**Organic solar cell physics analyzed by Shockley diode equation**

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The drift-diffusion model [1] is widely used for modeling the operation of organic solar cells (OSCs). Although this model describes the operation of OSCs very well, there are still some missing explanations and open issues concerning photogeneration of charge carriers, their transport and especially recombination [2]. The drift-diffusion model is not phenomenological and it is difficult to trace the impact of each process on OSC J-V curve using this model. Also, there are some elements of OSCs that can’t be taken into account by the drift-diffusion model such as serial resistance and leakage currents (shunt resistance).

As a first step, we have modeled the ITO/PEDOT:PSS/P3HT:PCBM/Al solar cell with a simple one-diode equivalent circuit. The parameter values were extracted from the measured dark J-V curve that was fitted with the least square method. With the same set of parameters, varying only shunt resistance, the J-V curve for illuminated OSC was successfully reproduced. According to this result we came to the conclusion that our OSC follows diode behavior in a great extent. Thus, its operation can be described by Shockley diode equation.

In a second step, we have calculated the ITO/PEDOT:PSS/P3HT:PCBM/Al solar cell J-V curve with the drift-diffusion model. The model is the same as in [3] with Dirichlet’s boundary conditions and the transfer matrix calculation of interference effects added [4]. Two different types of recombination, monomolecular and bimolecular, were considered. By comparison of simulated J-V characteristics with the Shockley diode equation we have analyzed photogeneration, transport and recombination contribution to the OSC J-V characteristics. The short circuit current was taken as a representative of photogeneration and ideality factor was used for recombination analysis. Diffusion transport was investigated by the inverse saturation current.

Finally ITO/PEDOT:PSS/P3HT:PCBM/Al solar cell diode parameters obtained by comparison of the measured J-V curve with the one-diode equivalent circuit model were related to drift-diffusion parameters.

REFERENCES

[1] L. J. A. Koster, E. C. P. Smits, V. D. Mihailetchi, P. W. M. Blom, Phys. Rev. B 77, 08205 (2005).

[2] G. Li, L. Liu, F. Wei, S. Xia, X. Qian, IEEE Journal of Photovoltaics 2 No. 3, 320 (2012).

[3] Ž. Jelić, J. Petrović, P. Matavulj, J. Melancon, A. Sharma, C. Zellhofer, S. Živanović, Physica Scripta T162, 014035 (2014).

[4] D. W. Sievers, V. Shrotriya, Y. Yang, J. of App. Phys. 100, 114509, (2006).