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High-performance polymer solar cells with >10% efficiency

Polymer solar cells (PSCs) with bulky heterojunction structure have attracted considerable attention due to their advantages in making flexible, light weight and large area solar cell panels through the low cost roll-to-roll printing technologies. In the past decades, tremendous efforts have been devoted to developing new materials and device fabrication methods to improve the power conversion efficiencies (PCEs) of PSCs. In 2014, the PCEs have been boosted to ~10% for the PSCs with single junction and ~11% for the PCS with double/triple junctions. According to the reported results, the new materials and processing methods of the photovoltaic active layer in PSCs are of equal importance.

In 2004, Yongfang Li and Jianhui Hou *et al.* at the Institute of Chemistry, Chinese Academy of Sciences (ICCAS) pioneered the concept of two dimensional π-conjugation in the design and synthesis of photovoltaic polymers. The conjugated side chains could broaden the absorption spectrum and enhance the hole mobility of 2D-conjugated photovoltaic polymers. After that, they focused on the design of highly efficient photovoltaic polymers based on 2D-conjugated benzodithiophene (2D-BDT). In early 2014, Li *et al.* [1] first used alkylthio groups to improve photovoltaic properties of 2D-BDT-based polymers. More recently, Hou *et al*. [2] further modified the 2D-BDT using linear alkylthio groups. In this work, a novel photovoltaic polymer PBDT-TS1 (Figure 1) was designed and synthesized with a linear alkylthio chain staying in the state-of-the-art polymer PTB7-Th for the well balance of absorption range, molecular order and energy level. Owing to the broad spectral coverage, ordered packing and high mobility of 1×10^{-2} $cm^2/(Vs)$, conventional PSC with PBDT-TS1 as donor polymer exhibited a high PCE of 9.5%, which outperformed two reference polymers PTB7-Th under the similar conditions. By optimizing the morphology with finely-selected processing solvent, the PCE of PBDT-TS1:$PC_{71}BM$-based PSC was further promoted to 10.2%, which was certificated by National Institute of Metrology (NIM), China [3]. Notably, this is the first single junction PSC with conventional geometry providing >10% of PCE .

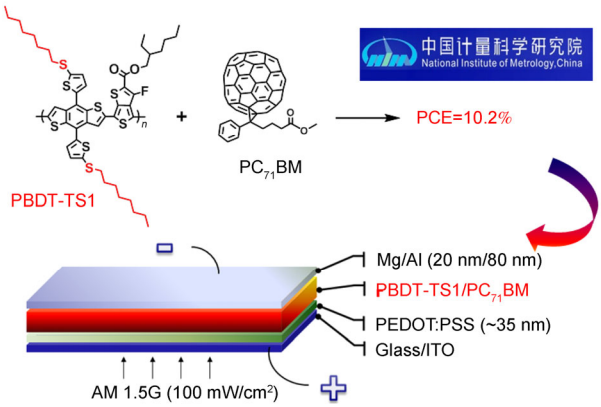

Figure 1 Molecular structure of PBDT-TS1 and the photovoltaic result certificated by National Institute of Metrology (NIM), China.

Undoubtedly, PBDT-TS1 is one of the best photovoltaic polymers, which could be served as a suitable model material for device engineering and morphology studies. Higher PCE of 11% or even 12% could be expected in PBDT-TS1-based single junction PSC through the collective innovations of interfacial modification and device architecture design.

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