Advanced Simulation of Photodetectors 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.

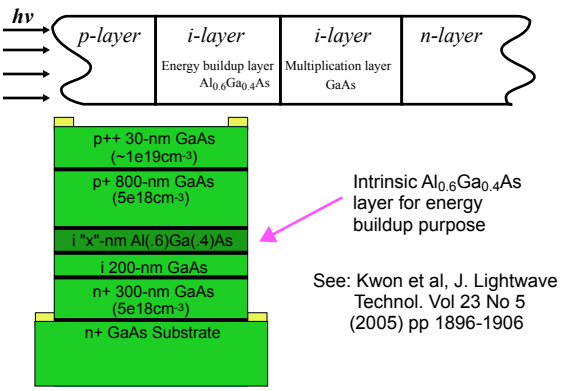
Models and Features

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 modeling photo-detectors and avalanche photodiodes include the following features.

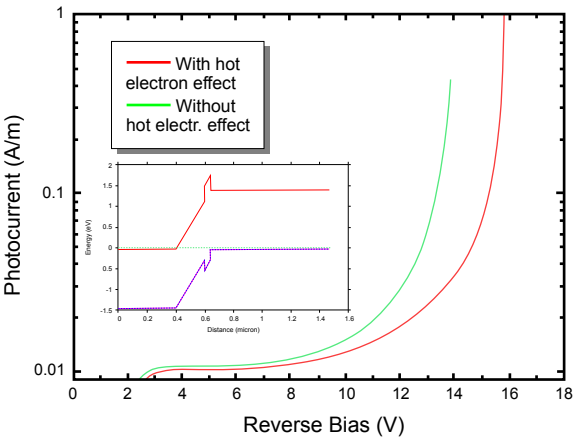
Physical Models & Advanced Features
Hydrodynamic models for hot carriers
Quantum wells and k.p theory
Thermionic emission model
Impact ionization models
Intersubband optic absorption
Field dependent mobility model
Doping density dependent lifetime
Interface states and recombination
Temperature dependent model and low temp(<77K) simulation
A large number of material models

Application Demonstrations

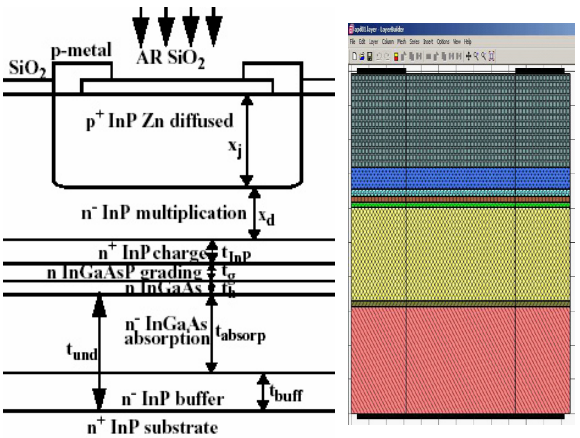
Photodetectors have extensive applications in fields from astronomical observation, remote sensing imagers and optic fiber communications etc. Modeling capabilities are here demonstrated with PIN photo-diodes, separate absorption, grading, charge, and multiplication avalanche photo-diodes (SAGCM APDs) for optic fiber communications, and quantum well infrared photodiodes (QWIPs) for remote sensing.



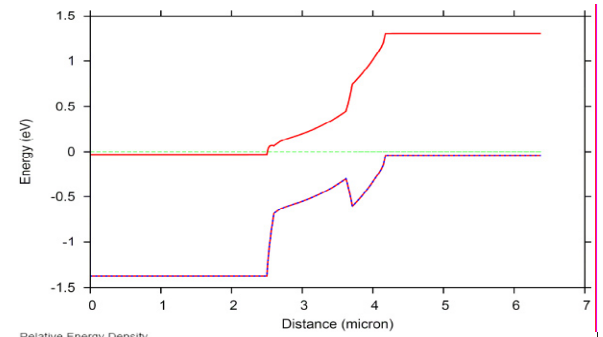
See: Kwon et al, J. Lightwave Technol. Vol 23 No 5 (2005) pp 1896-1906

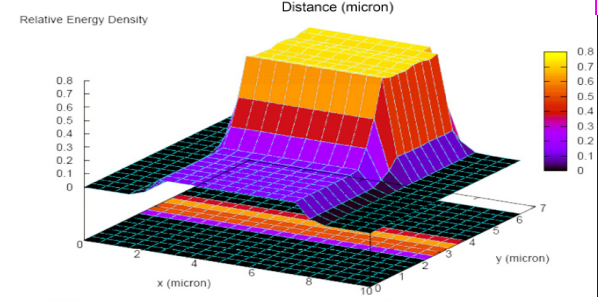


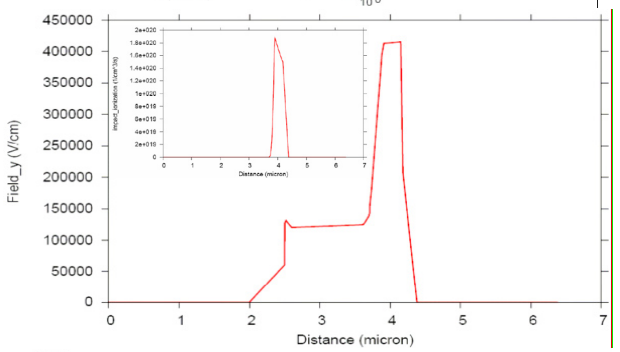
Modeling results for InP/InGaAs SAGCM APDS are presented below. The basic InP/InGaAs SAGCM device structure can be built up with Crosslight Layer Builder.

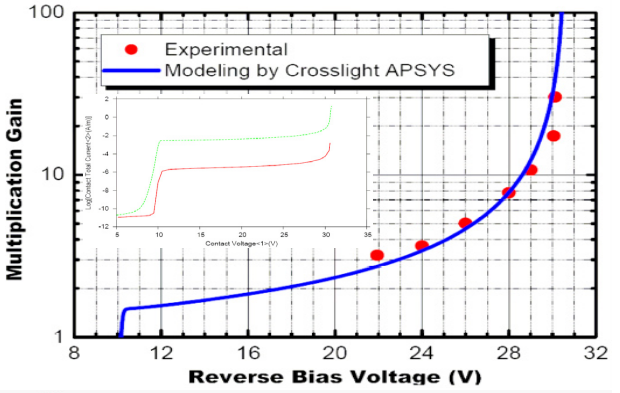


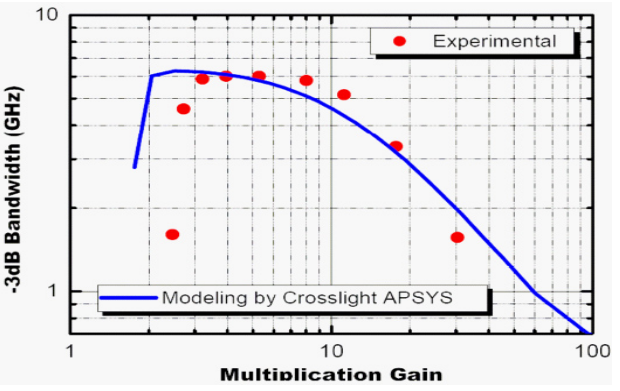
Optical absorption is mainly in InGaAs layer and impact ionization mainly in n^- InP layer.



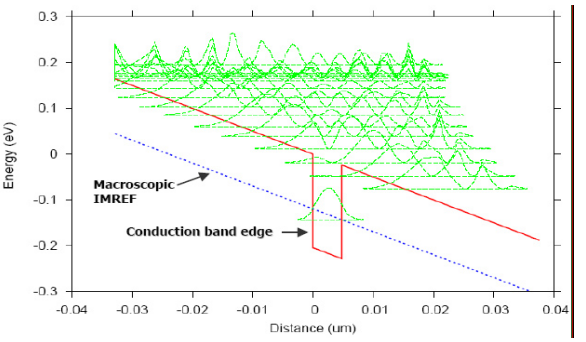








For QWIPs, the single well bound and unbound states from APSYS modeling is presented below.



For full QWIP device, the modeling results show good agreement with experiment.