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Advances in Applied Science Research, 2012, 3 (2):706-712

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ISSN: 0976-8610
CODEN (USA): AASRFC

The influence of solvents on formation of self- focusing in organic dye using CW laser light

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ABSTRACT

Owing to the nonlinear effect of optical field-induced director reorientation, self-focusing of an optical beam can occur in organic dye and an almost diffraction compensated propagation can be observed with milliwatts of light power and propagation lengths of several millimeters. This open the way for applications in all-optical signal handling and reconfigurable optical interconnections. Self-focusing of an optical beam in 2,8-Phenazinediamine,N8,N8,3-trimethyl- hydrochloride(1:1)dye in aqueous and Dimethyl Sulphoxide cells solutions using cw laser beam at 631.7 nm has been studied experimentally.The relationships between different solvents and required optical power have been examined. The nonlinear refractive index of dye-DMSO and dye -aqueous are found to be in the order of 7.859×10^{-7} cm^2/Watt, 7.178×10^{-7} cm^2/Watt, respectively. The results indicate that 2,8-Phenazinediamine,N8,N8,3-trimethyl-, hydrochloride (1:1) dye solutions are potential candidate for low-power optical limiting application. The optical limiting behavior of the solvents of the dye are also demonstrated. Thermo-optic coefficients (dn/dT) of DMSO and water solvents are measured too.

Key words : Organic dye , cw laser , Self- focusing , Solvent effect.

INTRODUCTION

Self focusing occurs when a light beam having nonuniform spatial profile (such as a Gaussian laser beam) and sufficient intensity propagates through a nonlinear medium having an intensity dependent index of refraction [1]. The change in refractive index in all optical materials are dependent to a greater or lesser degree on the intensity of the optical field. Thus intensity dependent index of refraction,n, is usually expressed as the sum of two terms.

$$n = n_0 + n_2(E^2/2) \qquad (1)$$

$$n = n_0 + n_2\left(\frac{I}{2}\right)$$

$$n = n_0 + \Delta n$$

Where E is the peak amplitude of the electric field, n_0 is the background refractive index , I is the laser light intensity and Δn is the refractive index change. If the optical beam frequency is relatively far from any resonance absorption line of the medium, then the nonlinear index of refraction, n_2 , can arise from one of the following mechanisms: molecular orientation Kerr effect, molecular redistribution or libration, third-order nonlinear polarizability , electrostriction and thermal changes [2-5].

Self-focusing would be of minor interest were it not for its role in enhancing the local optical intensity to extraordinary high values. In the vicinity of a self-focusing ,the field strength is large enough to drive a host of nonlinear processes including multi- photon absorption, stimulated scattering and dielectric break down, which might otherwise be absent at the incident intensity [6,7].