

Space charge limited current simulation of I-V characteristics of poly[9,9-di-(2'-ethylhexyl)fluorenyl-2,7-diyl]-based light emitting diode

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Polyfluorenes (PFs) have emerged as an attractive class of semiconductive polymers for light-emitting diode (LED) applications due to their unique combination of high photoluminescence and electroluminescence efficiencies, good photo stability and thermal stability, easy processability, and emission covering the entire visible range at low operating voltages. It is therefore desirable to develop proper models for the operation of PF based LEDs, which predict the dependence of current on the driving voltage to facilitate optimization of device performance. In the present work, polymer LED device was manufactured with the configuration of ITO/ PEDOT:PSS (30 nm)/PF (40 nm)/Al (200 nm). The light emitting polymer thin film layer was pristine poly[9,9-di-(2'-ethylhexyl)fluorenyl-2,7-diyl]. We have used space charge limited current theory for the single-carrier case to model the fabricated device, taking into account field-dependent hole mobility. Al was used as a cathode to form a hole-dominated device because of the poor electron injection from Al to polymer. There is an electron injection barrier between Al and polymer of ~ 1.6 eV compared to the negligible hole injection barrier of ~ 0.34 eV between PEDOT:PSS and polymer.

At 300 K, we find a zero-field mobility $\mu_0 = 2.551 \times 10^{-13} \text{ m}^2/\text{Vs}$, and an electric-field coefficient for the hole mobility $\gamma = 3.171 \times 10^{-4} (\text{m/V})^{1/2}$. With these parameters, the theoretical calculation agrees well with the I - V measurement for bias voltages above 2 V as shown in Figure 1. We conclude that the hole carrier density is not space charge limited under 2 V for polyfluorene based LEDs.

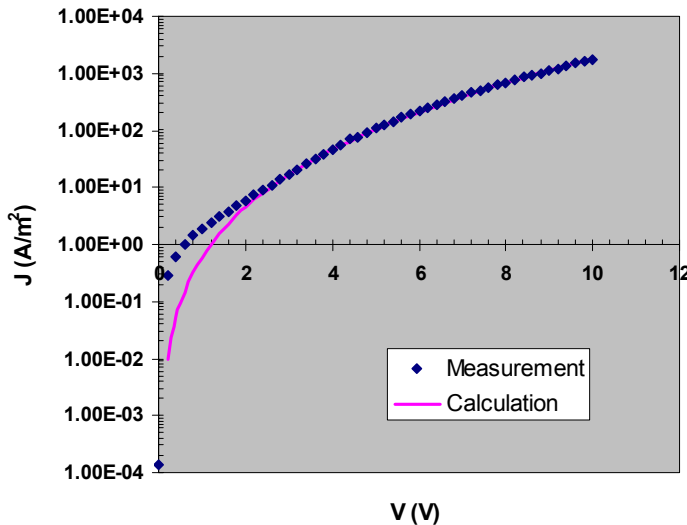


Figure 1. Current density-voltage (J - V) characteristic of polyfluorene based LED: Comparison of experimental and modeling results.

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