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Diffraction Ring Technique and Nonlinear Optical Properties of 5-Aminoindazole

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Abstract: *The nonlinear optical properties of 5-Aminoindazole in Dimethyl sulfoxide (DMSO) solvent was studied using single beam Z-scan technique with a continuous-wave radiation at 473 nm of an output power of 4.6 mW. All the solution samples showed large nonlinear refractive indexice and absorption coefficient of the order of 10^{-8} cm^2/W and 10^{-3} cm/W, respectively. The concentration-dependent nonlinear refractive index was also investigated. We presents experimental evidences of observing diffraction pattern in 5-Aminoindazole: DMSO solvent with the calculation of the refractive index change, Δn , the relative phase shift, $\Delta\Phi$, and effective nonlinear refractive index ,n_2. The solvent of spectroscopic grade and was used without further purification. All the solutions used for the study were freshly prepared.*

Keywords: *nonlinear refraction index; Z-scan ; cw laser; diffraction rings*

I. Introduction

Organic dyes have many advantages over other nonlinear optics (NO) materials. Photoisomerization of organic molecules enables modifies their linear and nonlinear polarizability of them as well as optical nonlinear refraction. Since the optical properties of organic molecules can be controlled optically, it has intrigued considerable interest of people [1,2]. The nonlinear optical phenomena of organic dyes can result from electronic response and/or nonelectronic one. The electronic nonlinearity is induced by either population redistribution or distortion of electronic clouds. A molecule undergoes a transition from its ground state to its excitation state after absorbing a photon. The dipole moment of the molecule changes during such a transition. The change in the dipole moment will give birth to electronic nonlinearity. A nonelectronic response is a non-radiative interaction such as cis-trans isomerism, the changes in density and temperature [3–5]. It has been well known that the nonlinear optical behavior of materials can vary greatly by changing different laser duration or different laser wavelengths. Thus, studies about the mechanism of their nonlinear optical response with different laser duration or different laser wavelengths are expected to be more interesting and important. If the nonlinear mechanism is understood for certain laser pulses, the NLO properties optimization can be well accomplished. Z-scan technique is a simple and effective tool to determine the nonlinear properties [6]. It has been widely used in material characterization because it provides not only the magnitudes of the real part and imaginary part of the nonlinear susceptibility, but also the sign of the real part. Both nonlinear refraction and nonlinear absorption in solid and liquid samples can be measured easily by Z-scan technique, which use the change of transmittance of nonlinear materials [5].

In this work, we demonstrate the optical nonlinearities of a 5-Aminoindazole at different concentration in Dimethyl sulfoxide (DMSO) through Z-scan technique under laser excitation at 473 nm cw solid state laser with an output power of 4.6 mW and presents experimental evidences of observing diffraction pattern in 5-Aminoindazole: DMSO solvent with the calculation of the refractive index change, Δn , the relative phase shift, $\Delta\Phi$, and effective nonlinear refractive index ,n_2 .

II. Materials and Methods

A. Absorption spectra

The solution samples of 5-Aminoindazole were prepared in DMSO. The former was contained in a 1mm quartz cuvette. The linear absorption spectrum of the sample solution with the concentrations of 2mM, 4mM, 6mM and8mM in DMSO solvent is shown in Fig.2, which was acquired using a UV–VISNIR spectrophotometer (Type: CECIL –CE-3550) .

The Z-scan experiments were performed using a 473 nm solid state laser beam, which was focused by +50 mm focal length lens. The laser beam waist ω_0 at the focus is measured to be 22.19 μm and the Rayleigh length Z_R =3.27 mm. The schematic of the experimental set up used is shown in Fig.2. A 1mm wide optical cell containing the solution of 5-Aminoindazole is translated across the focal region along the axial direction that is the direction of the propagation laser beam.