Lecture15: PMOSFET

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NMOSFET

- In the NMOSFET, electrons are mobile carriers.
  - When V_{GS} is lower than V_{TH}, holes are depleted from the Si/SiO$_2$ interface.
  - When V_{GS} is larger than V_{TH}, electrons are collected at the Si/SiO$_2$ interface. (Electron inversion)

- Imagine its "dual" device with a negative V_{TH}.
  - When V_{GS} is larger than V_{TH} ($|V_{GS}| > |V_{TH}|$), electrons are depleted from the Si/SiO$_2$ interface.
  - When V_{GS} is smaller than V_{TH} ($V_{GS} < V_{TH}$), holes are collected at the Si/SiO$_2$ interface. (Hole inversion)
  - Is there such a device? *Yes.*

PMOSFET

- The PMOSFET

NMOSFET symbol

PMOSFET symbol
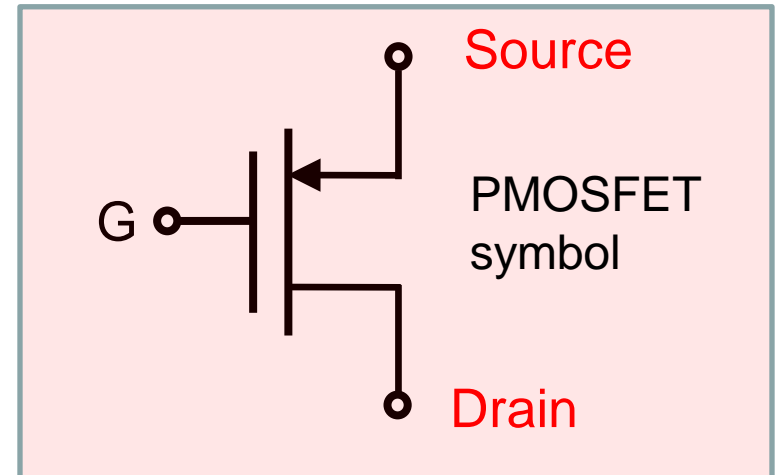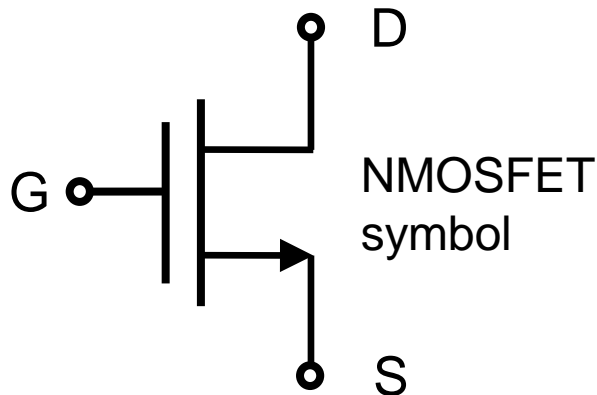
- Example) $V_{TH,P} = -1.5$ V. Assume that V_S is 3 V. The gate voltage of 2 V does not turn on the transistor. 1 V turns on the transistor.
- The drain voltage is lower than the source voltage. In the usual operation condition, the drain current is negative.
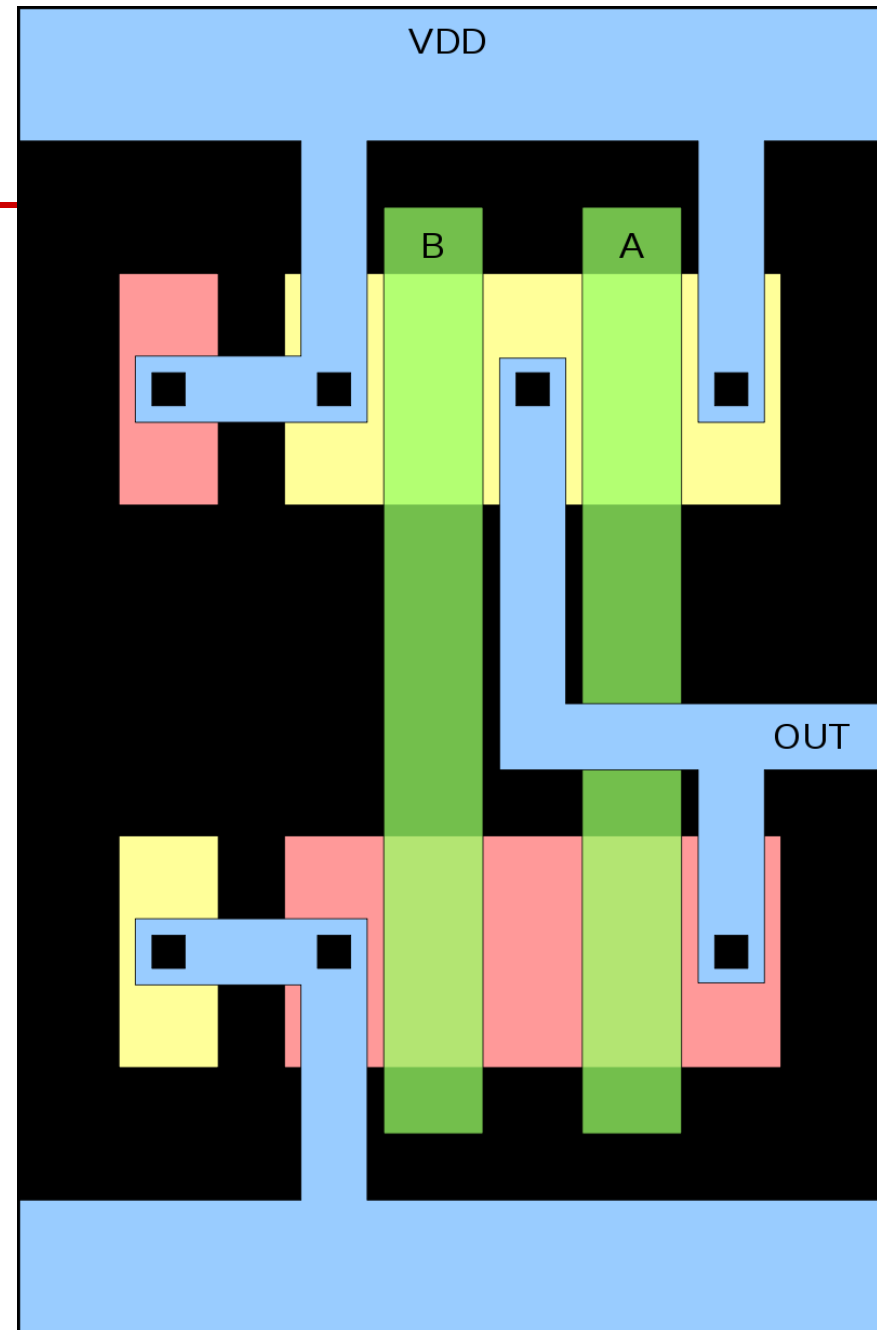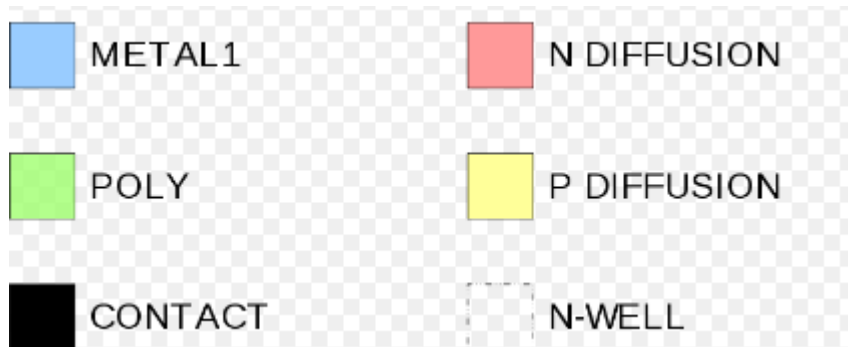
How to fabricate it

- We need an n-type substrate.
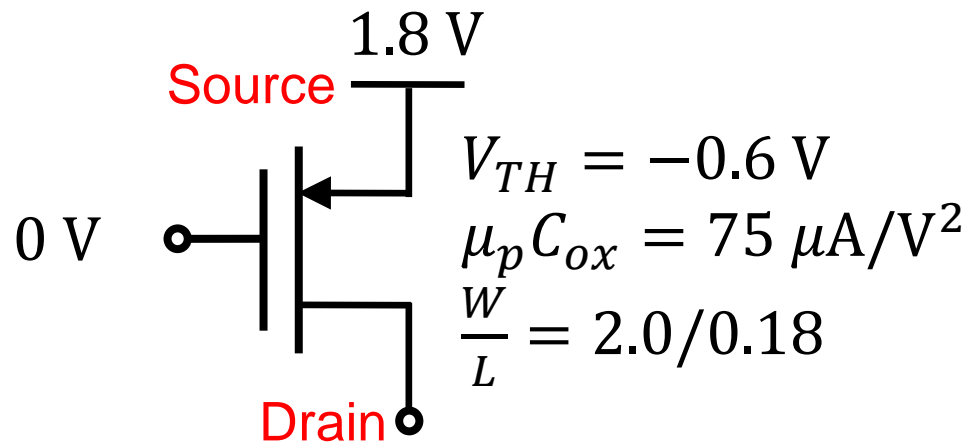 - Also two highly doped p-type regions are required.
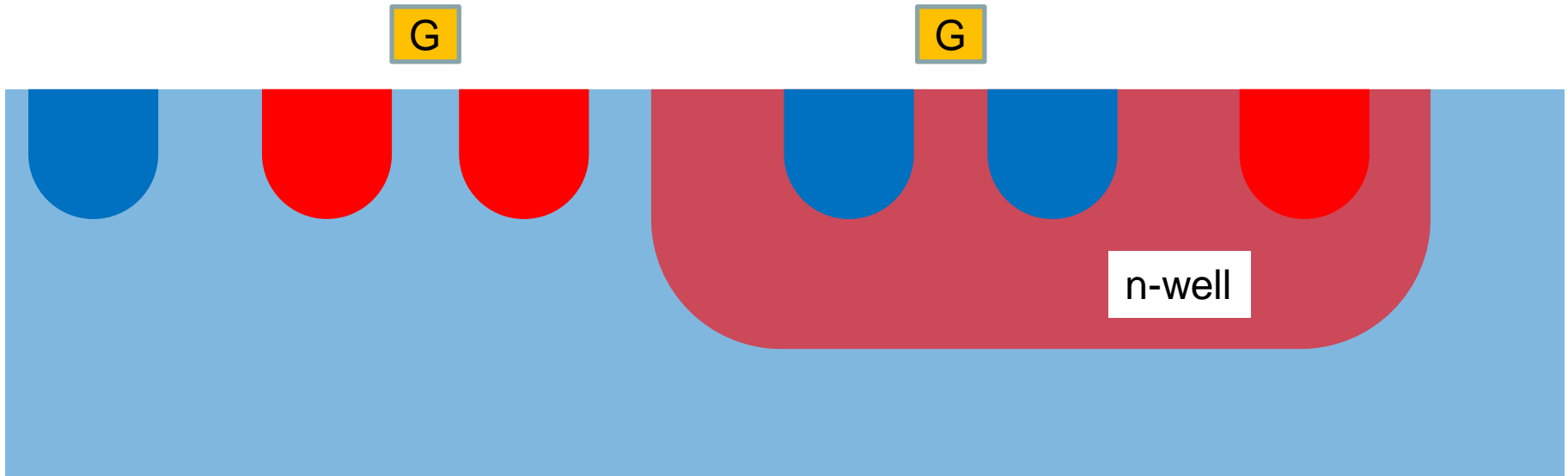
Layout example

- Taken from Wikipedia
  – Draw its circuit schematic.

Biasing of PMOS devices

- Express the source current as a function of the drain voltage.
  - The absolute value of "gate overdrive" is 1.2 V.
  - It is not 0.6 V.

$$1.8 \text{ V}$$

Source

$$V_{TH} = -0.6 \text{ V}$$
$$\mu_p C_{ox} = 75 \text{ } \mu\text{A/V}^2$$
$$\frac{W}{L} = 2.0/0.18$$

0 V

Drain

- Do the same job with the gate voltage of 1.8 V.