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Study of the Properties of laser Beam Propagation through the (Reactive Red) dye

Saddam Flayeh Haddawi[1]*,Jinan Ali Abd[2], Wasan Mnati Mohmmed[3],Hassan A.majeed[4]

University of Babylon, College of Science for women, Department of Laser Physics, Babylon, IRAQ

Abstract : In this work, the properties of the laser beam were studied by using optical system that consists of the (He- Ne) laser ((λ =632.8nm, p=1.04mw) and solid state laser beam (422nm),P=14.64mw, the parameter of LASER beam (spot, profile distribution, intensity) in the (Reactive Red dye) with concentration 10^{-9}mole.L^{-1} were studied at different distance. Measurement was obtained by using a CCD camera. Absorption spectrum of the dye was measured by using The Ultraviolet –Visible Spectrometer. Absorption coefficient value for Reactive Red was calculated in the two cases.
Key words : reactive red; He- Ne laser; solid state laser.

1. Introduction

Laser beam shaping that redistributes the irradiance and phase of an incident beam (usually Gaussian beam) to achieve a desired intensity distribution has been intensively studied using techniques of segmentation, a polarization[1-7]. Beam characteristics developed from the wavelength, polarization, beam waist radius, continuity and coherence of lasers and complex index of propagation medium deeply affect the applications[8]. There are many applications in which the accurate knowledge of the laser beam diameter and divergence is critical[9]. More accurate and fast measurements of the laser beam width are obtained with a CCD camera that provides a direct and real time view of the laser beam profile[10]. This factor has been defined such that M2 = 1 for an ideal Gaussian beam. Real laser beams have factors greater than one. For example helium neon lasers have typically an M2 factor of less than 1.1 the beam quality is important for many laser measurements and optical designs, where the M2 factor cannot be neglected[11]. Many lasers emit beams with a Gaussian profile, in which case the laser is said to be operating on the fundamental transverse mode, or "TEM00 mode" of the laser's optical resonator[12].Propagation of optical waves through random media such as the atmosphere, the ocean, and biological matter, is very important in many applications such as optical communications and astronomical imaging[13,14].

Experimental part

1- Absorption spectral measurement for used Reactive Red

The spectrophotometer has been used to measure the Absorption and Transmission spectra of the dyes under study; it has range from 190 to 800 nm. It measures Intensity of light passing through a sample (I)and compares it to the Intensity of light before it passes through the sample (I_o) The ratio I / I_o is called the transmittance and is usually expressed as a percentage (T%) The absorbance, A is based on the transmittance.[15-18]

A= - log (T/100)

2- Measurement of two lasers beam profile in GRL dye

The(spot, the profile distribution and intensity) of the laser beam is measured by using two lasers systems different wavelength and power (He-Ne laser =632.8nm, p=1.04mw, solid state laser =422nm, p=14.64mw) respectively. The method was used to determine the spot, shape and the intensity of laser beams in red reactive dye concentration in pure water is 10^{-9}MIPlaced dye into the glass tube and fixit on the stand between the laser and the CCD camera then, the beam laser focused at the center of the camera as shown in figure (2), after that the best spot of the laser beam was measured at the presence the software in computer for all lasers, as shown in figure (3) .

Figure (1) Experimental setup of the Reactive red dye with concentration 10^{-9}

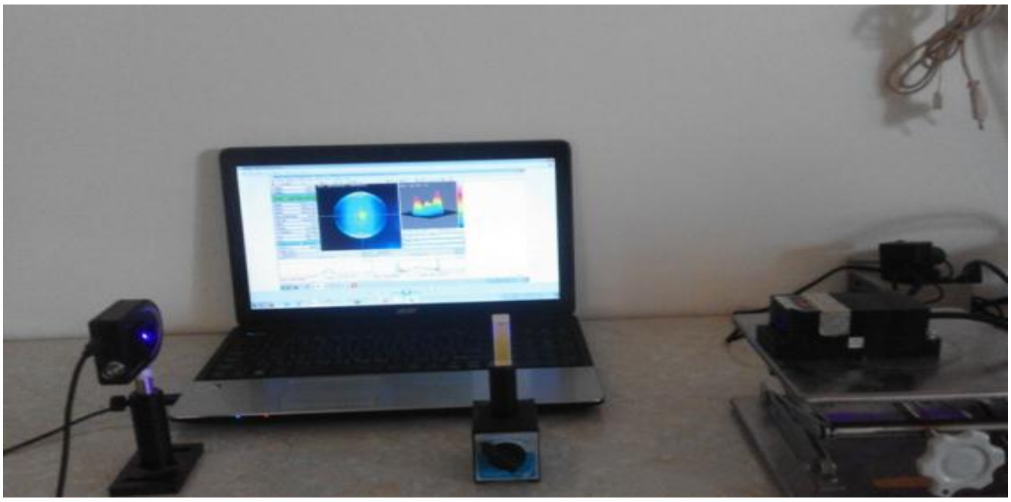


Figure (2) image of the spot beam in Reactive red dye

Result and dissection

1- Absorption spectral measurement for used GRL dye

Figure (1) represents absorption spectral of red reactive dye with concentration (10^{-9}) at region (UV) and (Visible). It is noticed that the first maximum peak at wave length 280nm in UV region light and the second maximum peakat wave length 475nm in VIS region

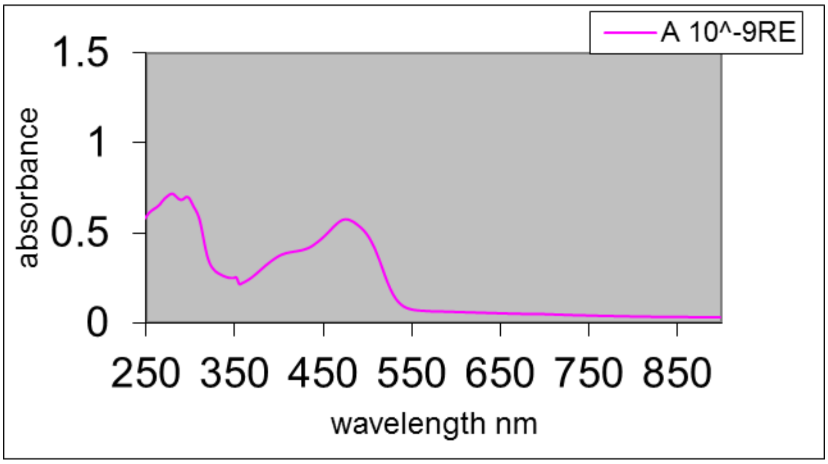
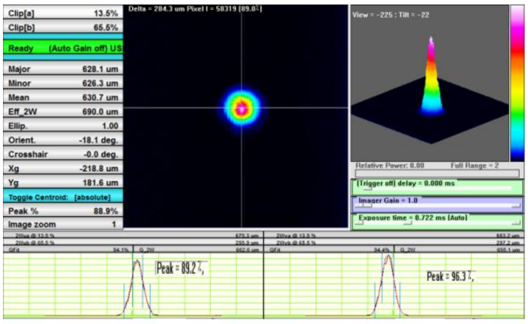
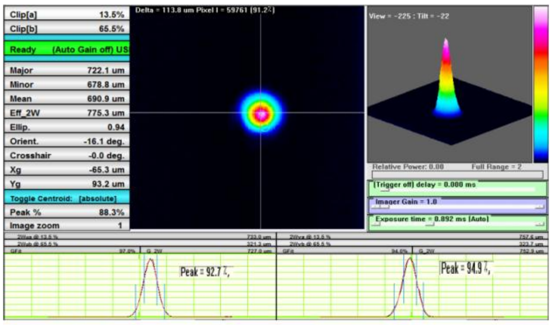


Figure (3) absorption spectral for Reactive Red (10^{-9} M)

2 - He-Ne laser beam in Red reactive dye at concentration 10^{-9}MI

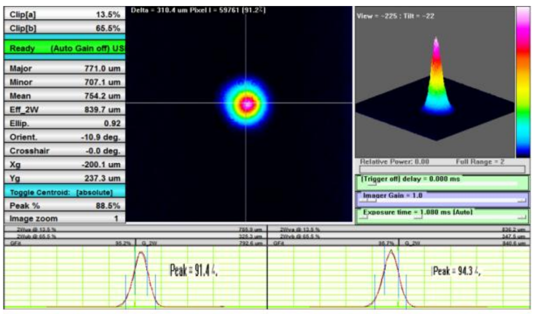
In fig(4)(a, b, c, d) noticed that beam spot relatively regular circuit and shape of the distribution intensity was Gaussian shape at different distances (10,20,30,40)cm for He-Ne laser by using Red reactive dye. while the intensity (peak values) changed(89.2,92.7,91.4,95.8)% with different distances (10,20,30,40)cm, as shown in table (1).

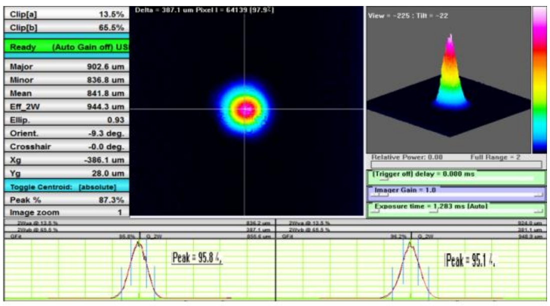




(a) **(b)**

Figure (4) show laser beam spot and profile of He-Ne laser at different distance (a) 10 cm (b) 20 cm in Reactive Red Dye.





ca) **db)**

Figure (4) show laser beam spot and profile of He-Ne laser at different distance (c) 30 cm (d) 40cm in Red reactive dye

Table (1) and fig (5) shows that change intensity of beam and spot diameter with distance:

a. Intensity increased a little, increased at distance 20cm and then occurs decreased at 30cm and then increased at value 92% .
b. Decreased mean until reached 30 and then a little increased from 30cm-40cm.
c. C-Intensity increased until reaches maximum value at distance 40cm.

Table (1) beam peak and diameter change with change distance of He-Ne laser of Reactive Red dye

X cm	Peak(spot shape)%	Peak(distribution shape)%	Mean (diameter)µm
10	89.2	96.3	630.7
20	92.7	94.9	690.9
30	91.4	94.3	754.2
40	95.8	95.1	841.8

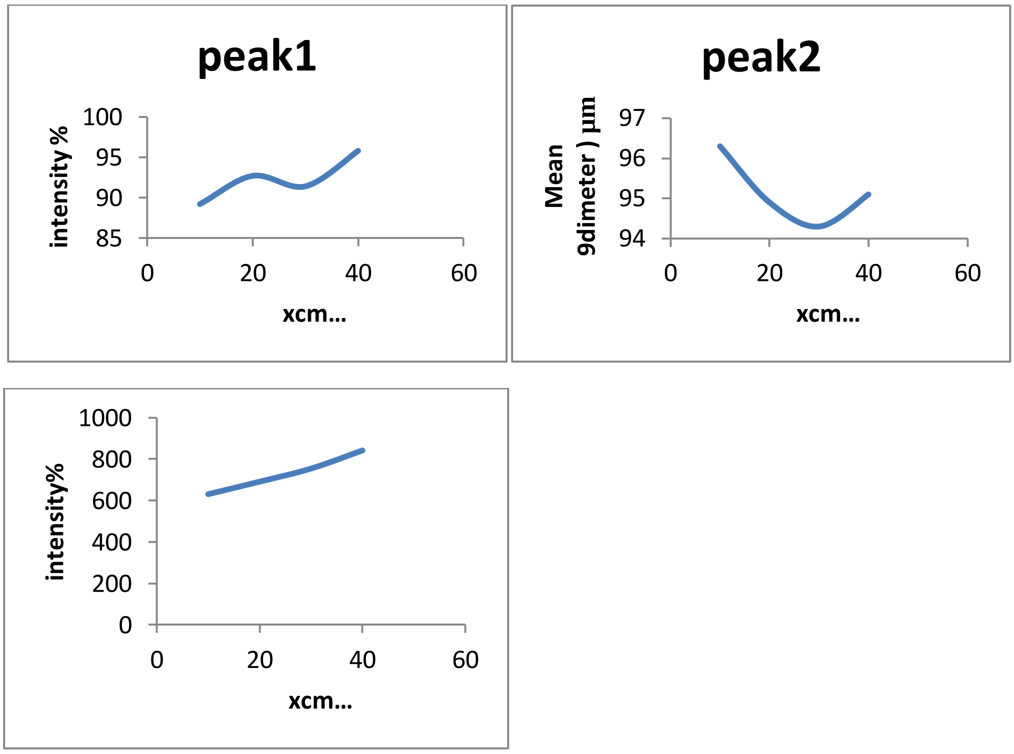
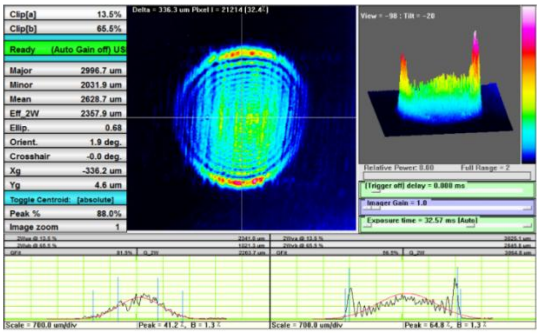


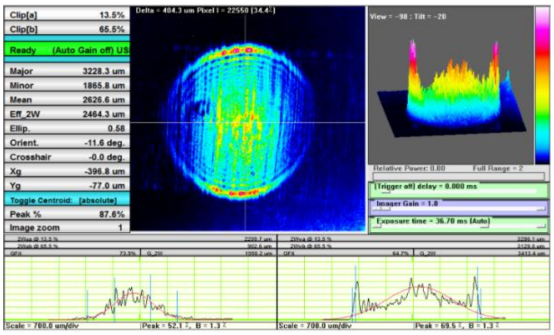
Figure (5) Peak intensity and diameter change with distance of He-Ne laser in reactive Red

3- Solid state laser beam (422nm), P= 14.64mw in Reactive Red dye at concentration 10^{-9}

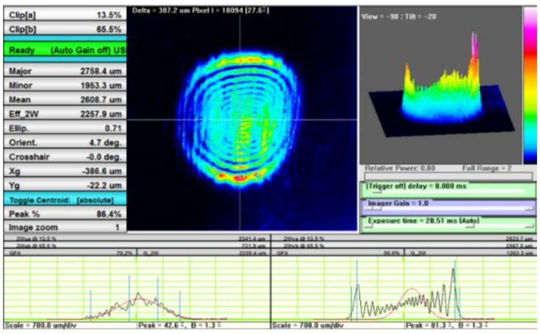
In fig (6), the result has shown that, different spot on the circular shape when using Reactive Red dye ,and appeared a little difference in shape of intensity distribution for Gaussian shape, it was noticed that the intensity change wasn't regular at different distance and was intensity value(52.1,41.2,42.6,37.6) % respectively with different distances (10, 20, 30, 40) cm, as shown in table (2).Concentration Reactive Red dye in water was a little effect on the shape spot and Gaussian distribution shape while the effect on the intensity was clear.



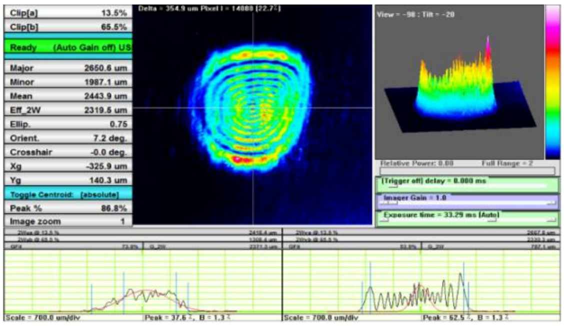
(a)



(b)



(c)



(d)

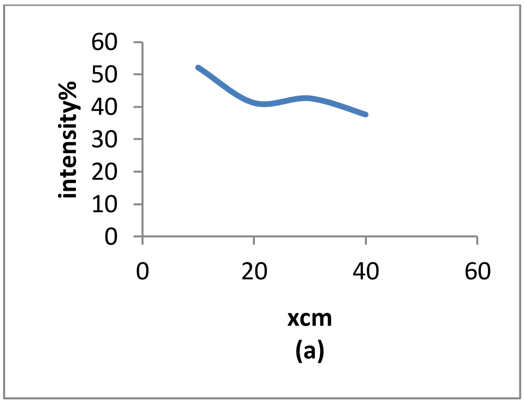
Figure(6)show laser beam spot and profile of solid state laser at different distance (a)10cm (b)20 (c)30 cm and (d)40cm in Red reactive dye

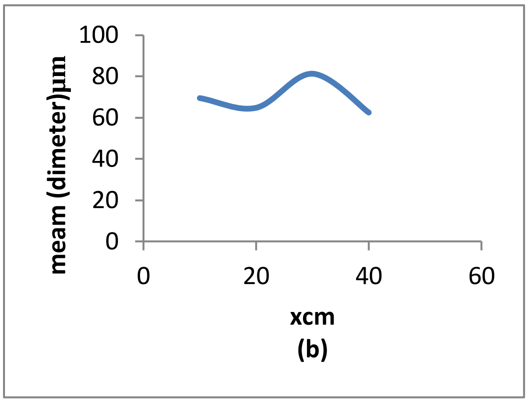
Table (2) and figure (7) showing that change intensity of beam and spot diameter with distance

a- decreased intensity until reached at distance 20cm then increased at distance 30 cm and then decreased at 40cm; b- Noticed that mean is decreased and then increase; c- Intensity is increased to distance 20cm and suddenly decreased at distance 40cm

Table (2) The beam peak and diameter change with change distance of He-Ne laser of Reactive Red dye

X cm	Peak(spot shape)%	Peak (distribution shape)%	Mean (diameter)µm
10	52.1	69.5	2626.6
20	41.2	64.8	2628.7
30	42.6	81.3	2608.7
40	37.6	62.5	2443.9





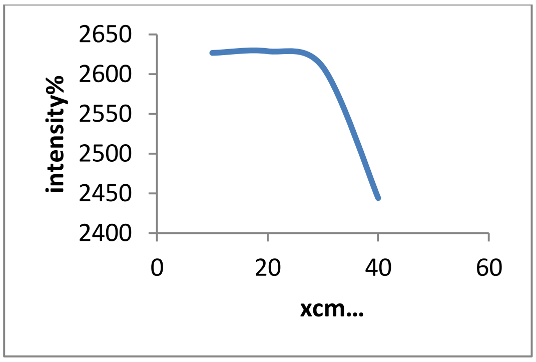


Figure (8)Peak intensity and diameter change with distance of solid state laser in Reactive Red dye

4-Calculating the absorption coefficient of the Reactive Red dye

Calculate absorption coefficient for two laser system with different wavelength and different powers for Reactive Red absorption coefficient calculated from equation (1).

Table (3) the absorption Coefficient of two lasers for Reactive Red dye

used material	Absorption coefficient(cm^{-1}) at λ= 632.8nm	Absorption coefficient (cm^{-1}) at λ=422nm
Reactive Red dye	0.0033	0.0048

Conclusion

1. The result has shown that the spot beams relatively regular circuit and the shape of the distribution intensity was Gaussian shape of He-Ne laser in air. When using semi-conductor laser system with short wave length (422nm) and power (14.64mw), a noticeable change in the shape of spot has been observed and distribution intensity shape was found as large broadening in the shape distribution intensity in air.
2. The absorption coefficient value of the two cases was changed according to type of laser.
3. The value absorption coefficient of solid state laser is smaller. Therefore this can be used this laser in under water Communications.

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