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ORIGINAL ARTICLE

Photophysical and Nonlinear Optical Properties of Azophloxine in Reverse Micelles

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Abstract

The photophysical and nonlinear optical properties of Azophloxine in Reverse micelle (RM) and dye-surfactant interaction were studied using Z-scan, spectrophotometer, and spectrofluorometer techniques. The different range of RM sizes and oil polarity is studied. RM is a mixture of water droplet in a continuous phase of oil and its polarity depends on oil polarity. The nonlinear absorption coefficient (β) and nonlinear refractive index (n_2) of Azophloxine in RM depend on the polarity of bulk. By using the NMR instrument, it was observed that the Azophloxine dye is intercalated in the reverse micelles in AOT/Water/Benzene solution and its average location corresponds with the core of the micelle close to polar groups of the surfactant. The rule of charge and length scale of surfactant on the value of β and n_2 of Azophloxine is studied. The results showed that the enhancement value of β and n_2 is due to the solubility reduction of Azophloxine with the anionic surfactant in aqueous solutions or increase of oil length scale in RM. The quantum perturbation theory was used to study the ratio of excited to ground state dipole moment of Azophloxine in RM. By using dynamic light scattering, it was observed that the size of RM reduced with an increase of dye concentration in RM.

Keywords Nonlinear optic · Z-scan · Azophloxine · Solubility · NMR · Dynamic light scattering

Introduction

Azo dye has good nonlinear optical properties [1]. Azophloxine or Acid red 1, has two sulphonic acids with negative charges. One of the interesting topics is the study of nonlinear optical properties of interaction of dye with surfactant in solvent and microemulsion [2–4]. The reverse micelle, consisting of water and oil mixed with a surfactant and the surfactant form a monolayer between the water and oil phase, while the surfactant hydrophobic tails are dissolved in the oil phase and the hydrophilic head groups are dissolved in the water phase [5]. The droplet size and the number of droplet are the important parameters for droplet formation, such that the droplet size can be described by molar ratio and the number of droplet can be described by the droplet mass fraction.

The nonlinear optical properties of materials have applications in photonic and medicine [6]. The Z-scan technique is the way to find nonlinear optic of materials [7]. The Z-scan instrument consists of an open and close aperture detectors, such that the nonlinear absorption coefficient can be extracted from an open aperture curve described by Sheik-Bahae et al. The transition of open aperture curves can be described using Eqs. 1 and 2 [8–10].

$$T_{OA} = \sum_{m=0} \frac{(-q_0)^m}{(m+1)^{\frac{3}{2}}} \tag{1}$$

That q_0 is

$$q_0 = \frac{\beta I_0 L_{eff}}{1 + \left(\frac{z}{z_0}\right)^2} \tag{2}$$

where L_{eff} and z_0 are the effective thickness and Rayleigh length of the sample, and β is the nonlinear absorption coefficient, respectively [10]. It was observed that the nonlinear

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