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Third-order response and improving the photovoltaic efficiency of the copolymer P3HT:PCBM doped with iodine as a solar cell

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ABSTRACT

Z-scan method using a 532 nm laser wavelength was employed to determine the nonlinear refractive index (NORX) of an iodine polymer film. This technique involved a closed aperture that allowed part of the laser beam to pass through and reach the sensitive membrane of the detector. According to the measurements, NORX indicates that the iodine-doped PMMA film exhibits a negative nonlinearity, with $n_2 = -339.14 \times 10^{-6} cm^2/W$. Furthermore, the value of the enhancement factor greater than one ($W_{merit}>1$) and a thermo-optic coefficient of 10^{-5}, making it a promising material for numerous industrial applications. The effects of the iodine dye on preserving the full brightness of the polymer film over an extended period were also investigated. Beside that a mathematical model was studied using experimental values and found that the color matching functions of the iodine-doped PVP/PMMA films remained stable. A layer of pure P3HT:PCBM was prepared and then doped with different iodine concentrations (0.9 and 1.5 mM). Adding iodine to the P3HT:PCBM layer at a concentration of 1.5 mM increased the dark current by 3 times. The conductance-frequency (G-F) and capacitance-frequency (C-F) measurements were performed in the range of 0 Hz–100 MHz, and then the interface state number due to depletion was determined. The power conversion efficiency (PCE) to be in the range (1.066–1.383).This study demonstrated that the iodine-doped polymer film is a promising material for optoelectronics application such as polymer-dispersed liquid crystals, electrophoretic displays, and X-ray sensors.

Introduction

Recently the workers at different laboratories are verification new materials for photovoltaic applications with a view to fabricate a convenient and low-cost solar cell devices. There are a different materials available now for solar cell fabrication, among these organic materials of pure P3HT:PCBM doped with varying iodine concentrations. P3HT:PCBM has concerned great attention as a potential candidate in photo- electrochemical and photovoltaic applications due to its diverse optical and physicochemical characteristics that make it suitable as an absorber material and a higher optical absorption coefficient. It is also known for its environmental compatibility as well as it has appropriate and nontoxic constituent elements. In this article P3HT:PCBM samples have been elaborated by a casting method because of its many advantages, such as: simplicity, low cost, easy to add doping materials and promising for high rate and mass production capability of uniform large area coatings in optoelectronics applications. However the nonlinear optics (NLRO) has been gaining traction as a potentially fruitful topic that has significant applications in the fields of photoelectronic modulation, photonic sensors and all optical modulation [1,2]. It is generally believed that organic materials are among the most significant groups of third-order nonlinear optical materials. This is because organic materials have big and fast nonlinearities, and it's easy to make them and put them into optical systems [3–5]. In addition, the NLRO characteristics of organic compounds have been found for a wide variety of optical areas, including high sensitive sensors [6,7], optical communications [8], photonic applications in terms of ultrafast response [9–11], optoelectronics [12], photo-catalysts [13], as well as the photovoltaic cells [14]. As a consequence of this, these materials have been the focus of much experimental and theoretical research over the past several years

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