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#### Silvaco TCAD Overview





#### **Athena: 2D Process Simulator**

- Simulation of all critical fabrication steps
- Prediction of multi-layer topology, dopant distributions, and stresses
- Import mask files
- Automatic and user-defined mesh generation and control
- Run-time extraction of process and device parameters
- Optimization of process flow and calibration of model parameters



# Atlas: 2D/3D Device Simulator

- Modular, and extendible platform
- Analyze DC, AC, and time domain responses for all semiconductor based technologies in 2D/3D
- Parallel processing supported on multi-core machines
- Fully integrated with Athena & DevEdit
- MixedMode: circuit and device simulation using SPICE netlists and SmartSpice models



#### **Atlas: Advanced Solutions**

- Incorporate effects of self-heating in 2D/3D device simulation, DC, AC, transient analysis
- Extended precision (80, 128, 160 & 256 bit)
- Curvetrace algorithm
- Traps, interface traps, and defects
- Comprehensive library of binary, ternary, quaternary and organic semiconductors
- User defined models with C-Interpreter







#### Atlas: MixedMode / Circuit Simulation

- Simulate physics-based devices in combination with compact analytical models in a circuit environment
- Any combination of Atlas 2D/3D modules
- Devices simulated with a SPICE netlist circuit description
- Wide range of SPICE models available
- Unlimited number of physical devices or compact model elements with MixedModeXL



# Atlas: GIGA – Electro-Thermal

- Wachutka's thermodynamically rigorous model for Joule heating, Generation and Recombination and Peltier-Thomson effects
- Dependence of material and transport parameters on lattice temperature
- Specify heat-sinks, thermal impedances, and ambient temperatures.
- Compatible with both the driftdiffusion and energy balance transport models





#### Atlas: Luminous – Optoelectronic Module

- Model light absorption and photogeneration in devices
- Arbitrary topologies, internal and external reflections and refractions, polarization dependencies and dispersion
- Mono-chromatic or multi-spectral optical sources
- DC, AC, and transient response in the presence of arbitrary optical sources



#### Atlas: Luminous – Optoelectronic Module

Light Simulation Options:

- Ray Tracing Method (RTM)
- Transfer Matrix Method (TMM)
- Beam Propagation Method (BPM)
- Finite Difference Time Domain (FDTD)
- Uniform and Gaussian illumination
- Circular and elliptical optical source
- User defined optical source





# DevEdit: 2D / 3D Device & Mesh Editor

- Create a device from scratch, re-mesh or edit an existing device
- Parameterize and vary automatically with DeckBuild or VWF
- Mirroring, stretching, cloning and joining
- GUI to draw or edit devices directly
- Re-mesh on volume data
- Import 1D doping profiles



# **Interactive Utility Tools**



# **DeckBuild: Deck Edit and Execute**

- Deck edit and execute
- Run-time control
- Break points, history files
- Parameter Extraction (EXTRACT statement)
- Variable Substitution (SET Statement)
- Templates to help with deck writing
- IF's and LOOPS
- Launch other utility tools
- Searchable database of 500+ examples (available online)



# **VWF: Design of Experiments & Optimisation**

- Automated Design of Experiments & Parameter Optimisation
- Split-lots created manually or using pre-defined methods
- Use with any of Silvaco's process, device, parasitic extraction and circuit simulators
- Can represent an entire flow from process simulation to spice circuit performance, or any part of the flow
- Grid engine compatible





# **VWF: Design of Experiments & Optimisation**

- Flexible: any mix of parameters (process, device, circuit etc)
- Auto-extract physical and/or electrical characteristics
- Optimisation: large array of local and global optimisers
- Response models can be generated over the experimental spread - input parameters can be rubber banded
- Export results worksheet use in SPAYN for additional statistical analysis or TonyPlot for viewing

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# **TonyPlot 2D: Interactive Visualisation Tool**

- Supports 1D, 2D, meshed data, Smith and polar charts
- Export data for use in third party tools
- Measurement tools (probes, rulers, etc)
- Overlay plots
- Movie Mode
- Cut lines
- Function and Macro



# **TonyPlot 3D: Interactive Visualisation Tool**

- Graphical rotation around any axis (x, y, z), repositioning and zoom in/out
- Surface contours
- Isosurfaces
- Probe within the 3D structure
- Hide materials or regions
- Fully customizable
- Cut-plane: 2D slice exported to file or TonyPlot 2D





# **The Victory Suite**



# Victory: Process Mode

- Multi-particle and flux models for physical deposition and etching with substrate material re-deposition
- Open Modelling Interface import your own models
- Monte Carlo implant simulation
- 3D oxidation (including stress)



# Victory: Process Mode

- Automatic meshing and Adaptive Mesh Refinement
- Multi-threading
- Mirroring
- Adaptive doping refinement
- Comprehensive set of 3D diffusion models: Fermi, three-stream, five-stream





#### Victory: Cell Mode

- Fast, layout-driven 3D process simulator specifically designed for large structures
- Layout-driven mesh generation
- User-controlled mesh placement
- Easy to learn and user-friendly SUPREM-like syntax



Flat panel LCD and TFT circuits.





#### Victory: Cell Mode

- Mask Layout-based Processing
- In-deck mask definition and manipulation
- Multi-threaded
- Unstructured mesh



#### **Victory: Device Simulator**

- Tetrahedral meshing for fast and accurate simulation of complex 3D geometries
- DC, AC and transient analysis for silicon, binary, ternary, quaternary and organic material devices
- Customizable material database
- Stress-dependent mobility and bandgap models



Diagonal MOSFET structure with the oxide layer removed to show the polysilicon and metalization layers.



IdVd 3D SOI NMOSFET simulation with body contact showing the kink suppression effect.



#### **Victory: Device Simulator**

- Customisable physical models
- Drift-diffusion and energy balance transport equations
- Self-consistent simulation of self-heating effects including heat generation, heat flow, lattice heating, heat sinks and temperature dependent material parameters
- Multi-threaded
- Atlas-compatible





Electrostatic potential isocontour for the SRAM cell.





