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nthesis and Optical Characteristics of PMMA Polymeric Films Doped with Methylene ue Dye for Laser Applications

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ABSTRACT

Poly(methyl methacrylate) (PMMA) polymeric films doped with methylene dye were sensitized using two concentrations of dye: 0.01 and 0.1 mM. The lin and optical power limiting (OPL) characteristics were investigated. The M films were made by dissolving the dye and polymer in dimethylformamide (D a quick and easy casting method. The wavelength range of 400–750 nm w calculate the linear absorption coefficients (α_o), linear refractive index (n), coefficients (k), and optical energy gap (E_g). The optical constants change doping concentrations rise, according to the results. It has been discovered the films, both direct and indirect optical transitions are possible due to the opti gap. The direct allowed optical band gap energy decreased from 1.831 eV to when doped with MB. A continuous wave (CW) solid-state laser (SSL) opera nm was used to investigate the optical limiting features of the composite different dye concentrations. The samples show a clear optical limiting effect, to the results. Wide-ranging applications are possible for the developed M composites.

TRODUCTION

ly(methyl methacrylate) (PMMA) is widely accepted as perior optical polymer. It offers higher visible-light mittance of 92%, compared to glass [1]. PMMA is also acterized by its resistance to harsh outdoor conditions and sure to ultraviolet (UV) radiation [2]. PMMA is widely in several applications as a popular host polymer because s non-toxicity [3], good mechanical stability [4], easy essing, brilliant flexibility [5], low cost [6], and excellent -forming ability [7]. These essential characteristics have e dye-grafted polymers attractive options for cutting-edge onics and optoelectronic applications. The integration of nic or inorganic functional constituents into a host matrix ides a practical route for tailoring the structural, optical, electronic properties of thin-film materials [8, 9]. In tional thin-film systems, material composition, processing itions, surface uniformity, and defect formation jointly rmine the resulting optical performance and suitability for ce integration [10]. The continuing development of onic, optoelectronic, and electronic devices therefore ires materials with controllable linear and nonlinear cal properties. These are used in optical networks, optical munications, data storage devices, and optical computing ignal processing. The term "nonlinear optical materials" s to any class of materials that exhibit effective and efficient nonlinear phenomena. This is necessary to achieve applications dependent on light intensity, such as optical amplification, refractive index changes, optical wavelength conversion, etc. [11]. In particular, methylene blue (MB), an organic cationic thiazine dye [12] with strong absorption in the visible region–at approximately 665 nm–offers promising opportunities for tailoring light–matter interactions when embedded in a polymer matrix [13]. Sukumaran and Ramalingam [14] focused on studying the spectral properties and linear and non-linear optical characteristics of MB with PMMA polymer and n-butyl acetate. Hassan et al. [15] studied diffraction patterns and Z-scan methods and the optical power limiting (OPL) of Iodine film, where it was observed that it has OPL. Parvin and Ahamed [16] applied a technique to the dye, which showed a high value for the nonlinear refractive index (n_2) as well as negative n_2 (self-defocusing) under experimental conditions. Despite considerable investigations on dye-doped polymers, managing and refining their optical response, especially for non-linear optical applications such as optical limiting, remains a substantial issue. The linear absorption coefficients (α_o), optical energy gap (E_g), and linear refractive index (n) are particularly sensitive to dye concentration, molecular interactions, and dispersion within the polymer host. Sensitive optical equipment protection has received a lot of attention lately. Most eye protection devices use materials that strongly absorb light at specific

elengths, which is crucial for protecting the eyes from erful, direct laser beams [17]. However, a comprehensive erstanding of how variable concentrations of MB influence optical performance of PMMA films, particularly in the ext of optical limiting behavior, is still limited. In this y, we focus not only on the preparation of MB/PMMA s doped with varying concentrations of MB, but also on application as OPL materials, with a systematic parison of the effects of different doping concentrations. ddition, the influence of low and high concentrations on

(20 mL for each MB mass), and C_M represents the concentration of the MB. The liquid polymer was prepared, according to the source [19], by dissolving 1 g of PMMA in 20 mM of DMF and left on a hot stirrer for 6 h at 50 °C. Table 1 shows the weights and sizes used to prepare all solutions. Subsequently, the solutions were utilized to prepare polymeric films in a 1:1 ratio. The film thickness was measured using a digital micrometer. The ultraviolet-visible (UV-Vis) spectrometer was used to record the absorption spectra of two films with MB concentrations of 0.01 and 0.1 mM and