Spectroscopic Study of Absorption and Fluorescence Rhodamine *610* Dye for Solution with Polymer

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Abstract

In this study was chosen Rhodamine 610, It was dissolved in ethanol and prepared in concentrations (10^{-5}) mole/liter, the absorption and emission spectra of different samples dyes as a laser medium effectively has been prepared and studied at room temperature . The achieved Results pointed that the absorption peaks were moving toward short wavelengths (BLUE SHIFT) when increasing the ratio of polymer additives and the fluorescence spectrum peaks were moving in the direction of longer wavelengths (RED SHIFT) when increasing the ratio (%50 and %70) of polymer.
Key word : dyes, laser dyes

الخلاصة

في هذه الدراسه اختيرت صبغة الردامين 610 واذيبت في محلولالايثانول وحضرت بتركيز 10^{-5} مول لكل لتر, اطياف الانبعاث والامتصاص للصبغات الليزريه اختلفت على نحو فعال كوسط ليزري تم اعداده بدرجة حرارة الغرفه. النتائج التي تحققت تشير ان قمم الامتصاص زحفت باتجاه الاطوال الموجيه القصيره(اللون الازرق) عندم زيدت نسبة البوليمر المضافهوقمم طيف الفلوره زيحت باتجاه الاطوال الموجيه الطويله (اللون الاحمر) عند زيادة نسبة 50% و70% من البوليمر .
الكلمات الدالة : الصبغات , ليزر الصبغات

1-Introduction

laser dyes are complex molecules containing a number of ring structures, which lead to complex absorption and emission spectra. The laser dyes can be categorized into different classes by virtue of their structures that are chemically similar. Common examples are the coumarins, xanthenes and pyrromethenes. The structure and composition of the molecule has an important influence on spectral emission. [Shankarling, 2010]. Moreover, polymers have become profitable for sensor technologies, because of their low cost materials and their fabrication techniques being quite simple. In the past few decades significant interest has been shown in polymer-based sensing materials, which exhibit a change of their absorption and/or fluorescence characteristics in response to an external stimulus. Some examples of these stimuli include heat, deformation, chemicals, light, and others, which make the sensors useful for a wide range of technologies [Crenshaw, 2007]. An important member in the family of poly (acrylic esters) is poly (methyl methacrylate) (PMMA). Although PMMA has a poor heat resistance [Sadek, 2011], it has been widely used in many fields, because of its outstanding chemical stability, transparent optical property, and excellent biocompatibility. It can incorporate dye molecules to become colorful and functional. Indeed, incorporating dyes into polymer supported matrices, such as PMMA, could keep them far away from the disturbance of external environments, which remarkably influences the spectral properties of dyes, [Wang, 2011].

2-Rhodamine 610

C28H31N2O3Cl · MW: 479.02

Table(1) The characteristics of dye Rhodamine *610*

Characteristics	
Lambdachrome number:	6100
CAS registry number :	81-88-9
Appearance :	green, crystalline solid
Absorption maximum(in ethanol);	552 nm
Molar absorptivity ;	10.7×10^{-4} Lmol^{-1} cm^{-1}
Fluoresearch and development purposes only.	

Lasing Performance Very efficient and frequently used laser dye for pulsed and CW operation; tunable around 610 nm.

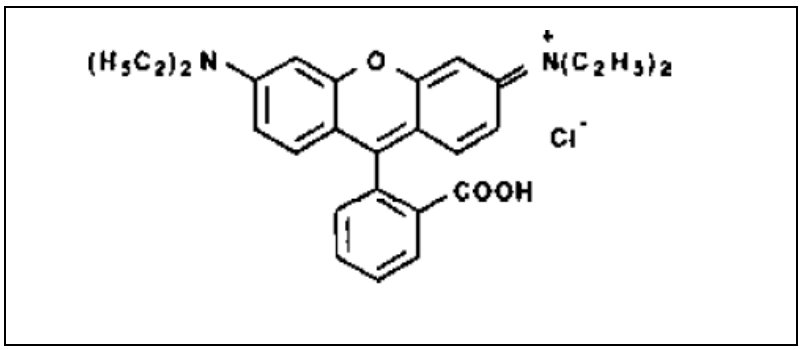

Figure (1) The chemical bonds of Rhodamine *610*

Table 2 The characteristics of dye Rhodamine *610*

Dye Laser Characteristics						
pump		Peak [nm]	Range [nm]	Effic. [%]	Conc. [g/l]	Solvent
Source	Wavelength [nm]					
XeCl-Excimer	308	600	588-644	12	0.91	Methanol
Nitrogen	337	622	599-650	Rel.	2.13	Methanol
Nd:YAG, 2nd	532	594	584-619	29	0.22	Methanol
Cu-vapo	510	591	5820618	21	0.62	Ethanol
Flashlamp	-	618	590-640	-	0.05	Ethanol
CW, Ar+	all	640	605-675	-	3.53	MeOH/Et

[Lambda Physik,1996; Bos, 1979; Dienes,1975; Stenhaouse,1979; Vrehen,1971; Masarnovskii *et al.*1979; Hargrove,1977; Drake *et al.*1975; Hammond,,1977].

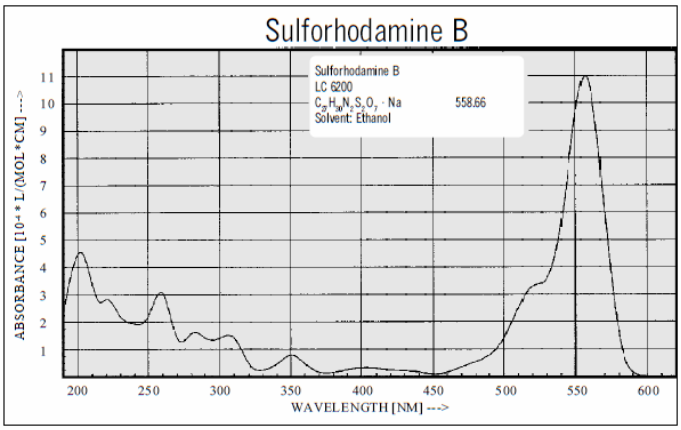

Figure (1) The absorption spectra of the dye solution Rhodamine *610*

3-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 .[Forster *et al*, 1975]

$W=M_w\ V\ C/1000$ …… (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 (50% and 70%) of this solution and mixed with the dye solution composition solution (dye + polymer) and mixing this solution until become homogeneous solution

4-Results and Discussion

Absorption Spectra of Rhodamine *610* Dye Solution

1-The absorption spectrum was measured of the dye solution Rhodamine *610* dissolved in ethanol with concentration 10^{-5} , as shown in figure (2)

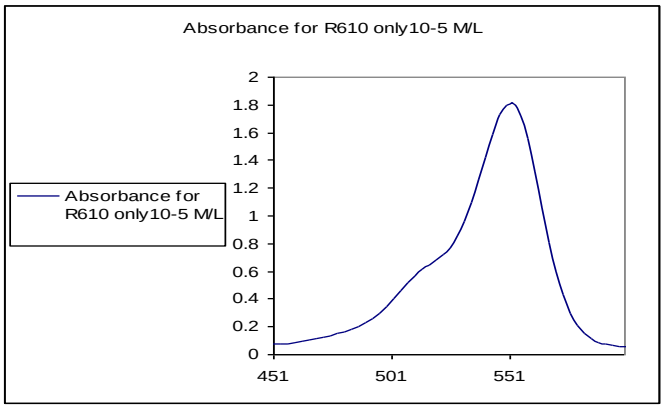

Figure (2) The absorption spectra of the dye solution Rhodamine *610* before adding PMMA polymer

Figure(2) illustrated , that the greatest value for the absorption 1.803 was reached when the wavelength of 551.495 nm.

2-The absorption spectrum was measured of the polymer sample with ratio 50% polymer is added to the solution with a concentration of 10^{-5} with liquid state as shown in Figure (3).

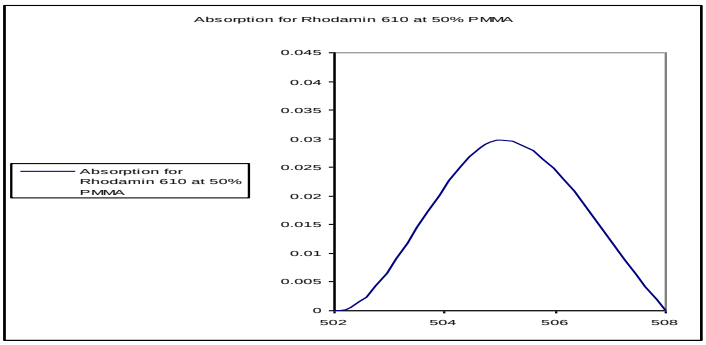

Figure (3) The absorption spectra of the dye solution Rhodamin610 prepared in concentration (10^{-5}) mole/liter with(PMMA) in%50 percentage

Figure (3) illustrated , that the greatest value of absorbance reached 0.029697 at the top of the greatest wavelength 505 nm.

3- The absorption spectrum was measured of the polymer sample with ratio 70% polymer is added to the solution with a concentration of 10^{-5} mole/Lin liquid state as shown in Figure (4)

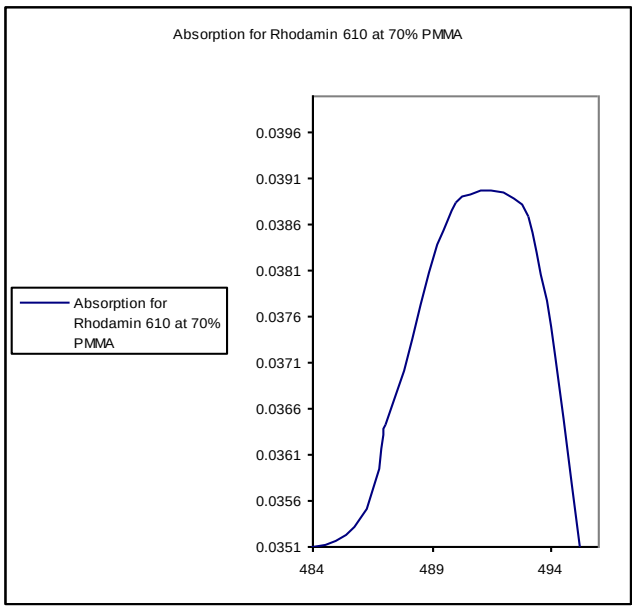

Figure (4) The absorption spectra of the dye solution Rhodamine*610* prepared in concentration 10^{-5} mole/liter with(PMMA) in (% 70) percentage.

Figure(4) illustrated , that the greatest value of absorbance reached 0.0389 at the top of the greatest wavelength 491,223 nm ,this results are illustrated in table (3).

Table (3) The laboratory results that have been obtained for the dye Rhodamin610 in absorbance case

Concentration (M) Liquid medium	Absorption beak location (nm) befor added PMMA		Absorption beak location (nm) after added PMMA		Ratio of polymer additives
	λ	absorbance	λ	absorbance	
$1x10^{-5}$	551.495	1.803	505	0.029697	50%
			491,223	0.0389	70%

Fluorescence Spectra of Rhodamine *610* Dye Solution

1-The fluorescence spectrum was measured of the dye solution Rhodamine *610* with concentration10^{-5} mole/L , as shown in figure (5) .

Figure (5) The fluorescence spectra of the dye solution Rhodamine *610* before adding PMMA polymer

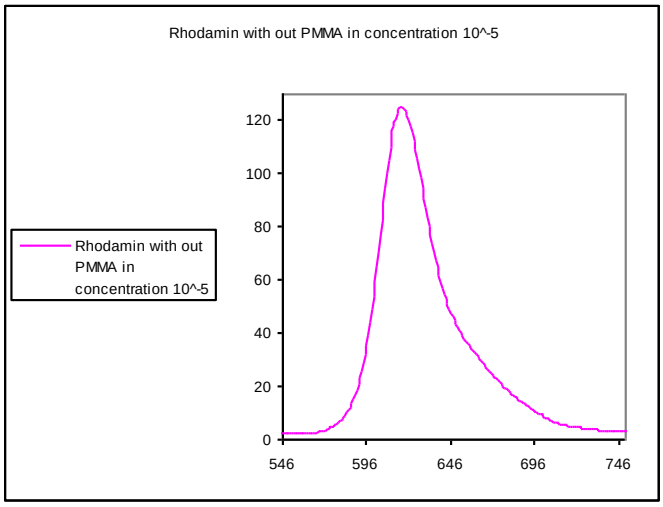

Figure (5) The fluorescence spectra of the dye solution Rhodamine *610* before adding PMMA polymer

Figure(5) illustrated , that the greatest value of fluorescence intensity 123,81was reached when the wavelength 619 nm.

2-The fluorescence spectrum was measured of the dye solution Rhodamine *610* with concentration10^{-5} mole/Lin the liquid stat after the addition of the polymer by 50%, as shown in Figure(6).

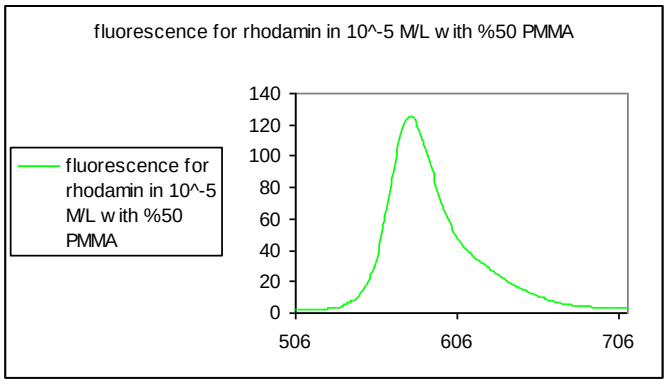

Figure (6) The fluorescence spectra of the dye solution Rhodamine*610* prepared in concentration 10^{-5} mole/L with(PMMA) in%50 percentage

Figure(6) illustrated , that the greatest value of fluorescence intensity (123.81) was reached when the wavelength (579) nm

3-The fluorescence spectrum was measured of the dye solution Rhodamine *610* with concentration10^{-5} mole/Lin the liquid state after the addition of the polymer by 70% , as shown in figure (7).

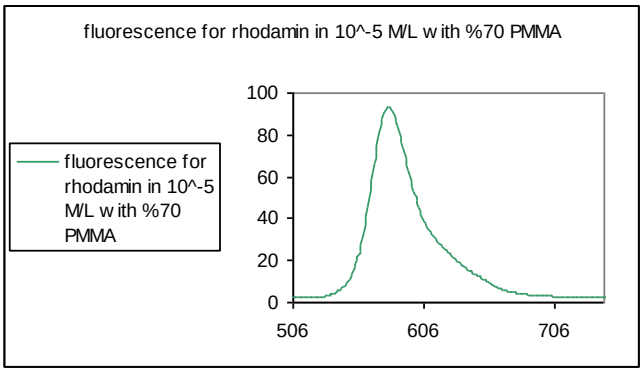

Figure (7) The fluorescence spectra of the dye solution Rhodamine *610* prepared in concentration 10^{-5}mole/liter with(PMMA) in%70 percentage.

Figure(7) illustrated , that the greatest value of fluorescence intensity(90.869) was reached when the wavelength (578.946) nm, this results are illustrated in table (4).

Table (4) The laboratory results that have been obtained for the dye Rhodamin 610 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	
$1x10^{-5}$	574.713	44.067	579	123.81	50%
			578.946	90.869	70%

The Polymers reveal is important in improving the optical properties of the laser dyes and reduceing dangerous toxin to it , and also polymers that were transparent optical excellent and were carried it high energies through the process of pumping the results that have been listed above illustrated in Table (3)and (4).

The absorption peaks moved toward shorter wavelength (blue shift) by (46.495) nm at the ratio 50%.

But when increasing ratio of the polymer additives to70% the amount of shift increased toward shorter wave length by (60.272)nm .

The fluorescence peaks moved toward longer wavelength (red shift) by (4.287) nm at the ratio 50%.

But when increasing ratio of the polymer additives to70% the amount of shift was decrease toward longer wave length by (4.233)nm

The use of polymer material with laser dyes is important 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 Al daamrat . The polymer molecules working to determine field disturbance and reduce the absorbability of the dyes .

The Either spectrum forms and results we see when increasing ratio of polymer cause to increase the 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 absorption when it is in the polymer and emittes it at less energy as well as occurrence of non radiations emissions will reduce radiation emissions.

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