Hole Trap Formation in Polymer Light-emitting Diodes Under Current Stress

Quan Niu, Roland Rohloff, Gert-Jan A. H. Wetzelaer, N. Irina Crăciun and Paul W. M. Blom
Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Polymer light-emitting diodes (PLEDs) are attractive for use in large–area displays and lighting panels, but their limited stability under current stress impedes commercialization. In spite of large efforts over the last two decades a fundamental understanding of the degradation mechanisms has not been accomplished. We demonstrate that the voltage drift of a PLED driven at constant current is caused by the formation of hole traps, which initially increases linearly with time (burn-in) and subsequently grows with the square-root of time. This transition is governed by the statistics between free and trapped holes. The mechanism for the efficiency decrease under stress, is the additional non-radiative recombination between free electrons and trapped holes. The observed trap formation rate is consistent with exciton-free hole interactions as the main mechanism behind PLED degradation. Revelation of hole trap formation being the cause of PLED degradation opens the possibility to suppress their negative effect on voltage and efficiency by blending the light-emitting polymer with a large band gap semiconductor. Due to trap-dilution these blend PLEDs show unprecedented stability.