

Modeling and Simulation of Organic Solar Cells Based on P3HT:PCBM using SCAPS 1-D (Influence of Defects and Temperature on the Performance of the Solar Cell)

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Abstract : In this work, we elucidate theoretically the effect of defects and temperature on the performance of the organic bulk heterojunction solar cell (BHJ) P3HT: PCBM. We have studied the influence of their parameters on cell characteristics. For this purpose, we used the effective medium model and the solar cell simulator (SCAPS) to model the characteristics of the solar cell. We also explore the transport of charge carriers in the device. It was assumed that the mixture is lightly p-type doped and that the band gap contains acceptor defects near the HOMO level with a Gaussian distribution of energy states at 100 and 50 meV. We varied defects density between 10^{12} - 10^{17} cm⁻³, from 10^{16} cm⁻³, a total decrease of the photovoltaic characteristics due to the increase of the non-radiative recombination can be noticed. Then we studied the effect of variation of the electron and the hole capture cross-section on the cell's performance, we noticed that the cell obtains a better efficiency of about 3.6% for an electron capture cross section $\leq 10^{-15}$ cm² and a hole capture cross section $\leq 10^{-19}$ cm². On the other hand, we also varied the temperature between 120K and 400K. We observed that the temperature of the solar cell induces a noticeable effect on its voltage. While the effect of temperature on the solar cell current is negligible.

Keywords : organic solar cell, P3HT:PCBM, defects, temperature, SCAPS

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