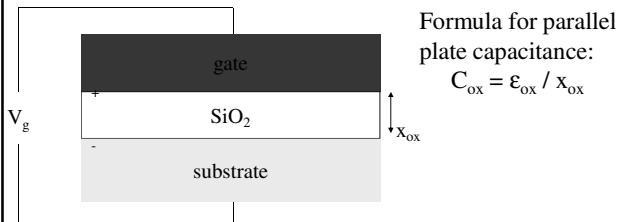


MOSFET as capacitor

- Basic structure of gate is parallel-plate capacitor:



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Body effect

- Reorganize threshold voltage equation:
 $V_t = V_{t0} + \Delta V_t$
- Threshold voltage is a function of source/substrate voltage V_{sb} .
- Body effect γ is the coefficient for the V_{sb} dependence factor.

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Channel length modulation length parameter

- λ describes small dependence of drain current on V_{ds} in saturation.
- Factor is measured empirically.
- New drain current equation:
 $I_d = 0.5k' (W/L)(V_{gs} - V_t)^2(1 - \lambda V_{ds})$
- Equation has a discontinuity between linear and saturation regions---small enough to be ignored.

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Leakage and subthreshold current

- A variety of leakage currents draw current away from the main logic path.
- The subthreshold current is one particularly important type of leakage current.

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Types of leakage current

- Weak inversion current (a.k.a. subthreshold current).
- Reverse-biased pn junctions.
- Drain-induced barrier lowering.
- Gate-induced drain leakage;
- Punchthrough currents.
- Gate oxide tunneling.
- Hot carriers.

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Threshold voltage

Components of threshold voltage V_t :

$$V_{t0} = V_{fb} + \phi_s + \frac{Q_b}{C_{ox}} + V_{II}$$

- V_{fb} = flatband voltage; depends on difference in work function between gate and substrate and on fixed surface charge.
- ϕ_s = surface potential (about $2\phi_f$).
- Voltage on parallel plate capacitor.
- Additional ion implantation.

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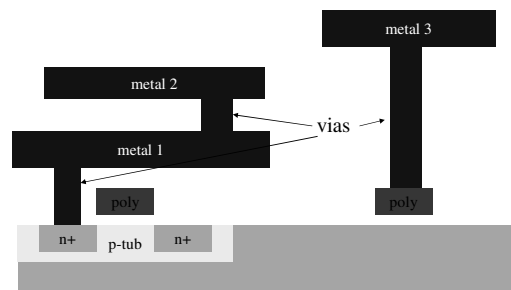
Topics

- Wire and via structures.
- Wire parasitics.
- Transistor parasitics.
- Fabrication theory and practice.

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Wires and vias



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Metal interconnect

- Many layers of metal interconnect are possible.
 - 12 layers of metal are common.
- Lower layers have smaller features, higher layers have larger features.
- Can't directly go from a layer to any other layer.

Copper interconnect

- Much better electrical characteristics.
- Copper is poisonous to semiconductors--- must be isolated from silicon.
 - Bottom layer of interconnect is aluminum.