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Study of thermal lens technique and third-order nonlinear susceptibility of PMMA base containing 5′, 5″-dibromo-*o*-cresolsulfophthalein

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Abstract Measurements of the third-order nonlinear susceptibility of 5′, 5″-dibromo-*o*-cresolsulfophthalein (BCP) in a chloroform solvent were studied using a cw diode laser at 532 nm as the source of excitation, both in solution and as a poly methyl methacrylate solid film, respectively. The optical response was characterized by measuring the intensity-dependent refractive index (n_2) of the medium using the Z-scan technique. The sample showed negative and large nonlinear refractive index values of the order of 10^{-7} cm^2/W and reverse saturable absorption with high values of the nonlinear absorption coefficient of the order of 10^{-4} cm/W. The nonlinear refractive index was found to vary with the concentration. The optical constants of the film were studied and the dispersion of the refractive index was discussed in terms of the Wemple–DiDomenico single oscillator model. Thermal lens technique was applied to investigate the thermo-optical properties (dn/dT) and the thermal diffusivity (D). In this technique a pump beam was aligned collinearly. A localized change in the refractive index of the sample due to the thermal heating produced a thermal lens that was then detected by the study of the focusing and defocusing of the pump beam. Morphological of a one-dimensional microscopic image surface profile scan and histogram curve of the film surface has been studied.

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1 Introduction

There has been a great need for nonlinear optical materials that can be used with low-intensity lasers for applications such as the polarized photo induced an isotropy, phase conjugation, image processing, nonlinear optics effect and all-photo switching [1–11]. The propagation of a laser beam in nonlinear media with intensity-dependent refractive index and absorption coefficient is accompanied by a variety of interesting phenomena. In order to utilize nonlinear optical (NLO) materials in photonic devices, such materials should possess a high NLO chromophore density so as to display large optical nonlinearity, low optical losses and ultrafast response time. Because there exists no symmetry requirement for third-order nonlinear optical effect this allows studies on a variety of organic molecules and polymers. The organic dye has good photo-thermal stability, dissolvability and easy preparation virtues, so that it can be used as a novel storage medium [12–15]. Most importantly, its structure can be modified to change the absorption property to act as a novel optical limiter for its nonlinear optics effect.

The organic dye molecules are known which possess *trans–cis* isomerization property under irradiation at an appropriate wavelength, which lead to reorientation of the organic groups, and reduce optical anisotropy. The *trans* isomerizes *cis* form usually by absorbing the light of short-wavelength (usually in UV region). We think the *trans–cis* isomerization can be photoinduced through two photon absorption process by absorbing the light of long-wavelength (in visible region) [16]. Bromo group is an effective group for the microscopic second order nonlinearities. Moreover, the bromo group can also obviously improve the transparency and the thermal stability of compounds [17, 18]. 5′,5″-dibromo-*o*-cresol-sulfophthalein (BCP) dye is one of the sulfonephthalein dye group where the central carbon

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