GTS NANO-DEVICE SIMULATOR

THE TRUE* PHYSICAL MODELING SOLUTION

IEDM PAPER 2016 2015

- DEEP INSIGHT, AS NEVER SEEN IN TCAD BEFORE
- UNRIVALED ACCURACY AND NUMERICAL EFFICIENCY
- QUICK FAMILIARIZATION, FAST RESULTS

High-Performance CMOS Logic | **S-RAM D-RAM** | **NOR Flash NAND Flash** | **SONOS 3D NAND**

Integrated materials database
Import from ab-initio simulation

Material
Crystal orientation

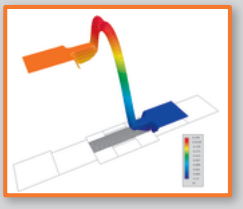
Geometry, Doping

Stress / Strain

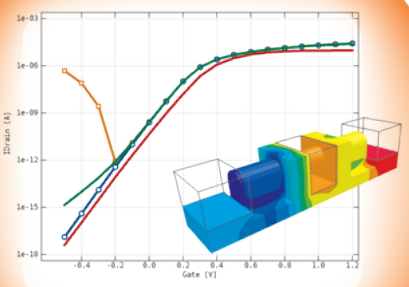
Import GDSII or from process
SWB integration
Unstructured grids

Under the barrier: I_{OFF}

Tunneling transport
Non-local 2D/3D QTBM model
Band-to-band & direct tunneling
SD & Gate barrier, leakage



I_{OFF}

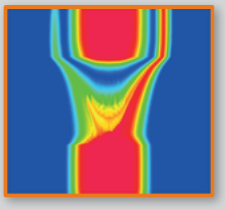


PHYSICAL DEVICE SIMULATION

Over the barrier: I_{ON}

Phase-space transport
Solving sub-band BTE, k•p based
Holes & electrons - NMOS/PMOS
Ballistic transport & scattering

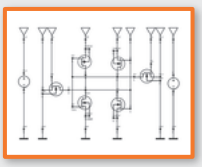
I_{ON}



- **Shrinking, path-finding**
- **Performance**
- **Reliability, variability**
- **Increasing yield**

Compact model extraction

Built-in circuit simulation
Mixed mode
Circuit reliability and variability



- **8 years of leading-edge experience**
- **In-house scientific research, with over 150 papers at IEDM, ESSDERC, SISPAD,…**
- **Consistent, integrated framework**
- **Import/export of industry standard files**
- **Grid and cloud support**
- **Acclaimed user interface**

7/5nm Nanowire | **14/10nm FinFET** | **UTB FD SOI** | **Tunnel FET** | **InGaAs InAlAs** | **SiGe**

GTS NDS – SUPERIOR TOOLS FOR SUPERIOR TECHNOLOGY

*Capturing all physical effects relevant for nano device performance, variability, and reliability

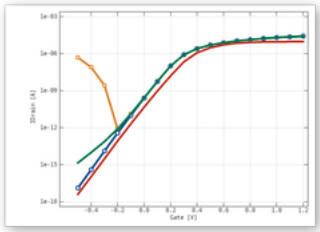
Predictions based on physics.

GTS Nano-Device Simulator

THE TRUE* PHYSICAL MODELING SOLUTION

NDS in Path-Finding

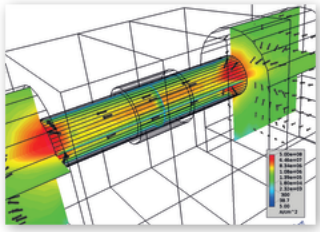
- Examine new architectures / novel channel materials for N7, N5
- Rely on physically sound predictions based on material properties
- Make profound decisions, understanding physical phenomena



NMOS I/V curve calculated by NDS' predictive physical models

NDS in Device Scaling and Introducing New Technologies

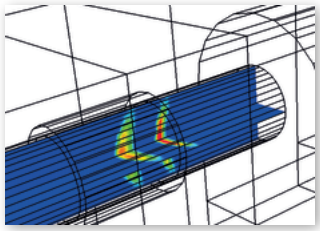
- Rely on predictive simulation for your future technology nodes
- Efficiently introduce and optimize FinFET / FD-SOI for N10 / N14
- Port parameters across technologies (for instance N22 to N14)
- Exploit the opportunities of an extended prediction window



8nm NMOS, current density

NDS in Performance Optimization for Logic and Memory Applications

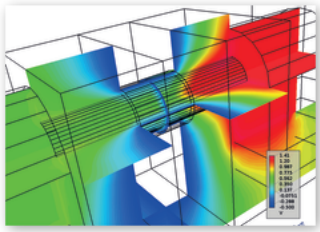
- Evaluate technologies for various applications with real physics
- Optimize performance on device and circuit level
- Study variability and reliability on device and circuit level



8nm NMOS, effective generation rate due to BtB tunneling

NDS in PDK Development

- Know your current and future platforms
- Evaluate technologies at early stages, on device and circuit level
- Benefit from Design-Technology Co-Optimization (DTCO)
- Extract parameters for compact models



8nm NMOS, potential profile

What makes the Difference

NDS integrates all models to simulate transistor performance:

Drive Current – *Boltzmann Transport* – I_{ON}

- Realistic band structure / phase-space approach
- Ballistic and dissipative transport for NMOS and PMOS
- Full coverage of confinement, orientation, strain
- Velocity overshoot, quantum resistance, ballisticity
- Adaptive algorithms – fastest code on the market

Off-State Leakage – *Tunneling Transport* – I_{OFF}

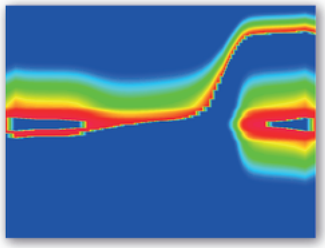
- Quantum-mechanical transport (QTBM)
- Full coverage of confinement, non-locality, band-gap widening
- Direct gate, source-to-drain and band-to-band leakage
- Sub-threshold slope, off-current bounce

Ready for New Materials – strained Si, SiGe, Ge, III/V

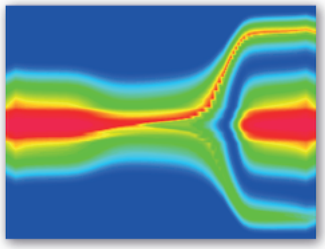
- Customer-editable materials database, import atomistic data

Integration / Industry-Standard Interfaces

- GDSII import, SWB integration, unstructured grids



8nm PMOS, ballistic distribution function in phase space



8nm PMOS, dissipative distribution function in phase space

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SUPERIOR TOOLS FOR SUPERIOR TECHNOLOGY

GTS NDS includes models and techniques published by GTS researchers at IEDM 2015 and IEDM 2016

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