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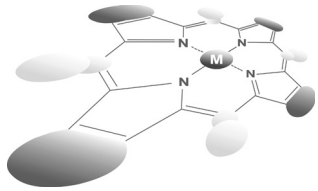

Optical limiting properties of 2,6-dibromo-3,5-distyrylBODIPY dyes at 532 nm

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This paper is dedicated to Professor Kazuchika Ohta on the occasion of his retirement.

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ABSTRACT: Optical limiting properties of 2,6-dibromo-3,5-distyrylBODIPY dyes were investigated by using the z-scan technique at 532 nm in the nanosecond pulse range. A strong reverse saturable absorption response was observed even in solution, which suggests that compounds of this type are potentially suitable for use in optical limiting applications.

KEYWORDS: BODIPYs, Knoevenagel condensation, nonlinear optics, optical limiting, z-scan.

INTRODUCTION

Optical limiting (OL) materials are useful in applications, since they can protect the human eye and sensitive optical devices from intense incident laser beams [1–3]. OL can depend on nonlinear absorption, scattering, or refraction with nonlinear absorption (NLA) usually being the main focus when molecular dyes are involved as is the case in this study. The second harmonic of Nd/YAG laser systems at 532 nm is particularly important in this regard [4–7]. Ideally, there should be high transmittance of low-intensity light, along with the attenuation of the incident laser beam, in a manner that limits the output fluence [1–3]. In recent years, there has been a strong focus on the OL properties of phthalocyanines [8–10], porphyrins [8, 11], fullerenes [1], carbon nanotubes [12], nanoparticles [13], metal nanowires [14] and other organic chromophores [15, 16]. The most important mechanisms that are involved in achieving optical limiting are NLA, nonlinear refraction and nonlinear light scattering [17, 18]. Solutions of molecular dyes such as porphyrins and phthalocyanines with a positive NLA coefficient exhibit reverse saturable absorption (RSA) with a decrease in transmittance at high-intensity levels [16], and hence function as optical limiters at wavelengths where there is only very limited absorbance under ambient light conditions. Two-photon absorption (2PA) is a resonant third-order nonlinear optical (NLO) process in which an excited state is formed by the simultaneous absorption of two photons of half-energy, in an intense focused light beam such as that generated by a laser source, and is described by the imaginary part of the third-order susceptibility Im[$\chi^{(3)}$] and second-order hyperpolarizabilities (γ) [19, 20]. The main goal in research on optical limiters is to identify materials that can maximize these two NLO parameters. The focus in this study is an investigation of the optical limiting that results from NLA processes at 532 nm when boron dipyrromethene (BODIPY) dyes with extended π-conjugation systems are used in this context.

BODIPY dyes have been considered for a wide range of applications, due to their facile synthesis and structural modification, high molecular extinction coefficients and photostability [21]. They would not normally be considered for use as optical limiters in the context of the second harmonic of Nd/YAG lasers, however, since they typically absorb strongly in the green portion of

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