Study of optical, electrical and the performance coefficients for the (Rhodamine B- Eosin) laser dyes Detectors

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Abstract. Background: The aim of research is the design of laser Detectors with organic pigments (Rhodamine B) and the dye of (Eocene) and the study of the absorption spectrum of the liquid dye used. Materials and Methods: Models were prepared with different concentrations (10-3-104) mol/L. In addition, Polymer Phenyl Pyrrolidone (PVP) was measured with different weights (0.1, 0.3). The research also discussed some of the opinions and discussions regarding the effect of concentration and polymer ratio that affect the absorbance spectra of these dyes. Results: The results showed that the strength and wavelength of the absorption spectra of the dyes used depend on the concentration, the polymer ratio and the increased concentration of the dye leading to interference between the absorption spectra. The velocity and the pre-irradiation were measured by laser and irradiation. Conclusions: Laser Irradiation led to an improvement electrical properties of the detector. The charges are increased to the delivery package. Detector increases with increased concentration of pigments. As concentration is increased causes increased of resistance to the surface, resulting in a decrease in current passing through the detector. The equivalent power of noise changes with light stream. This indicates that the greatest response it occurs when the equivalent noise capacity is as low as possible. The results showed that the detection increases the molecular concentration of pigments as well as increasing the noise capacity. Detectors prepared from photon detectors to increase the current by increasing the intensity of light. This is because the detection is a function of the spectral response, so it changes with the detector.

1. Introduction
Laser dyes are organic substances with rather complex compositions that have a large molecular weight, to contain their compositions on a series of carbon atoms linked to alternately single and double bonds. Most pigments have the ability to absorb the visible electromagnetic radiation with high efficiency [1, 2]. Visible radiation from most organic dyes has been used as an active medium in dye lasers. It is considered the first transducer laser in the visible spectrum region to possess a broad fluorine spectrum that allows laser output to be synthesized at any value selected within that range. Laser dyes produce continuous laser in the range of wavelengths ranging from 340 nm to 1.2 mm. In 2013, Ahmed and Saif [3] studied the optical properties of the Rhodamine B polymerized polymerase (PMMA/PVAc). The concentration of the grafted dye was observed with different polymers, increasing both the absorption
spectra and the fluorine spectrum [3]. Laser detectors: They are known as devices that convert the light rays falling on them into external electrical signals that can be measured [4, 5]. Detectors are divided into two main types depending on the nature of the interaction between the falling light rays and the detector material. The difference between these two types of detectors is that the thermal detectors respond to all falling wavelengths, while photonic detectors capture a certain range of falling rays, within this range, the response to a specific wavelength is [6]. Irzaman and Rusdiana, 2001 synthesized Al / Si by depositing aluminum on silicon (100) using vacuum deposition technique during pressure (2 × 10^-4 torr) the researchers studied the detector response [7]. It has been shown that in the range between 800-1000 nm it is highly sensitive when lit by continuous and intermittent flux at 200 Hz. Jabouri, 2003 produced many diodes with a silicon and the thickness of the electrodes ranged from 50-300 (Ao). The aim of research is the design of laser detectors with organic pigments and the dye of Eocene [8].

2. Materials and Methods

The dye was used in the form of solid green crystals, which were well dissolved in ethanol, a fluoridated red solution when dissolved, and can be dissolved in other solvents such as distilled water and benzene, chemical formula C28 H31 N2O3 Cl, and molecular weight 478.5 gm/mol [9]. The dye is also used in the form of solid orange crystals, forming a buffered orange solution when dissolved, and its chemical formula C20 H8 Br4 Na2 O5 and its molecular weight 691.9 gm/mol [10]. Pyrrolidine Poly Vinyl (PVP) has the chemical formula (C6H9NO) n) and its molecular weight 40000 gm/mol [11]. For the concentrations mentioned, the solvent used is ethanol and its chemical formula (C2 H5 OH) and its molecular weight is 46.07 gm/mol and purity of 99.9% [12].

3. Detector Coefficients

3.1. Responsivity (R)

The ratio between the output signal (voltage or current) from the detector to the power of the incident light is represented by the following relationship [13]:

\[ R \text{ (V/W or A/W)} = \frac{\text{Iph}}{\text{Pin}} \text{ or } \frac{\text{V}}{\text{P}} = \text{R} \text{ ........... (1)} \]

\( \text{Iph} = \) Light Current; \( \text{Pin} = \) Incident light Power; \( V = \) Voltage

3.2. Noise Equivalent Power

It is defined as the falling radiation power that gives a signal equivalent to the detector noise (current or voltage). Thus, the equivalent noise capacity is the least capable of being detected by the detector, which gives a signal to noise ratio. \( \text{(S / N)} \) is equal to one unit [14].

If \( \text{NEP} \) is the equivalent noise power, \( \text{in} \) is the noise current and \( \text{R} \) is the response \( (\text{R}_\lambda) \), the relationship between them is as follows [15]:

\[ \text{NEP (W)} = \text{ ............... (2)} \]

3.3. Directivity and Specific Directivity \( (D \text{ and } D^*) \)

It is a measure of detector sensitivity and equal inverted noise equivalent [16]:

\[ D \text{ (W-1)} = \text{ ............... (3)} \]
When D was increased, the detector's ability to detect the signal was higher [16]. This is because the detection value is not often suitable for comparing different types of detectors. It has been found that the detection value in many cases is proportional to the detector area. Another parameter is defined for the performance of the detector (D*) [14].

\[ D = \frac{A}{F} \]  \hspace{1cm} (4)

A: The actual area of the detector (cm²)
F: Bandwidth (Hz)

3.4. Gain

The detector gain is calculated from the following relationship [4]:

\[ G = \frac{I_{ph}}{I_d} \]  \hspace{1cm} (5)

\[ I_d = \text{Dark Current} \]

The dye solution is prepared by dissolving an appropriate amount of dye powder in a certain volume of solvent used according to the formula [17]:

\[ m = \frac{C \times V \times M}{1000} \]  \hspace{1cm} (6)

m: The weight of the dye needed to obtain the desired concentration in grams
C: Concentration to be obtained by a mol/l unit
V: Volume (cm³)
M: Molecular Weight

The dilution relationship was used to obtain a lighter concentration than the first concentration [17]:

\[ C_1 V_1 = C_2 V_2 \]  \hspace{1cm} (7)

C₁: First concentration
C₂: Second concentration
V₁: The required size of the first concentration
V₂: The size needed to be added to the first concentration for the second concentration.

Polymer (PVP) was added with different weights (0.1, 0.3, 0.5) g for the measured concentration and comparison of the results.

Use the laboratory HR-200 for the weight and polymer weight used in the preparation of liquid samples supplied by Japan company limited, 210. The absorption spectrum emitted from the pigment solution
used by the SCINCO Mega-2100 (UV-Visible) spectrometer with wavelengths (190-1100) nm was also recorded. The fluorine spectrum emitted from the dye solution was also recorded using a spectrometer from Japan, Optimize SL-174. The use of magnetic stirrer (Chinese) containing HETTER is used as the purpose of using the device to homogenize the solution and accelerate the melting of the polymer.

The solutions were deposited on silicon bases for 2.5 x 1.5 cm thin films. The bases were mixed with 10m distilled water and 20m of high purity ethanol solution by ultrasonic cleaner (400-150) plant from the company (Japan-Skymen) for 30 minutes to ensure good cleaning. The deposition of electrodes from aluminum (99.99%) was carried out using the thermal segregation system in vacuum and the voltages and current of the membranes were measured using the Keithley 616-digit electrometer to measure the current change in the detector with the change of the voltages. The voltages and current of the samples after laser irradiation were measured at a different dimension from (10, 20, 30) cm, where the laser diode was used with a 532 nm wavelength and 200μw.

4. Results and Discussion

The absorption spectra of the Rhodamine B and the dioxin was studied with the presence of a PVP polymer at different rates (0.1, 0.3). Figures 1, 2 shows that the absorption peak is increased by increasing the molar concentration. While the maximum wavelength of the absorption peak of the solution of Rhodamine B at 553 nm and 556 nm were 10-3 M and 10-4 M, respectively. While the maximum wavelength of the absorption peak of the iodine solution is concentrated at 10-3 M and 10-4 M of 534 nm and 536 nm, respectively as shown in Figures 3, 4. Table 1 shows the absorption peak and the wavelength peak of the recorded samples of the liquid dye used.

| Dyes   | Cm M  | Weight of Polymer (g) | Peak wavelength nm | Peak absorptance | $(\Delta \nu)^{1/2}$ $\times 10^{17}$s$^{-1}$ |
|--------|-------|-----------------------|--------------------|------------------|------------------------------------------|
| Rhodamine B | $10^{-3}$ M | -----                | 553                | 0.67             | 0.073                                    |
|         | $10^{-3}$ M | 0.1              | 554                | 0.63             | 0.085                                    |
|         | $10^{-3}$ M | 0.3              | 554                | 0.49             | 0.1                                     |
|         | $10^{-3}$ M | -----              | 555                | 0.6              | 0.09                                     |
| Rhodamine B | $10^{-4}$ M | 0.1              | 555                | 0.48             | 0.1                                     |
|         | $10^{-4}$ M | 0.3              | 555                | 0.4              | 0.1                                     |
|         | $10^{-3}$ M | -----              | 534                | 0.48             | 0.111                                    |
| Eosin   | $10^{-3}$ M | 0.1              | 534                | 0.32             | 0.115                                    |
|         | $10^{-3}$ M | 0.3              | 534                | 0.28             | 0.125                                    |
|         | $10^{-4}$ M | -----              | 536                | 0.43             | 0.107                                    |
|         | $10^{-4}$ M | 0.1              | 536                | 0.22             | 0.15                                     |
| Eosin   | $10^{-4}$ M | 0.3              | 538                | 0.166            | 0.166                                    |
Figure (1) Absorption spectra of the rhodamine B type at the concentration of 10^{-3} M with the presence and absence of polymeric material (pvp)

Figure (2) Absorption spectra of Rhodamine B concentration 10^{-4} M with presence and absence of polymeric (pvp)
Figure (3) Absorption spectra of the Eosin dye at the concentration of $10^{-3}$ M with the presence and absence of polymeric (PVP)

Figure 4. Absorption spectra of the Eosin dye at the concentration of $10^{-4}$ M with the presence and absence of polymer material (PVP)

Based on the current-voltage properties of the models recorded using equations (1-5), the coefficients of the detectors were calculated. Figs. 5, 6 show current-voltage of the detector at concentration $10^{-3}$ M and $10^{-4}$ M. Table 2 shows detector parameters.
**Table (2)** Detector coefficients for Rhodamine and Eosin formulations with a different concentration of the material using laser beam at a distance of 30 cm with polymer PVP (0.3 g)

| $C_m$ | $R_A$ | $NEP$  | $D$   | $D^*$  | $G$   |
|-------|-------|--------|-------|--------|-------|
| $M$   | $(A/W)$ | $(W)$  | $(W^{-1})$ | $cmHz^{1/2}w^{-1}$ |       |
| $10^{-3}$ | 0.02 | $1.2 \times 10^{-4}$ | $0.8 \times 10^4$ | $1.54 \times 10^4$ | 1.6   |
| $10^{-4}$ | 0.03 | $1.5 \times 10^{-4}$ | $0.6 \times 10^4$ | $1.29 \times 10^4$ | 1.3   |

Figure 5 Current-voltage with concentration $10^{-3}$ M with light radiation and dark with laser irradiation on different dimensions

Figure 6 Current-voltage with concentration $10^{-4}$ M with light radiation and dark with laser irradiation on different dimensions
The absorption spectra of Rhodamine and Eosin in the ethanol solution at a different concentration was investigated by the presence and absence of polymeric material from Figs. (1-4). This is due to the presence of a large number of dye molecules in the ground energy level that can absorb enough photons. The decrease in the wavelength of the absorption peak can be explained by increasing the molar concentration by knowing that large absorption by a large number of dye molecules leads to additional energy that decreases the wavelength of the absorption peak. The results showed that the use of polymeric material with laser dyes to prepare membranes as effective laser catalysts is more important than liquid solutions. When combining dye with polymeric material, it prevents the spread of molecules to the surface, which increases optical stability [18]. Detectors prepared from photon detectors to increase the current by increasing the intensity of light on it.

5. Conclusions

It was found that the irradiation of the detector by the laser led to an improvement in the electrical properties of the detector, as a result of the electrons irritation, the charge carriers are increased to the delivery package. Detector response increases with increased concentration of pigments. As increased concentration causes increased resistance to the surface, resulting in a decrease in current passing through the detector. The absorption spectra of Rhodamine and Eosin in the ethanol was investigated by the presence and absence of polymeric. This is due to the presence of a large number of dye in the ground energy that can absorb enough photons. The decrease in the wavelength of the absorption peak can be explained by increasing the molar concentration by knowing that large absorption by a large number of dye molecules leads to additional energy that decreases the wavelength of the absorption peak. The results showed that the use of polymeric material with laser dyes to prepare membranes as effective laser catalysts is more important than liquid solutions. Detectors prepared from photon detectors to increase the current by increasing the intensity of light. The equivalent power of noise changes with the change of the incoming light stream. This indicates that the greatest response occurs when the equivalent noise capacity is as low as possible. The results showed that the detection increases the molecular concentration of pigments as well as increasing the noise capacity. This is because the detection is a function of the spectral response, so it changes with the detector response.

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