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Investigating some linear and nonlinear optical properties of the azo dye (1-amino-2-hydroxy naphthalin sulfonic acid-[3-(4-azo)]-4-amino diphenyl sulfone)

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ABSTRACT

The optical constants of an azo dye (1-amino-2-hydroxy naphthalin sulfonic acid-[3-(4-azo)]-4-amino diphenyl sulfone) films have been investigated. The transmittance and absorbance spectra were measured in the wavelength range of (300–900) nm. The oscillator energy (E_o), dispersion energy (E_d) and the static refractive index (n_0) have been determined by the Wemple–DiDomenico method. The nonlinear refractive index and the nonlinear absorption coefficient of the azo dye in the ethanol solution were measured by the Z-scan technique using diode laser at 657.2 nm wavelength. The low power optical limiting properties based on the nonlinear refraction of this material have also been studied.

1. Introduction

Recently, the azo dye has become an attractive material due to its optical properties. It has been applied in diverse applications such as the polarized photoinduced anisotropy, nonlinear optics effect and all-photoswitching [1–11]. The azo dye has good photo-thermal stability, dissolvability and easy preparation virtues, so that it can be used as a novel storage medium [12–15]. Most importantly, its structure can be modified to change the absorption property to act as a novel optical limiter for its nonlinear optics effect.

The study of optical absorption transition of azo dye, particularly, the absorption edge has proved to be very useful for the elucidation of the electronic structure of these materials. It is possible to determine the indirect and direct transition occurring in the band gap of the materials by the optical absorption spectra. The transmittance data can be analyzed to determine the optical constants such as refractive index, absorption index and the dielectric constant.

This paper reports the linear optical constants of the azo dye (1-amino-2-hydroxy naphthalin sulfonic acid-[3-(4-azo)]-4-amino diphenyl sulfone) film through an optical spectral analysis, also, the nonlinear optical properties for the azo dye in the ethanol solution were investigated by the use of the Z-scan technique.

2. Experimental

2.1. Sample preparation

An azo dye was prepared by a method similar to that described by Fox [16]. In the present method the dye was prepared as follows:

1. (0.006 mol, 1.4898 g) of the amine was dissolved in 2 ml of conc. HCl and then 10 ml of distilled water was added, then the mixture was stirred and kept in an ice bath.
2. 0.456 g of $NaNO_2$ was dissolved in about 5 ml of distilled water and kept in an ice bath.
3. Diazonium salt was prepared by adding sodium nitrite solution in step (2) dropwise to the cold solution of amine in the step (1) with stirring and keeping the temperature below 5 °C.
4. A coupler was prepared by dissolving (0.006 mol, 2.4017 g) of chromotropic acid disodium salt dehydrate in 25% sodium hydroxide solution and keeping it in ice bath.
5. The diazonium salt was added dropwise to the couplers with a constant stirring, keeping the temperature below 5 °C, the dyes were neutralized with dilute hydrochloric acid solution.
6. The resulting crudes were recrystallized from the methanol; the purity of the resulting azo dye was 94% yield of orange color, the m.p. was >300 °C.

The azo dye has been characterized by the elemental analysis and the IR, and UV spectra. The chemical structure and molecular formula of the chosen azo dye is shown in Fig. 1.

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