

Charge Injection Model for Organic Light-emitting Diodes

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Ever since the discovery of electroluminescence in the conjugated polymer PPV and its derivatives, much effort has been devoted to the study the characteristics of organic semiconductor devices for optical and electronic applications. To improve the device efficiency, a detailed understanding of the charge injection process is necessary. Charge injection from metal to amorphous organic films is not well understood, and cannot solely be described by thermionic injection or hopping injection [1]. The mobility in organic semiconductors is low and carrier diffusion near the contact is very important. In this work we develop an analytical model to describe the charge injection in organic devices based on both drift-diffusion theory and multiple trapping theory. The developed model can explain the temperature characteristics and agrees well with recent experimental data.

The potential barrier near the contact is formed by a superposition of an external electric field and an induced field binding the carrier via its image charge to the electrode. Very close to the contact the potential can be approximated under a constant field [2]. Beyond a critical distance, however, the field deviates from a constant and the potential has to be calculated by solving Poisson equation. The critical distance distinguishing the two areas can be obtained by connecting the drift-diffusion equation and multiple trapping theory. The injection current can be calculated from this critical value.

Figure 1 shows the temperature dependence of the injection current as obtained from the analytical model. A comparison of the model and experimental data is plotted in Fig. 2, with the barrier height Δ as a parameter [1]. Good agreement is obtained.

Acknowledgements

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References

- [1] J. C. Scott, *J. Vac. Technol. A*, 23, 521-531 (2003)
- [2] V. I. Arkhipov, P. Heremans, *Journal of Applied Physics*, 84, 848 -856 (1998)

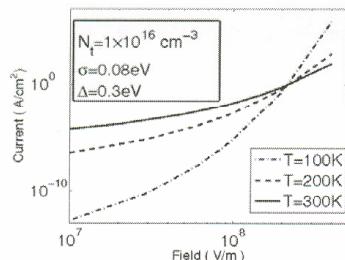


Fig.1: Temperature-dependence of the injection current as predicted by the model.

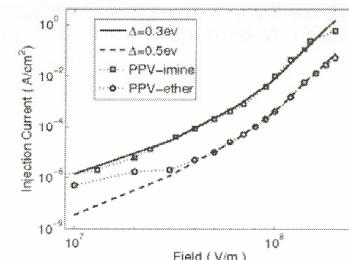


Fig.2: Comparison between the model (lines) and experimental data [2] (symbols).