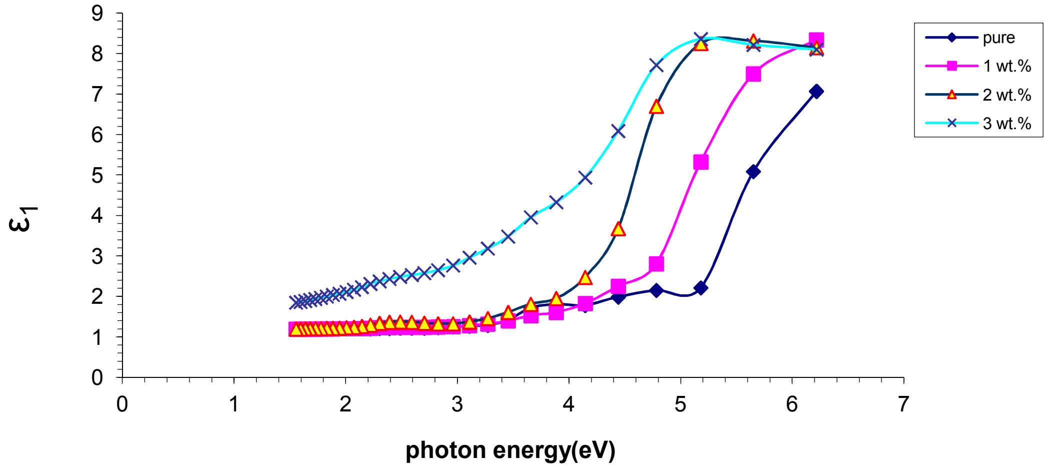

FIG.7
The variation of real part of dielectric constant composite with photon energy

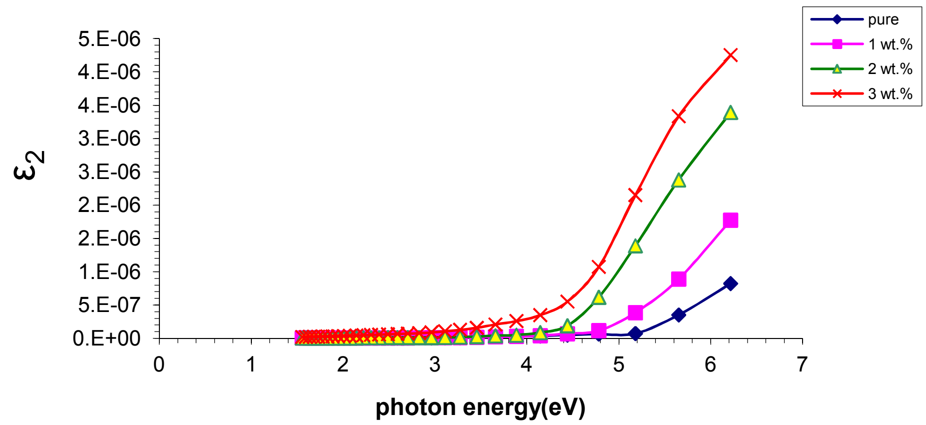

FIG.8
The variation of imaginary part of dielectric constant composite with photon energy