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FROM ATOMS TO SYSTEMS

The Four Process Simulation Options

Modeling - Geometric – Emulation – Physical

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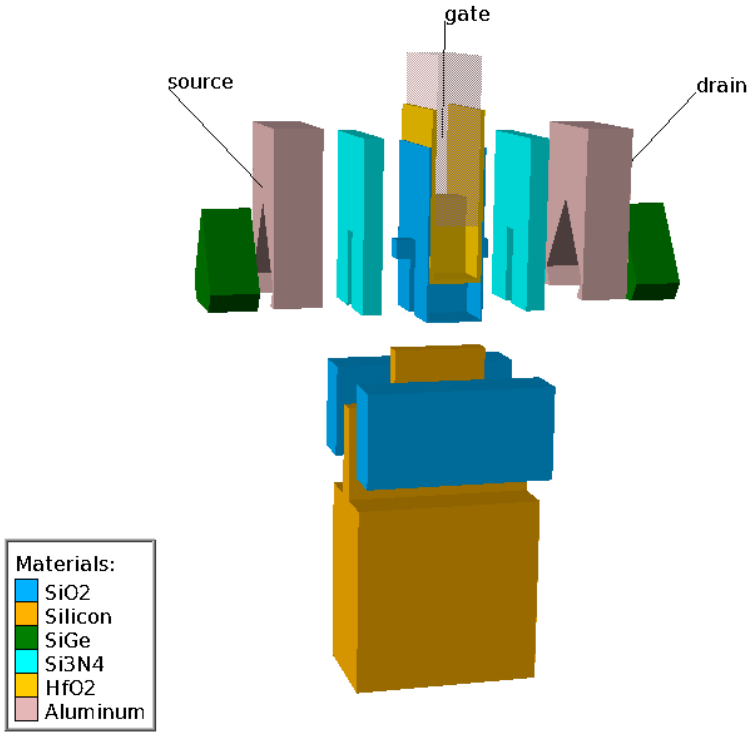
Four Process Simulation Options

- The purpose of a process simulator is to create a virtual representation of a physical structure.
- There are four basic ways to create the structure:
  1. Solid modelling (assembly of geometric shapes)
  2. Process simulation using geometric style etch/deposit
  3. Use a topographical etch/deposit emulation engine
  4. Simulate the etch/deposit chamber physics
- Other process steps, implant diffuse, etc., independently have similar physics or rule-based options.

Solid Modeling Approach



- In this most basic approach, various shapes are created using a solid modelling tool which are then “stitched” together to form the basic simulated structure.
- An exploded diagram (left) shows constituent parts of a FinFET structure created entirely using solid modeling.

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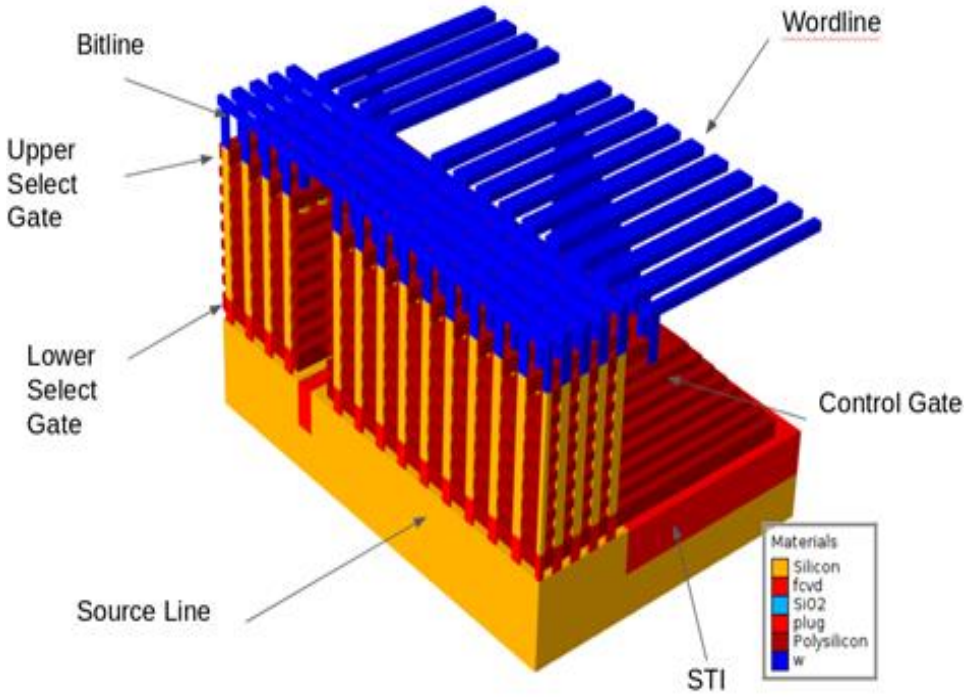
Geometric Operations for Etch/Deposit



- After loading mask data, the process run sheet is followed to create the structure but etch and deposit steps are limited to geometric functions of the masking layers.
- Fast prototyping simulations of large structures are possible.

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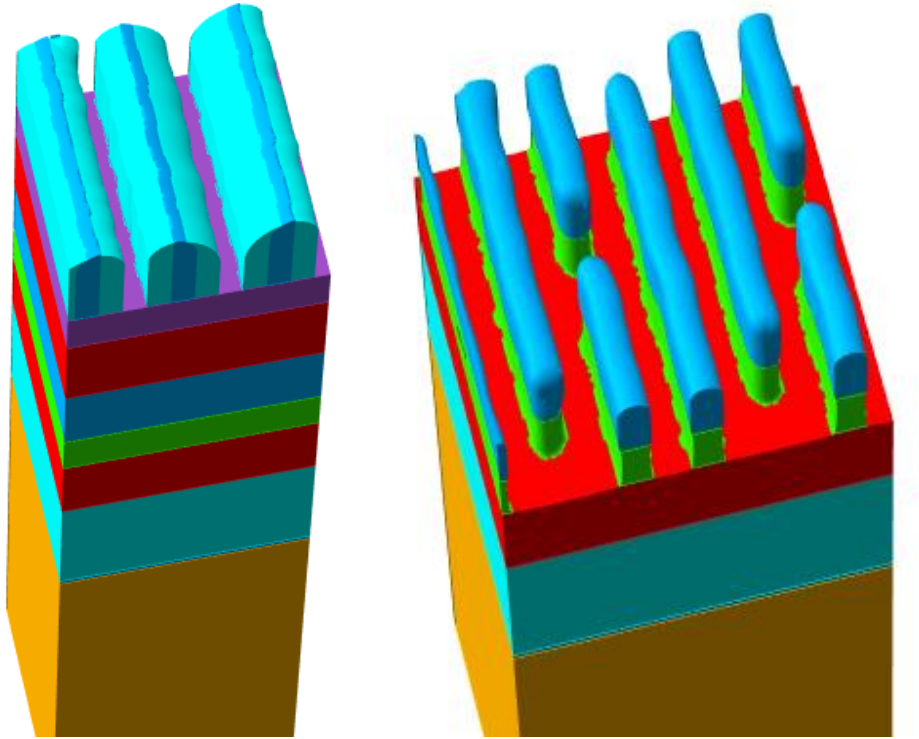
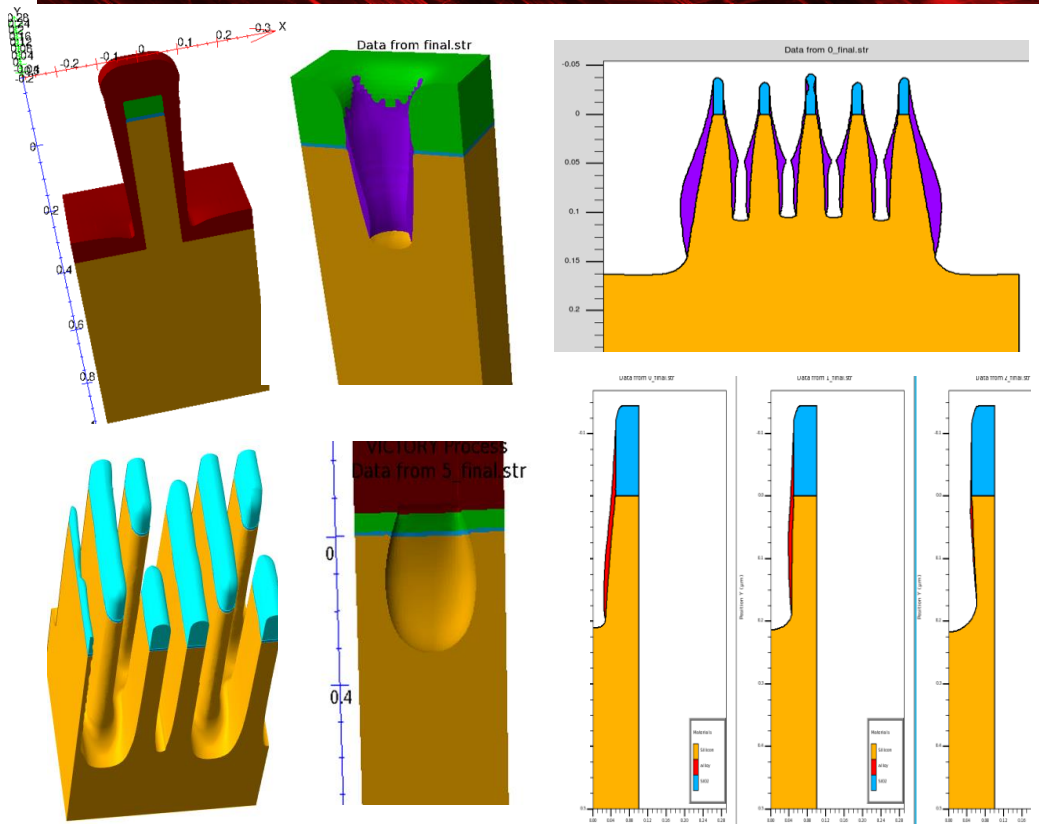
Topographical Process Emulation



- After loading mask data, the process run sheet is followed to create the structure as before.
- However, an Emulation style engine uses topographic-based mathematical functions, to create more complex conformal layer deposit and rounded etch shapes.

Chamber Physics Simulation for Etch/Deposit/Oxidation



- A step towards further predictable simulation, is to simulate the basic etch/deposit chamber physics
- Typical inputs for the model are material and incoming particle angular dependency of etch/deposit rates, sticking coefficients, polymer re-deposit, etc.

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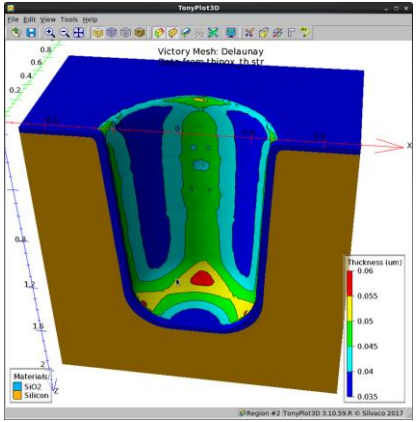
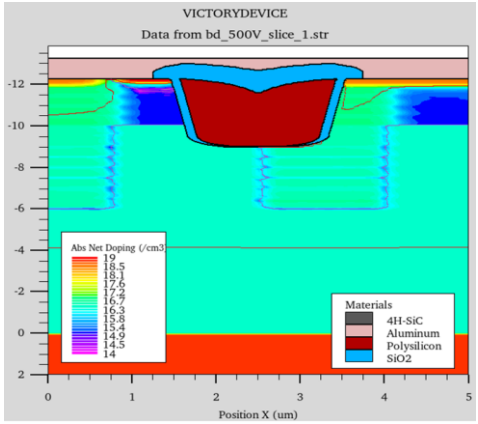
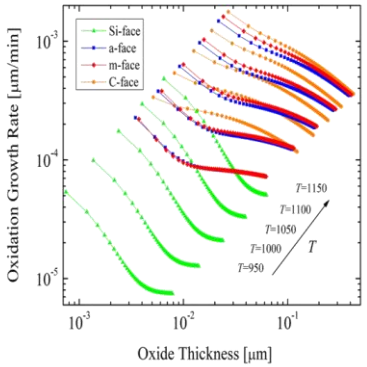
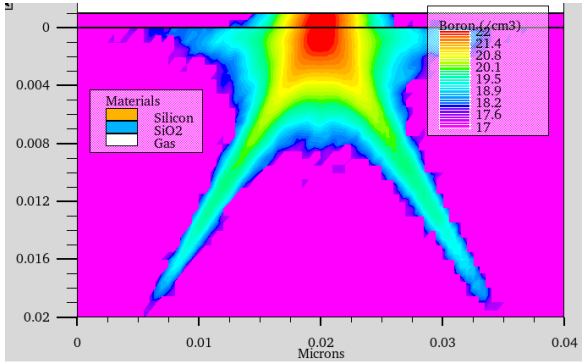
Other Physics or Rule-Based Options









- Silvaco also provides physics or rule-based model options, for implant, diffuse and oxidation process steps.
- This mix and match approach facilitates very flexible structure creation techniques.

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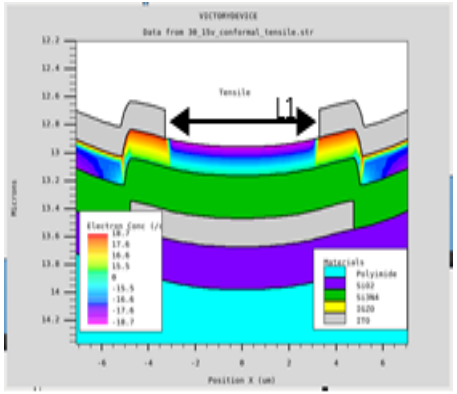
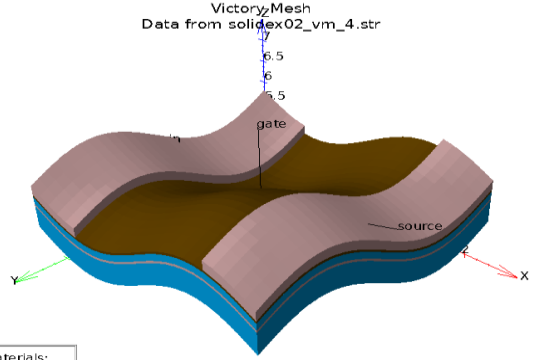
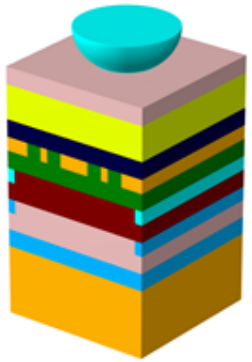
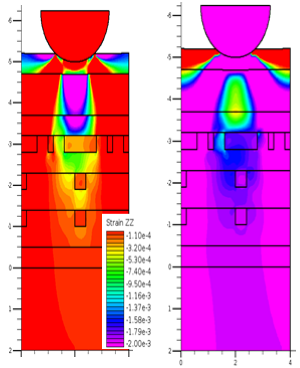
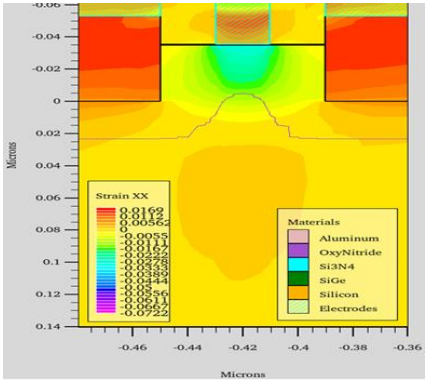
Integrated Stress Analysis











- Structure stress can be analyzed at key points during structure creation, or at every step during the structure creation process flow (“stress history” feature)

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Summary

- Four process simulation options are available
- Physics or rule-based options for implant/diffuse
- 3D physics-based crystal direction dependent oxidation
- Mix-and-match approach facilitates great flexibility
- One tool set for large geometric structures, and detailed analysis of etch, deposit, oxidize and stress

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