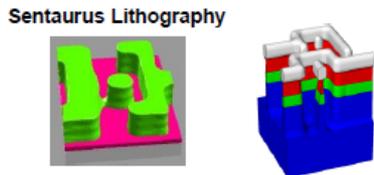
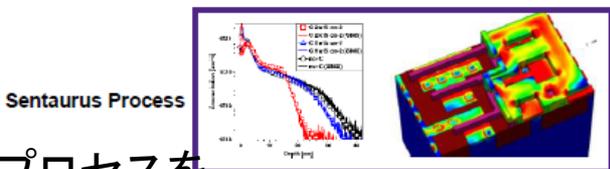




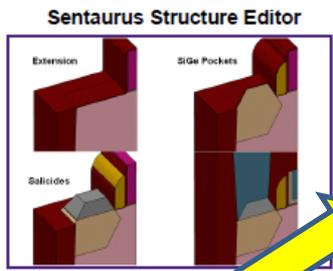
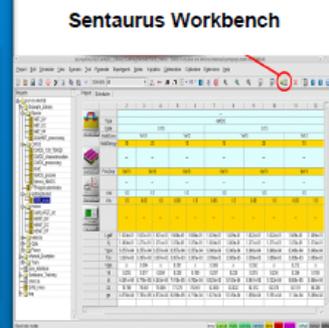
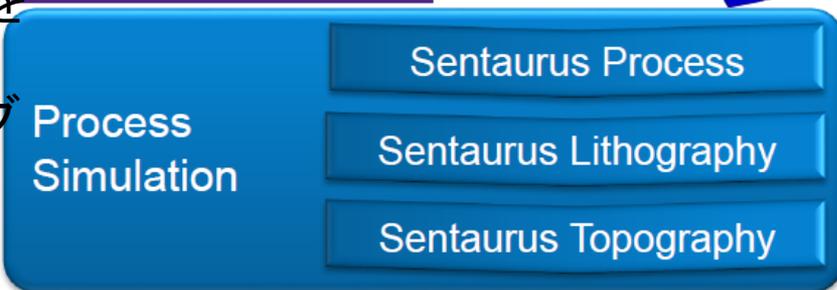
Introduction

Koji Nakamura (KEK)

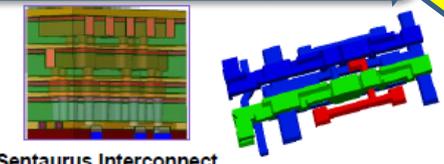
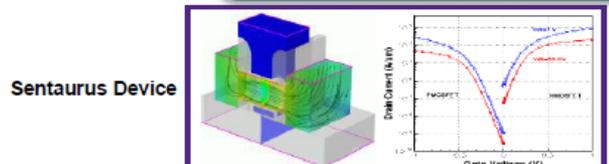
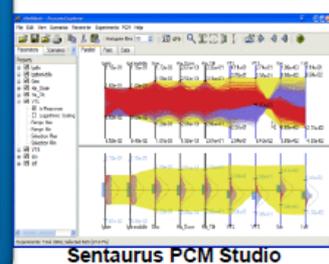
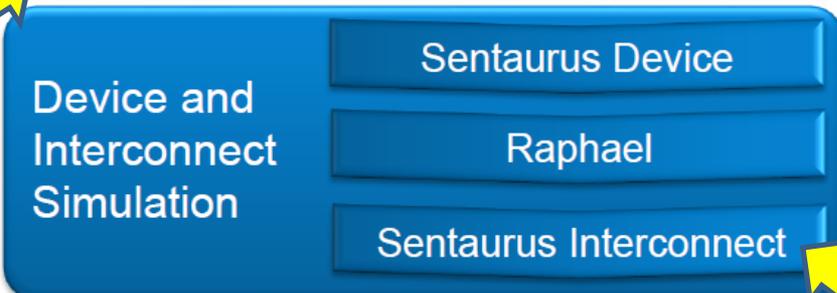
Sentaurusの概要



実際の半導体プロセスをシミュレート
ex ドーピング, エッチング



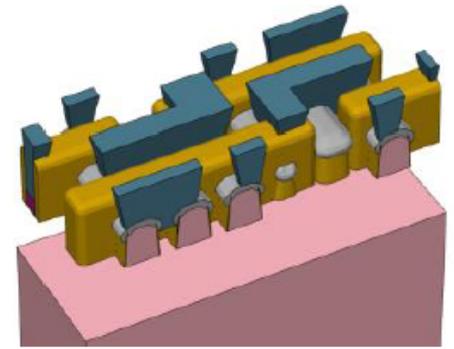
半導体プロセスをシミュレーションせずに構造を作ることができる



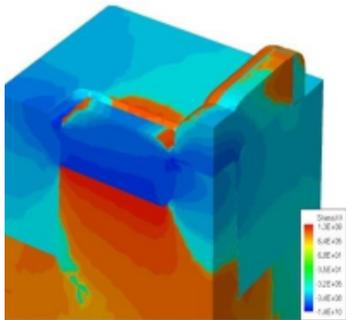
デバイスの動作確認
IVとかCVとかMIP応答
FETの動作 etc...

プロセスシミュレーション

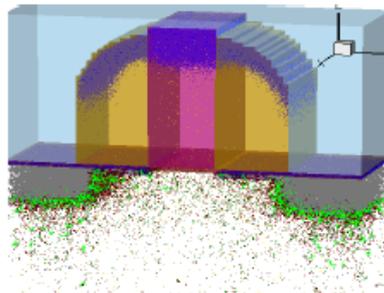
- General purpose multidimensional (2D/3D) process simulator
- Integrated 3D geometric modeling engine (depo/etch/pattern)
- Adaptive meshing (to geometry/species changes)
- API for user-defined models
- Advanced physical models:
 - Analytic and Monte Carlo implantation
 - Diffusion: laser/flash annealing, kinetic Monte Carlo
 - Mechanical stress
 - Oxidation/Silicidation



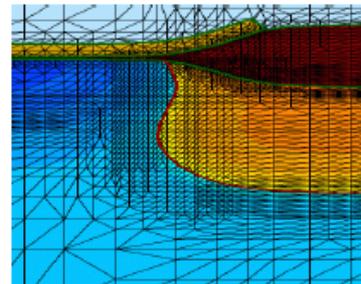
FinFET SRAM



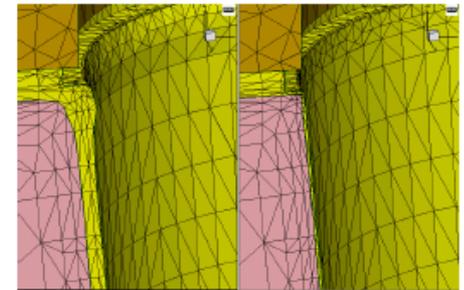
Mechanical Stress



Kinetic Monte Carlo



Adaptive Meshing



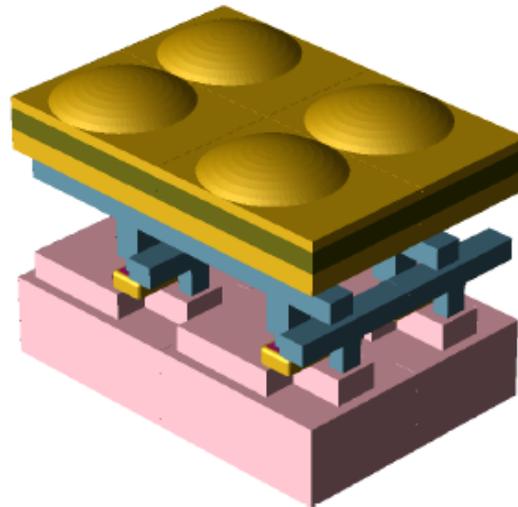
Oxidation

Structure Editor

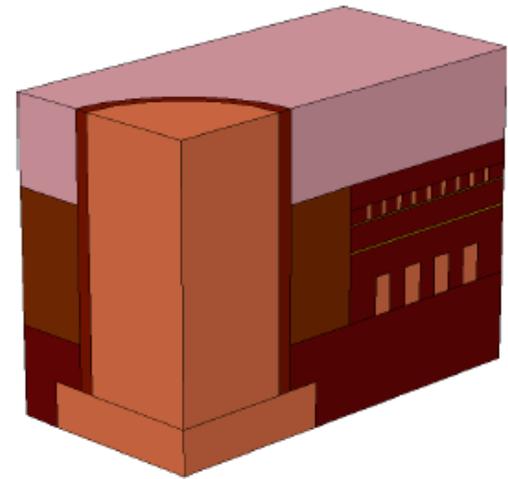
- Geometrical operations
- Easy to use GUI
- Scripting language
- Advanced geometrical modeling with analytic doping definitions
- Direct interface to meshing engines



S-RCAD DRAM



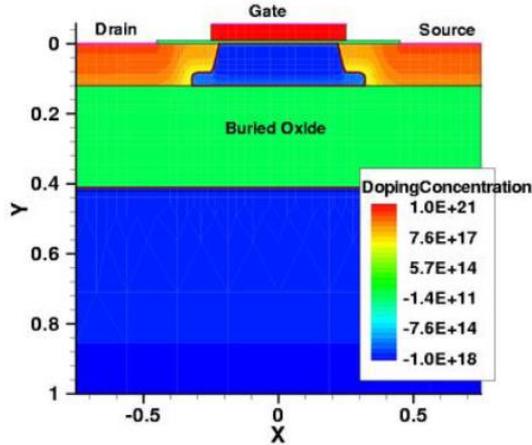
CIS pixels with microlenses



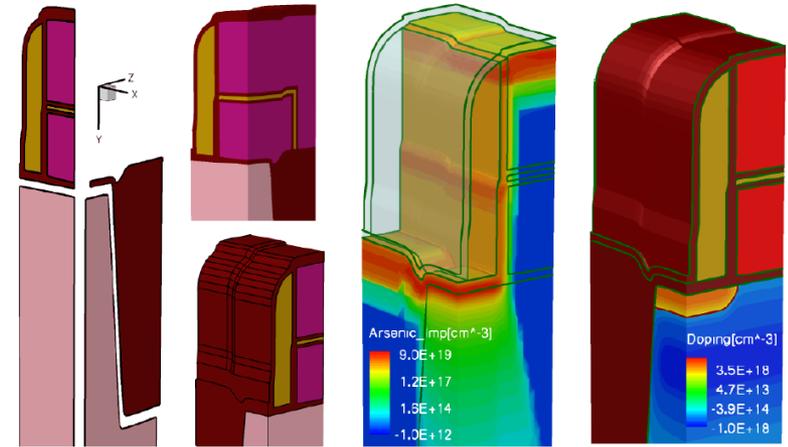
TSV Structure

Structure Editor

2D structure Editor (SOI nMOS transistor)

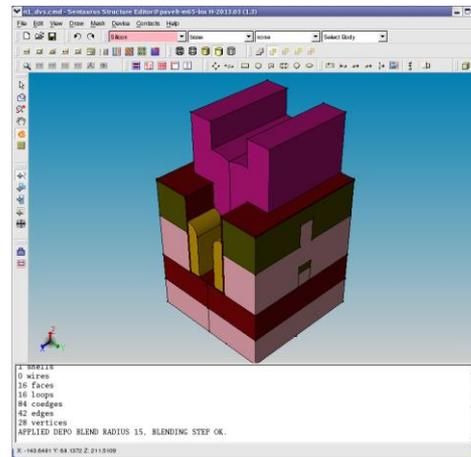


2D -> 3D Structure Construction

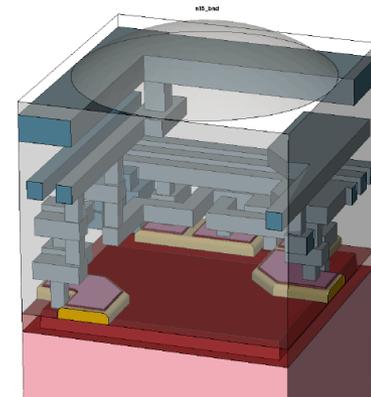
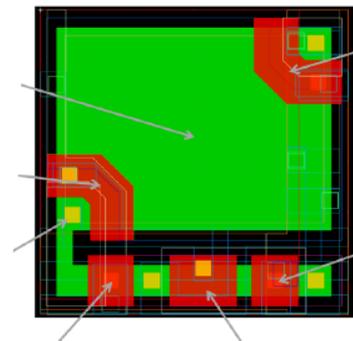


Process Emulation Mode

- Support for :
 - Depo/Etch
 - マスクの製作、パターンニング
 - GDS2 fileの読み込み



GDS file



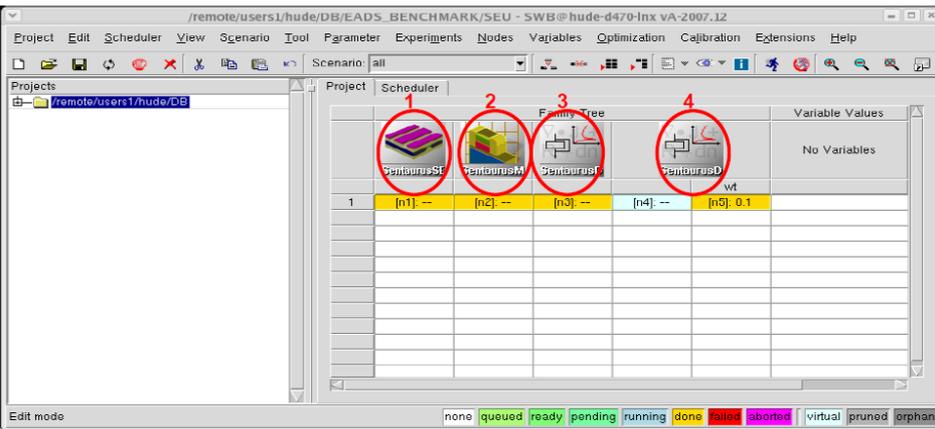
Device Simulator

- 汎用的な2D/3Dのデバイスシミュレータ
- Silicon, SiGe, Ge, SiC など
- ドリフト-拡散、流体力学、熱力学を考慮したシミュレーション
- より高度な物理モデル
- できること
 - 電場シミュレーション (IV/CVなど)
 - CMOS(MOSFET)の詳細なシミュレーション
 - メモリーのシミュレーション
 - Particle Interaction (Alpha線、Heavy Ion)
 - Total Dose Radiationの影響
 - 酸化膜電荷、バルクのトラッピング、CMOSのBit-Flipping

と、いろいろな機能がありますが...

どのように使うのが良いか？

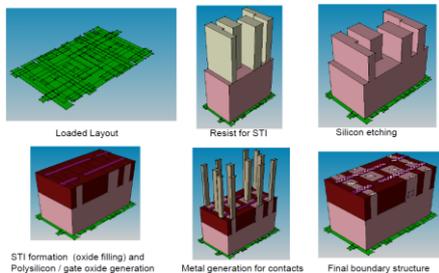
- よほど半導体プロセスに興味がない限りは...
- Structure Editor (-> Mesh) -> Device simulationがベスト？



ワークベンチでこんな感じに進める。
詳細は次の演習で。

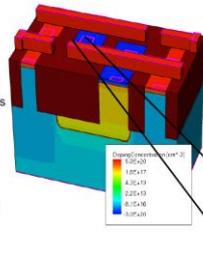
1. Sentaurus Structure Editor – 3D SRAM structure generation
2. Sentaurus Mesh – 3D Doping and Mesh definition
3. Sentaurus Device – Off-state regime simulation
4. Sentaurus Device – Heavy Ion impact simulation

Structure Generation



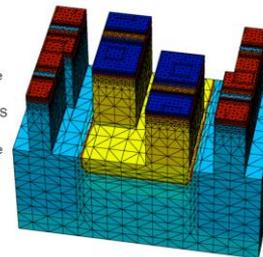
Doping Definition

- Constant doping profile in Polysilicon and Pwell
- Analytical doping profile (Gaussian) in the Source/Drain of NMOS and PMOS Transistors
- Analytical doping profile (Gaussian) in the channel of NMOS and PMOS Transistors
- Analytical doping profile (Gaussian) in the access drain (bit line) and access gate (word line).



Meshing

- Meshing strategy:
 - Refinement on doping (junctions refinement)
 - Refinement at Silicon / Gate Oxide interface
 - Refinement in the channel of NMOS and PMOS Transistors.
 - Relaxed mesh inside the substrate
- Mesh statistics:
 - Mesh nodes number: 31825
 - Meshing time: 114 s



Simulation of Charge Track

3D charge deposition

