Optical Materials 139 (2023) 113824

Contents lists available at ScienceDirect

Optical Materials

journal homepage: www.elsevier.com/locate/optmat

Research Article

Thermal nonlinearity and all-optical switching of synthesized Azo-Cl compound

Uhood J. Al-Hamdani [a], Qusay M. A. Hassan [b,*], Rita S. Elias [c], H.A. Sultan [b], Saja A. Alshlshat [d], C.A. Emshary [b]

[a] Department of Chemistry, College of Education for Pure Sciences, University of Basrah, Basrah, 61001, Iraq
[b] Department of Physics, College of Education for Pure Sciences, University of Basrah, Basrah, 61001, Iraq
[c] College of Pharmacy, University of Basrah, Basrah, 61001, Iraq
[d] Petroleum Engineering, University of Almaaqal, Iraq

ARTICLE INFO

Keywords:
Liquid crystal
DPs
Z-scan
All-optical switching

ABSTRACT

Azo-Cl compound is synthesized and fully characterized via NMR and mass spectroscopies. The Azo-Cl compound thermal properties, theoretical chemical shifts, chemical structure, electron absorption spectrum, frontier molecular orbitals, the atomic dipole moment, corrected Hirshfeld charge analysis and electrostatic molecular potential of the Azo-Cl compound are studied in details. The Azo-Cl compound nonlinear refractive index (NLRI) is estimated via diffraction patterns (DPs) and the Z-scan, using low power continuous wave (cw) laser beam. The all-optical switching (AOS) property is recognized in the Azo-Cl compound using two laser beams. We found that the value of the NLRI of sample calculated by the diffraction patterns is greater than the value calculated by the Z-scan, due to the use of different input powers in both cases. The experimental results proved that the sample showed a high NLRI in the range of 10^{-7} calculated by the Z-scan method under low input power of 5 mW, which indicates that the Azo-Cl compound is a good candidate to be used in optical device applications.

1. Introduction

It is witnessed in the recent years a constant interest for the search of new materials, materials with improved properties and new synthesized materials [1–3] for the possible use in wide range of applications such as optical data storage [4], image processing [5], phase conjugation [6], all optical switching (AOS) [7–9] and optical limiting [10–14]. Such materials should have nonlinear properties such as high nonlinear refractive index (NLRI), n_2, and fast response time. Two types of experimental techniques have been used to determine n_2 based on the propagation of low power, continuous wave (cw) laser beams viz., diffraction patterns (DPs) [15] and Z-scans [16]. The first one is based on the diffraction of laser low power, single transverse mode beams that enamate from the beam Gaussian wave front on a far field screen.

Liquid crystal or mesomorphic state is neither crystalline nor fully isotropic liquid are useful in the manufacture of electronic display devices and light emitting materials. Azo ester dyes are equally useful as normal dyes including changing their color with changing frequency of exposed light [17,18]. Azo compounds have the following advantages over substances with other linkages such as ester, tolane or Schiff base. Azo compounds are thermally very stable and are attractive from the point of view of studying photo induced effects [19].

Azo compounds have received intense interest since 1979 in different disciplines viz., some monomeric azo-and azoxybenzenes and their polymer [20], optical parameters of azo dye-doped polymer thin films on silicon [21], azobezens for photonic networks applications such as third-order nonlinear optical properties [22], effect of substituent in novel azo-naphthol dyes for nonlinear optical studies [23], characterization of azo dye para red and new derivatives [24], spectral study of chelating azo dyes [25], photophysical and nonlinear optical properties of azophloxine [26], new azo compound for biological evaluation [27], mild coupling of azomethine imines with alkylidenecyclopanes via C–H activation [28], and different nonlinear properties of azo-hydrazone toutomerism [29], of azonaphthol dye [30], of azo-(β) diketene dye [31] and of azo-nitrone compound [32].

It was found that the addition of atoms to the LC give rise to significant impact on it's optical properties. The spatial orientation and position of the added atoms have influence on the nematogenic

* Corresponding author.
E-mail address: qusayali64@yahoo.co.in (Q.M. A. Hassan).

https://doi.org/10.1016/j.optmat.2023.113824
Received 15 October 2022; Received in revised form 22 March 2023; Accepted 20 April 2023