Transient Electroluminescence in Perovskite Devices: The Role of Ion Migration

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Abstract

Perovskite solar cells (PSCs) show great promise to compete in the photovoltaic market, thanks to their outstanding performance as the light absorber material in thin film solar cell stacks, their simple solution-processing and low-cost fabrication process. Similarly, perovskite light-emitting diodes (PeLEDs) are a promising technology for efficient and cost-effective lighting and displays. To further optimize the performance, stability, and reliability of perovskite devices, detailed characterization and understanding of performance losses over time are required. This includes examining the recombination pathways of charge carriers and how these change with the migration of mobile ions, which can be a major limiting factor for achieving (and maintaining) the highest possible performance. Metal halide perovskite semiconductors show mixed ionic-electronic conductivity. Mobile ions can slowly redistribute under light or voltage, in timescales ranging from milliseconds up to minutes or hours. This study focuses on the impact of mobile ion redistribution on charge recombination processes, by looking at the transient electroluminescence (TrEL) profiles of perovskite devices. The inclusion of mobile ions in drift-diffusion simulations is found to be crucial to reproducing the experimental TrEL responses of PSCs and PeLEDs. These findings contribute to the understanding of transient ionic processes in perovskite-based devices.

Keywords

Perovskite, Solar Cells, Light Emitting Diodes, Pulsed Operation, Simulation, Transient Electroluminescence