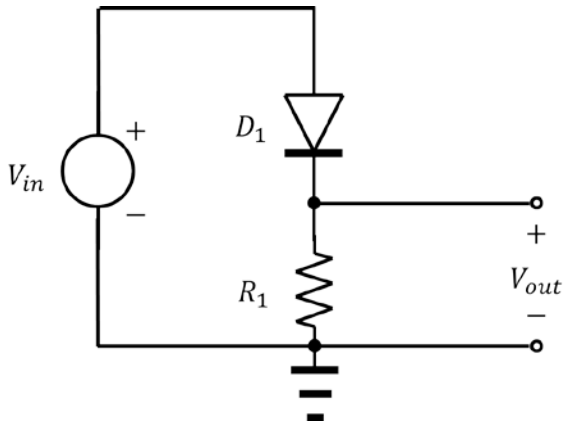
Lecture9:
Physics of MOS transistors (1)

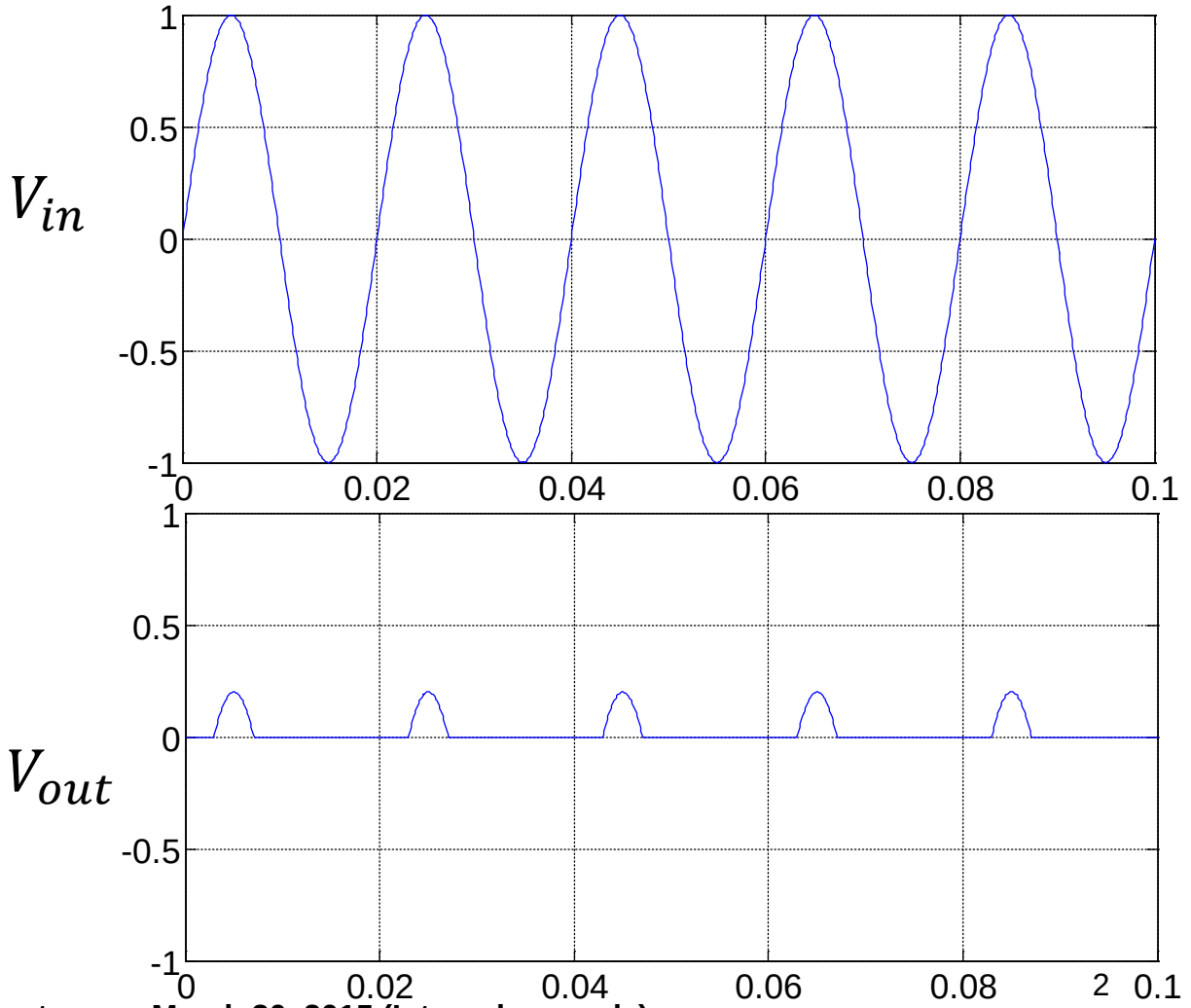
Sung-Min Hong (smhong@gist.ac.kr)

Semiconductor Device Simulation Lab.
School of Information and Communications
Gwangju Institute of Science and Technology

Rectifier, revisited

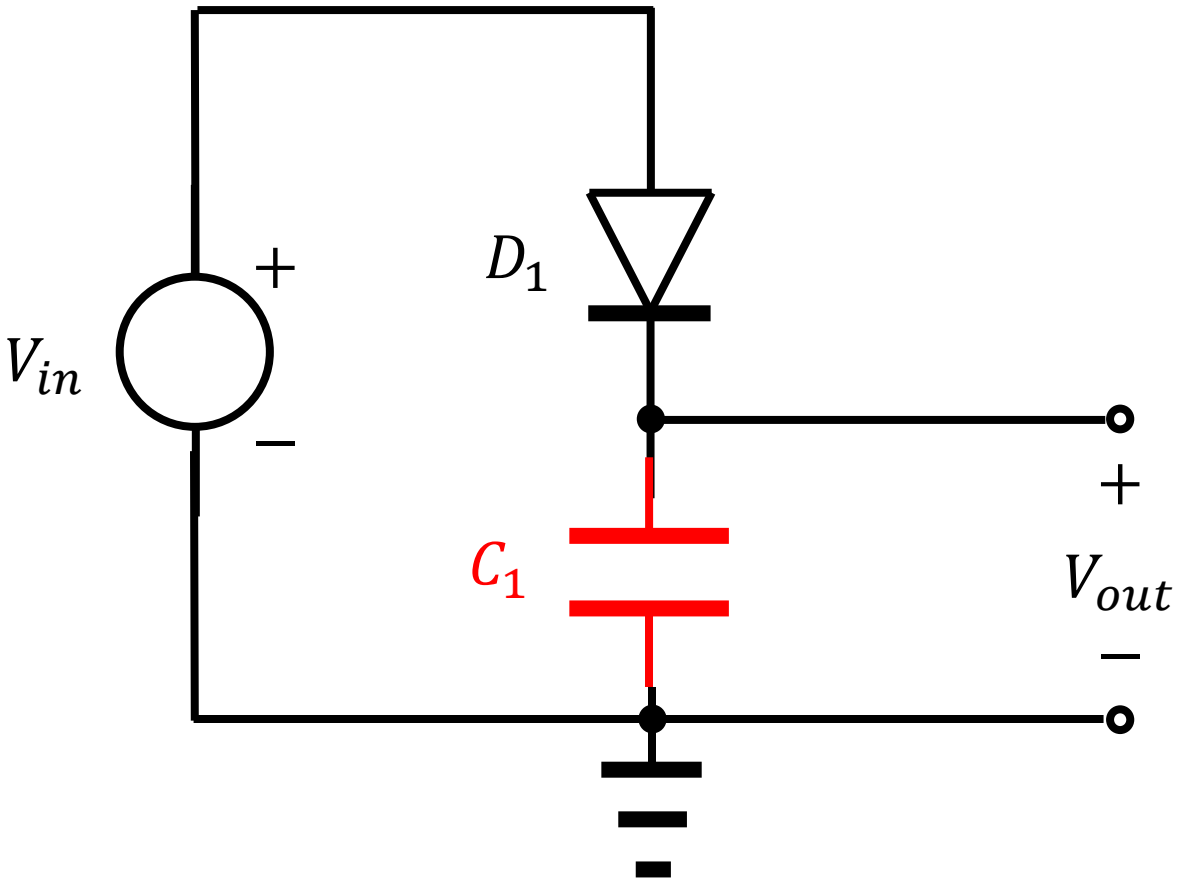
- Constant-voltage model?





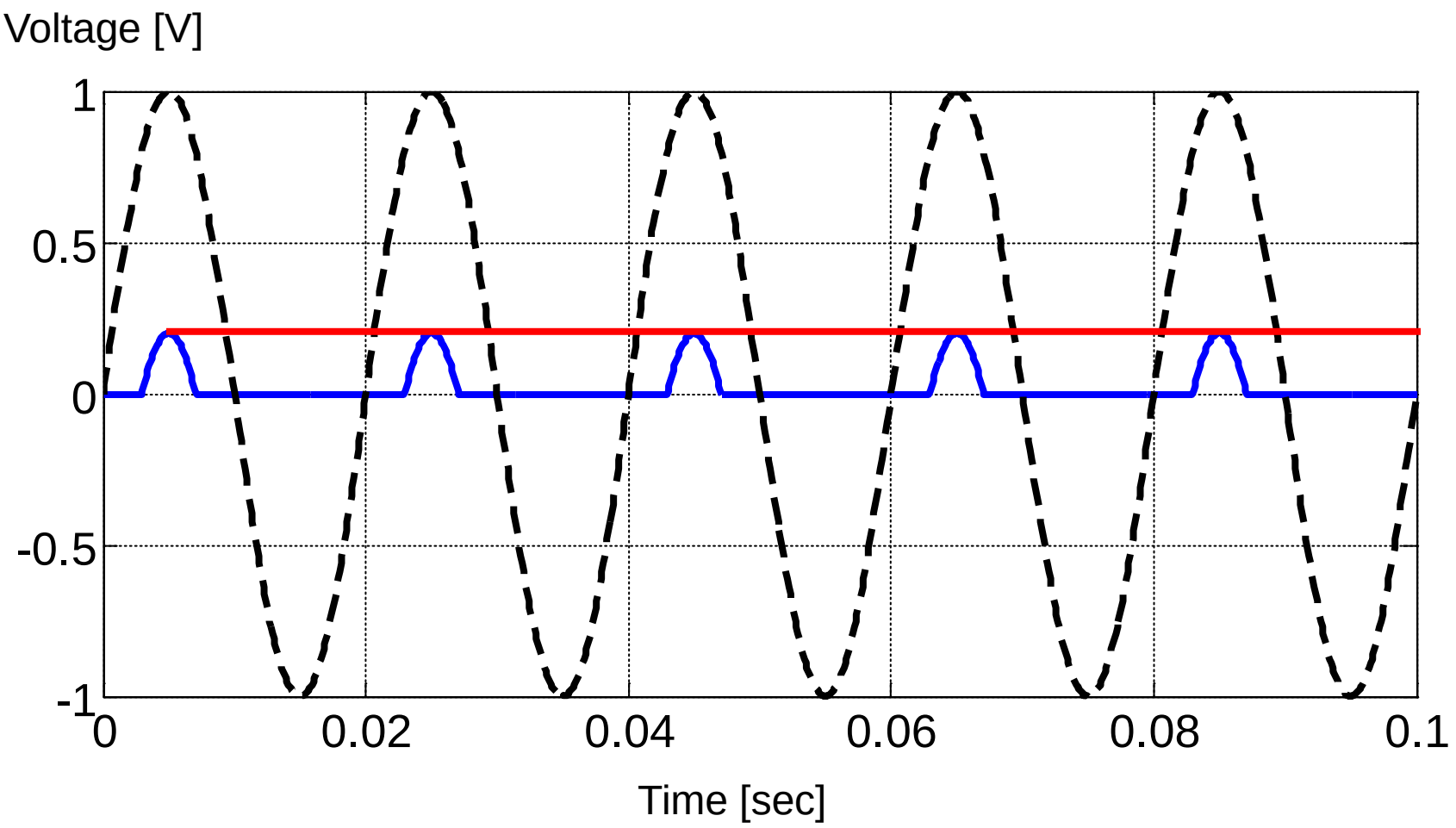
Introducing a capacitor (1/2)

- Difference from the previous one?



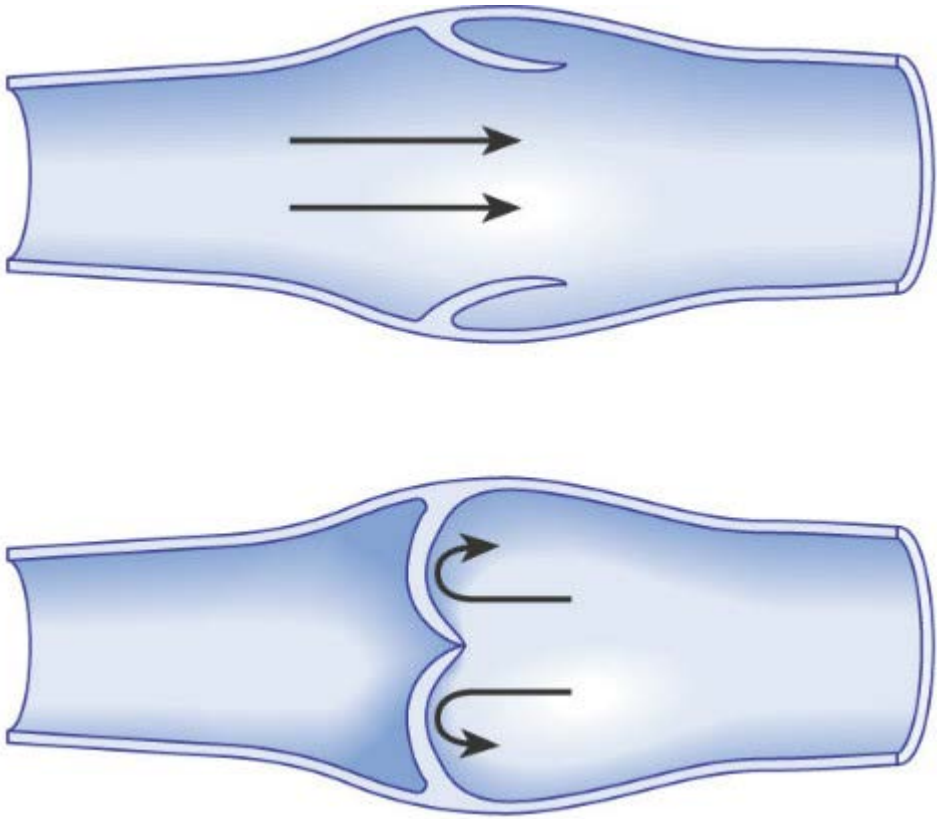
Introducing a capacitor (2/2)

- Difference from the previous one?



Analogy

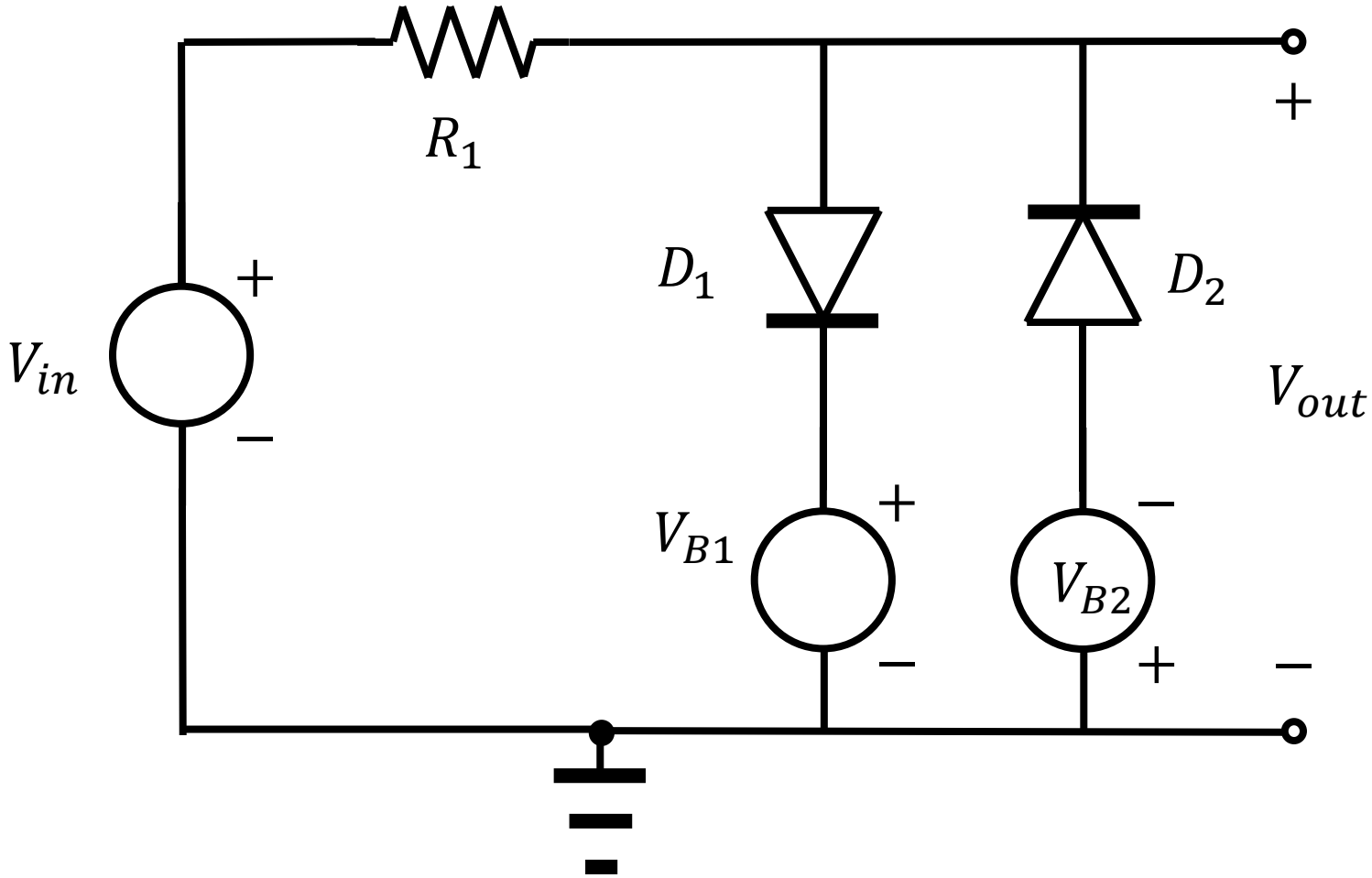
- A blood vessel



(Google image)

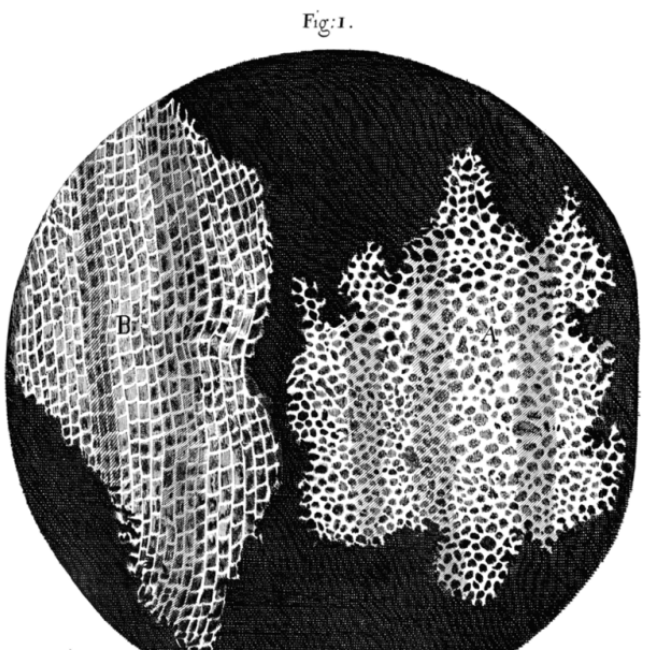
Limiter

- Level-shift for both half cycles



MOSFET

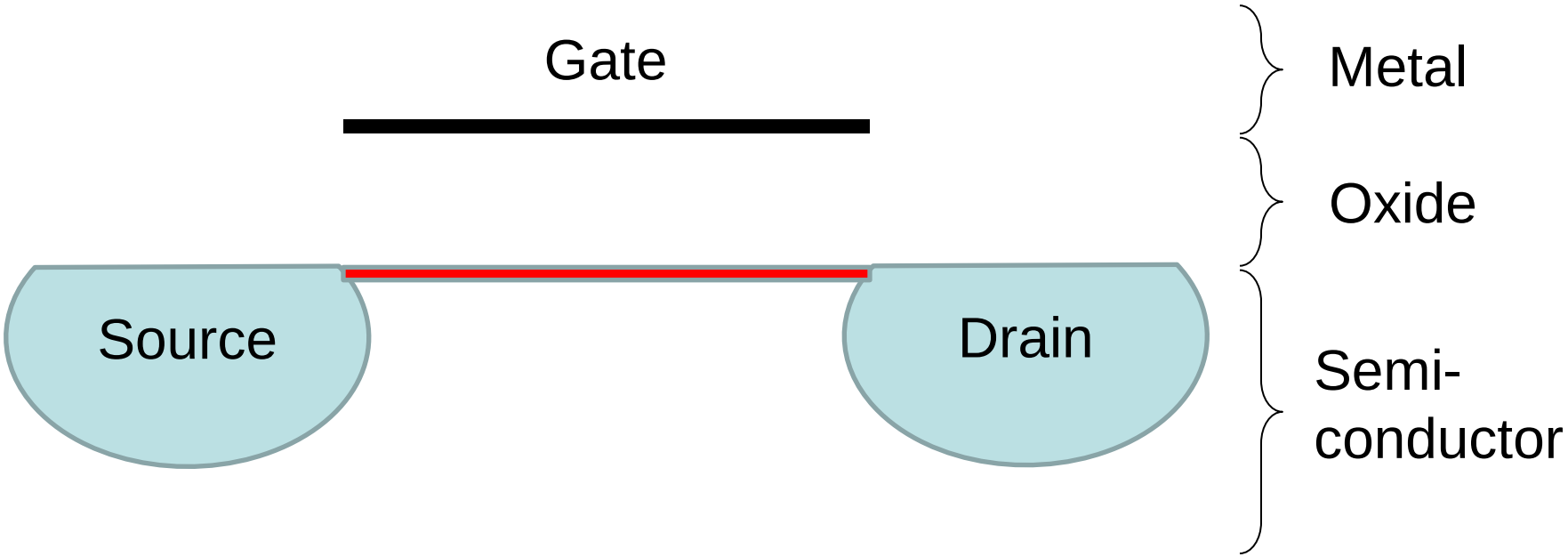
- Metal-Oxide-Semiconductor Field-Effect Transistor
  - *How can I explain its importance properly?*
- In the biology,
  - All living organisms are composed of cell(s).



Structure of cork (Wikipedia)

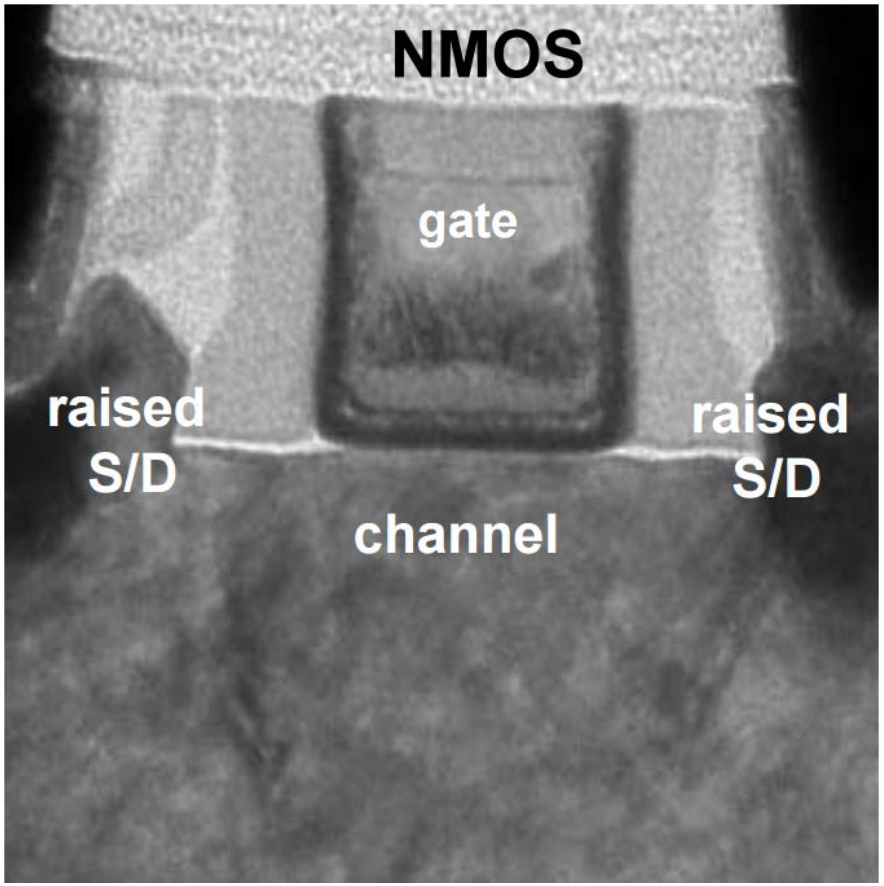
Its generic structure

- Vertical structure
  - Metal-Oxide-Semiconductor
- Terminals
  - Gate, Source, Drain, (and substrate)



Actual device

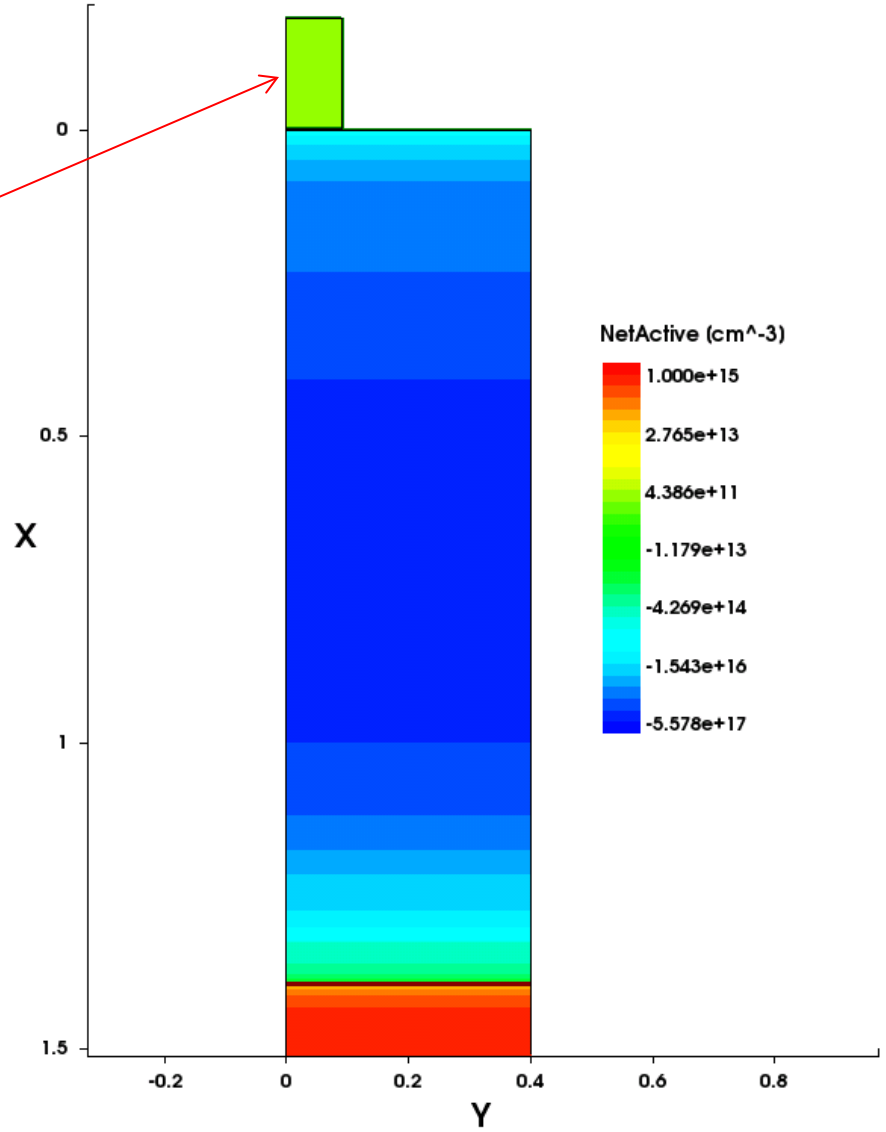
- TEM image of a MOSFET
  - 32nm node
  - (somewhat old…)



(Packan et al., IEDM 2009)

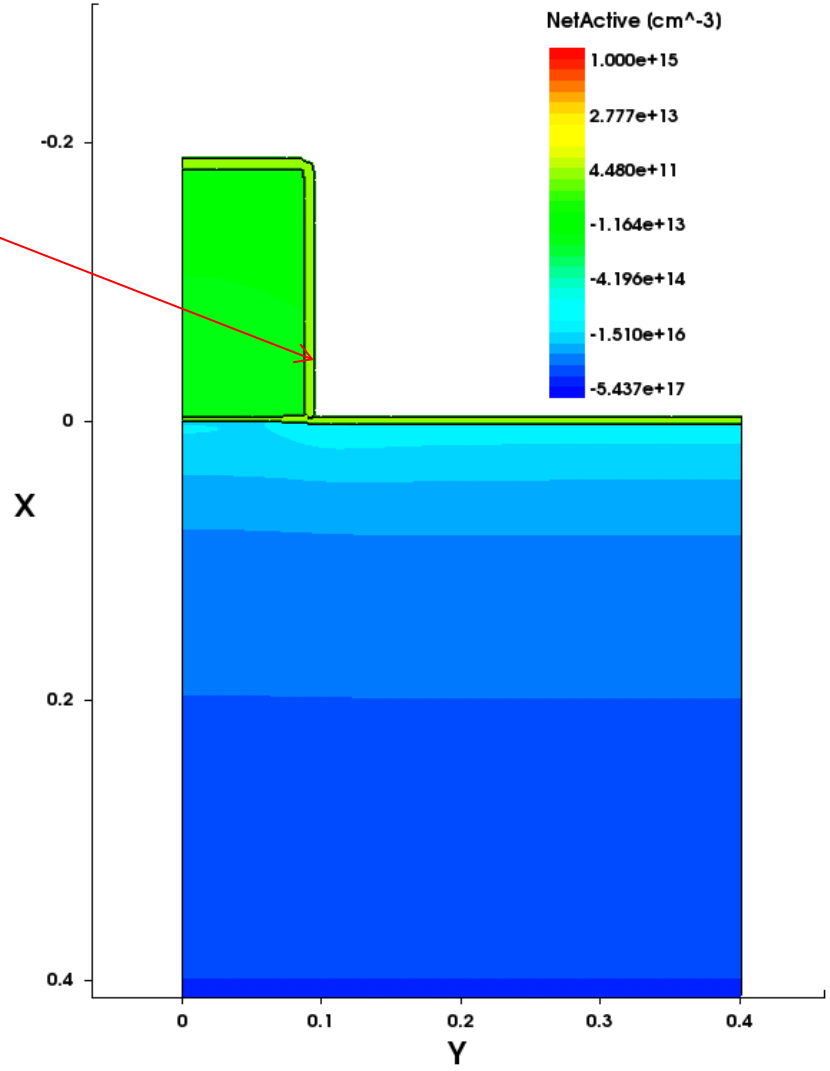
How to fabricate it (1/6)

- 0.18 μm NMOSFET
  - P-well formation
  - Gate oxidation
  - Gate definition
  - (Half structure is shown.)



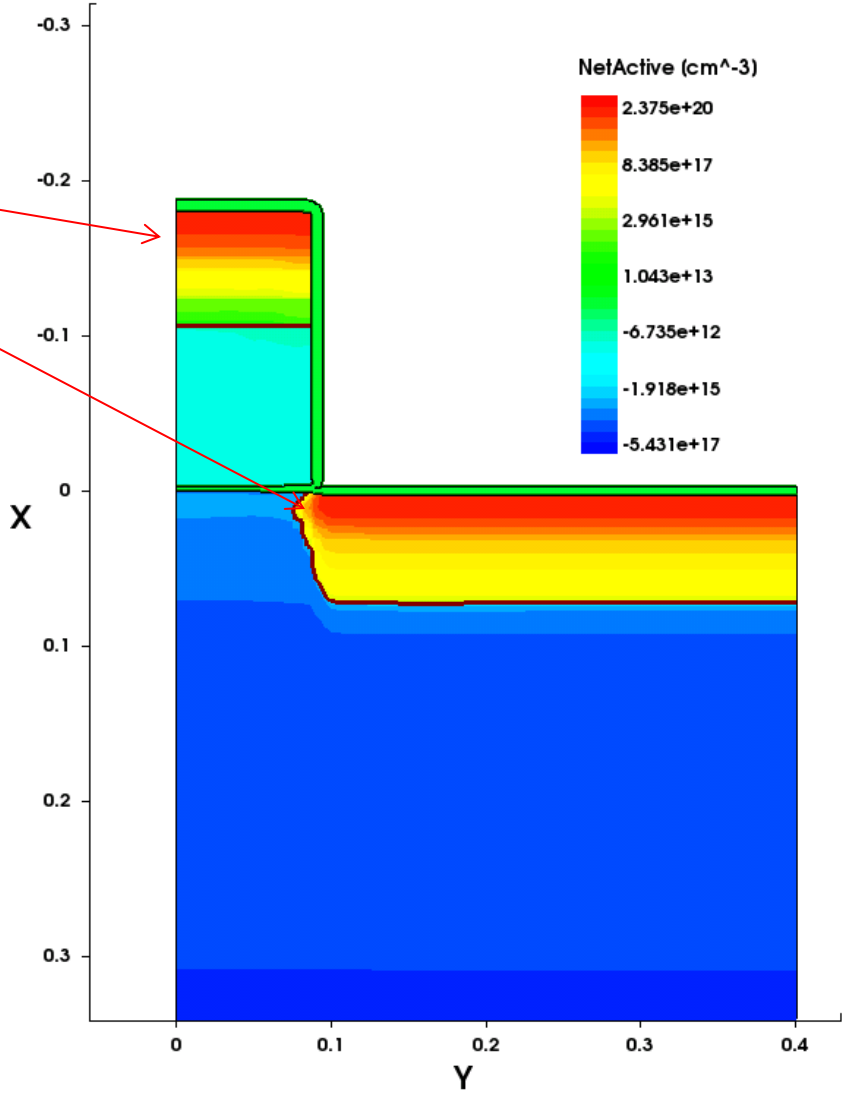
How to fabricate it (2/6)

- 0.18 μm NMOSFET
  - Gate re-oxidation



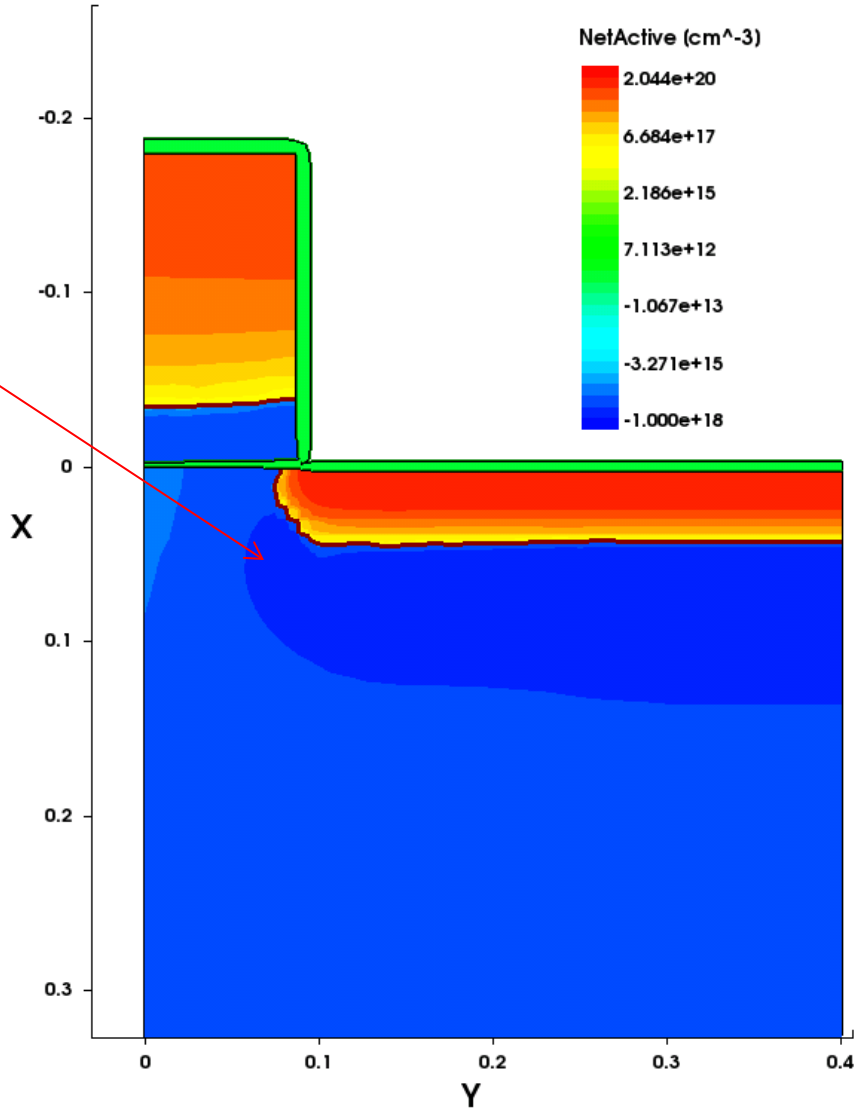
How to fabricate it (3/6)

- 0.18 μm NMOSFET
  - LDD implant



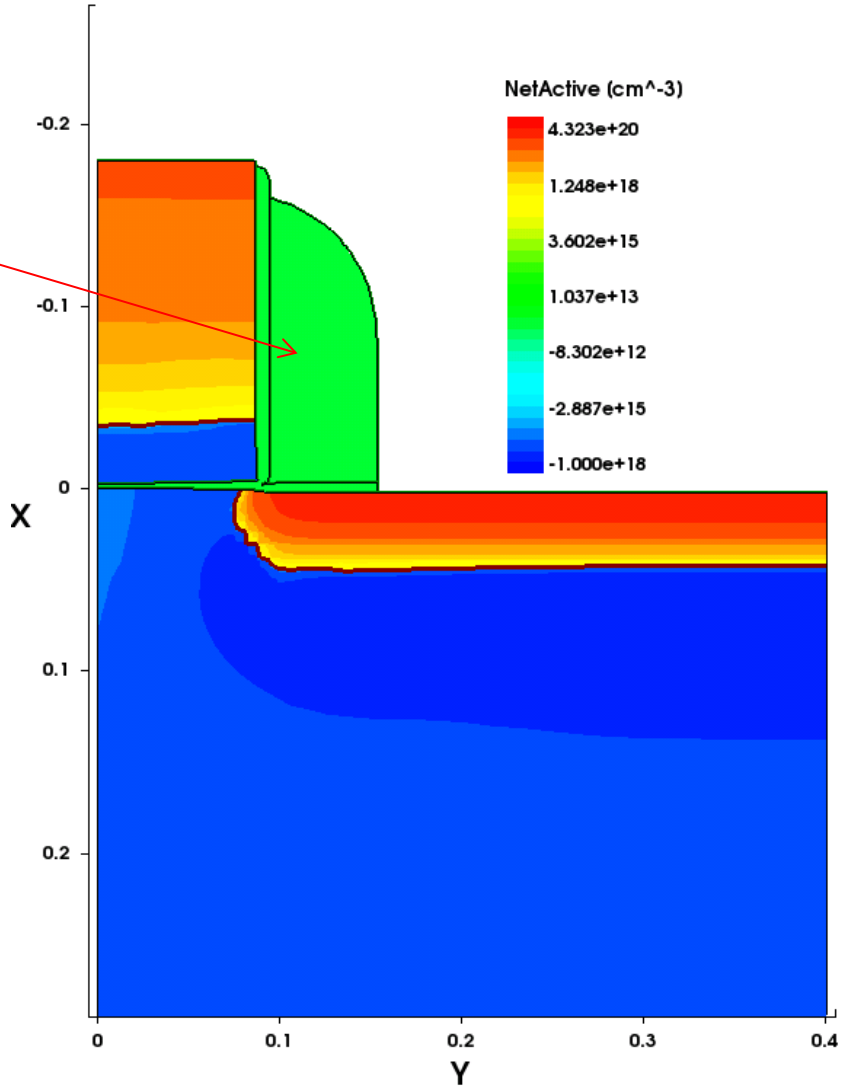
How to fabricate it (4/6)

- 0.18 μm NMOSFET
  - Halo implant



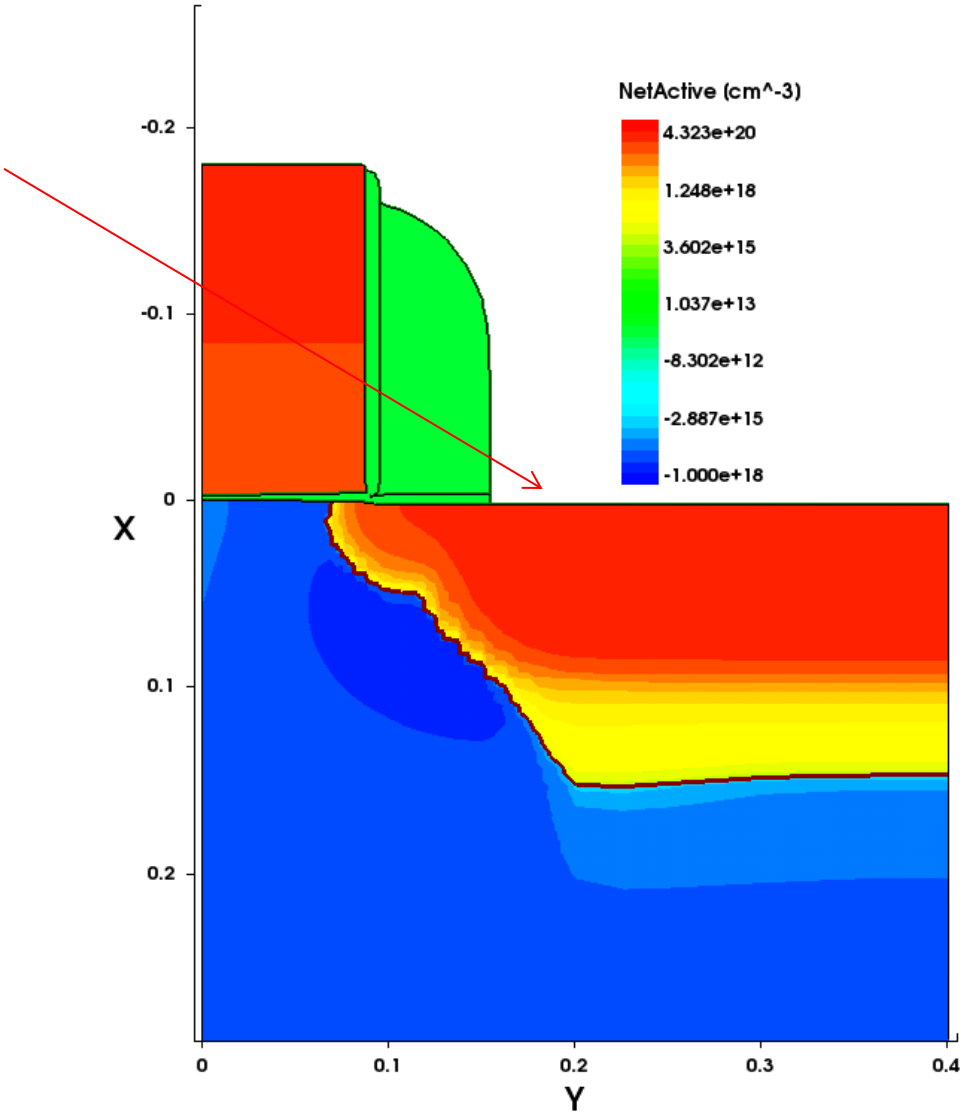
How to fabricate it (5/6)

- 0.18 μm NMOSFET
  - Nitride spacer



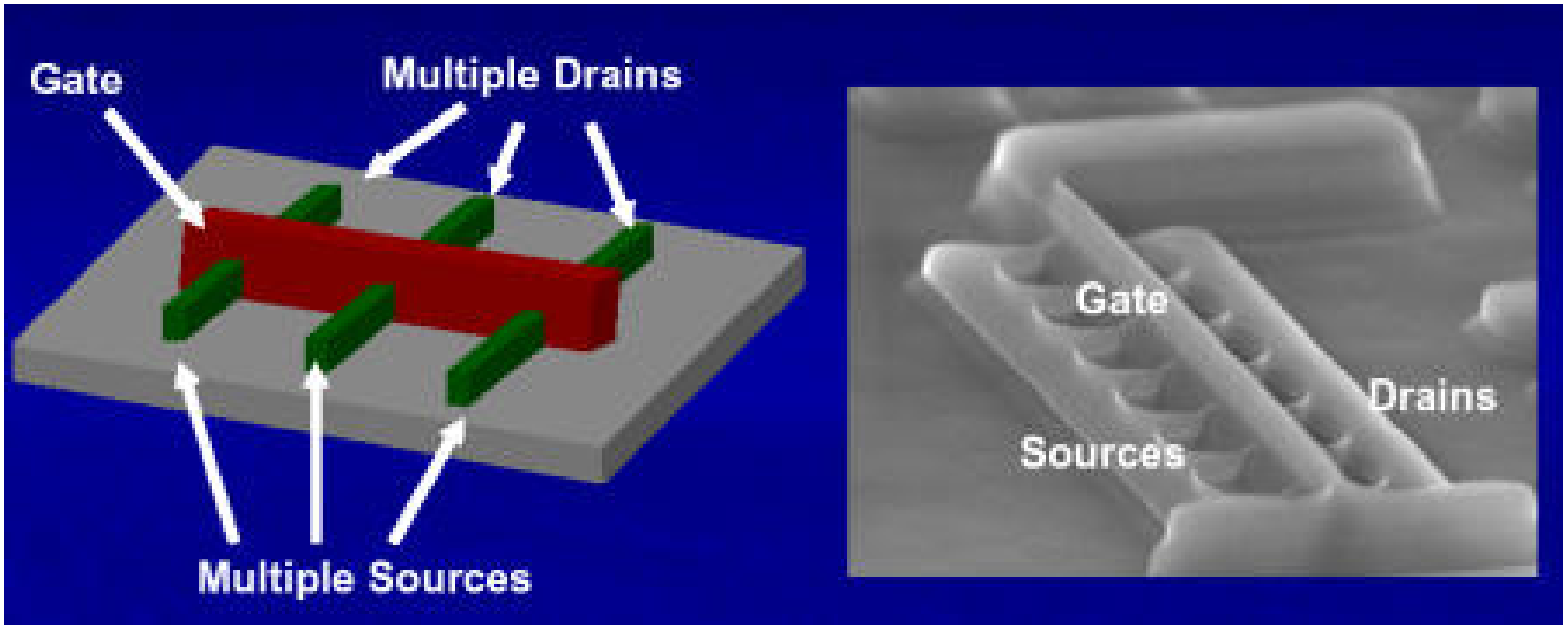
How to fabricate it (6/6)

- 0.18 μm NMOSFET
  - Source/drain implant



Top view

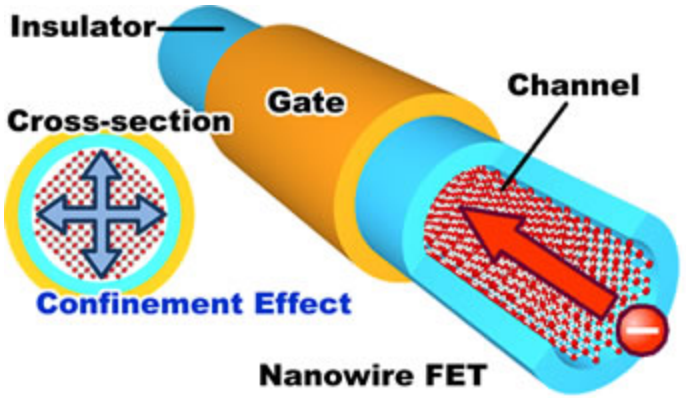
- TEM image of a MOSFET
  - 22nm node
  - (a few years ago…)



(Wikipedia)

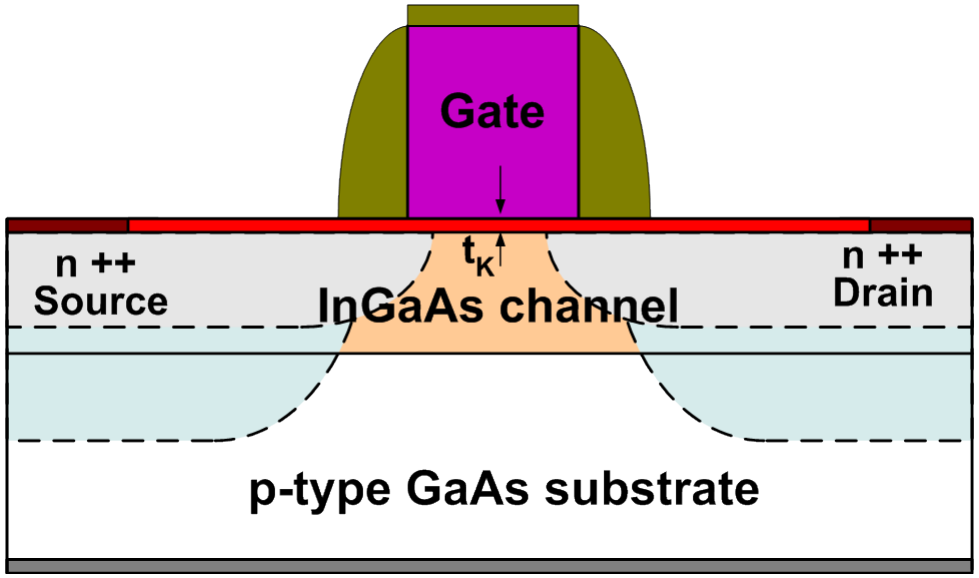
Future

- Nanowire?



(Google images)

- III-V?



(Google images)

Other application

- Up to now, we have seen the MOSFET used for the logic application.
  - CMOS RF

- However,
  - NAND Flash memory
  - Power device
  - Various sensors

Read your textbook!

- On Wednesday, the I-V characteristics will be derived.
  - Subsec. 6. 2. 2.