

Double layered perovskites by surface molecular engineering to achieve high efficiency dopant-free P3HT based HTM perovskite solar cells

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The discovery of organo-lead halide perovskite has offered the promising candidates of next-generation solar cells with Power Conversion Efficiency (PCE) surpassing over 20% in just a few years. Such a steep rise in PCE is credited to outstanding optoelectronic properties such as absorption coefficient, long charge carrier diffusion length, high carrier mobility and favorable bandgap in relation with visible light. Perovskite solar cells typically structure electron transport layer and hole transport layer enclosed the perovskite active layer. Prior to its performance, only two organic hole transport materials (HTM) have been widely reported and have led to considerably high PCE: spiro-OMeTAD and poly(triarylamine) (PTAA). However these polymeric HTM have several drawbacks in combination of the need for hygroscopic dopants in its application that initiate degradation of the perovskite active layer. Poly(3-hexylthiophene) (P3HT) is a widely used alternative organic HTM with excellent electric conductivity and easily fabrication method compare to the previously stated HTM, but suffering lower open-circuit voltage (Voc) due to additional non-radiative recombination at the perovskite/P3HT interlayer [1]. Another study has also revealed that flat P3HT surface provide physically poor contact constrain efficient hole transport from perovskite to P3HT [2]. To tackle these issues, here we report the use of hydrophobic secondary alkyl ammonium cation and methylamine oxide can be successfully assembled to form very thin insulating layer from perovskite surface itself simply by in situ reaction. The surface molecular engineered thin layer perovskite surface then so be called double layered perovskite aimed at modifying the morphology of the perovskite/P3HT interface will provide better contact from alkyl molecules of which could give favourable van der Waals interaction. Moreover the $N^+(\text{CH}_3)_3$ moiety giving the hydrophobicity effect to hinder direct exposure to moist air. Therefore these work not only trying to tackle the low PCE problem but also generate a strategy to improve stability by modifying the interface of perovskite/P3HT.

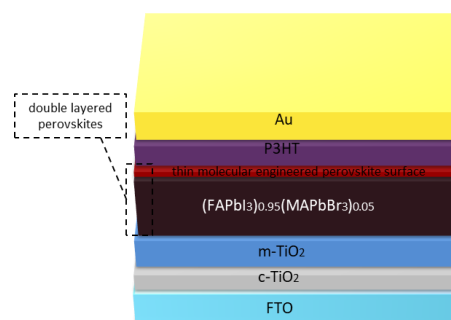


Figure 1. Schematic of device architecture

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[1] Stolterfoht M, et al., *arXiv*:1810.01333.2018

[2] Eui Hyuk Jung, et al., *Nat*, 2019, 3, 511.