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EFFECT OF DIAMETER PIHHOLE ON A OPTICAL LIMITER OF ORGANIC DYES

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Abstract:

The optical limiter properties of R6G dye in acetone solution were studied, at different concentrations and thickness using Nd:YAG laser at a wavelength (532) nm. The optical limiter measurements were characterized by measuring the intensity of the medium using the optical limiter system. Optical limiting characteristics of the dye at various concentrations, diameter of hole and thickness were studied. The samples at different concentrations showed depend the optical limiter of the concentrations, diameter of hole and thickness, and have a good optical limiter.

Keywords: *Optical limiter, Rhodamine 6G, The dyes, nonlinear optical.*

1- Introduction:

Nonlinear optical (NLO) materials are giving increasing attention because of wide applications such as all- optical switching, optical communications, optical power limiting and, optoelectronic and photonic devices [1]. The organic compounds with delocalized electron systems and a large dipole moment have nonlinear susceptibilities larger than of the inorganic compounds [2]. the laser dyes are one of the material which can show very high nonlinear optical properties [3]. Rhodamine 6G (R6G) dye is one of the important dyes which use in different fields such as photostability, high absorption coefficients and excellent fluorescence quantum yields [4]. The dyes are very suitable in the field of nonlinear optics because of their optical properties very high. The Z-scan method has acceptance by nonlinear optics community as a standard method to study nonlinear optical properties. Recently, The focus was of interest in the outer edges of the beam rather than the central part, and increase the sensitivity[5,6]. Optical limiting is one of the important applications of third order optical nonlinearity of materials. Nonlinear optical materials can be used for protecting sensors against high-intensity laser pulses and high-power laser beams. Devices developed for this purpose are called optical limiters. An optimum practical optical limiter can be designed and fabricated by predicting and studying the characteristics of an ideal optical limiter. An ideal optical limiter is a photonic device or component has ideal optical limiting characteristics. It can take any intensity input laser beam both continuous wave (CW) or pulsed wave of any time duration [7,8].

In this work, optical limiter of Rhodamine 6G (R6G) solution were studied, with take effect the concentration, thicknesss and diamitere of pinhole.

2- EXPERIMENTAL WORK:

a- Material:

R6G dye has the 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, as shown in figure (1) [9].

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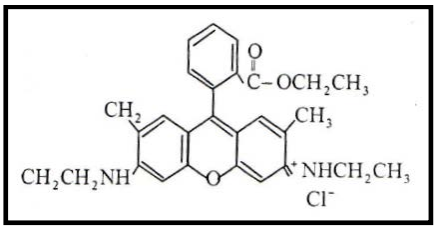

Fig (1): The structure of The dye R6G [9].

The Acetone has the formula (CH_3COCH_3), refractive index about (1.361) at temperature 17 C^0, purity (99 %), and molecular weight (58.08 $g.mol^{-1}$).

The Spectrophotometer T60 supplied from the English company (Instruments) 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).

b- Optical limiter technique:

The laser Nd:YAG at a wavelength 532 nm with (90) Mw (MHHL-532-100 mw) used as the excitation source in optical limiter method. The experimental setup of the optical limiting system is used as shown in the figure (2), where, (O) is an aperture with diameter (0.5 and 1.5) mm, is used to control the cross-section of the beam coming out of the sample, the nonlinear medium is sample put in focal point (z=0), L is the convex lens with 30 cm focal length, and then the laser beam falls on the photo detector (PD) [10].

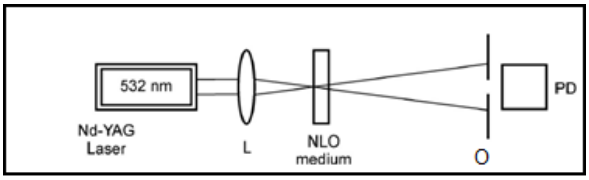

Fig (2): Experimental setup for the optical limiter.

3- Results and discussion:

3-1- Spectra of R6G solution:

The spectrum of the material used (R6G) at different concentration in acetone solvent shown in figure (3), using Spectrophotometer T60 from the company of English (Insrtrumrnts). As we see, maximum spectrum at (550) nm in visible region.

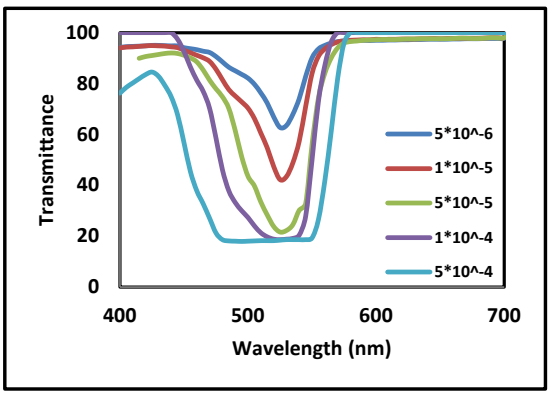

Fig (3): Spectra of transmittance of R6G solution.

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3-2- Optical limiter:

The optical limiting of (R6G) solution with (90) mW for different concentrations and an aperture pinhole (1.5 mm) are shown in figure (4). We noted, the output power changes lineary with the input power but after a certain value the output stay dont change (threshold value), due to a greater part of the beam cross-section being cut off by the hole [11,12].

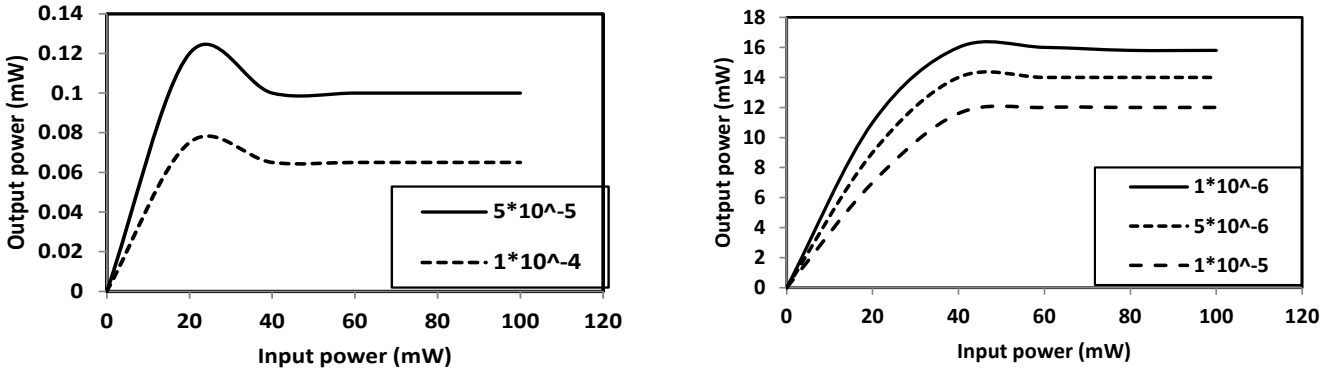

Fig (4): Optical limiter of (R6G) at different concentration.

The output power tends to be constant, because its nonlinear absorption coefficient increases with increase in the incident irradiance. In liquids, where the thermal expansion is large, high absorbance of the nonlinear material at the corresponding wavelength leads to increase in temperature and density of the sample. Heating due to laser absorption is responsible for changing the absorption coefficient and optical limiting effect [13]. As is evident, The best limiter of laser beam in ($1*10^{-4}$ m/L) concentration with value (14) mW as shown in table (1).

Table (1): Threshold power of (R6G) solution.

C (M/L)	threshold power (mw)
$1*10^{-6}$	28
$5*10^{-6}$	30
$1*10^{-5}$	32
$5*10^{-5}$	15
$1*10^{-4}$	14

Effect of hole diameter optical limiter is shown in figure (5), in which, 0.5 mm hole diameter. As noted, decrease of threshold power of optical limiter to reach aboute (1.6) mW at ($1*10^{-6}$) m/L concentration as shown in table (2), compare with (14) mW at same concentration and (1.5) mm diameter of hole.

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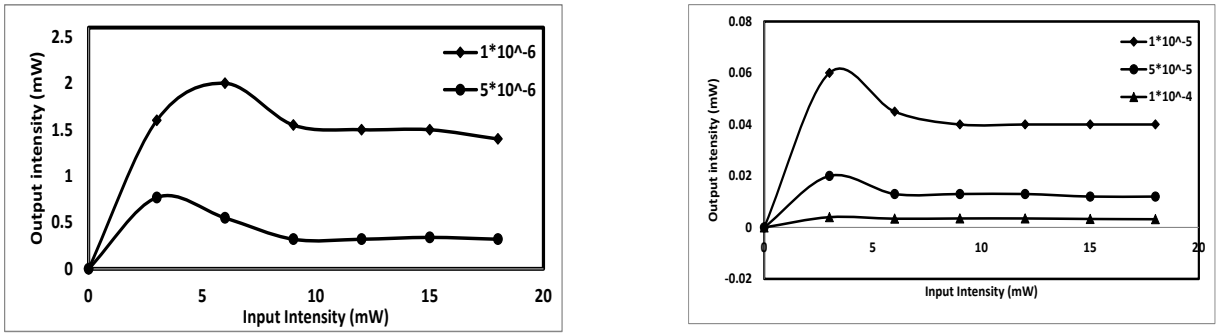

Fig (5): Optical limiter of (R6G) at different concentration.

Table (2): Threshold power of (R6G) solution at (0.5 mm).

C (M/L)	threshold power (mw)
$1*10^{-6}$	2.7
$5*10^{-6}$	2.5
$1*10^{-5}$	1.6
$5*10^{-5}$	1.6
$1*10^{-4}$	1.6

Figure (6) shwon, thickness of samples effect have been taken. Which shows, change of threshold power of optical limiter with thickness (3,4, and 6) mm at ($5*10^{-5}$) m/L and (1.5) mm diameter of hole.

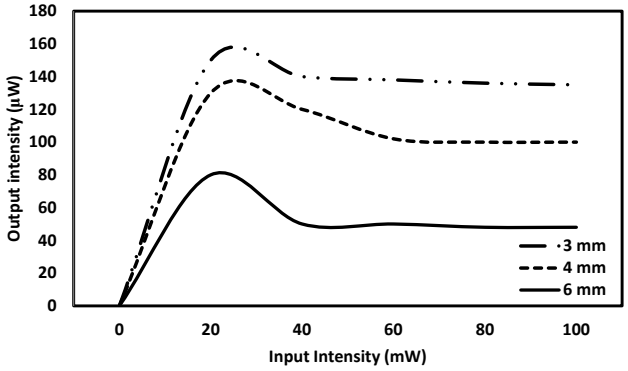

Fig (6): Optical limiter of (R6G) at different thickness.

Increasing the thickness of the sample significantly contributed to reducing the threshold limit of the optical limiter, which can be used in several promising applications.

Table (3): Threshold power of (R6G) solution.

($5*10^{-5}$) m/L and (1.5) mm	
C (M/L)	threshold power (mw)
3mm	19
4mm	18
6mm	12

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4- Conclusion.

Our aim studies the nonlinear optical properties by using optical limiter of Rhodamine 6G (R6G) dye solutions in acetone solvent at different concentrations and thickness, with Nd:YAG laser at a wavelength (532) nm. The results showed the threshold oh optical limiter depended on of both the concentration, diameter of hole and thickness of samples. So, (R6G) dye has applications in optical limiter.

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