Ion Migration in Perovskite Solar Cells with Simulation and Experimental Analyses

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Abstract

Ion migration has challenged the practical applications of perovskite solar cells with undesirable hysteresis and degradation effect. We observe that the migration of cations from the perovskite layer towards the contact layer (CIS) is the main cause of high hysteresis and reduced efficiency. To better understand the behavior of *J-V* hysteresis under different scan rates and pre-bias conditions, the ionic patterns, recombination rates, and the electric potential were analyzed. The electron lifetime determined through V_{OC} decay experiments and simulations, and found that selecting appropriate scan rates is crucial for achieving high-efficiency and low-hysteresis perovskite solar cells. Additionally, it is found that device pre-biasing at a voltage close to its open circuit voltage can reduce cation migration from the perovskite/CIS interface towards the CIS contact, leading to higher efficiency and lower hysteresis. Conversely, Negative pre-bias voltages, can increase hysteresis and show inverted hysteresis behavior (-1 to -2 V) due to facilitating cation migration at the CIS side. Lastly, it is found from V_{OC} and simulation results that pre-conditioning within the range of milliseconds to seconds is important to have a highly efficient and hysteresis-free solar cell device.

Keywords

Perovskite Solar Cell, Ion-migration, Hysteresis, Pre-conditioning