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# Lecture15: PMOSFET

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# NMOSFET

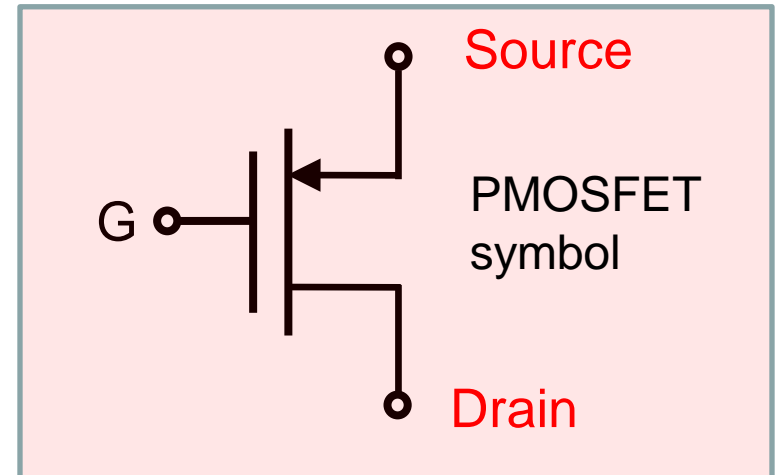
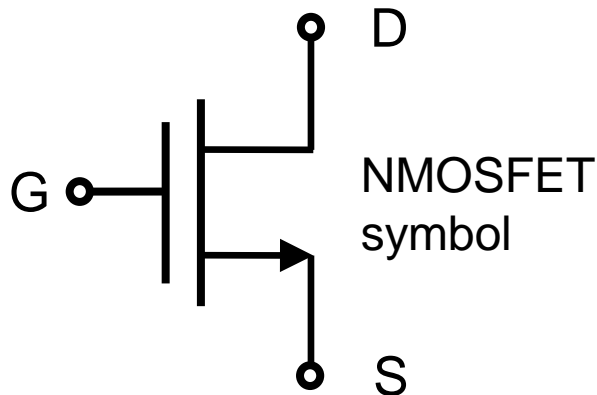
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- In the NMOSFET, electrons are mobile carriers.
  - When  $V_{GS}$  is lower than  $V_{TH}$ , holes are depleted from the Si/SiO<sub>2</sub> interface.
  - When  $V_{GS}$  is larger than  $V_{TH}$ , electrons are collected at the Si/SiO<sub>2</sub> 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<sub>2</sub> interface.
  - When  $V_{GS}$  is smaller than  $V_{TH}$  ( $|V_{GS}| < |V_{TH}|$ ), holes are collected at the Si/SiO<sub>2</sub> interface. (Hole inversion)
  - Is there such a device? Yes.

# PMOSFET

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- The PMOSFET

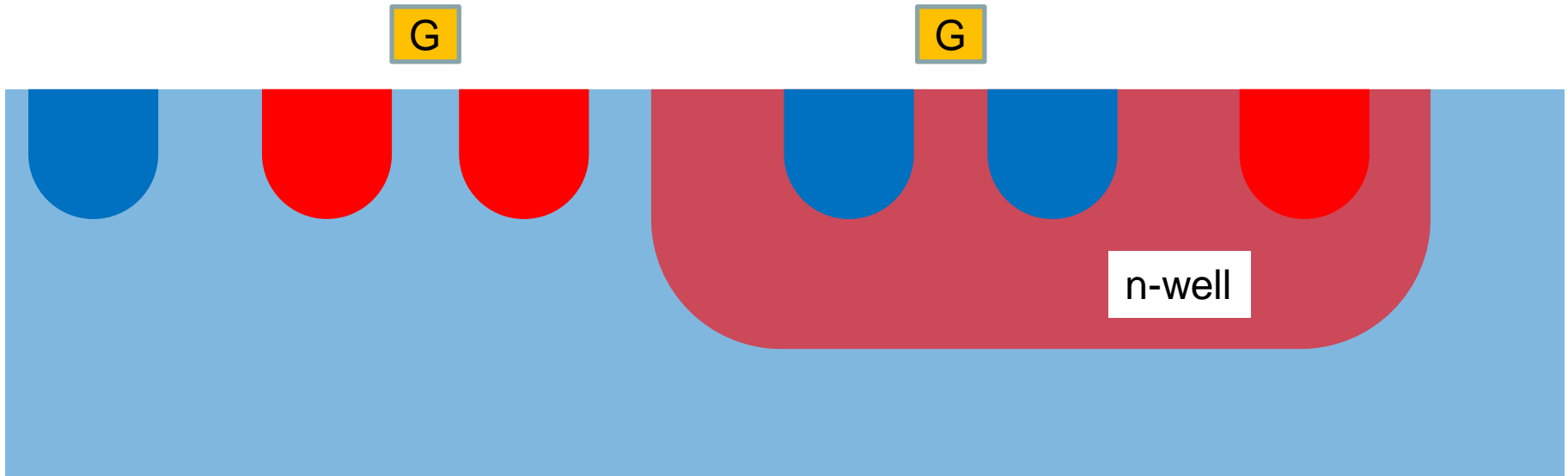


- Example)  $V_{TH,P} = -1.5$  V. Assume that  $V_S$  is 3 V. The gate voltage of 2 V does not turn on the transistor. 1 V turns on the transistor.
- The drain voltage is lower than the source voltage. In the usual operation condition, the drain current is negative.

# How to fabricate it

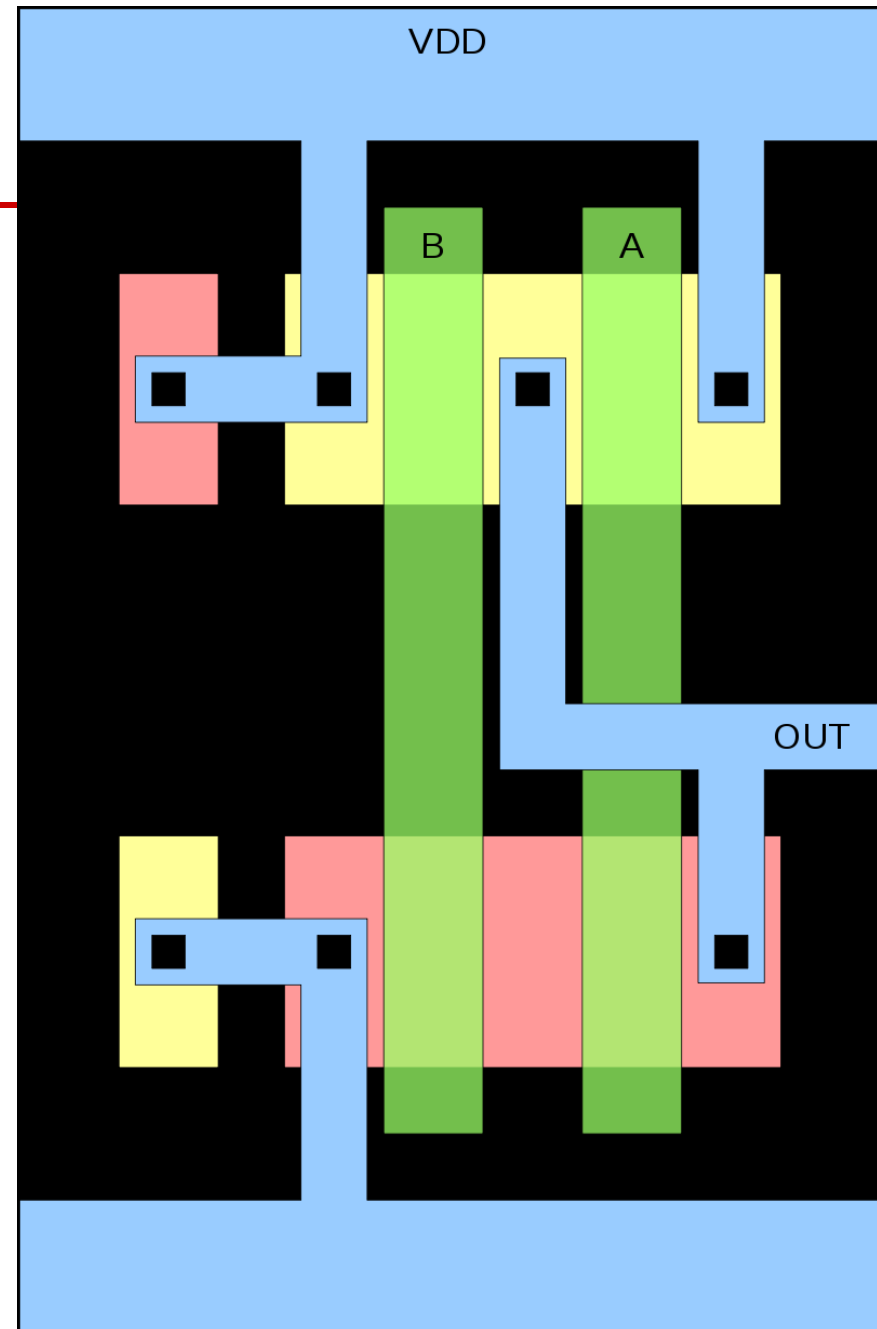
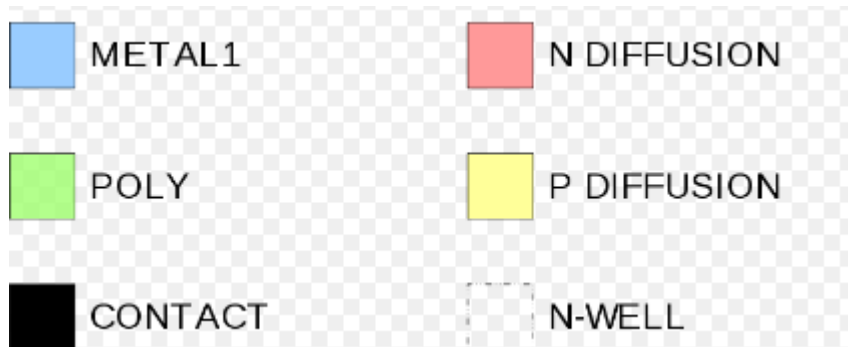
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- We need an n-type substrate.
  - Also two highly doped p-type regions are required.



# Layout example

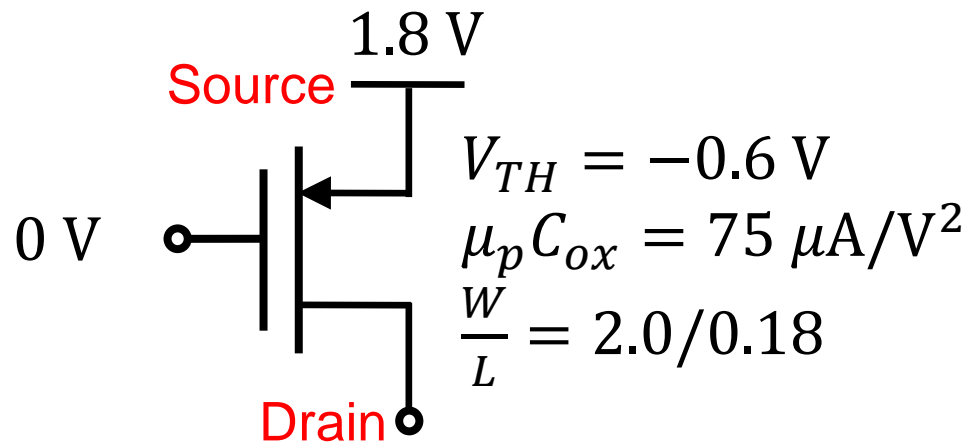
- Taken from Wikipedia
  - Draw its circuit schematic.



# Biasing of PMOS devices

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- 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.



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