# Brief Introduction of wxAMPS 3.0

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## 1. Modeling tandem solar cells by using band-to-band tunneling model

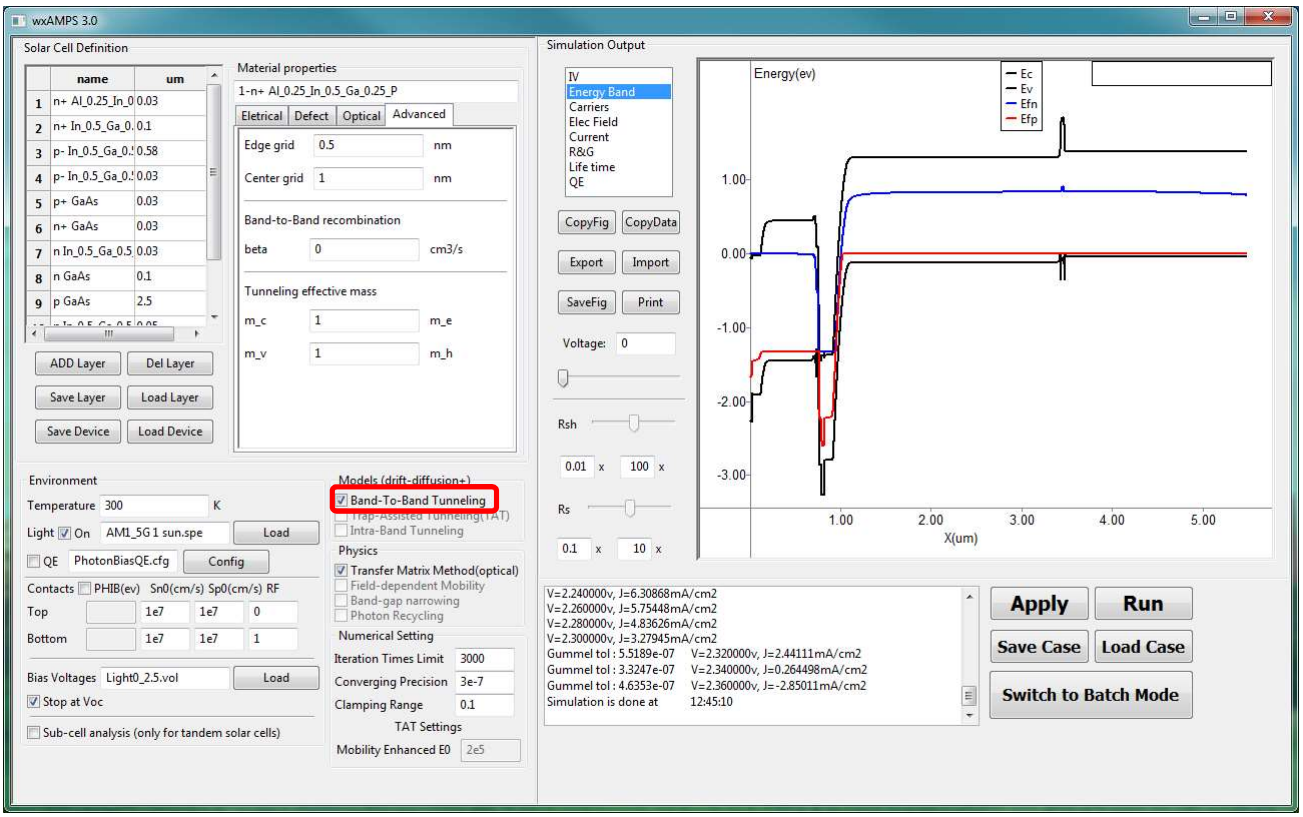



Fig. 1 Illustration of the working environment of wxAMPS 3.0. Check the *band-to-band tunneling* as shown by the red box to turn on this mechanism.

## 1.1 Tuning tunneling effective mass at the tunneling junction

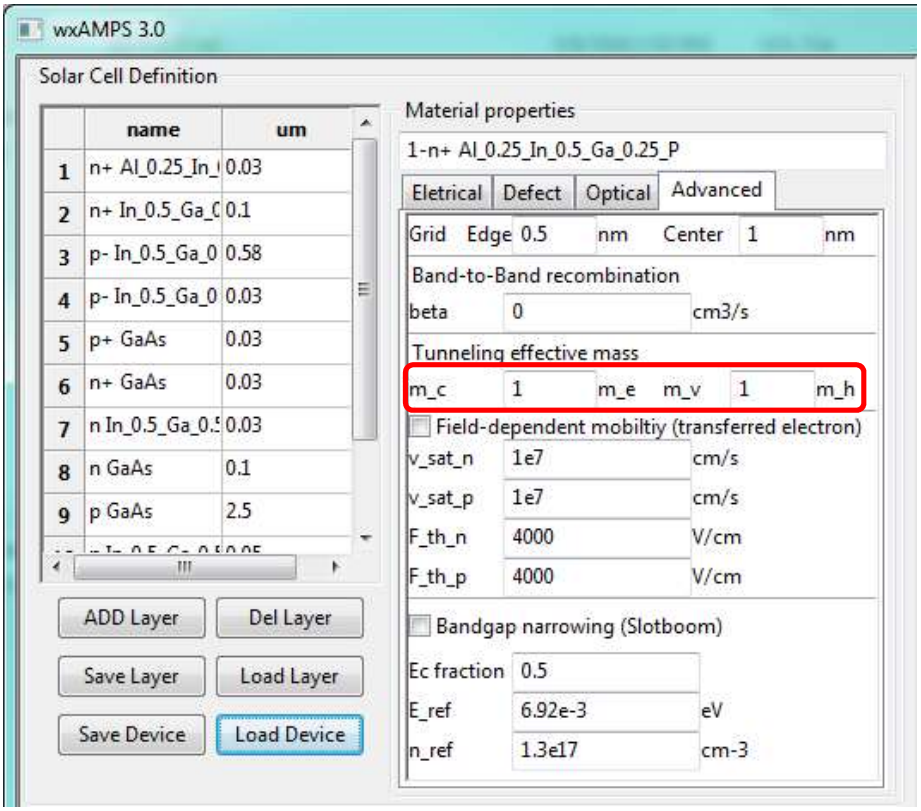



Fig. 2 The tunneling probability is sensitive to tunneling effective masses at the tunneling junction. If tunneling effective masses are too big to allow enough tunneling current across the junction, the simulation may not converge at all.

## 1.2 Optical model and QE simulation

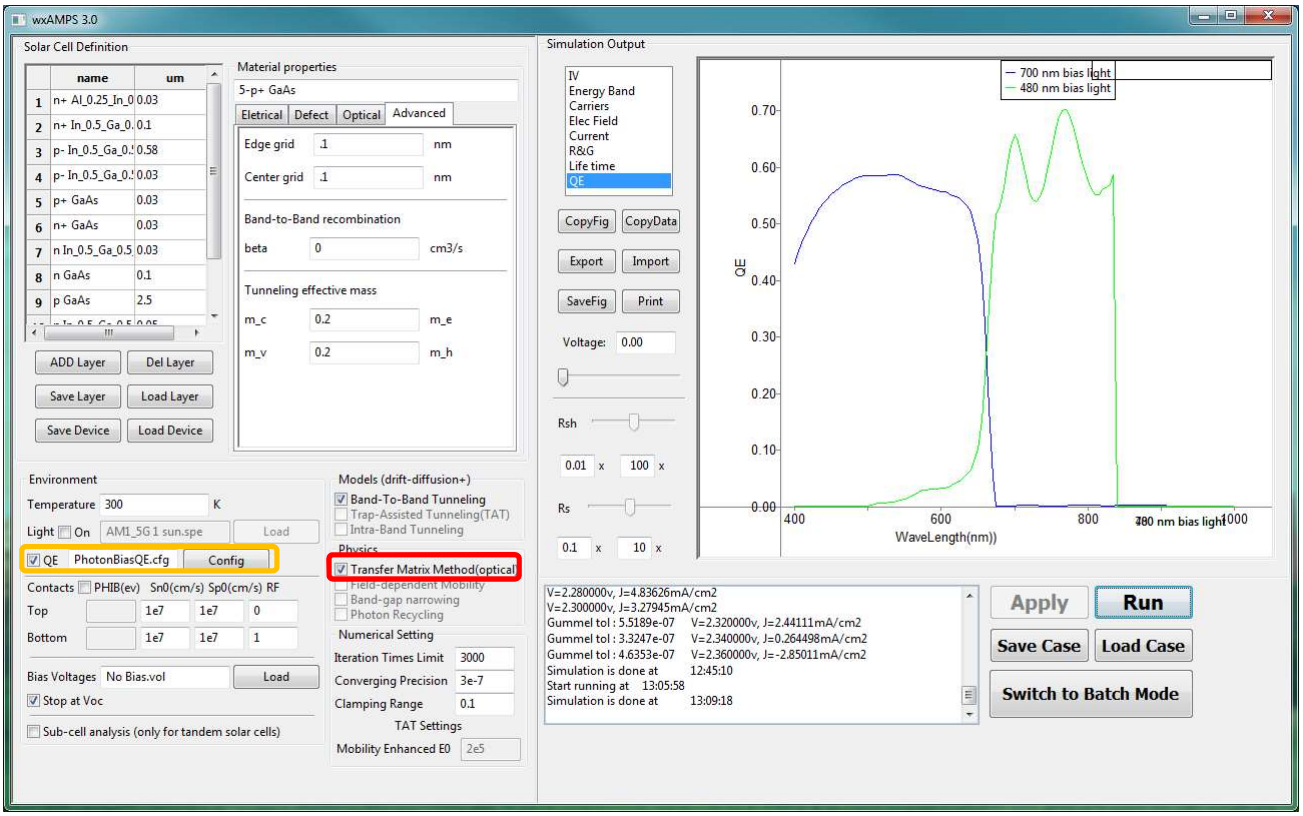



Fig. 3 If the device is flat and the optical interference is significant, turn on the *transfer matrix method* by checking the checkbox in the red area (Otherwise, *Beer-Lambert law* will be used). The QE simulation requires loading a .cfg file where clarifies the wavelengths of bias lights and the corresponding photon amounts (you can know the format and more details by opening .cfg file with any text editor). By using the transfer matrix method, the interference pattern (shown in the green QE curve) can be observed in the QE of the bottom cell.

## 1.3 Tips of convergence

The convergence quality of the solution can be assessed by checking the current continuity across the whole device (seen in Fig. 4).

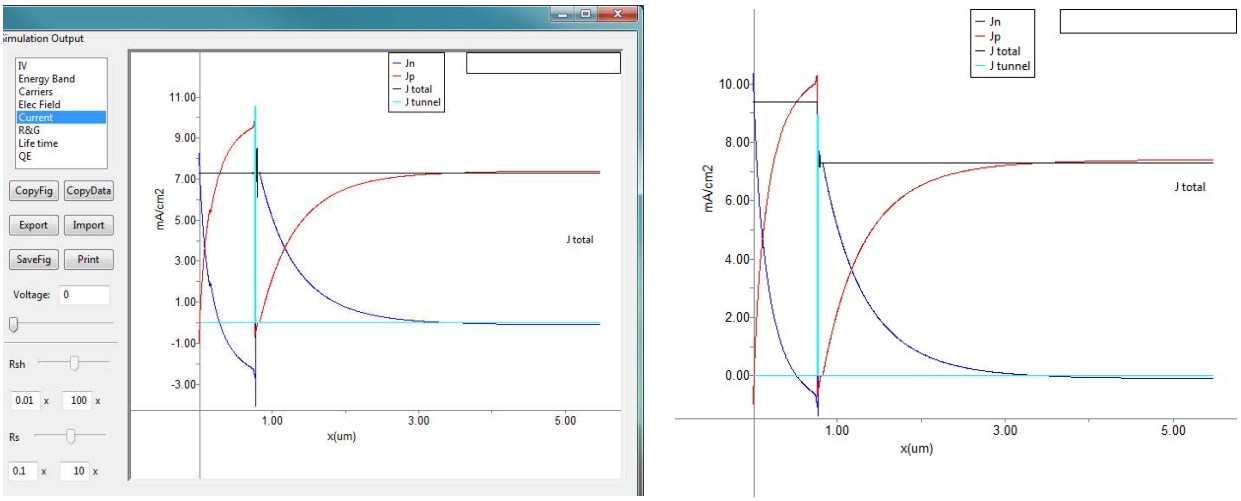



Fig. 4 The figure on the left (obtained by using the converging precision 1e-7) demonstrates a good convergence, however, the right one (the converging precision is 1e-6) is not that good since the currents of top cell and bottom cell don't match.

Notice!!! The Band-to-band model currently requires long time to achieve a solution (~30 minutes for an IV curve of a 2000-grid device), and sometime it may fail in converging. In order to increase the convergence property, following methods can be tried:

**1. Tune the grids. Especially for the tunneling junction, a well-refined grid is strongly recommended.**

**2. Tune the *numerical setting*, such as increasing the *Iteration Times Limit* (>5000), tuning *converging precision* (1e-8 ~ 1e-9), and playing with "*Clamping range*".**

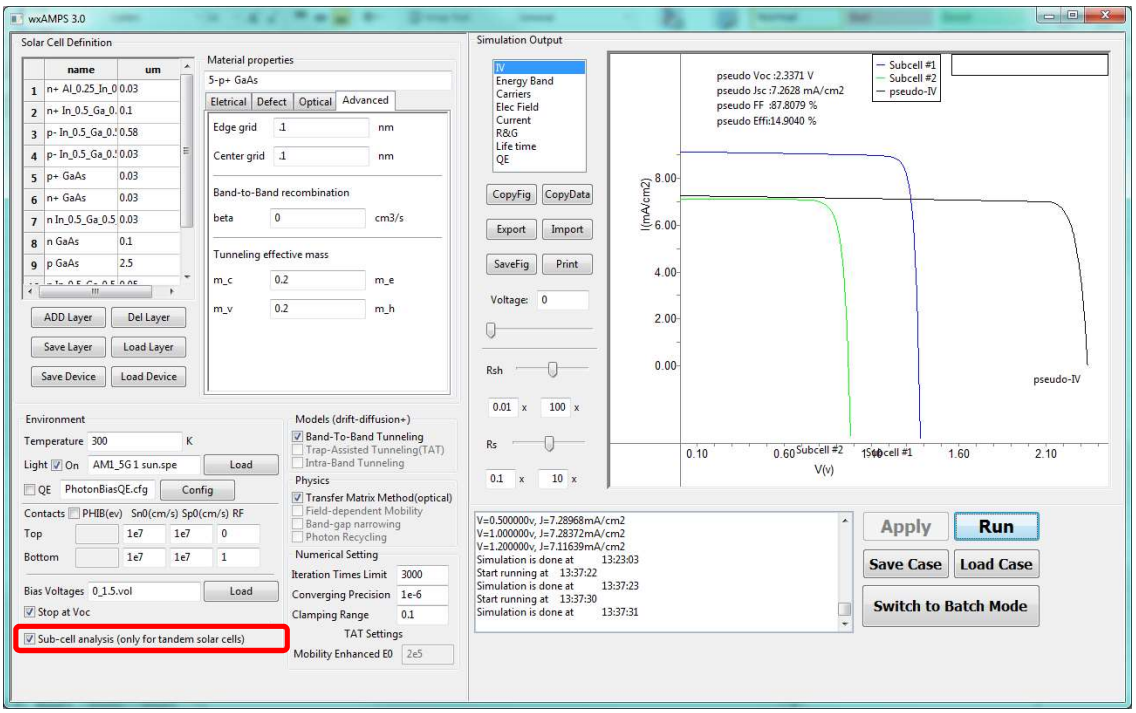
**3. Reduce voltage steps if simulation fails at high voltage.**

It is also observed that the code is hard to converge when there is a big current mismatch between sub-cells. Therefore, a sub-cell analysis (described next section) is recommended for quick diagnosis.

## 2. Sub-cell analysis

This is a very useful feature for the tandem solar cell design. IV curves of each sub-cell are generated by using the absorption profile based on the total device, and then a “pseudo-IV curve” is obtained according to these sub-cell IV curves. The “pseudo-IV curve” is an idealistic curve which assumes the tunneling junction is Ohmic contact. Sub-cell analysis runs very fast, and can be utilized to analyze the current matching of sub-cells.

(a)



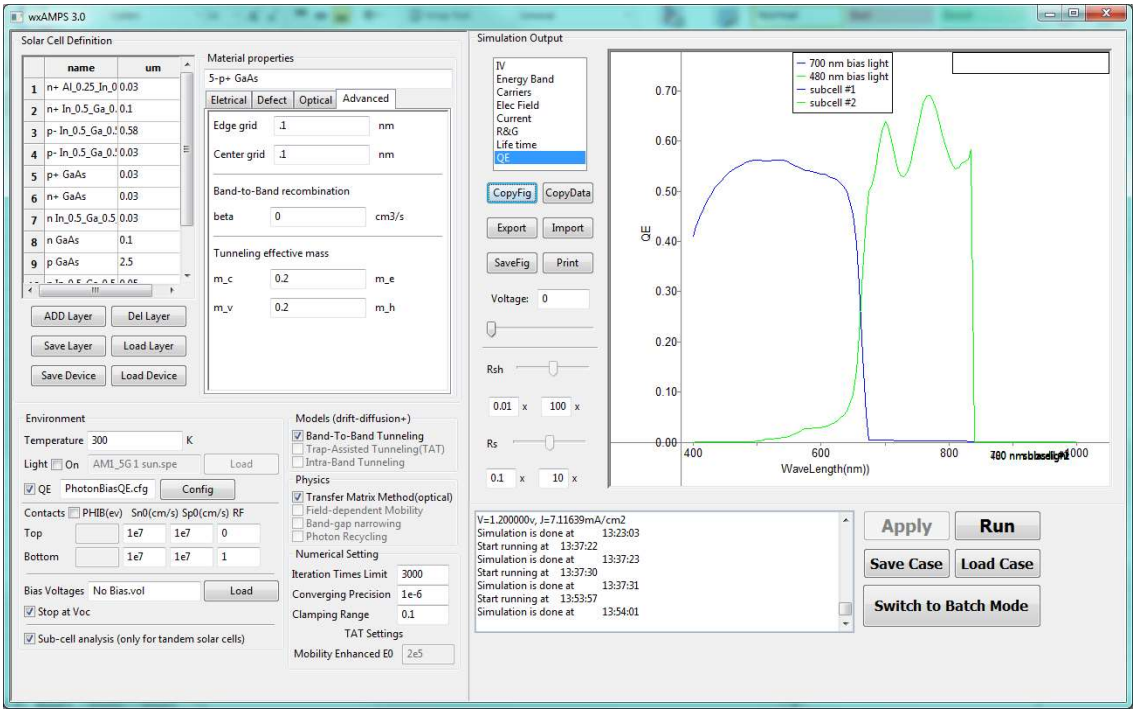
(b) 


Fig. 5 A demonstration of the sub-cell analysis. (a) IV curves of two sub-cells and the pseudo-IV curve. (b) QE of each sub-cell obtained by using sub-cell analysis.

## 3. Limitation of current version

- All grey items displayed in wxAMPS 3.0 are to be developed.
- QE simulation currently only supports dual junction.

For more information, please check the website:

https://wiki.illinois.edu//wiki/display/solarcellsim/Simulation+Software

Please acknowledge Prof. Rockett, Dr. Yiming Liu and Prof. Fonash of PSU in any of your articles, reports, course lectures, and presentations which employ wxAMPS in simulation results.