IOP Publishing Nanotechnology
Nanotechnology **34** (2023) 315704 (11pp) https://doi.org/10.1088/1361-6528/acd1f8

Designed and synthesized *de novo* ANTPABA-PDI nanomaterial as an acceptor in inverted solar cell at ambient atmosphere

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Received 5 November 2022, revised 27 April 2023
Accepted for publication 3 May 2023
Published 18 May 2023

Abstract

In this work, a novel soluble and air-stable electron acceptor containing perylenediimide moiety named ANTPABA-PDI was designed and synthesized with band gap 1.78eV and that was used as non-fullerene acceptor material. ANTPABA-PDI possess not only good solubility but also much lower LUMO (lowest unoccupied molecular orbital) energy level. Furthermore, its excellent electron acceptor capability also supported by density functional theory calculation which validates the experimental observations. Inverted organic solar cell has been fabricated using ANTPABA-PDI along with P3HT as standard donor material in ambient atmosphere. The device, after characterization in open air, exhibited a power conversion efficiency of 1.70%. This is the first ever PDI based organic solar cell that has been fabricated completely in ambient atmosphere. The characterizations of the device have also been performed in ambient atmosphere. This kind of stable organic material can easily be used in fabricating organic solar cell and therefore it can be used as the best alternative as non-fullerene acceptor materials.

Supplementary material for this article is available online

Keywords: inverted organic solar cell, PDI-based organic nanomaterials, non-fullerene acceptor, PDI-based acceptor at ambient temperature

(Some figures may appear in colour only in the online journal)

Introduction

In recent years, organic solar cell (OSC) that converts sunlight into electricity becomes a major field for promising synthesis of renewable and clean energy. It has some specific advantages such as simple and low-cost preparation methodology with a lightweight, semitransparent, and flexible nature over conventional silicon cells, typically used for large-scale energy production [1]. Not only they are considerably thinner and more flexible, but they are also quicker to produce [2]. They are thus better suited for powering everyday devices and systems which are not in constant use, such as sensors or electrical appliances. Organic electron acceptors, such as C60, carbon nanotube, naphthalene, perylene anhydride and its imide derivatives, have received increasing interest due to their electron transporting ability applicable in n-channel organic thin film field-effect transistors (OFETs), [3–7] organic light-emitting diodes (OLEDs), [8, 9] and organic solar cells [10–15]. However, most organic electron acceptors are air and moisture sensitive. For example, the organic solar

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