S. I. Ibrahim
Energy and Renewable Energies Technology Center, University of Technology/Baghdad, Iraq
chemistsulafa_59@yahoo.com

J. A. Kathum
Energy and Renewable Energies Technology Center, University of Technology/Baghdad, Iraq

K. S. Rida
Energy and Renewable Energies Technology Center, University of Technology/Baghdad, Iraq

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Spectroscopic Characteristics For Rhodamine C Tincture in Diverse Solvents

Abstract- *The article included calculating the quantum aptitude and Radiative emission probability, Radiative life time, and fluorescence life time of Rhodamine C with fixed concentration ($5*10^{-5}$ mol/l) in some solvent (Distilled water, Methanol, Ethanol, 2-Propanol, Dichloromethane, Ethyl acetate, Dimethyl formamide) which differ in their polarity.*
There is a slight change in the crest of the absorption which showed up at wavelength (555-560 nm), the red shift was about (16-23 nm) of RC dye in different solvent.

Keywords*: Xanthenes dye, Rhodamine C (RC), Radiative emission probability (K_{fm}), Radiative life time (τ_{fm}),*

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1. Introduction

The broad wavelength, tunability and the fluorescence yield noteworthiness of organic dyes contribute in their expansive utilize. Fluorescent dyes that have high transformation efficiency and wide range spectrum can be utilized as an active laser media, for example, Xanthene's dye. Optical properties of Xanthene's dye rely upon many factors, such as, concentration and solvent [1-4.[
Solvents have an important role to play in measuring the spectroscopic properties of dyes. To understand their effect we need to explain experiments or enhancing the performance of dyes, many researchers have explained different topics about this subject which includes the study of extent of subjects, for example "spectral properties ", "nonradiative process"," dipole moment", "polarity", quantum yield", etc… [3-9].
This research is complementary to a range of researches done by researchers at the Energy and Renewable Energies Technology Center, University of Technology, Iraq [10-16].
There is no exist research's on the influence of different solvents on Rhodamine C, so that the aim of this article is to study the influence of variation solvents on their optical properties.

2. Experimental part

I. Materials

Methanol (CH_3OH) analytical grade 99.9% from (Scharlau, Spain), Ethanol (C_2H_5OH) from (GCC, UK), 2-Propanol (C_3H_8O) from (VWR International Prolabo ,UK) . Dichloromethane (CH_2Cl_2) from (GCC, UK), Ethyl acetate ($C_4H_8O_2$) from (GCC, UK) , Dimethyl formamide (C_3H_7NO) from (Sinopharm chemical reagent Co.Ltd, China), and distilled water have been used to study their effect on spectral properties of Rhodamine C ($C_{28}H_{31}N_2O_3Cl$), figure (1) , from (HIMEDIA company, India) .

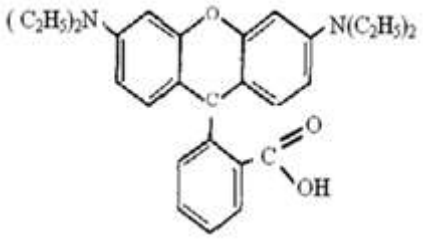

Figure (1): Scheme of Rhodamine C

II. Spectrophotometer Measurements

1.UV-Visible Spectrophotometer (T60) (PG Instruments Limited) , has been used to record the absorption spectrum of samples.
2.Shimadzu spectrofluorophotometer-RF-1501 has been used to record the fluorescence spectrum of samples.

III. Refractive index

Refractometer (Bellingham and Stanley Ltd, Tunbridgewells, ABBE60, England), has been used to measure the refractive index of samples.

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The measured refractive index for used diverse solvents is shown in table (1).

Table (1): Measured refractive index for used diverse solvents at 20 c^0.

Solvent	n^{20}
Water (H_2O)	1.33297
Methanol (CH_3OH)	1.32969
Ethanol(C_2H_5OH)	1.362055
2-Propanol (C_3H_8O)	1.377875
Ethylene glycol($C_2H_4(OH)_2$)	1.43084
Dichloromethane (CH_2Cl_2)	1.42503

IV. Calculating the value of (K_{fm}), (τ_{fm}), (τ_f), and (q_{fm}) mathematically:

From Bowen-wokes equation, Radiative emission probability (K_{fm}) can be calculated as [17]:

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

(n) represents refractive index, (ύ) wave number at max. absorption wavelength, ($\int\varepsilon(\bar{v})d\bar{v}$) the value of area under curve was obtained by using " MATLAB" program .

Also we can calculate radiative and fluorescence life time (τ_{fm}), (τ_f) depending on the equation below respectively :-

$$K_{fm} = \frac{1}{\tau_{fm}} \quad ---(2)$$

$$q_{fm} = \frac{t_f}{t_{fm}} \quad ---(3)$$

Where:

(q_{fm}) represents quantum efficiency

by depending to the equation which mentioned below:

$$q_{fm} = \frac{No.ofQuantaEmitted}{No.ofQuantaAbsorbed} \quad ---(4)$$

3. Results and Discussion

Tables (2),(3) illustrate the experimental results of ($5*10^{-5}$mol/l RC) in six different solvents obtained from the (absorption, and , fluorescence) spectrum , which shows that there is a change in the peak of maximum absorption from (555 nm) to (560nm) , and from (572nm) to (583 nm) in the peak of maximum fluorescence , stock shift was about (16-23nm). Figures (2), (3) illustrate the total absorption and transmittance spectrum respectively of (RC) in selective solvent. Figure (4) illustrates the spectrum of (absorption, and, fluorescence) for (RC) dye with each solvent separately.

while both of ethyl acetate and dimethyl formamide decolor the dye ,figure (5) illustrates the absorption spectrum of (RC) in DMF solvent for the original prepared concentration ($3.54*10^{-4}$ mol/l)and diluted solution($5*10^{-5}$mol/l) this is due to the hydrogen bonding between solvent molecules and dye molecules (carboxylic groups, which presents as lactone form) , the decolor forms of (RC) dye in ethyl acetate showed absorption peak at (580nm) with very low intensity (0.065), and not exhibit fluorescence spectrum , and this applies on DMF.

From table (3) it is clear that the quantum efficiency and Radiative emission probability(K_{fm}),of the dye increases with the decreasing of dielectric constant and solvents polarity, which can be arranged as follows:

Distilled water > Methanol> Ethanol > 2-Propanol> Dichloromethane.

This behavior of the Rhodamine C dye in the solvents mentioned above is due to the formation of hydrogen bonds between them.

4. Conclusion

From the above we can conclude the following:

1- The quantum efficiency increases with the decreasing of relative polarity and dielectric constant of the solvent.
2- Radiative emission probability increases with the decreasing of relative polarity and dielectric constant of the solvent.
3- Radiative life time decreases with decreasing of the relative polarity and dielectric constant of the solvent.
4- Both of (ethyl acetate), and,(dimethyl formamide) bleaching dye color .

Table (2): The absorption and fluorescence wavelength of RC dye at relative maximum intensity in different medium.

Solvent	Wavelength ($ABS_{max.}$)(nm)	Absorbance Intensity	Wavelength (F_{max})(nm)	Fluorescence Intensity
Water	560	1.806	583	159.03362
Methanol	560	1.741	576	438.0906
Ethanol	555	1.704	572	792.51363
2-Propanol	560	1.728	581	411.257284
Dichloromethane	560	1.681	580	506.1984

Table (3): Quantum efficiency, radiative and fluorescence life time of RC dye in different medium.

Solvent	Stock shift (nm)	Quantum efficiency %	K_{fm}	τ_{fm} (nsec)	τ_f (nsec)
Water	23	43.70946	1.8367	0.5444	0.2379
Methanol	16	44.26578	3.2474	0.3079	0.1363
Ethanol	17	49.41787	3.4691	0.2882	0.1424
2-Propanol	21	54.81283	3.4871	0.2867	0.1571
Dichloromethane	20	61.49479	3.7298	0.2681	0.1648

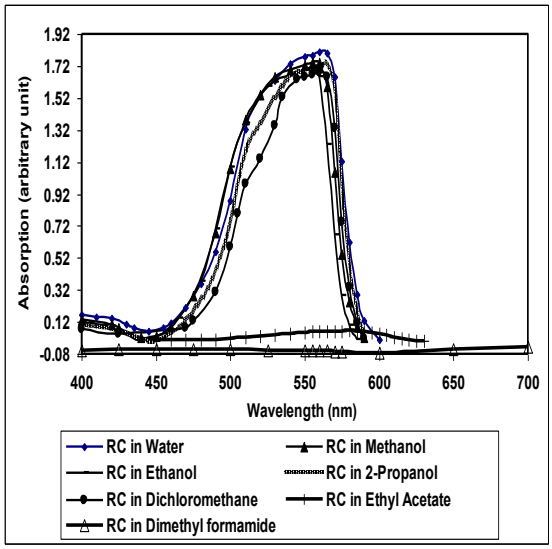

Figure (2): Absorption spectrum of Rhodamine C in studied solvent.

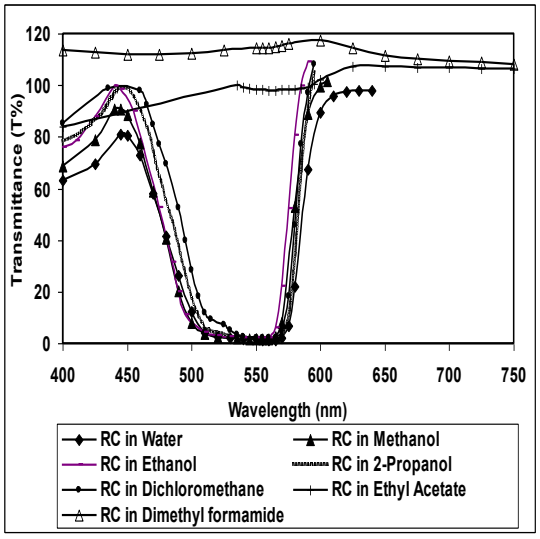

Figure (3): Transmittance spectrum of Rhodamine C in studied solvent.

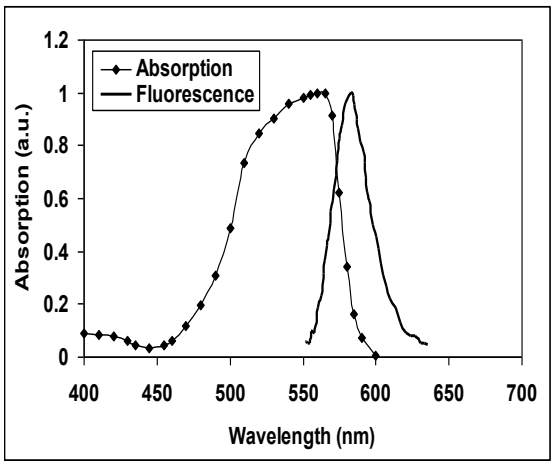

Figure (4a): in Water

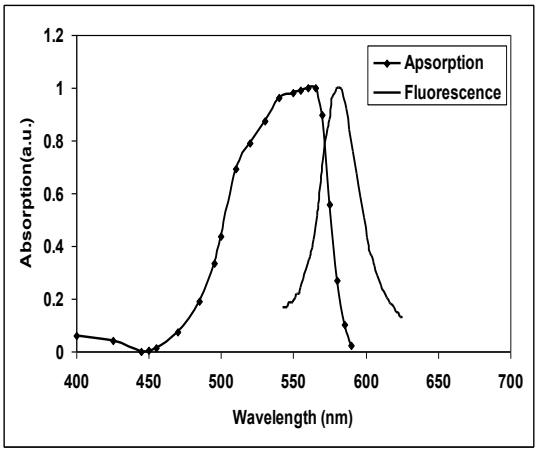

Figure (4d): in 2-Propanol

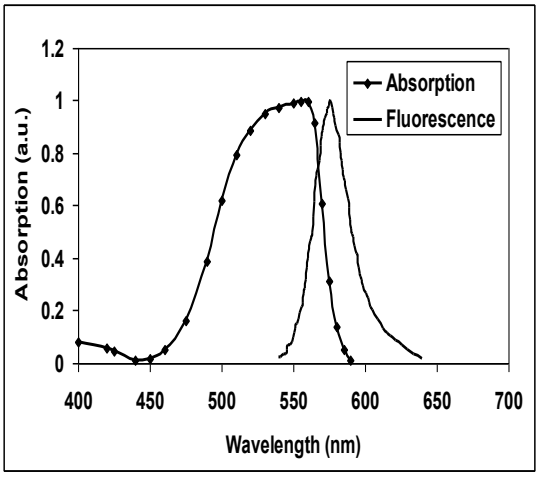

Figure (4b): in Methanol

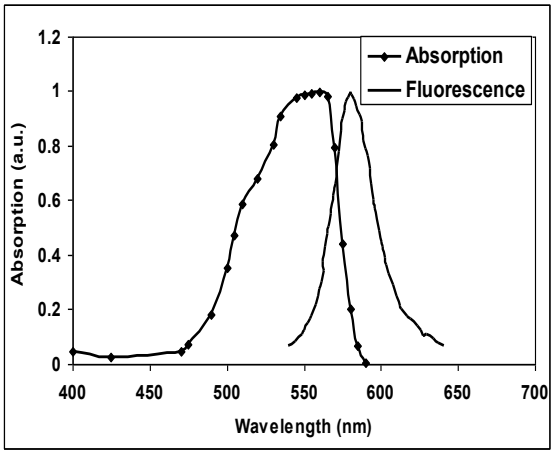

Figure (4e): in dichloromethane

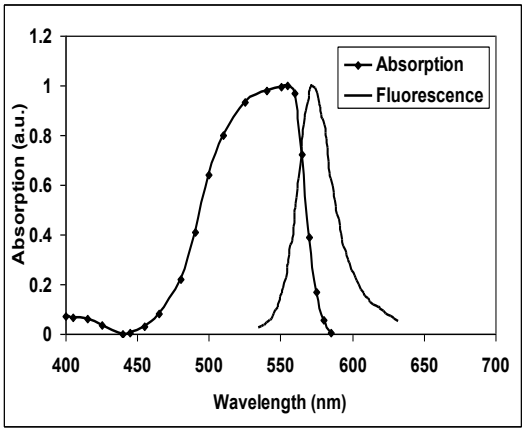

Figure (4c): in Ethanol

Figure (4) (a, b, c, d, and e): Absorption and Fluorescence spectrum of Rhodamine C in studied solvent.

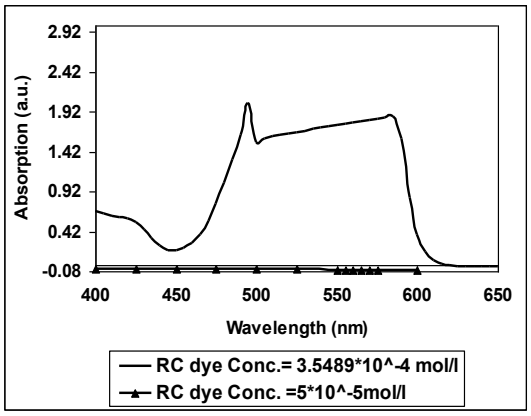

Figure (5): Absorption spectrum of Rhodamine C in Dimethyl formamide solvent .

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