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SIMULATION AND ANALYSIS
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Taurus-Device

Multidimensional Device Simulation

Taurus-Device is a complete program for semiconductor device simulation. Taurus-Device simulates electrical and thermal characteristics of any semiconductor device in 1, 2 or 3 dimensions.

A wide variety of devices, ranging from deep submicron MOSFETs or bipolar devices to large power device structures, can be modeled.

TAURUS-DEVICE HELPS YOU:

- Determine static and transient electrical and thermal characteristics of your device.
- Investigate breakdown and failure mechanisms.
- Understand the internal device operation.
- Generate data for compact model generation to allow analysis of circuit designs before processing.
- Specify and use new equations and models.

3D MOSFET SIMULATION

The advanced 3D capabilities of Taurus-Device allow you to analyze complicated 3D effects su as channel length/width, breakdown and parasitic effects.

The device structure can be constructed by analytic boundary and doping description or by phy process simulation via the seamless interface to Taurus-Process™, Avant!'s multidimensional process simulator.

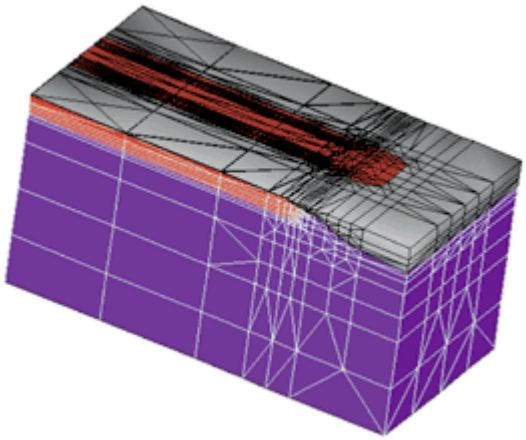

Figure 1: 3D MOSFET structure used for the investigation of channel width effects

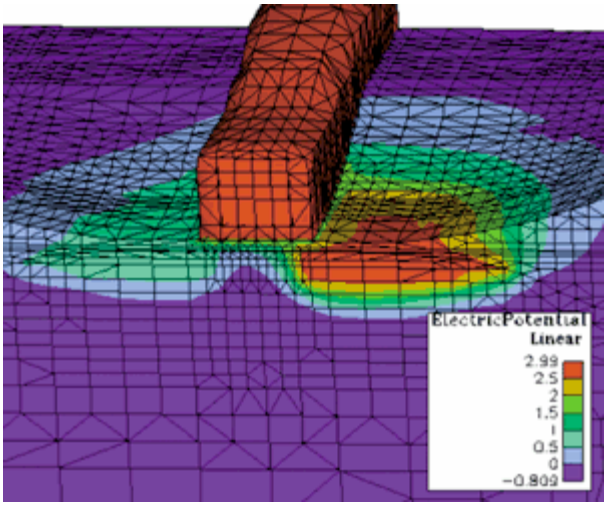

Figure 2: Potential distribution at Vg=1.8V, Vds=2.1V of a complete MOSFET structure as generated by process simulation. The mesh from process simulation was used after refinement the channel area.

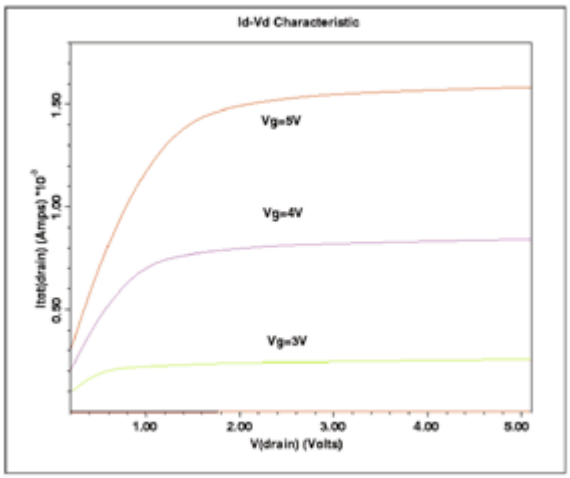

Figure 3: Id-Vd characteristics for the device shown in figure 1.

3D BIPOLAR DEVICE SIMULATION

The efficient 3D capabilities of Taurus-Device can be applied to any type of device. Typical bipo devices include submicron BJTs, power diodes and thyristors, and bipolar-MOS devices like BiCMOS and IGBT. The mesh generation resolves device structure and doping profiles accurat with a minimum number of mesh points, and the adaptive mesh and un-refinement capabilities maintain optimal meshes throughout a simulation. Taurus-Device can be used for regular simulations, including on-state and switching, or to investigate special phenomena like 3D breakdown, latch-up or thermal instabilities.

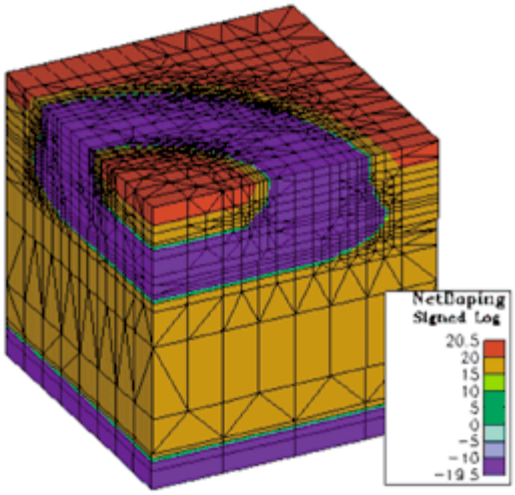

Figure 4: A circular BJT device. This structure contains 10720 mesh points, typically a factor of less than conventional 3D device simulation with the same accuracy.

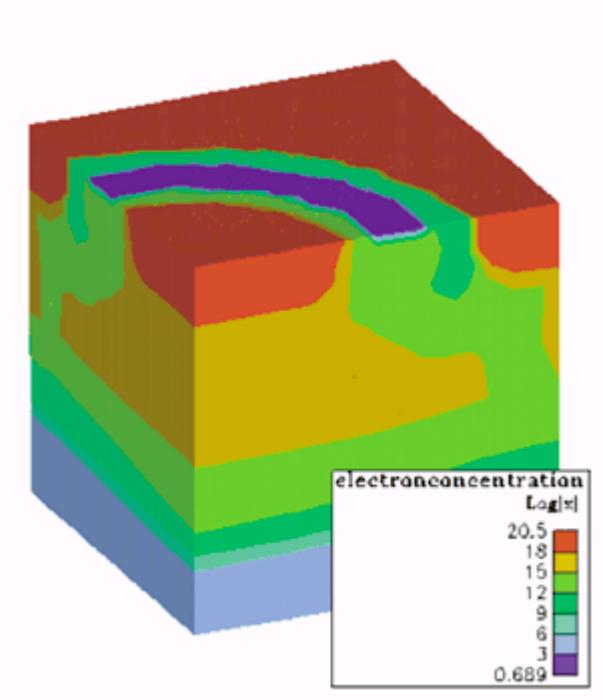

Figure 5: Electron concentration at Vbe=0.8V, Vce=5.0V.

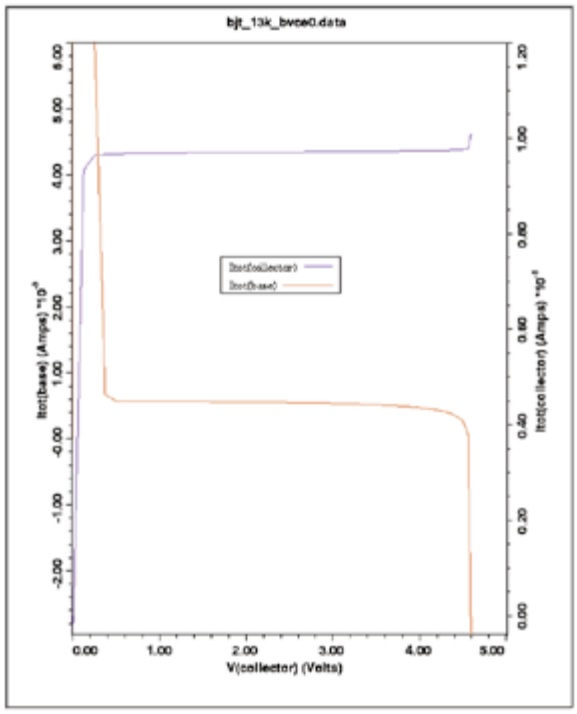

Figure 6: Collector (blue) and base (red) current breakdown characteristics for the device in figu 4.

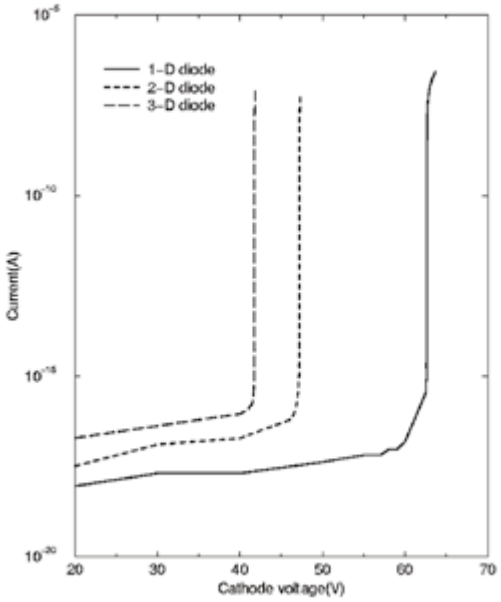

Figure 7: Junction breakdown characteristics of a diode device for 1D, 2D, and 3D geometry.

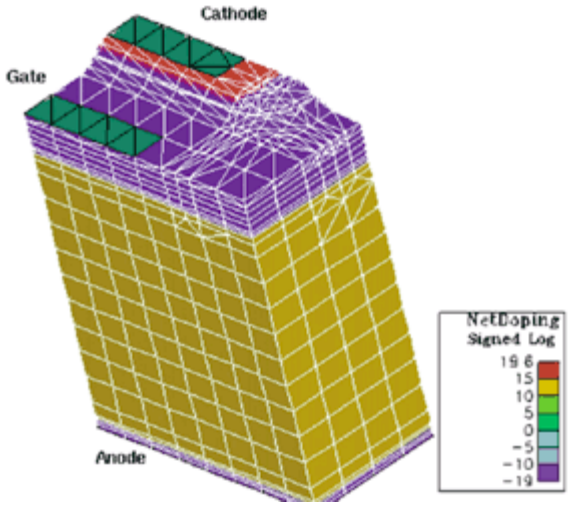

Figure 8: Gate turn-off thyristor structure for the analysis of 3D effects at the cathode-finger termination.

MESH GENERATION

Efficient, automatic mesh generation greatly facilitates the simulation process in Taurus-Device Three mesh packages are available: a complete 1D-2D-3D quadtree-octree mesh, a 2D bound conforming mesh and a 3D advanced unstructured mesh with boundary layers. Advanced featu including adaptive refinement and un-refinement, anisotropic refinement, boundary layers and a level set boundary description allow the construction of optimal meshes for any type of structure and for efficient moving boundary simulations.

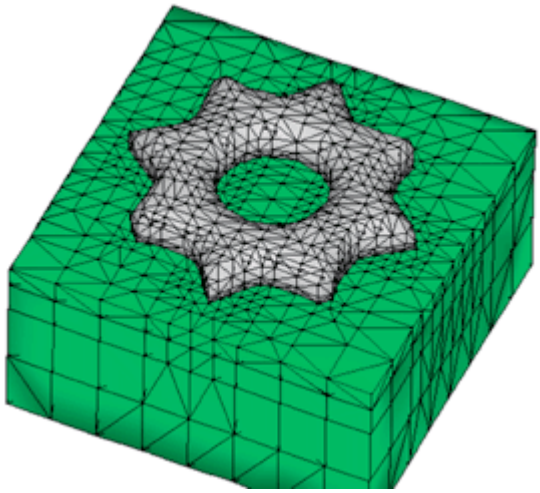

Figure 9: Gear structure generated by deposition and etch.

PHYSICAL MODEL AND EQUATION INTERFACE (PMEI)

As an optional capability, Taurus-Device has a physical model and equation interface (PMEI) th allows for easy and flexible defining of new physical models and partial differential equations. U the PMEI, a user can do simulations using his own set of models and equations. Areas of partic importance include impurity and defect diffusion, electromigration, mobility, impact ionization ar hot carrier modeling, but the PMEI is equally applicable to all partial differential equation simulations.

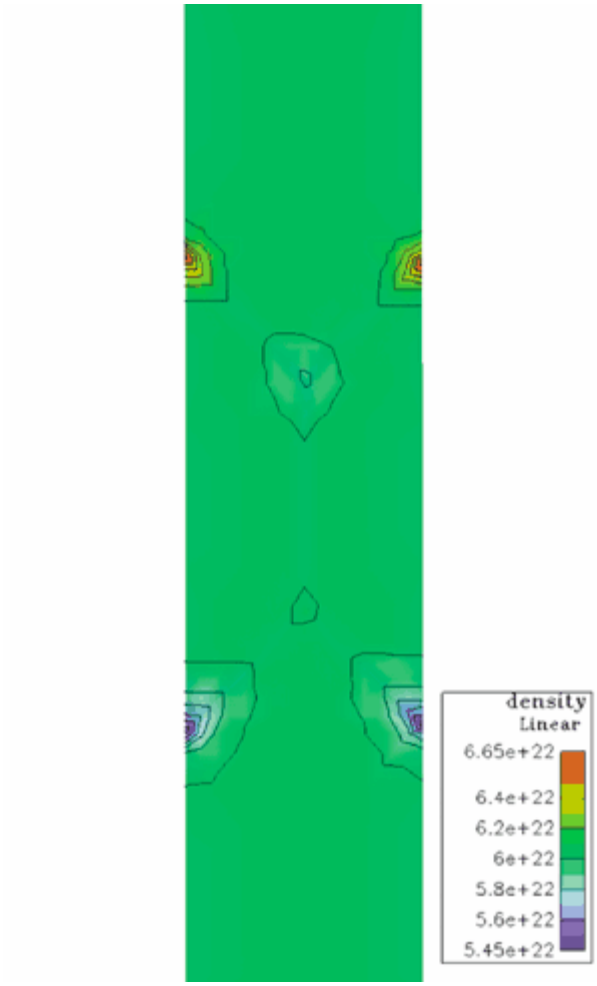

Figure 10a

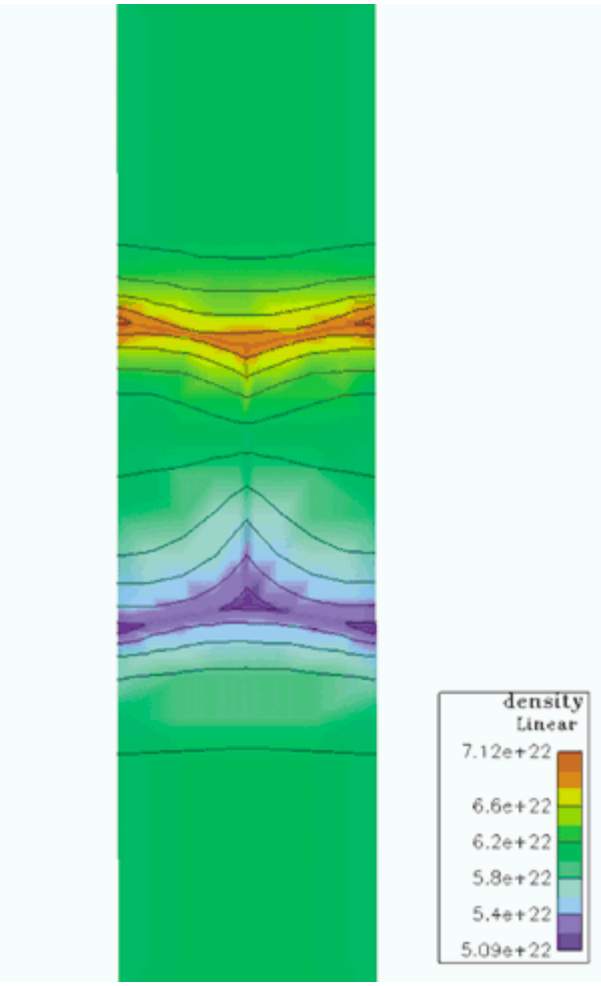

Figure 10b

Simulation of mass transport driven by electromigration using Physical Model and Equation Interface of Taurus-Device. Figures 10a and 10b have different angles between grain boundari and the electric field, generating different types of voids.

TAURUS-DEVICE SPECIFICATIONS

SIMULATION FEATURES

- Simulation of arbitrarily shaped 1D, 2D and 3D structures.
- Advanced adaptive mesh generation, which provides optimal grids with excellent solutio and structure resolution using a minimum number of mesh points.
- Optional physical model and equation interface, which allows a user to define and solve physical models and partial differential equations.
- Dynamic memory allocation -- the size of the simulated problem is limited only by the capacity of the computer.
- The solution method may be controlled by the user, i.e. all available or user-defined equations can be solved individually, iteratively coupled or fully coupled.
- Large selection of fast, direct and iterative linear solvers.

DEVICE MODELS

- Complete device simulation including electrical and thermal characteristics for semiconductor devices ranging from VLSI to power devices.
- Complete set of models, including breakdown analysis, high-field and channel mobility. Fowler-Nordheim, hot-carrier and band-to-band tunneling models.

DEVICE CIRCUIT SIMULATION

- One or several physically modeled devices can be connected in a circuit with compact m and passive components.

CONFIGURATION

- Platform: Runs on UNIX platforms from Hewlett-Packard and Sun Microsystems.
- Memory: Recommended memory range from 8Mb (1D) to 1Gb (3D).
