Spectroscopic Study of Fluorescence Coumarin 480 Dye for Solution with polymer

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ABSTRACT

In this study were chosen coumarin (480), and It was dissolved in ethanol and prepared in concentrations ($_{10^{-4}}$) mole/liter*, the absorption and emission spectra of different samples dyes as a laser medium effectively been prepared and studied at room temperature . The achieved Results pointed that the absorption peaks are moving toward short wavelengths (BLUE SHIFT) when increasing the ratio of polymer additives and the fluorescence spectrum peaks are moving in the direction of longer wavelengths (RED SHIFT) when increasing the ratio (%20 and %40) of polymer.*

Keywords: Fluorescence Coumarin 480, laser medium, polymer additives, fluorescence spectrum peaks

INTRODUCTION

Organic dye which can be tuned over a wide spectral region from ultraviolet to near infrared. And are very useful coherent light sources. Many new materials have since been added, and the total number of lasing compounds is now unknown, a most detailed list of laser dyes was published by K. H. Drexhage in 1973 [1]. Dye lasers have made a large impact on society due to their lasing potential, high quantum yield, wavelength tunability and self-mode locking capabilities [2]. the applications for these lasers have appeared in industrial, military, and medical instruments. In industry, Dye lasers were first discovered by Sorokin and Lankard in 1966 and these lasers have been used in semiconductor fabrication, chemical purification, catalyst production, curing of pigment coatings, and combustion diagnostics. In medicine, dye lasers have been used for removing birthmarks, breaking stones in the gallbladder, angioplasty, and for cancer studies [3]. Most dyes are strong absorbers in the ultraviolet region. There are Several variables can influence the efficiency and the output wavelengths of the dye including the concentration of the dye, the solvent type, and the pumping wavelengths, Organic dye lasers are capable of emission across a broad bandwidth making them suitable for tunable lasers. There are several classes of laser dyes including polymethines (700 to 1500 nm), xanthenes also known as rhodamines (500 to 700 nm), coumarines (400 to 500 nm) and scintillators (320 to 400 nm) [4].Laser dyes are dissolved in solvents, such as water, toluene, methanol, polymethyl methacrylate (Plexiglas) [5]. and even jello [6]. The ratio of dye molecules to solvent molecules is at a ratio of 1 to 10,000 or more so that each dye molecule is surrounded by solvent molecules. radiative decay dominates in the dye molecules Due to the shielding by the solvent . Otherwise, nonradiative collisional decay dominates as energy is transferred to the medium causing it to heat up. Most dyes have near unity quantum yield (the quantum yield is defined as the ratio of radiating excited molecules to the total number of excited molecules) [7].

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MATERIALS

Dyes

The dye used was C480 (Coumarin 480) laser dye (C16H17NO2), molecular weight:255.23 gm/M supplied by Lambda Physics LC (4800). C102 was used as received without further purification, Appearance: yellow, crystalline solid, Absorption maximum (in ethanol): 389 nm, Molar absorptivity: 2.15 x 104 L mol^{-1} cm, Fluorescence maximum (in ethanol): 465 nm, Efficient laser dye for pulsed and CW operation; tunable around 480 nm [8-13].

Table 1. The characteristics of C480 dye in ethanol solvent

Solvent	*Ethanol*
Peak	473 nm
Tuning Range	452 nm .. 500 nm
Efficiency	16 %
Concentration	0.40 gram / liter
Comments	aka Coumarin 480

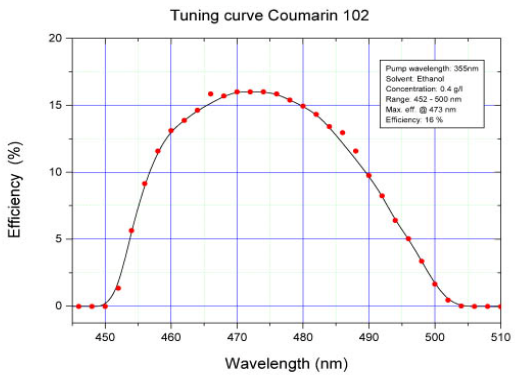

Figure 1. The efficiency spectra of the dye solution C480 a function of wavelength

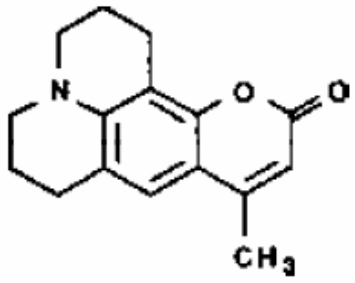

Figure 2. The chemical structure of C480

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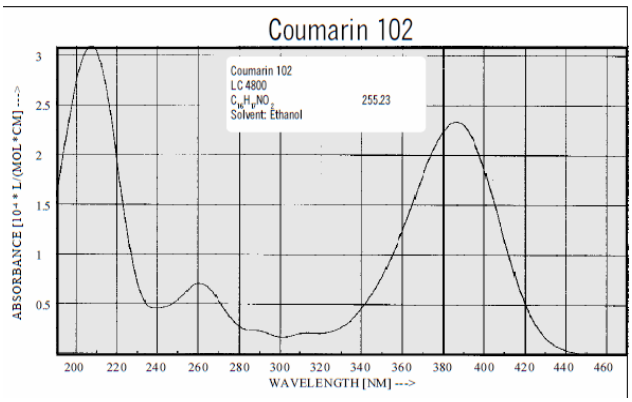

Figure 3. The absorption spectra of the dye solution C480

Table 2. The characteristics of dye C480

Dye Laser Characteristics							
pump		Range [nm]	Peak [nm]	Ref.	Solvent	Conc. [g/l]	Effic. [%]
Source	Wavelength [nm]						
Xecl-Excimer	480	308	2.30	18	460 - 510	8,9	Methanol
Nitrogen	470	337	1.44	Rel.	454 - 506	10	Methanol
Nd:YAG,3rd	480	355	0.40	15	462- 497	8,11	Methanol
Flashlamp	480	-	0.05	-	460 - 530	12	Methanol
CW,A r^+	482	UV	2.0	-	463 - 515	8,13	Bz./Eg

Polymer

Transparent plastic material is colorless and characterized by high flexibility and high transparency recipe with a higher refractive index makes it important to use them with organic dyes. This is a polymer of polymers with glass installation random. The chemical formula of the monomer is CH2C (CH3) COOCH3 and its melting temperature (213C^o) and molecular weight (84000gm / mol) and density

(1.2gm / cm^3) [15].

The presence of aggregates on the substitutes linear polymeric chains impede the crystallization of the polymer because they impede polymeric chains of convergence of each other. Therefore, the existence of the group substitutes prevent polymer (poly instance Metha Akrlaat PMMA) of crystallisation so it is of amorphous polymers. [16].

Solvent

The following solvents was used:

an organic solvent whose scientific name (NN-Dimethyl formamide) and symbolized a brief (DMF) or (DMFA) with a molecular formula C3H7NO and molecular weight: (73.10gm /

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mol) and boiling point (153°C) and its density is 0.9445g / cm^3, a high Arctic where a polarity equal to 6.4

Unity compositional are- :

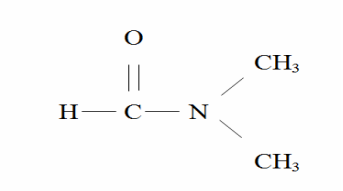

Figure 4. The chemical bonds of C480

This is the best solvent of organic solvents in order to contain the carbonyl group has been used effectively dye mthel Formamaid pure amounted to 99.5% purity and equipped by the company MERCK-Schnchardt German .

The refractive index of the solvent is (1.42803), either percentages of its components have reached - :

N19.16% and O21.89% and H9.65% and C49.30% Percent composition: [14].

Samples Preparation

The dye solutions were prepared by dissolving the required amount of the dye into the solvent; the weight of the dye was measured using a Mattler balance of 0.1mg sensitivity. The weight of the dye W (in gm) was calculated using the following equation .

$W=M_w V C/1000$ …… (2-1)

Where:

M_w molecular weight of the dye (gm/mole).

V the volume of the solvent (ml).

C the dye concentration (mole/l).

To prepare dilute solution the following equation was used:

$C_1 V_1 = C_2 V_2$ …… (2-2)

Where:

C_1 is the high concentration (M).

V_1 is the volume before dilution (l).

C_2 is the low concentration (M).

V_2 is the total volume after dilution (l).

Preparation Dyes Solution

PMMA polymer was prepared by dissolving 70gm of polymer powder in 100ml of (dimethyl formamide) and taking percentages (20% and 40%) of this solution and mixed with the dye solution composition solution (dye + polymer) and mixing this solution until become homogeneous solution

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RESULTS AND DISCUSSION

Absorption Spectra of C480 Dye Solution 1-The absorption spectrum was measured of the dye solution coumarin 480 dissolved in ethanol with concentration 10^{-4} , as shown in

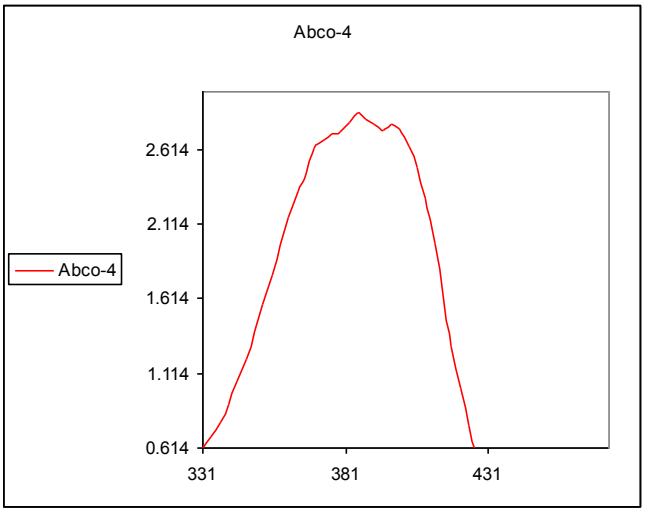

Figure 5. The absorption spectra of the dye solution C480 before adding PMMA polymer

Figure 5 illustrated , that the greatest value for the absorption 2.7829 was reached when the wavelength of 384.474 nm.

2-The absorption spectrum was measured of the polymer sample with ratio 20% polymer is added to the solution with a concentration of 10^{-4} with liquid state as shown in Figure 6.

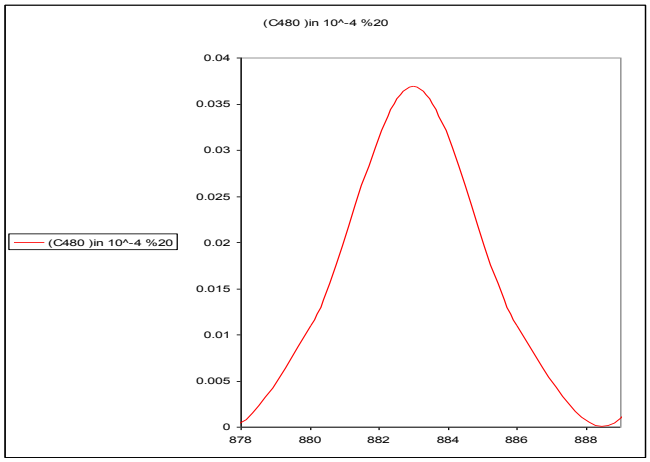

Figure 6. The absorption spectra of the dye solution C480 prepared in concentration (10^{-4}) mole/liter with(PMMA) in%20 percentage

Figure 6 illustrated , that the greatest value of absorbance reached .03684 at the top of the greatest wavelength 883 nm.

3- The absorption spectrum was measured of the polymer sample with ratio 40% polymer is added to the solution with a concentration of 10^{-4} [M/L] in liquid state as shown in Figure 7.

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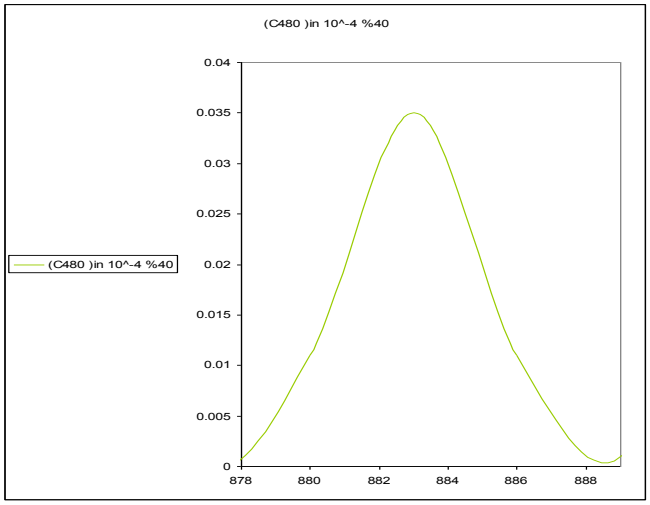

Figure 7. The absorption spectra of the dye solution C480 prepared in concentration 10^{-4} mole/liter with (PMMA) in (% 40) percentage.

Figure 7 illustrated , that the greatest value of absorbance reached 0 .0349 at the top of the greatest wavelength 883.001 nm ,this results are illustrated in table 3.

Table 3. The laboratory results that have been obtained for the dye C480 in absorbance case

Concentration (M) Liquid medium	Absorption beak location (nm) befor added PMMA λ	absorbance	Absorption beak location (nm) after added PMMA λ	absorbance	Ratio of polymer additives
1×10^{-4}					20%
			883	0.03684	
	384.474	2.7829			
			883.001	0.03491	40%

Fluorescence Spectra of C480 Dye Solution

1-The fluorescence spectrum was measured of the dye solution coumarin 480 with concentration 10^{-4} [M/L], as shown in figure 8.

Figure 8. The fluorescence spectra of the dye solution C480 before adding PMMA polymer

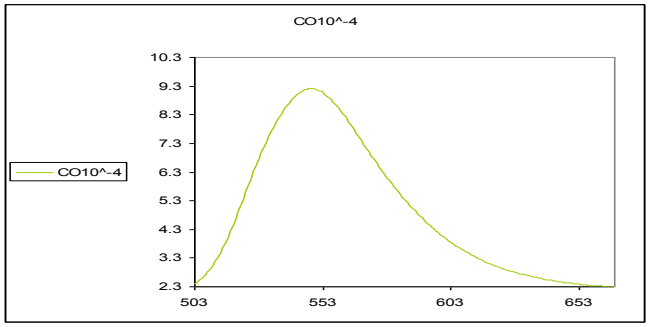

Figure 8. The fluorescence spectra of the dye solution C480 before adding PMMA polymer

Figure 8 illustrated , that the greatest value of fluorescence intensity 9.216 was reached when

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the wavelength 468,204 nm.

2-The fluorescence spectrum was measured of the dye solution coumarin 480 with concentration 10^{-4} [M/L] in the liquid stat after the addition of the polymer by 20%, as shown in Figure 9.

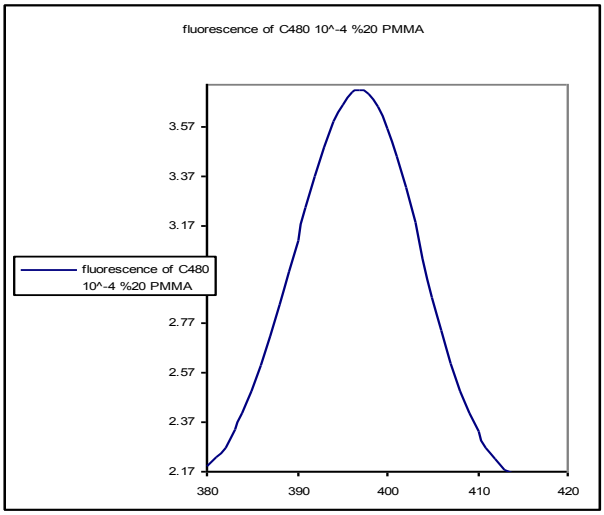

Figure 9. The fluorescence spectra of the dye solution C480 prepared in concentration 10^{-4} M/L with (PMMA) in%20 percentage

Figure 9 illustrated , that the greatest value of fluorescence intensity (24,56) was reached when the wavelength (587) nm

3-The fluorescence spectrum was measured of the dye solution coumarin 480 with concentration 10^{-4} [M/L] in the liquid state after the addition of the polymer by 40% , as shown in figure 10.

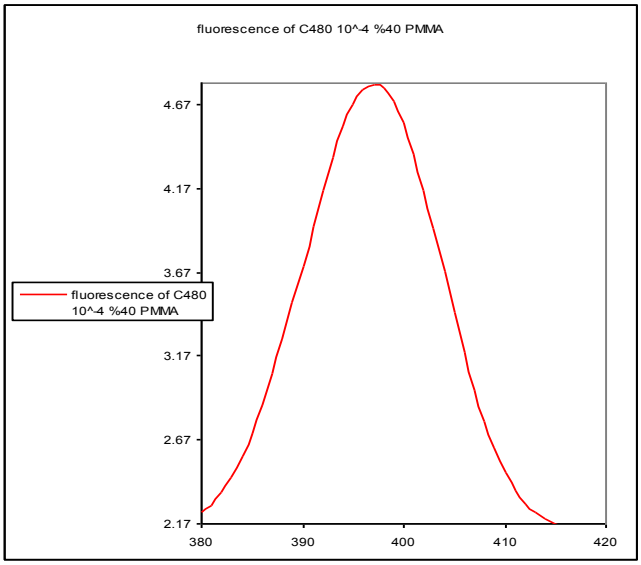

Figure 10. The fluorescence spectra of the dye solution C480 prepared in concentration 10^{-4} mole/liter with(PMMA) in%40 percentage.

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Figure 10 illustrated , that the greatest value of fluorescence intensity(30,53) was reached when the wavelength (591,88) nm, this results are illustrated in table 4.

Table 4. The laboratory results that have been obtained for the dye C480 in fluorescence case.

Concentration (M) Liquid medium	*Fluorescence beak location (nm) befor added PMMA*		*Fluorescence beak location (nm) after added PMMA*		*Ratio of polymer additives*
	λ	*Intensity*	*λ*	*Intensity*	
			587	24,56	
		9.216			20%
1×10^{-4}	468.204			30,53	
			591,88		40%

The Polymers reveal its importance in improving the optical properties of the laser dyes and reduce dangerous toxin to it , and also polymers that are transparent optical excellent And carried it high energies through the process of pumping and note the results that have been listed above illustrated in Table 3 and 4.

The absorption peaks moving toward longer wavelength (red shift) by (118.796) nm at the ratio 20%. But when increase ratio of the polymer additives to40% the amount of shift was increase toward longer wave length by (123.676)nm .

The use of polymer material with laser dyes its importance reveal in that it reduces the spread of the molecules to the surface, which reduces decay and this leads to an increase in the optical stability, so as not to form a Aldaamrat. The polymer molecules working to determine field disturbance and reduce the absorbability of the dyes.

The Either spectrum forms and results we see that Fluorescence spectrum peaks shift toward longer wavelength (red shift) by (71.204) nm at the ratio 20% and at the ratio 40%. when increasing ratio of polymer this is causes to increase of intensity because increase the chances of collisions between the molecules as well as be Aldaamer resulting from concentration of dye molecules which leads to higher energy absorbed when it was in the polymer and emitted it at less energy as well as occurrence of non-radiations emissions were would reduce radiation emissions.

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