Syntheses and study the optical and electrical properties of Polyaniline-Oxalic thin film

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Abstract:

Polyanilne-Oxalic have been successfully synthesized by using aniline hydrochloride and ammonium per sulfate in ice path at$(0\text{-}5)^0$C, and oxalic acids as dopents.

The structural and optical properties of (PAni) are investigated by using UV-VIS spectra photometer, the XRD analysis and FT-IR pattern confirmed the formation of (PAni) .

The UV-VISspectra show three absorption peaks at (299),(362),(454) nm , the value of E_g is equal to 2.7 eV .The electrical properties are investigated. The experiment results show that the D.C. electrical conductivity of PAni-ox. are (8.2×10^{-2}S/cm) at R.T.

Keywords: Polyaniline- Oxalic, optical properties, DC electric conductivity .

تحضير ودراسة الخواص البصرية والكهربائية لغشاء بولي انلين- الاوكزالت

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الخلاصة:

في هذا البحث، حُضّر البولي انلين مع حامض الاوكزالت من ملح الانلين وامونيابيرسلفات في حمام ثلجي وبدرجة حرارة (0-5) درجة سليزية.حسبت الخواص البصرية والبنائية لبولي انلين باستخدام جهاز المطياف الضوئي UV-VIS شُخصت النماذج باستخدام تقنية الأشعة السينية XRD والأشعة تحت الحمراء FT-IR .وضحت نتائج المطياف الضوئي ظهور ثلاث قمم للامتصاص عند الطول الموجي (299،362،454) نانومتر. وجد من النتائج البصرية ان فجوة الطاقة لبولي انلين – اوكزالت بحدود 2.7 eV . درست الخواص الكهربائية للبوليمر المحضر وكان مقدارالتوصيلية الكهربائية (8.2×10^{-2}S/cm)..

الكلمات المفتاحية: بولي انلين- الاوكزالت، الخصائص البصرية، التوصيلية الكهربائية المستمرة .D.C.

1. Introduction

Polyanilne (PAni) is the most useful conducting polymers (CP) because it has led to the development of new models to explain their observed properties , particularly various mechanisms of charge transport[1,2].

Also (PAni) is the oldest because of it's facile synthesis, environmental stability , simple acid/base doping/ de-doping chemistry , low cost and high pseudo-capacitance under-line it's importance [3,4]

In addition, the use of (PAni) nanofibers or their composites can significantly enhance the sensitivity, selectivity and response time of Polyanilne-based chemical sensors and found place as a gas sensor. The extensive range of potential technological applications of (PAni) includes storage batteries , light emitting diode . and bio-sensors [4,5]

CP-semi conductor .hybrids can play a role in photovoltaic cell as hole-acceptors. The electron transfer from CP to the semi conductor layer can be detected by measuring the quenching of photoluminescence from conducting polymer after addition of Semiconductor nanocrystals [6-8] or by photo induced absorption experiments [9].

2. Method

Three – necked equipped with thermometer and stirrer , charged with 17ml Aniline hydrochloride , which dissolved with 1M Oxalic acid and cooled to $(0\text{-}5)^0$C .

17ml of Ammonium persulphat $(NH_4)_2S_2O_8$ dissolved in 1M Oxalic acid added drop wise slowly and very carefully to the flask and stirred for (2hrs) in ice bath, then for (24hrs) in R.T. The polymerization reaction proceeds for (4days), the polymer is filtered and finally washed with (0.2M)Hcl and acetone. The obtained polymer was dried at 60^0C under vacuum.

3. characterization

powder X-ray diffraction pattern (XRD) of PAni-ox in powdered form was recorded using pert.pro MPD-Phillips of Netherland operated at 40KV and 20 mA , using a Cu kα as source of radiation with (λ=1.5406 ^{0}A) and Ni(filter), with a scan rate of 2^0 min , and scan range of ($0<2\theta<60$). (XRD). Analysis was done to identify the structure of PAni. FTIR analysis was performed in range 4000-400 cm^{-1} with FTIR model 8400 spectrophoto meter by SHIMADZU under ambient condition Infrared spectroscopic studies were conducted to investigated the type of chemical bonding of(PAni-ox) . UV-VIS spectroscopic measurement of absorbance spectra of (PAni-ox). Were recorded using a spectrophotometer Mark(CE-7200) from England.

4. Result and Discussion:

The XRD pattern reveals amorphous nature of PAni-ox as shown in Fig.(1)

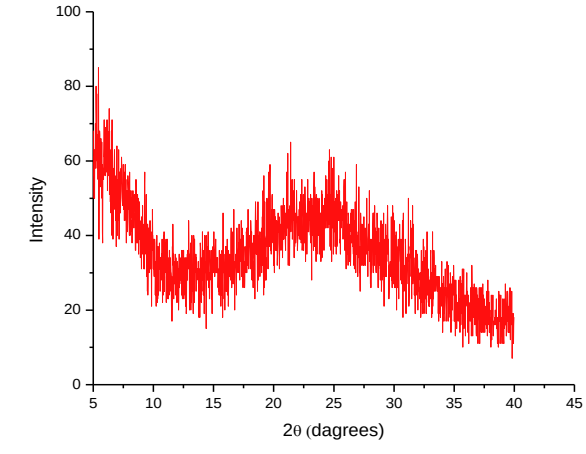

Fig.(1): XRD pattern of PAni- ox.

The FT-IR spectrum of PAni-ox is represented in Fig. (2).

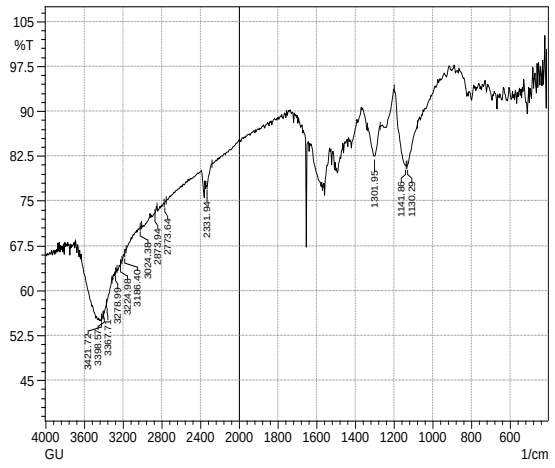

Fig.(2): FTIR spectrum of PAni-ox

The figure shows vibration bands around 3224, 3421 cm-1 which are attributed to the N-H stretching 0f C=C aromatic . The band 1301 cm-1 is due to C-N . (1130,1141) cm-1 bands are due to C-C and 800 cm-1 is due to bending of aromatic.

Ultraviolet and visible spectra for PAni-ox is shown in Fig. (3). The figure shows three major absorption peaks. The peaks at (λ=299 , 362, 454)nm . The peak observed at λ=299 nm is due to π-π* transition of benzenoid ring [10]. The less intense band peak at λ=362nm is due to π-π* transition, while the peak at 454 nm is on account of to polaron- π* transition and shift of electron from benzenoid ring to quinonoid ring [11]. Further, the peak at λ= 660 nm is due to π- polaron transition.

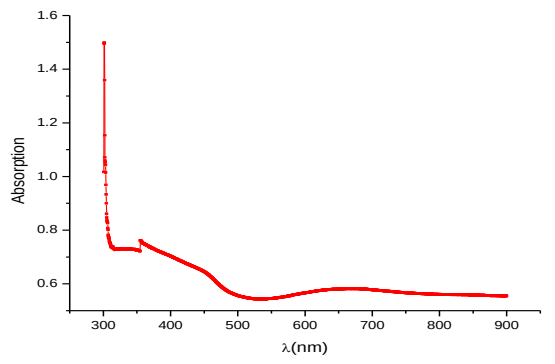

Fig.(3): UV-VIS spectrum of PAni-ox.

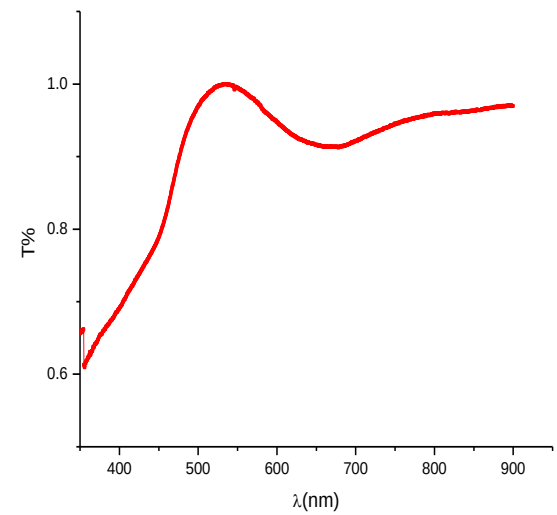

Fig.(4): The spectral transmittance of PAni-OX.

The relationship between absorption coefficient and indirect energy gap can be written as [12-14].

$$\alpha = \alpha_0 * \frac{[h\nu - E_g \pm E_p]^r}{h\nu} \quad \text{for } h\nu > E_g$$

$$\alpha = 0 \quad \text{for} \leq E_g$$

were E_g and E_P are respectively indirect energy gap, and the energy of the absorbed (+) or emitted (-) phonons.

The energy gap E_g was obtained by plotting $(\alpha h\nu)^{1/2}$ versus hν, as shown in fig. (5) the value of E_g is equal to2.7 eV.

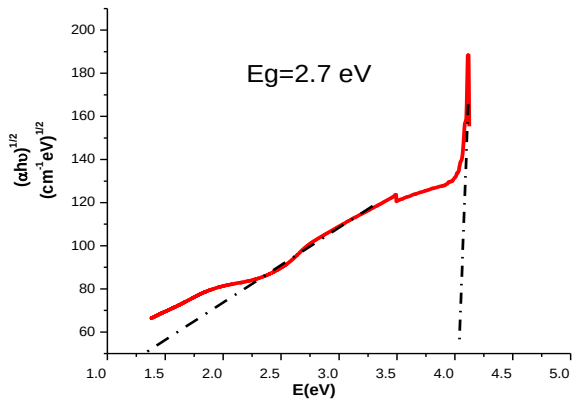

Fig.(5): Dependence of $(\alpha h\nu)^{1/2}$on the photon energy hν for PAni-ox.

Polyaniline are the most extensively studied material [15] and also known as a p-type semiconductor [16] .

The conductivity law follows the relation [17]

$$\sigma = \frac{I}{V}\left[\frac{L}{wtl}\right]$$

Where L is the distance between two poles ,w.the length of plot, t thickness of the film and l is the number of poles.

DC conductivity σdc of PAni-ox was measured in temperature range (295-313) ok as shown in Fig. (6).

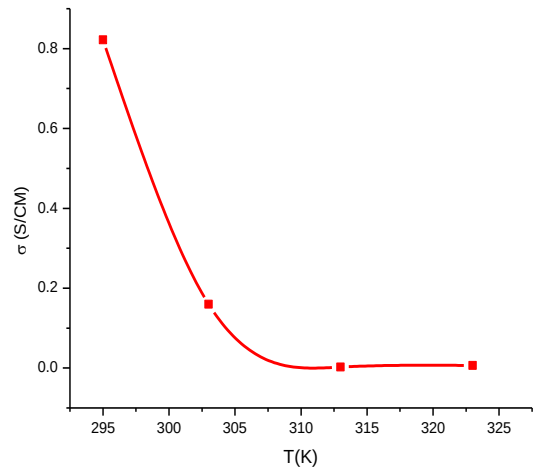

Fig.(6): Temperature dependence of conductivity as a function of temperature.

Polyaniline prepared by oxalic acid shows high conductivity because oxalic acid gives an oxalate anion, which is resonance stabilized because the negative charge is shared between the two oxygen atoms and carbon back bon of the polyaniline chain[18].

The conductivity values of PAni-ox at room temperature was found to be 8.2×10^{-2} s/cm and found to be decreased with temperature.

5. Conclusions

PAni-ox have been successfully synthesized by oxidative polymerization of aniline hydrochloride and ammonium persulfate. the XRD study reveals crystal nature of PAni –ox. The presence of characteristic functional groups in FT-IR spectrum confirmed formation of PAni-ox . the absorpance data reveal that the energy gap E_g of PAni-ox at R.T is equal to 2.7 eV. The temperature dependent conductivity(σ_{dc}) of PAni-ox was measured in the temperature range 295-313 ^{0}K and it was found at R.T8.2×10^{-2} s/cm.

6. Reference

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