



Spectroscopic study, theoretical calculations, and optical nonlinear properties of amino acid (glycine)-4-nitro benzaldehyde-derived Schiff base

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ABSTRACT

Schiff base of amino acid salt: potassium 2-((4-nitrobenzylidene)amino)acetate 4 ($C_9H_7KN_2O_4$), derived from the condensation reaction of amino acid (glycine) 1 and 4-nitro benzaldehyde 3 is synthesized and fully characterized by magnetic nuclear resonance (1H and ^{13}C NMR), infrared (IR), mass, UV-visible spectroscopies and melting point. The optical nonlinear (ONL) properties of amino acid Schiff base salt 4 are studied using continuous wave (cw), visible, single transverse fundamental mode, low power, 473 nm laser beam. Ring diffraction patterns (RDPs) and Z-scan techniques are adopted to calculate the nonlinear index of refraction (NIR) together with testing the sample property of optical limiting (OLg). RDPs are simulated numerically using the integral of Fresnel-Kirchhoff and compared with experimental findings.

1. Introduction

Recently, interest has been growing in the investigation of optical nonlinear (ONL) properties of various organic materials. The study of the ONL properties are carried out using three different techniques viz., spatial self-phase modulation [1] (SSPM), thermal lens (TL) [2], and the open and closed apertures Z-scans [3]. The passage of a Gaussian continuous wave (cw), single fundamental, TEM₀₀, mode laser beam through a nonlinear medium, resulted in phenomena in the transverse dimensions viz., SSPM, self-focusing (SF) and self-defocusing (SDF), beam break-up, optical switching, optical bi stability, optical solitons, optical limiting (OLg), etc. [4–25]. Two main properties of the nonlinear materials viz., the nonlinear index of refraction (NIR) and response times need to be determined. The SSPM and Z-scan techniques were used extensively for these purposes since 1967 [26–31]. The first technique leads to the determination of the medium total index of refraction change and its NIR [32] while the second one leads to the calculation of the nonlinear absorption coefficient (NAC), NIR and number of ONL parameters [3].

The absorption of part of incident laser beam energy with Gaussian extent by the medium leads to a bell-like heat distribution with the

maximum temperature be on the axis of the laser beam direction of propagation and minimum away from the axis. Such temperature distribution leads to change in the medium index of refraction hence a phase change of the laser beam mimics the transverse distribution of the laser beam occur. The absorption leads to two types of thermal currents within the nonlinear medium viz., conduction current horizontally and convection current vertically.

Schiff bases are organic compounds constituted by a condensation reaction of amine and various active carbonyl groups connected by an azomethine ($-N=CH-$) bond, serves as the principal moiety for a family of aromatic azomethine compounds [33]. In general, Schiff bases are of great importance in organic and pharmaceutical fields due to their wide and efficient applications in these areas [34]. Due to the important exploitations of Schiff base compounds in varied applications viz., image systems, phase conjugation, optical limiting, optical switching, and optical data storage etc. [35], these compounds have attracted intense efforts to discover their ONL properties such as their nonlinear absorptions, and NIR, etc [36,37].

On the other hand, Schiff bases that derived from amino acids and different active carbonyl groups are important for their diverse applications [38]. The amino acid Schiff bases are in chemistry use as

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