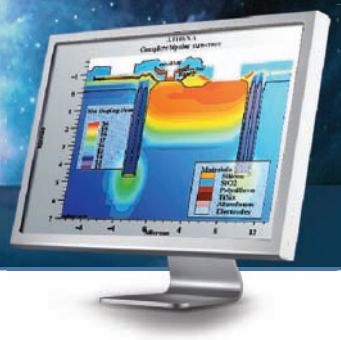
# Athena

## Process Simulation Framework



Athena framework integrates several process simulation modules within a user-friendly environment provided by Silvaco TCAD interactive tools. Athena has evolved from a world-renowned Stanford University simulator SUPREM-IV, with many new capabilities developed in collaboration with dozens of academic and industrial partners. Athena provides a convenient platform for simulating processes used in semiconductor industry: ion implantation, diffusion, oxidation, physical etching and deposition, lithography, stress formation and silicidation.

- **Fast and accurate simulation of all critical fabrication steps used in CMOS, bipolar, SiGe/SiGeC, SiC, SOI, III-V, optoelectronic, MEMS, and power device technologies**
- **Accurately predicts multi-layer topology, dopant distributions, and stresses in various device structures**
- **Advanced simulation environment allows:**
  - **easy creation and modification of process flow input decks including automatic control of layout mask sequences**
  - **automatic and user-defined mesh generation and control**
  - **interactive plotting of 2D structures and distributions as well as 1D cross-sections**
  - **run-time extraction of important process and device parameters**
  - **optimization of process flow and calibration of model parameters**
- **Focused TCAD support team of Ph.D. physicists continuously developing models for new semiconductor technology advances**
- **Replaces costly wafer experiments with simulations to enable shorter technology development cycles and higher yields**
- **Silvaco's strong encryption is available to protect valuable customer and third party intellectual property**

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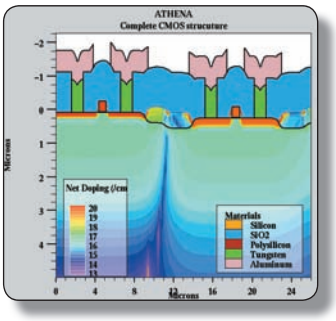
# SSuprem 4

## 2D Core Process Simulator

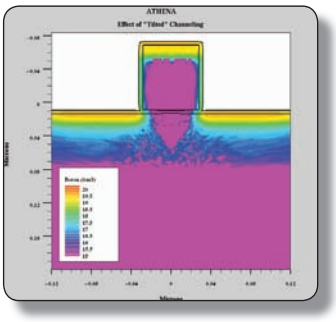
SSuprem 4 is a 2D process simulator that is widely used in the semiconductor industry for design, analysis and optimization of various fabrication technologies. SSuprem 4 accurately simulates all major process steps in modern technology by using a wide range of physical models for diffusion, ion implantation, oxidation, etching, deposition, silicidation, epitaxy and stress formation.




# MC Implant

## Advanced Monte-Carlo Implantation Simulator

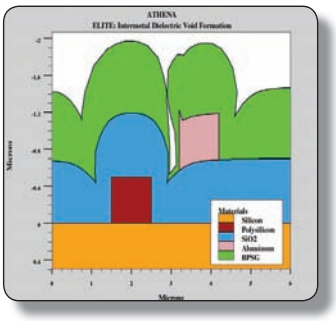
MC Implant is a generic ion implantation simulator, which models ion stopping, defect generation, and ion implantation distributions in amorphous and crystalline materials. Extensive comparisons with measured profiles have shown that MC Implant is highly accurate and predictive. The simulator can be used for a variety of ion/material combinations, arbitrary geometries, different substrate orientations, implant doses, energies and angles.




# Elite

## Advanced Physical Etching and Deposition Simulator

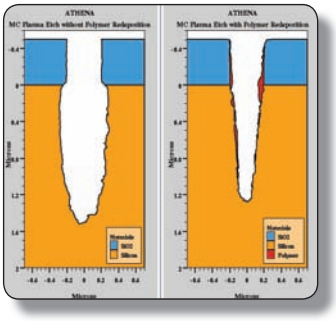
Elite is an advanced 2D topography simulator for modeling physical etching, deposition, reflow and CMP planarization processes for modern semiconductor technologies. Within the Athena framework, Elite provides seamless bi-directional integration with SSuprem 4 and Optolith process simulators and contains an additional MC Etch & Depo module, which provides several Monte Carlo based atomistic etching and deposition models.




# MC Etch & Deposit

## 2D Monte-Carlo Etch and Deposition Module

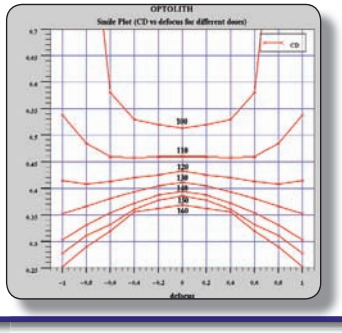
MC Etch & Deposit is an advanced topology simulation module seamlessly interfaced with Elite, through the Athena framework. The module includes several Monte Carlo based models for the simulation of etch and deposit processes which use fluxes of atomic particles.



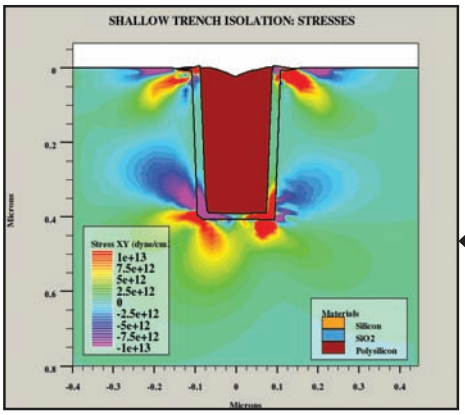

# Optolith

## 2D Optical Lithography Simulator

Optolith is a powerful non-planar 2D lithography simulator that models all aspects of modern deep sub-micron lithography: imaging, exposure, photoresist bake, development and reflow. Optolith provides a fast and accurate alternative to experimental evaluation of mask printability and process control. Optolith simulates both projection imaging and proximity printing with a large mask-to-resist gap.

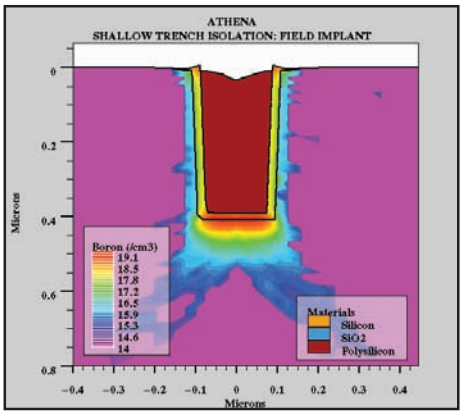


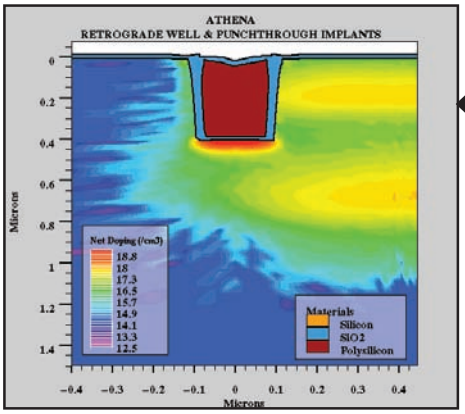
# Typical 90nm CMOS Process Flow




**SSuprem 4, Elite, MC Implant**

- Trench RIE
- Trench Oxidation
- Poly Deposition
- Planarization
- Field Implant



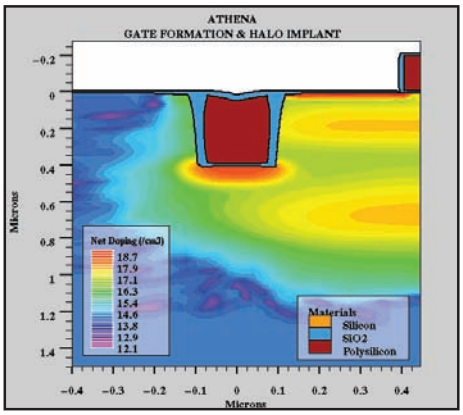



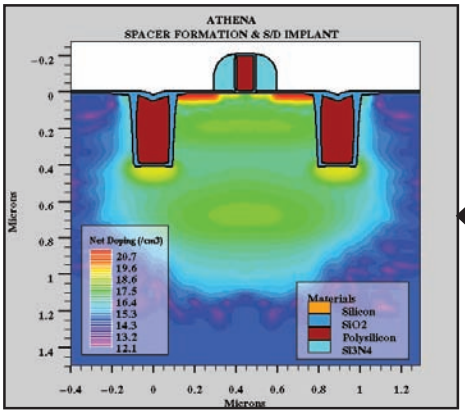

**MC Implant**

- Retrograde Well
- Punchthrough

**SSuprem 4, MC Implant**

- Gate Oxidation Step
- Polysilicon Gate Step
- Halo Implant
- S/D Implant



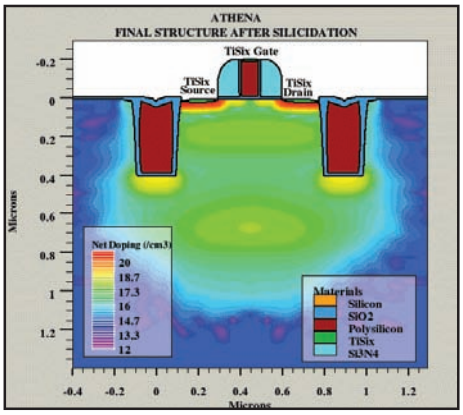




**SSuprem 4, Elite, MC Implant**

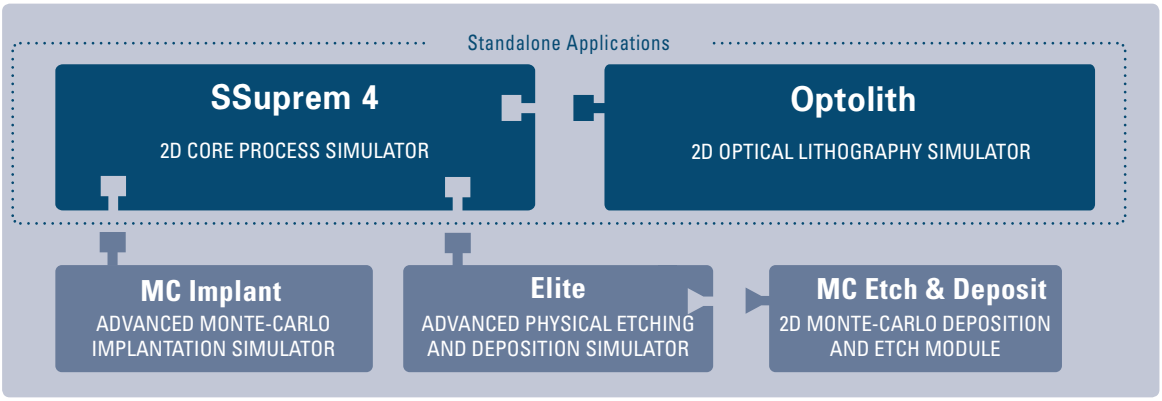
- Spacer CVD
- Spacer Etch
- S/D Implant

**SSuprem 4**

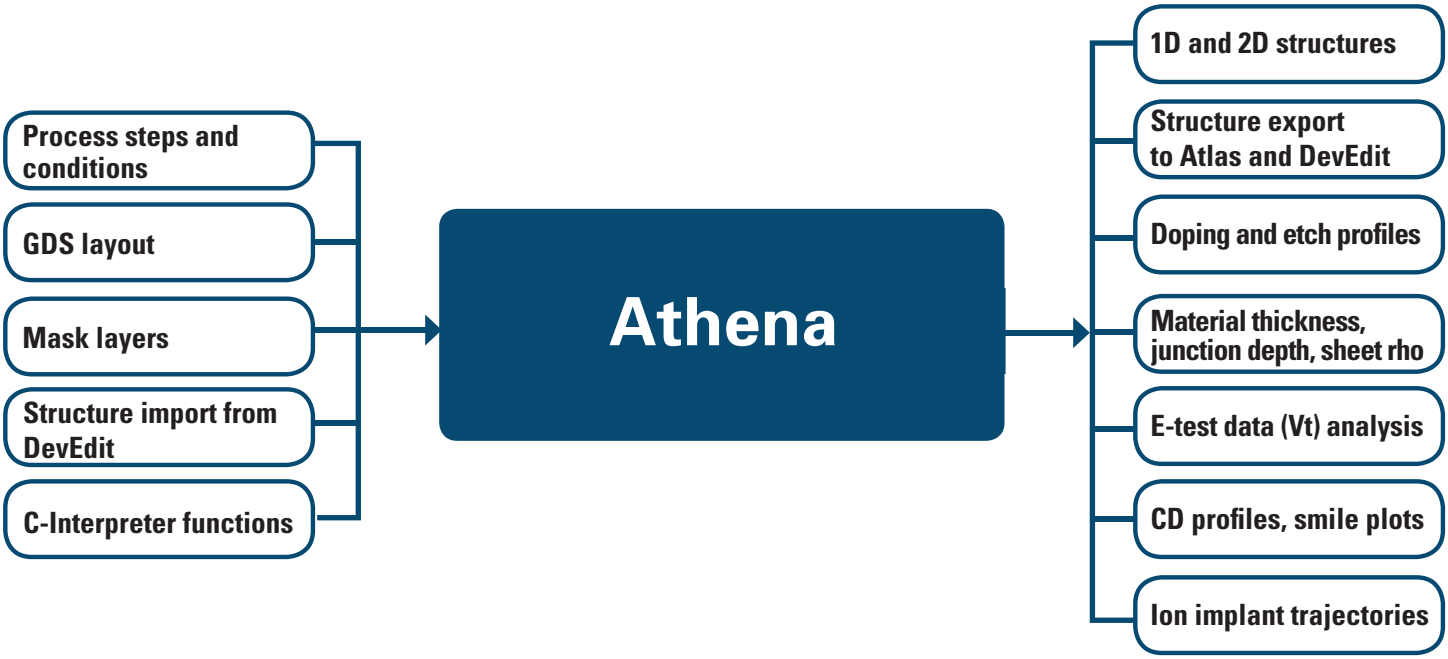
- S/D Spike Anneal
- Silicidation



# Athena Framework Architecture




# Athena Inputs/Outputs

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