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Synthesis, optical limiting behavior, thermal blooming and nonlinear studies of dye-doped polymer films

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Abstract

Homogenous (poly (6,6′-(2-hydroxy-5-(phenyldiazenyl)-1,3-phenylene) bis (methylene) bis (2-ethylphenol)) (PHPP) film has been properly deposited using the spin coating method. In this paper, the polymer film was characterized by Atomic Force Microscopy (AFM), histogram characterization, intensity distribution of the film, and scan of the microscopic surface. The bandgap E_g value was investigated by different ways. The Nonlinear Refractive Index (NLR) and Nonlinear Absorption (NLA) of the Flu-doped polymer, PbPc-doped polymer, and CuPc-doped polymer are determined using the Z-scan technique. Experimentation was conducted via a 532 nm diode laser and 3.554 KW/cm^2 incident laser intensity. The effects of concentration of dye-doped PHPP films on the behavior optical limiting have been discussed. Additionally, multiple induced self-diffraction patterns generated in dye-doped PHPP polymer films using the same diode laser were observed through the study. The thermooptic coefficient (*dn/dT*) of the Flu-doped polymer, PbPc-doped polymer, and CuPc-doped polymer has been formed equivalent to $-0.409 \times 10^{-5}\ K^{-1}$, $-0.88 \times 10^{-5}\ K^{-1}$, and $-1.133 \times 10^{-5}\ K^{-1}$, respectively.

1 Introduction

Over the past few years, a great deal of research has been carried out about polymer materials that have a wide range of manufacturing applications. One class of these materials is the conducting polymers which have excessive effort in different vital divisions of material science due to numerous usages in photonic and electronic devices [1, 2]. This is because of their distinctive characteristics such as the ability to construct intricate shapes and low density. The properties of versatile electrical and low-cost polymer coatings for manufacturing purposes have shown promising optical properties for optoelectronic applications. The manufacture of optical or electrical devices of high performance, e.g., Optical Light Emitting Diodes (OLED), conducting polymer transistors, coated optical diodes, data storage chips, and even endoscope monitors it becomes necessary over the past three decades [3, 4]. Several studies indicate the feasibility of implementing molecules variety applied as organic semiconductors which are commonly seen among electronic devices [5–10]. Besides improving the manipulation and stability of the atmosphere, one possibility is to make composite materials of conductive and nonconductive polymers. One way to synthesize these compounds involves making conductive polymer within conventional polymer matrices using a chemical polymerization process [8]. Moreover, they have prospective benefits as applications in optical storage schemes, e.g., low absorption loss, high thermal stability, and the ability to modify the refractive index on exposure to light [11].

It is very important to synthesize and investigates new doped polymers with unique optical properties for suitable applications. The spectroscopic characterizations of dyes are easily determined in solution which makes them a promising class of materials for this purpose. Various types of dyes have been used as dopants inside the matrix of different polymers to improve their optical properties [12, 13]. Especially, the metallo-phthalocyanines (MPcs) are wildly used as an important target for different technological applications (photonic and optoelectronic) due to their extended delocalized π-electron structure leading to strongly excited-state absorptions, high triplet yields, fast nonlinear optical (NLO) response times, and easy processing [14, 15].

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