CHARGE CARRIER AND ION DYNAMICS IN PEROVSKITE LEDS

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Perovskite light-emitting diodes (PeLEDs) currently reach up to about 20% external quantum efficiency and are becoming a promising technology for display and lighting applications [1]. Still, many issues regarding their performance remain unresolved, particularly those related to stability and operation in non-stationary regimes as well as performance hysteresis and variations of the electroluminescence (EL) and photolumi-nescence (PL) efficiency under electrical stress [2].

Some of those issues in PeLEDs based on $MAPbI_3$ perovskite were addressed in the recent work [3]. It was observed that the first-time application of constant voltage leads to a rapid (tens of seconds) three-fold increase of electric current and much slower increase of EL, until some saturation is reached (Fig. 1). Interestingly, immediately after voltage was applied, almost no EL was detected. Even more complex dynamics was observed under varied application of a sequence of rectangular voltage pulses [3].

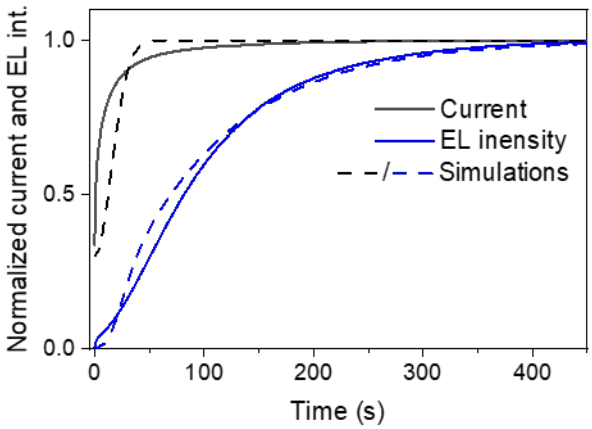

Fig. 1. EL and current dynamics in PeLED at room temperature under first-time application of 2 V voltage. Solid and dashed lines correspond to the experimental measurements and numerical simulations, respectively.

Detailed analysis of these and other measured kinetics suggested that they are manifestation of the spatial redistribution of mobile species, most likely iodine interstitials, characterized by ≈175 meV activation energy. By modeling ion drift and charge carrier dynamics and recombination in the perovskite material we were able to study how ion motion alters intrinsic electric field, charge carrier injection and their steady-state distributions within the perovskite layer, thus explaining the experimentally observed results and revealing the important role of the ion motion in the processes that take place in operating PeLEDs.

References

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