



Thermal and Nonlinear Optical Properties of Sudan III

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Abstract

We report the experimental and theoretical study of the diffraction patterns (DPs) and thermal properties of Sudan III. DPs are used in the calculation of the Sudan III nonlinear refractive index (NLRI), n_2 . As high as $n_2 = 7.69 \times 10^{-6} \text{ cm}^2/\text{W}$ is obtained. The study of the Sudan III thermal conductivity, TC, shows the reduction of the TC against the increase of the Sudan III temperature. The property, all-optical switching (AOS), is studied in details, both static and dynamic ones, using two, cw, visible, single mode laser beams of wavelengths 473 and 635 nm.

Keywords Sudan III · Thermal properties · Nonlinear optical properties · Diffraction patterns · All-optical switching

Introduction

Great interest has been expressed in the recent years, to study available materials, improved available materials, and synthesized new materials [1–15], due to the potential of enhancing their nonlinear optical (NLO) properties that leads to photonic devices use. Number of properties of materials have been studied simultaneously viz., thermal diffusivity [16], spectroscopic and thermal [17], thermally and optically induced change of structure, linear and NLO properties [18], nonlinear and thermo-optic parameters [19], thermal lens [20], thermo-optic coefficient [21, 22], medical, thermal and laser damage [23], optical and thermal [24], structural, thermal, and optical properties [25], thermal / spectral and optical enhancements [26, 27], etc.

Recently intense efforts have been directed towards the study of the NLO properties of variety of media by Jeyaram et al. viz., basic violet 3 solution via Z-scan techniques [28], novel organic compound [29], organic compound [30], and a Schiff base via variety of techniques [31] for variety of NLO applications. In addition, our group presented, new materials during the past six years, that possess high NLO properties, which demonstrated their potential for use as optical limiters and switches [32–38].

Sudan dyes are available in different types i.e., Sudan orange G, Sudan black B, Sudan brown RR, Sudan red B, Sudan red 7B, Sudan (I-IV), and Sudan red G [39–41]. These types of dyes have received vast interest including the optical properties viz., under the effect of solvents [42]. Sudan III dye doped polymer optical limiter behavior [43], vibrational studies investigation of structure and NLO properties [44], use in optical sensor applications [45], photo-induced dichroism [46], Sudan III/PVK film composite physical structure [47], and optical properties [48].

We believe that, the diffraction patterns and thermal properties of Sudan III dye have not been studied previously. Therefore, in the current work, we will study the thermal properties of Sudan III dye where the thermal conductivity (TC) of Sudan III at different temperatures were studied. By excitation with a visible, cw, laser beam, the NLO properties of Sudan III dye were also investigated. The nonlinear refractive index (NLRI), n_2 , of Sudan III was determined using diffraction patterns (DPs) method. A theoretical simulation of experimental results was carried out using Fresnel-Kirchhoff (F.K.) integral. The property, all-optical switching (AOS), of the Sudan III was tested using 473 nm and 635 nm laser beams.

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