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Optical characterization and all-optical switching of benzenesulfonamide azo dye

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ABSTRACT

A film of benzenesulfonamide azo dye has been prepared by spray pyrolysis method onto BK7 glass substrate with average thickness of 2.7 μm. This azo dye was derived from sulfamethoxazole and chromotropic acid by the Fox method. The optical constants (refractive index, n, extinction coefficient, k, dielectric constant, ε, optical, σ_{opt}, and electrical, σ_e, conductivities) were calculated for azo dye film by using spectrophotometer measurements of the absorption, transmittance and reflectance at normal incidence in the spectral range 300–900 nm. Third order nonlinear properties has been characterized by calculating the effective thermal nonlinear refractive index, n_2, and thermo-optic coefficient, dn/dT, of the azo dye solution using thermal lens technique. Furthermore, the thermal lens effect was utilized to demonstrate all optical switching for the sample solution.

1. Introduction

In recent years, the search for novel optical materials has increased owe to their applications in optical devices such as optical modulation, optical information, optical data storage and imaging [1,2]. Detailed investigations of linear and nonlinear optical coefficients enable to fabricate materials, appropriately designed at the molecular level for specific applications such as optoelectronic devices [3,4]. Azo dyes have drawn considerable attention due to their optical characteristics such as optical data storage and nonlinear optics [5]. Although the optical parameters of thin films are of crucial importance, few researches have so far focused on optical parameters of azo dye films [6]. Optical tests giving transmittance and reflectance spectra provide the data to determine optical constants such as refractive index, n, extinction coefficient, k, and dielectric constant, ε [7]. The analysis of optical absorption could provide useful information to the elucidation of electronic structure of material [8]. Other analysis showed that optical absorption spectra could provide the necessary parameters to determine direct and indirect transitions occurring in the band gaps of the materials [9]. High-speed and high-sensitivity optical devices play important roles in optical information processing, optical computation and optical communication. Therefore, the study of all-optical switching characteristics is of importance. The optical switching property is closely concerned with the material of the device. Many materials for optical switching device have been reported, including Rhodamine-B-doped and Au(1 1 1)-doped PMMA film [10], 2-(2′-hydroxy phenyl)benzoxazole [11], hydrogenated amorphous silicon-sulfur alloy [12], Pt:ethynyl complex [13], photochromic dithienylethene derivatives [14], ethyl red doped polymer film [15], bromophenol blue solutions [16], antiferroelectric liquid crystals [17], congo red in solution [18], dye doped liquid crystal gel [19], liquid crystal cells [20],ytterbium doped fiber [21–23], etc. The optical switches based on organic materials are superior to traditional ones based on inorganic materials due to their higher sensitivities and easier fabrication process. Especially, the azo polymer offers great potential applications ranging from optical data storage [24], to optical switching, due to the flexibility [25], the compatibility in fabrication [26] and the reversible trans–cis–trans photoisomerization [27].

Optical switching has been studied extensively in azo materials such as azobenzene containing polymer films [28], in azo-dye doped polymer waveguide [29], azo polymer material [24,27] and azo polymer waveguide [18]. In these studies the switching process is attributed to trans–cis photo isomerization of azo dyes followed by cis–trans thermal or optical relaxation [29].

This work reports the optical properties of azo dye (1,8-Dihydroxynaphthalene-3,6-disulfonic acid-[2-(4-Azo)]-N-(5-methyl-3-isoxazolyl)benzenesulfonamide) film prepared by spray pyrolysis method onto BK7 glass substrate by using

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