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Communication

A near-infrared porphyrin-based electron acceptor for non-fullerene organic solar cells

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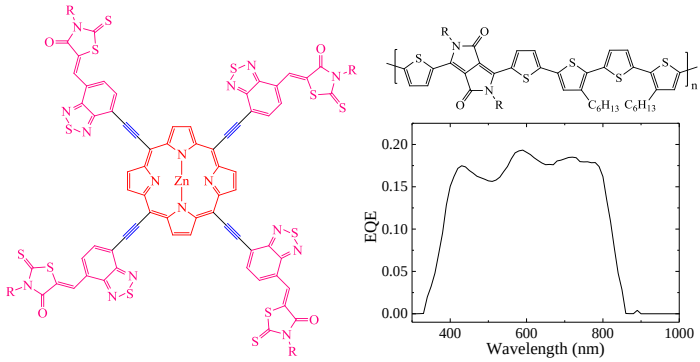
Graphical abstract



A star-shaped electron acceptor with porphyrin as core and rhodanine-benzothiadiazole as end groups linked with ethynyl units was developed for non-fullerene solar cells, in which a PCE of 1.9% with broad photo response was achieved when combining with a diketopyrrolopyrrole-polymer as electron donor.

ABSTRACT

In this work, a new star-shaped electron acceptor based on porphyrin as core, rhodanine and benzothiadiazole as end groups, was developed for non-fullerene solar cells. The molecule shows three distinct absorption regions due to the Soret and Q-bands of the porphyrin and the intramolecular charge transfer in the molecule. This molecule as electron acceptor was applied into non-fullerene solar cells by using a diketopyrrolopyrrole-based conjugated polymer as electron donor. An initial PCE of 1.9% was achieved with a broad photo-response from 300 – 850 nm. The results demonstrate that porphyrin can be used to design near-infrared electron acceptors for organic solar cells.

Keywords:
Electron Acceptor
Non-fullerene organic solar cells
Porphyrin
Diketopyrrolopyrrole
Near-infrared

Non-fullerene organic solar cells (NFOSCs) that use conjugated materials to replace fullerene derivatives as electron acceptor in bulk-heterojunction solar cells have made great progress in recent years [1-4]. The power conversion efficiencies (PCEs) of NFOSCs have rapidly increased from 3% [5] to 13% [6] in five years, surpassing the performance of fullerene-based solar cells [7]. NFOSCs also show good stability under high temperature and bendable condition, indicating their promising application in flexible large-area devices [8].

In contrast to the limited fullerene derivatives, many kinds of non-fullerene electron acceptors have been developed in order to tune the absorption spectra, energy levels and crystalline properties [9]. Among them, conjugated molecules with near-infrared (NIR) absorption spectra and deep frontier energy levels represent the highest efficient electron acceptors, such as an electron acceptor named ITIC that was developed by Zhan *et al.* [10]. When combining with wide band gap conjugated polymers as electron donor, NFOSCs based on the NIR acceptors perform broad photo-response, extending to 1000 nm [11]. Consequently, high photocurrent above 20 mA/cm could be obtained and meanwhile the PCEs were above 10%. Therefore, it will be important to explore electron acceptors with NIR acceptors toward high performance organic solar cells.

Porphyrin is a promising building block to construct conjugated molecules due to its strong electron-donating ability and large π-conjugated systems to provide good charge transport [12]. Porphyrin-based conjugated materials have also been widely applied in dye-sensitized solar cells [13, 14], field-effect transistors [15] and organic solar cells as electron donor [16]. However, porphyrin-based