



Absorption Resonance Energy Transfer Between Organic Dyes (Cumarin And Rohdamain)

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Abstract

The spectral properties absorption of laser dyes (C480 & R610) mixture have been studied; this type of laser dye belongs to the coumarinoids and Xanthenes family, and has been dissolved in ethanol to prepare (1:1, 1:2, 1:3, 1:4, ratio) from Cumarin 480(C48): Rohdamain 610 (R610) in (10^{-4} 10^{-5} , 10^{-6}) M/L concentration at room temperature. The achieved results pointed out to an increase in the absorption intensities with the increased concentration of R610 from (10^{-6} , 10^{-5} to 10^{-4} M/L the same thing for C480 which are found in agreement with Beer – Lambert law and the achieved Results pointed that the absorption peak are moving toward short wavelengths (BLUE SHIFT) when increasing the ratio of concentration.

Keywords: Dye laser, Fluorescence resonance energy transfer, Silica gel matrices. Absorption spectrum.

1- Introduction

Energy transfer is a physical phenomenon first described over 90 years ago, [1]. Due to its sensitivity to distance, Electronic energy transfer in a dye mixture is established as an additional effective mechanism to extend the wavelength of lasing and tunability in an energy transfer dye laser (ETDL). For such dye laser an enhancement or decrease in the laser energy output is noticed. An ETDL with wide tunability has been achieved using two, three, and four component dye mixtures. The most frequently used donor-acceptor pairs in the ETDL are: crestyl violet rhodamine 6G, rhodamine B-DODC, Coumarin - acrivlavine, different Coumarin dyes with some aromatic compounds[2]. Fluorescence resonance energy transfer is a nonradiative process whereby an excited state donor D (usually a fluorophore) transfers energy to a proximal ground state acceptor A through long-range dipole-dipole interactions [3,4]. Organic dyes are characterized by a strong absorption band in the visible region of the electromagnetic spectrum. Such a property is found only in organic compounds which contain an extended system of conjugated bonds (alternating single and double bonds). By adjusting the model parameters on the basis of empirical data, it is possible to predict the absorption properties of yet unknown dyes[5]. The long-wavelength absorption band of dyes is attributed to the transition from the electronic ground state S_0 to the first excited single S_1 [6] because of the large transition moment the rate of spontaneous emission is rather high (radiative lifetime on the order of nanoseconds) and the gain of a dye laser may exceed that of solid-state lasers by several orders of magnitude.[7]. The sample absorbs energy in the form of photons from the radiating field. The intensity of the absorption varies with frequency. The variation in the intensity is known as the absorption spectrum.[8] The width and shape of the

lines are measured by the spectral density. The classification

of absorption lines depends on the nature of the quantum mechanical change in the molecule or atom, [9] Vibrational lines are generated due to change in the vibrational state of the molecule and for example the infrared region. Electronic lines are generated due to change in the electronic state of molecule or an atom for example the visible and ultraviolet (UV) region. [8],[10]. Transmission spectrum will have its maximum intensities at wavelengths whereas the absorption is weakest as more light is transmitted through the sample. Donor-Acceptor Interactions may occur between contiguous solute and solvent molecules, [11]. The additional stabilization from charge-transfer resonance depends on overlap of donor and acceptor orbitals, so the strength and structural influence of charge-transfer interactions is optimized when the relative orientation of donor and acceptor molecules is such as to maximize this overlap, [12] The Energy emitted of the laser from active medium is equal to the difference between the triple-level, [13]. The density of a typical solid is about 20% larger than the corresponding liquid, while the liquid is roughly 800 times as dense as the gas, [14]. The liquid state of most compounds stable over a surprisingly large temperature range while a solution is the homogeneous liquid phase which results from the mixing of a solute (gas, liquid or solid) with a liquid solvent [15]. The solute and surrounding solvent molecule exert a mutual net attraction mutual. The aggregation of solvent molecules around a solute is known as solvation, [16]. Impurities effect the presence of defects due to increased operations radiation less rate, especially transit IC (Internal conversion) between excitation singlet state case (S_1) and the tripartite case, [17].



2.Experimental Chemical Materials.

Ethanol (C₂H₅OH) Ethanol (C₂H₅OH), of molecular weight 46.07 supplied by Gain land Chemical Company, U.K. ethanol is a polar, portico solvent frequently used to dissolve laser dyes. [18].

2.1. Coumarin 480

The dye used is C480 (Coumarin 480) laser dye (C₁₆H₇NO₂) [19]. Molecular weight: (255.23) gm/M, equipped with the company (Lambda physic) German.

2.2. Rhodamin 610

Lambda chrome number: 6100, CAS registry number: 81-88-9R610 is a green, crystalline solid, [20][21]. Absorption maximum (in ethanol): 552 nm Molar absorptive : 10.7L mol⁻¹ cm⁻¹. Fluorescence maximum (in ethanol): 580nm And equipped with the company (Lambda physic) German.

The dye solutions are prepared by dissolving the required amount of the dye into (the solvent ethanol). The dyes are prepare in concentrations (10⁻³, 10⁻⁴, 10⁻⁵ and 10⁻⁶) M as shows in figure (1) the weight of the dye is measured using a (Mettler) balance of 0.1mg sensitivity. The weight of the dye (W) in gm.



Figure (1) concentrations (10⁻³, 10⁻⁴, 10⁻⁵ and 10⁻⁶) M/L of C480 and R610 dyes

dyes (C480 & R610) mixture have been prepared by fixed the ratio of C480 increased the ratio of R610 ascending. Both dyes dissolved in chloroform to prepare (1 : 10⁻⁴, 1 : 10⁻⁵, 1 : 10⁻⁶) M/L at room temperature dissolved in ethanol to prepare (1:1, 1:2, 1:3, 1:4, ratio) from (C48) : (R610) in (10⁻⁴, 10⁻⁵

, 10⁻⁶) M/L concentration the same think for (R610:C480) the sample was prepared at room temperature. As shown in figure (2),(3).



Figure (2) (1:1, 1:2, 1:3, 1:4, ratio) from (C48) : (R610) in (10⁻⁴, 10⁻⁵, 10⁻⁶) M/L concentrations

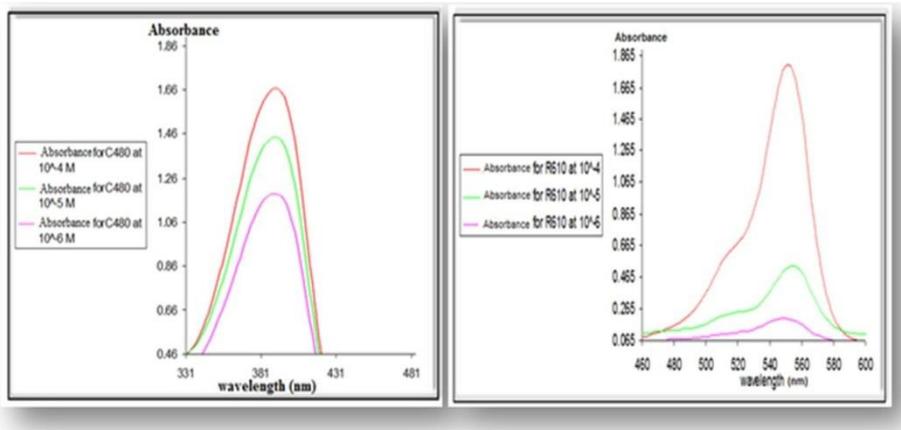


Figure (3) (1:1, 1:2, 1:3, 1:4, ratio) from (R610) : (C48) in (10⁻⁴, 10⁻⁵, 10⁻⁶) M/L concentration

3-Results and discussion

The Absorbance Spectrum of the Dyes Solution C480 in Ethanol (C₂H₅OH) the absorbance spectrum is measured

at room temperature for the dye solution C480 dissolved in ethanol at (1 × 10⁻⁴, 1 × 10⁻⁵, 1 × 10⁻⁶) M/L concentrations, as shown in figure(4).



Figure(4): The Absorbance Spectrum for C 480 and R610 dissolvent in ethanol

Table (1): The Effect of Concentration on The Absorbance Spectrum of the Dye C480 and R610 in Ethanol Solvent

C480			R610		
concentration	Wavelength(nm)	Absorbance	concentration	Wavelength(nm)	Absorbance
1X 10 ⁻⁴	391	1.668	1X 10 ⁻⁴	553.8	1.81
1X 10 ⁻⁵	388	1.432	1X 10 ⁻⁵	551	0.537
1X 10 ⁻⁶	386	1.179	1X 10 ⁻⁶	584.2	0.070

Figure (4) illustrated the absorbance spectra of dye solution C480 and R610 dissolved in ethanol solvent at room temperature and at concentrations (1 × 10⁻⁴, 1 × 10⁻⁵, 1 × 10⁻⁶) M/L. The results from table (1) show greater absorbance (1.668) at the maximum wavelength (391) nm when the concentration (1 × 10⁻⁴) M, and observes that the decrease in concentration leads to move the beak of the absorbance spectrum towards the shorter wavelength (Blue Shift) to became (388) nm and absorbance (1.432) when the concentration decrease to the (1 × 10⁻⁵) M/L. The results show lower absorbance (1.179) at the minimum wavelength (386) nm when the concentration (1 × 10⁻⁶) M/L for C480 dye . Where the R610 dye show greater absorbance (1.81) at the maximum wavelength (553.8) nm when the concentration (1 × 10⁻⁴) M/L, and observes that the decrease in concentration leads to move the beak of the absorbance spectrum towards the shorter wavelength (Blue Shift) to became (551) nm and absorbance (0.537) when the concentration decrease to the (1 × 10⁻⁵) M/L. The results show lower absorbance (0.070) at the minimum wavelength (584.2) nm when the concentration (1 × 10⁻⁶) M/L. The Absorbance Spectrum of the Dyes Solution C480 and R610 in Ethanol solvent (C₂H₅OH) according to the ratio of C480 and R610 (1:1,1:2,1:3,1:4) respectively. The absorbance spectrum is measured at room temperature for the dye solution at (1 × 10⁻⁴, 1 × 10⁻⁵, 1 × 10⁻⁶) M/L concentrations, as shown in figure(5)and (6).

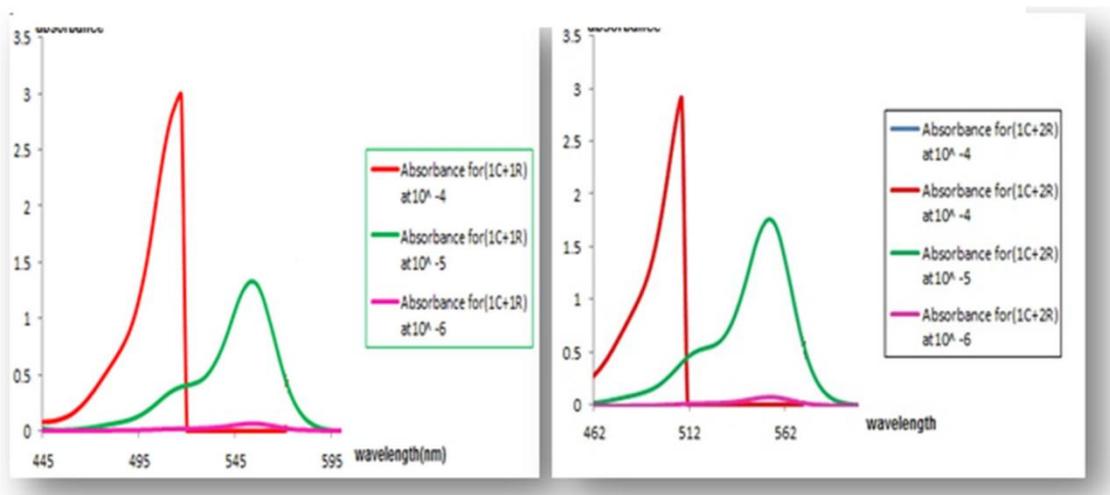


Figure (5): The Absorbance Spectrum for (1C480 +1R610)and (1C480 +2R610) Dissolved in Ethanol at(1 × 10⁻⁴ ,1 × 10⁻⁵ ,1 × 10⁻⁶)M /Lconcentrations

Table(2): The Effect of Concentration on The Absorbance Spectrum of the ratio from Dye (1 C480:1R610)and (1 C480:2R610)ratio in Ethanol Solvent

1C480:1R610			1C480:2R610		
concentration	Wavelength(nm)	Absorbance	concentration	Wavelength(nm)	Absorbance
1X 10 ⁻⁴	517	2.9866	1X 10 ⁻⁴	508	2.8923
1X 10 ⁻⁵	550	1.277	1X 10 ⁻⁵	553	1.7561
1X 10 ⁻⁶	547	0.05	1X 10 ⁻⁶	553	0.07133

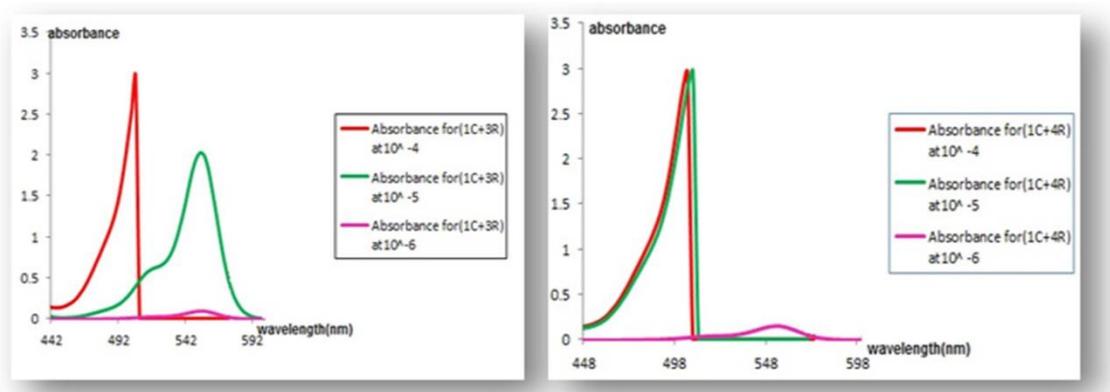


Figure (6): The Absorbance Spectrum for (1C480 +3R610)and (1C480 +4R610) Dissolved in Ethanol at(1 × 10⁻⁴ ,1 × 10⁻⁵ ,1 × 10⁻⁶)M/L concentrations

Table(3): The Effect of Concentration on The Absorbance Spectrum of the ratio from Dye (1 C480:3R610)and (1 C480:4R610)ratio in Ethanol Solvent

1C480:3R610			1C480:4 R610		
concentration	Wavelength(nm)	Absorbance	concentration	Wavelength(nm)	Absorbance
1X 10 ⁻⁴	505	2.9488	1X 10 ⁻⁴	508	2.9610
1X 10 ⁻⁵	550	1.9464	1X 10 ⁻⁵	505	2.942
1X 10 ⁻⁶	550	0.0854	1X 10 ⁻⁶	544	0.1084

Figure (5),(6) illustrated the absorbance spectra of dye solution C480 and R610 dissolved in ethanol solvent at room temperature and at concentrations (1 × 10⁻⁴ ,1 × 10⁻⁵ ,1 × 10⁻⁶) M/L according to the ratio of C480 and R610 (1:1,1:2,1:3,1:4) . The results from table (2,3) show greater absorbance was(2.9866) at ratio (1C480:1R610) at the wavelength(517) nm at the

concentration (1 × 10⁻⁴) M/L, and observes that the increase in ratio of R610 leads to move the beak of the absorbance spectrum towards the longer wavelength (Red Shift) to became (544) nm at lower absorbance (0.1084) when the ratio (1C480:4R610) at the concentration decrease to the (1 × 10⁻⁶) M/L. The Absorbance Spectrum of the Dyes Solution R610 and C480in Ethanol solvent (C₂ H₅ OH) according to the ratio of

R610 and C480 (1:1,1:2,1:3,1:4) . The absorbance spectrum is measured at room temperature for the dye solution at (1×10^{-4} , 1×10^{-5} , 1×10^{-6})M/L concentrations, as shown in figure (7) and (8).

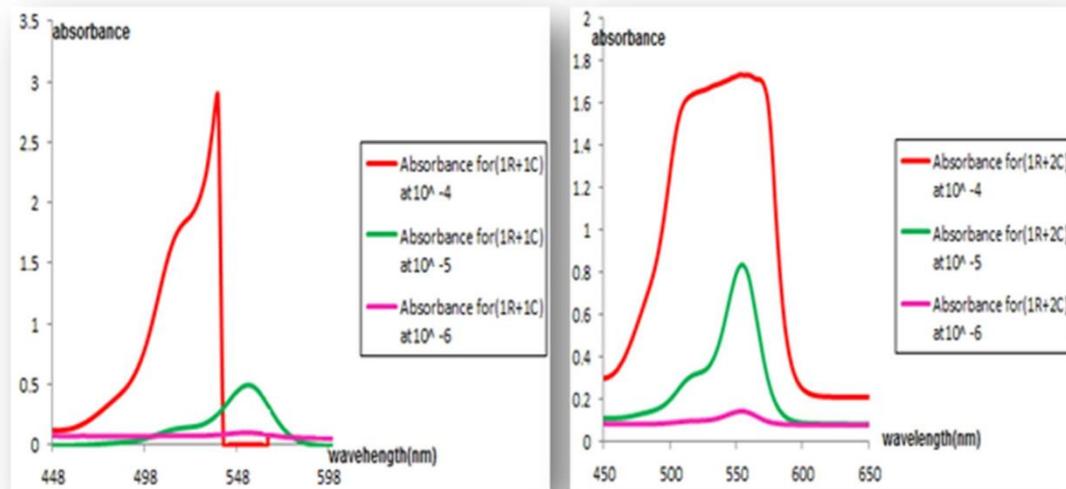


Figure (7): The Absorbance Spectrum for (1R610+1C480)and (1R610+2C480) Dissolved in Ethanol at (1×10^{-4} , 1×10^{-5} , 1×10^{-6})M concentrations

Table(4): The Effect of Concentration on The Absorbance Spectrum of the ratio from Dye (1R610:1C480)and (1R610:2C480)ratio in Ethanol Solvent

1R610:1C480			1R610:2C480		
concentration	Wavelength(nm)	Absorbance	concentration	Wavelength(nm)	Absorbance
1×10^{-4}	532	1.6810	1×10^{-4}	528	2.871
1×10^{-5}	550	0.7931	1×10^{-5}	547	0.419
1×10^{-6}	526	0.10	1×10^{-6}	520	0.0730

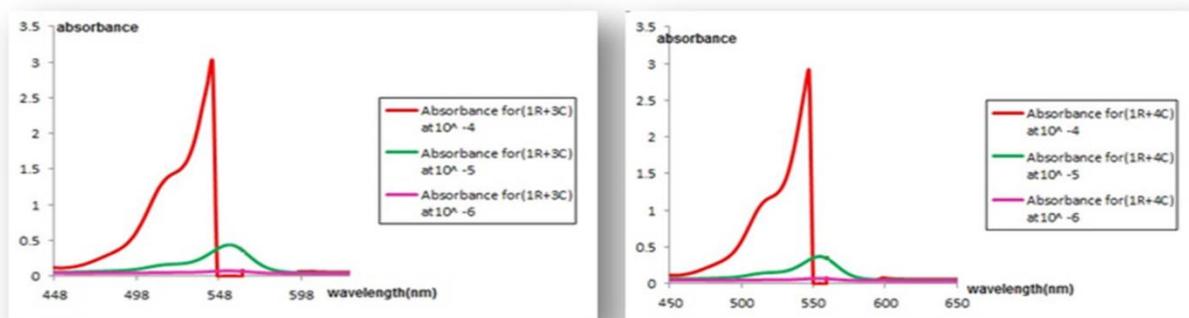


Figure (8): The Absorbance Spectrum for (1R610+3C480) and (1R610+4C480) Dissolved in Ethanol at (1×10^{-4} , 1×10^{-5} , 1×10^{-6}) M/L concentrations

Table (5): The Effect of Concentration on The Absorbance Spectrum of the ratio from Dye (1R610:3C480) and (1R610:4C480) ratio in Ethanol Solvent

1R610:3C480			1R610:4C480		
concentration	Wavelength(nm)	Absorbance	concentration	Wavelength(nm)	Absorbance
1×10^{-4}	388	2.126	1×10^{-4}	547	2.892
1×10^{-5}	367	0.2088	1×10^{-5}	550	0.324
1×10^{-6}	349	0.070	1×10^{-6}	550	0.0648

Figure (7),(8) illustrated the absorbance spectra of dye solution R610 and C480 dissolved in ethanol solvent at room temperature and at concentrations (1×10^{-4} , 1×10^{-5} , 1×10^{-6}) M/L according to the ratio of R610 and C480 (1:1,1:2,1:3,1:4). The results from table (4,5) show greater absorbance was (2.892) at ratio (1R610:4C480) at the wavelength (547) nm at the concentration (1×10^{-4}) M/L, and increased the ratio of C480 leads to move the beak of the absorbance spectrum towards the longer wavelength (Blue Shift) to become (550) nm at lower absorbance (0.0648) when the ratio (1R610:4C480) at the concentration decrease to the (1×10^{-6}) M/L.

4-Conclusions

from upper result note that the make mixed between two dyes was effected on the spectroscopy properties and this effect depend on the ratio of mixed. Increases absorption intensity due to increasing stability, as a result of the arrangement of atoms in more regular. It was noted that the spectra of absorption. Finally, it was concluded that process of mixing dyes had an obvious effect on the spectra of absorbance where they recorded the highest peaks of the absorbance intensity. The ratios of mixture between the dyes (R610&C480) were equal, this was because of the mutual effect between the two dyes, and the effect resulted from the spectral resonance overlap between spectral absorbance region for C480 dye and R610 spectral absorbance region.

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