$CH_3NH_3PbI_3$ Perovskite Solar Cells Employing Cu-Phthalocyanine Doped Poly-3-hexylthiophene Hole-Transporting Layer

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Introduction

Organic-inorganic perovskite solar cells (PSCs) have recently emerged at the forefront of photovoltaics research. Over the past six years, the power conversion efficiencies (PCEs) have rapidly increased from 3.8% in 2009 to approximately 20% in 2015. Herein, we report the use of hydrophobic poly (3-hexylthiophene) (P3HT) Hole transport layer (HTL) to prevent moisture ingress into the perovskite layer. Cu-phthalocyanine (CuPc) chlorobenzene suspension is introduced as a dopant for enhancing charge extraction. CuPc is thermally and chemically very stable material, and by mixing with a P3HT solution, the aggregation of CuPc nanoparticles was suppressed. Interestingly, the incorporation of the CuPc into P3HT solution led to the significant enhancement of the PSCs' efficiency from 7.90% to 10.10%.

Results and Discussion

Mesoscopic PSCs were fabricated with the structure fluorine-doped tin oxide (FTO)/compact-TiO_2 /MAPbI3/P3HT:CuPc/Au in ambient air. Figure 1 presents the solar cell configuration and scanning electron microscope (SEM) cross-sectional of the device. The light and dark current density–voltage (J–V) curves of the best performance devices measured under simulated 1.5G solar irradiation at 100 mW/cm^2 is shown in Fig. 2. The short-circuit current density (J_{sc}) of 20.00 mA/cm^2, an open-circuit voltage (V_{oc}) of 0.840 V, a fill factor (FF) of 0.470 and PCE of 7.90% were obtained

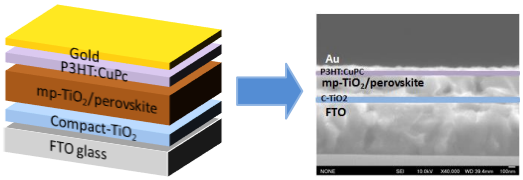

Fig. 1. Device architecture and SEM cross-section image of PSCs.

from the pristine P3HT device. While the optimized device with P3HT: CuPc as HTL shows a J_{sc} of 21.40, V_{oc} of 0.870, and FF of 0.541 leading to a PCE of 10.10%.

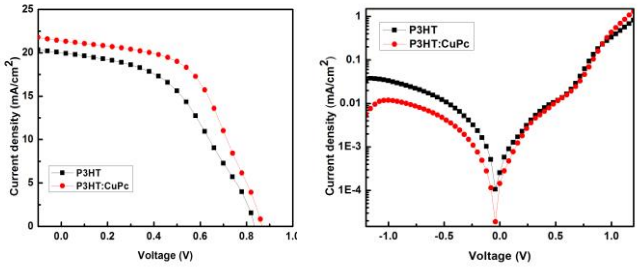

Fig. 2 (a) J–V curves of P3HT and P3HT:CuPc PsCs. (b) dark J–V of P3HT and P3HT:CuPc PSCs.

The improved photovoltaic performance obtained by the P3HT:CuPc device could be attributed to the suppressed leakage current and charge recombination due to an efficient hole transporting and electron blocking as shown in Fig. 2 (b)

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References

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