Computational Microelectronics

Lecture 1 Technology Computer-Aided Design

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Welcome

Welcome!

- Computational Microelectronics (계산전자공학)
  - Code: EC7114
  - Lecture 3, no experiment, credit 3

- Instructor: Sung-Min Hong
  - School of EECS

Resources

- Presentation materials

  https://github.com/hi2ska2/cm2023f

  – There are some archived repositories.

- Homowork submission

  – GIST LMS system

- YouTube channel

  https://www.youtube.com/@SungMinHong

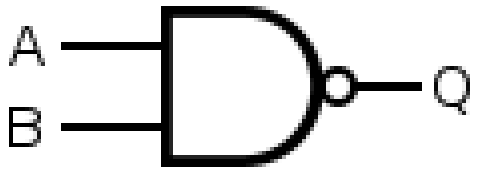
Evaluation

- Attendance (10%)
- Homework (40%)
- Final presentation (50%)
  - Prepare and submit your own presentation.
  - It will be uploaded in my YouTube channel.

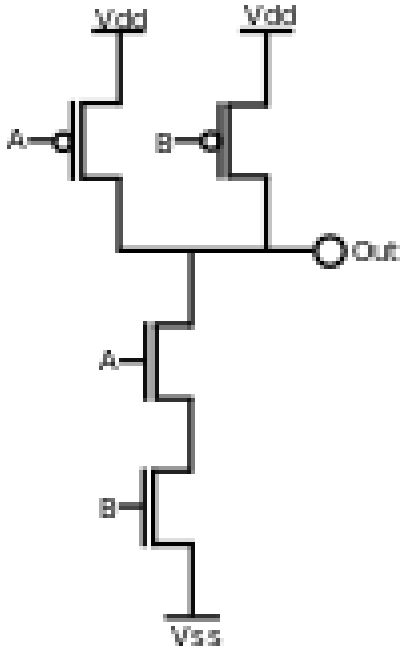
Technology Computer-Aided Design (TCAD)

Various ways to consider a NAND2 gate

- Logical symbol, circuit schematic, layout, …
  - Then, what is the physical reality?



(Wikipedia)



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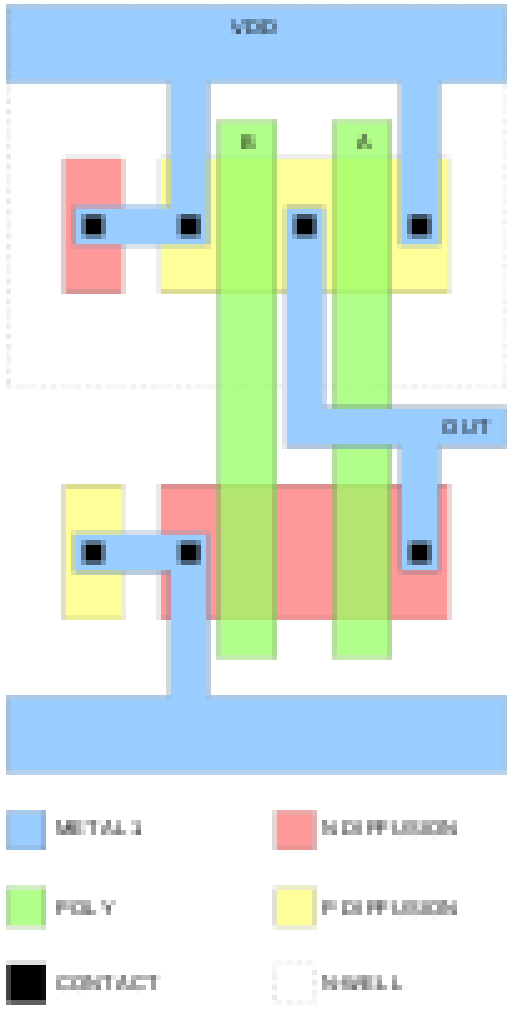
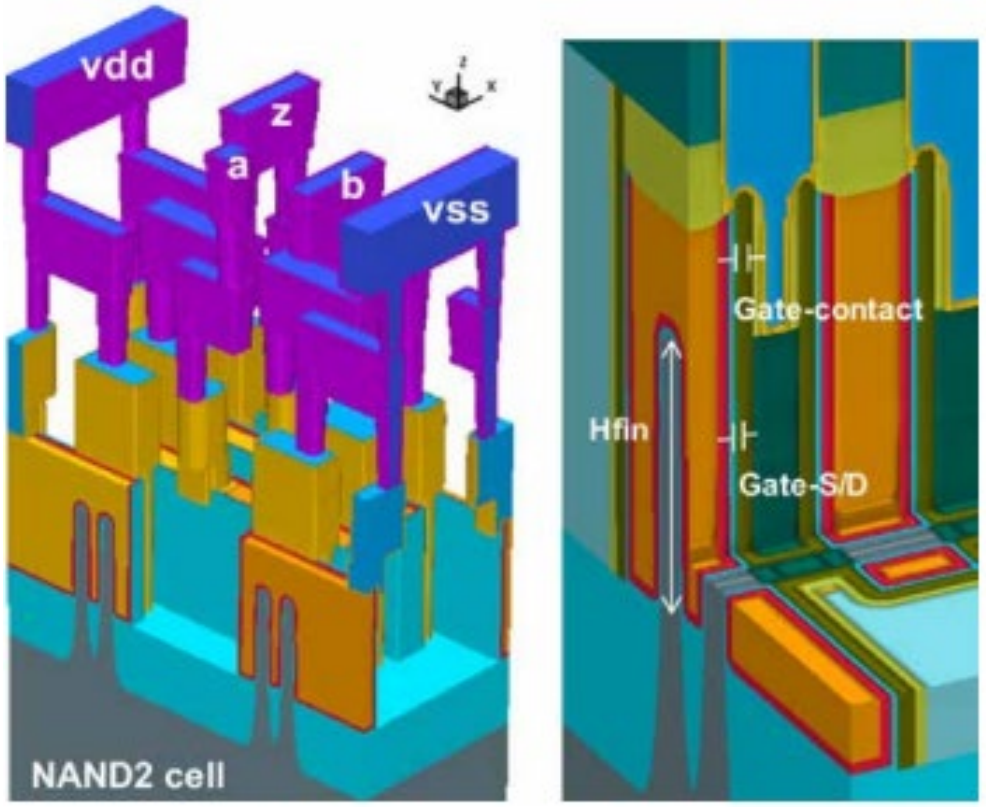


(Wikipedia)

3D structure of a NAND2 gate

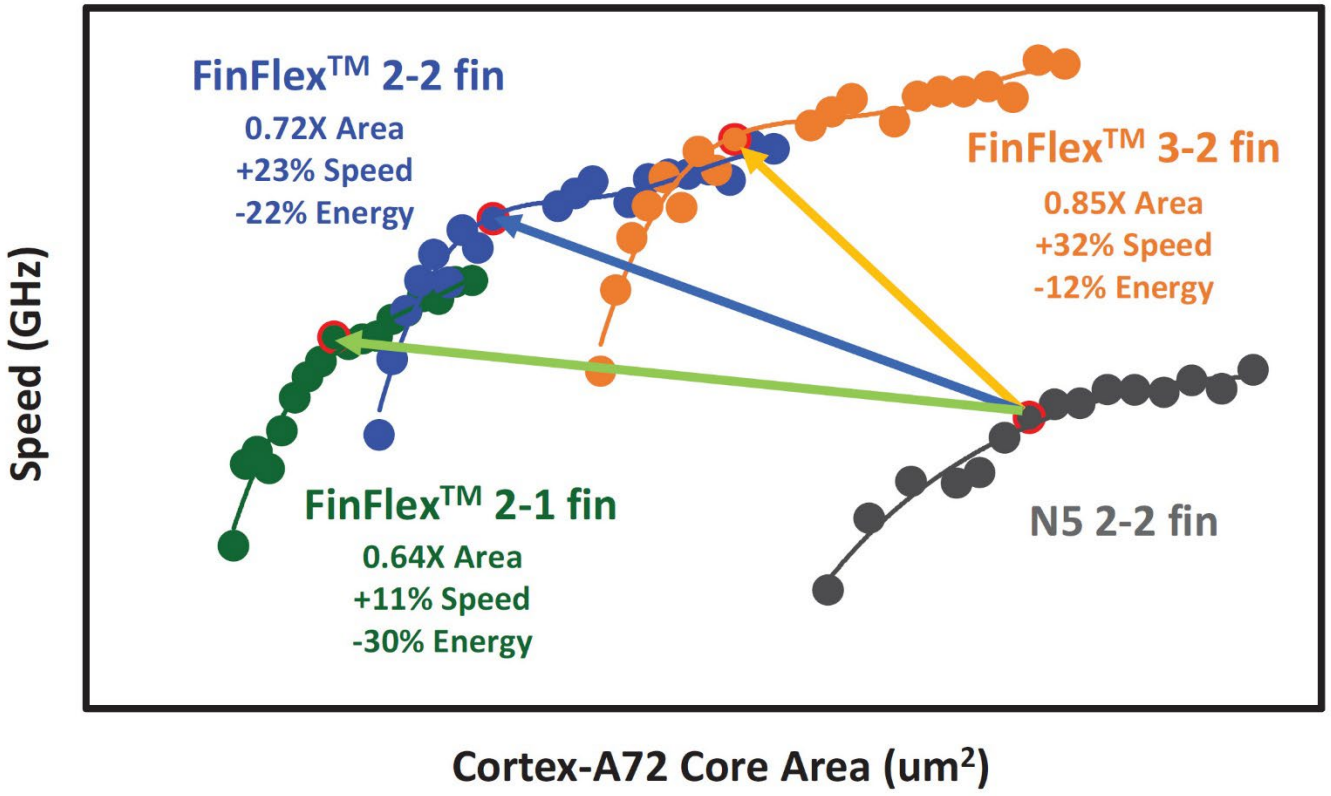
- Silicon, insulator, metal, …
  - Voltages as logical signals



(Synopsys)

Semiconductor device technology

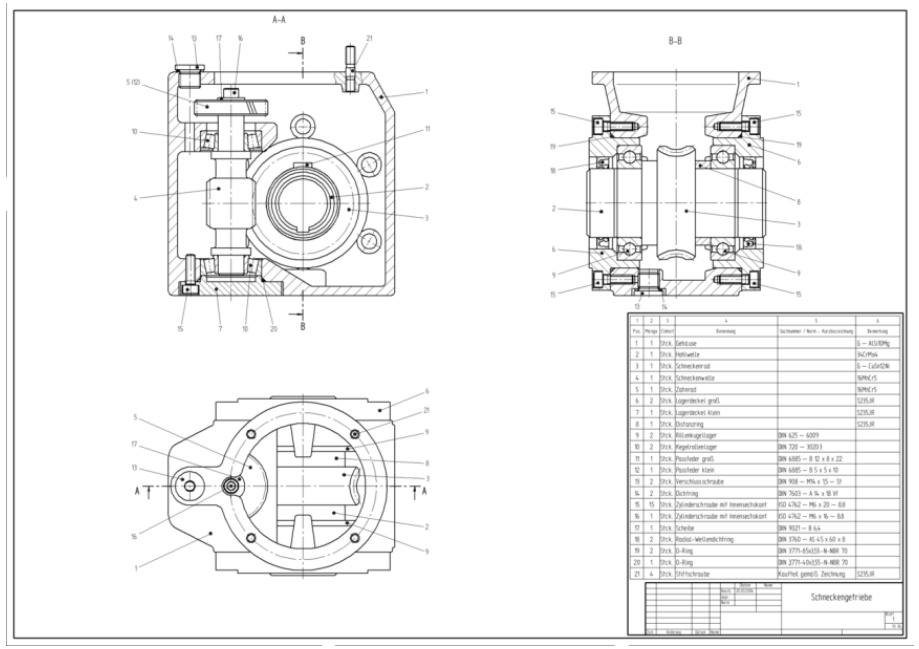
- Tough development goal at every technology generation
  - Example) TSMC's 3-nm node (N3E @ IEDM 2022)
  - Trial-and-error? No.
  - We need a guide.



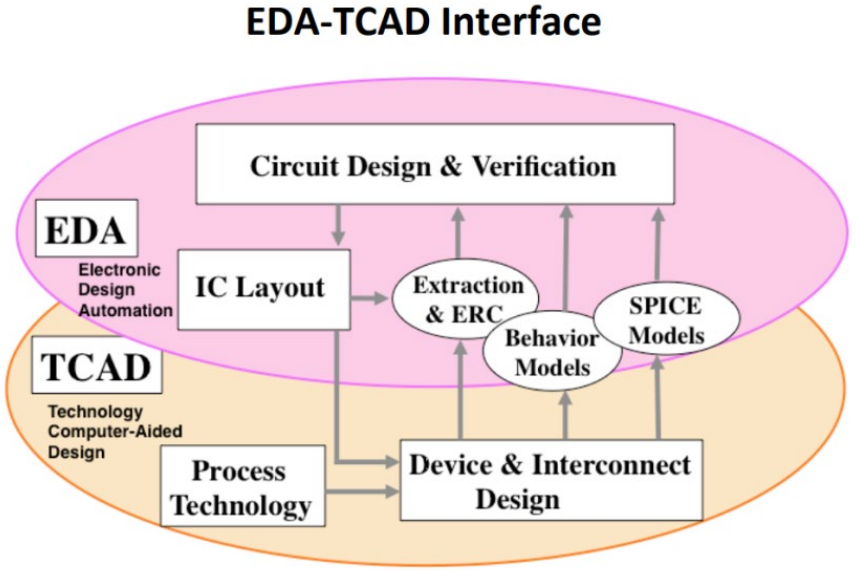
(TSMC)

TCAD (Technology CAD)

- Process simulation, device simulation, and so on
  - CAD?
  - Technology = Semiconductor device technology



2D CAD drawing (Wikipedia)



(Prof. Dutton's ICCAD 2014 TCAD to EDA Workshop presentation)

TCAD vendors

- Companies offering TCAD tools
  - Synopsys, Silvaco, GTS, …

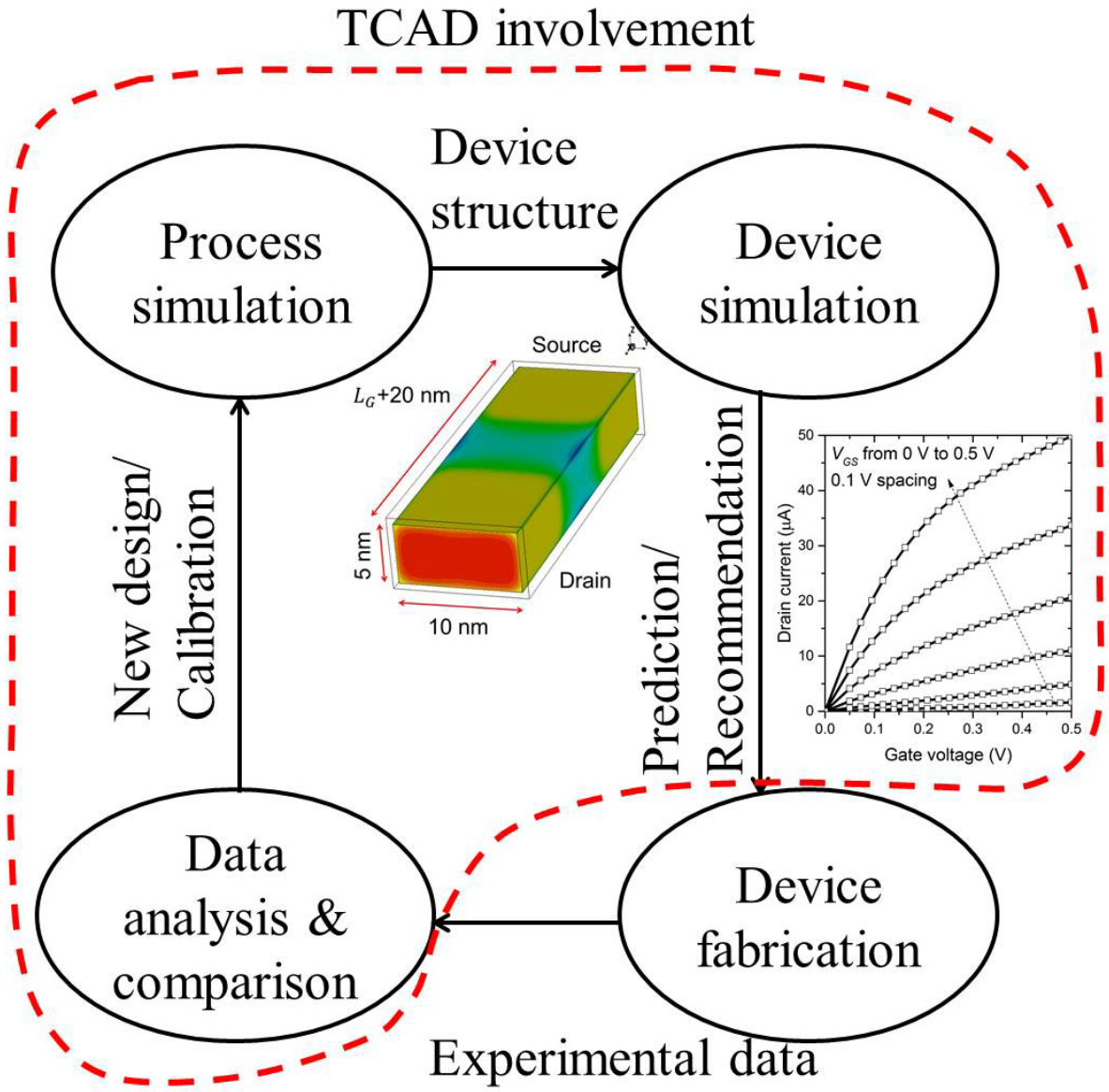
In this course,

- You build your own codes.
  - For what?

(Kim Bellard)

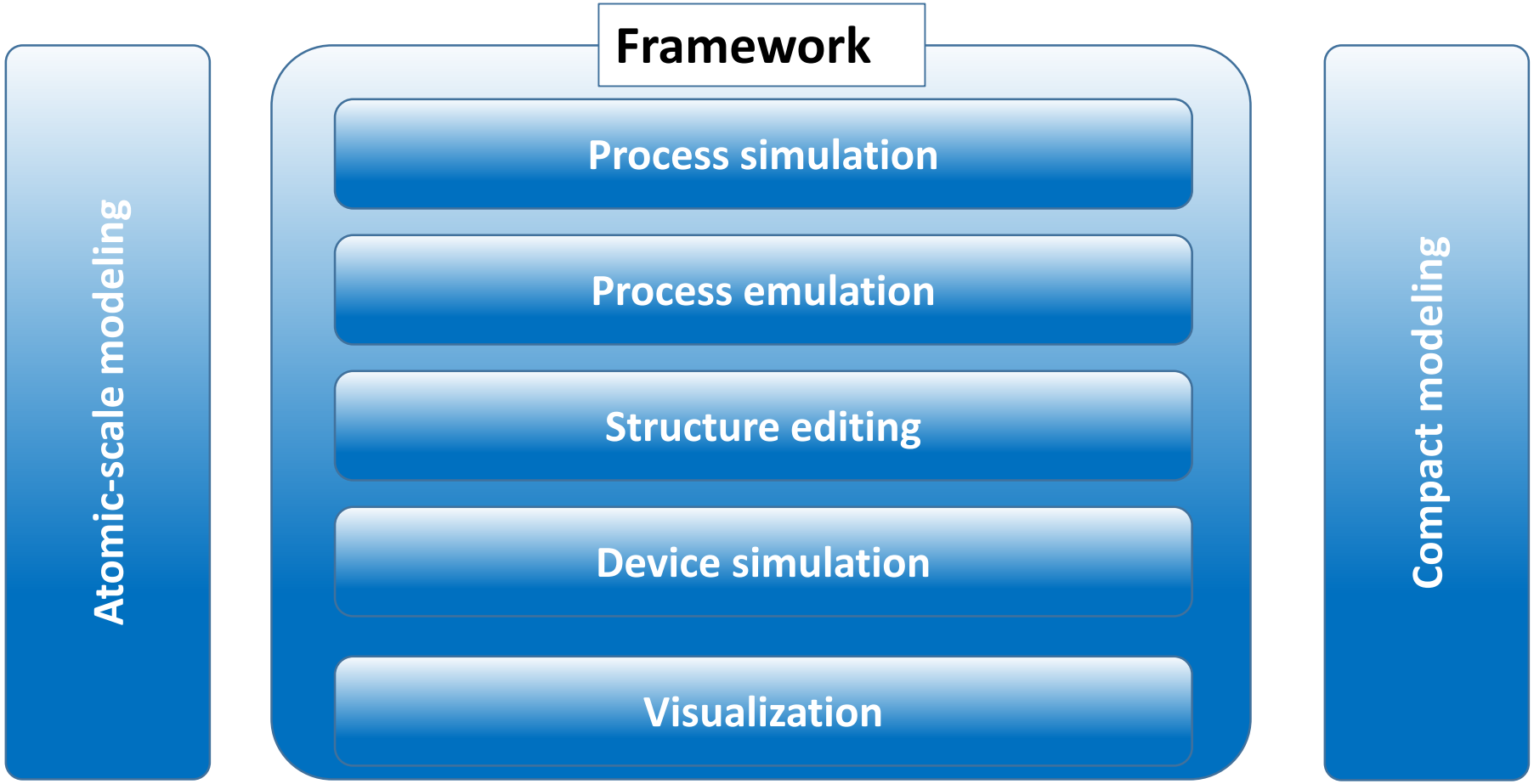
Simulation flow

- Technology development cycle
  - TCAD is heavily employed.
- Process simulation
- Device simulation



Various TCAD tools

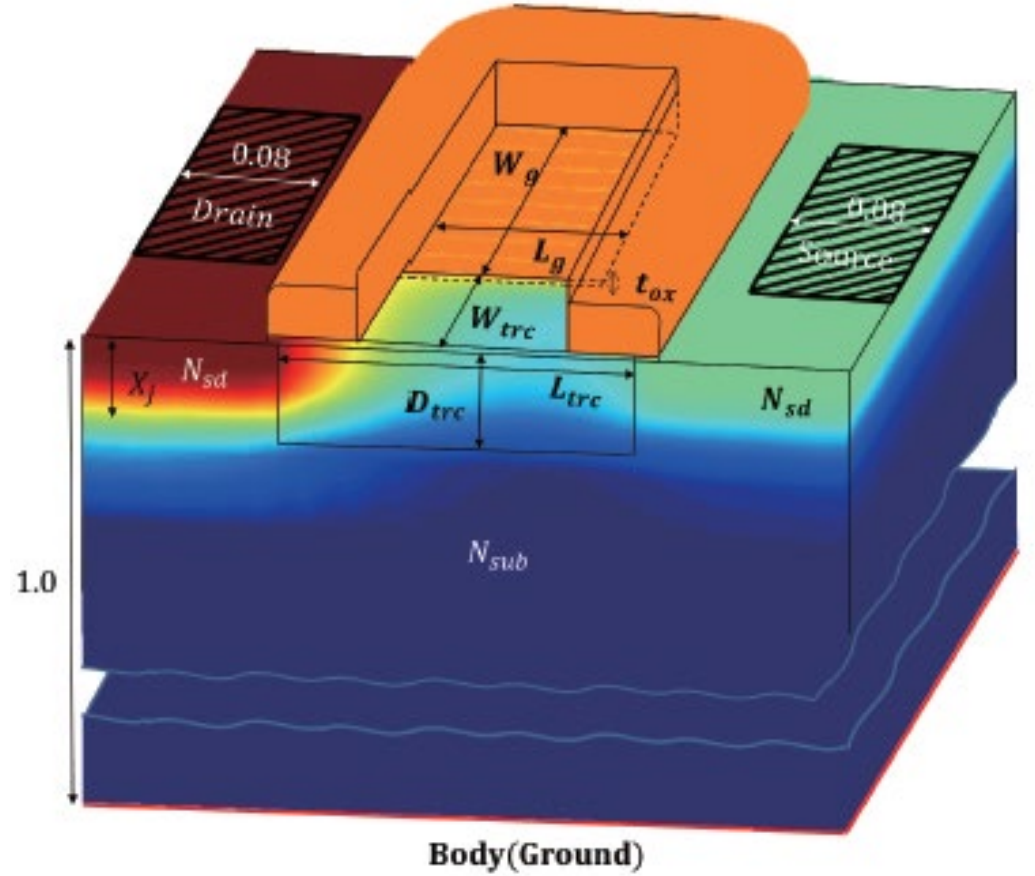
- There are many TCAD tools.



Process simulation

Three-dimensional device structure

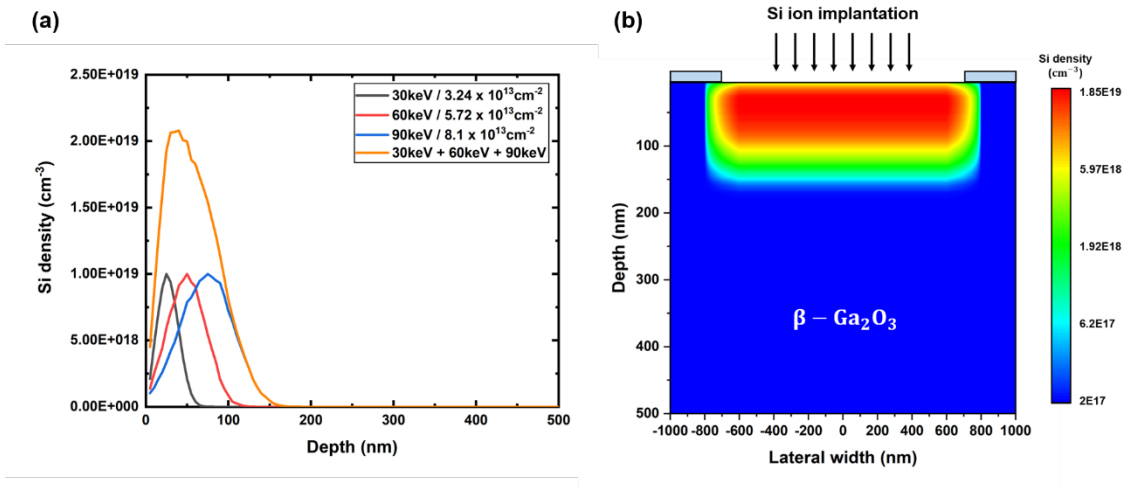
- Complicated structure
  - Several materials
    - Silicon, SiGe, …
    - Oxide, nitride, HfO_2, …
  - Position-dependent doping profile
    - N-type & P-type
- "Unstructured" mesh
  - Sets of tetrahedra



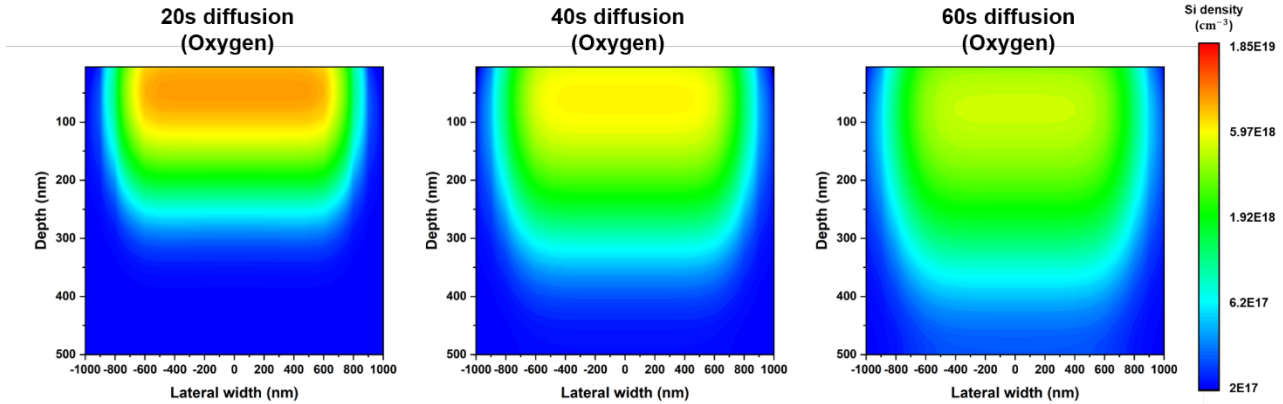
Three-dimensional planar MOSFET (Han et al., SISPAD, 2021.)

Various process steps

- Wafer (🡐 Not covered)
- Oxidation
- Photolithography
- Etching
- Deposition & ion implantation
- Interconnect (🡐 Not covered)
- EDS (🡐 Not covered)
- Packaging (🡐 Not covered)



Ion implantation profile

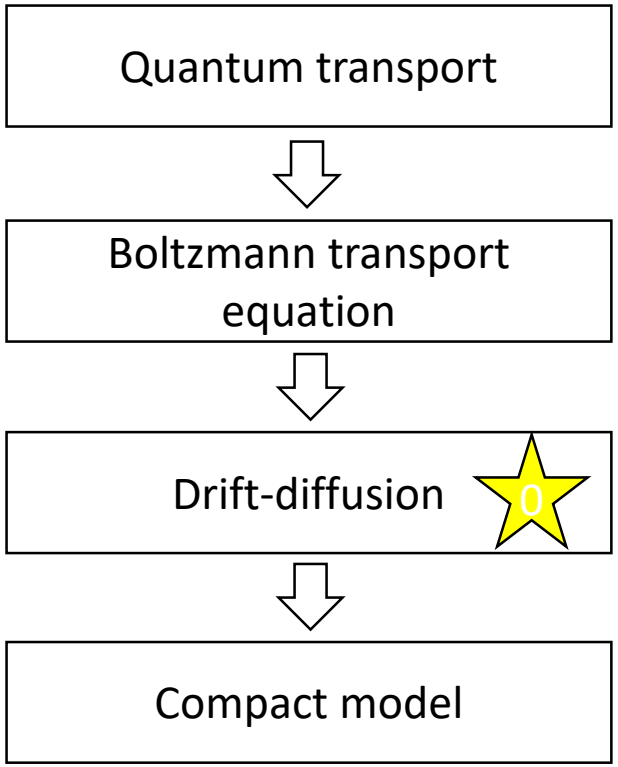


Dopant profiles after diffusion

Device simulation

Transport theory

- Goal: Predicting the electrical characteristics of devices
  - Description about the electronic motion
  - A set of partial differential equations ➔ numerical solutions



HW#1

- Due: AM08:00, August 30
- Problem#1
  - Write a “Hello, world!” program and submit your report through the GIST LMS system.

Thank you!