



# Determination of the optical constants, nonlinear optical parameters and threshold limiting of methyl red-epoxy resin film

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## ABSTRACT

A methyl red-epoxy resin film is prepared on a glass substrate. The film linear optical properties are studied using the experimentally obtained absorbance and transmittance spectra. The nonlinear optical properties are obtained via the linear measurements and the Z-scan technique. Based on the nonlinear properties, the optical limiting property of the film is investigated. The sample is proven to possess the properties of an optical limiter at the wavelength of 473 nm, as the threshold limiting value of the film is equal to 13.5 mW. Also, the threshold limiting value of the film is compared to the values for materials characterized by having a good thresholds limiting value, and from comparison, it appear that the prepared film in this study has better threshold limiting value than that possessed by these materials.

## 1. Introduction

There have been a continuous need for materials with high third-order nonlinear index of refraction that can be used with low-intensity laser beams in many potential applications viz., beam flattening, optical limiting, optical switching, spatial dark soliton transmission, data storage, weak absorption measurements, image processing, phase conjugation [1–31] etc.

The measurement of the nonlinear optical properties are carried out via two techniques viz., linear where absorbance, transmittance and reflectance of the solid medium are measured against wavelength at very low light power and the nonlinear via the thermal lens, diffraction ring patterns and the Z-scan which are usually carried out using laser beams with moderate to low power continuous wave, cw, laser beams. Materials such as tris thiourea zinc sulphate [32], nickel oxide [33],  $\alpha$ -methyl curcumin: PMMA [34], quaternary a-Ge<sub>15-x</sub>Sb<sub>x</sub>Se<sub>50</sub>Te<sub>35</sub> [35], zinc oxide [36], ER doped nickel nitrate film [37], Zn-doped CdO [38], PVC polymer [39], EBT doped PVA film [40] were studied based on the first technique. Dye-doped nematic liquid crystal [41], mercury dithizonate [42], triarylmethane dyes [43], lyotropic liquid crystals [44], organic dye [45,46], LiNbO<sub>3</sub> [47], red chromophore/silica hybrid film [48], ZnO [49], potassium dichromate [50,51], crocin [52], methyl orange doped droplet [53], crystal violet [54], and congo red [55], were studied based on the Z-scan. Curcuminoids [56], dihydropyridone [57], OpTpPzNi (II) and PcAlCl [58], cobalt (II) phthalocyanine [59],

nanoparticles copolymer [60] were studied due to diffraction ring patterns and the Z-scan.

Methyl red is organic azobenzene photochromic material. It's structure character is "N=N" double bond between two phenyls, so that it has the property of active photochromical that can generate trans and cis isomerization by light irradiation so that it is called photoisomerization. The effective mechanism for enhancing large optical nonlinearities believed to be the *trans*-cis configuration changes. Methyl red have been widely studied in the past viz., its nonlinear optical properties [61] its photocatalytic degradation [62], its radiation-induced color bleaching in polyvinyl film dosimeter [63], in the DFT studies in doped ZTS crystals for possible nonlinear optical applications [64], in the structure and optical properties of new polyvinyl alcohol grafted methyl red [65], in an equilibrium and structure study in aqueous solutions [66], in the optical properties of PMMA doped with methyl red films [67], in bioremediation of hazardous azo dye methyl red by a newly isolated *Bacillus megaterium* [68], etc.

Epoxy resins, ERs, were used widely in aerospace's, machinery, construction and many other fields as a result of its low cost, mechanical out-standing properties, superior chemical, and thermal resistance, dimensional stability, ease processing [69–73] etc.

The aim of the present work is the search for materials to be used in photonic applications and responds to visible lower power laser beams so it can be used in many optical applications especially its use as an optical limiter. To achieve this purpose, a film is prepared by mixing the

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