Exp. Theo. NANOTECHNOLOGY **2** (**2018)** 21 – 31

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Comparison of spectral properties of Rohdamin 6G dye.

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The spectral properties of liquid and matrix sample of Rhodamine 6G (R6G) were evaluated. The acetone an used as a solvent and epoxy as host. The study for different concentration ($5*10^{-6}$, $1*10^{-5}$, $5*10^{-5}$, $1*10^{-4}$ and $5*10^{-4}$ M/L) show that the absorption peak be will agree with Beer-Lambert law. And there are a blue shift the absorption curves and Red shift in fluorescence curves with the concentration increase. The quantum efficiency for liquid were larger than the solid matrix. Also the stock shift increase the concentration in both liquid and solid samples.

Keywords: Xanthene dyes; Laser dye; Rhodamine 6G.

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1. INTRODUCTION

Rhodamine dyes are fluorophores that belong to the family of xanthenes along with fluorescein and eosin dyes [1]. Rhodamine 6G dye is commonly used as an active medium in tunable lasers due to its high fluorescence quantum yield [2], and also they have broad reaching applications due to their photostability, high absorption coefficients and excellent fluorescence quantum yields [3]. Where the quantum efficiency is one of the most important optical properties of fluorescent materials and it is the essential parameter in determining the lasing characteristics of the active laser medium [4]. By using Rhodamine dye in solid state is as a medium is effective helped solve a lot of problems such as such as toxicity and flammability and they are compact, versatile and easy to operate and maintain [5]. Organic polymers used as host materials for dye lasers provide an alternative to the conventional liquid dye laser [6], one of important of polymer is epoxy risen, where epoxy resin belongs to the principal polymer under the term thermosetting resins, which covers a wide range of cross-linking polymers including unsaturated polyester resins, phenol-formaldehyde resins, and amino resins. Thermosetting polymers form an infusible and insoluble mass of heating, due to the formation of a covalently cross-linked and thermally stable network structure [7]. Epoxy resin is two component, the first called basis (Risen) and the second sclerosing (hardener), together when mixing the certain percentage produces severe adhesion compound, it's used as adhesive or mixed with other substances [8]. Rhodamines dye have various applications in many scientific branches, where used as laser dyes, fluorescence standards (for quantum yield and polarization), pigments and as fluorescent probes to characterize the surface of polymer nanoparticles, fluidity of lipid membranes as well as in the detection of polymer-bio conjugates, studies of adsorption of oligonucleotides on latexes, studies of structure and dynamics of micelles, single-molecule imaging and imaging in living cells [9].

The Quantum efficiency is the ratio of the number of emitted photons of the number of absorbed photons (or the fluorescence quantum yield is the fraction of excited molecules that return to the ground state S_0 with emission of fluorescence photons) [10, 11].

$$q_{FM} = \frac{\text{Number of photon emitted}}{\text{Number of photon absorption}} \tag{3}$$

And also the radiation lifetime can be calculated using relation as follows:

$$K_{FM} = 2.88 * 10^{-9} n^2 \bar{\nu}^2 \int \in (\bar{\nu}) d\,\bar{\nu} \tag{4}$$

Exp. Theo. NANOTECHNOLOGY **2** (**2018**) 21 – 31

Where, n is refractive index of a medium, ύ is wave number at the maximum absorption, and ∫ε(ύ)d ύ is the area under the absorption spectrum curve as a function of the wave number.

In this work we used R6G dye were dissolved in acetone solvent and R6G dye doped epoxy resin polymer for different concentration ($5x10^{-6}$, $1x10^{-5}$, $5x10^{-5}$, $1x10^{-4}$, and $5x10^{-4}$ mol/l) and study spectral properties of it. This research is a continuation of work at the Energy Research Center.

2. Experimental part

R6G dye will Molecular formula ($C_{28}H_{31}N_2O_3Cl$), molar mass (479.02 g/mole), supplied by HiMedia Laboratories Pvt company. Ltd. India and it's the structure shown in figure (2).

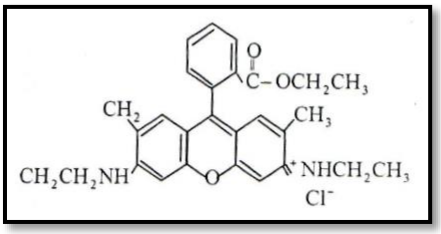


Figure (1): The structure of Rhodamine 6G.

Acetone (systematically named propanone) has the formula (CH_3COCH_3), refractive index about (1.361) at temperature 17 C^0, purity (99 %), molecular weight (58.08 $g.mol^{-1}$). The Spectrophotometer T60 supplied from the English company (Insrtrumrnts) was used to measure the absorption spectra of liquid samples, This device operates within the range of the visible and ultraviolet region where contains lamp of execution, and the emission spectrum taken by using (Spectrofluorometer-model SL174, Elico). Refractive index is taken by using a refractometer (Bellingham and Stanley Ltd, Tunbridgewells, AR4, England).

3. Results and didcussion

From figures (2,3), the peak of absorption spectra of R6G dye solution and solid state increase with concentrations increasing and these agreements with Beer – Lambert Law. And

also shifted the peak of absorption toward to a short wavelength (blue shift) with increase the concentration for both sample solution and solid sample, where with increasing

Exp. Theo. NANOTECHNOLOGY **2** (**2018)** 21 – 31

dye concentration, there is an increase in dimer concentration which it has shorter wavelength than monomers [12]. It has noted that the Stokes shift of the solid sample is less than that in the liquid sample, the Stokes shift of the dye molecule in the solid matrix depends on the difference in the dipole moments between the ground state and the excited state of the dye molecules [13]. The quantum yield of the R6G dye in the solid sample is lower than that in the liquid simple, where decrease in the quantum yield can be due to the reabsorption and reemission processes [13]. From Table 1 and 2 shows the absorption, fluorescence peaks, stock shift, quantum efficiency, lifetime of radiation and fluorescence for R6G dye in solid state and liquid state. It is observed, The peaks of the fluorescence spectrum of liquid sample and solid sample shifted to a long wavelength (red shift) with increase the concentration, because of energy loss in the excited state due to vibrational relaxation [14]. The quantum efficiency for both solid and liquid sample decreased as the dye concentrations were increased because of the decrease the probability of non-radiative transition (Inter System Crossing (I.S.C) and Internal Conversion (I.C). Figure (4) shows the plot of (αhν)2 vs photon energy (hν) obtained by extrapolating the straight line portion of the curves at α=0 [15], Where we noted, decrease slight of energy gap with increased concentration of sample, this due to the creation of the site levels in forbidden energy gap [16]. Also, the values of energy gap of solid matrix and liquid samples are convergent, as shown in the table (3). The results are in agreement with researches works [17,18].

Table 1: Shows the stock shift, The quantum efficiency of fluorescence, the radioactive and fluorescence lifetime of R6G dye solution .

C (M/L)	Absorption λ_{max} (nm)	Fluorescence λ_{max} (nm)	Stock Shift (nm)	q_{EF} %	τ_{Fm} (nsec)	τ_F (nsec)
$5*10^{-6}$	525	551	26	98. 53	1.41	1.39
$1*10^{-5}$	525	555	30	97.55	3.71	3.62
$5*10^{-5}$	525	555	30	71.70	13.84	9.93
$1*10^{-4}$	525	560	35	51.24	21.2	10.87
$5*10^{-4}$	495	570	75	33.27	58.41	19.43

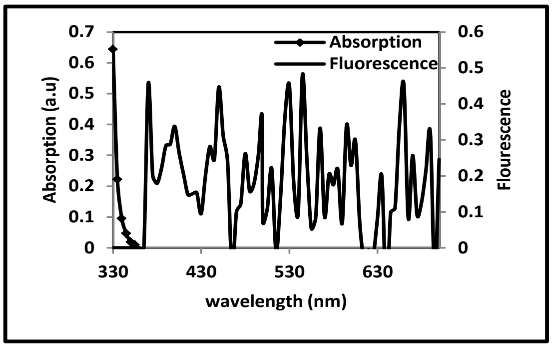
Exp. Theo. NANOTECHNOLOGY **2** (**2018**) 21 – 31

Table 2: Shows the stock shift, The quantum efficiency of fluorescence, the radioactive and fluorescence lifetime of R6G dye doped epoxy.

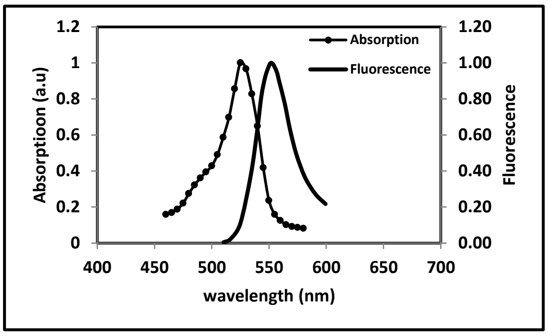
C (M/L)	Absorption λ_{max} (nm)	Fluorescence λ_{max} (nm)	Stock Shift (nm)	q_{EF} %	τ_{Fm} (nsec)	τ_F (nsec)
$5*10^{-6}$	540	555	15	95	6.22	5.95
$1*10^{-5}$	540	560	20	84	6.65	5.61
$5*10^{-5}$	540	563	23	82	10.64	8.82
$1*10^{-4}$	540	565	25	78	13.26	10.38
$5*10^{-4}$	435	565	30	75	16.6	12.52

Table 3: Energy gab of R6G dye solution and R6G dye matrix.

C (L/M)	E_g (ev) Liquid	E_g (ev) Solid
$5*10^{-6}$	2.27	2.24
$1*10^{-5}$	2.27	2.36
$5*10^{-5}$	2.26	2.35
$1*10^{-4}$	2.245	2.33
$5*10^{-4}$	2.2	2.32

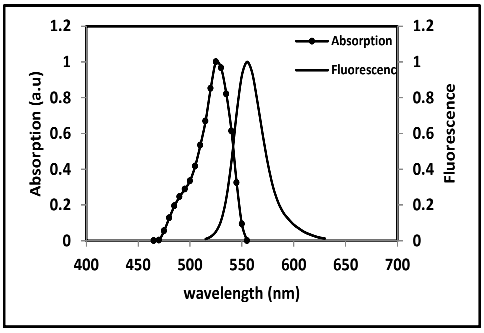


Acetone solvent

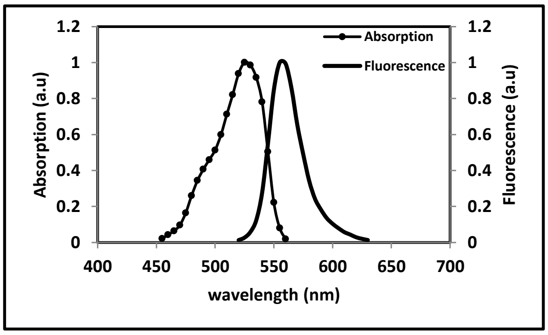


R6G dye solution ($C=5*10^{-6}$)

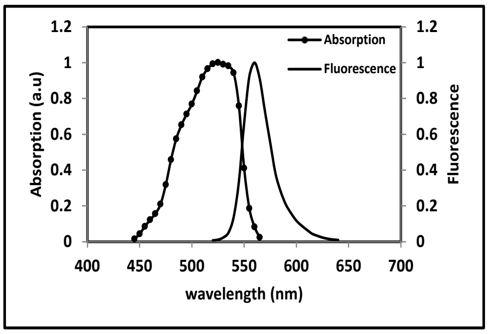
Exp. Theo. NANOTECHNOLOGY **2** (**2018)** 21 – 31



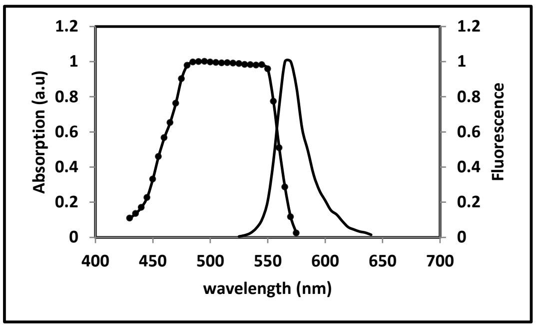
R6G dye solution (C=1*10^{-5})



R6G dye solution (C=5*10^{-5})

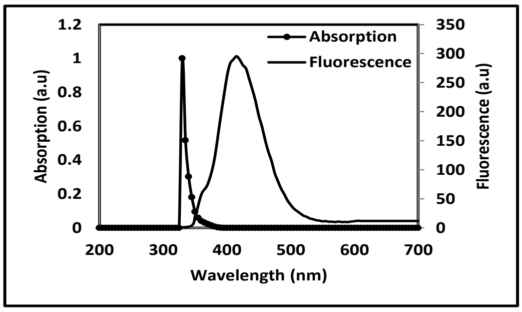


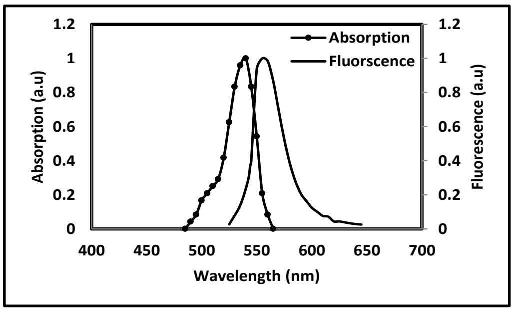
R6G dye solution (C=1*10^{-4})



R6G dye solution (C=5*10^{-4})

Figure (2): The fluorescence and absorption spectra for R6G dye solution dissolved in acetone.





Exp. Theo. NANOTECHNOLOGY **2** (**2018)** 21– 31

Epoxy resin R6G dye solid (C=5*10^{-6})

R6G dye solid (C=1*10^{-5}) R6G dye solid (C=5*10^{-5})

R6G dye solid (C=1*10^{-4}) R6G dye solid (C=5*10^{-4})

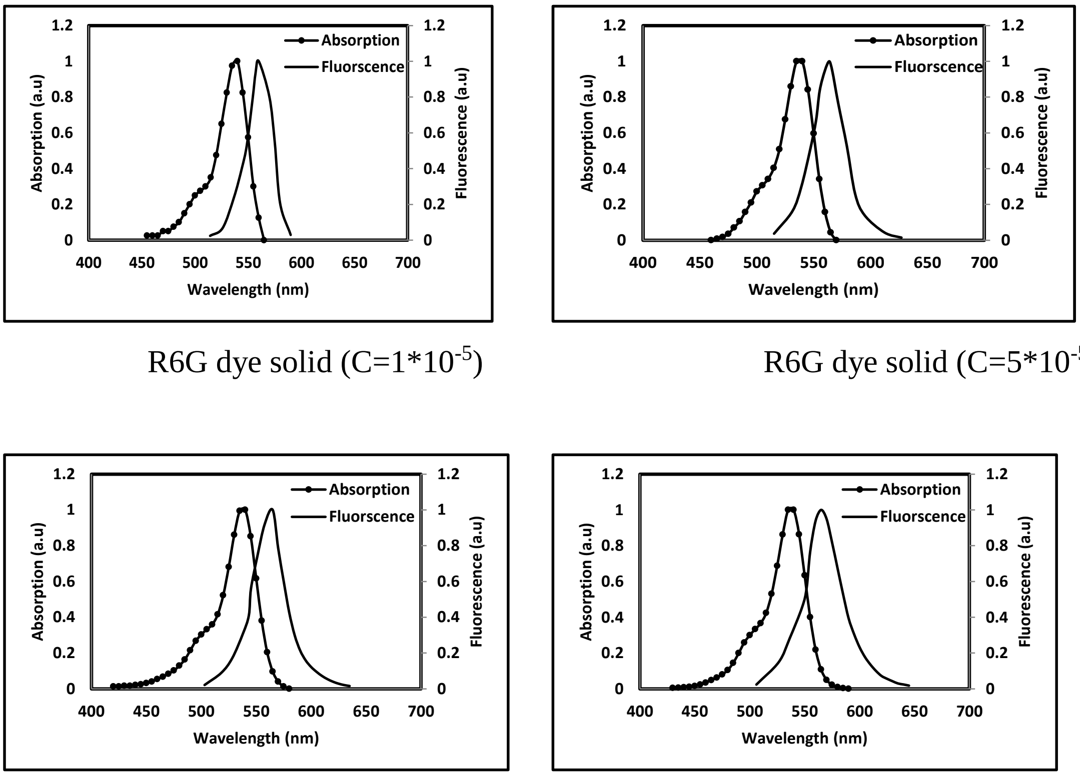
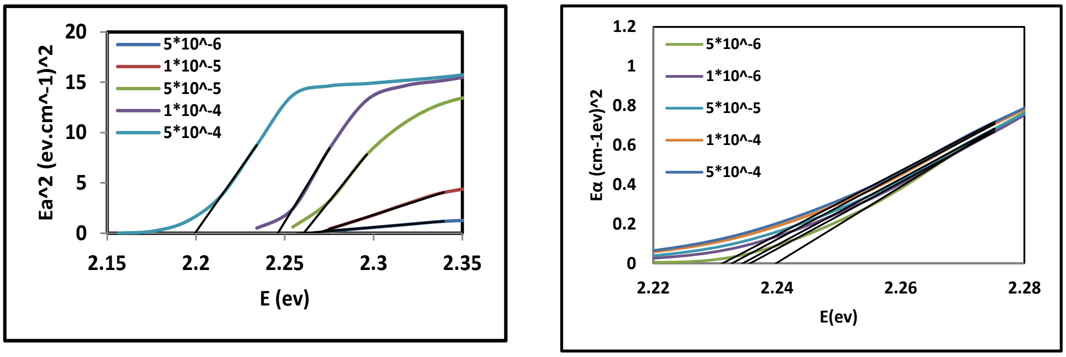


Figure (3): The fluorescence and absorption spectra for R6G dye doped epoxy resin.

Exp. Theo. NANOTECHNOLOGY **2** (**2018**) 21– 31



R6G dye solution R6G dye solid

Figure (4): Energy gab of R6G dye solution and R6G dye matrix.

4. Conclusions

The study of the Rhodamine 6G dye solutions and solid in the acetone solvent with increase concentration could conclude: Shifted the fluorescence spectrum of Rhodamine 6G dye toward the longer wavelength (red shift) but the liquid simple has shifted a larger than from solid samples. Increase in the relative intensity of the absorption with increase the concentration. Increase both the fluorescence lifetime and radiative lifetime, and also it has observed the fluorescence lifetime is small as compared to a radiative lifetime. Decrease the overlap between the absorption spectrum and the fluorescence of due to increase of stokes shift with increases concentration of the dye and stock shift of liquid larger than of solid. The quantum efficiency of the dye decreases when the dye concentration increases, and the liquid simple have a quantum efficiency larger than of solid simple.

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Exp. Theo. NANOTECHNOLOGY **2** (**2018)** 21– 31

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