Effect of Laser Organic Dyes on the Optical Properties of (PVA-PEG) Blend

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Abstract

This paper discovers the study effect of Rhodamine Bdye (RB) addition on optical properties of polyvinylalcohol (PVA) and Polyethylene glycol (PEG) blend. The composites samples were prepared by adding (RB) percentages of 0, 0.013, 0.015, 0.017 and 0.020 wt. % to the (PVA-PEG) blend. The films were prepared by castingmethod with different thicknesses. The absorption noted in range of wavelength (200 - 800) nm. While the optical constants such as extinction coefficient, absorption coefficient, energy gap of the forbidden transition, indirect taj/improving of(RB) concentration. The energy gap reduced with reduction the weight percentages of (RB). 5524

Keywords: Rhodamine B, Polyvinyl Alcohol, Polyethylene glycol, absorption coefficient.

DOI Number:10.14704/nq.2022.20.8.NQ44580 **NeuroQuantology 2022; 20(8): 5524-5530**

1- Introduction

The composites at latest years appeal the attention engrossed both in science and industry applications. There is the option to syndicate electric, optical and mechanical properties of basic components in the sample. From vision of optical point, several fascinating properties of these composites obtained [1].Polyvinyl Alcohol suggest a mixture of excellent films binder features and formation, along with insolvability in organic solvents and cold water. This mixture of features is valuable in application variety. Moreover, it covers a backbone carbon with hydroxyl groups close to carbons methane. The hydroxyl groups could be a source of bonding hydrogen [2]. The steadiness of thin films polymer on solid-substrates is on excessive technological significance in the applications were extending from protective coats to painting, optical electronic and semiconductor devices[3,4]. Many mechanisms of conductivity like the Pool-Frenkel effect, hopping conduction, Schottky effect, and space charge limited conduction advised for the charge's transportation [5]. This paper comprised the (RB) addition effect on the properties of optical of (PVA – PEG) blend.

2-Materials and Methods

The raw materials used in this paper were 75% gm of Polyvinyl Alcohol (PVA) dissolved in 60 ml of distilled water at temperature 70 0C, mixed by a magnetic stirrer in 1 hour.25% gm of Polyethylene Glycol (PEG) added to the PVA at a temperature 50 0C mixed by amagnetic stirrer for 30 minutes to obtain more homogeneous solution. Using the casting method to prepare the (PVA-PEG-Rhodamine B Dye) with different concentrations of Rhodamine B Dyeadded to the blend as (0, 0.013, 0.015, 0.017, 0.020) wt. % mixed for 30 minutes attemperature 50 0C, the thickness of prepared thin films was 0.015 micrometer.

3. Resultsand Discussions

3.1.Optical Microscope Measurement

Figure (1) show the images of (PVA - PEG - RB) composites with different concentrations of (Rhodamine B) at magnification power (10 X). This Figure displays the aggregation of dye as clusters at concentrations with low values. With growing, the dye concentration creating network pathsinside the (PVA – PEG) blend [6].

3.2. The absorbance of (PVA-PEG-RB) composites

Figure 2 shows the absorbance of (PVA-PEG-RB) composite vs wave length, the figure indicate that the absorption rises with dye addition, and reduction with wavelength rises because of free electron number rising that absorbed the light incident [7].The high absorption of composites in the UV-region attributed to the energy of photon sufficient to cooperate with the atom, the excitation of electrons from a lower to a level with higher energy with absorbing a photon energy [8].

3.3. The Absorption coefficient and energy band gap of composites

Figure 3 shows the coefficient of optical absorption as a function of photon energy for (PVA-PEG-RB) composite, it was institute that the composite consumes a little absorption coefficientat a minor photon energy after that growth with rising photon energy depending on the structureof composite. The study of spectra of absorption coefficient might expose the energy gap $E_g$between the valence band and the conduction band due to transitions of direct and indirect forboth amorphous and crystalline materials. The absorption coefficient rises with growing in(RB) concentration. The absorption coefficient (α) calculated from the following equation [9]:

$\alpha = 2.303A/t$ ....(1)

Where: A is absorbance and (t) is the thickness of sample.

Figure 4 and 5 characterized the variation of indirect for allowed and forbidden transition as a function of photon energy of (PVA-PEG-RB) composite. According to the “model of indirect transition” for amorphous semiconductors planned by Taue [10]

$\alpha h\upsilon = B (h\upsilon - Eg)^{n}$ ....(2)

Where B is a constant associated to the valance and conduction band properties, hυ is the photon energy, E_g is the optical energy band gap, n=2, or 3 for transition of both of indirect(allowed and forbidden). From the direct plots of $(\alpha h\nu)^{1/n}$vs (hν) for these samples as shown inFigure 4 and listed in Table 1, $E_g$calculated from the extrapolations intercepts to zero with thephoton energy axis $(\alpha h\nu)^{1/n} \rightarrow 0$. It is seen that the concentration of (RB) rising in the systemleads to reduction in E_g. This might be recognized to structural disorder growth of thecomposites with growing (RB) concentrations.

3.4. Extinction Coefficient and Refractive Index

Figure 6 and 7 show the variation of extinction coefficient (k) and refractive index (n) as afunction with the wavelength for (PVA-PEG- RB) composite Extinction coefficient (k_0) is calculated by using the relation [11]:

$k = \alpha \lambda / 4\pi$ ………… (3)

Where λ is the wavelength, α is the absorption coefficient. While the refractive index of the filmscalculated by the following equation [5]:

n = [4R /(R-1)2 – k2] – (R-1) / (R-1) ……. (4) 5525

Where R is the reflectance and k are the extinction coefficient, the k values rise with growing (RB) concentration. This growing shows that the through material the electromagneticradiation is transient faster in the transient photon energy with low levels, this as the incrementof photons dispersion and optical absorption in polymer matrix [12]. While the refractive index nrising with increment of (RB) concentration and reduced with increment of wavelength. Thisperformance can be recognized as growing of the concentration of (RB) density [13], also maythe variation of the absorption coefficient which principals to deviation of spectrum in the chargepolarization location.

3.5. Dielectric Constants

The real and imaginary of dielectric ($\varepsilon_1$and ε_2) can be calculated by using equations [14]:

$\varepsilon = \varepsilon_1 - i\,\varepsilon_2$ …….. (5)

$\varepsilon_1 = n_2 - k_2$ …….. (6)

$\varepsilon_2 = 2nk$ …….. (7)

Figure 8 and 9 represented the real and imaginary part of the dielectric constant vs the incident wavelength, it's clear that the real and imaginary part of the dielectric constant were improved with (RB) concentration growing, this because of extinction coefficient and refractive index amassed [15].

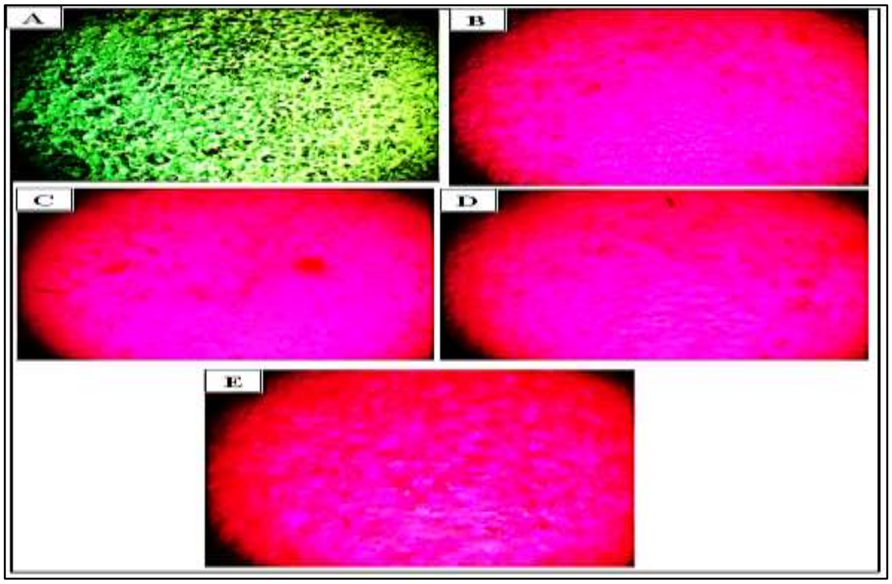

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Figure (1) Photomicrographs (10 X) for (PVA-PEG-ABD) composites: (A) for (PVA-PEG) blend, (B) for 0.013 wt % (Rho), (C) for 0.015 wt % (Rho), (D) for 0.017 wt % (Rho), (E) for 0.020 wt % (Rho).

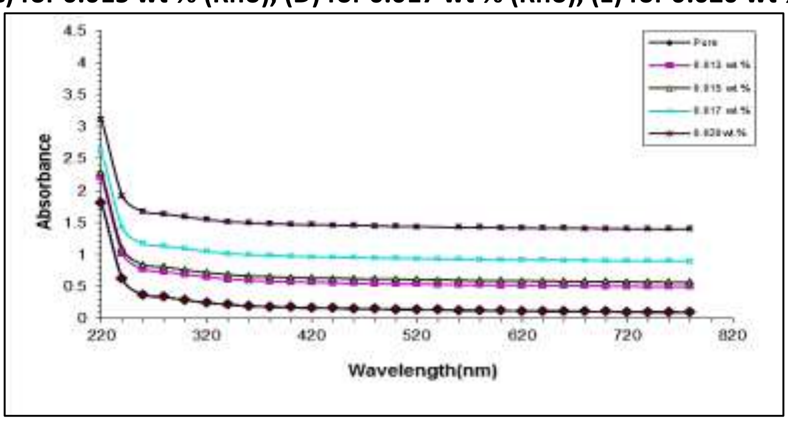

Figure (2) The absorbance as function of wavelength for (PVA-PEG-Rhodamine B) dye.

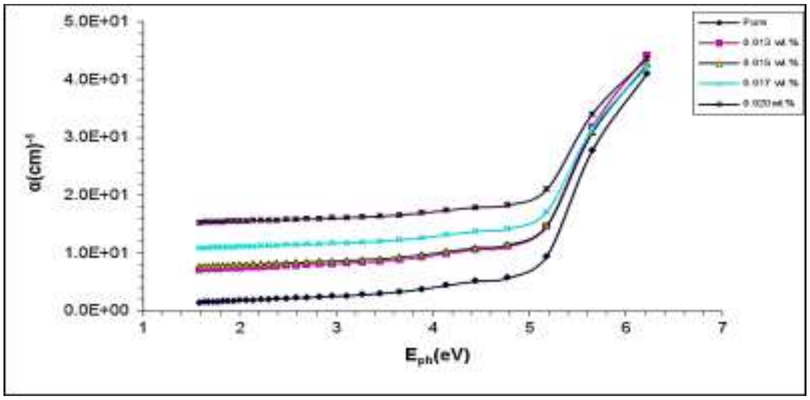

Figure (3) The absorption coefficient as a function of wavelength for (PVA-PEG-RB) dye.

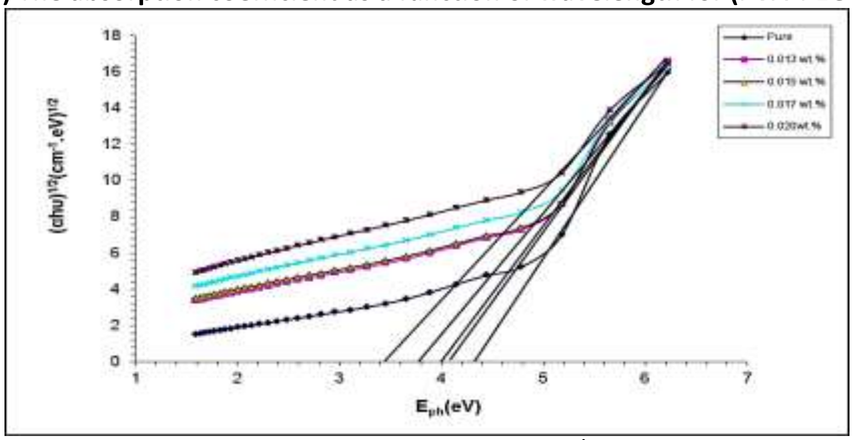

Figure (4) The energy gap for the allowed indirect transition$(\alpha h\upsilon)^{1/2}$ as a function of photon energy of (PVA-PEG-RB)dye.

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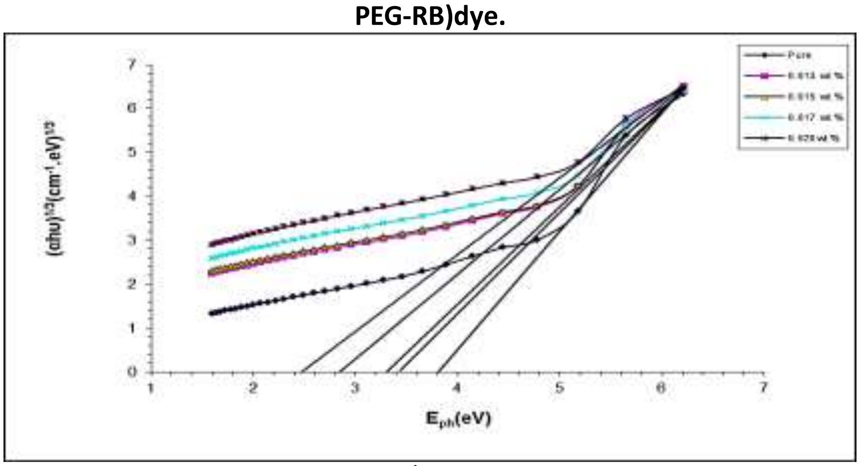

Figure (5) The variation of $(\alpha h\nu)^{1/3}$ as a function of photon energy for (PVA-PEG- RB)composite.

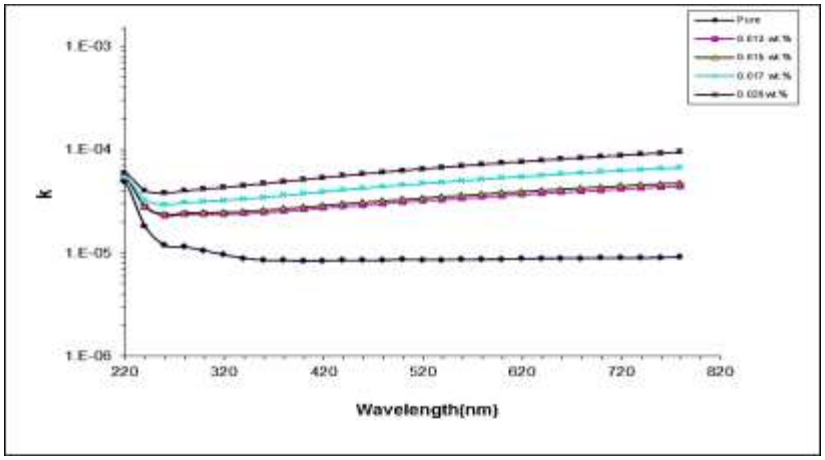

Figure (6) The Extinction coefficient as a function of wavelength for (PVA-PEG-RB) dye.

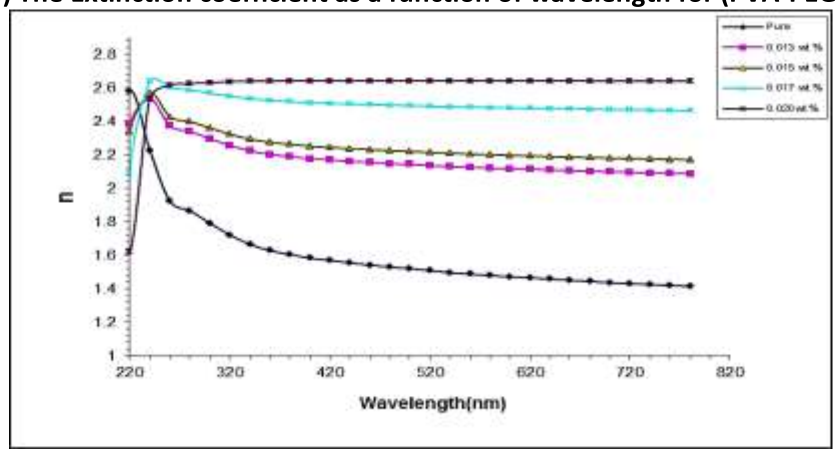

Figure (7) The refractive index(n)as a function of wavelength for (PVA-PEG-RB) dye.

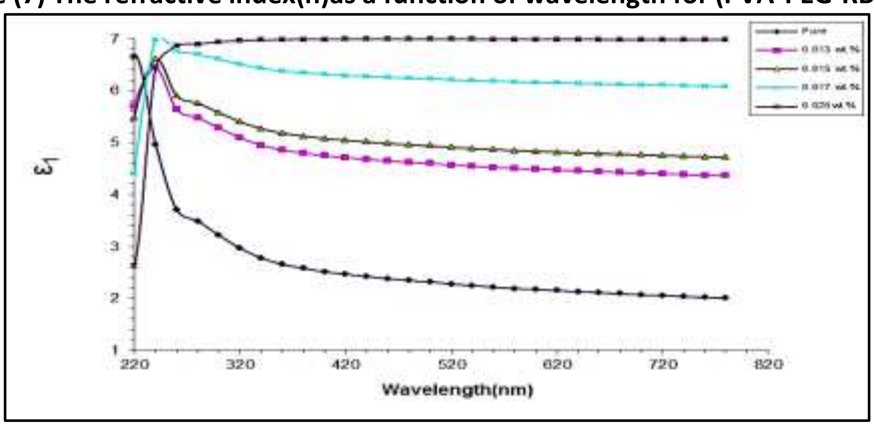

Figure (8) The real dielectric constant(ε_1) as a function of incident wavelength for (PVA-PEG-RB) dye.

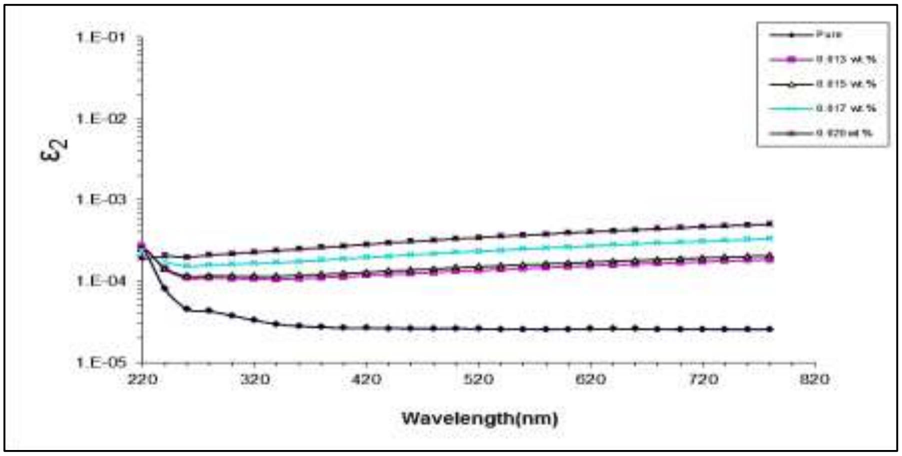

Figure (9) The imaginary dielectric constant(ε_2) as a function of wavelength for (PVA-PEG-RB) dye.

Table (1): The values of energy gap for the allowed and forbidden indirect transition for (PVA-PEG-RB) nanocomposites

(RB)dye wt.%	E_g(eV)	
	Allowed	Forbidden
0	4.28	3.8
0.013	4.15	3.61
0.015	4	3.27
0.017	3.69	2.82
0.020	3.4	2.45

4. Conclusion

Studying the optical properties of (PVA-PEG-RB) composites in the spectral region 200-800 nm. The composites have high absorbance in the ultraviolet and visible region and poor absorbance in the IR region making it suitable for using in solar thermal devices. The inter band transitions were found to be indirect type. The optical energy gap has been found to reduction with the growing the concentration of RB. The extinction coefficient, refractive index and real and imaginary dielectric constant are increasing with the increasing of the concentration of RB.

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