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Absorption, Extinction Coefficient and Energy Gap of PVA/Starch Doping Rhodamine-B

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Abstract: The properties of PVA and starch polymer mixes doped with Rhodamine-B are the subject of this study., which has a weight-to-weight ratio of 1:1. PVA and starch polymer mixes with varying glycerin ratios of 0, 25, 30, 35, and 40% wt. Different percentages of the polymer mixture consisting of sarch/PVA with 30% wt/wt of glycerine) were doped with rhodamine dye (0,1,2,3,5). Samples were then analyzed using FTIR, which revealed active groups as well as a clear association between the materials used, Optical spectrum was also measured for the (300-900 nm) range, Optical characteristics of the combination, such as absorbance, absorption coefficient(α), optical energy gap(Eg) and Extinction Coefficient(K), have been researched.

INTRODUCTION

Study from optical properties of materials and the experimental measurements related to them represents the progress in techniques of devices become one of the important works in the history of materials science and optical communication does not take place without the correct understanding of (photonic devices). The optical properties of materials and how these properties can affect the performance of devices[1,2]. Polyvinyl alcohol is differentiated by its ability to dissolve in water, as it dissolves slowly in cold water but easily and quickly at high temperatures. It is also resistant to the action of solvents and oils, and it has an exceptional ability to stick to cellulosic materials, which is why it was chosen for this study. It is utilized in the paper and textile industries, as well as in oxygen-resistant films and photographic film coatings, and its electrical and optical properties vary depending on the impurities supplied [3,4,5]. It is now used for emulsification, estimation, and glues, as well as in natural samples as a medicine conveyance framework and layers PVA can also be used in medicinal applications, such as fake veins, synthetic digesting systems, and contact lenses. Because of its resemblance to the biological body, it has been identified as a medicinal substance. [6,7]. Also, because of its strong biodegradability, starch is blended with PVA to detoxify and filter live shelf water.[8]

MATERIALS AND METHOD

PVA was purchased from Merck and used as received. Cornstarch was purchased from Sigma Aldrich and commercial glycerin is purchased from the pharmacy**.** Preparation of polymer blends and Preparation of doping polymer blends with Rhodamine-B [9].

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RESULTS AND DISCUSSION

Fourier-Transform Infrared Spectroscopy

The vibration of the (O-H) group with a strong hydrogen bond was assigned to (3389-3289) cm^{-1}, except that the sub-bands of the (CH_2)and CH stretching vibrations were assigned to 2943 and 2931 cm^{-1}, respectively. the beam at 1614 cm^{-1} is assigned to the (C = O) group. In the CO stretching vibration range [10.11,12] 3000-3700 cm^{-1} represents the hydroxyl tensile region, PVA displays a broad absorption band centered at (OH) 3293 cm^{-1}. When a combined band with lignin OH 3274 cm^{-1}, changes to a region below the wave. This indicates the formation of new hydrogen bonds, either within the PVA or between the PVA and the doping agent ratio. The FT-IR measurement of the mixtures indicated the establishment of a relatively strong hydrogen contact between the hydroxyl groups of the sample prepared by infrared spectroscopy in the range (4000–400) cm^{-1} shown in Figures (1,2,3,4,5). It shows bands broad, center when stretched by PVA and the dopant appears to be able to form hydrogen bonds with a semi-crystalline polymer [13, 14, 15].

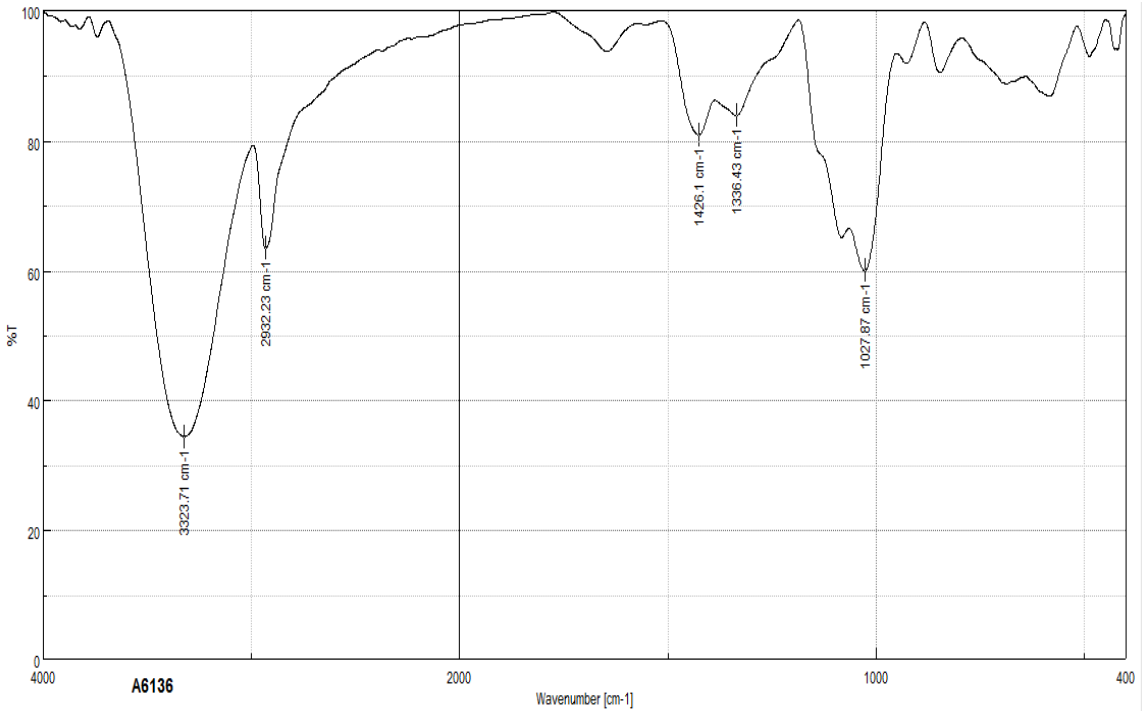


FIGURE 1. FT-IR spectra of a polymer blend with glycerin and 1% ratio of Rhodamine-B

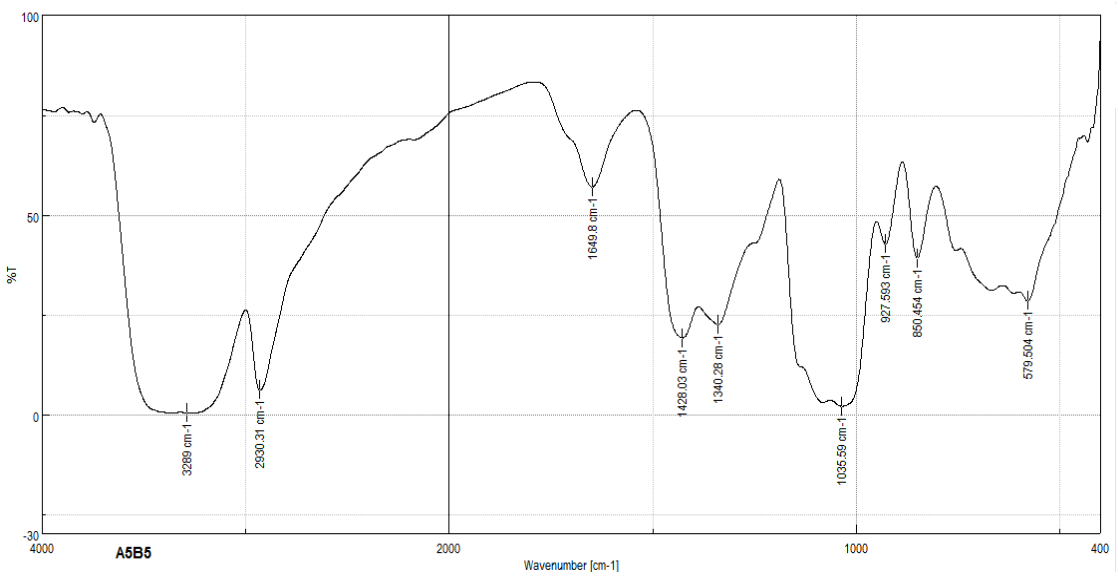


FIGURE. 2. FT-IR spectra of a polymer blend with glycerin and 2% ratio of Rhodamine-B

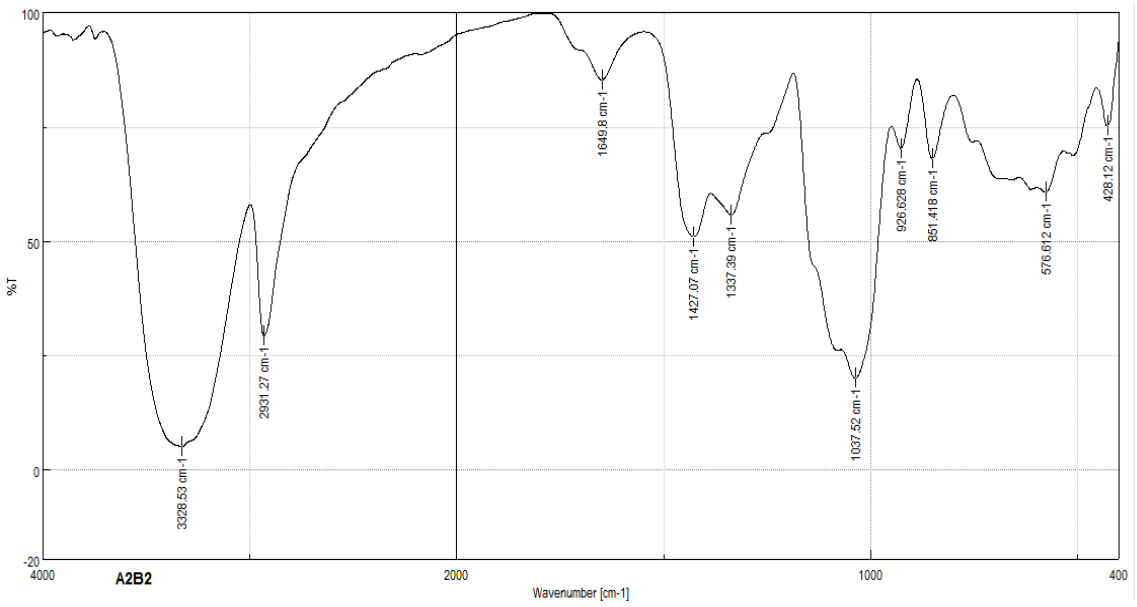


FIGURE 3.FT-IR spectra of a polymer blend with glycerin and 3% ratio of Rhodamine-B

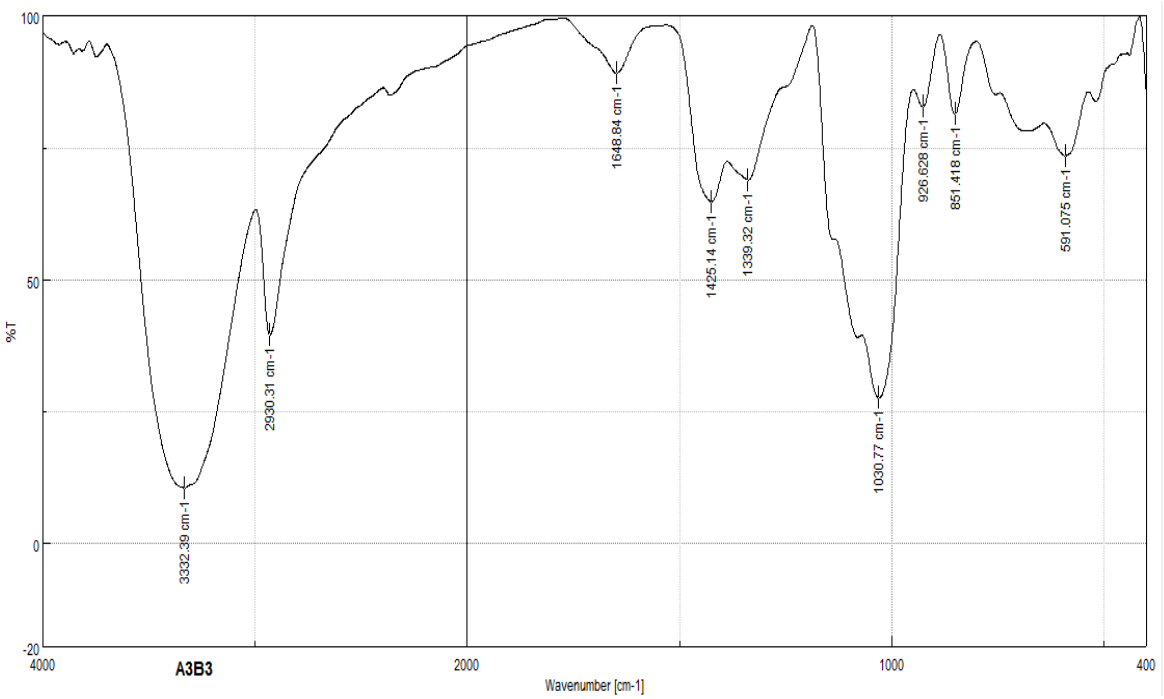


FIGURE4. FT-IR spectra of a polymer blend with glycerin and 4% ratio of Rhodamine-B

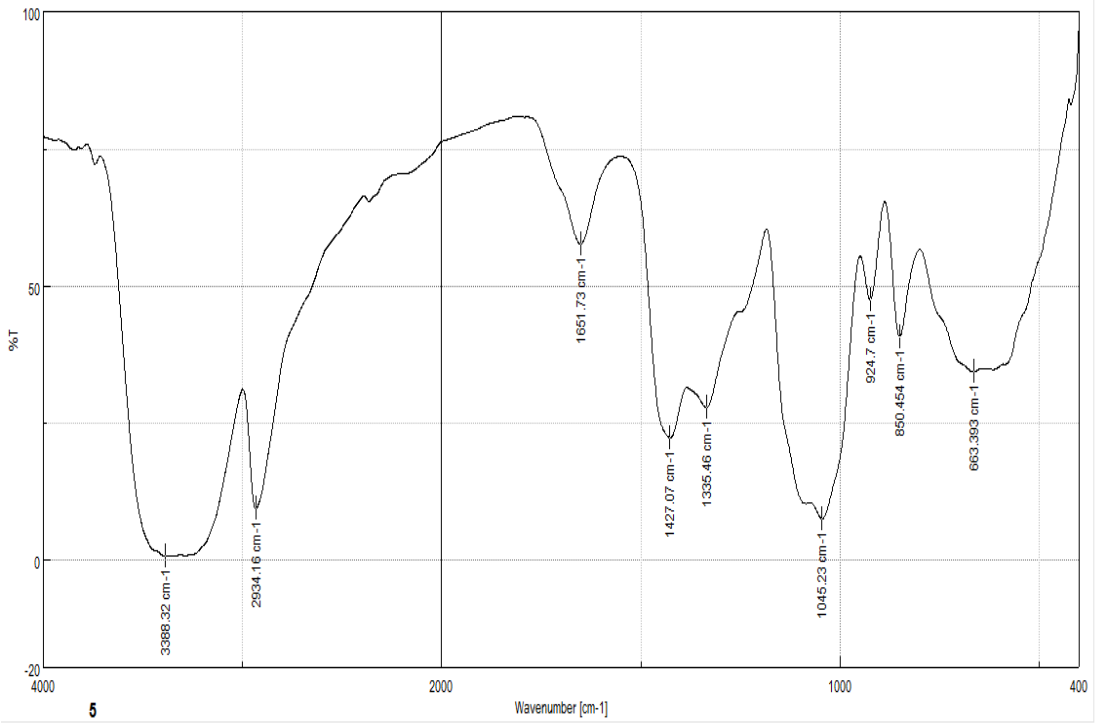


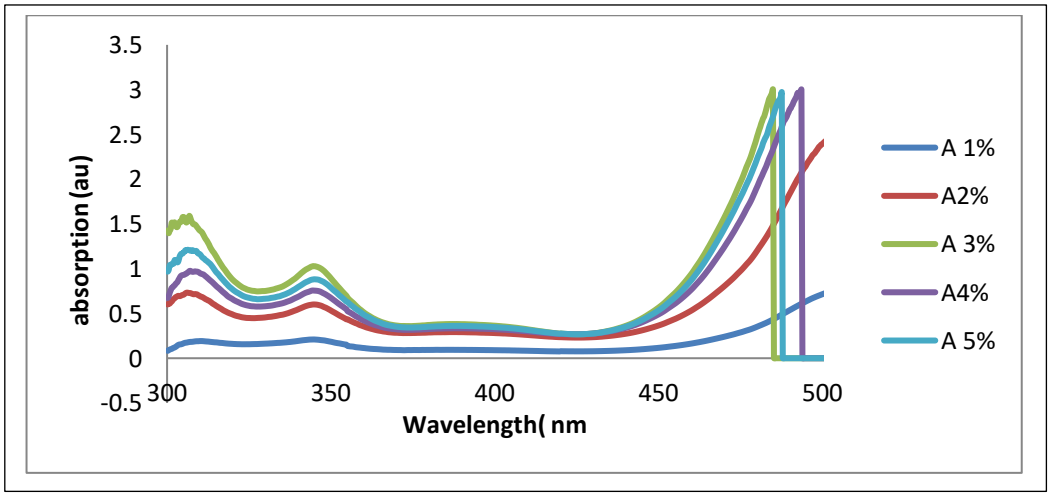
FIGURE 5. FT-IR spectra of a polymer blend with glycerin and 5% ratio of Rhodamine-B

Liner Optical Properties

When light is incident a material, several reactions occur as a result of the incident rays' interaction with the material, including the process of absorption, for which part of the incident light is absorbed by the material and transformed into heat, another part passes through the material and is known as transmitted light, and the remaining part suffers a process of reflection and is known as reflected light. Since the Lambert-Beer law states that the absorbed portion of the fall rays is proportional directly to the number of particles that absorb it as well as directly with the thickness of the model, so we see that the spectrophotometer that calculates the relative value of the transmitted light has a close and direct relationship with the absorption according to the Beer-Lambert law(16).

Absorbance Spectrum.

Absorbance (A) measurements were taken with a two-beam UV-Visible spectrophotometer (U-1500-HITECH). At room temperature, these measurements were taken. Fig.(6) It displays the absorbance spectra of 1,2,3,4, 5 and demonstrates that the greatest absorbance is at 3%, and this ratio contains absorption bands at wavelength 350 as well as absorption at wavelength 480, due that the ultraviolet characteristic absorption in PVA is generally determined by two factors: the presence of acetaldehyde and soluble air in the vinyl acetate monomer during polymerization. In the case of the latter, the creation of the vinyl acetate-oxygen copolymer and its subsequent degradation to aldehydic-type products adds to the polymer chain structures comparable to those introduced by acetaldehyde. PVAs with low UV absorption can be made by carefully excluding acetaldehyde and air during vinyl acetate polymerization and using the right initiator. The intensity of all three absorption bands is significantly reduced when PVA is treated at room temperature with weak aqueous alkali. While hot dilute acid removes the 330 m band, there is no consistent shift in relative intensities(17).



FIGUR.6. The absorption curve of a polymer blend with glycerin and ratio of Rhodamine-B

Absorption Coefficient(α)

by Beer-Lamber's formula used:-

$$a = 2.303\frac{A}{d} \ldots\ldots\ldots \qquad (1)$$

If the absorbance A from the absorbance spectrum is known, the absorption coefficient can be calculated.fig (7) ,graph depicts the relationship between the absorption coefficient and photon energy,It also demonstrates that the behavior of the absorption coefficient corresponds to the behavior of the absorption spectrum. And Because the absorption coefficient values are less than 10^{-4}, it is apparent that the electronic transmission is indirect. Because the incoming phonon absorbs photons (the phonon momentum is small), the speed must be corrected by the phonon momentum[18].

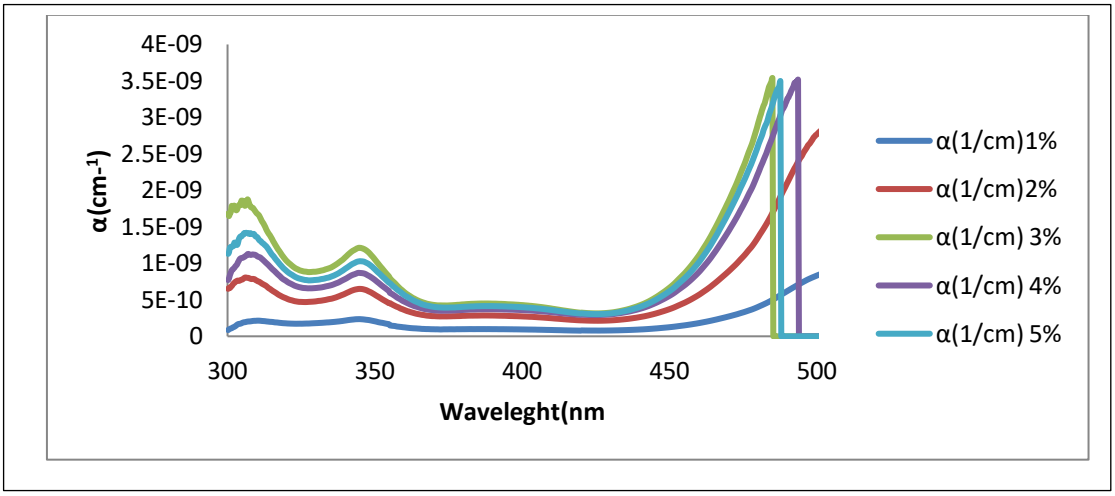


FIGURE 7. Absorption coefficient curve of polymer blend with glycerin and ratio of Rhodamine-B

Extinction Coefficient(K)

Light diminishes in the direction of wave propagation when it moves through matter. There's many two types of attenuation absorption and scattering, both of which result in a loss of light intensity in the direction of propagation. Light absorption is represented and described as one of the properties of matter in this application by the attenuation coefficient,can be calculated by [19]:-.

$$k = \frac{\alpha \lambda}{4\pi} \dots\dots\dots\dots (2)$$

where λ:- wavelength of light(nm).

Figure 8 shows the relationship between the damping coefficient and the wavelength. The figure shows that the damping coefficient values range from $0.5x10^{-8}$ to $4x10^{-8}$, according to wavelengths in the range from (300- 500)nm. Here is a thorough and exact description of the thin films' light absorption process

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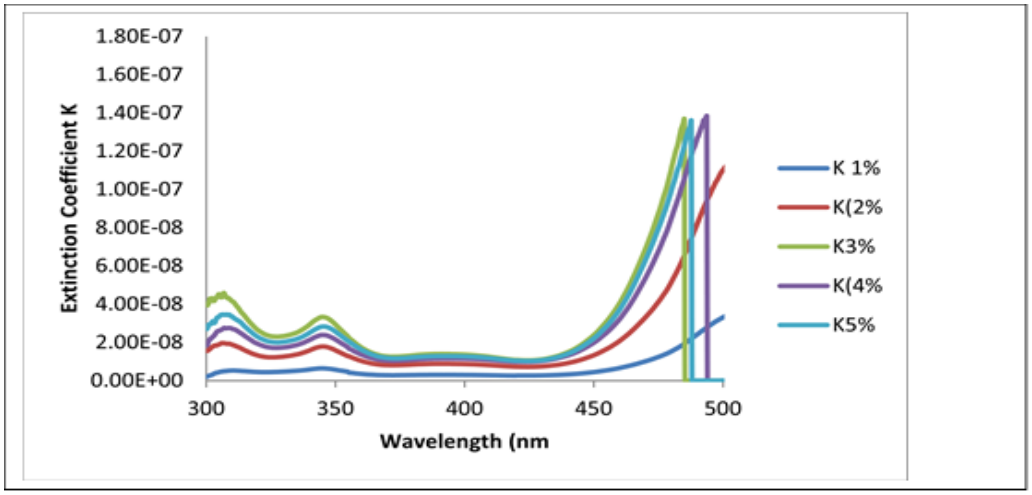

FIGURE.8: Extinction coefficient curve of a polymer blend with glycerin and ratio of Rhodamine-B

Optical Energy Gap

In indirect transitions, the absorption of photons with energy similar to the energy of the gap Eg necessitates the absorption or emission of phonon lattice vibrations during the absorption process, When the electron moves from the valence band to the conduction band, a change in its crystal momentum occurs, and this change is not provided by the incident phonon (the phonon momentum is very small), so the difference in momentum must be compensated by the phonon momentum.

Relationship in the absorption coefficient is linked to the photon energy hv for the integrand transition by the equation[19]:-

$$\alpha\, h = A(hv - E_g)^m \ldots\ldots\ldots (3)\text{-}$$

m:- Where ($m = \frac{1}{2}$) and (2)
If it was direct and indirect optical transition respectively, hv is the photon energy,
A is the constant band, and E_g is the energy gap.
Figure (8). shows the indirect permitted transition. Where the optical energy gap is calculated by drawing a straight line from the absorption edge and crossing it with the photons' energy axis(17).
optical energy gap value was calculated in the following way:

TABLE 1: Optical Energy

Sample	Optical Energy Eg(eV)
1%	2.29
2%	2.30
3%	2.20
4%	2.22
5%	2.21

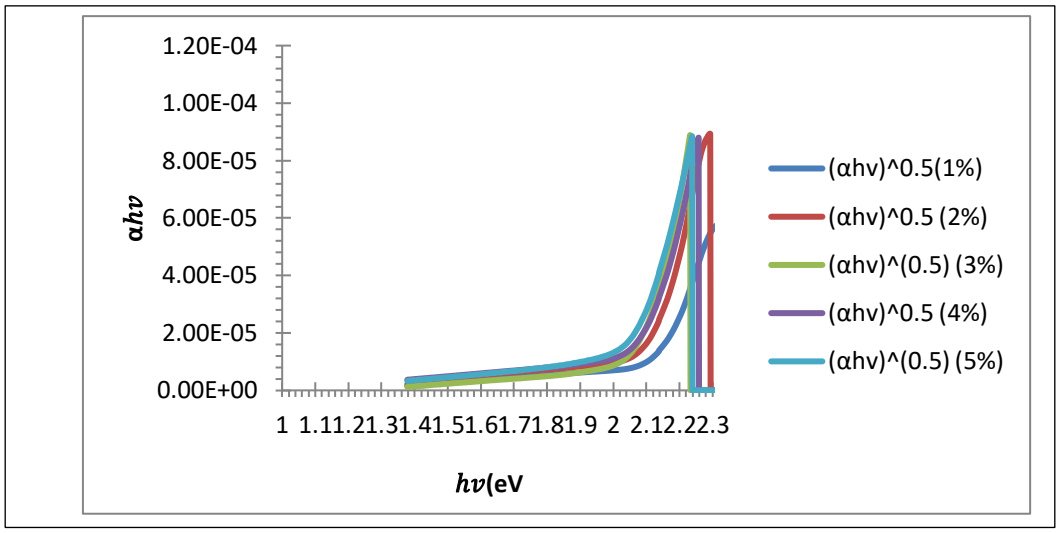

FIGURE 9. Optical energy gap curve of a polymer blend with glycerin and ratio of Rhodamine-B

CONCLUSIONS

This researcher found that the absorbance of this combination is within the visible fold, and the absorbance was better than the ratio of 3%, and the best value of the energy gap is 2.2, and the transmission is indirect, implying that extra energy bundles may be supplemented in different domains.

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