Effect of Thickness variation on The Optical Properties of (Poly Vinyl Alcohol : Green Methyl) Films

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Abstract

Poly (vinyl alcohol) doped with different Green methyl concentration (4%) by solvent cast method for different thickness the prepare films were 5, 10, 15,and 20 µm. Transmission and absorption spectrum have been recored in order to study the effect of increasing thickness on some opttical constans such as transmittance, reflectance, absorption coefficient, refractive index and extinction coefficient. The film study reveals that all these parameters affect by increasing the thickness. The films show indirect allowed interband transitions that influenced by the thicknesses , the optical energy gap has been increased from about (3.36 eV) for the (5 µm) , (3.39 eV) for the (10 µm) , (3.41 eV) for the (15µm) and (3.45 eV) for the (20 µm) .

Keywords: Poly(vinyl alcohol), solvent cast method, Effect of Thickness, Optical Properties.

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تأثير السمك على الخواص البصرية لأغشية بولي فنايل الكحول المشوبة بالمثيل الاخضر

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الخلاصة

تم تحضير اغشية من بوليمر بولي فنايل الكحول المدعمة بالمثيل الاخضر بأنسبة (4%) بطريقة الصب وباسماك مختلفة (20 , 15 , 10 , 5)مايكرومتر . تم دراسة اطياف الامتصاص والنفاذية مع زيادة السمك على بعض الثوابت البصرية مثل الانعكاسية والنفاذية ومعامل الامتصاص ومعامل الانكسار ومعامل الخمود لأغشية بوليمر بولي فينيل الكحول . لقد وجد ان جميع الثوابت البصرية التي تم دراستها تتأثر بزيادة السمك. كذلك وجد في هذه الدراسة ان الانتقالات الحاصلة نتيجة لتأثير السمك هي انتقالات مسموحة غير مباشرة . وجد ان فجوة الطاقة البصرية تزداد بزيادة السمك حيث (3.36 eV) لـ (5 µm)، (3.39 eV) لـ (10 µm) ، (3.41 eV) لـ (15 µm) ، (3.45 eV) .

الكلمات المفتاحية : بولي فنايل الكحول، طريقة الصب ، الخصائص البصرية، تأثير اختلاف السمك.

Introduction

Poly(vinyl alcohol) (PVA), is a water-processable polymer, with excellent chemical resistance, optical and physical properties which recommend it and itscomposites for broad industrial uses. PVA can be combined with other polymers or fillers to enhance its properties [1,2] , which are useful in technical applications including biochemical and medical. The important feature of semicrystalline PVA isthat the presence of crystalline and amorphous regions and its physical properties,which are resulting from the crystal–amorphous interfacial effects. These two regions are well separated by portions of an intermediate degree of ordering, which enhances the macromolecule, producing several crystalline and amorphous phases [3]. Optical behavior of the polymer are affected by doping which depends on the interaction between the polymer and the dopant . the doped polymers have been the subjects of interest for the theoretical and experimental studies, because of the physical and chemical properties needed for specific application may be obtained by adding or doping with some dopant. It is observed that doping a polymer with metal salts has significant effect on their physical properties including optical,

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and electrical properties. These changes in physical properties, depend on the chemical nature of the dopant and the way in which they interact with the host polymer [4,5,6].

In the present work is to investigate the optical properties of poly vinyl alcohol (PVA) doped with 4% of Green methyl with different thicknesses by solvent cast method

Experimental Details

Poly Vinyle alcohol polymer (PVA) solution was prepared by adding deionzied distilled water to solid PVA and then stirred by a magnetic stirrer at 70 ˚C for one hour, a solution of (Green methyl) was prepared by adding deionized distilled water to (Green methyl)and then stirred by a magnetic stirrer at room temperature for ½ h. Appropriate mixtures of PVA and (Green methyl) solution were mixed for (4%) different thicknesses 5 µm , 10 µm , 15 µm and 20 µm. The solution was poured into flat glass dish. Homogenous films were obtained after drying in an oven for (1 h) at 60 ˚C .The film thickness was measured with a digital micrometer (China Hunan E&K Tools Company) and the average area was (4 x 4) cm2. Absorbance and transmittance measurement were carried out using UV/VIS Spectrophoto meters in the wave length range (190 – 1100) nm

Results and Discussion

Figure (1) shows the of Poly Vinyl Alcohol : Green Methyl) Films for different thickness as a function of wavelength we can observe that the transmittance decreases with increasing the thickness This may be attributed to the creation of levels at the energy band by increasing thickness and this leads to the shift of peak to smaller energies. There are no absorption bands in the visible region good absorption at which region the films are transparent and this result agree with previous studies [7]

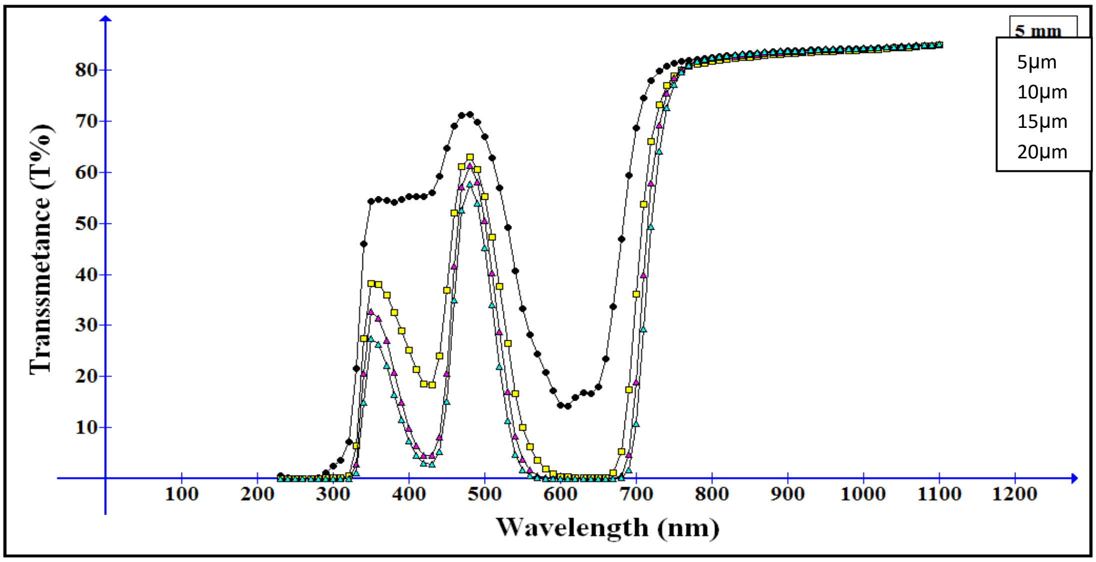


Fig. (1) Title under the graph

Figure. (2): shows the of Poly Vinyl Alcohol : Green Methyl) Films for different thicknesse as a function of wavelength was found to increase with increasing the thickness.

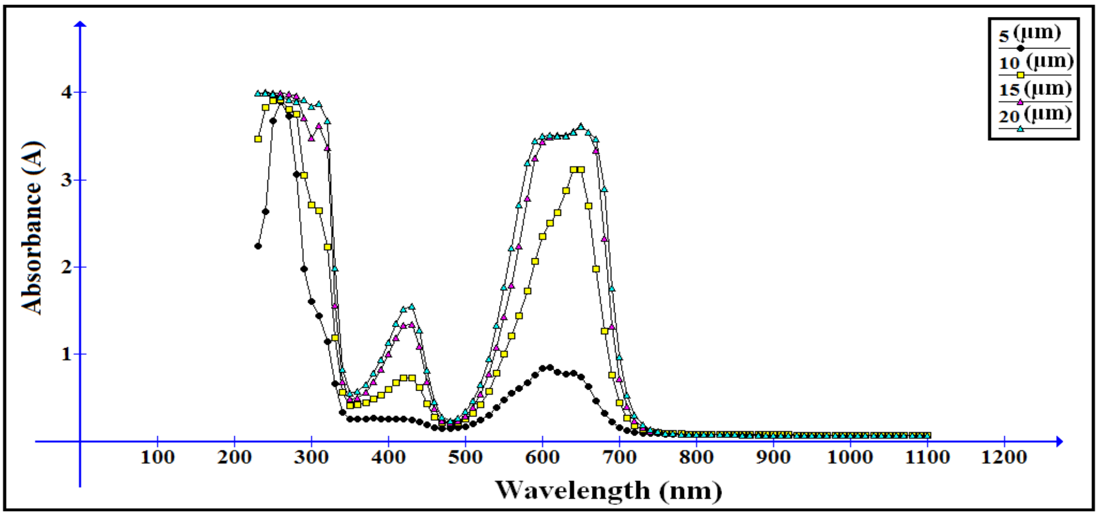


Fig. (2): Absorbance of (PVA- Green Methyl) for thickness films

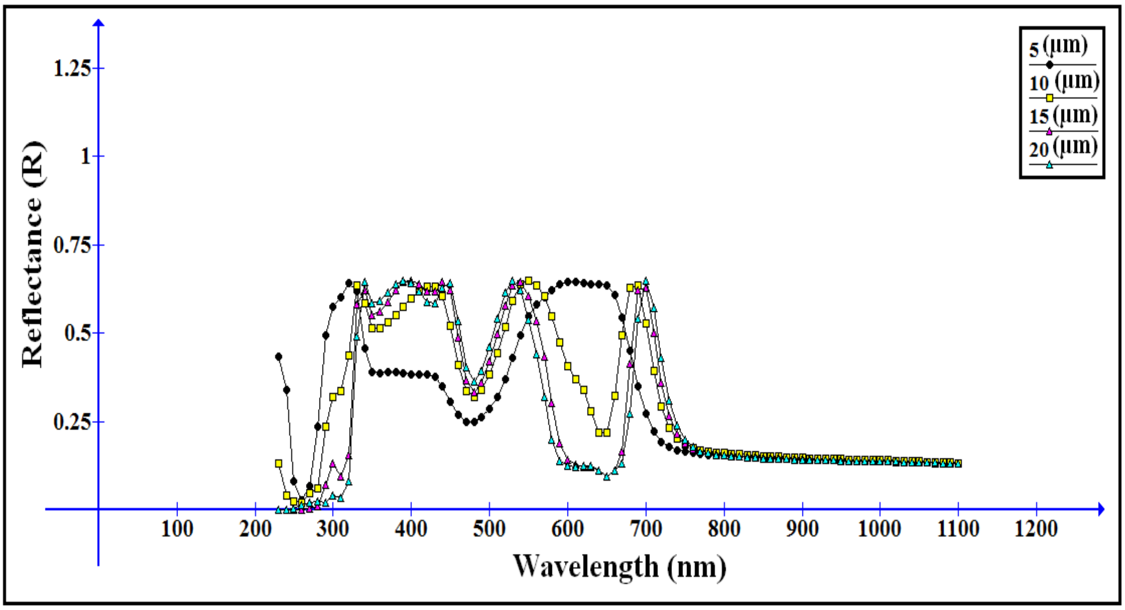


Figure. (3): Reflectance of (P V A- Green Methyl) for thickness films.

The absorption coefficient of PVA Green Methyl films prepared by solvent cast method are determine from the region of high absorption at the fundamental absorption edge of film. The absorption coefficient was calculating using Lambert law [8]:

$$\alpha = \frac{2.303A}{t} \qquad \text{------------- (1)}$$

Where (A) is the Absorbance and (t) is the film thickness

Figue. (4) show that absorption coefficient decreases with increases of strong absorption at which, wave length at short wavelength (absorption coefficient) takes higher value and then increases with decreasing (wavelength) (increasing photon energy).

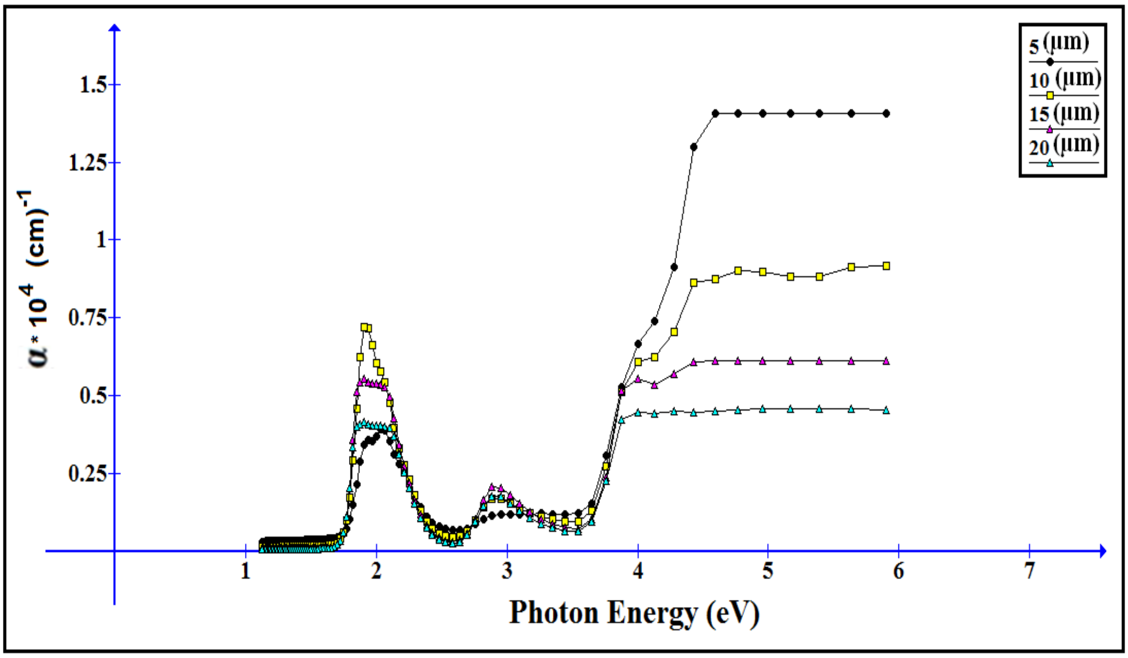
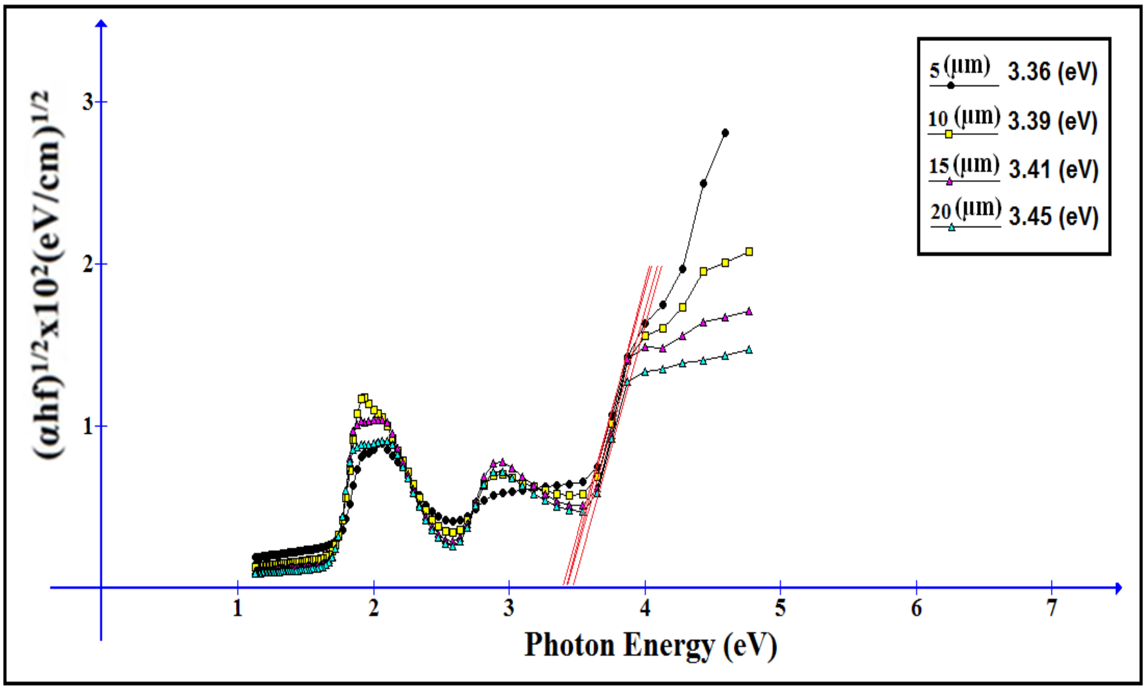


Fig. (4) Absorption Coefficient of (PVA- Green Methyl) different thickness films.

The optical energy gap of the films for allowed indirect transition is determined by the following relation [9]:

$(\alpha h\upsilon)^{n} = A\,(h\upsilon - E_g)$ ------------(2)

Where (E_g) is the optical energy gap of films, (A) is a constant and (hv) is the incident photon energy. the optical energy gap can estimated by plotting ($\alpha h v$)1/2 versus photon energy (hv) , then extrapolating the straight line part of the plot to the photon energy axis Figures (5) shows the variation of the optical energy gap of (PVA: Green methyl) for different thickness films. The optical energy gap increases from (3.36 , 3.39 , 3.41 , 3.45) eV as the thickness increases from (5 ,10 ,15 , 20) µm, This may be explained by invoking the occurrence of local cross linking within the amorphous phase of the Poly(vinyl alcohol) , in such a way as to increase the degree of ordering in these parts [10].



The Fig. (5) Visual Energy Band Gap of (PVA- Green Methyl) different thickness films.

refractive index is a suitable state parameter directly correlated to the material density. Fig. (6) Shows the variation of the refractive index with the films thickness. It is clear from this figure that the films are influenced by the film thicknesses, The refractive index of these films is slightly increases with the increase in the films thickness. The refractive-index measurements can have a correlation with the electrical properties of the prepared films. The refractive index (n_0) can be determined from the reflectance (R) using the relation [11]:

$$n_{\circ} = \left(\frac{1+R}{1-R}\right) + \sqrt{\frac{4R}{(1-R)^2} - k_{\circ}^{2}} \quad \text{------------- (3)}$$

the refractive index depends on the strength of the bonds, on density, and on molecular weight, increasing the thickness may alter all these parameters in a manner which increases the corresponding refractive index.

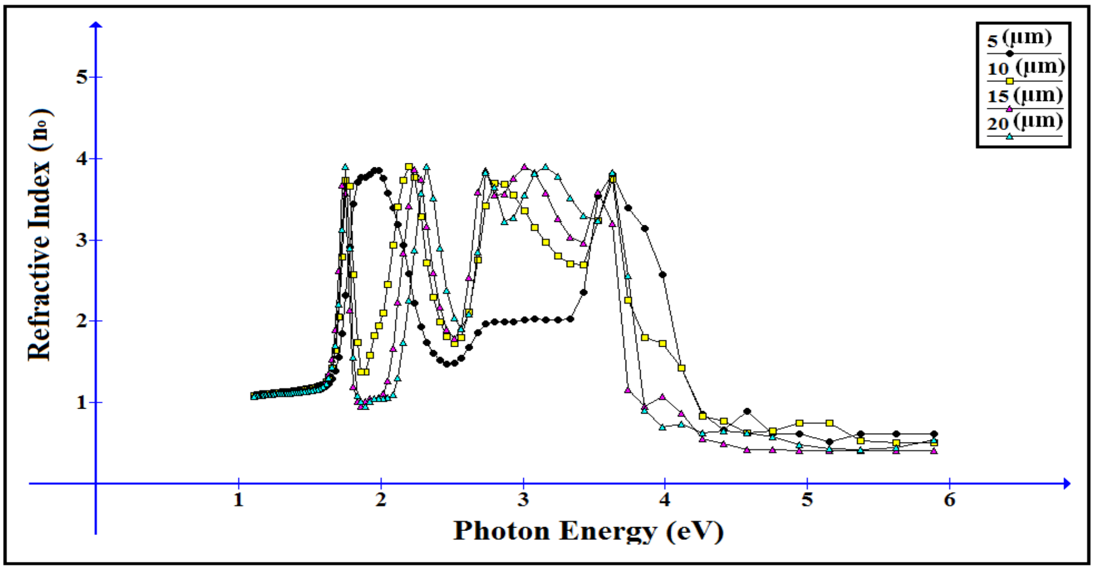


Figure. (6) Refractive index of (P V A- Green Methyl) different thickness films.

The behavior of extinction coefficient (k_O) is nearly similar to the corresponding absorption coefficient at different thicknesses. We can observe from Fig.(7) that extinction coefficient increases with increasing of films thickness. This is attributed to the same reason mentioned previously in absorption coefficient.

The extinction coefficient (k_O) can be determined by using the rapport [12]:

$$k_{\circ} = \frac{\alpha \lambda}{4 \pi} \qquad \text{------------- (4)}$$

Where (α) is the absorption coefficient and (λ) is the wavelength of the incident photon. Fig. (7) Shows the variation in ($k_\circ$) as a function of the photon energy ., It can be notice that the extinction coefficient increases as the film thickness increase.

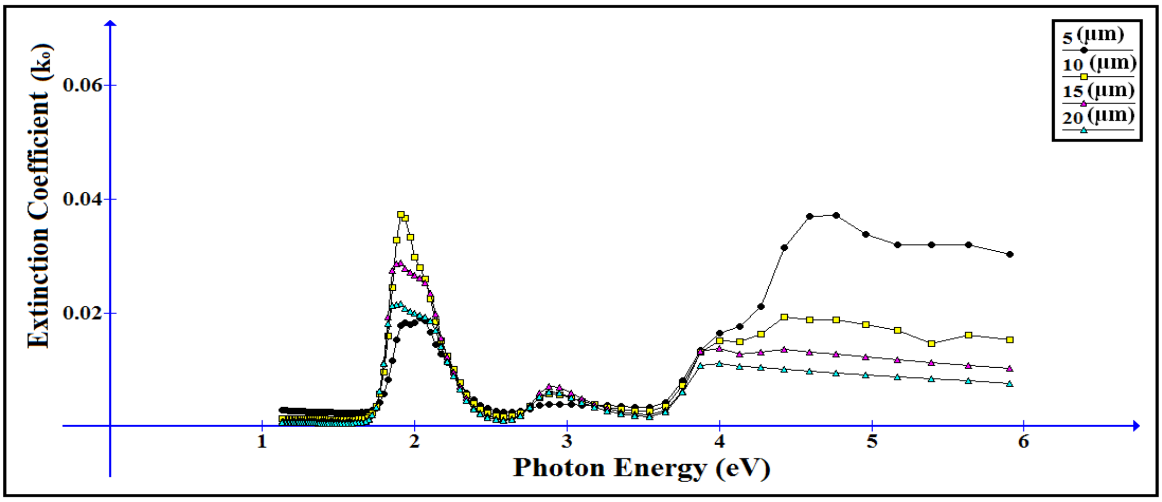


Fig. (7) Extinction coefficient of (PVA- Green Methyl) different thickness films.

Conclusions

The detailed study of the PVA Green Methyl films thickness effect on some optical properties has shown that all the optical constant such as transmittance, reflectance, absorption coefficient, refractive index, and extinction coefficient have been affected by increasing the thickness. And the the optical energy gap has been increased from about (3.36 eV) for the (5 µm) , (3.39 eV) for the (10 µm) , (3.41 eV) for the (15µm) and (3.45 eV) for the (20 µm) .

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