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Performance improvement of perovskite solar cells using novel structure design

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In the past decades, many types of the renewable energy, such as solar power, wind power, and biomass energy, are extensively developed owing to the nature fuel has been gradual decrease. Among these renewable energies, solar power is the most promising. The solar power includes Si-based solar cells, III-V solar cells, organic solar cells, and so on. Among them, the organic solar cells have many advantages including easy fabrication in large area, flexibility, lightness, and low cost. For organic solar cells, perovskite is superior to other organic materials in terms of its small absorption bandgap, small exciton binding energy, long exciton lifetime, and large carrier-diffusion length. Consequently, the perovskite solar cells have attracted much attentions.

In this work, multi-layer electron and hole transportation structures were applied to perovskite solar cells to improve the mismatch problem of the carrier mobility. In the perovskite solar cells, the balance electron and hole mobilities reduced the carrier recombination in the cells, which could improve the performance of the cells. The space-charge-limited current (SCLC) method was used to calculate the electron and hole mobilities of the perovskite devices with various electron transportation layers (ETLs) and hole transportation layer (HTL). Compared with the perovskite devices with PC60BM ETL, the current density and PCE of the perovskite solar cells with PC70BM/C70 dual ETLs and PTB7 HTL treated at temperatures of 100 oC were enhanced from18.22 mA/cm2 to 24.11 mA/cm2 and 7.07 % to 14.11 %, respectively. The performance improvement of the perovskite solar cells with PC70BM/C70 dual ETLs and PTB7 HTL treated at temperatures of 100 oC was attributed to that The best carrier mobility balance ratio (μh/μe) of 0.90 for the perovskite devices with PC70BM/C70 dual ETLs and PTB7 HTL treated at temperatures of 100 oC was obtained.

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