Design of Fused-ring Electron Acceptors for Efficient Organic Solar Cells

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Compared to the rapid development of new electron donor materials, the development of novel electron acceptors has lagged behind. Fullerene derivatives such as $PC_{61}BM$ and $PC_{71}BM$ have been the dominant electron acceptor materials. However, there remain incentives to develop non-fullerene electron acceptors that will not only retain the favorable properties of fullerenes, but also overcome their insufficiencies, such as weak and narrow absorption in the visible region, and limited energy level variability. Organic solar cells based on non-fullerene acceptors exhibited lower efficiencies than their fullerene counterparts. Development of high-performance non-fullerene acceptors is a challenge. We have carried out pioneering and systemic work on synthesis of polymer electron acceptors based on perylene diimide and their application in all-polymer solar cells. We reported the first example for three-dimensional non-fullerene acceptors. More recently, we created novel fused-ring electron acceptors and fullerene-free solar cells yielded efficiencies > 9%. Furthermore, we fabricated large-area, flexible, fullerene-free, ITO-free, vacuum-free solar cells using roll-to-roll solution process under ambient conditions, which exhibited improved efficiency and stability relative to fullerene-based solar cells.

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