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Recent research progress of photovoltaic materials for high performance polymer solar cells

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Polymer solar cells (PSCs) have attracted great attention in the past decade, because of the advantages of a simple device structure, lightweight and capability to be fabricated into flexible and semi-transparent devices. The key photovoltaic materials of PSCs are conjugated polymer donors and the fullerene or non-fullerene acceptors. Recently, the non-fullerene n-type organic semiconductor (n-OS) (such as the low bandgap n-OS ITIC) acceptors have attracted great attention for their high photovoltaic performance. To match with the low bandgap ITIC acceptor, we developed a series of medium bandgap 2D-conjugated D-A copolymer donors based on bithienyl-benzodithiophene (BDTT) as donor unit and fluorobenzotriazole (FBTA) as acceptor unit. The D-A copolymer donors possess complementary absorption spectra and matching electronic energy levels with ITIC acceptor. By side chain engineering (alkyl-thienyl, alkylthio-thienyl, trialkylsilyl-thieny or alkyl-difluorothienyl substitution) on the thiophene conjugated side chains of the medium bandgap polymers, the power conversion efficiency (PCE) of the PSCs with the polymers as donor and ITIC as acceptor reached 9.26%5~11.63%. By side chain isomerization of ITIC, the PCE of the non-fullerene PSCs was further improved to 11.77%6~12.05%7. The results indicate that the side chain engineering of the conjugated polymer donors and n-OS acceptors are an effective way to improve photovoltaic performance of the PSC. In addition, we also developed high-performance low bandgap n-OS acceptors and low cost conjugated polymer donor materials recently.

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