Efficient Solar Cells Via Sulfur-fused Helical Perylene Diimides Design Concept

Tech ID: 33687 / UC Case 2018-270-0

BACKGROUND

In recent years, **bulk heterojunction (BHJ)** solar cells have attracted intensive attention in solar energy research because they are lightweight, flexible, and roll-to-roll processable. **Fill factor (FF)** is one of the key parameters of **BHJ** solar cells that determine the maximum efficiency of the cell, along with open-circuit voltage and short-circuit current density. Theoretical analysis suggests that the superiority of fullerene over non-fullerene electron acceptors is in the charge transfer. Recently, several studies have reported solution-processed **BHJ** devices using non-fullerene acceptors that have achieved **FF** of 50-70%. Continued progress will require the design, synthesis, and testing of new motifs for electron acceptors. Therefore, to obtain high photovoltaic performance, tuning the aggregation behavior of donor-acceptor molecules and the optimization of the morphology of blend films are essential. Among the vast library of non-fullerene acceptors, **perylene diimide (PDI)** derivatives have been widely investigated due to their excellent electron-accepting ability and high electron mobility. The fill factor of organic solar cells is limited by the competition between recombination and extraction of free charges. What is needed then, are novel **PDI** designs that improve **FF** while maintaining high **PCE** and **external quantum efficiency (EQE).**

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed a breakthrough in solar cell efficiency and stability through novel sulfur-fused perylene diimides. This series of novel sulfur-fused **perylene diimides (PDIs)** shows significant promise in improving the fill factor, electron mobility, and overall efficiency of bulk heterojunction solar cells. These new compounds, **2PDI-nS**, where n is an integer, have been utilized both as electron acceptors in organic solar cells and as electron transporting layers in perovskite solar cells, demonstrating high device fill factor, low open circuit voltage loss, and improved device efficiency and stability. Moreover, **2PDI-nS** as an electron transporting layer in perovskite solar cells led to improved device efficiency and stability. **2PDI-nS** can be synthesized in five steps with high overall yield, and the sulfuration reaction can be applied to various **POI** derivatives. The fused **POIs** have glassy structure, strong light absorption, high electron mobility and tunable **LUMO,** can be potentially used as **ETL** in perovskite solar cells, electron acceptor in organic solar cells and active layer in n-type transistors.

ADVANTAGES

- High electron mobility
- High device fill factor
- Low open circuit voltage loss
- Improved device efficiency and stability

APPLICATIONS

- Solar technology

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,245,077	02/08/2022	2018-270

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OTHER INFORMATION

KEYWORDS

solar, solar cells, bulk heterojunction, BHJ, solar power, perylene diimides

CATEGORIZED AS

- **Energy**
  - Solar

RELATED CASES

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