Lighting Up Semiconductor World…

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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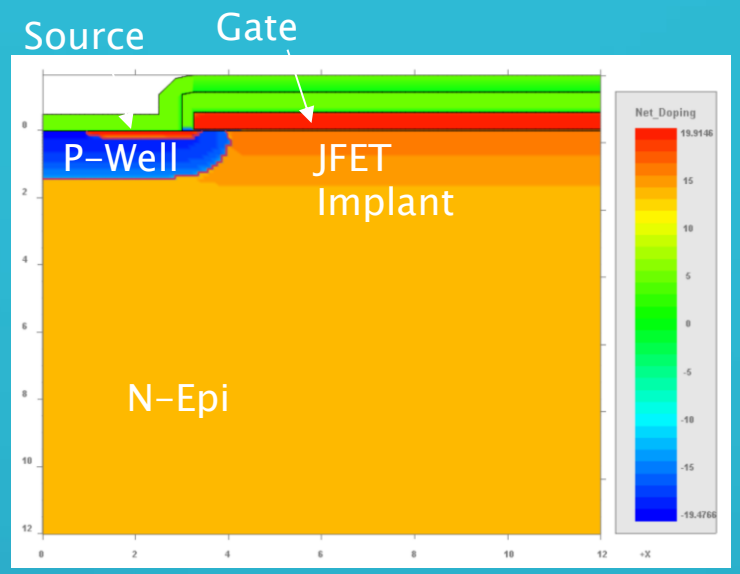
- Advanced features:
  --Efficient 2/3D simulation code for process, stress and device simulation.
  --Graphics processing unit (GPU) accelerated 3D simulation.
  --Industry standard Suprem IV-based process model.
- Good convergence for high voltage breakdown simulation.

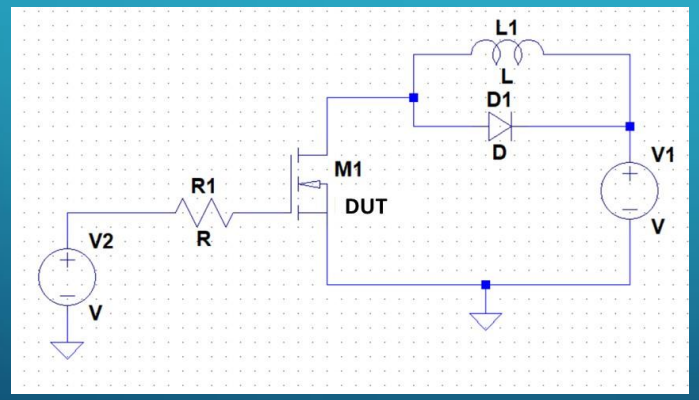
- Comprehensive DC, transient and AC analysis capability.

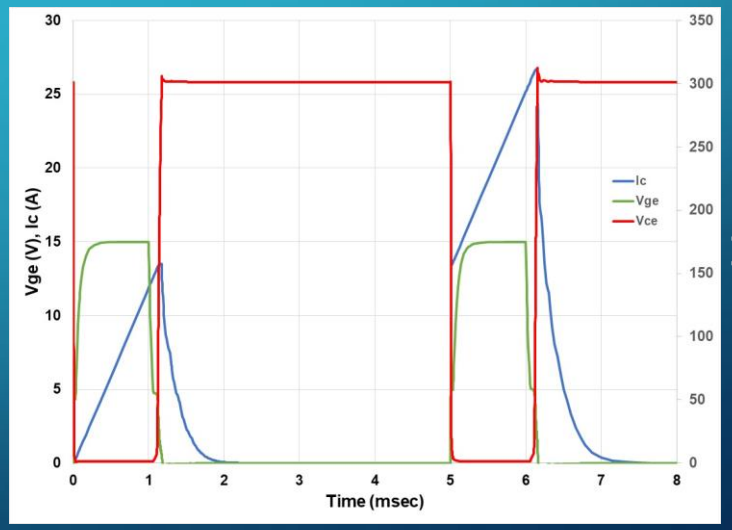
- Mixed-mode circuit simulation capability.

- Full power device datasheet parameter simulation including breakdown voltage, Q_g and C-V curves.



Net doping profile of an IGBT





Mixed-mode simulation for switching characteristics

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Crosslight NovaTCAD Simulation of Super-Junction MOSFET

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

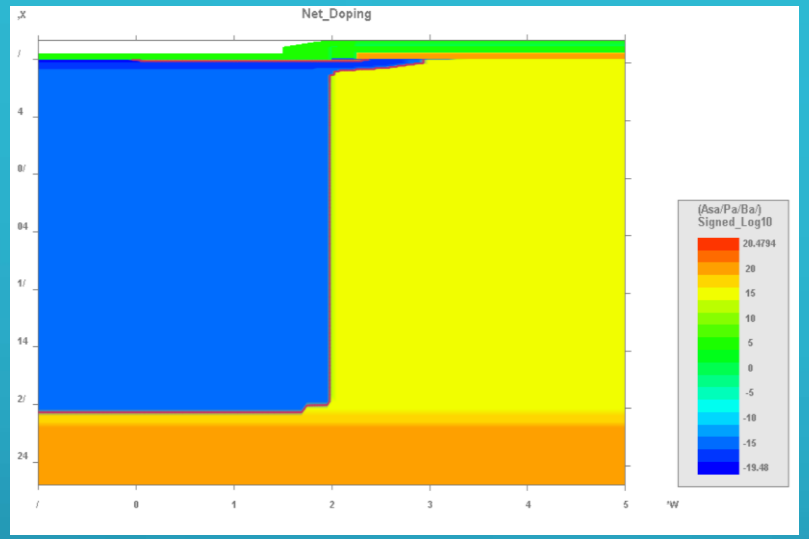
- Advanced features for device simulation:
  --Good convergence up to 5000V breakdown voltage
  --Accurate physical models for impact ionization and mobility
  --Flexible and user-editable material macros

- Realistic simulation project templates

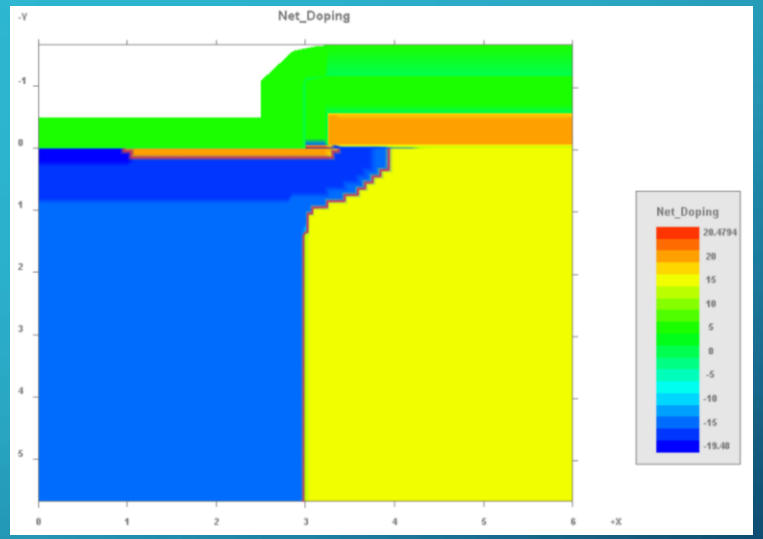
- Graphics process unit (GPU) parallel processing capability for large-mesh/3D simulation

- Mixed-mode simulation for direct switching characteristics parameter extraction

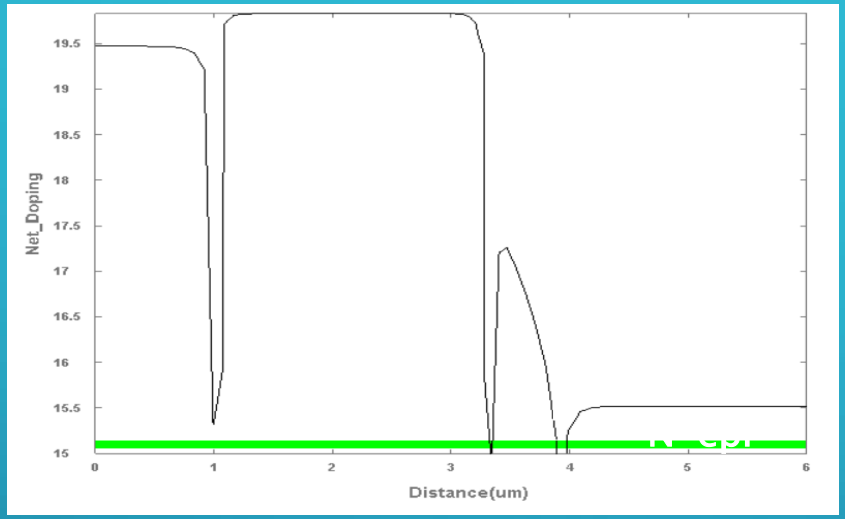
- Full datasheet extraction simulation including Q_g and C-V curves



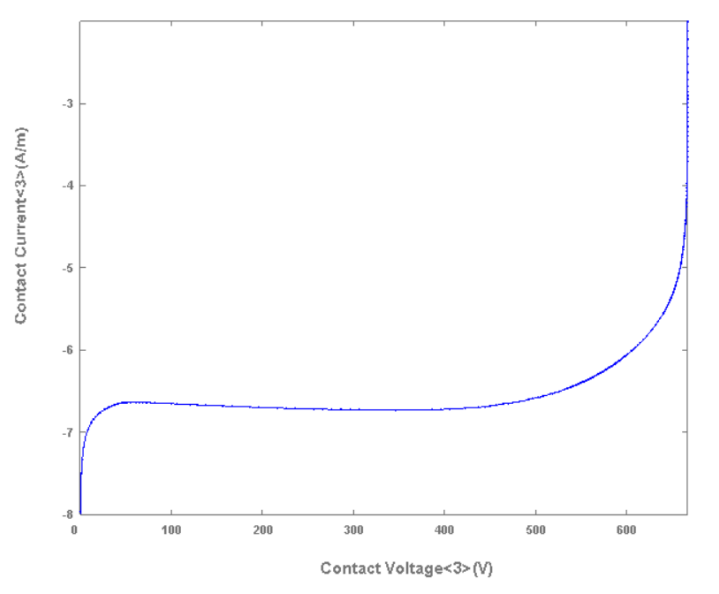
Simulation of net doping in cross-section of SJ MOSFET



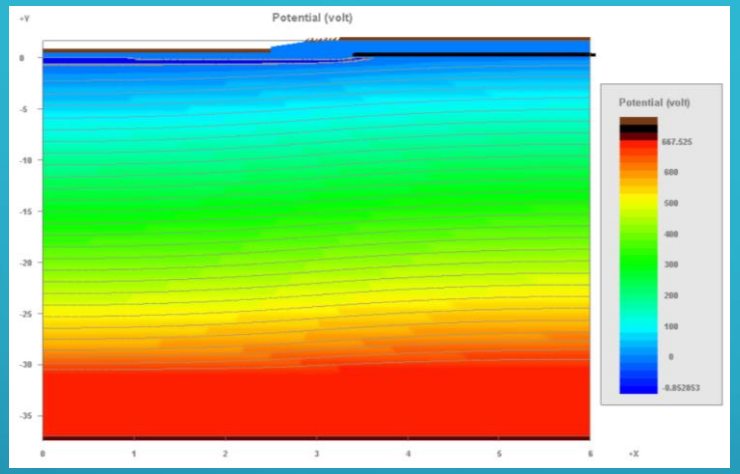
Surface channel region (net doping)



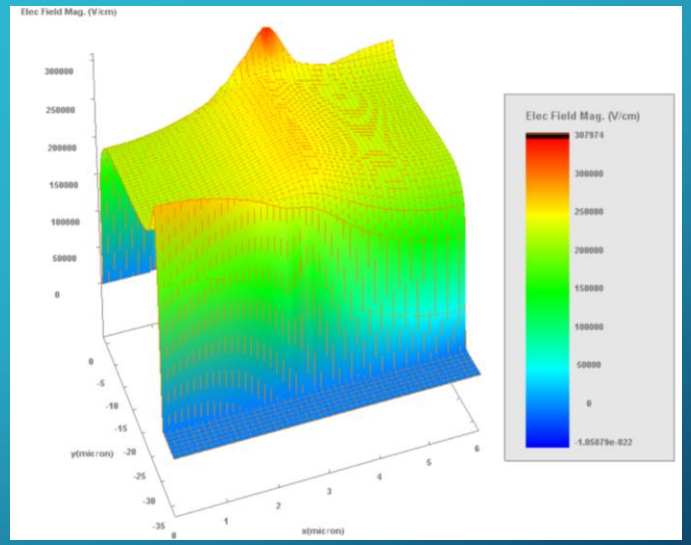
Channel doping profile for SJ MOSFET example



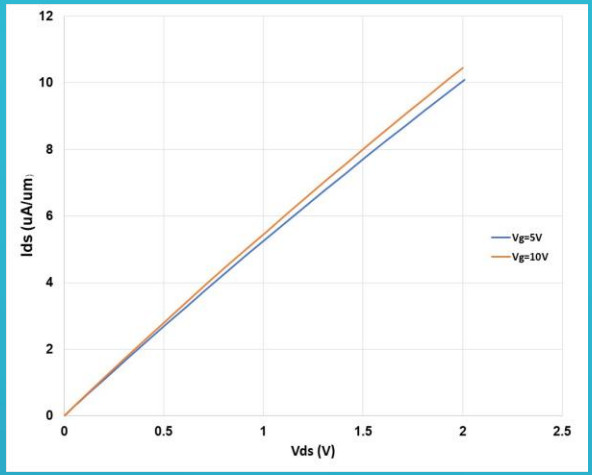
Simulated breakdown characteristics



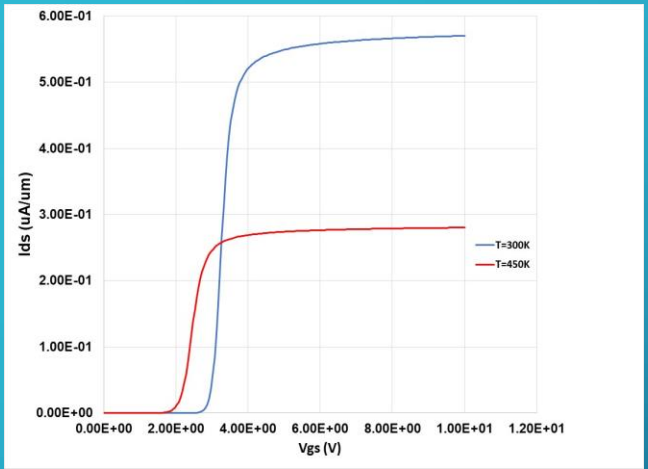
Simulated equipotential lines at breakdown



Electric field profile



(a)



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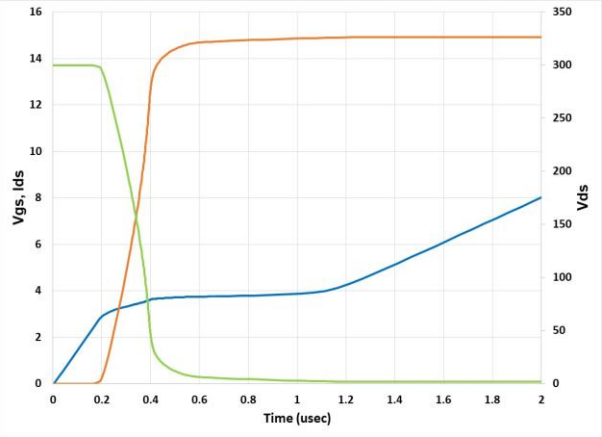

(c)

(a) R_{ds} extraction for different V_{gs}
(b) Temperature-dependent V_{th}
(c) Turn-on/off parameter extraction

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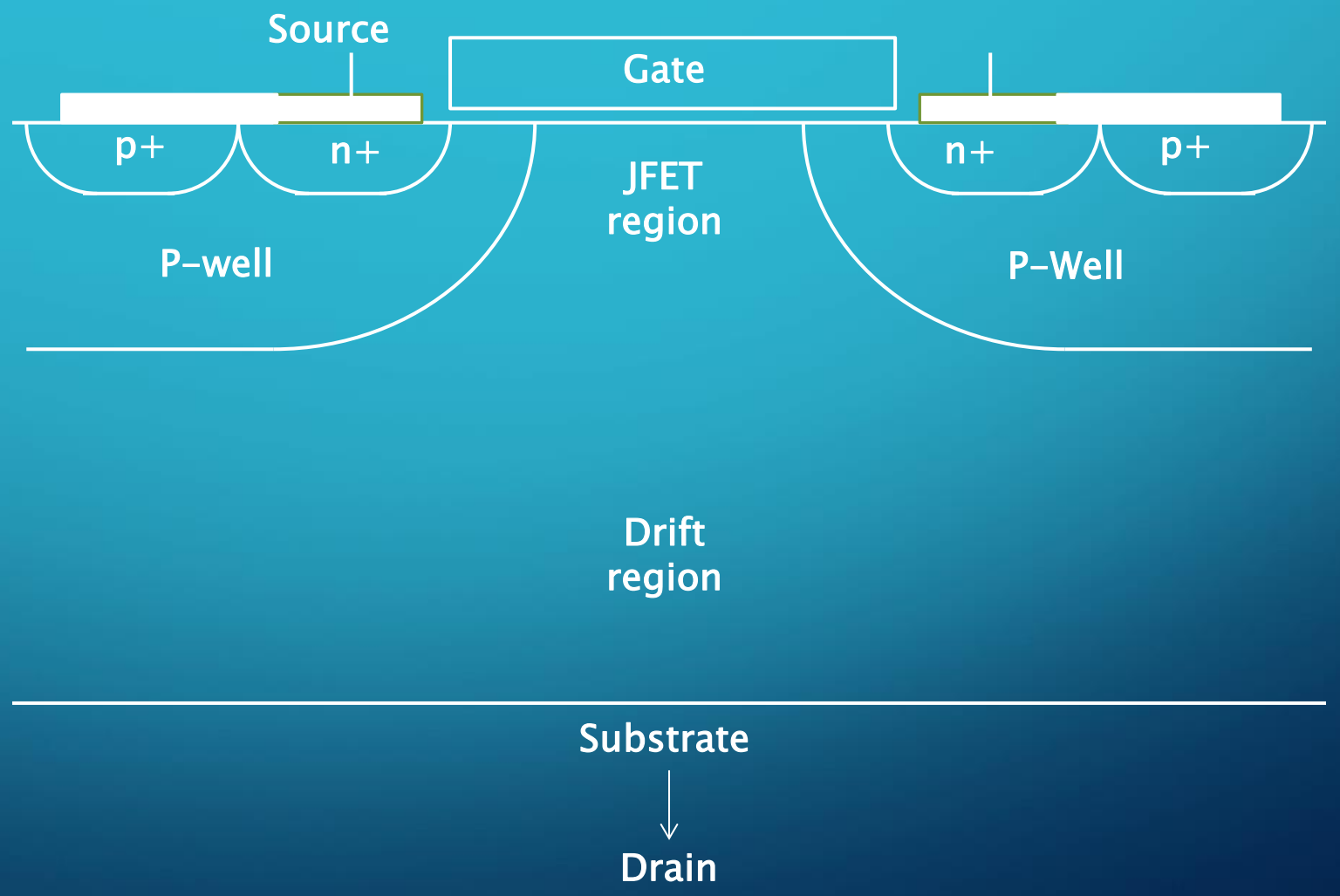
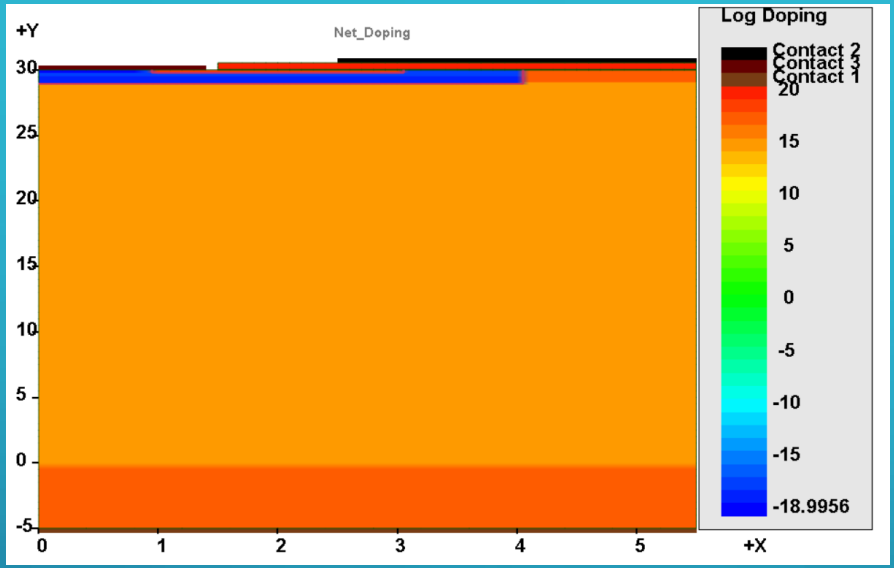
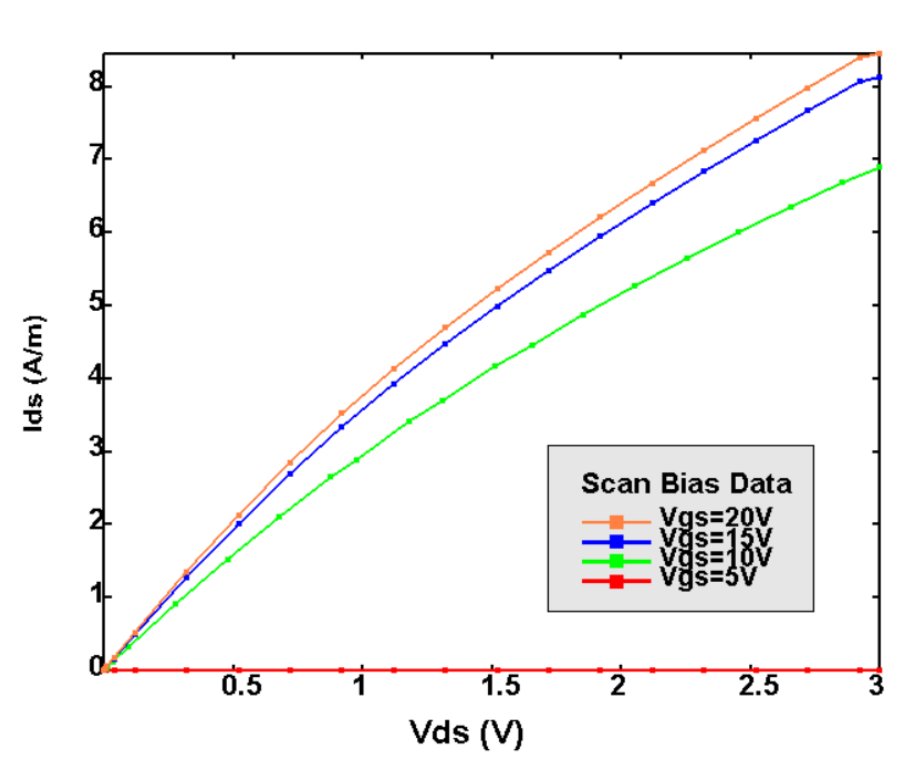
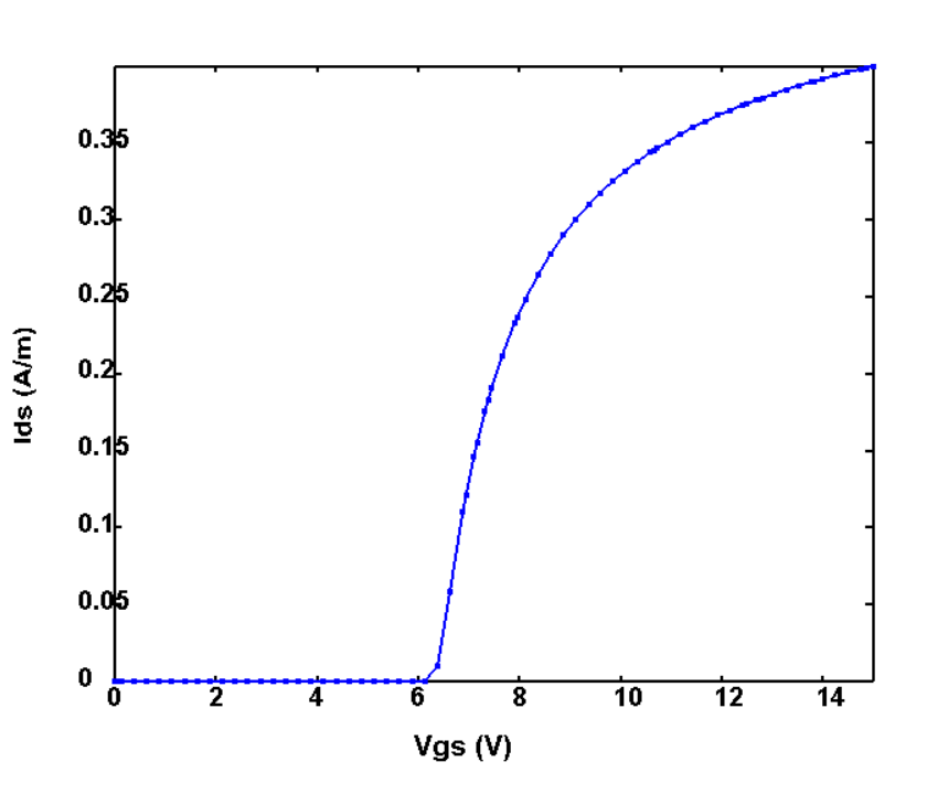
Typical Simulated SiC MOSFET



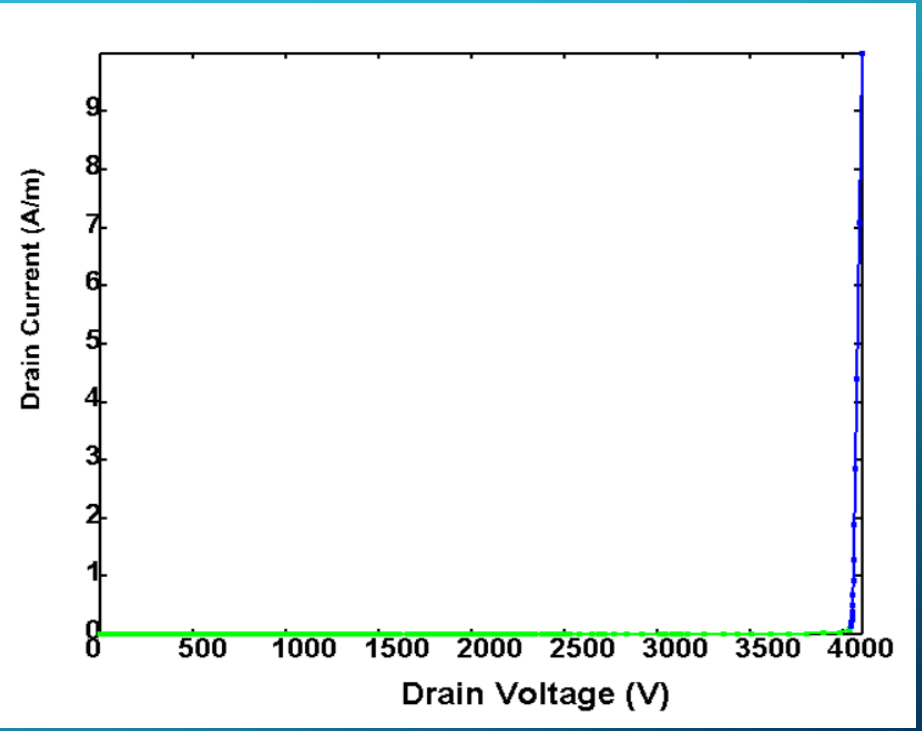




Net doping profile and R_{ds} extraction for various V_{gs}



Vth extraction



BV_{dss} Simulation: 4000 Volts @ $V_{gs}=0$

Thanks for your attention!