



## Full length article

## Study of nonlinear optical properties and optical limiting of acid green 5 in solution and solid film

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## ABSTRACT

Experimental investigation of the nonlinear optical properties of aqueous solution of acid green 5 and acid green 5 doped polyvinyl alcohol film, by Z-scan technique using continuous wave (CW) laser is presented. Both samples exhibit large negative nonlinear refractive index. The optical limiting properties were also studied. The efficiency of the optical limiting was found to depend on the diameter of the detector aperture and the position of the sample. The dye exhibits good optical limiting properties in solution and solid PVA host. The mechanism of optical limiting is found to be predominantly of a thermal origin.

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## 1. Introduction

Over the past three decades, researchers have focused on finding materials with potential applications such as optical limiter. Among these materials, the organic compounds have the best properties compared to the rest of the materials since they possess high non-linear optical properties, easy molecular design, architectural flexibility, low cost and high damage threshold [1]. Organic materials that proved to be effective as an optical limiter are porphyrins [2,3], hexamethylin-dotricarbocyanine perchlorate dye [4], metallophthalocyanines (MPcs) [5–7], sudan red B [8], fullerenes [9,10], 3,4-pyridinediamine [11], carbon black and carbon nanotubes suspensions [12–14], 3,4-diaminopyridine [15], octaisopentyloxy-phthalocyanine [16], vanadyl phthalocyanine [17], thiophene-based conjugated polymer [18], chicao sky blue 6B [19], sudan III dye doped polymer [20], 2,6-dibromo-3,5-distyrylBODIPY dyes [21], metal organic complex-Bis thiourea zinc acetate single crystal [22], phloxine B [23], copper phthalocyanine into polymer host [24], 2,3-Pyridinediamine [25], zinc-phthalocyanine in polymer-phthalocyanine composite film [26], disperse red 1 dye doped polymer [27], acid blue 29 [28] 4,40-bis (3-methoxy benzylidene amino) biphenyl doped poly-methyl methacrylate (PMMA) [29] and parsley oil [30].

In this work, we report for the first time the nonlinear optical properties of aqueous solution of acid green 5 (colour index number 42095) and acid green 5 doped polyvinyl alcohol (PVA) film. Experiments were performed at a wavelength of 632.8 nm using

Z-scan technique. The optical limiting properties of the samples were also studied. The mechanism that explains the behavior of the optical limiting is given.

## 2. Experimental

## 2.1. Preparation of sample

Acid green 5 and polyvinyl alcohol (PVA), which is chosen as a host polymer in this study, were purchased from Aldrich and used without further purification. The acid green 5 belongs to the triphenylmethane groups. Acid green 5 is a sodium salt of dibenzyl diethyl diamine-triphenyl carbinol triphenyl sulphonic acid. It is highly soluble in water. Green solution is obtained on dissolving acid green 5 in water. The chemical structure and molecular formula for acid green 5 are given in Fig. 1. To prepare the films, a known quantities of PVA and acid green 5 were dissolved in distilled water separately, then the solution of acid green 5 and that of PVA were mixed completely and stirred for 3 h using a magnetic stirrer. The ratio of PVA solution and acid green 5 solution is 1:1. The concentration of the acid green 5 in water was 0.5 mM. The mixed solution was then spread on a clean glass slide by the casting method and dried at room temperature for 24 h. The film thickness was measured by using a digital micrometer (Leybold-heraeus, Germany) and found to be approximately 30  $\mu\text{m}$ . The aqueous solution concentration was 0.1 mM while the film prepared from a solution of 0.5 mM concentration made of acid green 5 doped PVA. We also prepared films with thicknesses less and bigger than 30  $\mu\text{m}$ . The results of these two samples were not shown

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