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Optical energy gap and Absorption Studies of Blue 8GX Dye Thin Film Prepared by Spray Pyrolysis Method

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Abstract: *Three sample thin film of Blue 8GX have been prepared by spray pyrolysis method onglass substrate with thicknesses (743, 457 and 95 nm). The optical parameters such as the optical energy gap were calculated for Blue 8GX dye thin films by using spectrophotometer (UV mini 1240 spectrophotometer made in a Japanese company called Shimadzu) measurements of the absorption in the spectral range (580 to 700) nm. The optical energy gap was estimated from absorption coefficient. The optical energy gap was found in range (1.968, 1.973 and 1.977) eV forBlue 8GX dye samples.*

Keyword: *Blue 8GX dye, thin film, Spray pyrolysis method, Optical energy gap.*

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I. Interoduction

In recent years, the search for novel optical materials has increased owe to their applications in optical devices such as optical modulation, optical information, optical data storage and imaging [1, 2]. Detailed investigations of linear and nonlinear optical coefficients enable to fabricate materials, appropriately designed at the molecular level for specific applications such as optoelectronic devices[3,4].Blue8GXdyeConstitution5-Amino-9-diethyliminobenzophenoxazonium Perchlorate$C_{20}H_{20}N_3O_5Cl$ · MW: 417.85Was shown in figure (1)

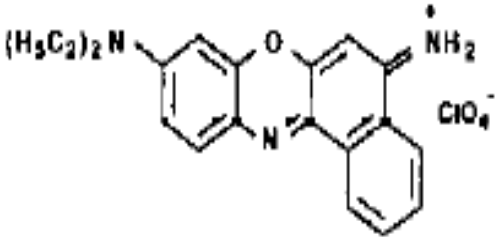

Fig (1). Chemical structure and molecular formula of the Blue 8GX Dye.

Characteristics Lamb dichromic® number: 6900CAS registry number: 53340-16-2Appearance: green, crystalline solid Absorption maximum (ethanol): 633 nm Molar absorptivity: 7.75 x 10^4 L mol^{-1} cm^{-1}Fluorescence maximum (in bas. ethanol): 672 nmfor research and development purposes only [5, 6]. This work reports the Optical energy gap ofBlue 8GX thin film prepared by spray pyrolysis method onto glass substrate by using spectrophotometer measurements the absorption and determination the optical energy gap responsible for optical absorption.

II. Experimental

Blue8GXAmino-9-diethyliminobenzohenoxazoniumPerchlorate$C_{20}H_{20}N_3O_5Cl$)(M = 4000 $mg.mol^{-1}$) was dissolved in NN Dimethyl for three different concentration (0.5, 1, 1.5)$mg.mL^{-1}$. The dye was kept in a refrigerator for 24 h, then prepared three sample thin film of Blue 8GX by spray pyrolysis method onto glass substrate with thicknesses (743- 457 and 95 nm). The Blue 8GX dye has been characterized by the UV spectra. The chemical structure and molecular formula of the chosen Blue 8GX dye is shown in Fig (1).

The spray pyrolysis method used here is basically a chemical deposition method in which fine droplets of the desired material are sprayed onto a heated substrate. Continuous films are formed on the hot substrate by thermal decomposition of the material droplets. TheBlue 8GX films were deposited onto glass slides, chemically cleaned, using the spray pyrolysis method at 170^oC substrate temperature. Concentration (0.5 – 1.0 and 1.5 $mg.mL^{-1}$) ofBlue 8GX dye in Dimethyl solvent was used for all the films. TheBlue 8GX to substrate distance was 3.5 cm and during deposition, solution flow rate was held constant at 2 ml/min. The substrate

temperature was measured using an Iron-Constantan thermocouple. The thickness of the thin films was measured by weight [8], difference method using a sensitive microbalance. The optical measurements ofBlue 8GX dye film were carried out at room temperature using (UV mini 1240 spectrophotometer made in a Japanese company called Shimadzu) Spectrophotometer in the wavelength range from 580 to 700 nm. The substrate absorption is corrected by introducing an uncoated cleaned glass substrate in the reference beam.

III. Result And Discussion

Table 1. Describe the concentration and thick ness for different sample

No of sample	Concentration (mg.mL^{-1})	Thickness (nm)
Sample 1	0.5	95
Sample 2	1.0	457
Sample 3	1.5	743

Determination of the optical energy gap of the Blue 8GX dye The optical absorption (A), spectra in the (580– 700) nm wavelength range for the Blue 8GX dye thin film are depicted in Fig (2) the maximum absorption observed at wavelength 621 nm then it decreases to Blue 8GX at wavelength >700 nm. The absorption edge of the film occurs at wavelength (621 nm) corresponding to photon energy (2 eV) [7,8]

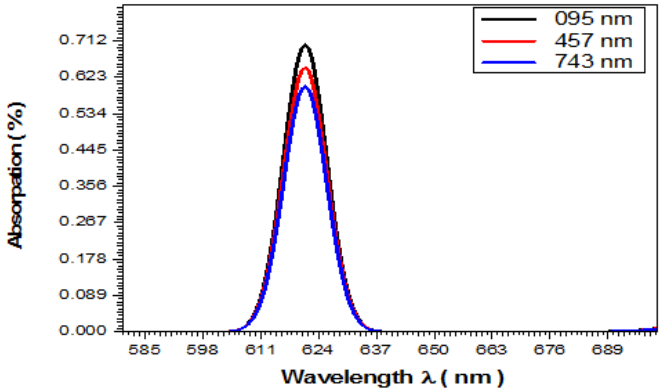

Fig (2) Absorbance with wavelength of the Blue 8GX dye thin film

$$\alpha h\nu = B(h\nu - E_g)^n \qquad (1)$$

Where $E_g$the energy gap, constant B is different for different transitions, (hv) is energy of photon and n is an index which assumes the values 1/2, 3/2, 2 and 3 depending on the nature of the electronic transition responsible for the reflection. The absorption coefficient, α is given by

$$\alpha = \frac{2.303\,xA}{d} \qquad (2)$$

Where d is the thickness of the sample and Ais the absorbance.

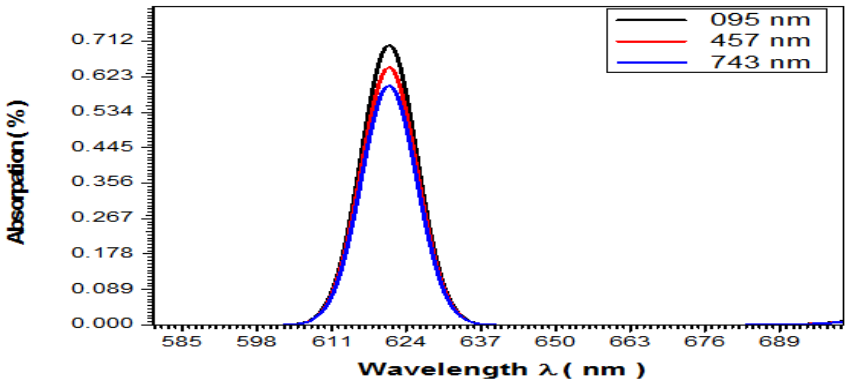

Fig. (3). the variation of absorption coefficient (α) with (λ) of theBlue 8GXdye thin film.

To understand the nature of energy band gap transition in this material[9,10], a graph of ln(αhv) vsln(hv- E_g) is drawn for the case of sample as shown in Fig.(4) . The plot in the figure is a straight line, the slope of which gives n = 2. This confirms that the transition is direct transition in these materials. When graph is plotted between ($\alpha h\nu)^2$ and (hv), a straight line is obtained. The extrapolating of the straight part of the curve to meet the hvaxis, the intersection point .The value of (Eg) obtained was (1.968) eV, which is approach the value of

(1.977) eV reported elsewhere. The value of (Eg) was decreased from (1.977) eV to (1.968) eV when the thickness decreased from 743 nm to 95 nm. The decreasing of (Eg) may be related to decrease in grain boundaries and their density due to the heating effect of the polycrystalline thin films. It was observed that the different structures of the films confirmed the reason for the band gap shifts.

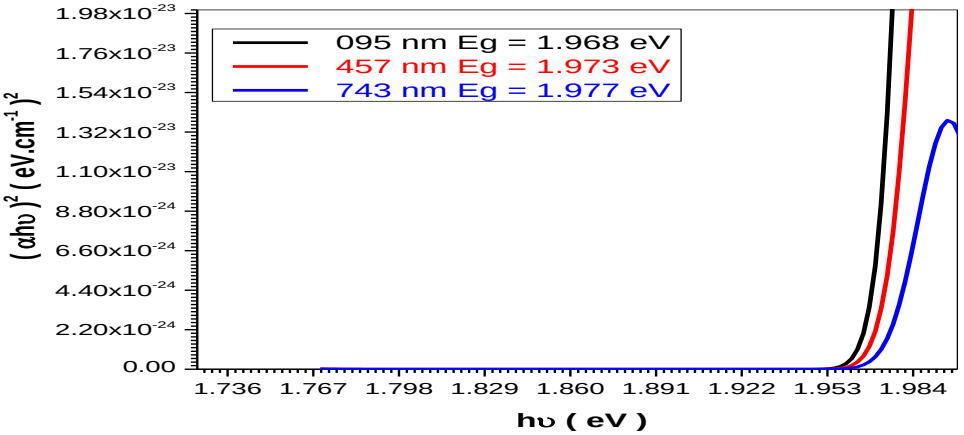

Fig (4) Plot $(\alpha h\nu)^2$as a function to photon energy of the Blue 8GX dye thin film.

IV. Conclusion

The absorption spectra of Blue 8GX dye thin film prepared by spray pyrolysis method on glass substrates are studied. The optical energy gap of the film has been obtained. The absorption spectra show that the film has a broad and strong absorption band in the region of 450–600 nm. The optical energy gap was estimated from absorption coefficient. The allowed optical transition responsible for optical absorption found to be forbidden direct transition with optical energy gap of 1.976 eV for Blue 8GX dye sample.

Acknoledgment

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