STUDY EFFECT OF DIFFERENT SOLVENT POLARITY ON THE ABSORPTION AND THE FLUORESCENCE SPECTRUM OF PHENOLPHTHALEIN LASER DYE

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ABSTRACT

In this research study the effect of different polarity solvent strength (Ethanol, DMSO, DMF, CCL4) and different concentrations (1×10^{-3} ,1×10^{-4},1×10^{-5}, 1×10^{-6},1×10^{-7}) Ml to dye phenolphthalein solution to (the absorption and the fluorescence spectrum ,linear optical properties (refraction and absorption coefficients), fluorescence life time and Quantum Yield. Where we noticed the removal of absorption and fluorescence spectrum peak towards shorter wavelengths (blue shift) to increase the strength and polarity of the solvent concentration of the solution. And increase the intensity of absorption spectrum and linear optical properties (absorption coefficients and refraction), an increase of concentration of the solution. The fluorescence spectrum emissivity decreases by increasing the concentration of the solution. The effect of different type and strength of the solvent polarity on the intensity of the absorption spectrum and the fluorescence emissivity effect was irregular.

Keywords: phenolphthalein; polarity effect; absorption; Fluorescence; fluorescence lifetime; Quantum Yield

INTRODUCTION

Dye lasers active medium consists Of organic dye Dissolve in a liquid such as ethyl alcohol or methanol or water [1].Organic dyes that have the ability to absorb the spectrum of electromagnetic radiation and thus sent a wide range of wavelengths and wavelengths greater than those that have been absorbed, as the radiation emitted from most organic dyes helped to use as active medium in dye lasers. It produces lasers dye a radiation , capable of tunable over the wavelengths of incident (340 nm- 1.2μm), and depending on the dye type used, the dyes laser organic is a systems of large and complex molecules that is ,they Hydrocarbon unsaturated, contain bonds duplication associated (Conjugated double bonds) of carbon atoms, as well as from the bonds of a single and double alternating, and is one of Al Chromosphere Systems where the advantage of these systems high absorbency capacity in the visible region and the region ultraviolet [2-3] . Because of the wide spectrum covered by the lasers, dye has become an important and growing role in various applications include (the study of a broad spectrum of physical chemistry) [4] .

In 2005,G.S.S. Saini et al. studied the absorption and fluorescence spectra of Rhoda mine 6G laser dye [5] .

In 2013, Qusay Ragheb Ali studied the spectra of absorption and fluorescence and the calculation of the, fluorescence lifetime to (Coumarin 307, Acriflavine, and RhodamineB) after dissolved in a suitable solvent (ethanol, chloroform, DimethylSulfoxideDMSO, propanol) and a wide range of concentrations (10^{-3} - 10^{-6}) Ml[6] .

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In 2015 ,The rod Jaber Abdul-Zahra studied linear spectral characteristics (absorption and permeability and Flora and the refractive index and absorption coefficient) of the Acridine dye to different concentrations (1×10^{-3}, 5×10^{-5}, 1×10^{-4}, 5×10^{-4}, 1×10^{-5}) Ml [7].

MATERIALS

Dye phenolphthalein an organic compound is a white crystalline powder, which is used phenolphthalein on a large scale in the calibrations acid the base is used as evidence in calibrations acids and bases because the color of the dye varies depending on the change middle, and be colorless in the acid middle and Pink in the neutral middle acidic pink in the middle, neutral and red color in the Basilar middle that the molecular formula of the dye phenolphthalein C_{20} H_{14} O_4 and Molecular Weight (318.32 gm / Mol) and be a density (1.28 gm / cm3).

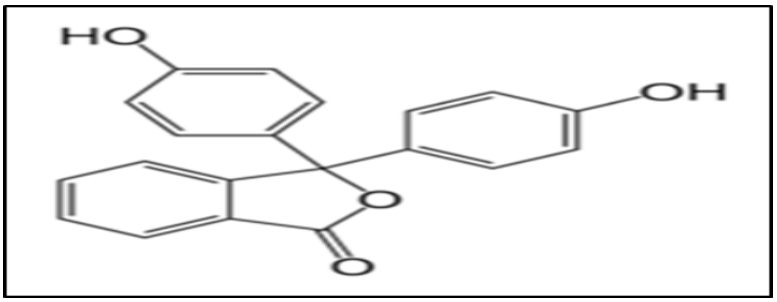

Figure (1) Composite phenolphthalein preparation [8].

As well as the use of different solvents and as described in the table (1).

Table 1. Recipes solvents used [8-9-10]

Solvents	*Chemical formula*	*Polarity*	*melting point C°*	*Density gm / cm³*	*Refractive index N*	*molar mass gm/mol*
Ethanol	C_2H_5OH	1.69	78.4°	0.789	1.3614	46.07
DMF	C_3H_7NO	3.82	153°	0.94	1.4305	73.09
DMSO	C_2H_6OS	3.96	189°	1.1004	1.479	78.13
CCL_4	CCL_4	0	76.72°	1.59	1.4601	153.82

Prepare various concentrations of solvents dyes

To prepare the dye phenolphthalein solution concentration (1×10^{-3} Ml), it has been thawed (0.001gm) of powder dye in volume(10 cm^3) of differentsolvents that were used in the searcha (DMF, DMSO, ethanol , CCL_4) according to thedilution relationship :

$$w_m = \frac{C \times V \times M_w}{1000} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

w_m: necessary dye weight to get the desired concentrations (gm), C: concentrations to be prepared(Ml), V: volume of solvent (cm^3) necessary to add to the powder dye, M_w : molecular weight of the dye used (gm / mol).

Prepare solutions of lower concentration (1×10^{-4}, 1×10^{-5}, 1×10^{-6} ,1×10^{-7} Ml) of the concentration that has been prepared added volume (9 cm^3) of the same solvent to volume (1Ml) of high concentration (1×10^{-3}) according to the relationship :

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$C_1V_1 = C_2V_2$…….. (2)

where:

C_1: The first concentration (higher), C_2: the concentration second (lighter), V_1: the required volume of the first concentration , V_2: the volume after dilution .

RESULTS AND DISCUSSION

Through the practical results of the Prepared samples show that the effect of the solvent change and Polarity power a big effect on the wavelength (λ_{max}), where it was the removal of wavelengths to the peak of absorption spectrum towards shorter wavelengths (blue shift) when increasing polarity power of the solvent when solvents (CCL_4 ,DMSO and DMF)This is a result of the polarity effect of the solvent on the electronic energy distribution and on the order of the energy levels of molecular electronics, which are of the type ($\pi\ \pi^*$) or of the type ($n\ \sigma^*$).Since the polarity of the solvent effect on the distribution charge density within the Prepared samples. It was the result of solvent ethanol is different from that where the effect was the greatest of (DMF), and can be due to other factors affecting the electronic distribution of levels of energy such as power bondspH and polarization that have Relationship in the dielectric constant of the material. The impact of the increase on the intensity of the absorption spectrum was their regular effect, as shown in Table (2).

Table 2. The effect of the solvent polarity on the wavelength and absorbance

Solvent type	The polarity	λ_{max} (nm)	A
CCL_4	0	292- 277	0.76 -0.24
Ethanol	1.69	235- 205	0.97 – 0.34
DMF	3.82	280- 262	0.89 – 0.23
DMSO	3.96	202-190	0.56 – 0.08

After obtaining the results the absorption spectra can calculation linear optical properties(absorption coefficients (αo) and refraction(no)) enter the following mathematical relationships in the computer program (Excel).

$\alpha_o = 2.303\ A / d$ ……(3)

$$n_0 = \left(\frac{4R}{(1-R)^2} - K^2\right)^{\frac{1}{2}} - \left(\frac{R+1}{R-1}\right) \quad \ldots\ldots\ldots (4)$$

Where:

A: is the absorbance and d : is the optical path length and R: is the reflectivity and K:decay factor.

Table 3 shows the effect of the type and the polarity of the solvent and Concentration of the solution on linear optical properties where we noticed that the impact be related to its effect on the distribution of energy levels as described in the above, the intensity of absorption.

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Table 3. The effect of the solvent polarity on the linear optical properties

Solvent type	*The polarity*	$\alpha_o(cm^{-1})$	n_o
CCL_4	0	1.76 – 0.55	2.15 – 1.44
Ethanol	1.69	2.25 – 0.79	2.15- 2.08
DMF	3.82	2.05 – 0.54	1.29- 0.15
DMSO	3.96	2.13 – 1.99	2.15 – 1.44

Through the results of fluorescence spectra can calculation fluorescence lifetime $\boldsymbol{\tau_f}$ and fluorescence Quantum Yield (Q_f), using the relationships (3) and (4) respectively:

$$\boldsymbol{\tau_f} = \frac{a \times \boldsymbol{\tau}_{fRB}}{\mathbf{a}_{RB}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

$\boldsymbol{\tau}_{fRB}$ that fluorescence lifetime of Standard compound is a Rhoda mine and $\mathbf{a}_{RB}$: represents the area under the curve for Rhoda mine fluorescence either a: represents the area under the curve of the fluorescence Prepared dye .

$$\phi_F = \frac{\int F('\nu)d'\nu}{\int \varepsilon('\nu)d'\nu} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where:

$\int F('V)d'V$: the area under the curve fluorination and $\int \varepsilon('V)d'V$: the area under the curve absorption .

After the calculation of area under the curve (a) of the absorption and fluorescence curves using a computer program (GEUP 6) and The results were as shown in the table (5).

Table 5. The effect of the solvent polarity on fluorescence lifetime and fluorescence Quantum Yield

Solvent type	*The polarity*	$\tau_f(ns)$	Q_f
CCL_4	0	4.22 – 1.57	0.62 - 0.76
Ethanol	1.69	3.85 – 1.22	0.62 – 0.76
DMF	3.82	1.84 – 1.03	0.85 – 0.53
DMSO	3.96	2.52 – 1.02	0.58 – 0.81

It is the table we note that the effect of changing the solvent polarity on fluorescence lifetime and fluorescence Quantum Yield, was the polar effect of Solvents (DMSO, ethanol) The

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highest value high compared with other solvent can be attributed to the polarity as well as the polarization of both solvents .

CONCLUSIONS

1- Through the practical results of the absorption spectra show that the intensity of the absorption wavelength of these spectra increased with increasing concentration of the dye solution phenolphthalein dissolved in various solvents while we noticed decrease emissivity fluorescence intensity with increasing concentration .

2- That the solution to increase the dye concentration leads displaces absorption spectra and fluorescence peak toward high energies (blue shift) in various solvents that were used .

3- To change the focus dye solution has a significant effect on the nonlinear optical properties (linear coefficients of refraction and absorption) for the absorption spectra and permeability with increasing focus increasingly refraction and absorption coefficients as well as the old time where increasingly focus .

4- Through practical results show that the change of solvent type and Polara significant impact on the wavelength of the molecular energy transitions where increasing polarity of the solvent increases crawling towards shorter wavelengths (blue shift).

5- That the type of solvent and the strength of polarity significant impact on the fluorescence lifetime as the lifetime increases with the polarity of the solvent .

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