Contact and Junctions

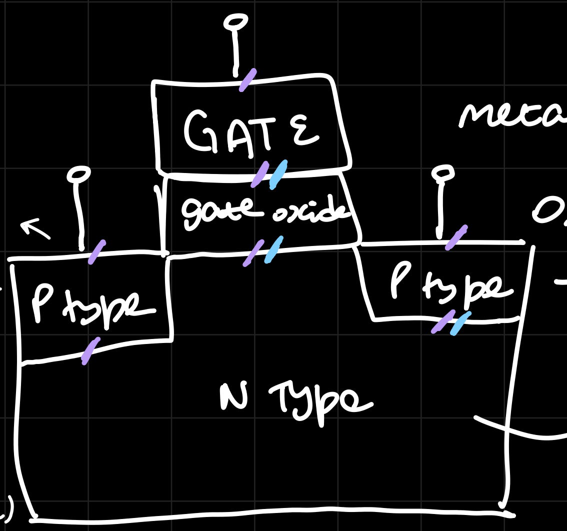
17/03/25

Si : 1.12 eV
Ge : 0.7 eV } band gap

MOSFET

crystalline
metal / poly-crystalline (P-Si)

oxide (SiO_2) amorphous



Si crystalline

if the junction isnt prepared properly, we can observe a voltage barriers - i.e. voltage drop (not ideal)

2x semiconductor - semiconductor → semiconductor - insulator → metal - insulator

# of Junctions = 4 + 3

# of contacts = 3

Junction resistance ∝ voltage drop

for an ideal MOSFET, if we reverse the polarity of the current, it will change the direction but naore remains the same. But if there is junction resistance, we may or may not get same results

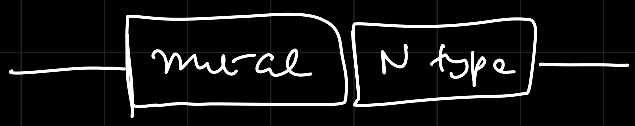
JUNCTIONS

→ HOMOJUNCTIONS: Junction b/w 2 differently doped regions of the same semiconductor

→ HETEROJUNCTION: between 2 different types of materials

→ METAL-SEMICONDUCTOR JUNCTIONS

metal - semiconductor →



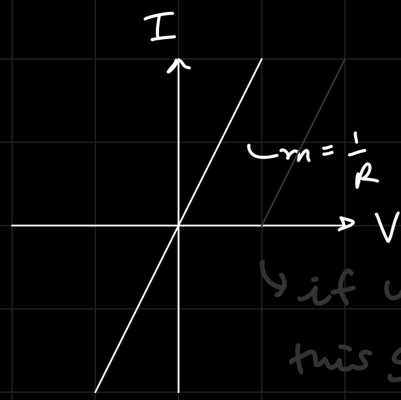
↑

M-S junction

Ohmic → non rectifying contact

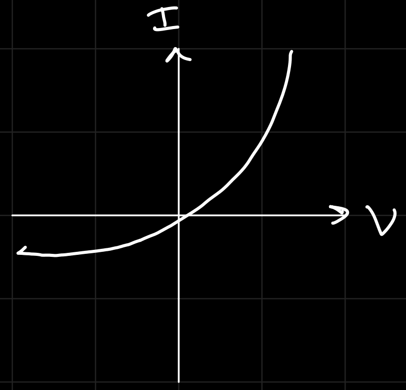
Schottky → Rectifying contact

Ideal ohmic contact (Au - P type Si) ↙

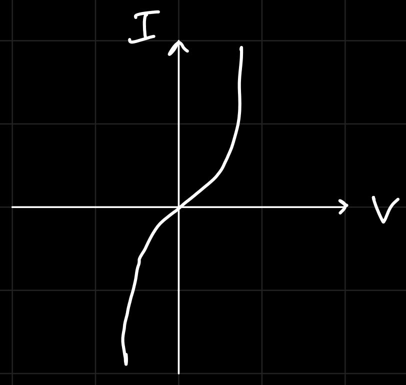


↳ if we have this graph, this is also ohmic but with some volt drop V_c.

Schottky contact
(Al – n type Si)



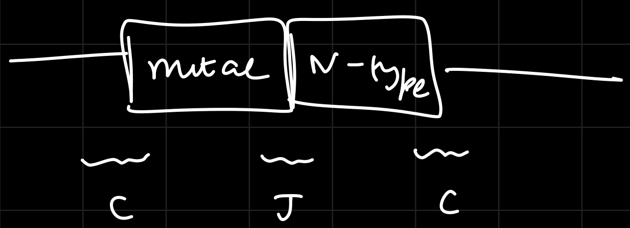
non-linear "ohmic" contact
(Al – n^+ type Si)
heavily doped



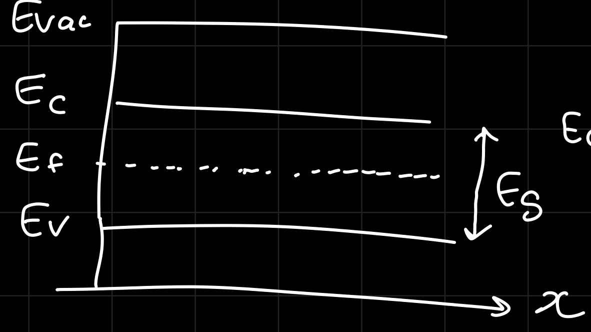
↳ linear for very small V

Energy dissipation relation
$\equiv$ E-K relation
visualized with an Energy Band Diagram

Closely related to E-x
(real space distance)

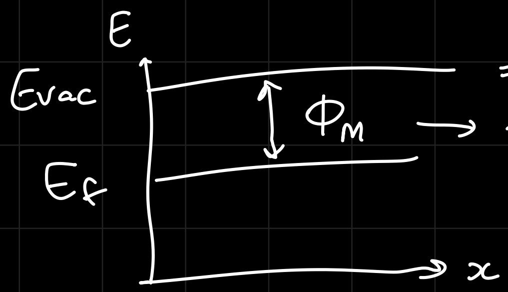


reference point for E-x graph
↳ $E_{vac} \Rightarrow E = 0$
vaccum



$E_c = E_v + E_g$

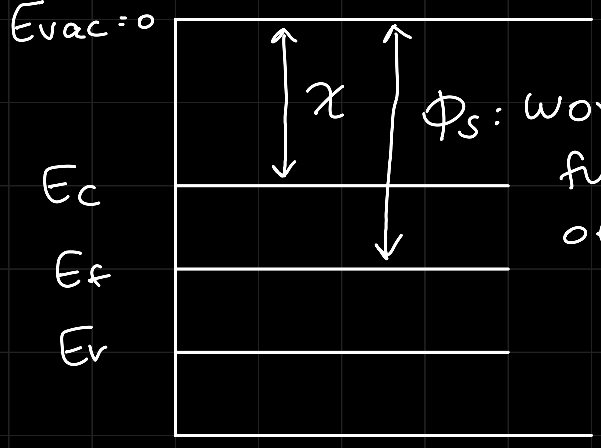
lets take a metal $(E_c \simeq E_v \simeq E_f)$
overlap



$= 0$

Φ_M → min. energy to excite the e^- to vaccum
= work function of the metal

Now, going back to the semiconductor



ϕ_S: work function of the semiconductor

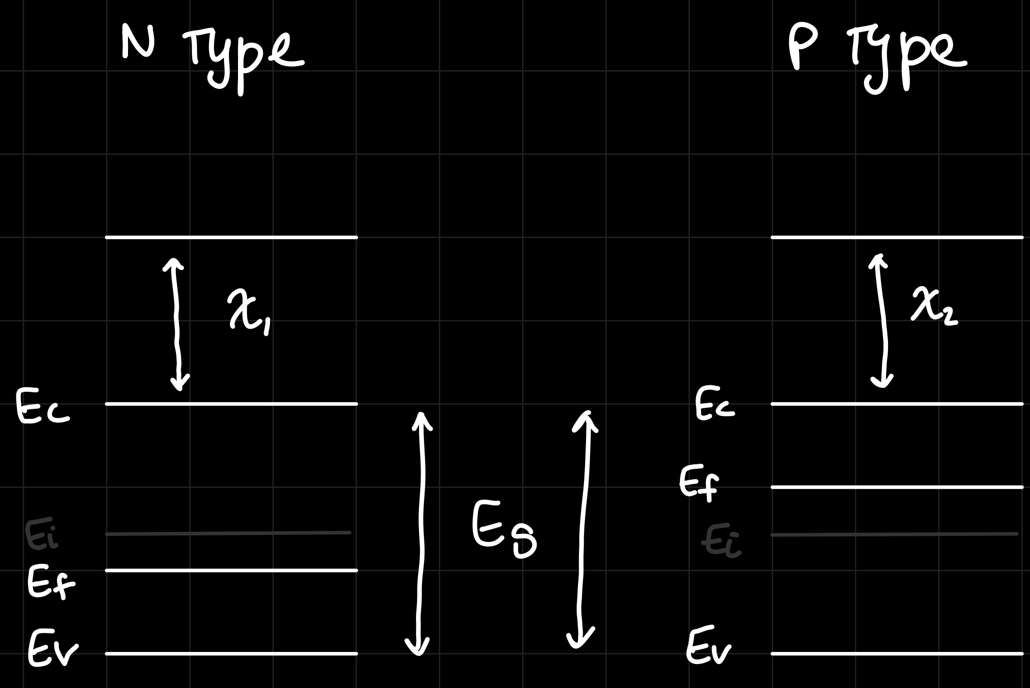
χ : e^- affinity
(chi)

for semiconductors, we need 3 params
ϕ_S, χ, E_g

ϕ_s : work func can change with doping

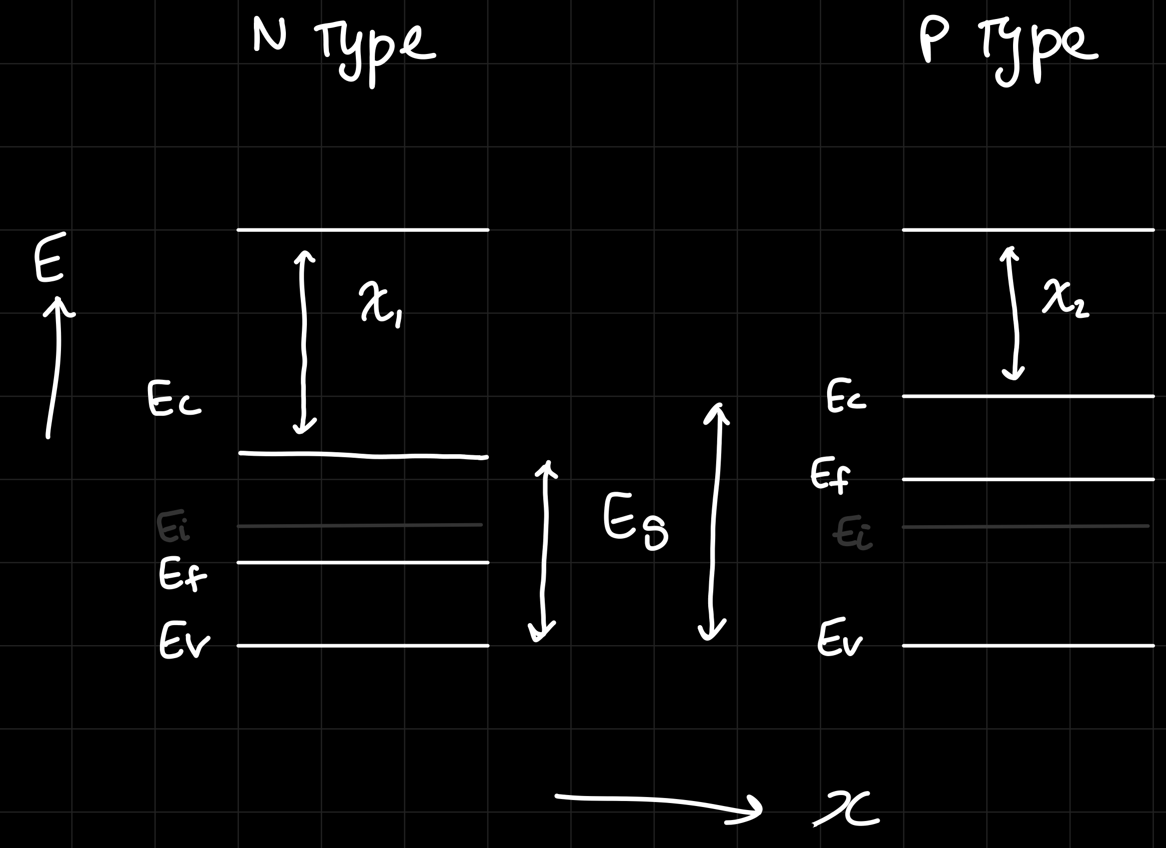
χ and E_g : uniform properties

$$\phi_{s\ p\text{-type}} > \phi_{s\ n\text{-type}}$$



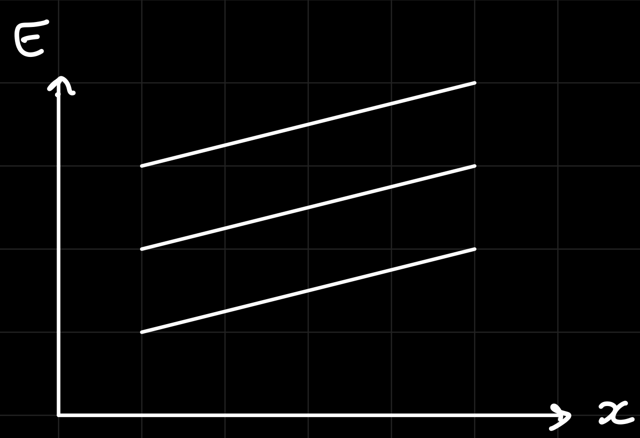
Same band gap

uniform χ : $\chi_1 = \chi_2$



different E_g

→ What if E_c, E_v, E_f are varying with x

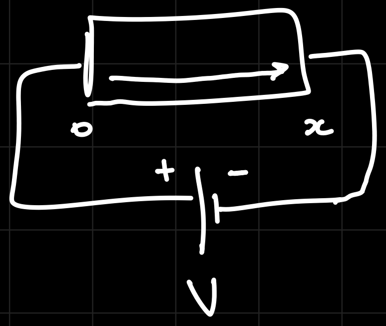


$$E = -\frac{dU}{dx}$$

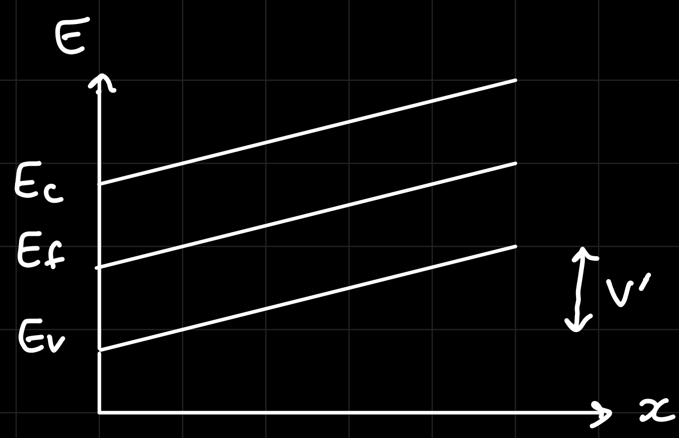
if $U = \text{const} \rightarrow E = 0$

elif $U(x) \rightarrow E = \text{constant}$

$U = kx$



$V = 0$ $\qquad\qquad$ $V = V'$



Energy Band Bending

Slope determines direction of $\bar{E}$