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Change on Optical Properties due to Different Molarity

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ABSTRACT

Effect of difference molar on the optical properties of Al_2O_3 samples, prepared samples by Sol-gel method. The optical characteristics of the prepared samples have been investigated by UV/Vis spectrophotometer(min 1240) in the wavelength range (370 – 390) nm .The samples have a direct allow electronic transition with optical energy (Eg) the value of 0.1 M sample (Al2O3) obtained was (3.276) eV while for other 0.3 M sample (Al_2O_3) was (3.269) eV. The value of (Eg) was decreased from (3.276) eV to (3.269) eV. The decreasing of (Eg) related to increasing Aluminum Oxide molar on the samples. The maximum value of (n) is (2.1358) for all samples at the differances wavelength which is agreement with molar of Aluminum Oxide increased for all samples of (Al_2O_3). The results indicate the sample have good characteristics for optoelectronic applications.

I. Introduction

Transparent conducting oxides (TCOs) are electrical conductive materials with a comparably low absorption of light. (TCO) samples have emerged as excellent candidates due to interest in their promising applications in next-generation electrode. A wide variety of transparent conductors in terms of new materials are becoming available that could serve as an alternative to ITO [1]. ITO is one of the best transparent conductors, but indium is quite expensive [2]. The electrodes fabricated utilizing TCO samples in optoelectronic devices have excellent physical properties of high visible transmittance, low resistivity, high infrared reflectance, and large absorbance [3]. Because Al_2O_3 materials are large-band-gap semiconductors with peculiar physical properties of high chemical stabilities and large exciton binding energies, they are of current interest due to their potential applications in optoelectronic devices, such as photo detectors, solar cells, light-emitting diodes, and laser diodes. Low-resistivity Al_2O_3 samples may be realized by using several dopants, such as, Ga, and In of the group III [4]. Aluminum doped zinc oxide (AZO) coatings exhibit high transparency and low resistivity and these materials are suitable for fabricating transparent electrodes in solar cells, gas sensors and ultrasonic oscillators. They are also found in applications such as surface acoustic devices, optical waveguides and micro-machined actuators. They are an alternative material to tin oxide and indium tin oxide, which has been most, used up to date [4]. For the most used (ITO) as a transparent conducting oxide which has transmittance (≥90%), low specific resistance (≤10-3 Ω/cm) in the visible rays area, so it is used as the transparent electrode of the solar cell, display fields widely. But the raw materials of ITO are expensive, and it has weak point of the degradation phenomenon and toxicity when it is exposed in the hydrogen plasma [2-4]. Ohyama reported that the use of 2-methoxyethanol and mono ethanolamine, solvents with high boiling point, resulted in transparent Al_2O_3 samples with strongly preferred orientation and that better electrical and optical properties had been obtained in 0.5 at.% aluminum doped ZnO thin films heated in reducing atmosphere. Nunes found that when the doping concentrations of Al, In and Ga were 1, 1 and 2 at.%, respectively, electrical and optical properties of doped ZnO were superior [2]. Various techniques such as molecular beam epitaxy (MBE) [6], pulse laser deposition (PLD) [7], magnetron sputtering [8], chemical vapor deposition (CVD) [9], atomic layer deposition [10], electron beam evaporation [11], hydrothermal method [12], and sol-gel process [13] have been applied to ZnO thin film preparation. The sol-gel method has distinct potential advantages over these other techniques owing to its lower crystallization temperature, low cost, simple deposition procedure, easier compositional control, ability to tune the microstructure via sol-gel chemistry, and large surface area coating capability. In this work preparing Al_2O_3 samples were prepared by the sol-gel method with different molar (0.1 ,0.2 and 0.3) M . The optical properties of the (Al_2O_3) samples were investigated. In particular, optical parameters such as the optical band gap, absorption coefficient, refractive index and extinction coefficient, real and imaginary dielectric constant were comprehensively studied in order to investigate the effects of molar on the optical properties of (Al_2O_3) samples.

II. Experimental

The precursors used in the synthesis Al_2O_3 by sol-gel process Aluminum nitrate dehydrate $Al(NO_3)_3{\cdot}9H_2O$. The need for surfactant is fulfilled by the use of 2-methoxyethanol (ME) $CH_3OCH_2CH_2OH$. The stock solution for the samples was prepared using Aluminum nitrate (0.1M,0.2 M and 0.3 M) dissolved in 300 ml of ethanol in the glass beaker. Then the solution was stirred for 60 min at 80°C until we get milky solution. Drops from 2-methoxyethanol (ME) was added to the solution as stabilizer to get a transparent solution. We get then the Aluminum oxide solution. And then kept the Aluminum oxide solution at lab's temperature about

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24 hours, then we filter it, and we obtained the Sol ready to be used the samples . After prepared the samples , they were ready for characterization. The molar of the (Al_2O_3) sample were about (0.1 M, 0.2 m and 0.3 M) for all samples . The optical transmittance and reflectance of the (Al_2O_3) samples were measured as a function of wavelength by UV-visible spectroscopy , and other optical constant was calculated.

III. Results

From figure 1 to figure 5. It clear that the relation between absorbance, transission, reflection, absorption coefficient and extinction coefficient with wavelength respectively for different samples of Al_2O_3.

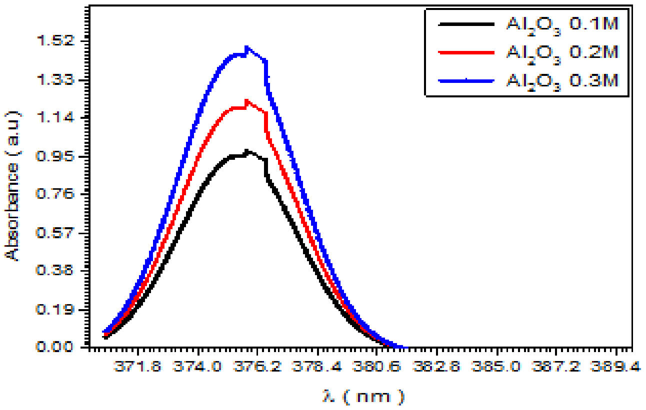

Fig1. The relation between absorbance and wavelengths of three (Al_2O_3) samples in different molar (0.1M,0.2 M and 0.3M)

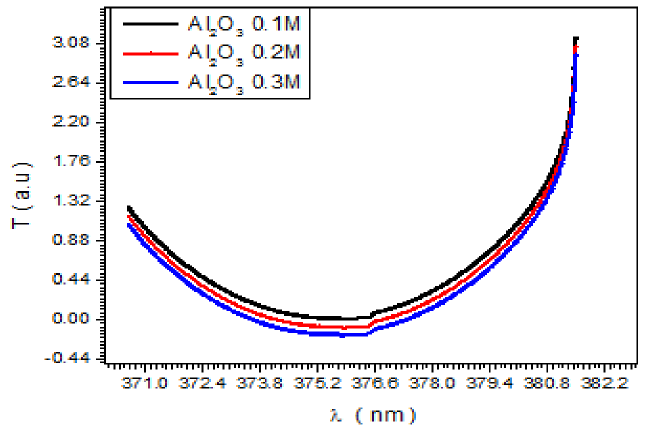

Fig 2. The relation between transission and wavelengths of wavelengths of three (Al_2O_3) samples in different molar (0.1M,0.2 M and 0.3M)

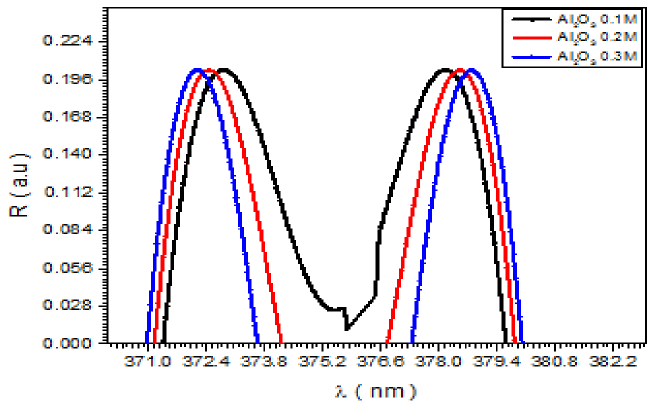

Fig 3. The relation between reflection and wavelengths of three (Al_2O_3) samples in different molar (0.1M,0.2 M and 0.3M)

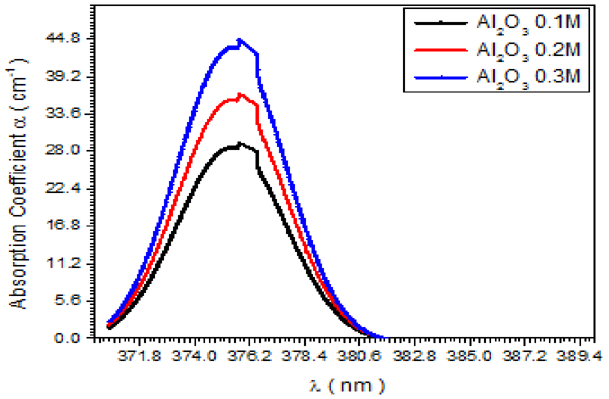

Fig 4. The relation between absorption coefficient (α) and wavelengths of of three (Al_2O_3) samples in different molar (0.1M,0.2 M and 0.3M)

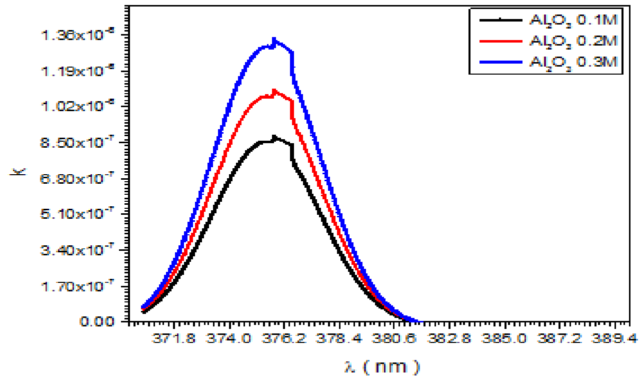

Fig 5. The relation between extention coefficient (k) and wavelengths of three (Al_2O_3) samples in different molar (0.1M,0.2 M and 0.3M)

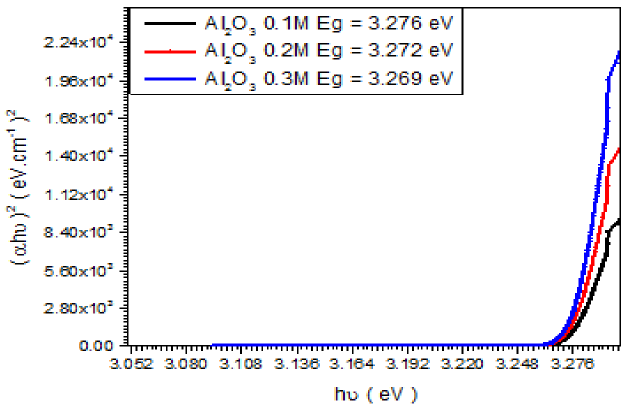

Fig6. The optical energy band gab of three (Al_2O_3) samples in different molar (0.1M,0.2 M and 0.3M)

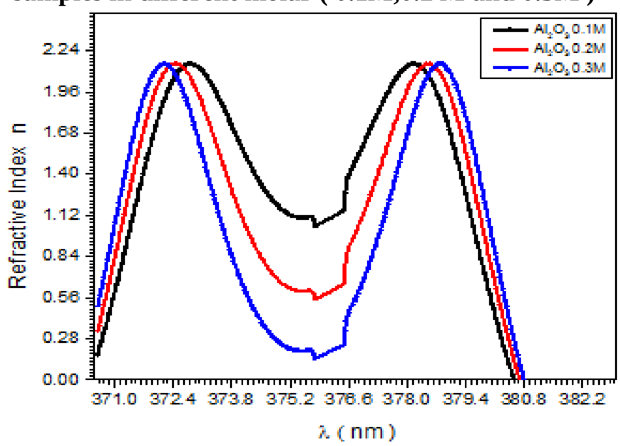

Fig 7. The relation between refractivie index and wavelengths of three (Al_2O_3) samples in different molar (0.1M,0.2 M and 0.3M)

IV. Discussion

The absorbance we found the behavior of curves is the same for three samples of (Al_2O_3) studied using UV-VS min 1240 spectrophotometer .Show the resolute of absorbance in fig(1). In fig. (1) shows the relation between absorbance and wavelengths for three samples of (Al_2O_3), the rapid increase of the a absorption at wavelengths ranged (370 -390 nm) . The effects of Aluminum Oxide (Al_2O_3) molar in the absorbance value increased when the molar increase , also in fig (1) show that the maximal value at 375 nm wavelength.

Transmittance: In fig(2) shows the transmission for three samples of (Al_2O_3) and we have dissicused in this secation from the ranged (250 -300 nm). And in fig.(2), the transmittance spectra value well be decrease when the Aluminum Oxide molar increased ,the average transmittance of 0.1 M samples equal 0.77 (a.u) at 380 nm but for 0.3 M equal 0.57 (a.u) at the same wavelength .

Reflectance: Shows the results of reflectance spectra of the eleventh sample was treatment by (Al_2O_3) in different molar in fig (3). In fig. (3) show the reflectance spectra of the three sample the maximum value equal (0.204) a,u at tow region the first one (372 to 373) nm and the other (378 to 379) nm , in the first region there was (blue shift) when the molar increased and the second region was (red shift) .

Absorption coefficient (α) :The absorption coefficient (α) of the three prepared sample was by (Al_2O_3) were found from the following relation

$$\alpha = \frac{2.303xA}{t} \qquad (1)$$

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 three sample was treatment by (Al_2O_3) , which obtained that the maximal value of(α) equal 44.6 cm^{-1} for 0.3 M sample in the U.V region(375 nm) , 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 in fig.(4) shows that the value of (α) for the three samples of (Al_2O_3) decrease while the molar decreased.

Extinction coefficient (K) :Extinction coefficient (K) was calculated using the related

$$k = \frac{\alpha\lambda}{4\pi} \qquad **$$

The variation at the (K) values as a function of (λ) are shown in fig. (5) for three samples of (Al_2O_3) and it is observed that the spectrum shape of (K) as the same shape of (α). The Extinction coefficient (K) for three samples of (Al_2O_3) in fig.(5) obtained the value of (K) at the (370-390 nm) region was depend on the samples treatment method , where the value of (K) at 375 nm for 0.3 M sample equal $1.3x10^{-6}$ while for 0.1M sample at the same wavelength equal $8.7x10^{-7}$.The effects of Aluminum Oxide (Al_2O_3) molar in the Extinction coefficient (K) value was decreased when the molar decreased . The optical energy gap (Eg) : The optical energy gap (Eg) has been calculated by the relation

$$(\alpha h\upsilon)^2 = C(h\upsilon - Eg) \qquad (2)$$

Where (C) is constant. By plotting $(\alpha h\upsilon)^2$ vs photon energy (hυ) as shown in fig.(6) for the three prepared samples by (Al_2O_3) . 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 (4.6) the value of (Eg) of 0.1 M sample obtained was (3.276) eV while for 0.3 M sample (Al_2O_3)obtained was (3.269) eV. The value of(Eg) was decreased from (3.276) eV to (3.269) eV. The decreasing of (Eg) related to Aluminum Oxide (Al_2O_3) molar on the samples. It was observed that the different Aluminum Oxide (Al_2O_3) molar confirmed the reason for the band gap shifts .

The refractive index (n) : 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

$$n = \left[\left(\frac{(1+R)}{(1-R)}\right)^2 - (1 + k^2) \right]^{\frac{1}{2}} + \frac{(1+R)}{(1-R)} \quad n \qquad (3)$$

Where (R) is the reflectivity. The variation of (n) vs (λ) for three samples was treatment by (Al_2O_3) is shown in fig.(7). Fig (7) Show that relationship of three prepared sample by (Al_2O_3) refractive index (n) spectra ,which shows that the maximum value of (n) is (2.16) for all samples at tow differences region the first one at wavelength ranged(372 - 373) nm and the other region was (377 -378) nm which is agreement with blue shift when the Aluminum Oxide (Al_2O_3) molar increased for the first region and red shift for the other region of (Al_2O_3) samples . Also we can show that the value of (n) begin to decrease at 375 nm when the molar of Aluminum Oxide (Al_2O_3) increase .

V. Conclusions

(Al_2O_3) samples preparing by Sol-gel method , the rapid increase of the a absorption at wavelengths ranged (370 -370 nm) . The effects of Aluminum Oxide (Al_2O_3) molar in the absorbance value increased when the molar increase , also in fig (1) show that the maximal value at 375 nm wavelength . The value of (Eg) of 0.1 M sample obtained was (3.276) eV while for 0.3 M sample (Al_2O_3)obtained was (3.269) eV. The value of(Eg) was decreased from (3.276) eV to (3.269) eV. The decreasing of (Eg) related to Aluminum Oxide (Al_2O_3) molar on the samples . Hence, these treatment for thin film give a best optical properties to be used for optoelectronic Applications.

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