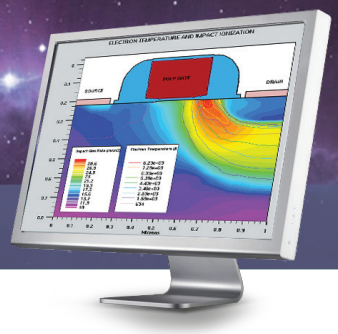
Atlas

Device Simulation Framework



Atlas enables device technology engineers to simulate the electrical, optical, and thermal behavior of semiconductor devices. Atlas provides a physics-based, easy to use, modular, and extensible platform to analyze DC, AC, and time domain responses for all semiconductor based technologies in 2 and 3 dimensions. Efficient and robust multi-threading algorithms significantly reduces simulation time while retaining accuracy on parallel CPU machines.

- **Accurately characterize physics-based devices in 2D or 3D for electrical, optical, and thermal performance without costly split-lot experiments**
- **Solve yield and process variation problems for optimal combination of speed, power, density, breakdown, leakage, luminosity, or reliability**
- **Fully integrated with Athena process simulation software, comprehensive visualization package, extensive database of examples, and simple device entry**
- **Choose from the largest selection of silicon, III-V, II-VI, IV-IV, or polymer/organic technologies including CMOS, bipolar, high voltage power device, VCSEL, TFT, optoelectronic, Laser, LED, CCD, sensor, fuse, NVM, ferro-electric, SOI, Fin-FET, HEMT, and HBT**
- **Connect TCAD to Tapeout with direct import of Atlas results into Utmost for SPICE parameter extraction**
- **Parallel processing supported on multi-core and multiple processor SMP machines**
- **Worldwide support**
- **Silvaco's strong encryption is available to protect valuable customer and third party intellectual property**

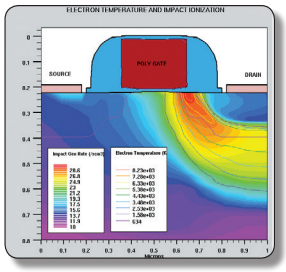
SILVACO

2D Device Simulation Modules

S-Pisces

2D SILICON DEVICE SIMULATOR

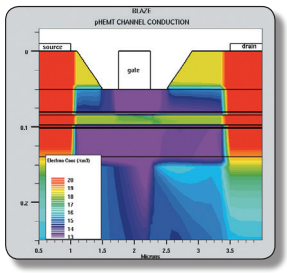
Advanced 2D device simulator for silicon based technologies that incorporates both drift-diffusion and energy balance transport equations. A large selection of physical models are available which include surface/bulk mobility, recombination, impact ionization and tunneling models.



Blaze

2D DEVICE SIMULATOR FOR ADVANCED MATERIALS

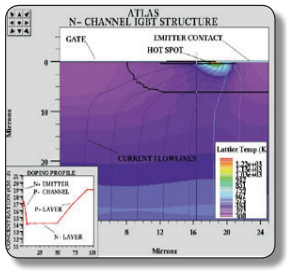
Simulates devices fabricated using advanced materials. Includes a library of physical models and material parameters for binary, ternary and quaternary semiconductors.



Giga

2D NON-ISOTHERMAL DEVICE SIMULATOR

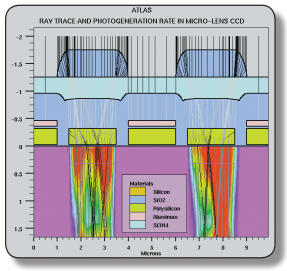
Simulates self heating effects when combined with S-Pisces or Blaze. Models include heat generation, heat flow, lattice heating, heat sinks, and effects of local temperature on physical constants. Thermal and electrical physical effects are coupled through self-consistent calculations.



Luminous

2D OPTOELECTRIC DEVICE SIMULATOR

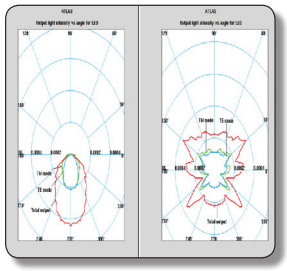
Advanced device simulator specially designed to model light absorption and photogeneration in non-planar semiconductor devices. Exact solutions for general optical sources are obtained using geometric ray tracing. This feature enables Luminous to account for arbitrary topologies, internal and external reflections and refractions, polarization dependencies and dispersion. Luminous also allows optical transfer matrix method analysis for coherence effects in layered devices. The beam propagation method may be used to simulate coherence effects and diffraction.



LED

2D LIGHT EMITTING DIODE SIMULATOR

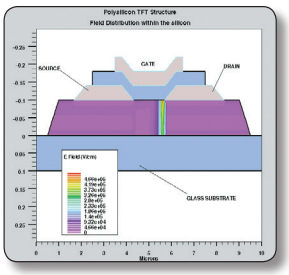
LED is a module used for simulation and analysis of light emitting diodes. It is integrated with the Blaze simulator and allows simulation of electrical, optical and thermal behavior of light emitting diodes.



TFT

2D AMORPHOUS AND POLYCRYSTALLINE DEVICE SIMULATOR

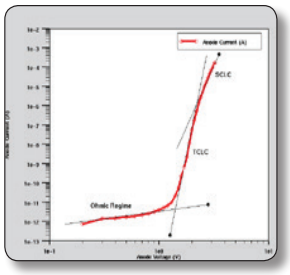
TFT is an advanced device technology simulator equipped with the physical models and specialized numerical techniques required to simulate amorphous or polysilicon devices including thin film transistors. Specialized applications include large area display electronics such as Flat Panel Displays (FPDs) and solar cells.



Organic Solar

ORGANIC SOLAR CELL AND PHOTODETECTOR SIMULATOR

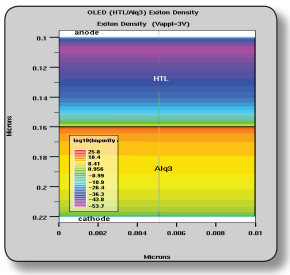
The Organic Solar module enables Atlas to simulate the electrical and optical properties of organic solar cell devices, photodetectors and image sensors. Organic Solar allows steady-state, transient and AC simulation of the electrical and optical behavior of photovoltaic organic devices. The exciton densities, diffusion, generation/recombination and dissociation characteristics can all be simulated.



Organic Display

OLED AND OTFT ORGANIC DISPLAY SIMULATOR

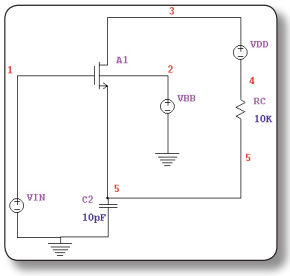
The Organic Display module enables Atlas to simulate the electrical and optical properties of organic display devices such as OTFTs and OLEDs. Organic Display allows steady-state and transient simulation of the electrical and optical behavior of active organic devices including singlet and triplet exciton densities, dopant exciton density, and optical emission characteristics.



MixedMode

CIRCUIT SIMULATION FOR ADVANCED 2D DEVICES

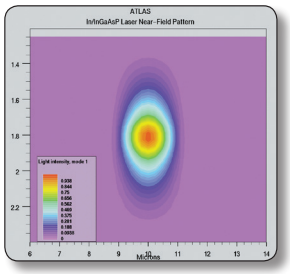
MixedMode is a circuit simulator that includes physically-based devices in addition to compact analytical models. Physically-based devices are used when accurate compact models do not exist, or when devices that play a critical role must be simulated with very high accuracy. Physically-based devices are placed in a SPICE netlist circuit description and may be simulated using any combination of Atlas 2D modules. The MixedMode XL license enables MixedMode users to use an unlimited number of physical devices or compact model elements in their circuits. This allows more sophisticated circuit definition.



Laser

SEMICONDUCTOR LASER DIODE SIMULATOR

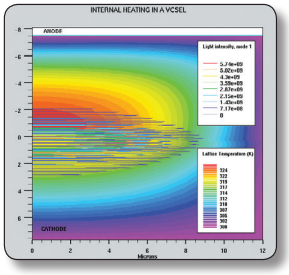
Laser is the world's first commercially available simulator for semiconductor laser diodes. Laser works in conjunction with Blaze in the Atlas framework to provide numerical solutions for the electrical behavior (DC and transient responses) and optical behavior of edge emitting Fabry-Perot type lasers diodes.



VCSEL

VERTICAL CAVITY SURFACE EMITING LASER SIMULATIONS

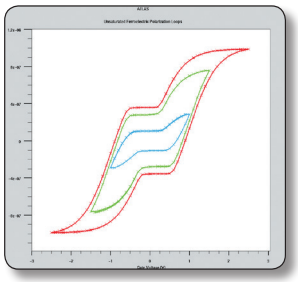
VCSEL is used in conjunction with the Atlas framework to produce physically based simulations of vertical cavity surface emitting lasers (VCSELs). VCSEL joins sophisticated device simulation to obtain electrical and thermal behavior with state of the art models for optical behavior.



Ferro

FERROELECTRIC FIELD DEPENDENT PERMITIVITY MODEL

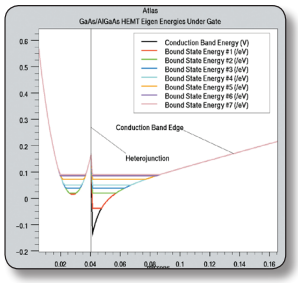
Ferro has been developed to combine the charge-sheet model of FET with Maxwell's first equation which describes the properties of ferroelectric film. The model can accurately predict the static I-V behavior of these devices as well as the dynamic response in transient and small signal modes.



Quantum

2D SIMULATION MODELS FOR QUANTUM MECHANICAL EFFECTS

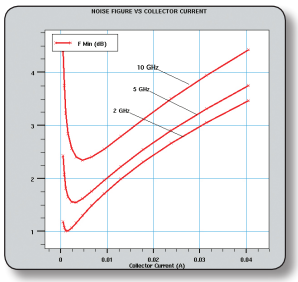
Quantum provides a set of models for simulation of various effects of quantum confinement and quantum transport of carriers in semiconductor devices. A Schrodinger – Poisson solver allows calculation of bound state energies and associated carrier wave functions self consistently with electrostatic potential. Schrodinger solver can be combined with the Non-equilibrium Green's Function (NEGF) approach in order to model ballistic quantum transport in 2D or cylindrical devices with strong transverse confinement. Quantum also includes models for the quantum mechanical corrections to drift-diffusion and hydrodynamic equations.



Noise

2D SMALL SIGNAL NOISE SIMULATOR

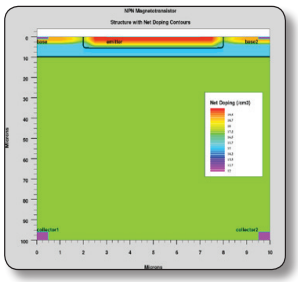
Noise combined with S-Pisces or Blaze allows analysis of the small-signal noise generated within semiconductor devices. Noise provides accurate characterization of all small-signal noise sources and extracts figures of merit which are essential for optimizating circuit design.



Magnetic

2D MAGNETIC DEVICE SIMULATOR

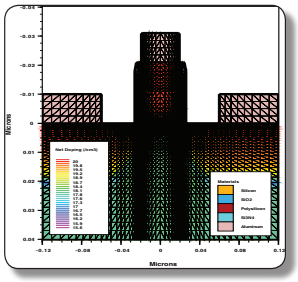
The Magnetic module enables the Atlas device simulator to incorporate the effects of an externally applied magnetic field on device behavior. The dynamics of the charge carrier motion are modified by the addition of the Lorentz force. This force is proportional to the vector product of the carrier velocity and the applied magnetic flux density vector. The Magnetic module allows the consequent changes to current flow and potential distributions to be calculated.



MC Device

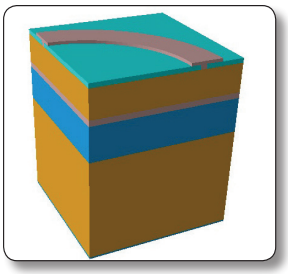
2D MONTE CARLO DEVICE SIMULATOR

Simulates the behavior of relaxed and strained silicon devices including non-equilibrium and ballistic effects in 2D. MC Device is fully integrated with Interactive Tools.



3D Device Simulation Modules

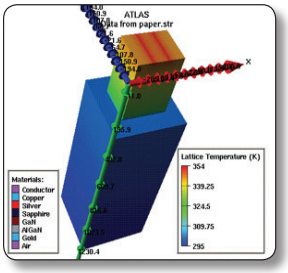
Device 3D



3D DEVICE SIMULATOR

Device 3D is a 3D device simulator for silicon and other material based technologies. The DC, AC and time domain characteristics of a wide variety of silicon, III-V, II-VI and IV-IV devices can be analyzed. Device 3D accurately characterizes physics-based devices for electrical, optical, and thermal performance without costly split-lot experiments. Device 3D solves yield and process variation problems for optimal combination of speed, power, density, breakdown, leakage, luminosity and reliability.

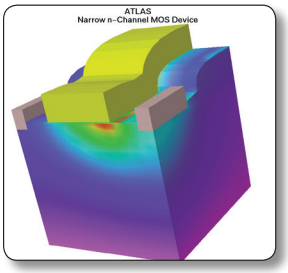
Thermal 3D



THERMAL PACKAGING SIMULATOR

Thermal 3D is a general heatflow simulation module that predicts heatflow from any power generating devices (not limited to semiconductor devices), typically through a substrate and into the package and/or heatsink via the bonding medium. Operating temperatures for packaged and heat sinked devices or systems can be predicted for the design and optimization phase or for general system analysis.

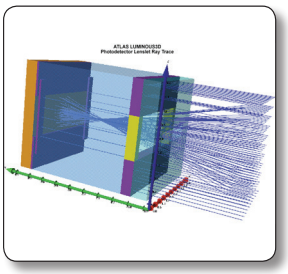
Giga 3D



3D NON-ISOTHERMAL DEVICE SIMULATOR

The Giga 3D module extends Device 3D by incorporating the effects of self-heating into a device simulation. It includes models for heat sources, heat sinks, heat capacity and thermal conduction. Physical and model parameters become dependent on the local lattice temperature where appropriate, allowing self-consistent coupling between the semiconductor device equations and the lattice temperature.

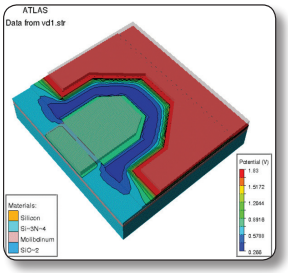
Luminous 3D



3D OPTOELECTRIC DEVICE SIMULATOR

Luminous 3D is an advanced simulator specially designed for analysis of optical response of non-planar semiconductor devices in three dimensions.

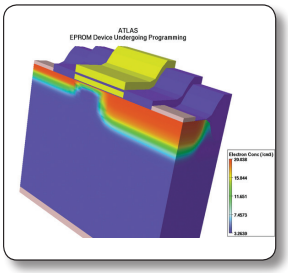
TFT 3D



3D AMORPHOUS AND POLYCRYSTALLINE DEVICE SIMULATOR

TFT 3D is an advanced device technology simulator equipped with the physical models and specialized numerical techniques required to simulate amorphous or polysilicon devices in 3D. TFT 3D models the electrical effects of the distribution of defect states in the band gap of non-crystalline materials. Users can specify the Density Of States (DOS) as a function of energy for amorphous silicon and polysilicon for grain and grain boundaries as well as the capture cross-sections/lifetimes for electrons and holes.

MixedMode 3D



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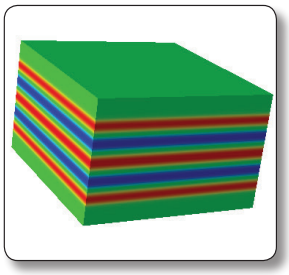
Quantum 3D



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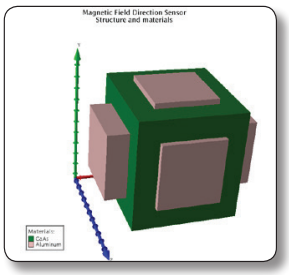
Magnetic 3D



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User Model Development Environment

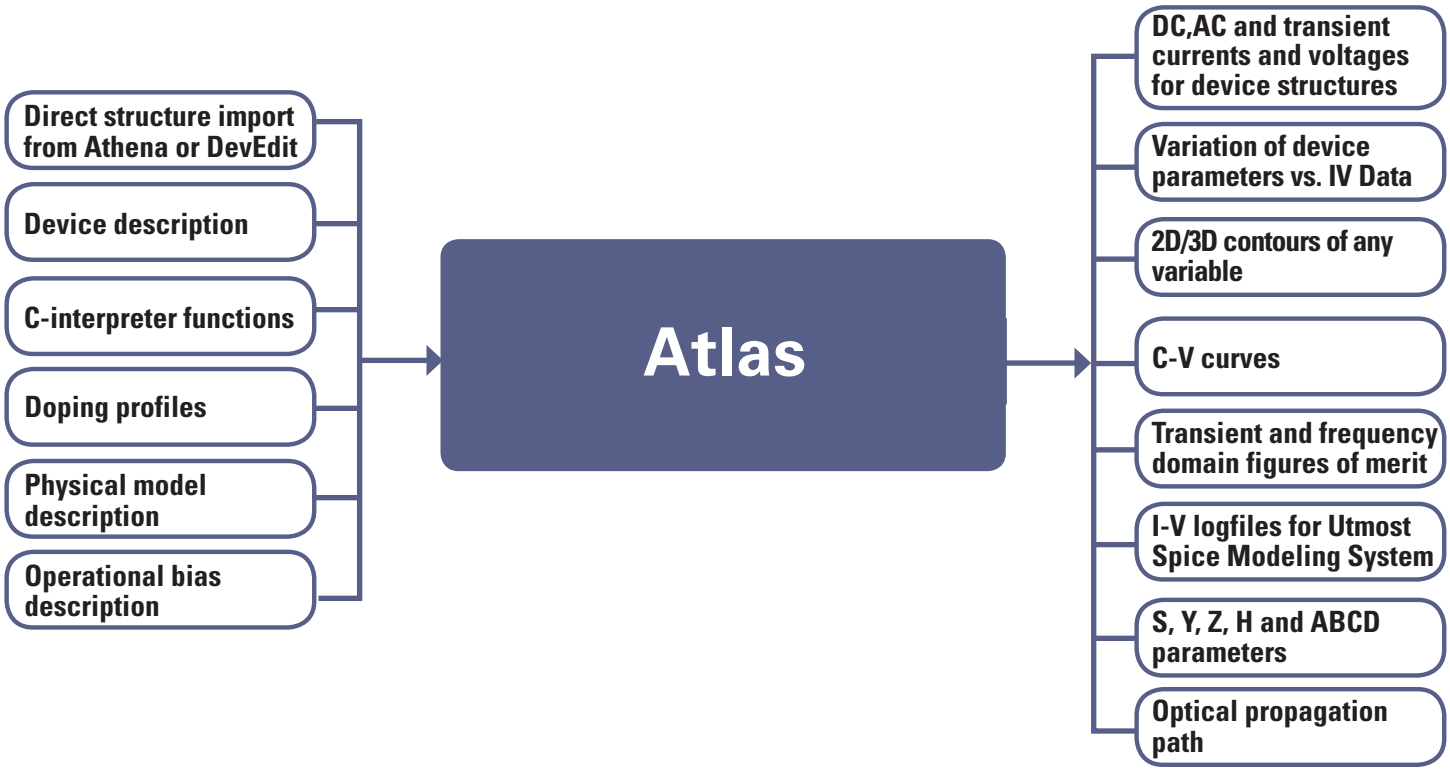
C-Interpreter

USER-DEFINED C-LANGUAGE MODEL INTERFACE

The C-Interpreter allows convenient and flexible definition of physical models and material parameters via an ANSI standard C-language interface. The C-Interpreter compiles the user-defined functions at run-time, while maintaining fast execution times. Atlas supports a wide range of C-Interpreter functions such as doping, composition fraction, defect density of state, temperature and composition dependent band parameters, as well as mobility, recombination and generation models.

```
/*
 * Generation rate as a function
of position
 * Statement: BEAM
 * Parameter: F.RADIATE
 * Arguments:
 * x          location x (microns)
 * y          location y (microns)
 * t          time (seconds )
 * *rat       generation rate per
cc per sec.
 */
int radiate(double x,double y,double
t,double *rat)
{
```

Atlas Inputs/Outputs



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