Investigation of third order nonlinearity of Ethidium bromide doped deoxyribonucleic acid) DNA)

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Abstract. The concentrations-dependent refractive index n_2 and the nonlinear absorption coefficient β of Ethidium bromide dye-doped deoxyribonucleic acid (biological polymer DNA) solutions in the SDL regime at 532 nm are reported. The Z- scan technique was performed in two ways and two different wavelengths, 532nm and 473nm, the open aperture technique and the closed aperture technique. From open aperture Z-scan measurements it is found that the Ethidium bromide doped deoxyribonucleic acid films exhibited reverse saturable absorption. The coefficient of nonlinear refraction and nonlinear absorption coefficient at 473nm wavelength is greater than at 532nm.
keyword: Ethidium bromide, Reverse saturable, Laser , DNA.

1. Introduction

During the last decade, dye doped deoxyribonucleic acid (DNA) or polymer are being focused because of their technological applications in optical devices [1-3], spintronics, human eyes [4], solar cells [5] , catalysis, optical and gas sensors protection [6], all optical switching [7], holographic gratings[8], optical storage [9] and super capacitors [10]. The characteristic feature of a deoxyribonucleic acid biopolymer is rod-like, double helix with π-electron-rich base pair stacking through hydrogen bonds between the bases and are stabilized by π-π interactions [11]. However, azo dye (Ethidium bromide**)** is a good material to be used as optical limiting materials. Many dyes can be easily inserted into the grooves of deoxyribonucleic acid helix. Some of other azo dyes, optical dyes or organic materials can be easily stacked on the surface of deoxyribonucleic acid helix. Since early work of doping dye into deoxyribonucleic acid (DNA) polymer [12,13], great investigators have demonstrated the nonlinear optical coefficients, optical limiting properties and self diffraction pattern of dye doped deoxyribonucleic acid matrices. Nonlinear optical (NLO) properties of deoxyribonucleic acid biopolymer in solution form [14], in azo dye films [15], in organic compounds [16] and in Rhodamine 6G-PVA [17] has been investigated recently. The mechanism of operation of this technique is based on the principle of spatial beam distortion [18], which grows from the optically induced nonlinear refractive index. From this method one can obtain both the nonlinear signal, the magnitude of the nonlinearity and the nonlinear refractive index value easily from experimental readings with a simple readout analysis [19]. Another benefit of this technique is its ease of application in studying transient phenomena [20]. The studies of Z-scan technique not only provide information about the non-linear optical properties of materials, but also provide important information regarding response time [21] and dynamics of transient processes, which contribute to obtaining the nonlinear refractive index [22].