MOSFET TRANSISTOR

NMOS Structure

Physical:

Symbol:

Operation:
1) When $V_{gs} > V_{th}$ (threshold voltage), a channel forms underneath the polysilicon.
2) If $V_{ds} > 0$, then a current $I_d$ flows.

Comments:
1) Depletion region due to the pn junction isolates the transistor from others in the same substrate.
2) Drain and source are interchangeable.
PMOS Transistor

Physical: Use the same diagram as for NMOS but reverse polarities and dopings.

Symbol:

\[ \text{NMOS:} \]
\[ D \text{ is larger potential} \]
\[ S \text{ is smaller} \]

\[ \text{PMOS:} \]
\[ D \text{ is smaller potential} \]
\[ S \text{ is larger} \]

Switch - ![MOSFET switch]

CMOS Transistors

Physical:

![CMOS Transistors diagram]
THRESHOLD VOLTAGE OF THE MOS TRANSISTOR

What happens as $V_{gs}$ increases from zero?

$V_{gs} < 0$

Accumulation

1. A depletion region forms under the gate. There are no holes, only negatively charged atoms.

2. A thin layer of mobile electrons appear at the surface of the silicon. (Weak inversion)

3. Finally, the mobile electron concentration equals the mobile hole concentration in the semiconductor (substrate). $V_{gs} = V_T$ (Strong inversion)

4. Further increases simply increase the channel depth and the electron concentration is much greater than the hole concentration.

NEXT - Components that make up the $V_T$. 