CROSSLIGHT TCAD SIMULATION OF POWER DEVICES
Contents

• Advanced models and capabilities
• Application for IGBT
• Application for SuperJunction MOSFET
• Application for SiC MOSFET
Process simulation

• Process model fully compatible with Suprem IV
• Point defect diffusion, clustered defect diffusion, oxidation enhance diffusion
• Ion implant, chemical etching and deposition
• Stress and stress dependent oxidation
Device simulation

- Various impact ionization models
- Various mobility models
- Fully self-consistent self-heating thermal modeling
- Interface trapping, interface charge, deep level traps taking into account various defects and dislocations
Advanced Numerical model

- Full 3D, cylindrical and mixed cylindrical-rectangle coordinate systems
- Smart parallel CPU/GPU multi-core solver up to 5 times acceleration for mesh above 100K.
Real World Application Oriented TCAD Settings

• Full datasheet parameter extraction
• BV, $R_{ds}$, transconductance, thermal resistance,
• $Q_g$, rise/fall time, turn–on/turn–off delay extraction from mixed–mode simulation.
• Full range simulation of $C_{oss}$, $C_{iss}$, $C_{rss}$ up to breakdown voltage.
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Advanced features:
--Efficient 2/3D simulation code for process, stress and device simulation.
--Graphics processing unit (GPU) accelerated 3D simulation.
--Industry standard Suprem IV–based process model.
Good convergence for high voltage breakdown simulation.

Comprehensive DC, transient and AC analysis capability.

Mixed-mode circuit simulation capability.

Full power device datasheet parameter simulation including breakdown voltage, $Q_g$ and $C-V$ curves.
Mixed-mode simulation for switching characteristics

Net doping profile of an IGBT
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Crosslight NovaTCAD Simulation of Super-Junction MOSFET

- Suprem IV–based process simulation with accurate models of implant and diffusion

- Advanced features for device simulation:
  -- Good convergence up to 5000V breakdown voltage
  -- Accurate physical models for impact ionization and mobility
  -- Flexible and user-editable material macros

- Realistic simulation project templates

- Graphics process unit (GPU) parallel processing capability for large-mesh/3D simulation

- Mixed-mode simulation for direct switching characteristics parameter extraction

- Full datasheet extraction simulation including Q_g and C–V curves
Simulation of net doping in cross-section of SJ MOSFET

Surface channel region (net doping)
Channel doping profile for SJ MOSFET example

Simulated breakdown characteristics
Simulated equipotential lines at breakdown

Electric field profile
(a) $R_{ds}$ extraction for different $V_{gs}$

(b) Temperature-dependent $V_{th}$

(c) Turn-on/off parameter extraction
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  -- Flexible and user–editable material macros
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- Full datasheet extraction simulation including $Q_g$ and C–V curves
Typical Simulated SiC MOSFET

- Source
- Gate
- Drain
- JFET region
- Drift region
- Substrate
- P–well
- P–Well
- p⁺
- n⁺
- n⁺
- p⁺
Net doping profile and $R_{ds}$ extraction for various $V_{gs}$
Vth extraction

$BV_{dss}$ Simulation: 4000 Volts @ $V_{gs} = 0$
Thanks for your attention!