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Far-field diffraction patterns and optical limiting properties of bisdemethoxycurcumin solution under CW laser illumination

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ABSTRACT

In this work, nonlinear optical properties of bisdemethoxycurcumin solution were studied using diffraction ring patterns method. Multiple diffraction rings observed as a continuous wave (CW) laser beam passes through a bisdemethoxycurcumin solution. The nonlinear refractive index, n_2, and change in refractive index, Δn, for sample were determined from the number of observed rings, and are found to be 0.8337×10^{-6} cm^2/W and 0.30946, respectively. The evolution of the diffraction ring patterns are numerically studied using the Fresnel-Kirchhoff diffraction integral theory. The experimental findings are in good agreement with theoretical analysis. Also the optical limiting properties of the sample were measured at 473 nm. The obtained results proved that the sample bear good optical limiting property.

1. Introduction

Due to the continuous considerable interest the search for materials exhibiting fast responses and large nonlinear refractive indexes have led to the discovery of large number of materials. These materials might have many applications in the future in the field of electronic and photonic devices [1–14]. In general, the variation of optical properties of materials induced by high intensity light is divided into light induced absorption changes and light induced refractive index changes. The second one i.e. light induced refractive index changes are usually described by

$$n = n_o + n_2 I \quad (1)$$

n is the total refractive index of the material in the presence of high intensity laser beams, n_o is the back ground refractive index, n_2 is the nonlinear refractive index and I is the incident light intensity.

Curcumin is the main curcuminoid of the Indian spice and food coloring agent turmeric, which is a member of the ginger family [15]. It can exists in at least two tautomeric forms in the electronic ground state; keto and enol. Curcumin exhibits interesting photo physical and photo chemical properties [16–18].

Curcumin is a natural yellow pigment isolated from rhizome of curcuma Longa L.(turmeric) [19]. It possesses a wide range of pharmacological properties including anti-inflammatory, hypocholesterolemic and anti-infectious activities. According to Henari et al. [20], the powdered rhizome is used in curries for flavoring and coloring of the diet. Curcumin has been used as a medicine for the treatments of inflammation, skin wound and cough. Its anticancer properties have generated interest resulting in many applications. Chemical analysis of the extraction products of this powder by a variety of solvent mixtures has shown that one of the principle components is bisdemethoxy [1,7-bis (4-hydroxyphenyl)-1, 6-heptadiene-3, 5-dione], curcumin. Demethoxycurcumin and bisdemethoxycurcumin have received little attention to study their nonlinear properties [20–22].

The current study focuses on improving the nonlinear optical properties and synthesizing new material. A result of studying the nonlinear response of bisdemethoxycurcumin solution via diffraction patterns is presented. The value of nonlinear refractive index, n_2, of this material has been evaluated using diffraction ring patterns technique. The optical limiting properties of bisdemethoxycurcumin solution are also investigated.

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