



## Studying the Effect of $\text{NiCl}_2$ Addition on the Optical Properties of Synthesized Chitosan

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### ABSTRACT

In this research natural bio polymer "chitosan" was synthesized using fish shells, Chitosan is made from chitin by a chemical process involving demineralization (DA), deproteinization (DP) and deacetylation (DA). Chitosan was doped with ( $\text{NiCl}_2$ ) by using casting method. The effects of addition of nickel chloride concentration optical properties of chitosan have been studied in the wavelength range (200-800) nm. The absorption coefficient, energy gap, refractive index and extinction coefficient have been determined. The results show that the optical constants change with increase of nickel chloride concentration.

**Key words:** Polymer, Nickel Chloride, Optical properties, Absorbance and Chitosan.

### INTRODUCTION

In recent years, polymers with different optical properties have been attracted much attentions due to their applications in the sensors<sup>1</sup>, light-emitting diodes<sup>2-4</sup>, and others<sup>5,6</sup>. The optical properties of these materials can be easily tuned by controlling contents of the different concentrations. Though a great deal of excellent work has been reported on such materials<sup>7-9</sup>, it is still meaningful to extend the research of these polymers.

A polymer of a particular group is characterized by the molecular weight of the monomer unit. To study the interactions in the solid state of the polymers of few models have been

suggested. One such model treats a polymer as an aggregate of fairly stiff tubes held together in approximately parallel bundles of forces arising from particle-particle potentials. The structure of polymers has been related to internal pressure and the same study has been extended to polystyrene solutions. Some of the interesting properties of polystyrene like the Gruneissen parameter, specific heat and bulk modulus have also been reported<sup>10</sup>. Chitosan (CS) is a natural carbohydrate biopolymer derived by deacetylation (DA) of chitin, a major component of the shells of crustacea such as crab, shrimp, and crawfish. After cellulose, chitin is the second most abundant natural biopolymer found in nature<sup>11</sup>. Chitosan is a non-toxic, biodegradable and biocompatible polymer. Over the last several years, chitinous polymers, especially chitosan, have

received increased attention as one of the promising renewable polymeric materials for their extensive applications in the pharmaceutical and biomedical industries for enzyme immobilization and purification, in chemical plants for wastewater treatment, and in food industries for food formulations as binding, gelling, thickening and stabilizing agent<sup>12</sup>. Chitosan has many properties that have generated interest in its use such as biodegradability, biocompatibility and its nontoxic nature<sup>13</sup>. The deacetylated product, chitosan, has an amine functional group, which is strongly reactive with metal ions.

The objective of this study was the synthesis of the chitosan and studies the effect of addition of  $\text{NiCl}_2$  concentration on optical properties of chitosan.

## EXPERIMENTAL

### Raw Material

Crawfish shells were obtained from commercial crawfish shells that separated, and washed under running warm tap water to remove soluble organics, adherent proteins and other impurities, and then they were dried and ground through a grinding mill.

### Isolation of Chitosan

Traditional isolation of chitosan consists of three traditional steps (Figure 1): demineralization (DM), deproteinization (DP), and deacetylation (DA). The polymer (chitosan) was dissolved in 2% acetic acid by using magnetic stirrer in mixing process to get homogeneous solution at  $90^\circ\text{C}$ , then the solution was cooled at room temp., after which solution was transferred to clean glass Petri dish of (5.5cm) 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/160/Shimadzu spectrophotometer.

## RESULTS AND DISCUSSION

### The absorbance of composites

Figure(2) shows the spectral dependence of the absorbance of the composites with different quantities of impurities .The figure shows that the

absorbance decay exponentially with an increase of the wavelength .the absorbance is very large in the UV- region , this decay becomes relatively slower in the visible and near infrared regions<sup>15</sup>.

### The Absorption coefficient and energy gap of compos

Figure (3) shows the relation between the absorption coefficients of the composite with photon energy. High absorption coefficient with impurities concentration may be due to the absorption by the

### Washing and drying

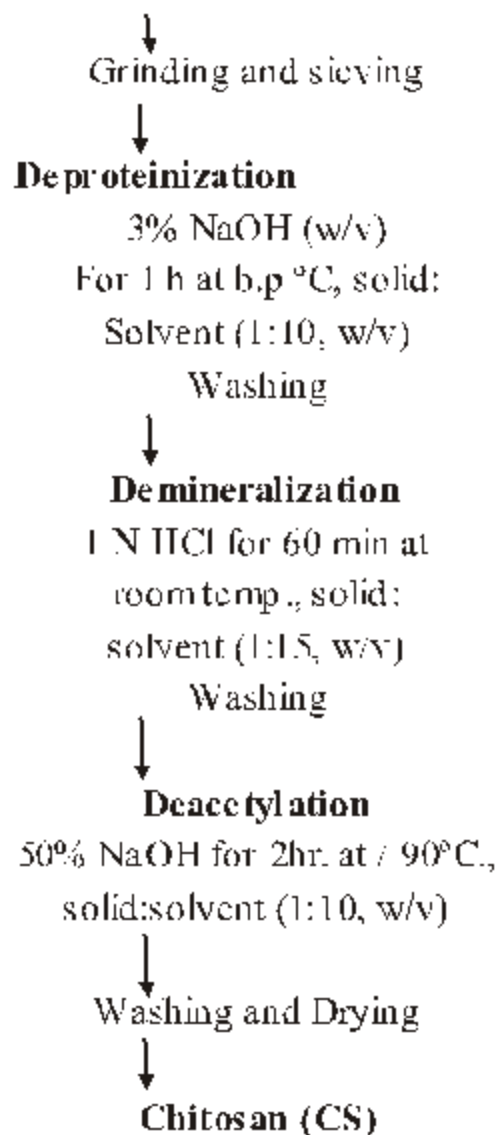


Fig. 1: Traditional Chitosan Production<sup>14</sup>

impurities .The absorption coefficient is smaller and stable in the low photon energy because of the scattering of the photon energy<sup>15</sup>.

Figures(4) & (5) give an indication that the composites have an indirect transition , by using these figures we can calculate the energy band gap in the range corresponds to higher than 4.5 eV of

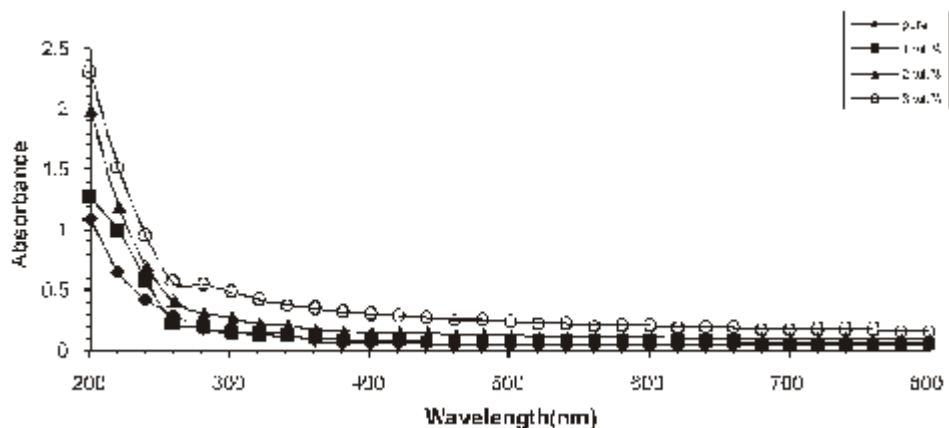


Fig. 2: The variation of optical absorbance for (CS-NiCl<sub>2</sub>) composite with wavelength

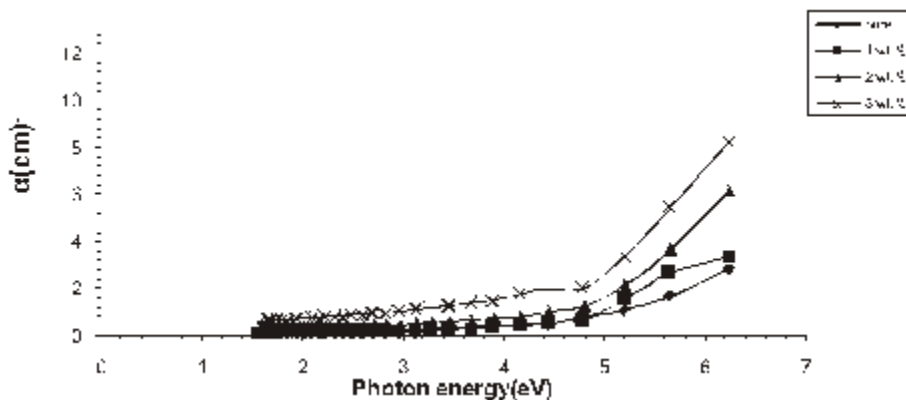


Fig. 3: The absorption coefficient for (CS-NiCl<sub>2</sub>) composite with various photon energy

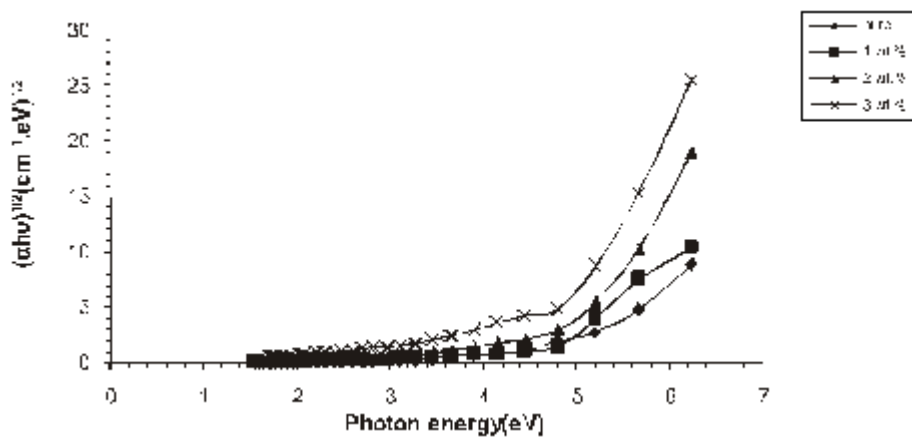


Fig. 4 The relationship between  $(\alpha hu)^{1/2}(\text{cm}^{-1} \cdot \text{eV})^{1/2}$  and photon energy of CS-NiCl<sub>2</sub> composites

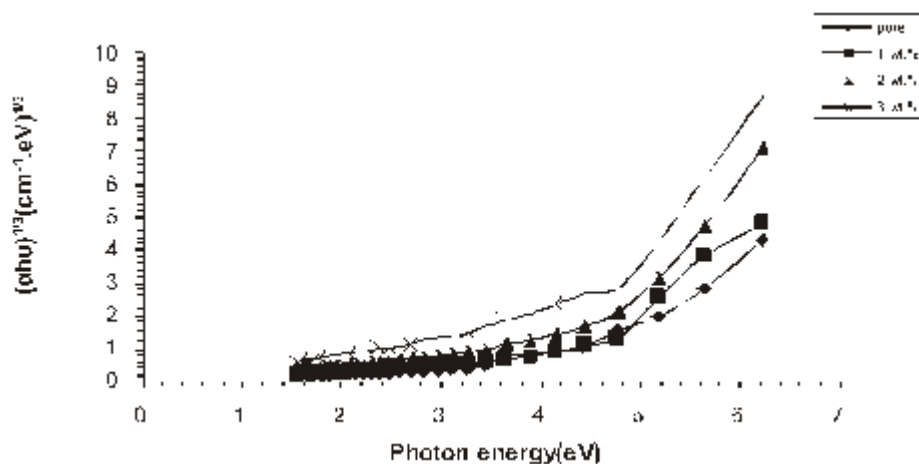


Fig. 5: The relationship between  $(\alpha h\nu)^{1/3}(\text{cm}^{-1}.\text{eV})^{1/3}$  and photon energy of CS-NiCl<sub>2</sub> composites.

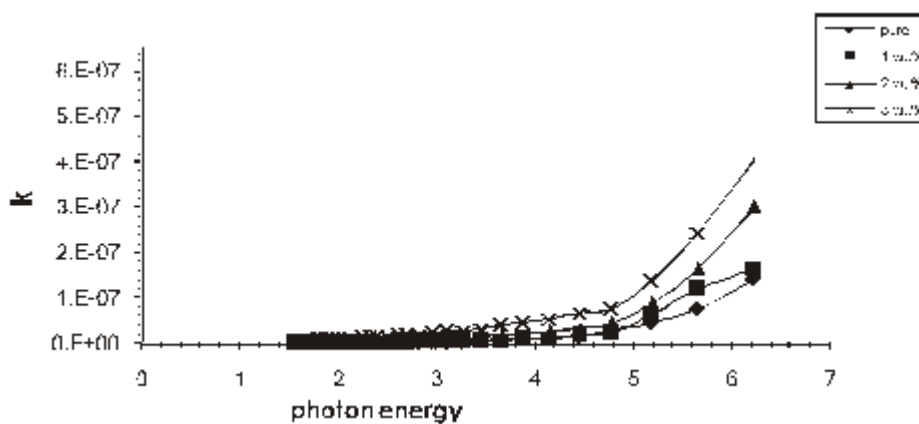


Fig. 6: The extinction coefficient for (CS-NiCl<sub>2</sub>) composite with various photon energy

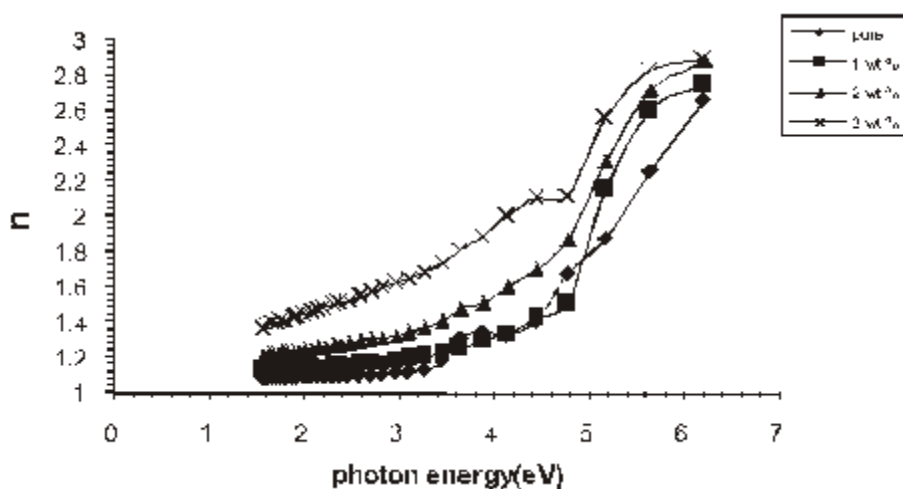


Fig. 7: The relationship between refractive index for (CS-NiCl<sub>2</sub>) composite with photon energy

the observed variation of the composite band gap this gives an indication about the effect of the differentiation in the molar concentration of the additives<sup>15-16</sup>.

**Refractive Index and Extinction Coefficient**

Figure (6) shows the variation of the extinction coefficient (K) as a function of the incident photon energy from this figure the values of the (k) is low in the low photon energy and increases with the increasing of the photon energy depending on conformation condition of the composite .By increasing the concentration of the additives the deviation from the chemical equilibrium increases too, so the absorption and (k) will increase as a

result of the scattering centers in the composites.

Figure (7) shows the variation in the refractive index (n) of the composites within a given incident photon energy. The values increase exponentially with increasing photon energy. This indicates that the electromagnetic radiation pass though the material is slower in the VIS and UV regions however the speed is higher in the visible and near Infrared region .

**Dielectric constant**

Figures (8) & (9) are used to illustrate the real and imaginary dielectric constant respectively .Both show the exponential increase with increasing

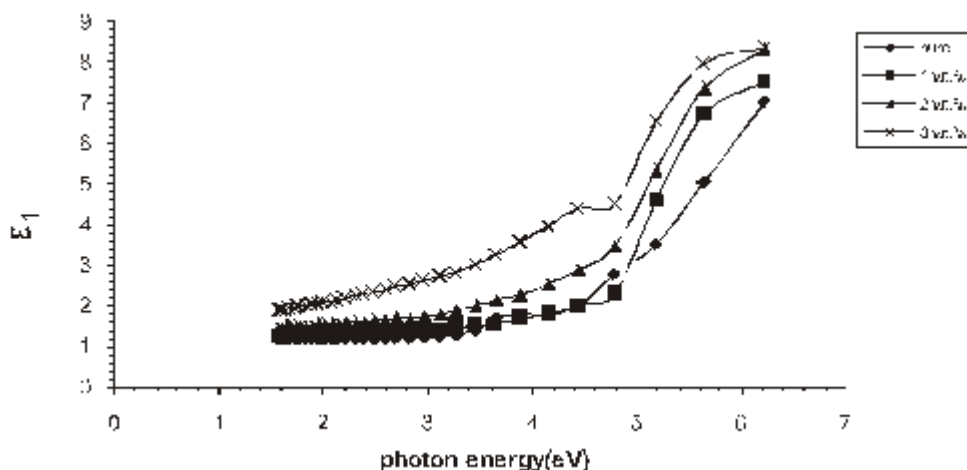


Fig. 8: The variation of real part of dielectric constant (CS-NiCl<sub>2</sub>) composite with photon energy

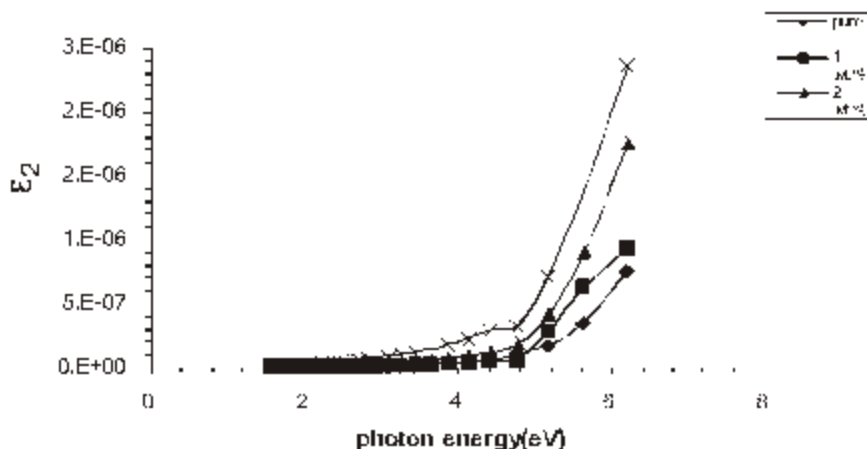


Fig. 9: The variation of imaginary part of dielectric constant (CS-NiCl<sub>2</sub>) composite with photon energy

the incident photon energy (from high values in the UV- regions) .The concentration of the additives plays an important role in both cases due to the electronic polarization. The effect is very clear in the high photon energy region<sup>15-16</sup>.

### CONCLUSION

The absorbance is very large in the uv, region.

The absorption coefficient is smaller and

stable in the low photon energy.

The absorption and (k) will increase as a result of the scattering centers in the composites.

The values of the refractive index (n) of the composites increase exponentially with increasing photon energy.

The real and imaginary dielectric constants show the exponential increase with increasing the incident photon energy.

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