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Optical Properties of Gum Arabic doping by Different Concentration of Iodine Using UV- Spectroscopy

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Abstract: *In this work, Gum Arabic (Talha) Nano-material samples were prepared with different Concentration (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar by doping with Iodine. Optical Properties of Gum Arabic doping by Different Concentration of Iodine measured by using the UV- Spectroscopy min 1240. In this work study the effaced of different concentration on the optical parameters. For all samples the absorbance increases upon increasing the concentration, while the transmission decreases. The value of Energy band gap (Eg) was decreased from (4.420) eV to (4.323) eV.*

Keyword*:* Concentration, Absorbance, Transmission, Reflectance, Energy Band Gap.

1. *Introduction*

Gum Arabic is a natural polymer, play an important role in our daily life. It is one of the major exported goods from Sudan more than 67% of world product is from Sudan. Gum Arabic has many uses in food stuffs and an adhesive material due to its high viscosity and also used as an additive to make stable suspension mixture for medical surprise, lithography, textiles, paint, inks, and cosmetic. Gum Arabic is most important commercial poly- saccharine and it is probably the oldest food hydro-colloid in current use. Gum Arabic is high molecular weight polymeric compounds, composed mainly of carbon core mixed in heterogeneous manner, including some materials in tonic forms as salts of macromolecules have weak conductive properties {C+2 , Mg+2 , K+ } {FAO, 1990}.Gum Arabic is produced from many species of Acacia of African origin. Chemically, A. Senegal gum is an Arabian galactoy protein composed of arabinose {17-34%}, GA lactose {32- 50%}, rhamnose {n- 16%}, glue carbonic acid {3- 50%} and protein 1. 8- 16%} with an optical rotation of {28° to 32°}. There are a lot of studies which are done in Gum Arabic but all of them are in normal uses in food stuff and adhesive material. So this study takes a different domain concerning new research in addition to identifying new application of Gum Arabic. This work is considered as conversion of (Arabic Gum) polymeric materials to become a good semiconductors material. In this work selecting Gum Arabic Poultice Polymeric and added iodine where we reduced value of energy gap in semiconductors [1, 2, 3, 4, and 5].

The interaction between an electron and photon

$$E = -\partial A/\partial t \quad \textbf{(1)}$$

$$\mu H = \nabla_r \chi A \quad \textbf{(2)}$$

$$\nabla_r A = 0 \quad \textbf{(3)}$$

The vector potential to have the form of plane wave

$$A = \frac{1}{2} A_a \exp[i(qr-\omega t)] + \frac{1}{2} A_a \exp[-i(qr-\omega t)] \quad \textbf{(4)}$$

Where **a** is the unit polarization vector in direction of E and {q} is the wave vector, the wave vector is related to the frequency by

$$q = \omega\eta / c \quad \textbf{(5)}$$

Where {c} is the velocity of light and {y} is the refractive index of the material. The energy of photon is simply

$$\zeta = \hbar\,\omega \quad \textbf{(6)}$$

The classical Hamiltonian of an electron with wave vector **k** interacting with a light wave of vector potential A is

$$H = \frac{1}{2m}(\hbar k - qA)^2 \quad \textbf{(7a)}$$

$$H = \frac{1}{2m}(\hbar^2 k^2 - \hbar q k . A - \hbar q A k + q^2 A^2) \quad \textbf{(7b)}$$

Using the operator form of K

$$H = \frac{1}{2m}(h^2 \nabla_r{}^2 + i2q\,h\,A \nabla_r + q^2 A^2) \quad \textbf{(7c)}$$

For low light levels

$$H = -\hbar \nabla_r{}^2/2m + (I\,q\,\hbar/m)\,A.\nabla_r \quad \textbf{(7d)}$$

$$H= H_0 + H \quad \textbf{(7e)}$$

H due to the electron – photon interaction [6,7,8 and 9]

H_0 unperturbed electron energy.

This interaction can result in change of state for the electron with time it is necessary to solve the time dependent Schrodinger equation

$$(H_0 + H)\psi = i\hbar\, \partial\psi/\partial t \quad \textbf{(8)}$$

$$\psi = \sum_n A_n(t)\, \psi_n \exp(-1\zeta_n t)/\hbar \quad \textbf{(9)}$$

Direct electron transition from a valence band state with wave vector K to a conduction band state with wave vector K the initial and find state for a direct transition are determined by the photon energy {hw} and the energy band structure.

$$H_{kk} = i\, q\, \hbar\, A/2mN \int_v \psi^*_k \exp(iq.r)\, (\nabla_r)\psi_k\, dt \quad \textbf{(11)}$$

Where ψ_K , ψ_K are the wave functions of valence and conduction band state respectively.

Probability in the entire crystal that on electron will make transition from a state with wave vector K to the state with wave vector K is.

$$|A_k(t)|^2 = 2\pi t/\hbar\, (q\, A/2m)^2\, (a.p_{k\,k^*})2\delta(\zeta_k - \zeta_{k^*} - \hbar\,\omega) \quad \textbf{(1 2)}$$

the total probability for a band – band transition is

$$P = 2V/(2\pi)^3 \int_{\Omega k} |Ak(t)|^2 f_o(1 - f_o)\, dk \quad \textbf{(13)}$$

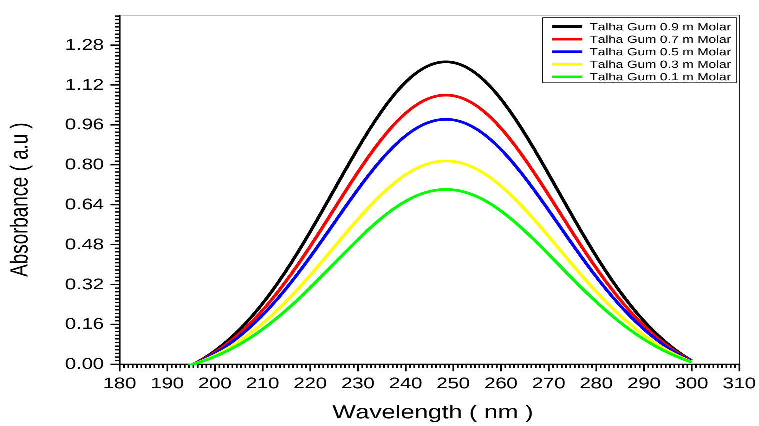
$$\mathbf{P = \zeta_g + \hbar^2 k^2 / 2mr} \quad \textbf{(14)}$$

m r is the reduced mass of the electron and hole [9,10 and 11].

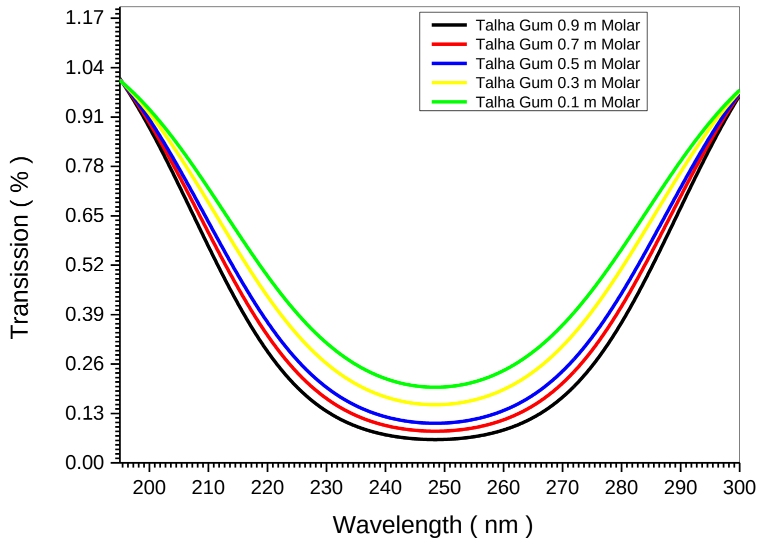
2. *Material and Method*

Dissolved Talha Gum Arabic, lending in distilled water each of them separately and added to a solution of iodine in different concentration (0.1,0.30.5,0.7 and 0.9) m Molar, then placed in Petri dishes and left to dry [11, 12]. The optical properties of all samples characterized at room temperature using min 1240 UV- Spectroscopy. From optical spectra of synthesized calculate all optical properties (Absorption Coefficient, Extinction coefficient, Optical Energy Band Gap, Refractive Index, Real Dielectric Constant and Imaginary Dielectric Constant)

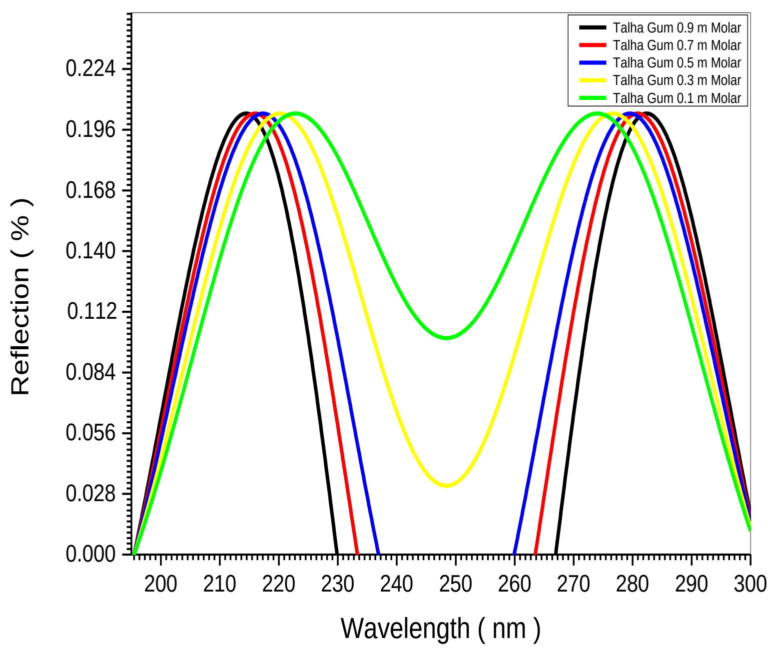
3. *Results*



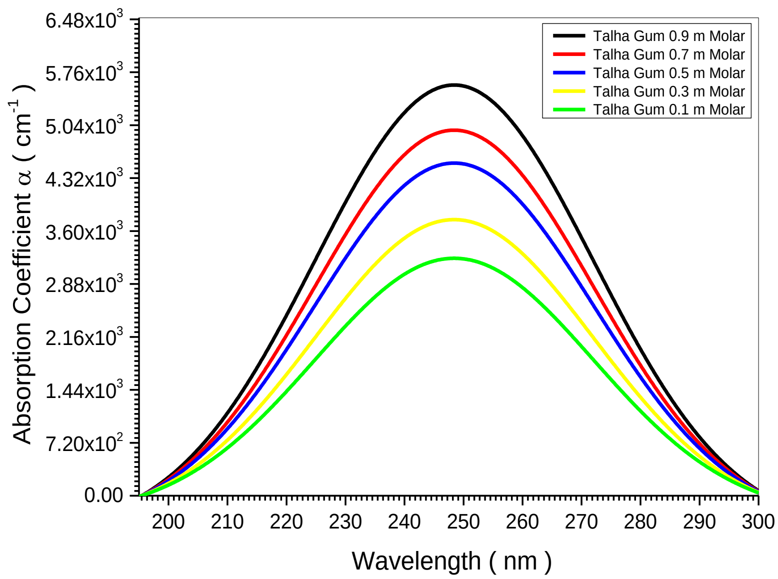
Fig(1) The relation between absorbance and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



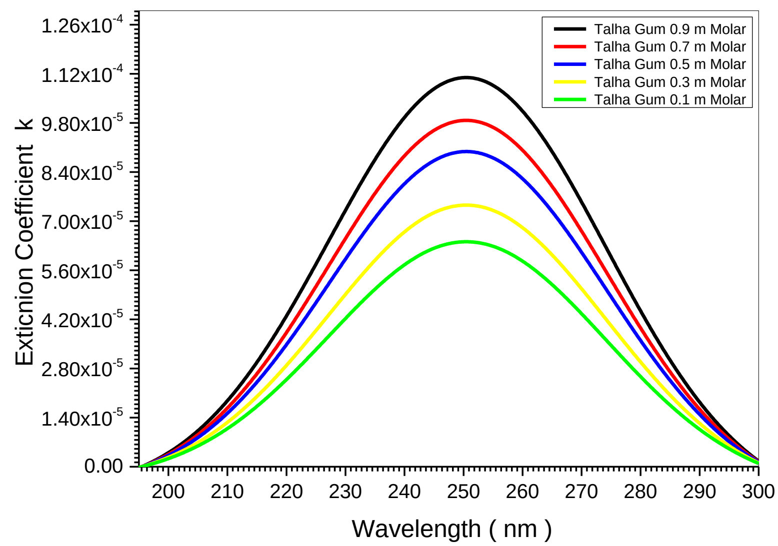
Fig(2) relation between transission and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



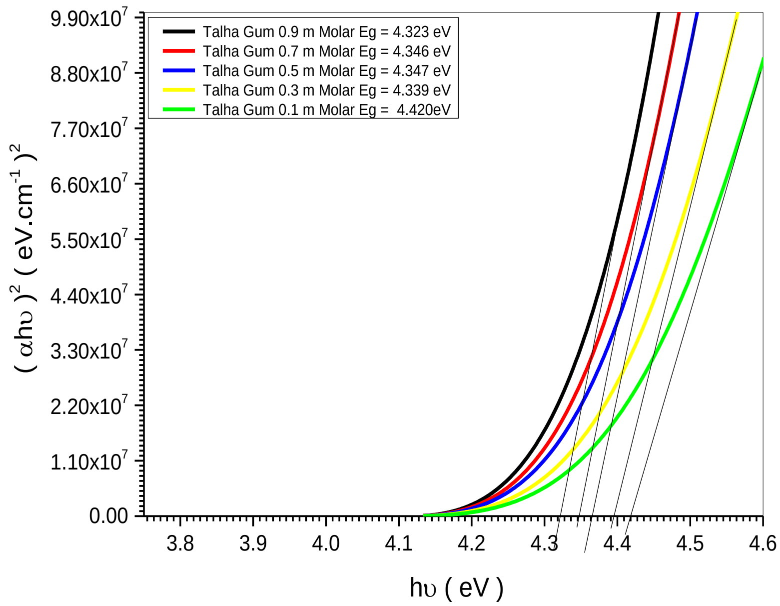
Fig(3) relation between reflection and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



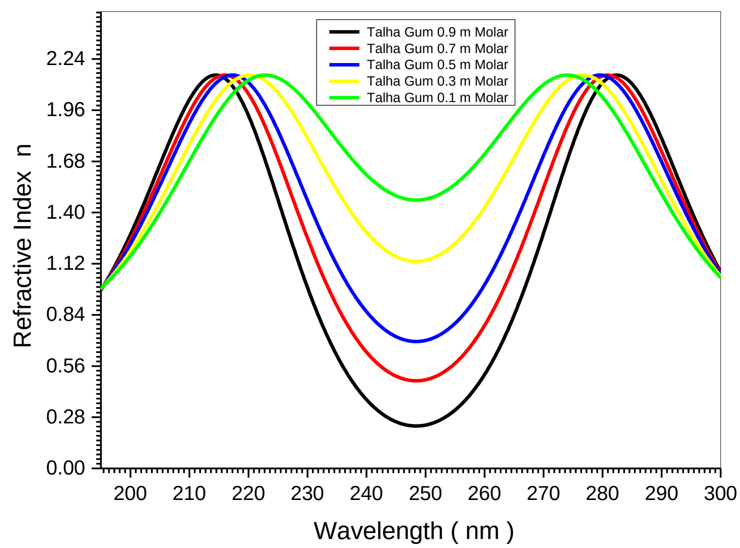
Fig(4) relation between absorption coefficient and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



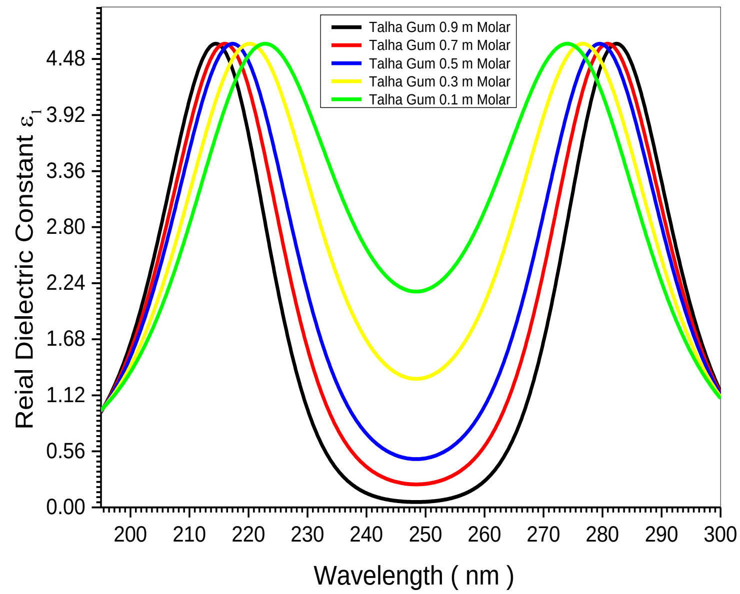
Fig(5) relation between exticion coefficient and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



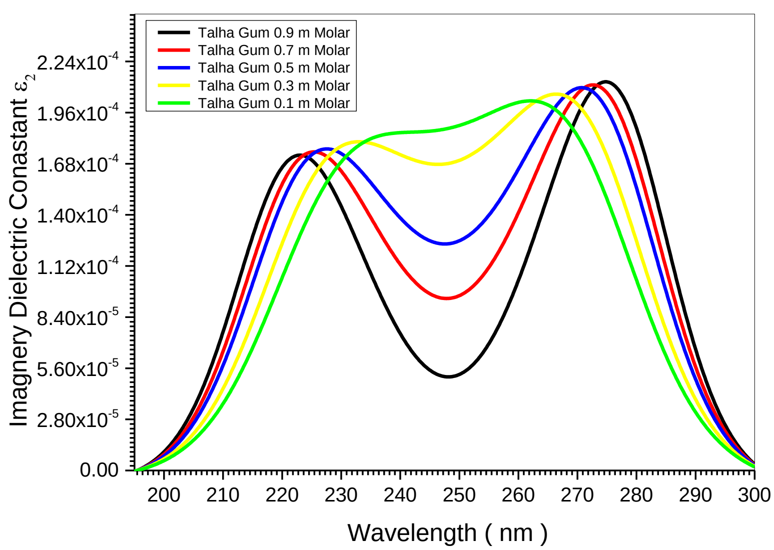
Fig(6) optical energy band gap of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



Fig(7) relation between refractive index and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



Fig(8) relation between real dielctric constant and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar



Fig(9) relation between imagnery dielctric constant and wavelengths of five Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar

4. Dissciuion

The absorbance we found the behavior of curves is the same for five samples of Talha Gum Arabic doping by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar studied using UV-VS min 1240 spectrophotometer. Show all resolute of absorbance in fig (1). In fig. (1)

shows the relation between absorbance and wavelengths for five samples of Talha Gum Arabic doping by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar, the rapid increase of the a absorption at wavelengths 250 nm crosponding photon energy 4.96 eV by doping increase.

The transission we found the behavior of curves is the same for five samples of Talha Gum Arabic doping by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar that showing in fig (2). In fig. (2) shows the relation between transission and wavelengths for five samples of Talha Gum Arabic doping by Iodine, the efficet of doping on the transission was increase doping decrease transission .

The reflection with five samples of Talha Gum Arabic doping by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar that showing in fig (3). In fig. (3) shows that the reflection for five samples of Talha Gum Arabic doping by Iodine was maximal value in tow area the first one in ranged (213 to 223) nm the second (273 to 283) nm in this tow point the samples become mirrors. The efficet of doping on the refelection was increase doping the transission in red sheft in first point and plue sheft in the second point .

The absorption coefficient (α) of the five prepared sample by Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples were found from the following relation $\alpha = \frac{2.303xA}{t}$ where (A) is the absorbance and (t) is the optical legth in the samples . In fig (4) shows the plot of (α) with wavelength (λ) of five sample was tretednent by Talha Gum Arabic + Iodine samples (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar , which obtained that the value of $\alpha = 5.59x10^3\ cm^{-1}$ for Talha Gum 0.9 m Molar sample in the U.V region(250 nm) but for Talha Gum 0.1 m Molar sample equal $3.22x10^3\ cm^{-1}$ at the same wavelength , this means that the transition must corresponding to a direct electronic transition, and the properties of this state are important since they are responsible for electrical conduction. Also, fig (4) shows that the value of (α) for the five samples of Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples increase while doing increased .

Extinction coefficient (K) was calculated using the related $k = \frac{\alpha\lambda}{4\pi}$ The variation at the (K) values as a function of (λ) are shown in fig. (4.5) for fivet samples of Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples and it is observed that the spectrum shape of (K) as the same shape of (α). The Extinction coefficient (K) for five samples of Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples in fig (5) obtained the value of (K) at the (250 nm) wavelength was depend on the samples treatment method , where the value of (K) at 250 nm for Talha Gum 0.9 mMolar sample equal $1.12x10^{-5}$ while for other sample Talha Gum 0.1 mMolar at the some wavelength equal $6.39x10^{-5}$ .The effects of Iodine doping on Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples was increased the iodine doping increased Extinction coefficient (k).

The optical energy gap (Eg) has been calculated by the relation $(\alpha h\upsilon)^2 = C(h\upsilon - Eg)$ where (C) is constant. By plotting (αhυ)2 vs photon energy (hυ) as shown in fig.(4.6) for the five prepared by Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples . And by extrapolating the straight thin portion of the curve to intercept the energy axis , the value of the energy gap has been calculated .In fig (6) the value of (Eg) Talha Gum Arabic doing by Iodine 0.9 m Molar sample obtained was (4.323) eV while for other sample Talha Gum Arabic doing by Iodine 0.1 m Molar sample obtained was (4.420) eV.The value of(Eg) was decreased from (4.420) eV to (4.323) eV. The decreasing of (Eg) related to increased of Iodine molar on the samples. It was observed that the different Iodine molar for Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples confirmed the reason for the band gap shifts .

The refractive index (n) is the relative between speed of light in vacuum to its speed in material which does not absorb this light. The value of n was calculated from the equation $n = [\left(\frac{(1+R)}{(1-R)}\right)^2 - (1+k^2)\,]^{\frac{1}{2}} + \frac{(1+R)}{(1-R)}$ Where (R) is the reflectivity. The variation of (n) vs (λ) for five samples was treetetment by Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples is shown in fig.(7). Fig (7) Show that relationsheep of five prepared sample by Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples refractive index (n) spectra,which shows that the maximum value of (n) is (2.158) for all samples at tow area the first one in ranged (213 to 223) nm the second (273 to 283) nm, the point was agreement with red sheft on the first point and plue shefte on the second point by increase for Iodine doping . Also we can show that the value of (n) begin to decrease befor 213 nm and after 283 nm of region spectrum .

Fig(8) shows the variation of the realdielectric constant (ε_1) with wavelengthof five samples prepared by Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples form, which calculatedfrom the relation $\varepsilon_1 = n^2 - k^2$ Where the real the dielectric (ε_1) is the normal dielectric constant . From fig (8) the variation of (ε_1) is follow the refractive index, where at tow area the first one in ranged (213 to 223) nm the second (273 to 283) nm for all samples of Talha Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples, where theabsorption of the samples at these wavelength is small, but the polarizationwas increase. The maximum value of (ε1) equal to (4.64) at at tow area the first one in ranged (213 to 223) nm the second (273 to 283) nm. The effect of treetetment by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar on the (ε1) was red sheft on the first point and plue shefte on the second point by increase for Iodine doping .

The imaginary dielectric constant (ε_2) vs (λ) was shown in fig(4.7) this valuecalculated from the relation $\varepsilon_2 = 2nK$ (ε_2) represent the absorption associated with free carriers.Asshown in fig(9) the shape of (ε_2)is the same as (ε_1), this means that the refractive index was dominated in these behavior . The maximum values of (ε_2) are different according to the tratment operation , so the maximum value of (ε1) equal to (4.64) at at tow area the first one in ranged (213 to 223) nm the second (273 to 283) nm Talha

Gum Arabic doing by Iodine (0.1 ,0.3 ,0.5 ,0.7 and 0.9) m Molar samples but (ε_2) for this sample equal ($1.78x10^{-4}$) for first point and ($2.14x10^{-4}$) for the second point,these behavior may by related to the different absorption mechanism forfree carriers.

5. Conclusion

The change of Iodine concentration effect on optical parapets for all Talha Gum Arabic samples. The maximal absorption value at wavelengths 250 nm crosponding photon energy 4.96 eV by doping increase. Refractive index (n) maximum value are (2.158) for all samples at tow area the first one in ranged (213 to 223) nm the second (273 to 283) nm. The decreasing of (Eg) related to increased of Iodine molar on the samples. It was observed that the different Iodine molar for Talha Gum Arabic samples confirmed the reason for the band gap shifts .

Reference

[1] www.wikipedia.org/wiki/Gum_arabic,(2015).

[2] B. Sc. thesis, SUZK. Y.S, dielectric properties of Gum Arabic, Alneelain University, 2010.

[3] Ph. D Thesis A, M.A., (2008) ...Faculty of science Sudan University of Science and Technology.

[4] www.sd.zain.com/Arabic/pages/Home.aspx.(june2014) .

[5] Anderson, D.M.W. and Herbich, M.A., (1963). The composition and properties gum nodules from Acacia. Seyal. J .Chem .

[6] Minami, T "Substitution of transparent conducting oxide thin films for indium tin oxide transparent electrode applications" Thin Solid Films 516, 1314 - 1321 (2008).

[7] D.H. Oh, Y.S. No, S.Y. Kim, W.J. Cho, J.Y. Kim and T.W. Kim, Journal of Ceramic Processing Research. Vol. 12, No. 4, pp. 488~491 (2011), 488.

[8] Chang, J.F.; Hon, M.H. The effect of deposition temperature on the properties of Al-doped zinc oxide thin films. Thin Solid Films 2001, 386, 79–86.

[9] Kim, Y.-S.; An, C. J.; Kim, S. K.; Song, J.; Hwang, C. S. Bull.Korean Chem. Soc. 2010, 31, 2503.

[10] Kim, M. S.; Yim, K. G.; Leem, J.-Y.; Kim, S.; Nam, G.; Kim, D. Y.; Kim, S.-O.; Lee, D.-Y.; Kim, J. S.; Kim, J. S. J. Korean Phys. Soc.

2011, 59, 346.

[11] Waleed. B. Abdala*, RawiaAbdElgani, Mubarak DirarAbd, Abdalskhi.S.M.Hsawsan Ahmed Elhouri Ahmed, Optical Prorates Of Waste Petroleum Coke Powder (Wpcp) Treatment By Acids [October 2018] Issn 2348 – 8034 Doi-10.5281/Zenodo.1445504 Impact Factor- 5.070 (C)Global Journal Of Engineering Science And Researches 21 Global Journal Of Engineering Science And Researches