Effects of silver nanoparticles towards the efficiency of organic solar cells

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Abstract We report an alternative approach to enhance the optical and electrical performance of a vanadyl 2,9,16, 23-tetraphenoxy-20H,31H-phthalocyanine-poly(3hexylthiophene) (VOPc:PhO-P3HT) blending system by integrating plasmonic spherical silver into an active layer of organic solar cells. Studies of the influence of the size distribution and optical properties of the silver nanoparticles were carried out using UV–Vis spectroscopy and field emission scanning electron microscopy, respectively. Electrical characteristics with and without the presence of metallic nanostructures were analyzed using $I–V$ characteristics to observe the plasmonic effects on the performance in the VOPc:PhO-P3HT organic solar cells.

1 Introduction

The use of metallic nanostructures in order to enhance performance of devices has been explored many years ago [1-3]. Plasmonics concerns properties of collective localized surface plasmon effect [5]. Many new technologies have emerged in which the use of plasmonics seems promising, including thermally assisted magnetic recording, thermal cancer treatment, catalysis and nanostructure growth, solar cells, sensors and actuators, and computer chips [6-12].

For improving the application of plasmonics, the surface plasmon resonance (SPR) in a device can be tailored as its strength depends on the shape, size, and distribution of the metal nanoparticles [11]. For thin film silver particle fabrication, various methods can be used such as thermal evaporation [13], radio-frequency (RF) sputtering [14], spray pyrolysis [15], the sol–gel method [16], chemical reduction [17], spin coating [18], ion implantation [19], etc. Plasmonic properties of nanoparticles are characterized by an absorption band in the visible range of the electromagnetic spectrum obtained experimentally employing UV/Vis/NIR spectroscopy [20] or theoretically by using simulation like the discrete-dipole approximation (DDA) [21, 22] and the finite-difference time-domain (FDTD) method [23].