Effect of Some Solvents on Spectroscopic Properties of Rhodamine 3GO Dye.

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الخلاصة

تم في هذا البحث دراسه تأثير بعض المذيبات (الإيثانول والميثانول، -2بروبانول، الأسيتون، وخلات الإيثيل) على طيفي الامتصاص والفلورة لصبغة الرودامين (3GO). أظهرت النتائج أن هناك زيادة في الكفاءة الكمية للإمتصاص مع زيادة الاستقطاب النسبي من المذيب وتناقصها مع زيادة لزوجة المذيب. يتم إزاحة طيف الفلورة نحو الطول الموجي الطويل (الأحمر). وتبين أن قيم ذروة الامتصاص لصبغة الرودامين في المذيبات اعلاه تقع بين الاطوال الموجيه(530-525) نانومتر، في حين أن قيم ذروة الفلوره بين(551.5-558.5) نانومتر وان العمر الزمني لطيف الفلورة يزداد بزيادة الكفاءة الكمية.

الكلمات المفتاحية

صبغة الرودامين (3OG)، الكفاءة الكمية للإمتصاص، العمر الزمني لطيف الفلورة.

Abstract

In this paper the effects of some solvent (Ethanol, Methanol, 2-Propanol, Acetone, and Ethyl acetate) on the spectrum of absorption and fluorescence of Rhodamine 3GO dye with constant concentration (3*10-5 Mol/l) at room temperature were studied. The results have shown that there is increasing in quantum efficiency with increasing of relative polarity of the solvent and decreasing with increasing in viscosity of the solvent. Fluorescence spectrum is shifted toward the long wavelength (red shift). It is found that the peak value of absorption wavelength for Rhodamine 3GO in these solvent ranging between (525nm-530nm) ,while there is a slightly changing between (551.5nm-558.5 nm) in the peak of fluorescence wavelength. Also non-radiative life time and fluorescent life time increases with the increasing the quantum efficiency.

Keywords

Rhodamine 3GO, quantum efficiency (qfm) fluorescent life time.

1. Introduction

The xanthene's dyes are the terribly studied class of luminescent dyes. One of these dyes is Rhodamine 3GO which contain Xanthylium as chromophore with amino groups as the usual auxochromes [1]. The effect of different solvents on the absorption and the fluorescence spectrum of the laser dye has been studied by many researchers ,such as , Al- Hamdani et.al [2] study the effect of solvent on the optical properties performance of active polymeric laser media , Al-Tememee N.A.A.et.al [3] study the effect of solvents on the dipole moments and fluorescence quantum yield of Rhodamine dyes, Nag A. et.al [4] discuss solvent effect on two-photon absorption and fluorescence of Rhodamine dyes, Vijila C. et.al [5] studied the photophysical characteristics of coumarin (485) dye doped poly(methyl methacrylate) modified with various additives, Zehentbauer FM. and his colleagues studied the fluorescence spectroscopy of Rhodamine 6G concentration and solvent effects [6]. Al-Hamdani. and his colleagues studied **:** the spectral properties for mixed liquid of Rhodamine (6G & 3GO)dyes dissolved in chloroform [7], the effects of luminous solar concentrator parameters (dyes mixture, host type and LSC thickness) on the Si solar cell performance efficiency [8] , the Z-Scan measurements of optical nonlinearities for (3GO) [9], and the spectral properties of Rhodamine (B&3GO)dyes mixture dissolved in chloroform [10].

In this work the effect of solvents type on the spectral properties of Rhodamine 3GO dye is examined in details.

2. Experimental work

Materials used in this research were: Rhodamine 3GO ($C_{26}H_{27}N_2O_3Cl$) from HIMEDIA company, India. Methanol from (BDH) Limited Poole company ,England . Ethanol Absolute from (GCC) Gainland Chemical Company ,UK. 2-Propanol (VWR International Prolabo) CE company. Some physical properties of used solvents is shown in table (1).

The absorption spectrum of samples were measured by using UV-Visible Spectrophotometer (T60) PG Instruments Limited. Fluorescence spectrum of samples are taken by using Spectrofluorometer-model SL174, Elico. Refractive index is taken by using Refractometer (Bellingham and Stanley Ltd, Tunbridgewells, ABBE60, England). Samples weight was measured by using electronic balance type (Denver Instrument, TP-214, Germany). Fixed concentration ($3*10^{-5}$ mol/l) of Rhodamine 3GO were prepared with different solvents.

The spectrum of the molecular fluorescence F(ύ) gives the relative fluorescence intensity at wave-number (ύ), this is related to the quantum efficiency by the following equation [11,12].

$$q_{fm} = \int_0^\infty F(\upsilon')d\upsilon' \qquad \ldots(1)$$

In order to evaluate absolute quantum efficiency, we have to consider both the radiative and non-radiative processes taking place in the medium, therefore

$$q_{fm} = \frac{K_{fm}}{K_{fm} + \Sigma K_d} = \frac{K_{fm}}{K_{fm} + K_{IC} + K_{ISC}} \qquad \ldots.(2)$$

Since $K_{fm} = \frac{1}{\tau_{fm}}$ ….(3) a

and $\tau f = \frac{1}{k_{fm} + \sum K}$ ….(3)b

Therefore :

$$q_{fm} = \frac{\tau_f}{\tau_{fm}} = \int_0^\infty F(\upsilon')d\upsilon' \quad \ldots(4)$$

Where, τ_f is the radiation life time can be calculated using relation as follow:

$$K_{fm} = \frac{1}{\tau fm} = 2.88\times10^{-9}\times n^2\times(\bar{\upsilon}^2)\int\varepsilon(\bar{\upsilon})d\bar{\upsilon} \quad \ldots(5)$$

Where, n is refractive index of a medium, , ύ is wave number at the maximum absorption, and $\int\varepsilon(\bar{\upsilon})d\bar{\upsilon}$ is the area under the absorption spectrum curve as a function of the wave number.

Quantum efficiency (q_{fm}) was calculated by using equation(1). Where MATLAB 6.5 program was used to calculate the area under curve for absorption and fluorescence spectrum.

3. Results and Discussion:

The transmittance of 3Go dye in different solvents is shown in figure 1 the absorbance , Absorbance = 2 - Log10 (T) is shown in figure,2. Figure (3,4) indicate fluorescence and fluorescence life time of Rhodamine 3GO in different solvent are depicted. It is showed that the absorption peak appeared at wavelength (525nm-530nm), and there is a slightly changing in fluorescence wavelength (551.5nm-558.5nm), red shift about (22nm-28.5nm) for R3GO in the study solvent. Transmittance was shown at wavelength (520nm-580nm). We can divide the solvent in two group first alcoholic groups, and the second groups content less polar and viscosity solvent acetone and ethyl acetate.

From the results obtained (Table 2,3) we can observed that in the first group quantum efficiency increased with increasing in relative polarity, and decreasing with increasing in viscosity because hydrogen bonding which cause an interaction with the dye molecule due to orientation of polarization, also viscosity have an important role in this case.

Fluorescence life time of R3GO decreased in alcohol solvent from methanol to 2-propanol and this behavior is similar to R6G because of the presence of the substituted ester group in the position of 9-phenyl [13].

The second solvent group quantum efficiency increased with increasing in relative polarity, and decreasing with increasing in viscosity. This is due to increasing in the viscosity of the solvent which surrounded dye molecule and reduced the area of spreading of dye molecule and causing restriction internal conversion. And according to the increasing in the quantum efficiency each of non-radiative life time, fluorescence life time increased while radiative emission probability decreased.

4. Conclusions

The results indicate that the solvent properties is a major parameter influence the spectral properties of Xanthine dyes. One conclude that quantum efficiency increase with increasing in relative polarity while quantum efficiency decreased with increasing in viscosity. Fluorescence life time decreased in alcohol solvent from methanol to 2-propanol.

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Table (1): Some physical properties of used solvents.

	Solvent	Relative Polarity	Boiling point(C°)	Density(g/ml)	Viscosity(CP)
Group (1)	Methanol	0.762	64.6	0.791	0.59(20C°)
	Ethanol	0.654	78.5	0.789	1.1(25C°)
	2-Propanol	0.546	82.4	0.785	2.4(20C°)
Group (2)	Acetone	0.355	56.2	0.786	0.36(20C°)
	Ethyl Acetate	0.228	77	0.894	0.45(20C°)

Table (2): The wavelength at relative maximum intensity for absorption and Fluorescence of R3GO dye at different solvents.

	Solvent	Absorption Wavelength (ABS_{max}.) (nm)	Absorbance (a.u.)	Fluorescence Wavelength (F_{max}.) (nm)	Fluorescence Intensity
Group (1)	Methanol	530	1.522	557	2378
	Ethanol	530	1.64	558.5	2319
	2-Propanol	530	0.995	556	2491
Group (2)	Acetone	525	0.972	551.5	2714
	Ethyl Acetate	530	0.252	552	3814

Table (3): Stock shift, quantum efficiency yield, radiative emission probability, radiative life time, and fluorescence life time of R3GO dye at different solvent.

	Solvent	Stokes shift (nm)	Quantum efficiency %	K_{fm}	t_{fm} (nsec)	t_f(nsec)
Group (1)	Methanol	27	85.3204	5.2706	0.1897	0.1618
	Ethanol	28.5	82.6811	6.4672	0.1546	0.1278
	2-Propanol	26	78.9445	6.5431	0.1528	0.1206
Group (2)	Acetone	26.5	66.6797	4.863	0.2056	0.1371
	Ethyl Acetate	22	52.4847	6.7228	0.1487	0.078

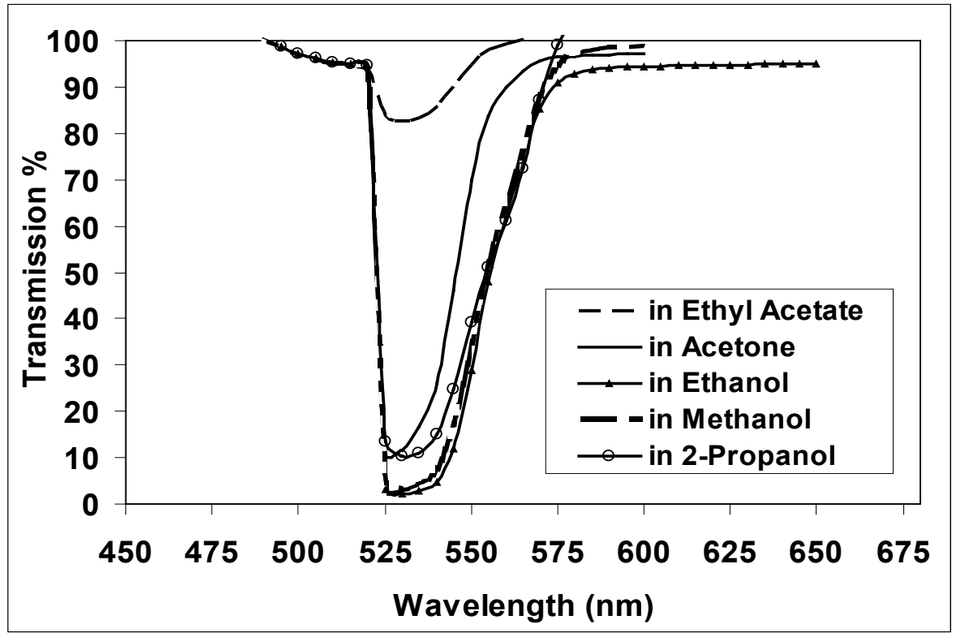

Fig. (1) : Transmittance of R3GO in different solvents.

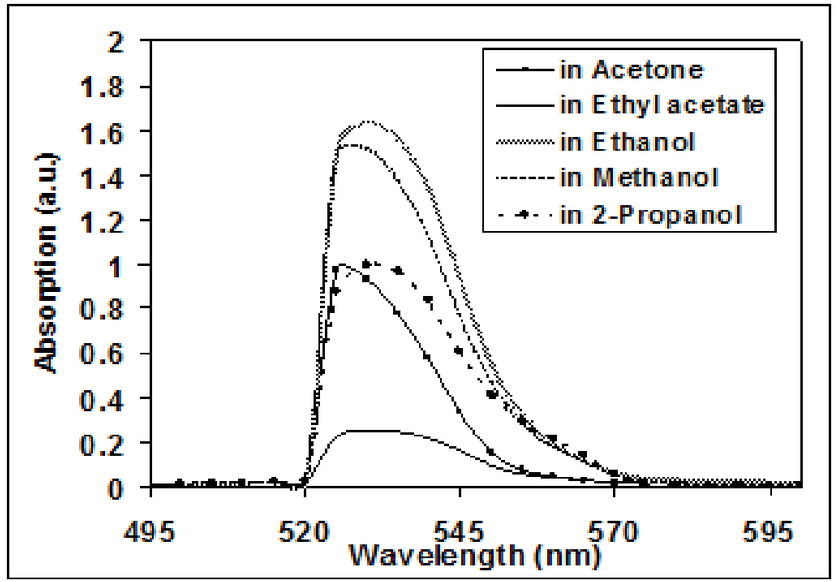

Fig. (2): Absorbance spectrum of R3GO in different solvents.

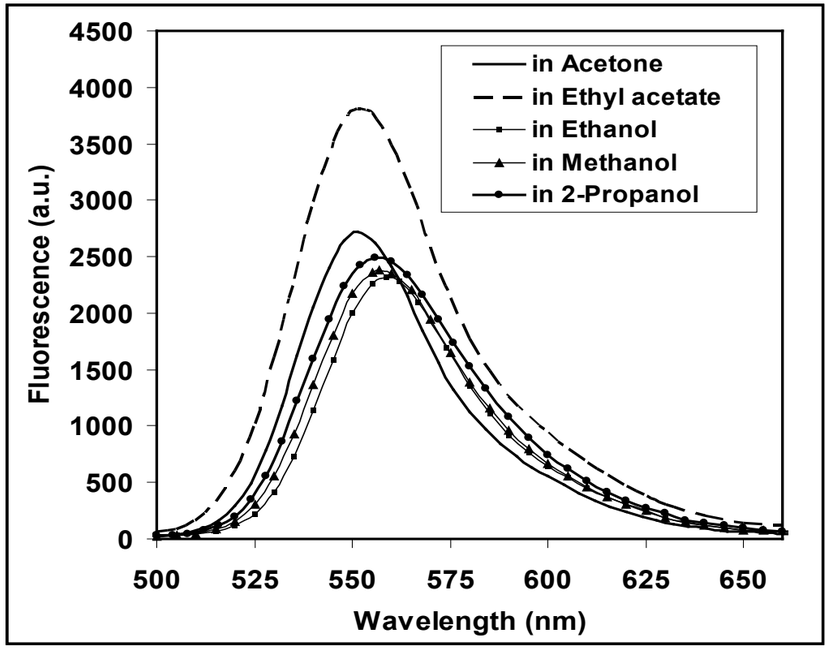

Fig. (3): Fluorescence spectrum of R3GO in different solvents.

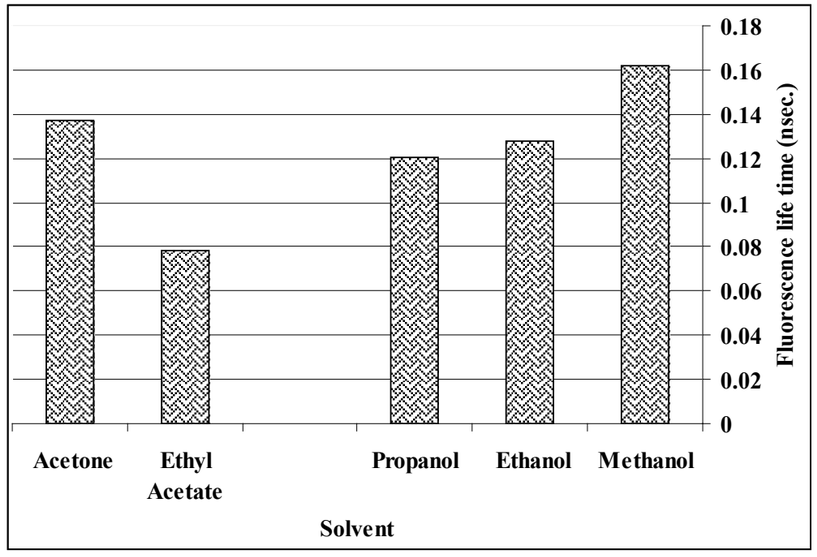

Fig. (4):Variation of fluorescence life time of R3GO with different solvents.