Understanding the Interfacial Energy Structure and Electron Ex-traction Process in Inverted Organic Solar Cells with Phos-phine-doped Cathode Interlayers

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Abstract

Cathode interlayers (CILs) play an essential role in achieving efficient organic solar cells (OSCs). However, the electronic structure at the electrode/CIL/active layer interfaces and the underlying mechanisms for electron collection remain unclear, which becomes a major obstacle to develop high-performance CILs. Herein, we investigate the relationship of the electron collection abilities of four cross-linked and n-doped CILs (c-NDI:P0, c-NDI:P1, c-NDI:P2, c-NDI:P3) with their electronic structure of space charge region at hetero-junction interface. By accurately calculating the depletion region width according to the barrier height, doping density and permittivi-ty, we put forward that the optimal thickness of CIL should be consistent with the depletion region width to realize the minimum en-ergy loss. As a result, the depletion region width is largely reduced from 13 nm to 0.8 nm at the indium tin oxide (ITO)/c-NDI:P0 in-terface, resulting in a decent PCE of 17.7% for the corresponding inverted OSCs.

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