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Z-Scan Measurement For The Thermo-Optic Coefficient and Transmitted Beam Profile Of 1.8-Dihydroxy-Naphthalin-3, 6 Disulfonic Acid-[2-(4-azo)]-N-(5-Methyl-3-Isoxazolyl)-Benzene Sulfonamide

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Abstract

The nonlinear optical properties of an azo dye (1.8-Dihydroxy-naphthalin-3, 6 disulfonic acid- [2- (4-azo)]-N-(5-methyl-3-isoxazolyl)-benzene sulfonamide) are studied by using z-scan and diffraction ring technique with continuous wave (cw) laser at a wavelength of 532 nm. The obtained results for the nonlinear refractive index , n_2 , and the thermo-optic coefficients , dn/dT , are found to be of the order of 10^{-8} Wcm^{-2} and 10^{-6} K^{-1} respectively. The transmitted beam profiles, the distribution of intensity corresponding to the sample positions and D- distribution of rings number of each pattern variation for the azo dye samples have been studied. These results indicate that the azo dye is a promising candidate for applications in nonlinear optical devices.
Keywords: Nonlinear refractive index, Thermo-optic coefficients, Diffraction ring.

1. Introduction

In recent years, extensive studies have been carried out on organic nonlinear optical (NLO) materials due their very high nonlinearity, less dense, chemical stability and short response time to optical excitation properties irrespective of their poor mechanical and thermal properties (Gandhimathi & Dhanasekaran 2012). NLO materials can be used to manipulate optical signals in telecommunication systems and other optical signal processing applications (Ogawa *et al* 2002). Organic materials are considered as one of the important classes of third-order NLO materials because they exhibit large and fast nonlinearities and are, in general, easy to process and integrated into optical devices (Bredas *et al*. 1995; Rik *et al*. 1998; Gubler 2002). Moreover, a fine-tuning of the NLO properties of organic compounds can be achieved by rational modification of the chemical structure (Gema *et al*. 2004). Various types of organic compounds have been studied to obtain materials with large third-order nonlinearity. On the other hand a wide range of techniques have been used to measure third-order nonlinearity: e.g. Z-scan (Sheik-Bahae *et al*.1989 ; Sheik-Bahae *et al*.1990), nonlinear interferometry (Moran *et al*. 1975), degenerate four-wave mixing (Qussaiy *et al*. 2006), nearly degenerate three-wave mixing (Adair et al.1987), ellipse rotation (Owyoung 1973), beam distortion measurements (Williams *et al*. 1984), optical third harmonic generation (THG) (Maker & Terhune 1965) and frequency resolved optical gating (Wang *et al*.1999).
Materials that possess nonlinear optical properties have been investigated extensively for their potential applications in optical fibers, data storage, optical computing, optical switching, and optical limiting (Lanzerotii *et al*.1996; Lidorikis et *al*.1997; Justus *et al*.1993; Alan *et al*.1993). Among the promising class of materials, azo dyes (Katz *et al*.1987; Brzozowski *et al*. 2001; Rangel-Rojo *et al*.1998; Yang *et al*. 2005) play a vital role because of their good photo-thermal stability, dissolvability etc. The character of its molecular structure is double-bond N= N between the two phenyls (Shengwen *et al*. 2004; Yildiz *et al*. 2002; Mendez *et al*. 2005). Its potential application is to work as novel optical limiter for its nonlinear optics effect. The extensive use of continuous wave lasers for various applications with power levels ranging from μW to kW has induced a need to protect the human eyes and sensors (Gayathri & Ramalingam 2008). In order to find the suitability of a material for nonlinear applications one needs to study its photo physical as well as its optical characteristics such as type of nonlinearity, its magnitude, response time etc . In this article, For azo dye (1.8-Dihydroxy-naphthalin-3, 6 disulfonic acid-[2-(4-Azo)]-N-(5-methyl-3-isoxazolyl)-benzene sulfonamide) portability in the form complexes with some metals, we have chosen vanadyle ion (VO^{+2}) for this study because of its importance, , existence in nature and its composition stable complexes in oxidative status (+4). The synthesis of the chosen azo dye is shown in Figure1. We report the results of the refractive nonlinearities studied by using the single beam Z-scan