Advanced Simulation of Solar Cells using APSYS

About APSYS

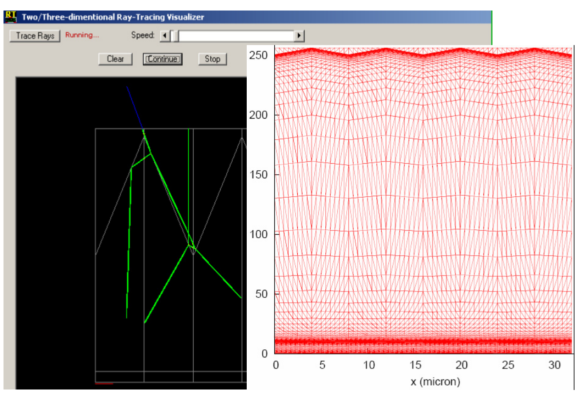
APSYS, Advanced Physical Models of Semiconductor Devices, is based on 2D/3D finite element analysis of electrical, optical and thermal properties of compound and silicon semiconductor devices. Emphasis has been placed on band structure engineering and quantum mechanical effects. Inclusion of various optical modules also makes this simulation package attractive for applications involving photosensitive or light emitting devices.

Models and Features

APSYS is a full 2D/3D simulator, which solves, self-consistently, the Poisson's equation, the current continuity equations, the carrier energy transport equations (hydrodynamic model), quantum mechanical wave equations, and the scalar wave equations for photonic waveguiding devices. Applicable features for solar cell modeling include the following features.

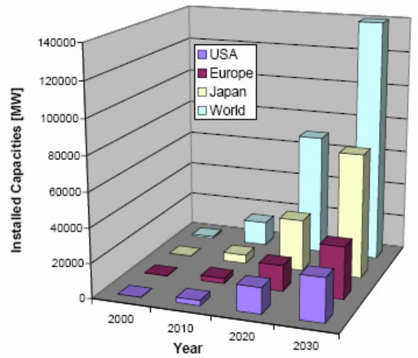
Physical Models & Advanced Features

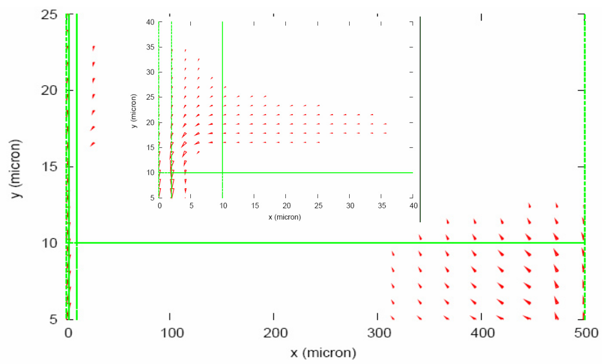
- Hydrodynamic models
- Traps and trap dynamics
- 2D/3D ray tracing
- Interface states and recombination
- Field dependent mobility model
- Doping density dependent lifetime
- Tunnel junctions
- Solar spectral absorption & optic coating
- A large number of material models

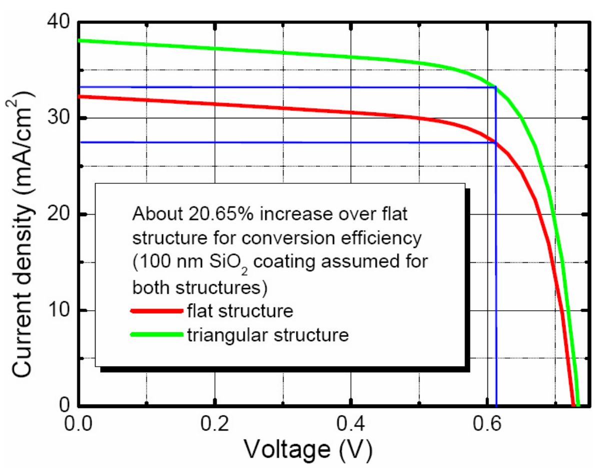


Application Demonstrations

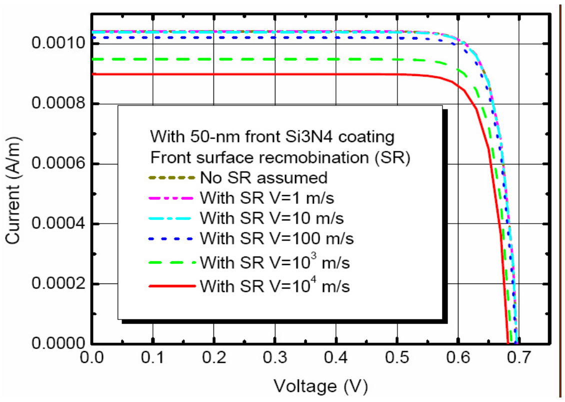
Si-based solar cells are efficient, affordable and compatible with well-established fabrication technologies with hot market. For Si rear-contacted cells (RCC) with textured front surface, RT techniques are utilized to compute the enhanced optic absorption. Conversion efficiency could be improved with about 20.7% percent for certain textured devices and good agreement with the experimental can be obtained. Other Si cells, like passivated emitter, rear totally diffused (PERT), and passivated emitter, rear locally diffused (PERL) cells can also be modeled.



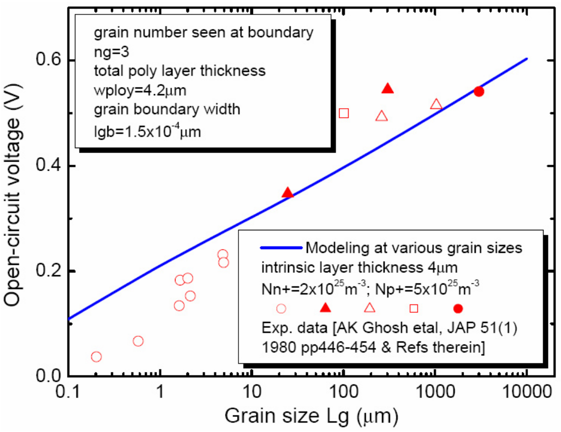




Surface recombination can be incorporated.

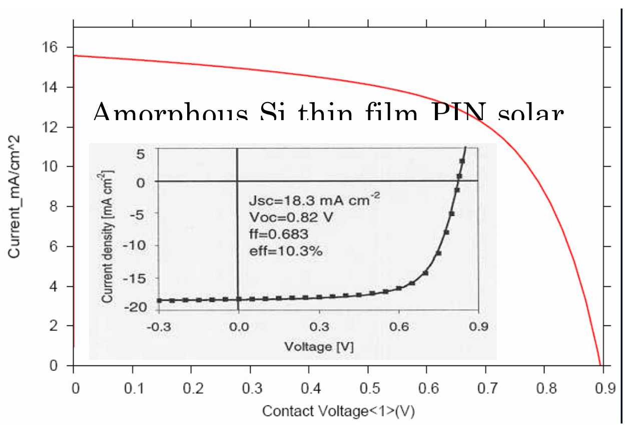


Poly-crystalline Si grain size effect can be modeled as well.



For amorphous Si thin film cell modeling, one can specify tail states and dangling bond states as impurity states, and specify their corresponding electron and hole capture cross section values. Good consistency with experiment can be obtained from modeling.

For modeling triple-junction GaInP/GaAs /Ge solar cells, the model of tunnel junction with the equivalent mobility enables an efficient modeling across the whole solar spectra, where all the spectrum data points are processed by taking into account the effects of multiple layer optical interference and photon generation.



Modeling results for triple-junction GaInP/ GaAs/Ge solar cells are displayed below.