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Investigation of optical limiting and third-order optical nonlinear properties of 2-Nitroaniline by *Z*-scan and *f*-scan techniques

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Abstract

The nonlinear optical properties of 2-Nitroaniline, which is known to be a superior nonlinear optical material, have been investigated. The optical properties, such as absorption coefficients, are analyzed with UV visible spectroscopy analyses. The third-order nonlinear optical properties of the sample are analyzed with *Z*-scan, Eclipse *Z*-scan and *f*-scan techniques. The nonlinear absorption coefficient, nonlinear refractive index and third-order susceptibility are examined using open aperture and closed aperture *Z*-scan methods. The nanoscale sensitive variations in the nonlinear optical properties are observed with the Eclipse *Z*-scan method. The third-order optical nonlinearities occurring in the nanoscale range are also analyzed using the *f*-scan method and compared with the results obtained from the *Z*-scan measurement. The optical limiting characteristics of the sample have also been examined for its low-power optical limiting applications.

Keywords: nonlinear optical material, *Z*-scan, eclipse *Z*-scan, *f*-scan, optical limiting

(Some figures may appear in colour only in the online journal)

1. Introduction

In the more recent past, nonlinear optical processes have been gaining more importance for the application in variety of optoelectronic, optical switching, telecommunication systems and photonic devices [1]. The development of organic materials can be utilized as a nonlinear optical material for third-order nonlinear optical processes, which have given more importance to the research of optoelectronic technology and devices based on them [2, 3]. Organic materials are prominent candidates as nonlinear optical materials because of the easier fabrication of the devices, low cost and fast nonlinear optical responses [1]. In recent years there has been growing interest in the research of aniline and its derivates for third-order nonlinear optical applications [4–6]. One among the derivates, namely nitroaniline, is given much importance for its large optical nonlinearity, which gains more attention for research in the field of nonlinear optics [7, 8]. The earlier reports reveal the optical properties and nonlinear optical behavior of nitroaniline derivatives in the form of crystals for nonlinear optical applications [9–13].

In recent years, the fabrication of optoelectronic and photonic devices have been made using organic materials because of their large optical nonlinearity and third-order susceptibility. The *Z*-scan is an extensively employed technique to determine the nonlinear optical properties and third-order susceptibility of the optical materials because of its simplicity and high sensitivity [14–17]. In this technique, the sample is scanned through the focal region of the propagation direction of the focused Gaussian beam along the *z*-axis, and the transmittance of the sample is monitored. The changes in the transmitted intensity at the far field occur due to the Gaussian

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