**Surface recombination influence on photocurrent spectra of organic photovoltaic devices**

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Organic solar cells (OSCs) have attracted extensive attention in the past decade as one of the promising photovoltaic technologies offering unique advantages over their inorganic counterparts, such as lightweight, low cost, flexibility, semitransparency, and solution-processing fabrication [1]. The design of novel narrow-bandgap donor and acceptor materials, interface engineering, novel processing methods, innovative device structures, and light management led to a significant improvement in power conversion efficiency (PCE),which exceeded 17% for single bulk heterojunction devices [2]. Still, the full photoconversion potential of these devices has not been reached because of the unresolved OSCs physics and the lack of adequate physical models describing devices’ operation.

It was established that surface processes, particularly a surface recombination as the loss mechanism have tremendous influence on the OSCs performance [3]. It is of a great importance to distinguish between the influence of the majority and minority carrier surface recombinations. Also, the impact of surface recombination (of majorities and minorities) is not identical at the anode and cathode contact, since the device is illuminated through the one of them.The surface recombination effects differ for the front and back electrode.The comprehensive study of surface recombination effects can be conducted through photocurrent spectra (PCS) analysis.

In this paper, a standard drift-diffusion model (DDM) that accounts for surface recombination and thermionic emission on electrode contacts through boundary conditions was used for PCS calculation [3]. The photogeneration rate profile in the photovoltaic device was determined from the Beer-Lambert law. The PCS were simulated for three cases: 1) electron dominated transport,(assuming electron mobility *µn*is much larger than hole mobility *µp*), 2) balanced transport (*µn*~*µp*), and 3) hole dominated transport (*µn*<<*µp*). For each type of transport, the effect of minority and majority carriersurface recombination at the anode and cathode was considered. This was done by taking the appropriate surface recombination velocity (SRV) to be reduced while other SRVs were assumed to tend to infinity.Adetailed analysis of the obtained results was performed by taking into account differentpenetration depths for different lightwavelengthswhich were determined from absorption coefficient spectrum. Also, the interplay between the bulk and surface recombination was considered, having in mind that the influence of thebulk recombination is significantly reduced at high reverse bias voltages, making the effects of surface recombination visible in the simulated PCS. In the zero-biased devices, the bulk recombination is almost completely dominant compared to the surface recombination.

The measured PCS for ITO/PEDOT:PSS/P3HT:PCBM/Al devices with eight different thicknesses of active P3HT:PCBM layer were compared to the ones calculated by described DDM. Excellent match between theory and experiment was accomplished indicating that there was no pronounced surface recombination in the fabricated devices.

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