Optical limiting studies and saturated output of continuous wave laser in Fluorescein solution

Aqeel Lafta Mghames, Hussain Ali Badran and Hussain Falih Hussain

Abstract— **Optical limiting performances in Fluorescein with different concentration of 2, 4, 6 and 8 mM are investigated by using 473 nm continuous wave (cw) laser. The optical limiting behavior is investigated via transmission measurement through the sample at different concentrations. The investigation shows that the optical limiting capability is concentration dependent. The results showed that the sample has obvious optical limiting effect. 8 mM concentration has the best limiting effect among the four concentrations chosen. It is also found that the threshold value of optical limiting is affected by sample absorption coefficient. The Fluorescein exhibits good optical limiting properties in solution.**

Index Terms— Optical limiting, Laser, Fluorescein, limiting thresholds

I. INTRODUCTION

Organic molecules with large third-order optical nonlinearities continue attracting attentions because of their potential application in optical communications, optical storage, optical computing, harmonic generation, all optical switching, optical limiting, eye and sensor protection, etc. [1,2]. Among all the nonlinear optical (NLO) properties applications, optical limiting (OL) is one of the most promising in practice, such as the protection of human eyes and optical sensors [3,4]. Several mechanisms could lead to optical limiting behaviour, such as reverse saturable absorption (RSA), two-photon absorption (TPA), nonlinear refraction and optically induced scattering [5,6]. In RSA, the absorption coefficient increases with increasing light intensity. Optical limiters based on RSA are very transparent for weak light and get opaque for the intense light.

Investigations of optical limiting performance have attracted considerable attention because of the increasing demands in laser protection against laser threats to sensors and human eyes. One major approach to laser protection is through the use of optical limiters. The present challenge is to develop new nonlinear optical materials with stronger optical limiting properties [7–9]. Typical optical limiting materials include carbon black suspension [10,11], carbon nanotube [12–15], azo dye [16-19], metallophthalocyanines [20] and metal clusters [21,22].

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Recently, because of the rapid progress in synthetic chemistry, various metal nanoparticles and material [23-34] have been considered as potential optical limiting materials. Here we report on the experimental investigation of the optical limiting properties of an organic compound, namely Fluorescein has been experimentally investigated by using continuous wave solid state laser SDL as excitation source at 473 nm wavelength. The organic compound which is used in this study are considered to be promising materials, mainly because they offer many advantages such as high damage threshold, easy molecular design, architectural flexibility, low cost and good process ability to form optical devices. Moreover, this organic compound has good solubility in chloroform.

II. EXPERIMENT

A. Preparation of Sample

Fluorescein, with molecular formula= $C_{20}H_{12}O_5$ and molecular weight =332.31 gmmol^{-1}, has been selected for our experiments. The chemical structure of Fluorescein is shown in Fig. 1. The solution sample of the Fluorescein was prepared as follows: 0.5 g of the sample powder was dissolved in 10 ml of chloroform, the organic solution was stirred at room temperature for 30 min and then the solution was filtered through a 0.2 mm syringe filter.

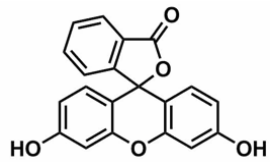

Figure 1 Chemical structure of Fluorescein.

B. UV-Visible spectroscopic studies

The linear UV-Vis (Ultraviolet-visible) absorption spectra for the Fluorescein in solvent chloroform was recorded using Cecil Reflected- Scan CE 3055 reflectance spectrometer. The optical absorption for the Fluorescein in the solvent chloroform with different concentrations, 2, 4, 6 and 8 mM, respictivily, shows absorption peak at 461 nm as can be seen in Fig. 2. Also it can be seen from the Fig. 2 that the absorbance of the sample increases with increasing the concentration due to the increase in the number of molecules per unit volume, so the absorbance will be increased.