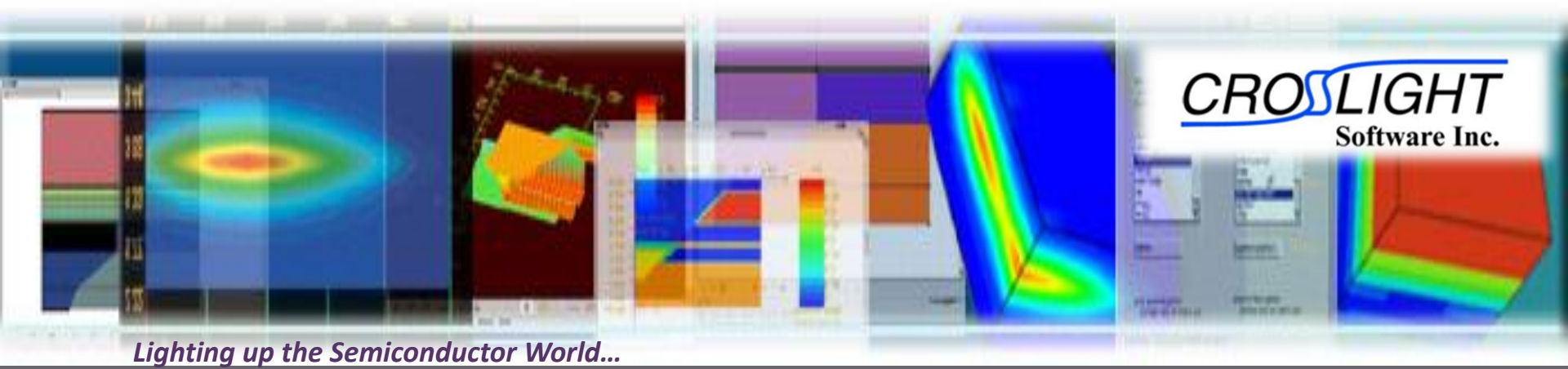
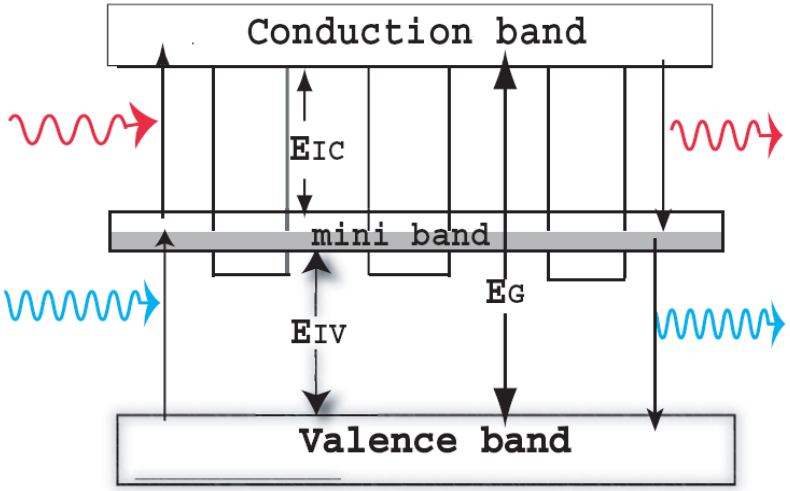


Lighting up the Semiconductor World…

Simulation of Quantum Well and Quantum Dot Solar Cell

Advantages

- Enlarged absorption wavelength range for a given material.
- Miniband transports, either cold carrier or hot carrier, believed to enhanced carrier lifetime.
- Hot carrier miniband transport to offer higher open circuit voltage.
- Cold carrier miniband transport to enhance short circuit current.



Modeling Approach

- 2D QW model to compute absorption spectrum and to form miniband.

- 3D QD model for absorption and miniband.

- Drift-diffusion model modified to account miniband transport at a proper effective miniband energy level.

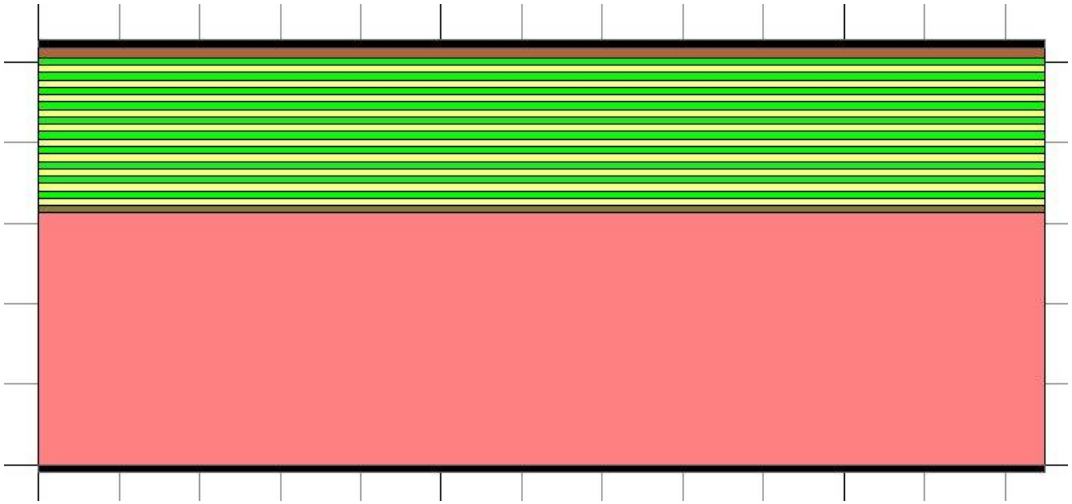
Reference structure (QD):

INAS QUANTUM DOT ENHANCEMENT OF GAAS SOLAR CELLS

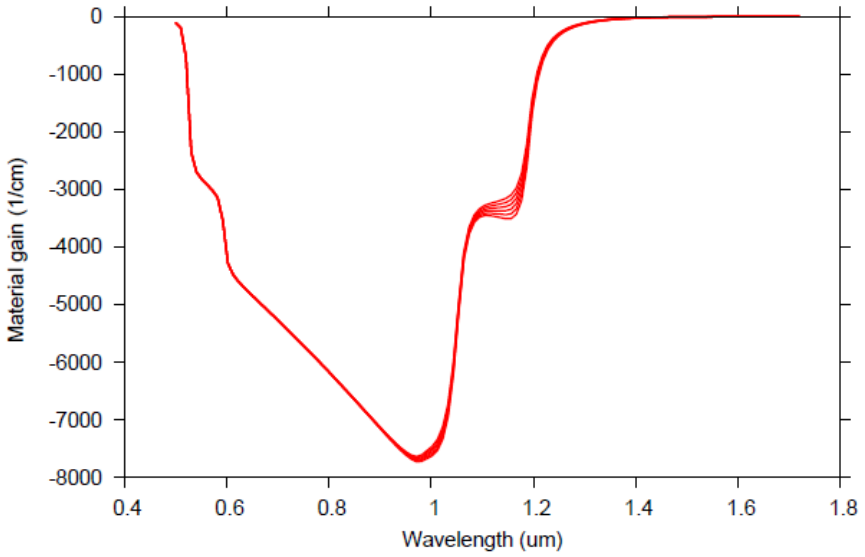
Seth M. Hubbard, et.al,
978-1-4244-5892-9/10 ©2010 p001217

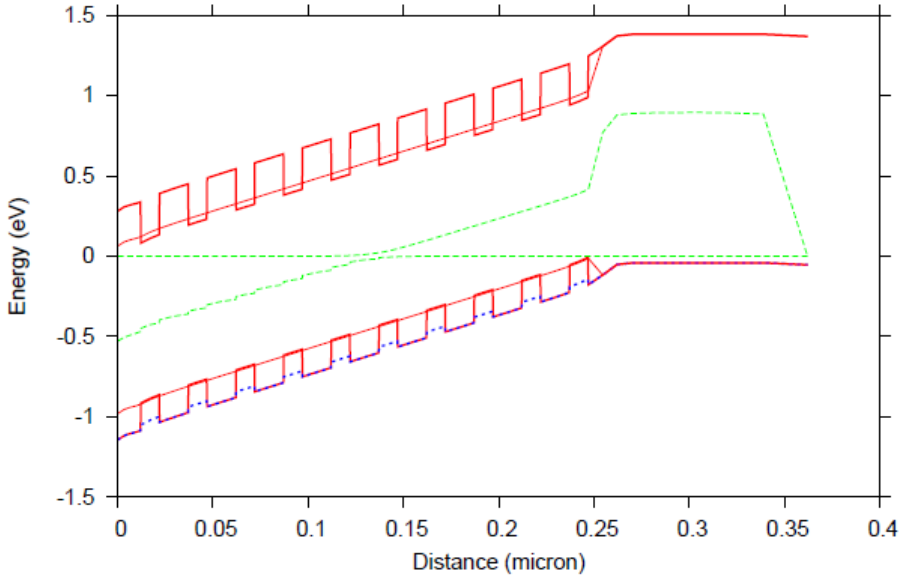
Reference structure (QW):

InGaAs/GaAs MQW solar cell with similar p-i-n structure

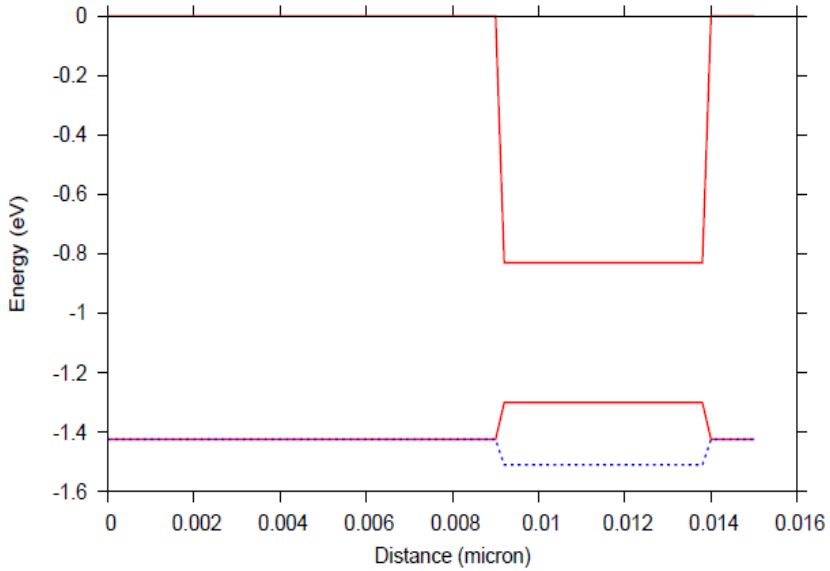


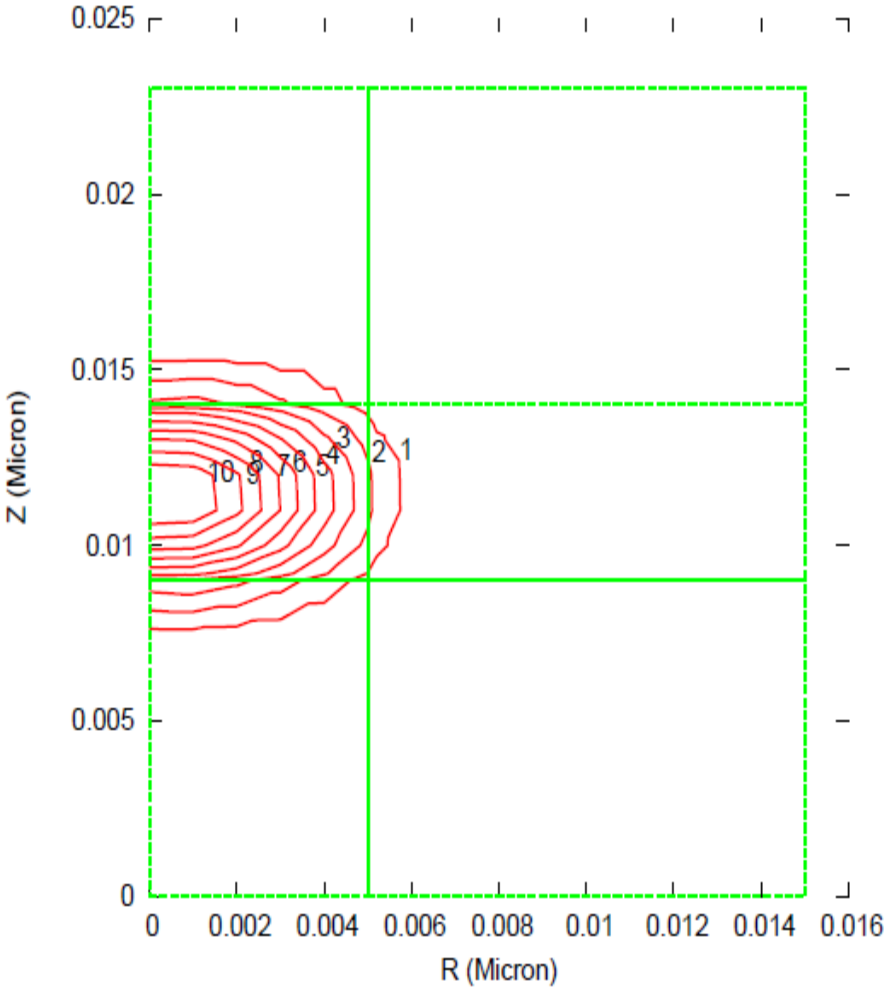
QW absorption and miniband:





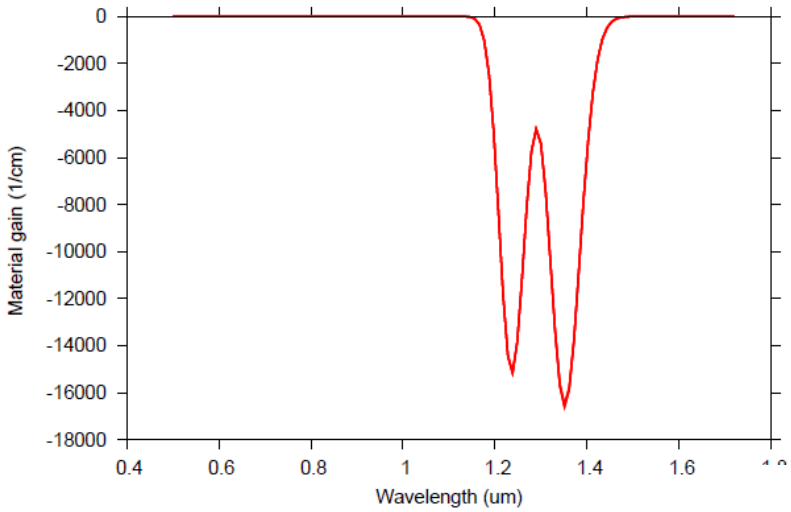
3D QD quantum solution:

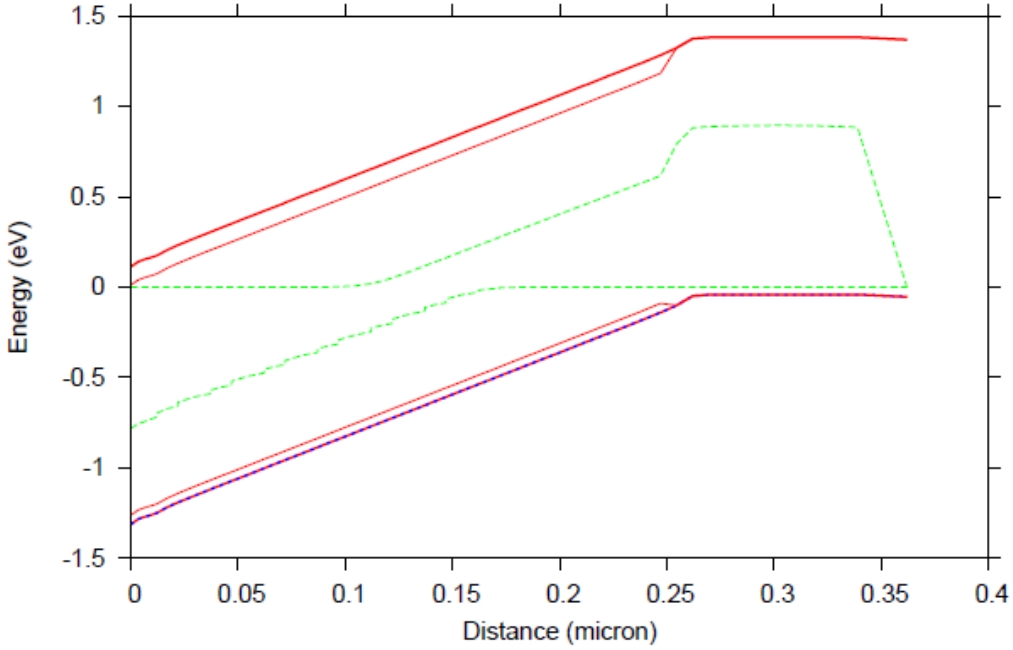




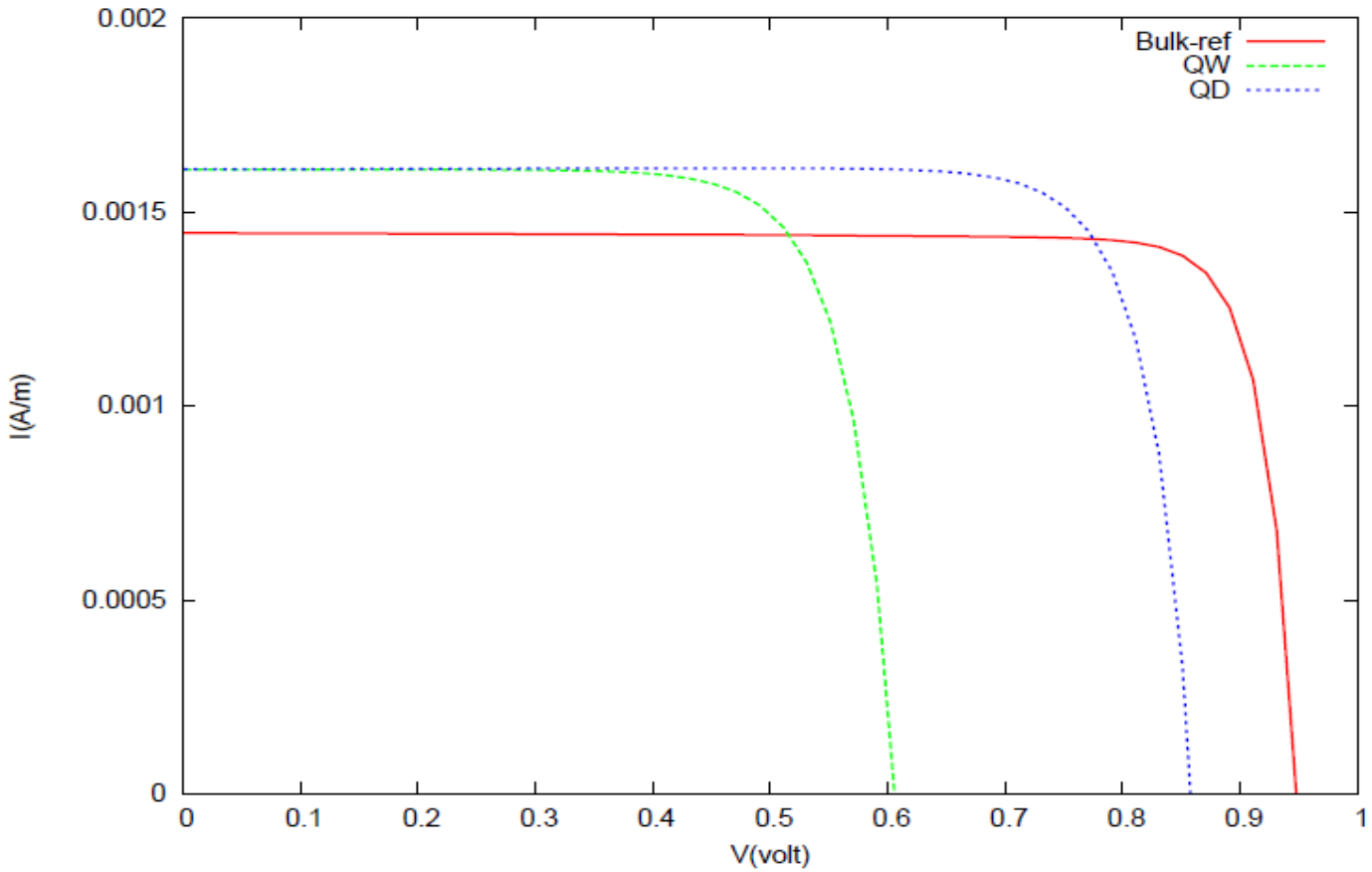
Simple cylindrical dot with InAs surrounded by GaAs.

QD absorption and miniband





Comparison of performance (device width = 10 um)



Reasonable agreement with experiment

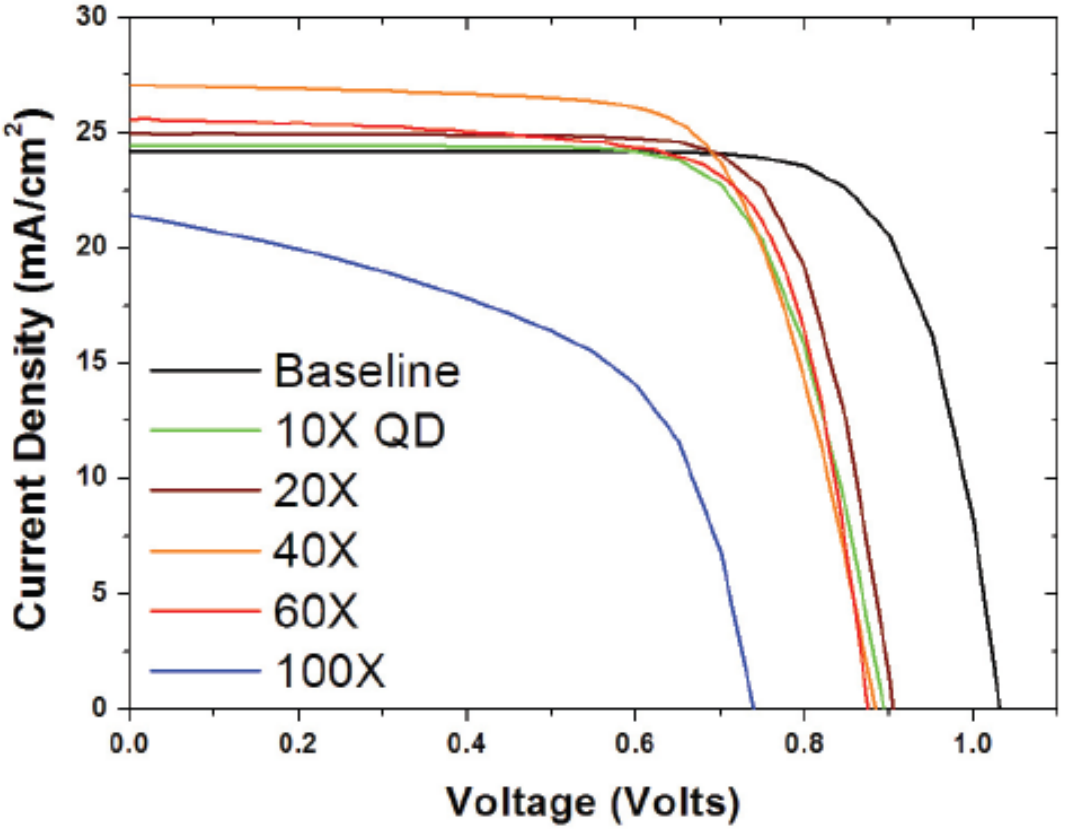


Figure 4. One sun AM0 light J-V curves for the baseline GaAs *p-i-n* cell and 5X-100X QD cells.

Conclusions

- Using an effective miniband model within the frame work of drift-diffusion theory, advantages of QW/QD solar cells can be demonstrated via simulation.

- With different energies of the effective miniband, cold and hot carrier miniband can be effeciently simulated.

- 2D QW and 3D QD quantum states solution accurately accounts for the widened absorption spectrum in QW/QD material.

A Glimpse

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