Optical Parameters of (KMnO₄) Doped (PVA)

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Abstract

Films of pure (PVA) and (PVA) doped by (KMnO₄) have been prepared using casting method. We have studied the effect of(KMnO₄) dopant on the optical properties of a polymer poly(vinyl alcohol) (PVA). Optical band energy gap (Eg) is estimated using (UV-VIS) spectra and it was classified as indirect allowed transition . Optical transmittance, Absorptance , Absorption coefficient , real and imaginary part of dielectric constant and Skin depth are investigated and correlated with the action of doping process.

Keyword: poly(vinyl alcohol),Optical Parameters , (KMnO₄),doing effect.

المعلمات البصرية لأغشية البولي فنايل الكحول المشوب ببرمنغنات البوتاسيوم

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المستخلص

حضرت أغشيةPVA النقية والمشوبة بـ(KMnO₄) باستخدام طريقة الصب الكيميائي. درسنا تأثير الشائبة(KMnO₄) على الخواص البصرية للبوليمر(poly(vinyl alcohol.

حسبت فجوة الطاقة البصرية(Eg) باستخدام طيف (UV-VIS) وصنفت كانتقال غير مباشر مسموح. قيست النفاذية , الامتصاصية ,معامل الامتصاص, ثابت العزل الحقيقي والخيالي وعمق الاختراق وربطت بعملية الاشابة.

الكلمات المفتاحية: بولي فنايل الكحول, المعلمات البصرية,برمنغنات البوتاسيوم,تأثير التشويب.

Introduction

Polymer materials present an increasing interest for the optical data processing technologies. They may be used as convenient data storage materials as well as in the fabrication of the passive and active light guides [1].

Poly (vinyl alcohol) (PVA) is one of the most important polymeric materials as it has many applications in industry and is of relatively low cost in manufacture. There are a large number of reports on pure PVA or on PVA with different additives [2].

In order to tailor materials with improved properties within the doped polymer, the first step is to understand and control the electronic mechanisms involved in the optical behavior. Many studies show that the properties like crystallinity, structural order, thermal stability[3], electrical and optical behavior of the polymer are affected by doping which depends on the interaction between the dopant and the polymer. In recent years, the doped polymers have been the subjects of interest for both 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, thermal, 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. The present work reports on the transition induced by the UV-VIS exposure of films of (PVA) doped with a (KMnO₄).

Experimental details

Poly (vinyl alcohol) (molecular weight 10000 g/mol) were used as a matrix polymeric material in this research supplied by (BDH chemicals) with high purity, the aqueous solution of this polymer was prepared by dissolving PVA in a mixed of deionzed water and ethanol and stirred by magnetic stirrer for about one hour until PVA was completely dissolved.

(KMnO₄) powder were dissolved in deionzed water. Appropriate mixtures of (PVA) and 8% weight (KMnO₄) solutions were mixed .

The solution was poured into flat glass. Homogenous films were obtained after drying the solution in an oven for 24 hours . The thickness of the prepared films was in the range of (25 ±5) µm.

Absorbance and transmittance measurements were carried out using double bean UV/VIS spectrometer (shimadzu Japan) in the wavelength range (300-900) nm .

Results and discussion

Fig.(1) shows the transmission spectra of as-deposited PVA film of thickness 20 µm and doped with 8% KMnO₄. It was found that the absorption edge shifts towards lower energies due to doping (red shift). Furthermore, the transmission was found to decrease with doping.
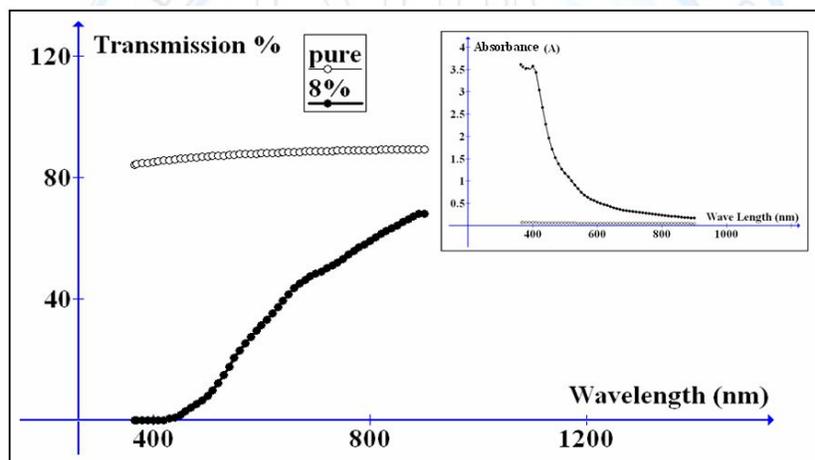

Figure (1) Transmittance against Wavelength for pure PVA , 8wt% KMnO₄ doped PVA samples. The inset shows the Absorbance vs. Wavelength.

Fig (2) shows The absorption coefficient (α) which was determined from transmission and reflectance spectra and the film thickness. The doping with KMnO₄ increases (α) sharply , the marked increase of the absorption coefficient at higher energies may be attributed to extra transition from the bonding molecular orbit to nonbonding molecular orbit[4].
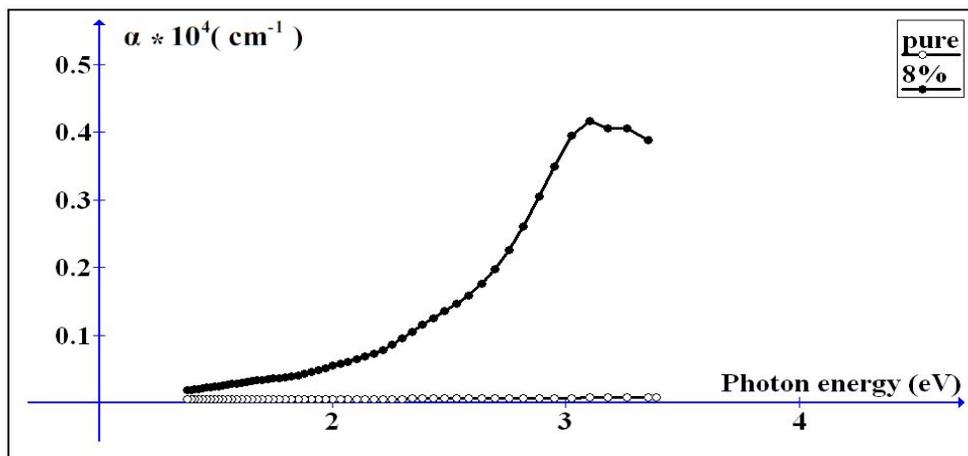
Figure (2) Absorption Coefficient as a function of Photon energy.

Fig. (3) can be considered as an evidence for indirect allowed transition. The energy gap decreases after doping, This might be attributed to the presence of dopant and its interaction results in the creation of new molecular dipoles could be a result of point defects created within the band gap[5],
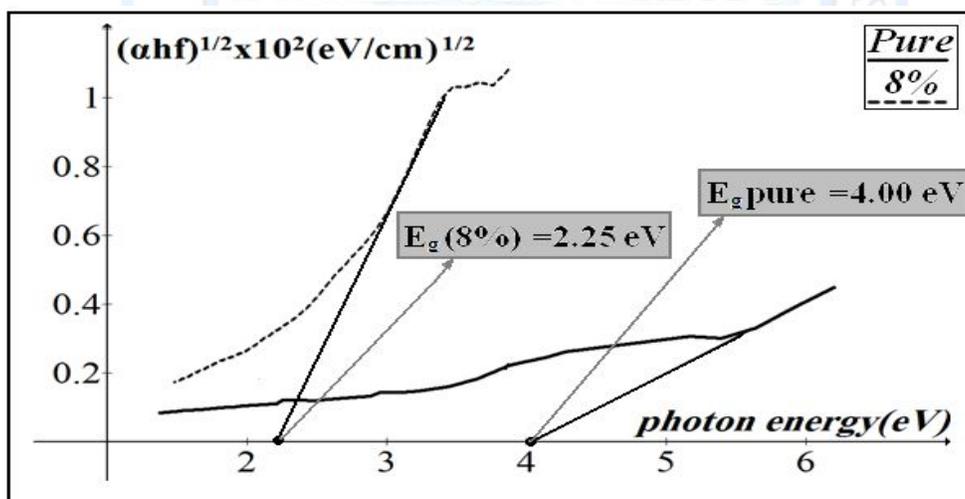

Fig. (3) Optical energy band gap of pure PVA , 8 wt%, KMnO₄ doped PVA samples.

In addition, the change in the optical energy band gap Eg indicates the occurrence of local cross linking within amorphous phase of the polymer in such a way as to increase the degree of ordering in these parts [6].

Real and imaginary parts of the dielectric constant were calculated and are shown in Fig. (4) and (5) .It is seen that the real and imaginary parts of dielectric constant increase with doping.
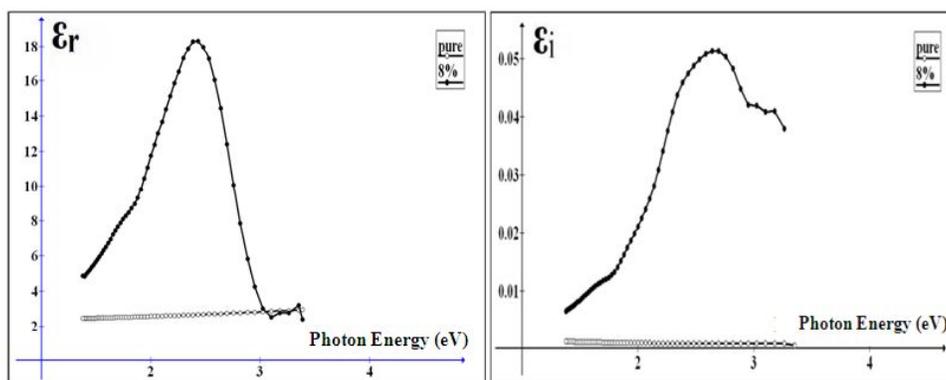

Fig. (4) ε_r vs. Photon energy.   **Fig. (5) ε_i vs. Photon energy.**

The real part of dielectric constant is higher than the imaginary part[7].

It is useful to define a characteristic ''skin'' thickness that is subject to an appreciable density of optical energy. A convenient form used widely is simply the inverse of α, i.e. $\chi = 1 / \alpha$. In other words, the electromagnetic wave will have amplitude reduced by a factor 'e' after traversing a thickness (called the skin depth) [8] . In long wavelength greater than absorption edge, skin depth decreases with doping as shown in Fig. (6), this might be due to increase in the probability of absorption with doping
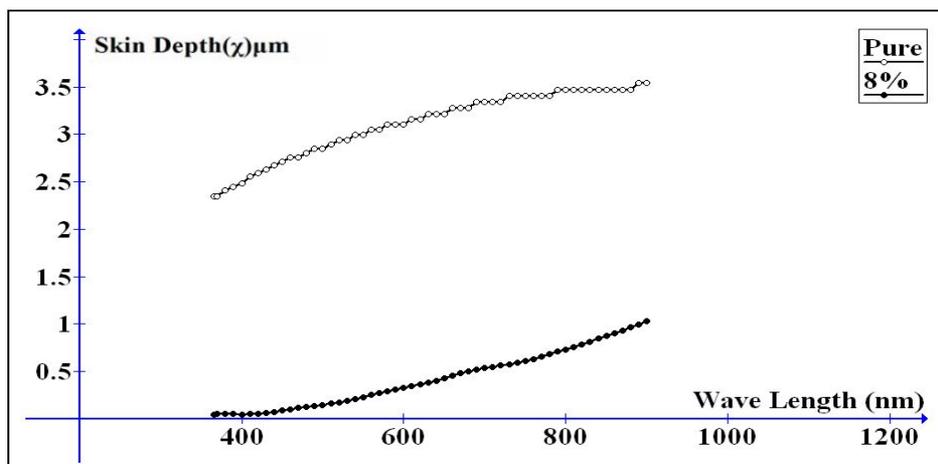
Fig. (6) Skin depth (χ) as a function of wavelength.

Conclusions

Pure (PVA) and (KMnO₄) doped (PVA) have been prepared successfully by casting method . (KMnO₄) doping have affected all the parameters under investigation by reducing the optical energy gap. from which we can estimate the energy gap of (PVA) and (KMnO₄) doped (PVA) . We found that Eg = 4 eV and 2.25 eV respectively. We conclude that the skin depth of the doped polymer deceased in comparison with the undoped (PVA).

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