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Thermal diffusivity of 2,3-Pyridinediamine determination by thermal blooming

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ABSTRACT

The nonlinear optical properties, optical limiting and self diffraction of 2,3-pyridinediamine in the solvent DMSO have been studied. The measurements were performed using a low power continuous wave (CW) from solid state laser (SDL) at 473 nm wavelength. The effect of the pH in 2,3-pyridinediamine solution on nonlinear optical properties, optical limiting and self diffraction pattern have been investigated. The results show the dependence of the nonlinear refractive index, nonlinear absorption coefficient, optical limiting threshold and number of diffraction rings on the pH values. This 2,3-pyridinediamine solution exhibit an interesting optical limiting performance with CW laser. Thermal blooming technique was applied to investigate the thermo-optical properties and the nonlinear refractive index. In this technique a pump beam was aligned collinearly. A localized change in the refractive index of the sample due to the thermal heating produced a thermal lens that was then detected by the study of the focusing and defocusing of the pump beam. With excellent nonlinear optical coefficient, the sample is expected to have potential applications in optical devices.

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1. Introduction

With the development of laser technology, there has been much interest in the development of optical limiting materials. Devices for the protection of human eyes and solid-state sensors from intense laser beams are sought [1–5]. Optical limiting results from intensity dependent optical nonlinear processes. Thus it is important to investigate the optical nonlinear responses of materials to select suitable materials as optical limiting media [6]. For optical limiter the material must exhibit strong nonlinear response and decreasing transmittance with increasing irradiance so that the transmitted pulse energy never exceeds the damage threshold for the optical sensor [7]. The OL behavior can be achieved by one or more of the nonlinear optical mechanisms such as excited state absorption reverse saturable absorption, free carrier absorption, multi-photon absorption, thermal defocusing/scattering and photo refraction [8–13].

The ultimate goal of this study is to develop optical sensitive devices in the visible spectral region. Organic materials are a promising system for various photonic applications due to their large optical nonlinearities and fast response [14]. In particular, the development of optical-limiting materials using organic solutions is attractive because they are easy to prepare, highly soluble and stable in both aqueous and organic solvents. However, in order to optimize their nonlinear optical response, to achieve main goal of this work, we study the effect of the pH on the nonlinear optical and optical limiting properties of organic material, namely 2,3-pyridinediamine. We find that the limiting threshold of the sample can be improved by increase the pH in sample solution. Thermal blooming technique is applied to evaluate the thermo-optic coefficient of 2,3-pyridinediamine with pH12. In thermal blooming experimental setup a transistor–transistor logic (TTL) modulated cw laser of wavelength 473 nm was used as the excitation source.

2. Experiment

2.1. Preparation of the sample

The 2,3-pyridinediamine solutions, in different pH, were prepared at room temperature (22 °C) with the addition of proper amounts of standard HCl or NaOH as following: Blank solutions (reference, 10 mM) were prepared by 0.0275 gm of the 2,3-pyridinediamine powder and was dissolved in 25 ml of DMSO; the solution was stirred at room temperature for 50 min then the solution was filtered through a 0.2 mm syringe filter. The solution sample was transferred into five cleaned dry test tubes. The proper

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