Impact of Ion Migration on the Performance and Stability of Perovskite-Based Tandem Solar Cells

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Abstract

The stability of perovskite-based tandem solar cells (TSCs) is the last major scientific/technical challenge to be overcome before commercialization. Understanding the impact of mobile ions on the TSC performance is key to minimizing degradation. Here, we present a comprehensive study that combines an experimental analysis of ionic losses in Si/perovskite and all-perovskite TSCs using scan-rate-dependent current-voltage (J-V) measurements with drift-diffusion simulations. Our findings demonstrate that mobile ions have a significant influence on the tandem cell performance, lowering the ion-freeze power conversion efficiency from >31% for Si/perovskite and >30% for all-perovskite tandems to around 28% in steady-state. Moreover, the ions cause a substantial hysteresis in Si/perovskite and all-perovskite TSCs at

high scan speeds (400 V/s and 40 V/s, respectively), and significantly influence the performance degradation due to field screening. Additionally, for all-perovskite tandems, subcell-dominated measurements reveal more pronounced ionic losses in the wide-bandgap subcell during aging, which we attribute to its tendency for halide segregation. This work provides valuable insights into ionic losses in perovskite-based TSCs, which helps to separate ion migration-related degradation modes from other degradation mechanisms and guides targeted interventions for enhanced subcell efficiency and stability.

Keywords

Perovskite-based Tandem Solar Cells, Mobile Ions, Ionic Losses, Wide-bandgap, Low-bandgap, Subcell Dominating Fast Hysteresis Measurements, Light Aging, Degradation