



Determination of Linear, Nonlinear, and the Optical Limiting Properties of Sudan Brown RR in a Solid Film and Solution

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Abstract

The casting technique is employed to prepare the film from a mixture of sudan brown RR (SBRR) dye and poly methyl methacrylate (PMMA). The surface profile of this film is identified using a scanning probe microscope and image J software. The linear optical (LO) properties of the solid film were studied. The nonlinear optical (NLO) properties of SBRR/PMMA film and sudan brown (RR) solution in dimethylformamide (DMF) as a solvent are evaluated using two methods including diffraction ring patterns and Z-scan. The optical limiting (OLg) property for the SBRR/PMMA film and SBRR solution was extensively investigated. The values of nonlinear refractive index (NRI) and threshold limiting (T_H) of the solid film and dye solution were compared.

Keywords Schiff base · RDPs · Z-scan · NIR · OLg · Optical materials

Introduction

The search for suitable materials which can be used in photonic applications such as optical phase conjugate [1], optical modulation [2], optical limiting (OLg) [3–13], optical bi-stability [14–17], optical switches [18–21], optical signal processing [22], and optical data storage [23–25], has increased during the past three decades due to these applications have attracted many academic groups working in this scope. The goal for preparing materials is to find the appropriate photonic applications for their usages according to their potential properties. Before investigating the photonic applications for any material, the nonlinear optical (NLO) properties for this material should be first studied. Once, the materials that have high NLO properties can be used in photonic applications.

In recent studies, many materials have proven to have high NLO properties such as inorganic materials, organic materials, and semiconductors [26–33]. Organic materials among the different materials have been identified to be the best compared to the others. Among the various organic materials that were introduced, the organic dyes, particularly

those contain an azo group. These dyes have found to possess efficient and high NLO properties. The molecular structure of an azo compound generally contains an azo group (-N=N-) which is bonded to any atomic group, and this atomic group can be any organic class. Sudan dyes belong to the azo aromatic compounds, containing azo and diazo groups. Many sudan dyes have been studied for their linear optical (LO) and NLO properties during the last past years. Where sudan I [34], sudan III [35, 36], sudan IV [37, 38], sudan red G, and sudan Orange G [39] showed high NLO properties. Also, sudan IV proved its efficiency in the field of optical storage [40]. At the same time, sudan III displayed the behavior of the optical limiter (OLr) [41].

From the foregoing, we can conclude that azo dyes, especially sudan dyes, have high NLO properties and that have the potential to be used in the field of photonic applications. This encouraged us to choose a sudan brown RR dye from the azo family and from the sudan group as a sample in the present study to achieve the goal of this study, which is to find a material used as an OLR with good specifications.

The surface profile and LO properties of the mixture of sudan brown RR (SBRR) dye and poly methyl methacrylate (PMMA) film were extensively studied in this paper. The NLO and OLg properties of SBRR/PMMA film and SBRR solution were also investigated. The LO properties were determined using the reflectance, transmittance, and absorbance spectra measurements of the SBRR/PMMA

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