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A numerical semiconductor model applicable to organic solar cells.

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Excitons are marginally important in classical semiconductor device physics, and their treatment is not included in standard solar cell modelling. However, in organic semiconductors and solar cells, the role of excitons is essential, as the primary effect of light absorption is exciton generation, and free electrons and holes are created by exciton dissociation. First steps to include excitons in solar cell modelling were presented by Green and Zhang. We extended their model (2006), including the space charge region, exciton surface dissociation, recombination at the contacts, and non-uniform bulk dissociation. This model showed that it IS possible to apply the standard semiconductor device modelling frame to situations were excitons are dominant, but the model was not general, and did not cover parameters relevant for organic solar cells. We now extended the numerical semiconductor model to more general situations (e.g., it is now not any more limited to a one sided n+p junction), and made it suitable for the application on organic solar cells (e.g. lower diffusion lengths). Organic solar cell behaviour is calculated as a function of the ratio of generated excitons to free eh-pairs, of the exciton dissociation mechanisms and of the diffusion length. Our numerical simulations show that a cell can work decently when there is enough exciton dissociation (wherever this be in the cell) and when both the electron and the exciton diffusion lengths exceed the “unit cell” thickness.