MASTER

Bis-thiophenepropylammonium based surface modification for efficient inverted perovskite solar cells

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BIS-THIOPHENEPROPYLAMMONIUM BASED SURFACE MODIFICATION FOR EFFICIENT INVERTED PEROVSKITE SOLAR CELLS

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Abstract

In the past years, perovskite solar cells (PSCs) have emerged as a promising photovoltaic (PV) technology owing to their tunable band gaps, high optical absorption coefficients, large carrier diffusion lengths and high defect tolerance. Moreover, its ease of fabrication, low-temperature processes and cost-effective property enable great promise for practical applications. Nevertheless, long-term operational and environmental stability remain critical concerns towards their commercialization. The interfaces between the perovskite layer and the adjacent charge transport layers have been reported to play a major role in power conversion efficiency (*PCE*) losses and instability. Therefore, tremendous efforts have been made to improve the interfacial properties between perovskite and the adjacent transport layers.

This thesis focuses on the upper perovskite/electron transport layer (ETL) interface modification by 3-([2,2'-bithiophen]-5-yl)propan-1-ammonium iodide (bis-TPAI) in inverted PSCs built on sputtered NiO_x as the hole transport layer. It is found that the bis-TPAI surface treatment has negligible effect on the surface morphology, the crystal structure and the band gap of the perovskite. Bis-TPAI treatment with a high concentration hinders the film absorption and carrier dynamics, while low and moderate concentrations of bis-TPAI effectively passivate the surface defects, and facilitate the charge carrier extraction. As a result, *PCE*s of 22.0% and 20.7% have been achieved for the champion devices treated with 0.01 mg/ml and 0.05 mg/ml bis-TPAI respectively, compared to 20.0% for the best control device. Moreover, the decrease of efficiency during maximum power point tracking (MPPT) measurements can be reduced and even eliminated by controlling the bis-TPAI concentration. This work provides insights into the mechanisms of perovskite/ETL interface improvement by bis-TPAI, which could be helpful for the design of efficient perovskite photovoltaic devices towards upscaling.