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Study on Effect of Gamma Radiation on Some Linear and Nonlinear Properties of Pyronine Y

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Abstract. This study was conducted to analyse the effects of gamma radiation on Pyronine Y (C17H10ClN2O) solution by investigating its structural properties, third-order nonlinearities, and the chemical's optical limiting characteristics. Typical absorbance characteristics were recorded by irradiating pristine samples with radiation in the 300-700 nm wavelength range. The parameters defining the non-linear optical characteristics displayed changes in response to different irradiation times. The experiment used a 532 nm continuous-wave (CW) laser (SDL-532-100T) to study the optical limiting properties of the sample. Optical limiting was observed to increase with a corresponding increase in irradiation dose. The study also highlights the potential use of gamma irradiation to enhance the nonlinear properties in optical applications.

Keywords: gamma irradiation, pyronine y, laser, optical limiting, optical device

INTRODUCTION

Given the number of practical applications of micro-scale optoelectronics, the nonlinear properties of substances are being studied with great interest and detail. Organic materials have witnessed significant growth in demand for nonlinear optical (NLO) applications. These materials may be used in devices like electro-optic modulators, second-harmonic generator, frequency converters, among other applications [1],[2]. Organic materials present other significant advantages such as thermal and chemical stability, spectral broadband response, low cost, simple structure and preparation, both in solution form and polymer film form [3],[4]. These advantages have led researchers to thoroughly investigate these organic materials for novel optical use cases such as optical power limiting, optical data storage, optical switching, and signal processing [5,8] that require a larger nonlinearity and quicker response time. Organic materials also include organic dyes that are fascinating materials for the examination of the non-linear optical characteristics. The dyes have large nonlinearities, better response time, and stronger light absorption in the visible part of the spectrum [9]. Additionally, the dyes have distinct flexibility and superior thermal and chemical stability in the form of dye-doped solid polymer films. Due to these characteristics, the dyes are often the substance of choice for nonlinear optical experiments. Optical limiting has massive and important applications and has received much attention. Researchers have experimented with many materials using nonlinear optical mechanisms to study optical limiting behaviour [10-16].

During the past three decades, the behaviour of optical limiting of organic, inorganic and semiconductors materials [17] have been studied. Among these materials, organic materials [18] have been given a good properties due to the properties they possess, such as high optical nonlinearity, fast response time[19], damage threshold and easy molecular design [20].Many of these materials have proven to be effective as optical limiter [20],[21]. This attention given to organic materials is not only due to their applications as optical limiter, but due to its utilized in optical phase conjugation [22], high density optical data storage [23], optical bistability [24] and all-optical switching [19].

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