New analytical model to simulate a PN tunnel junction

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Among photovoltaics devices, tandem solar cells score the highest efficiency at industrial scale as well as laboratory scale[1]. One of the key part of these devices is the tunnel junction between the subcells. This part is rarely the core of tandem cells studies and its simulation remains a challenge[2]. A first part of this work consisted in a review of analytical models for pn junction since 1960's. This review concludes that non-local models are more accurate[2,3] and band-to-band tunnelling (BTBT) adequate to model a tunnel junction[2,3]. The model we propose includes a classic pn tunnel junction and calculates each physical parameter with the latest method available. Starting from an existing model developed by J. Karlovsky[4], we have made several improvements to consider more physical phenomena.

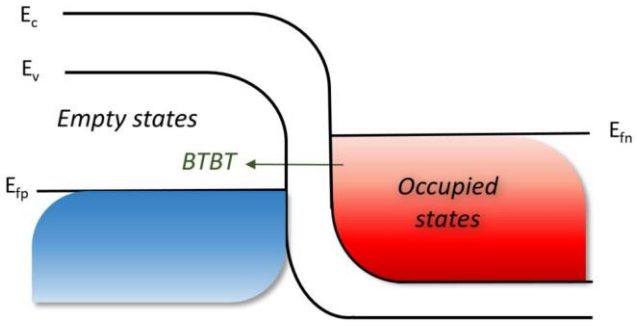

Figure 1: Schematic view of the band-to-band tunneling effect.

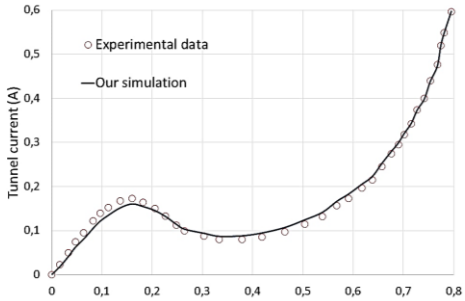

Figure 2: Simulation session with new model on a Silicon tunnel diode2. The model fits all parts of the curve, including the valley region

At this stage, a model has been developed to fit experimental curves given doping levels and the area of the junction. The simulation tool is able to determine fitting parameters for the material, series and shunt resistances. It has been tested on several homojunctions (Silicon, Germanium, GaAs) and compared to the last numerical simulation works[2,3].

References

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