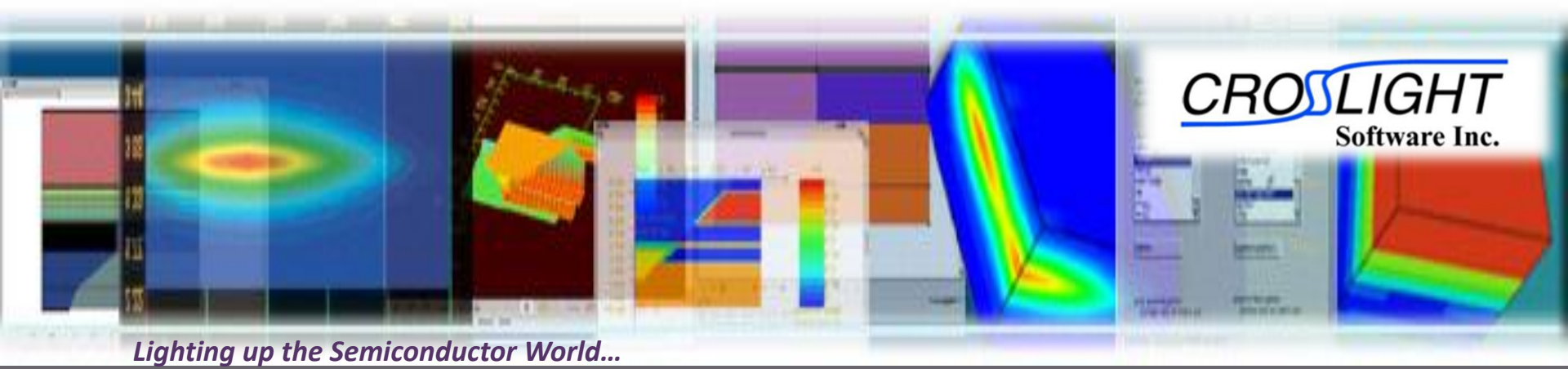



*Lighting up the Semiconductor World…*

# Introduction to Crosslight TCAD

## *Lighting up the Semiconductor World*

CROSSLIGHT Software Inc. Microelectronics Division

# A Glimpse

- Crosslight was established in Ottawa in 1993 as a spin-off company from the National Research Council (NRC) of Canada
- Founded by Dr. Zhanming (Simon) Li, most company leaders are also from NRC
- World's first commercial laser diode TCAD provider
- Best known for its numerical simulator for optoelectronics, Crosslight is a world leader in TCAD software
- Csuprem software based on Suprem IV licensed from Stanford University
- Windows-based complete 2D/3D tools for TCAD simulation.

# Company Locations and Agents

Canada Headquarters: Vancouver

China Branch: Shanghai

Japan Branch: Tokyo

Taiwan Agent: Grand Technology

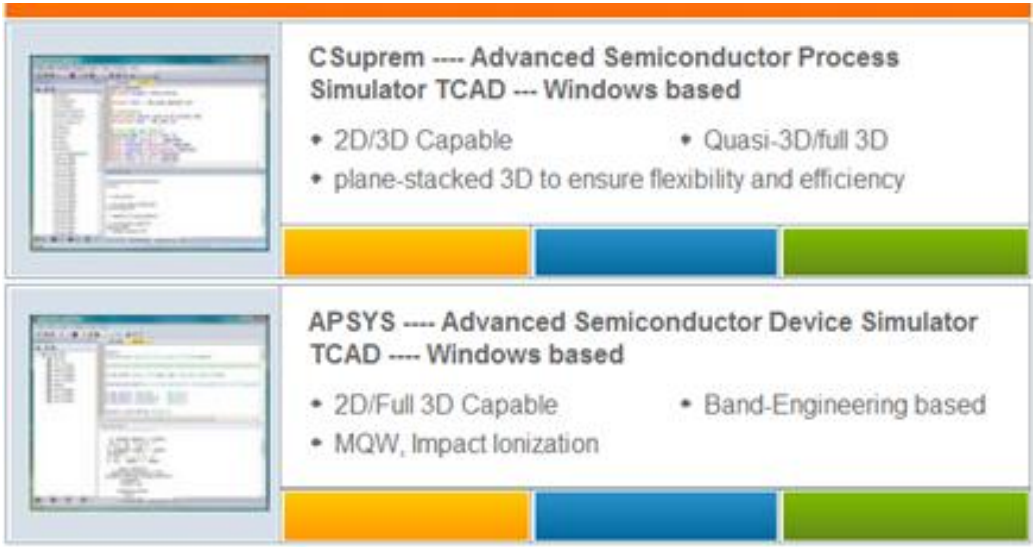
Korea Agent: CMS Technologies

# Products for Microelectronics Applications

CSuprem: 2D/3D process simulator based on Stanford's Suprem IV

APSYS: Advanced 2D/3D Device Simulation tool

MaskEditor: 3D process simulation sub-tool of CSuprem




## For Optics and Photonics Applications

PICS3D: 3D simulator for photonic IC

LASTIP: 2D simulator for laser diode

PROCOM：Compound semiconductor growth simulator

# Basic Functions

2D/3D process simulation

2D/3D device simulation for electrical, thermal and optical properties

AutoTCAD parameter batch simulation

Mix-mode simulation（currently only basic version is provided）

Graphical user interface for 2D/3D designs

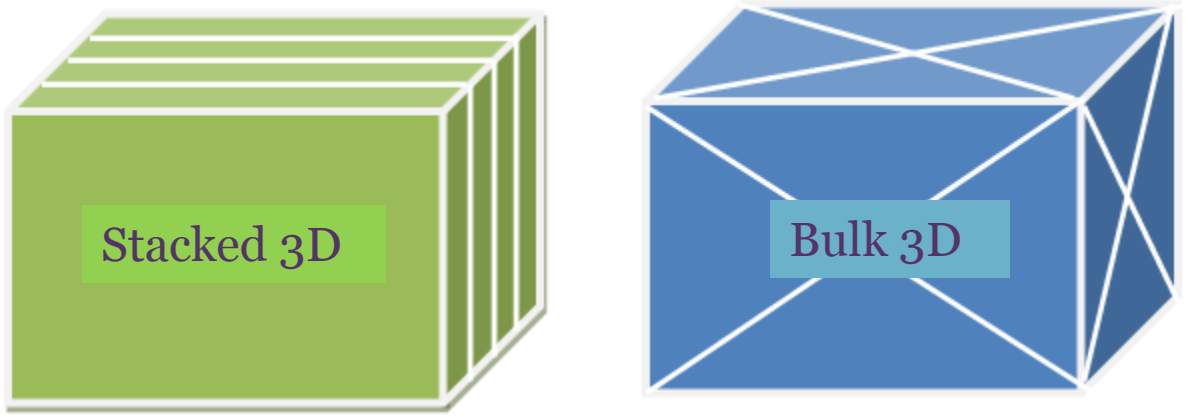
# Uniqueness of Crosslight 3D Simulation

All-new method of 3D meshing brings a totally different simulation experience：

High Efficiency: Less mesh points to build the same structure

Easy to use: Easily switch between 2D and 3D

High success rate: Increases 3D success rate by starting from successful 2D simulation



# Full 3D vs. Quasi3D

Full3D

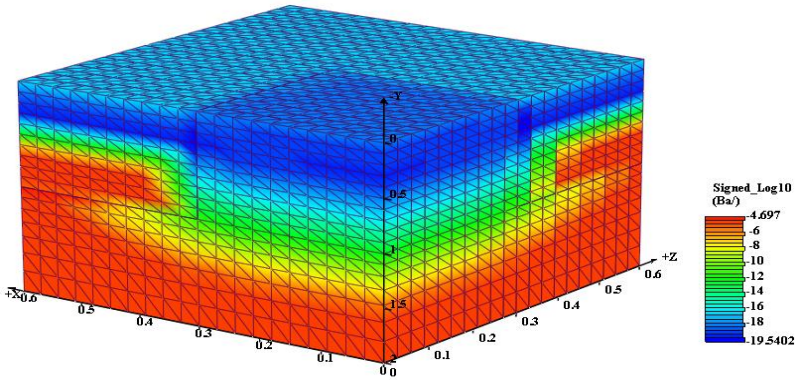
Takes into account all the plane to plane interactions

Quasi3D

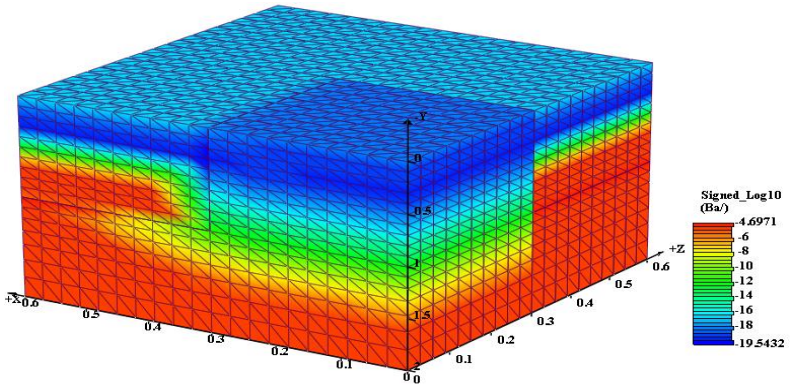
Plane to plane interactions are ignored

Hybrid3D

Only oxidation in the z direction is considered.

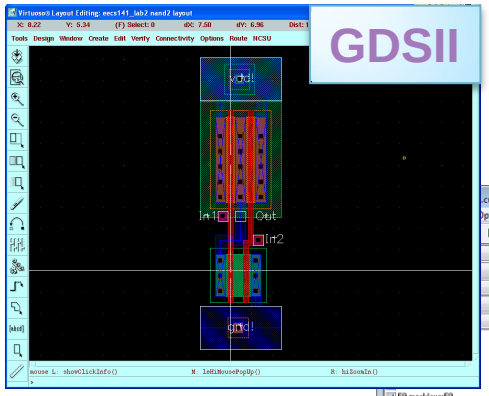


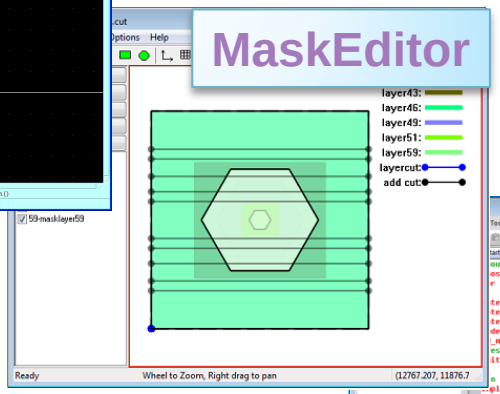

Full3D

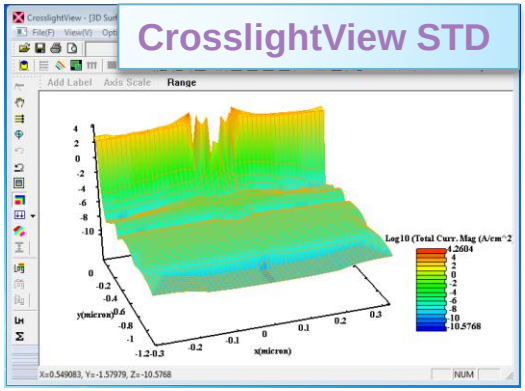


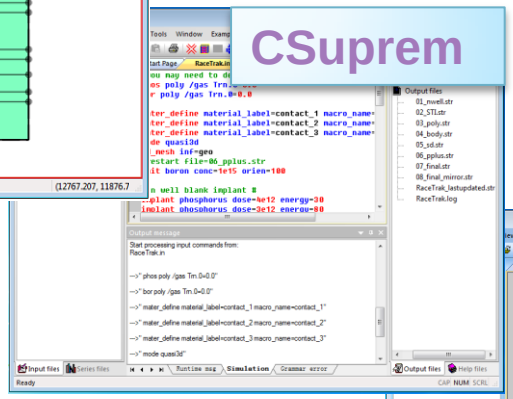

Quasi3D

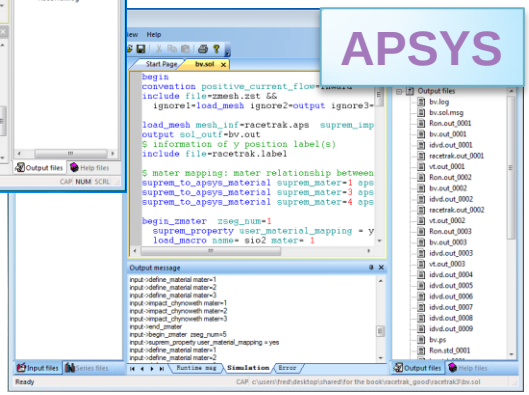
# Basic Steps of 3D Simulation

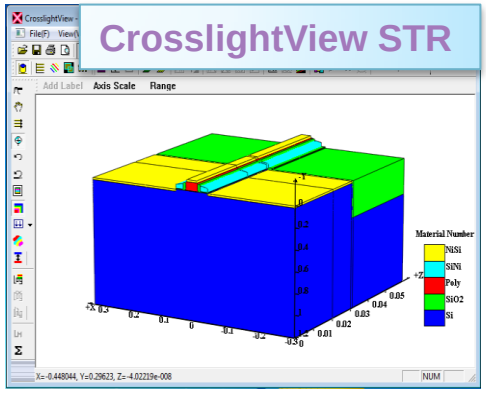


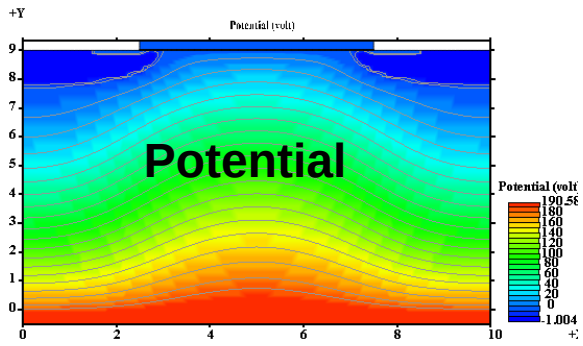



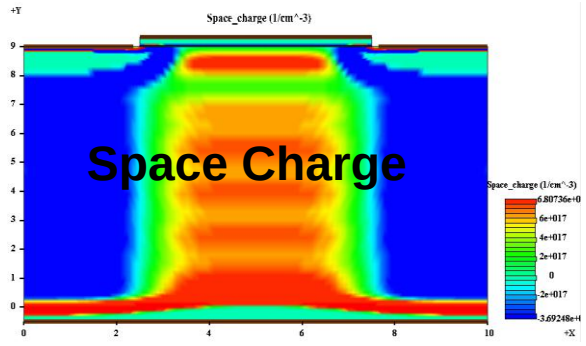



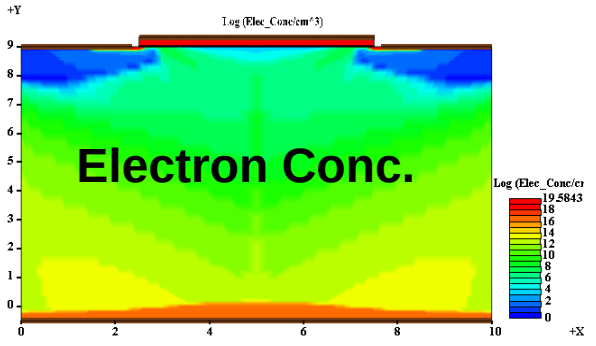



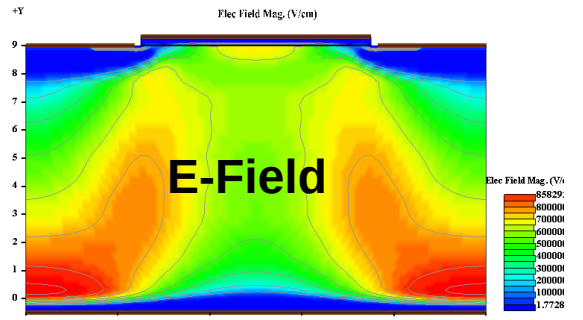



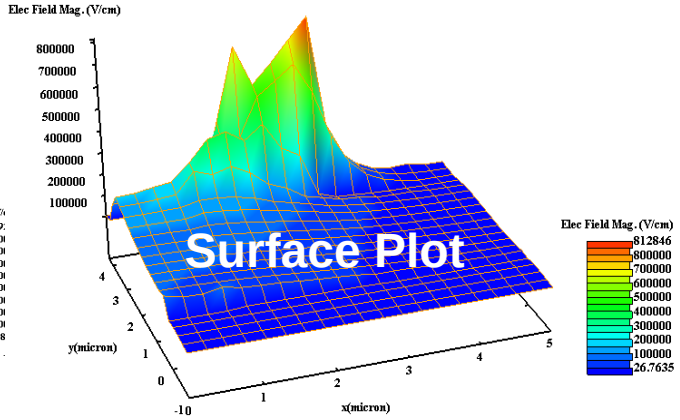
# Typical output of power device simulations (.std .str)

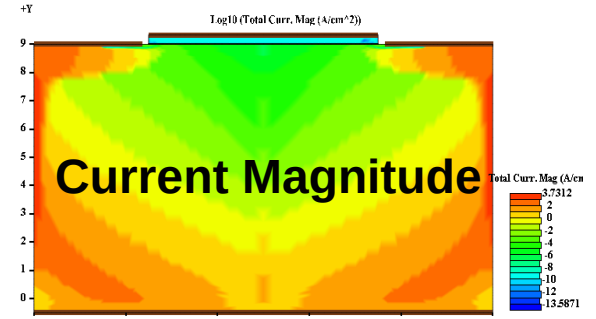


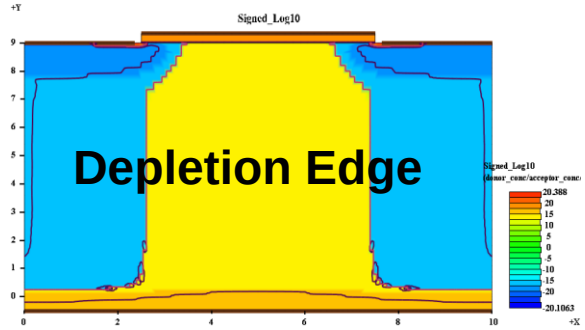



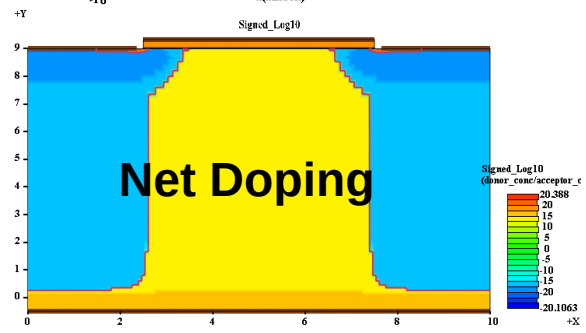



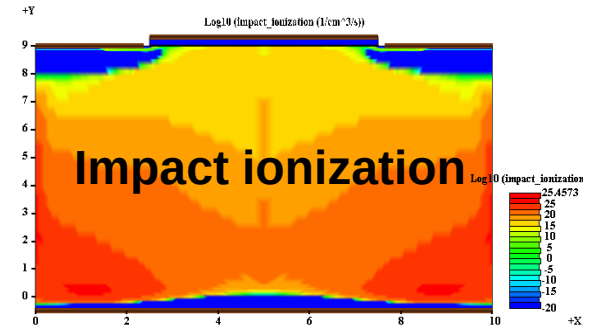



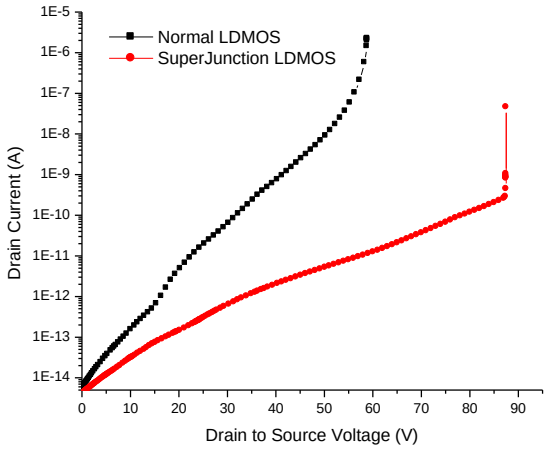



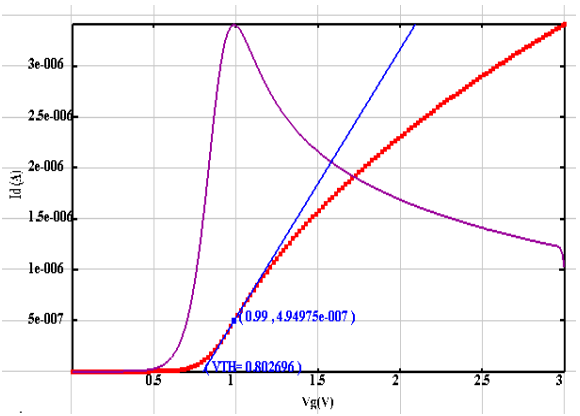



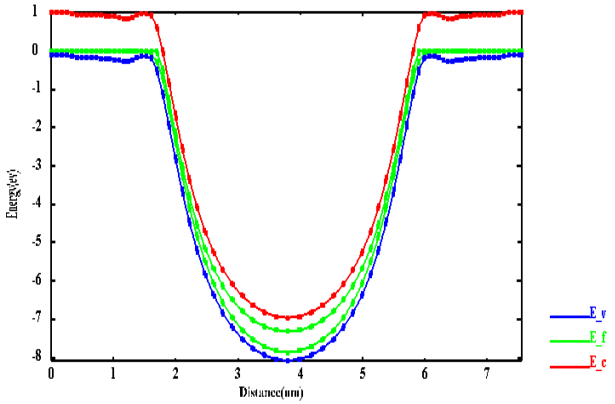
# Typical Output Curves (.out)



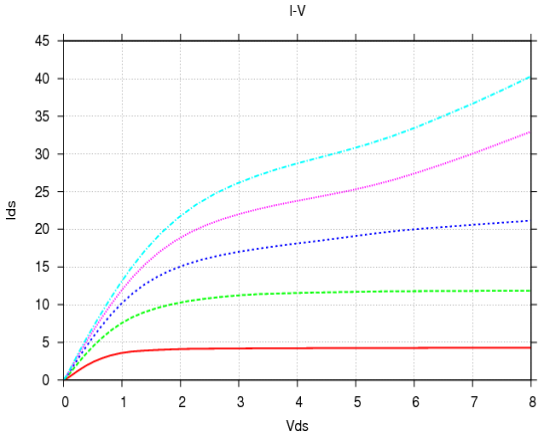

Breakdown



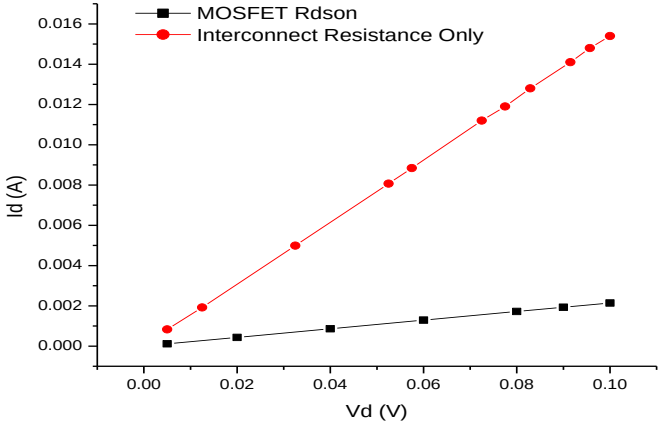

Threshold Auto Extraction



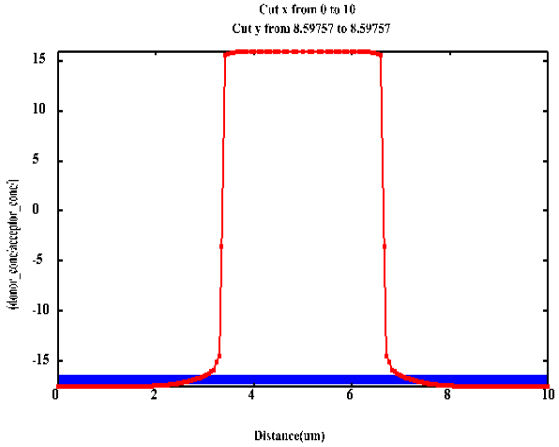

Band Diagram




Id-Vd Curves

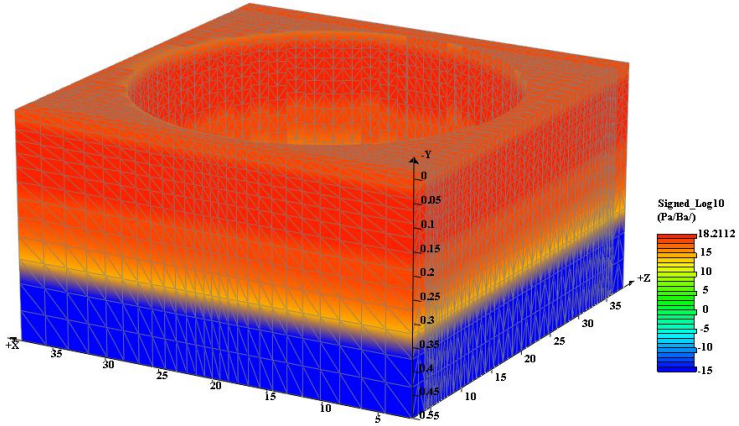



Rdson

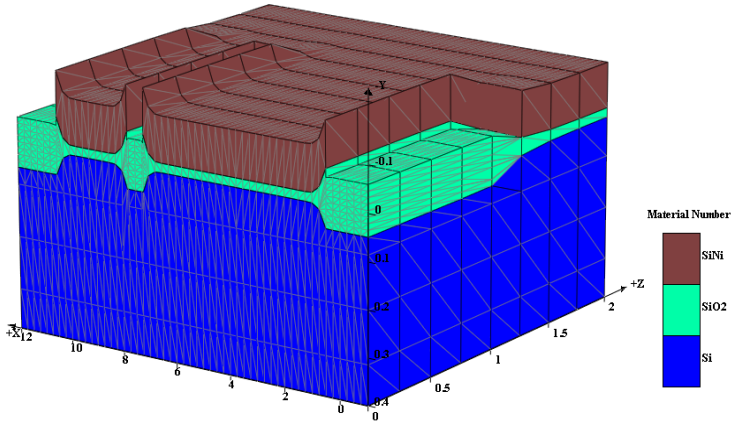



Cut-lines: Net Doping

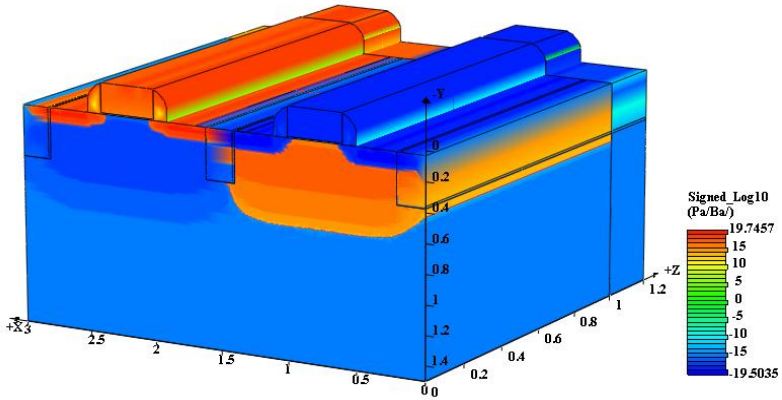
# Example 1: Simple 3D Process Simulation



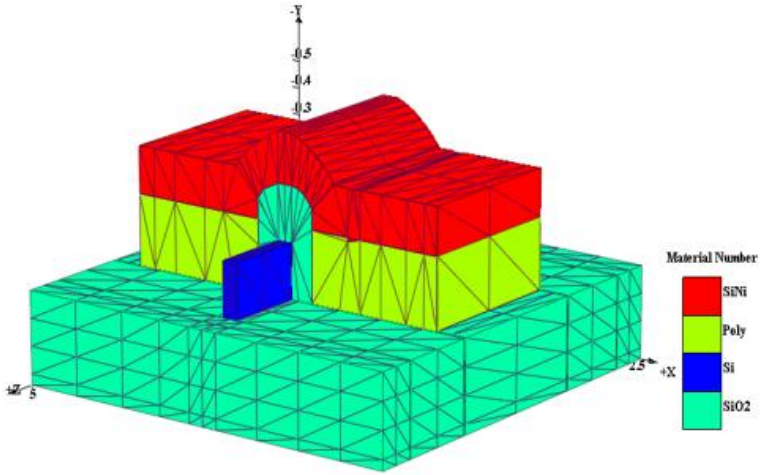

Inner Cylindrical Shape with Inner Doping




LOCOS Growth

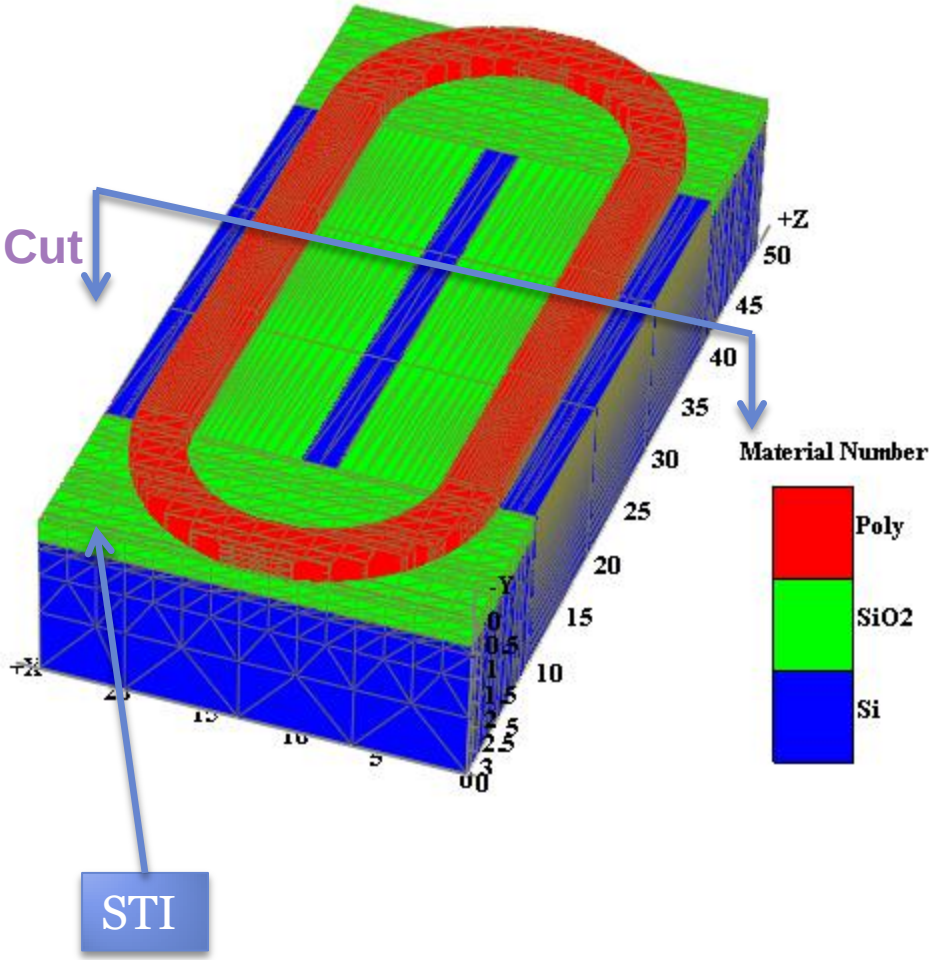


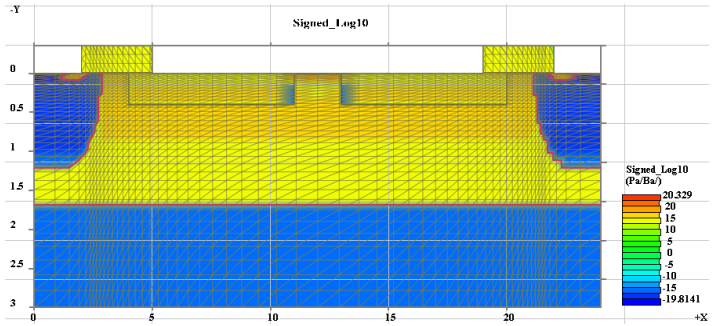

CMOS Process Simulation



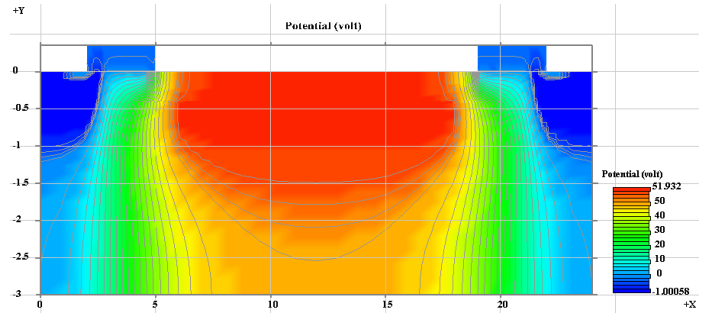

FinFET

# Example 2: Racetrack LDMOS



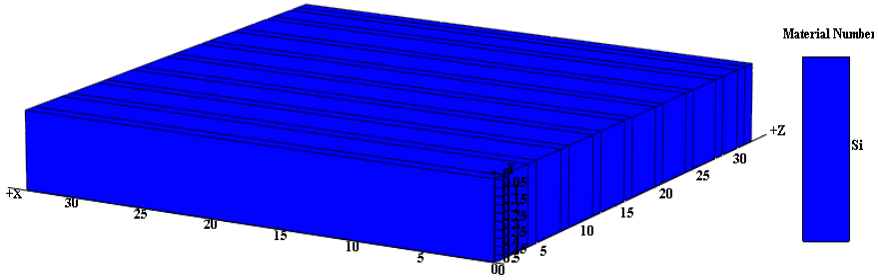

Net doping plot



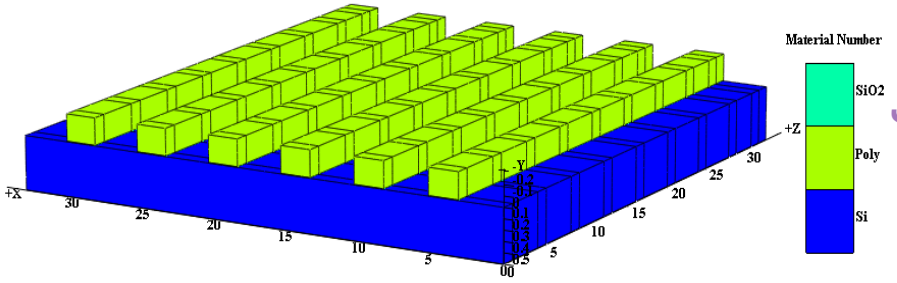

Potential plot

# Example 3: Interconnect Resistance

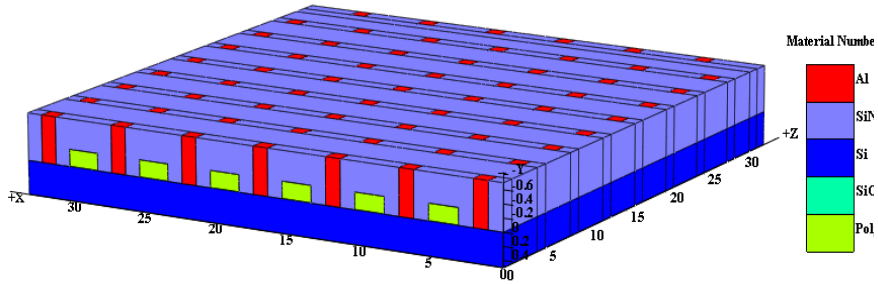
1. Substrate



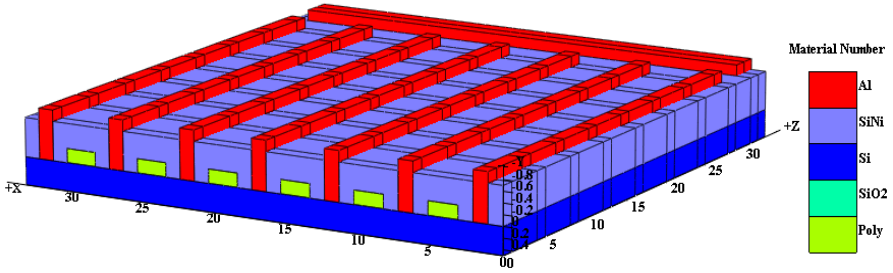

2. Poly Gates



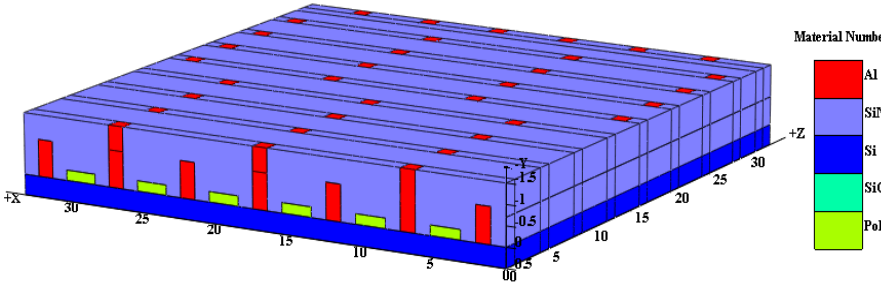

3. Contacts



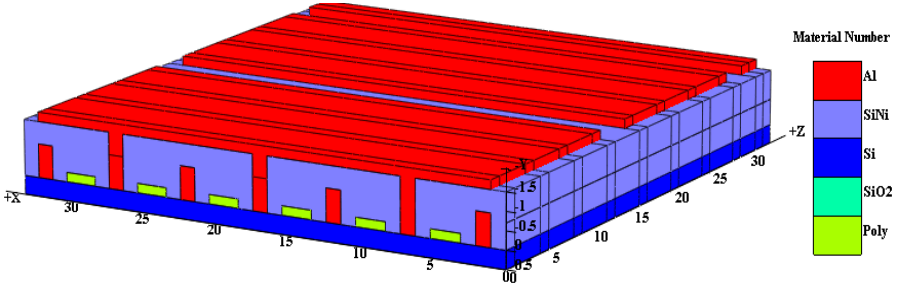

4. Metal1



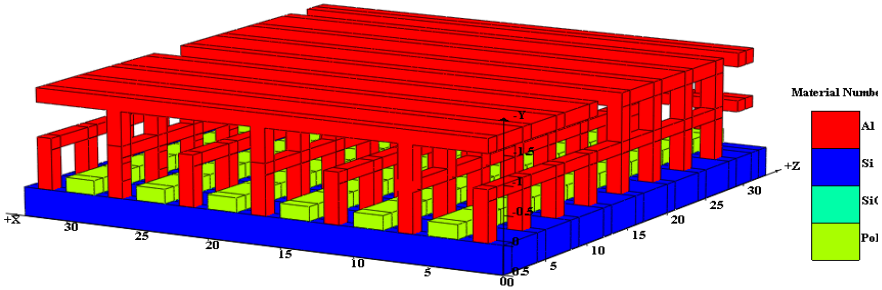

5. Via1



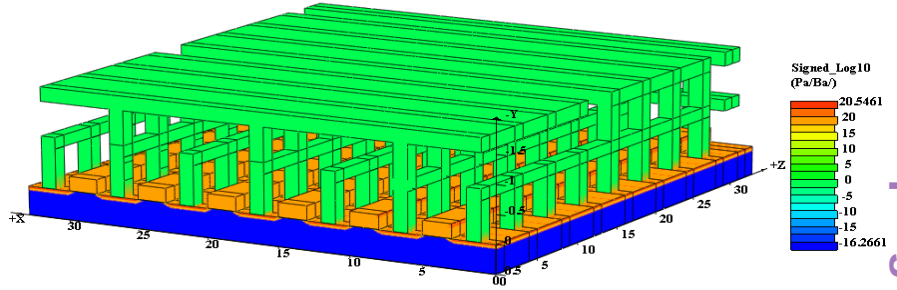

6. Metal2



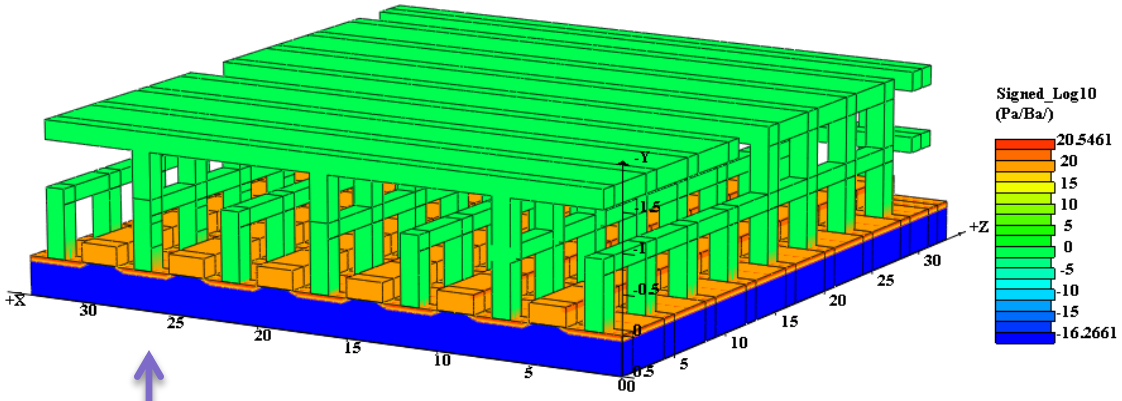

7. Etch IDL

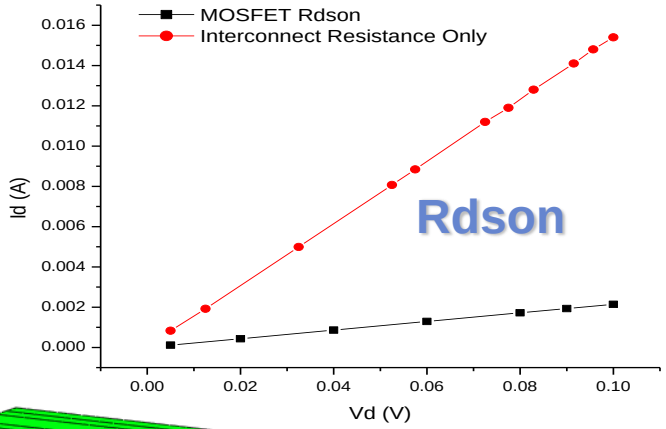



8. Net Doping



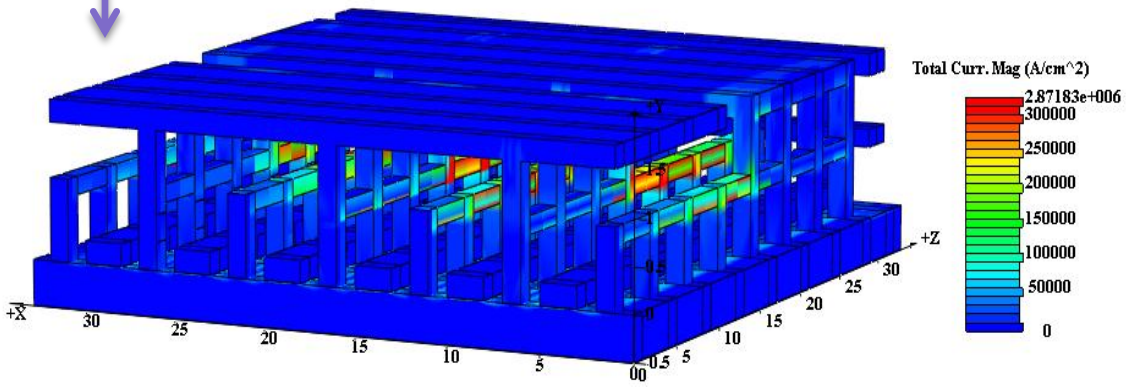
# Example 3: Interconnect Resistance

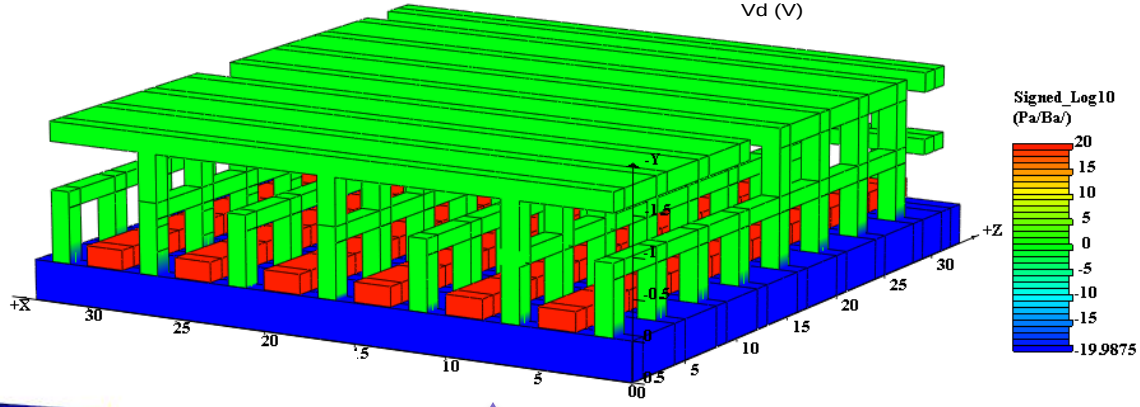



Structure with MOSFETs

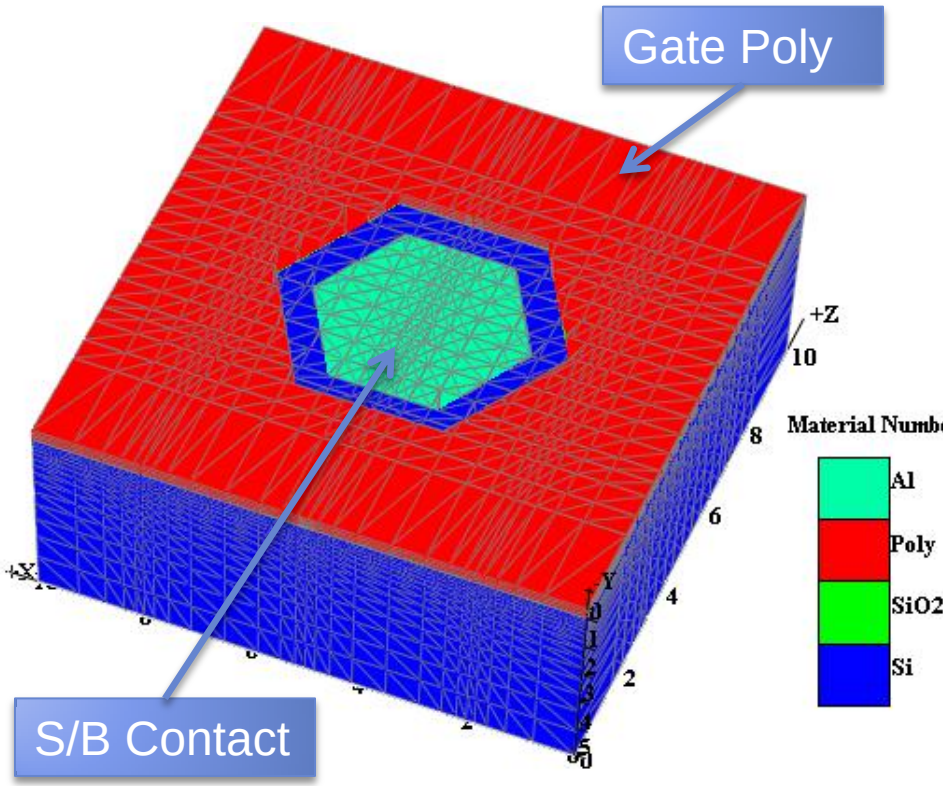
Structure with MOSFETs: Current Density



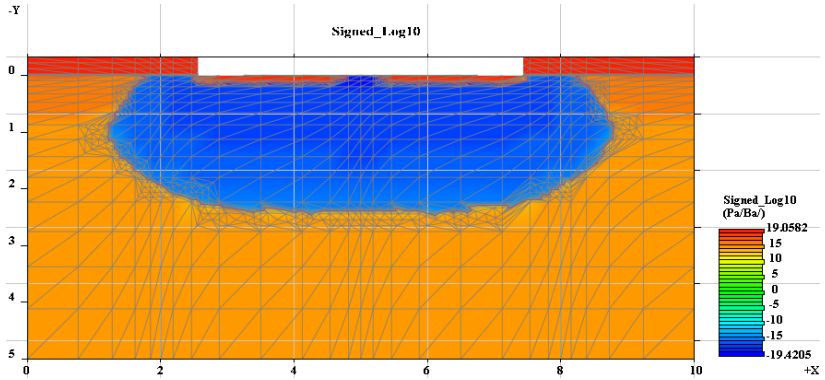




Structure without MOSFETs: Highly Doped Substrate

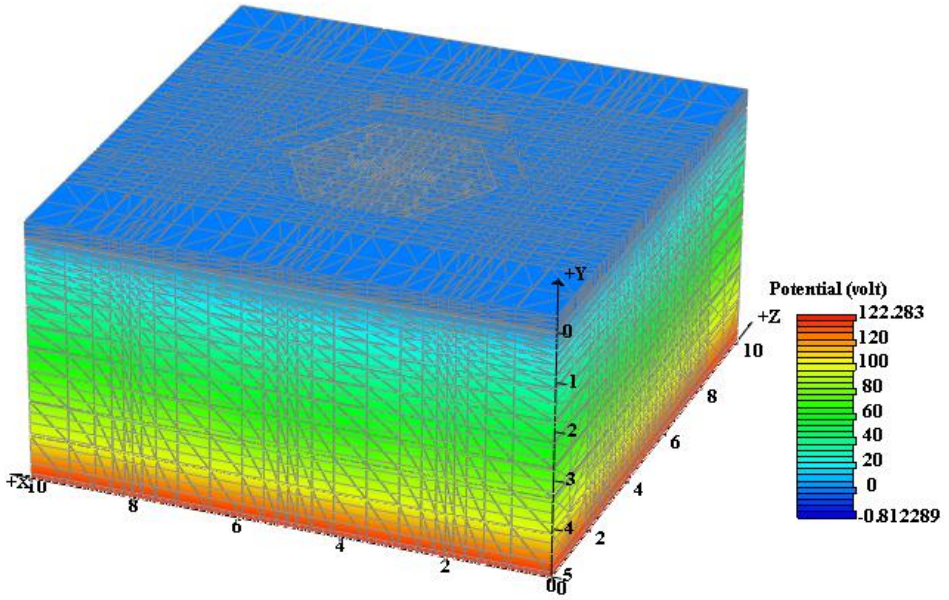
# Example 4: HEXFET




Device Structure Plot




Net Doping 2D Plot

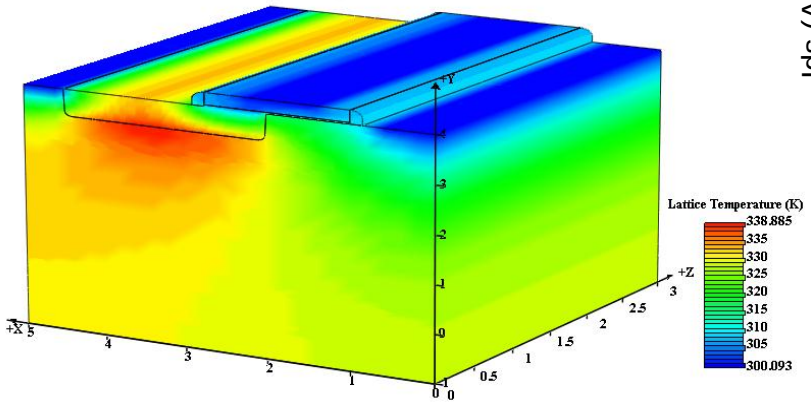


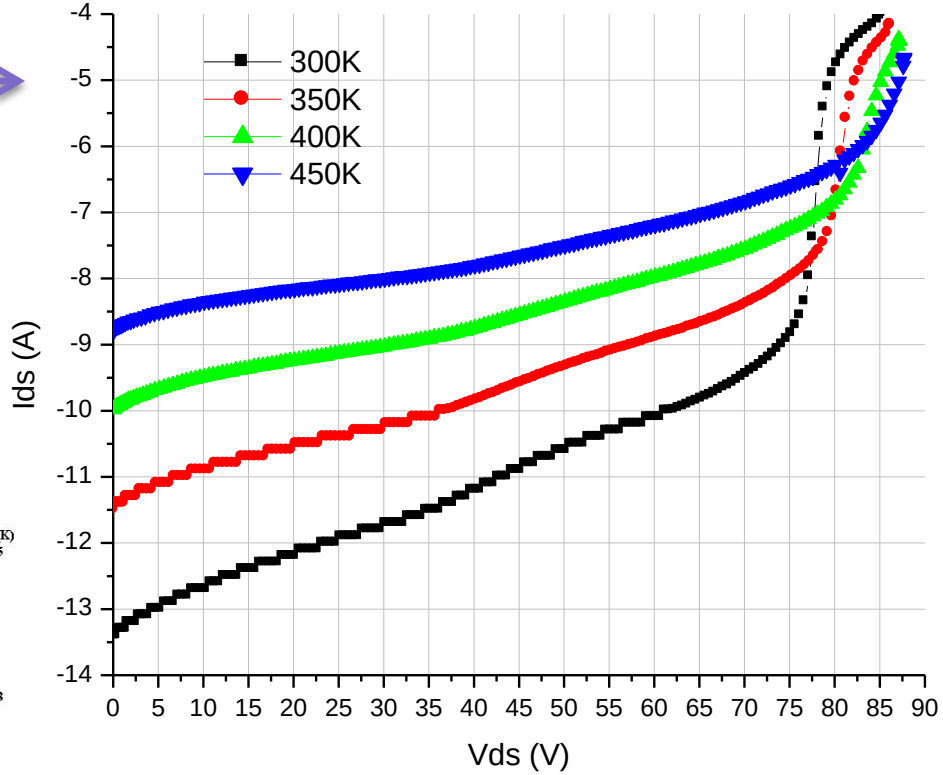

Potential 3D Plot

# Example 5: LDMOS Self-Heating

Constant Temperature

Self Heating



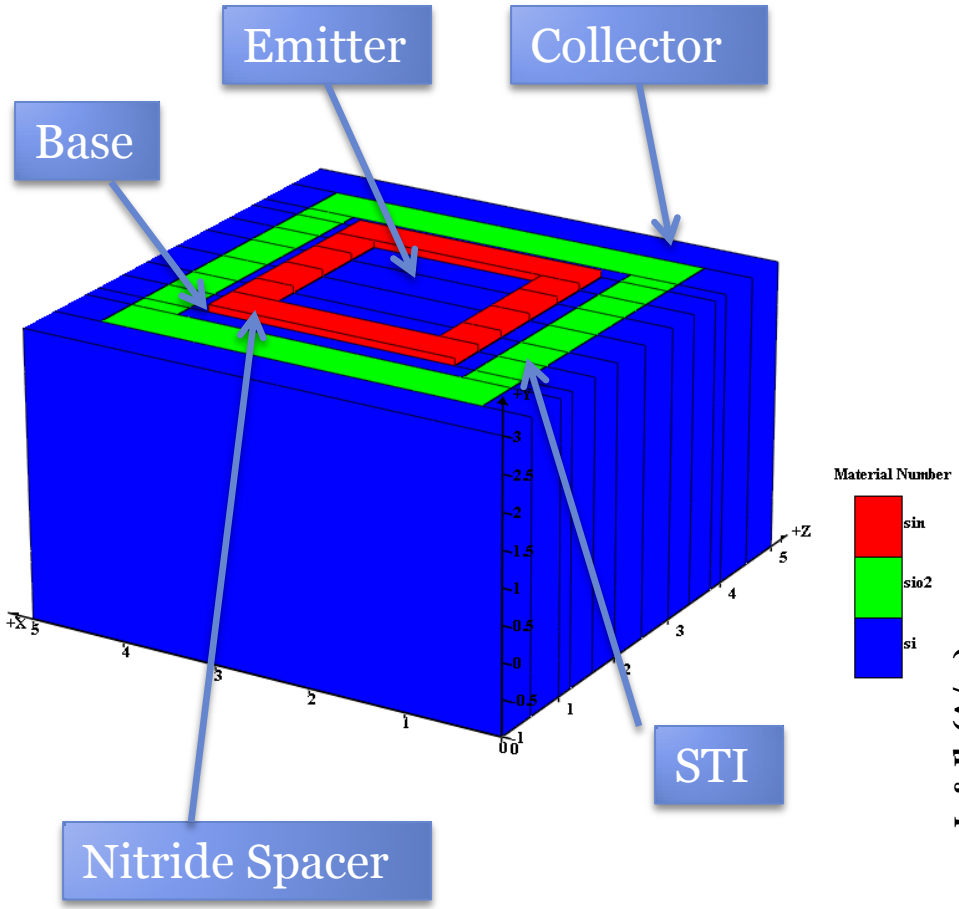



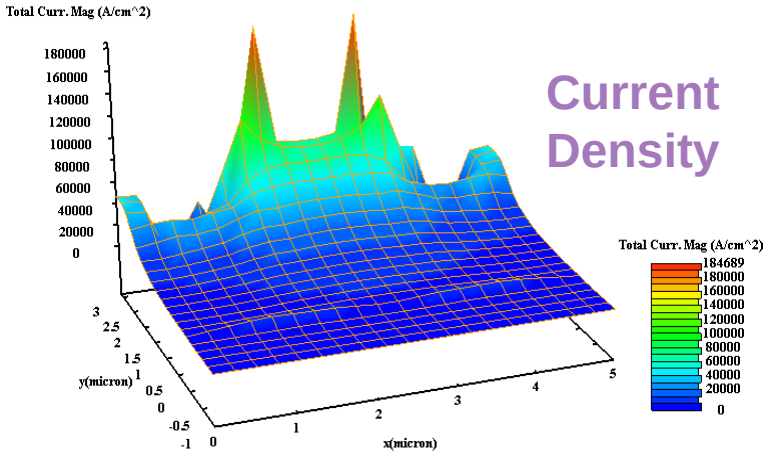

Vg=12V

Vd=55V

Self-heating with thermal conductance of 0.1 W/mK

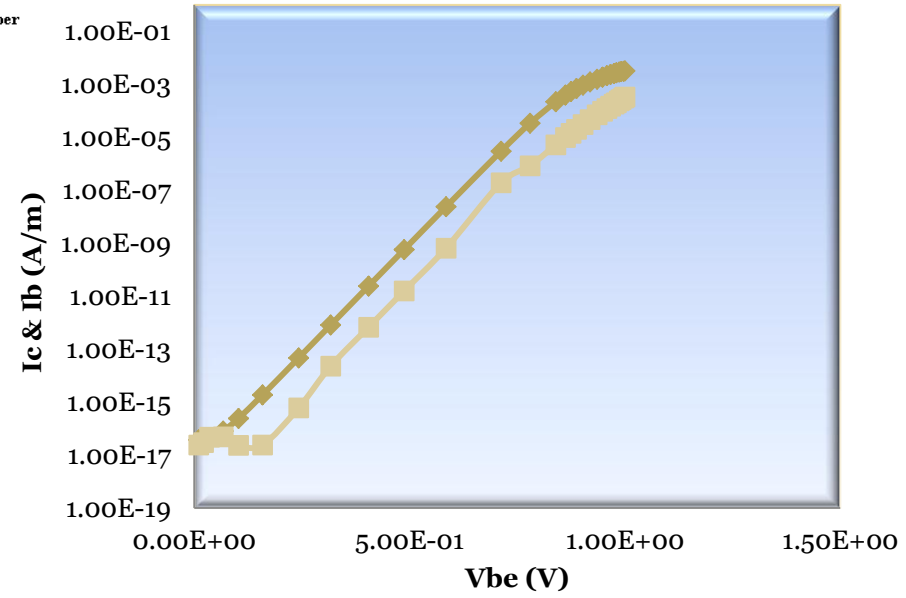
# Example 6: NPN BJT Gummel Plot



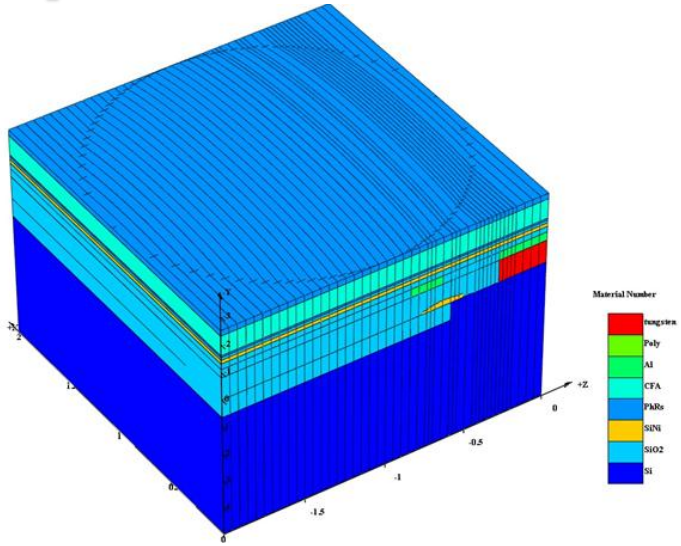




Current Density

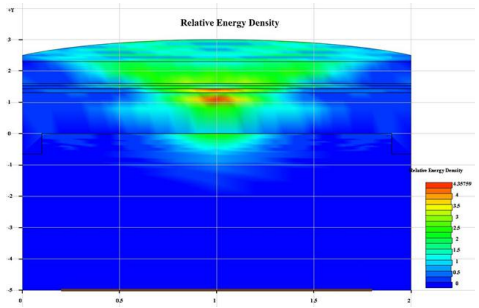
## Gummel Plot



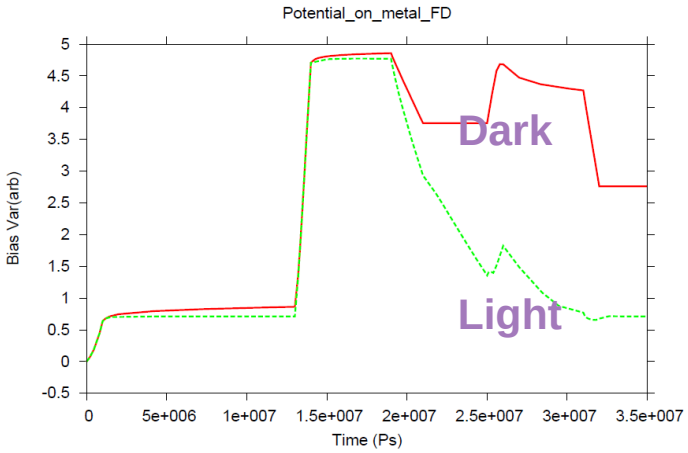
# Example 7: CMOS Image Sensor



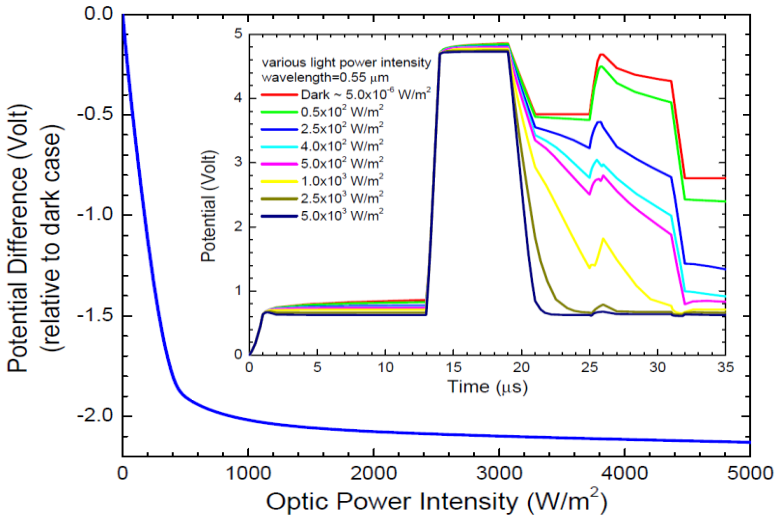

CMOS Image Sensor




FDTD and Focusing Effect




Potential Difference




Effect of Optical Power

# Silicon Device Demos Crosslight Currently has:

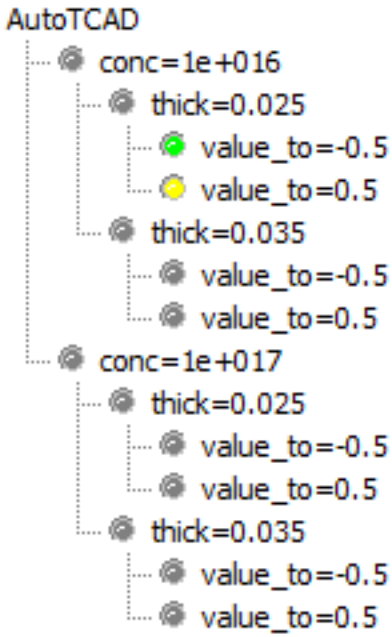
- MOSFET (includes SiGe strained silicon)
- LDMOS (includes race-track gate type)
- BJT (includes HBT)
- Interconnect
- VDMOS (includes HexFET)
- IGBT
- CMOS Image Sensor
- Others

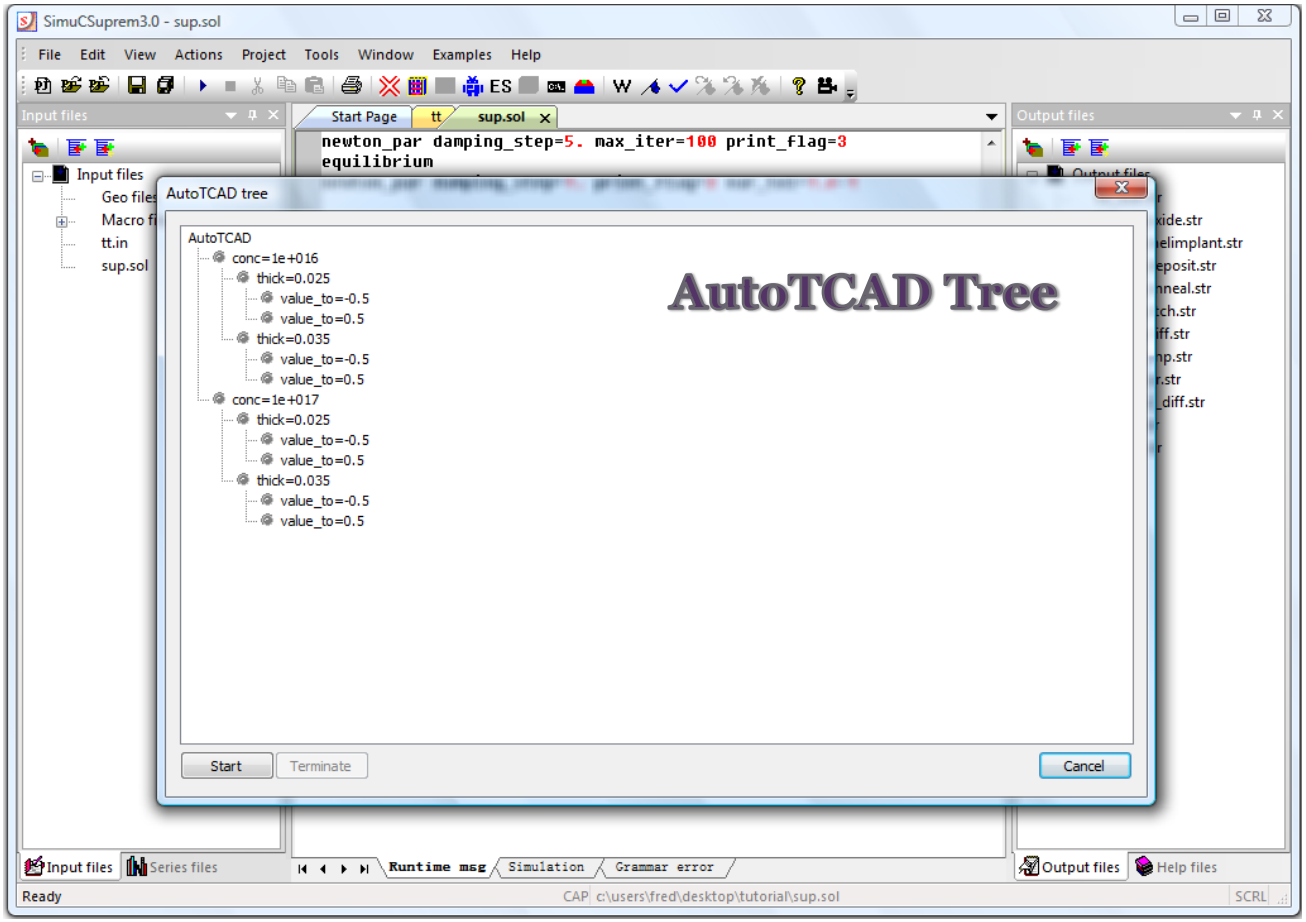
# AutoTCAD Batch Simulation

Process Parameters

Scan Parameters

Auto Display of Grids



# Graphic Card (GPU) Simulation



vs.


**High-end GPU cards typically have hundreds of cores, while today's CPUs only have 6 to 8 cores.**

**Benchmark result shows GPU simulation is at least twice as fast as CPU simulation by using new parallelized direct sparse solver.**

**The latest 2011 beta version of APSYS has integrated the GPU simulation function already, just change the newton_par parameter mf_solver to 4**

# Crosslight TCAD **Advantages**

**Great convergency**

**Industry leading solver speed**

**Highly efficient 3D mesh**

**High 3D success rate based on successful 2D models**

**GPU Simulation**

**Want to escape from your cubicle ? Bring your laptop to local coffee shop and do your simulation there!**

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