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Preparation and optical characterization of nanoparticle organic photoactive layer using new fullerene

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Abstract

Nanoparticle Organic photovoltaic devices (NPs-OPVs) have received a great attention due to utilizing eco-friendly material to prepare active layer in OPV without any hazard on the environment. Herein, poly (3-hexylthiophene) (P3HT) is employed as a donor with a new and low cost fullerene ICxA to prepare NPs photoactive layer. The NPs photoactive layer is prepared by minemulation method generating core–shell structure. A DLS and STEM measurements are preformed to calculate the particle size (which is around 40 nm). Optical properties then demonstrated for P3HT: ICxA NPs compared with P3HT: PCBM NPs by using UV–vis measurements. The finding of this report reveals that the low cost and a new acceptor ICxA behaviour relativity agree with PCBM as commercial material in NPs structure.

1. Introduction

Reducing carbon emission and preserving a health environment is a main motivation for researcher community in order to find alternative energy source instead of using fossil fuels [1]. Solar energy represents a main source of clean energy that does not end and reaches us in a scattered way. Modern technologies are employed to collect and benefit from solar radiation, without any harm to the environment. One of these technologies is the organic photovoltaic (OPV) solar cells which attracted a significant attention due to their great properties such as using in large scale, light-weight, flexible, and low-cost of the material [2, 3]. Nowadays, the organic photovoltaic photoactive layer can be prepared in two main structures: bulk heterojunction (BHJ) and nanoparticle (NPs) active layer. Over last three decades, BHJ-OPV devices have achieved a high efficiencies , which developed into encouraging technology due to their low manufacturing cost and utilizing it in large scale OPV devices [4, 5]. However, the main issue of BHJ devices is using harm solvents at fabrication process such as chloroform (CF), chlorobenzene (CB) and dichlorobenzene (DCB) [6].

The nanoparticle organic photovoltaics (NP-OPVs) offered a water processability concept of active layer material and then eliminating harm solvents [7, 8], with the ability to control the semi-conducting polymer in addition to preparing nanoscale morphology [9, 10]. Thus, the nanoparticle organic photovoltaics (NP-OPVs) have contributed in reduction the environmental, health, and safety issues in fabrication process of NPs devices, compared to conventional bulk heterojunction (BHJ) devices [9–12]. The NPs morphology is typically formatted in a core–shell NPs structure, for a common system poly(3-hexylthiophene) (P3HT):[6,6]-phenyl-C61-buteric acid methylester (PCBM) contains a P3HT rich ~70% in the shell and a pure PCBM in the core [13]. However, nanoparticle organic photovoltaics exhibit a low performance compared to BHJ-OPVs due to a lack in the charge generation process in the NPs morphology as it was investigated systematically to P3HT:PCBM previously [14]. To improve the NPs-OPV performance, many groups have worked to solve this problem of NPs-OPV. For instance, in P. C. Dastoor group have made investigation for long time and they improved NPs-OPV efficiency from 1.4%–3.3% [15, 16] . Furthermore, other groups improved new donors or acceptors material and they recorded high efficiency for NPs device to reached 3.8% [17]. In table 1, the improvement of NPs-OPV devices is listed for last 10 years.