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An analytical model for organic solar cells incorporating non-geminate monomolecular and bimolecular recombinations (Article)

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Abstract

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There is still a debate concerning the non-geminate recombination processes in organic bulk heterojunction solar cells. There are reports that suggest either only the non-geminate bimolecular recombination or the non-geminate monomolecular recombination is important, and also reports that suggest both non-geminate processes are important. In this paper, a physics-based analytical model for describing the current-voltage characteristics of organic bulk heterojunction solar cells is presented. The model incorporates both non-geminate recombination processes, which is an improvement compared with previous analytical models. This makes the model versatile by allowing us to choose whether to include both recombination processes or exclude one of the processes, depending on the studied device. In developing the model, a new method for calculating the non-geminate recombination and the current density in organic bulk heterojunction solar cells is proposed and employed. The model is validated with experimental current-voltage characteristics taken from the literature. Using the model, we show that considering the non-geminate recombination is important in order to properly predict the current-voltage characteristics of organic bulk heterojunction solar cells. The model can be useful for understanding the working operation of organic bulk heterojunction solar cells, and thus for predicting and improving the device performance. Finally, the method employed to develop the presented model can also be extended and employed to develop models for other devices. © 2018 IOP Publishing Ltd.

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