Over 14% efficiency for ternary organic solar cell with 300 nm thick active layer

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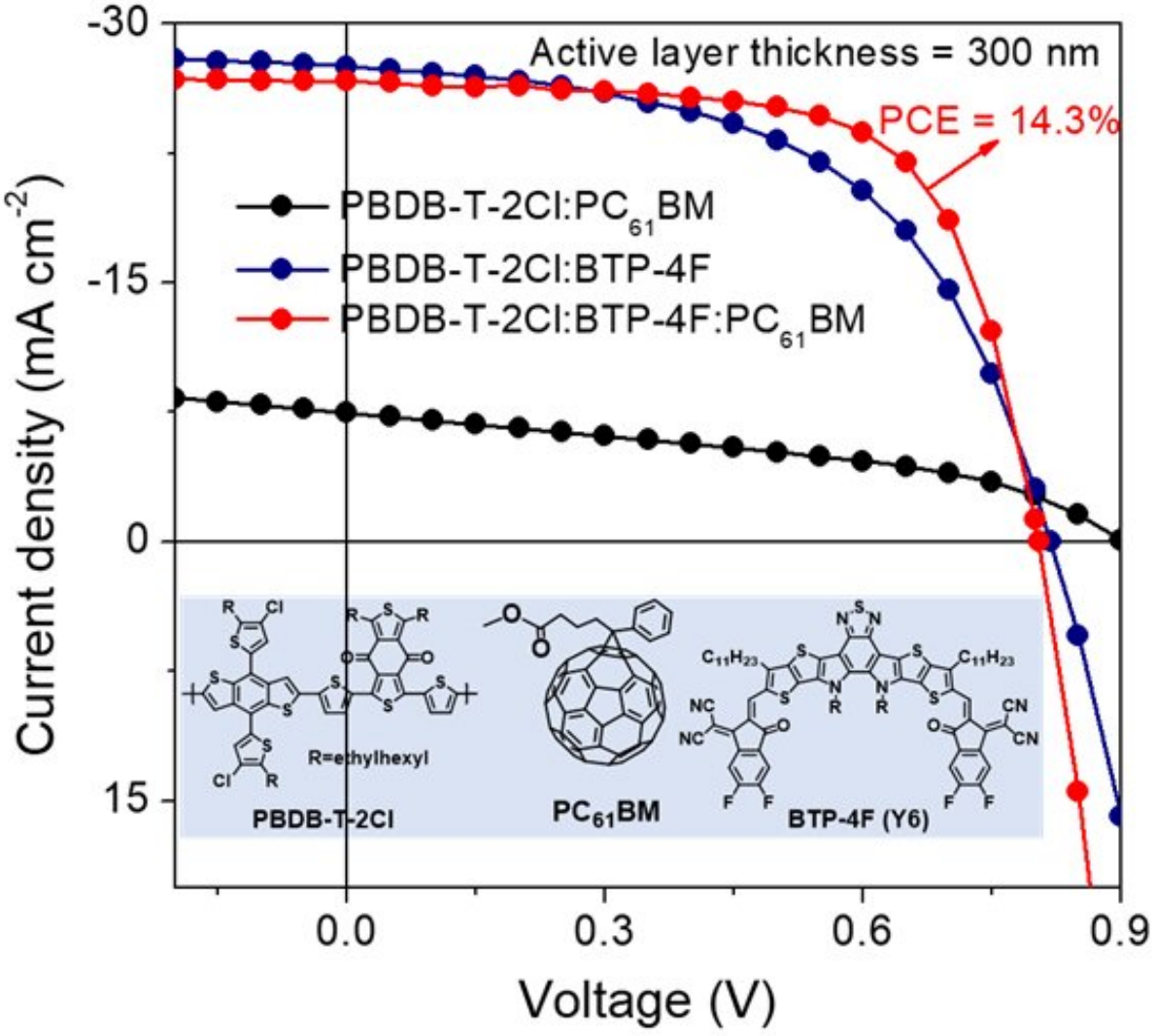

The J-V characteristics for OSCs based on PBDB-T-2Cl: BTP-4F, PBDB-T-2Cl: PC61BM and PBDB-T-2Cl: BTP-4F: PC61BM; the chemical structures of

active layer components. Credit: ©Science China Press

A thick-film (300 nm) ternary OSC is fabricated by introducing phenyl-C61-butyric-acid-methyl ester (PC61BM) into a PBDB-T-2Cl:BTP-4F host blend, as these materials present complementary absorption and well-matched energy levels. By delicately optimizing the blend film morphology and improving the charge carrier mobility, over 14.3% efficiency was achieved for the device based on PBDB-T-2Cl:BTP-4F:PC61BM.

Organic solar cells (OSCs) have drawn great attention due to their advantages of making large area and flexible solar panels through low-cost solution coating methods. Recently, single-junction OSCs with over 16% power conversion efficiency (PCE) have been reported. However, photovoltaic performance of these cells is very sensitive to the variation in the active layer thickness, which has been recognized as a big challenge for practical application of OSCs.

The photovoltaic performance of OSCs is determined by open-circuit voltage (VOC), short-circuit current density (JSC) and fill factor (FF). For the current high efficiency non-fullerene-based system, the efficiency of OSCs usually shows a sharp drop in FF upon increasing the thickness of the active layer. Such FF drops are generally caused by poor and imbalanced charge transport, which results in enhanced bimolecular charge recombination and the formation of space charge in thicker films.

Very recently, Professor Jianhui Hou's group in the Institute of Chemistry, Chinese Academy of Sciences demonstrated a thick-film (300 nm) ternary OSC with a power conversion efficiency of 14.3%. This excellent photovoltaic performance is achieved by introducing

phenyl-C61-butyric-acid-methyl ester (PC61BM) into a PBDB-T-2Cl: BTP-4F host blend. They found that the addition of PC61BM is helpful for improving the hole and electron mobilities, and thus facilitates charge transport in the thick active layers, leading to the improved efficiencies of OSCs. Their results illustrate that introducing a fullerene derivative as a third component is a facile and effective strategy to realize efficient thick-film OSCs.

More information: Lijiao Ma et al, A ternary organic solar cell with 300 nm thick active layer shows over 14% efficiency, *Science China Chemistry* (2019). DOI: 10.1007/s11426-019-9556-7

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