WIAS-TeSCA simulations in photovoltaics for a point contact concept of heterojunction thin film solar cells

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For a long time 1D simulation software such as SCAPS were the widely used semiconductor simulation tools in photovoltaics because of the relatively simple structure of solar cells. A novel point contact concept is an example for the necessary and useful application of 2D and 3D simulation in this field.

The photovoltaic performance of the wider-band gap chalcopyrite based thin film solar cells is limited by the recombination at the interface between the absorber and the buffer layer. In principle, the heterojunction should exhibit a high density of defect states at this interface due to lattice mismatch. The concept of a point-contact geometry at the front side of thin film chalcopyrite solar cell devices includes (i) an interfacial defect state passivation and (ii) a current transport only through these point contacts that cover a few percent of the device area, while the rest of the surface is electronically passivated by a dielectric coating. The introduction of a point-contact type structure allows for the relaxation of the requirements at the absorber/buffer heterointerface and could dramatically increase performance of heterojunction thin film solar cells.

The software WIAS-TeSCA for the numerical simulation of charge transfer processes in semiconductor structures, in principle, is suitable for use in thin film photovoltaics. It is based on the drift-diffusion model and allows for heterostructures. Modeling of the structured passivation layer with point contacts can be simplified by taking a structural unit with cylindrical symmetry so that the modeling is performed in 2D but provides results which will be a good approximation to the 3D structure. In the present model study, especially, the effect of the interfacial defect level and density, and of the point contact radius and area ratio have been investigated.