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Comparing the effect of P3HT and Spiro-OMeTAD as hole transport material in Sb_2S_3-based solar cells

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Background: The n-i-p structured Sb_2S_3 solar cells are widely developed based on various conditions of fabrication. Generally, these types of solar cells consist of different layers. Even though a high quality of the absorber layer (Sb_2S_3) is synthesized, the compactness of each layer is beneficial to enhance the performance. In this solid-state solar cells, the Hole Transport Material (HTM) is an attractive factor due to the commercialization difficulty of liquid electrolyte solar cells.

Objectives: In this study, Sb_2S_3 solar cells were fabricated with P3HT and Spiro, which were used as HTMs to extract the holes from the absorber to find the effect of HTMs in our system.

Methods: To fabricate the device configuration of FTO/TiO_2/Sb_2S_3/HTM/Ag, a mixture of titanium isopropoxide, butan-1-ol, and 2-ethanolamine and a mixture of $SbCl_3$, thiourea, and 2-methoxyethanol used to deposit TiO_2 and Sb_2S_3 layers respectively. The P3HT and Spiro solutions were prepared by dissolving 2 mg of P3HT in 100 µl of chlorobenzene and 3.6 mg of spiro-OMeTAD, 1.4 µl of 4-tert-butyl pyridine (tBP), and 0.8 µl LiTFSI solution (520 mg LiTFSI in 1 ml of acetonitrile) in 100 µl of chlorobenzene respectively. The prepared HTM precursors were spin-coated separately on Sb_2S_3/TiO_2 at 3000 rpm for 30 s and heated on the hotplate at 100 ºC for 15 mins.

Results: The power conversion efficiency (PCE) was obtained as $4.11 \pm 0.2\%$ and $4.01 \pm 0.18\%$ for the cell with spiro and P3HT respectively, by the current density (J)-voltage (V) measurements. A good current density (J) was received by Spiro (15.6 mA/cm^2) than P3HT (14.05 mA/cm^2), which enhanced the PCE. The EQE exhibited a wide range of spectrum for spiro-OMeTAD than P3HT, which was in good agreement with J.

Conclusion: In our system, the photo-generated electron-hole pairs are effectively separated by Spiro-OMeTAD than P3HT. The HTM plays a significant role to improve the PCE of solar device.

Keywords: *Efficiency, P3HT, Sb_2S_3, Solid-state, Spiro-OMeTAD*

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