Modeling of the electronic quantum transport in tunnel junction for multi-junction solar cell applications

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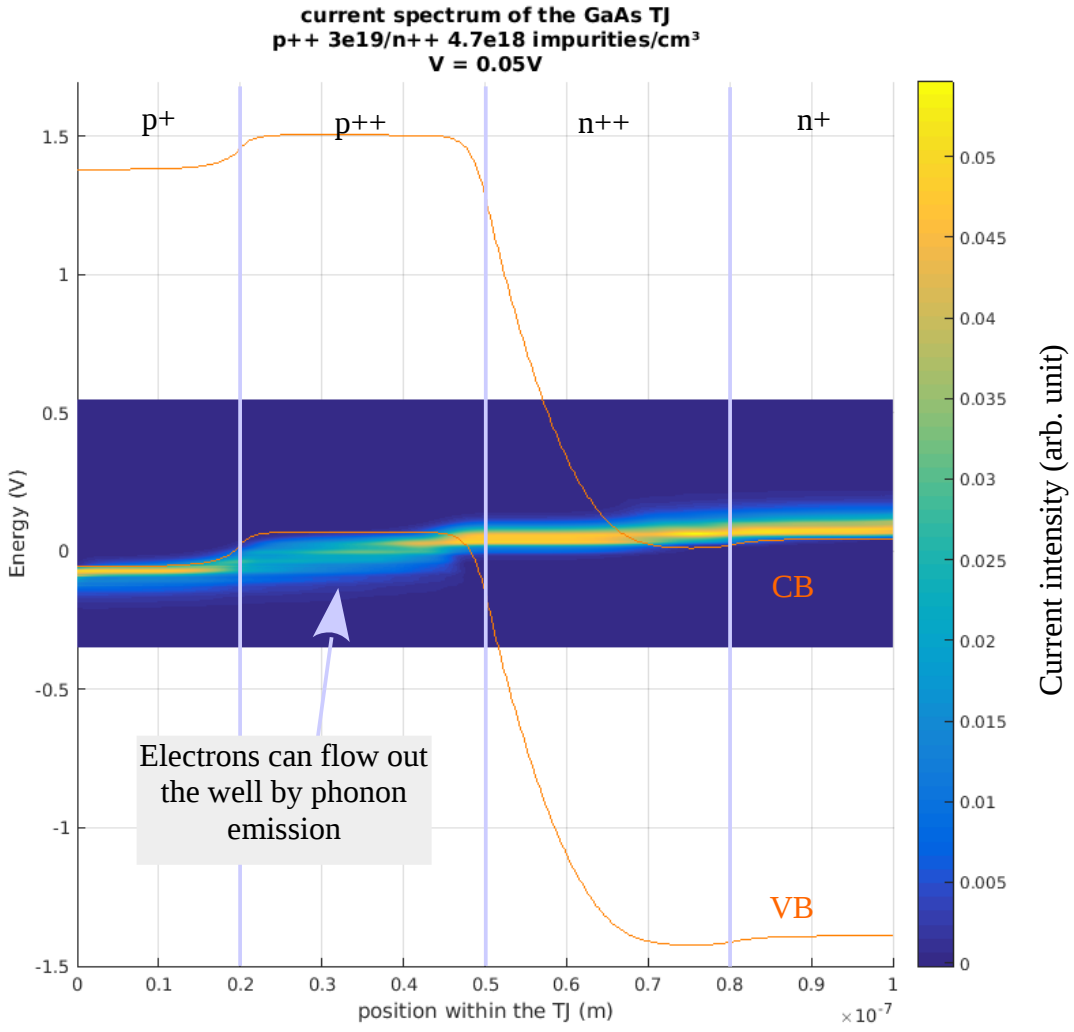
Recently, multi-junction solar-cells have reached efficiency as high as 46 %.[1] These solar cells are made of stacking of III-V semiconductors with different bandgaps. The main advantage of such cells, is that it allows to absorb different regions of the solar spectrum, and hence improve efficiency. In practice, the large photogenerated current can flow from a subcell to another with a small equivalent resistance thanks to tunnel junctions that connect the subcells in series.

In order to model the current that flows through these tunnel junctions (TJs), we have used the non-equilibrium Green function (NEGF) formalism that, unlike semi-classical approaches that can be found in literature, allows to take into account quantum effects such as confinement due to nano-structuration, tunneling or electron-phonon interactions.[2]

We shall see how this model can be used to optimize GaAs and GaN tunnel junctions by varying the thickness and the doping but also how it can be used to understand the impact of different physical parameters such as temperature or electron-phonon interactions.



[1] Press Release, Fraunhofer Institute for Solar Energy Systems, 1 December 2014

[2] N. Cavassilas et al., J. Renewable Sustainable Energy 6, 011203 (2014)