MOSFETs Part 5: MOS Energy Bands

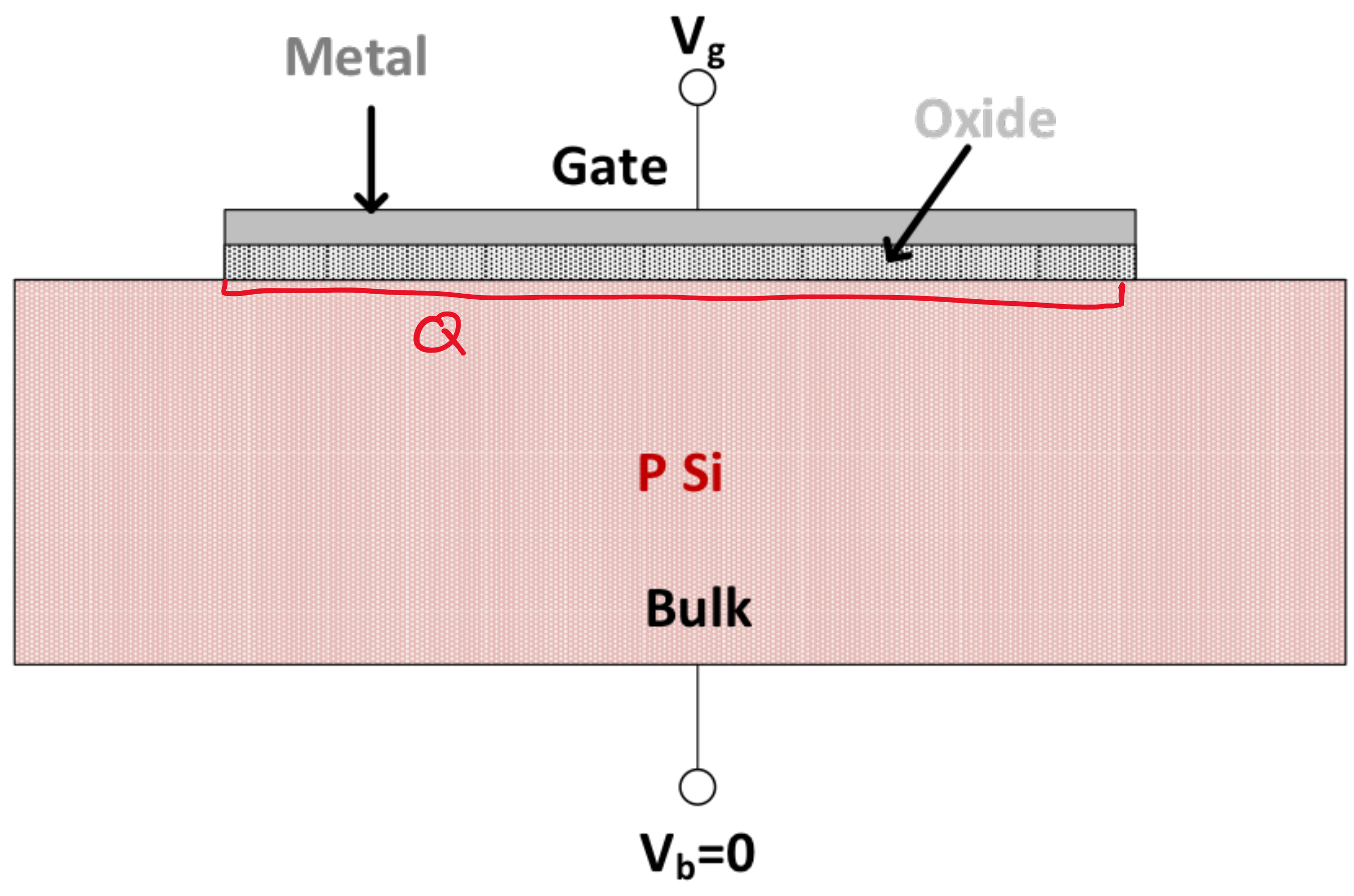
Monday 16 March 2020 09:24

The MOS Capacitor

- MOSCAP: Simplified version of the MOSFET
  - Simplified Analysis
- Analyse the capacitance as a way of understanding the channel charge:

$Q = C V$

Cap Vol



Metal Energy Band Diagram

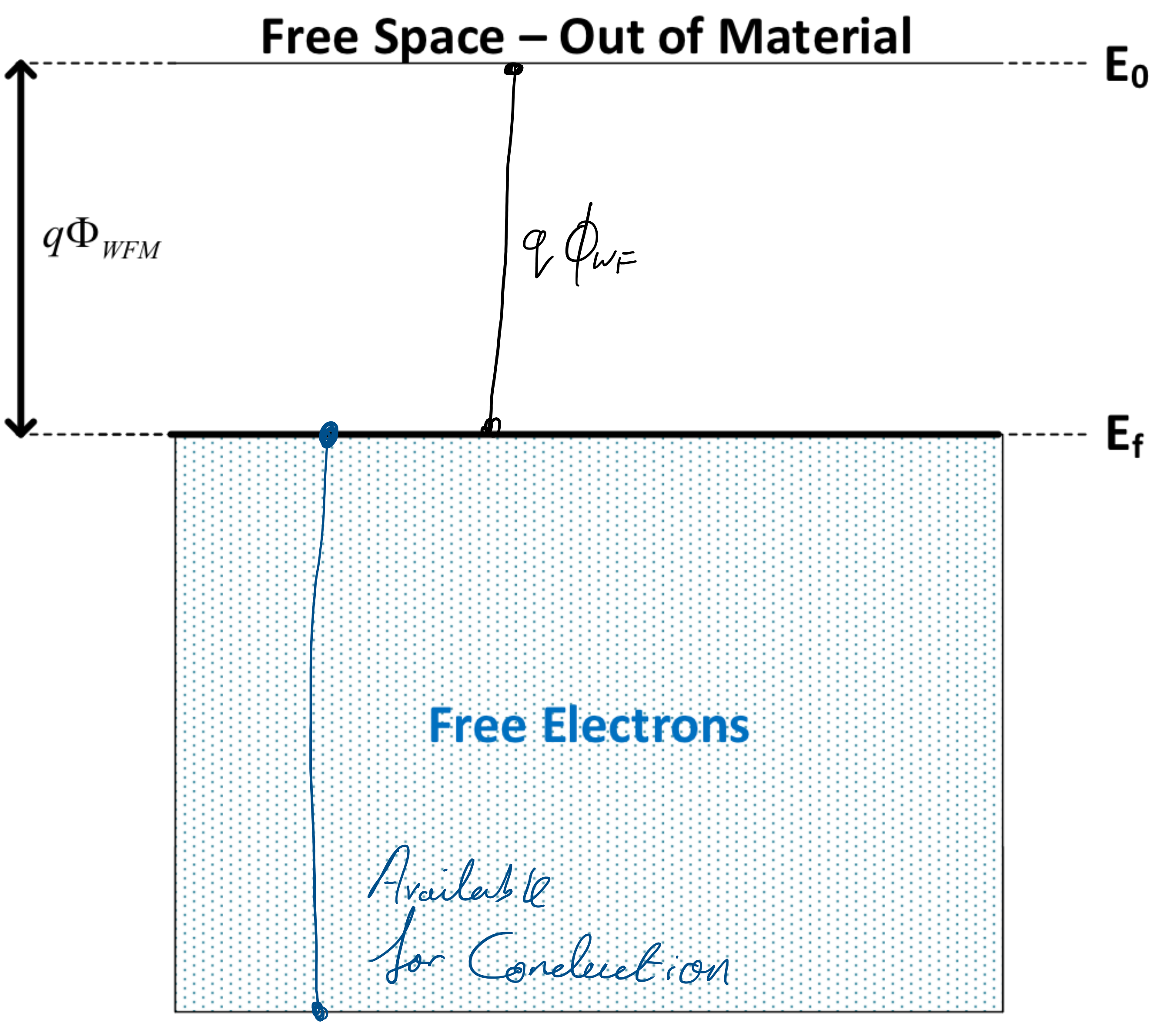
- Sea of free e below Fermi level
- Fermi Level:
  - E where there's a 50% chance of finding an e **should the state exist**
    - No Bandgap --> Always a state @ E_F
- Work Function: Avg. Energy required to remove e from the material

$q\phi_{WF} = E_0 - E_f$

- Typical Values:

Aluminium $\phi_{WF} = 4.26\,eV$

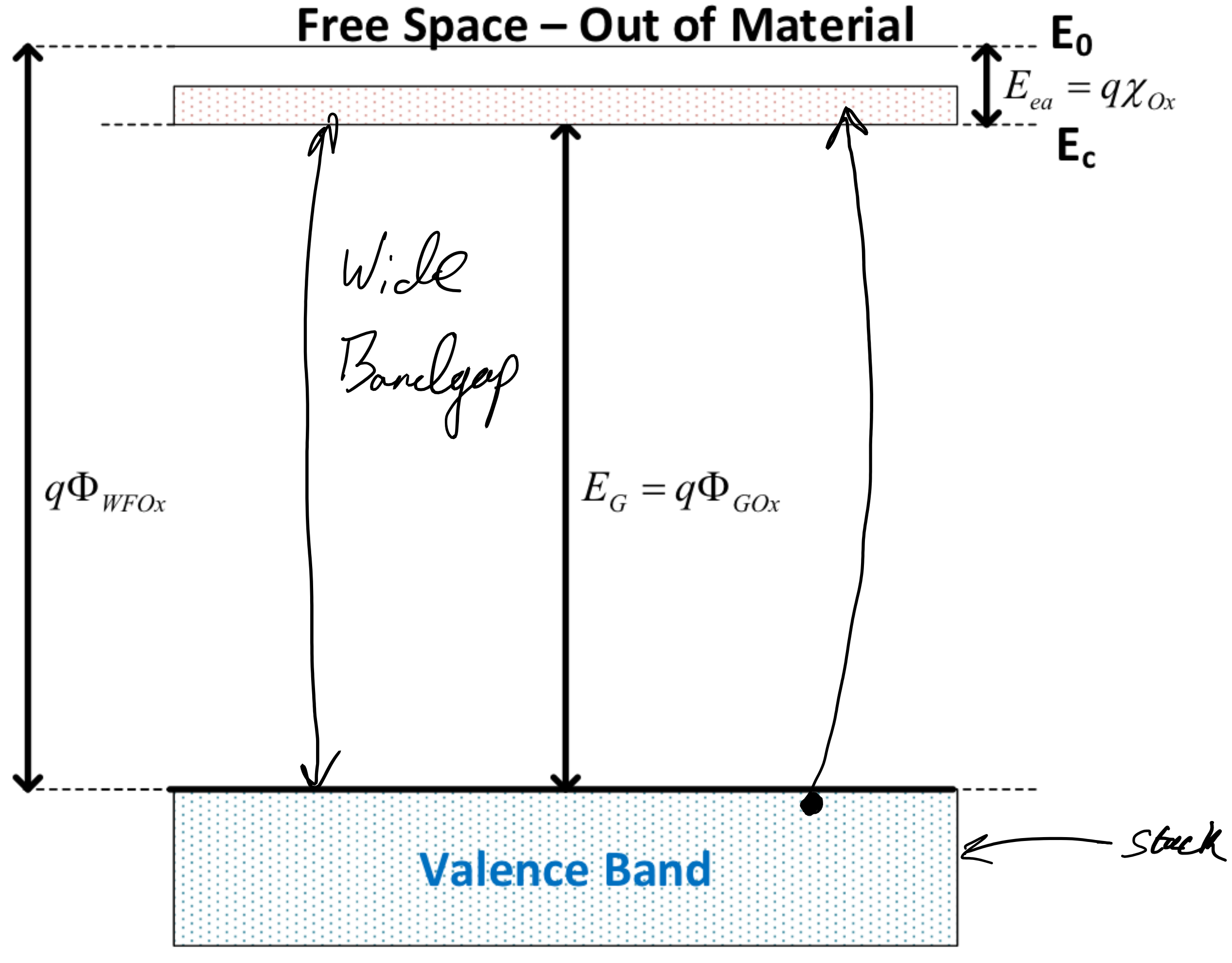
Polysilicon $\phi_{WF} \simeq 4.15\,eV$



Oxide Energy Band Diagram

- Wide bandgap
  - No e have energy to jump gap from valence to conduction band
    - Looks like an insulator
- SiO2: An excellent Oxide
  - Grown w/ steam or heat on the Si surface
  - Easy Processing
  - Aka sand or glass

$E_g^{SiO_2} \simeq 8eV$



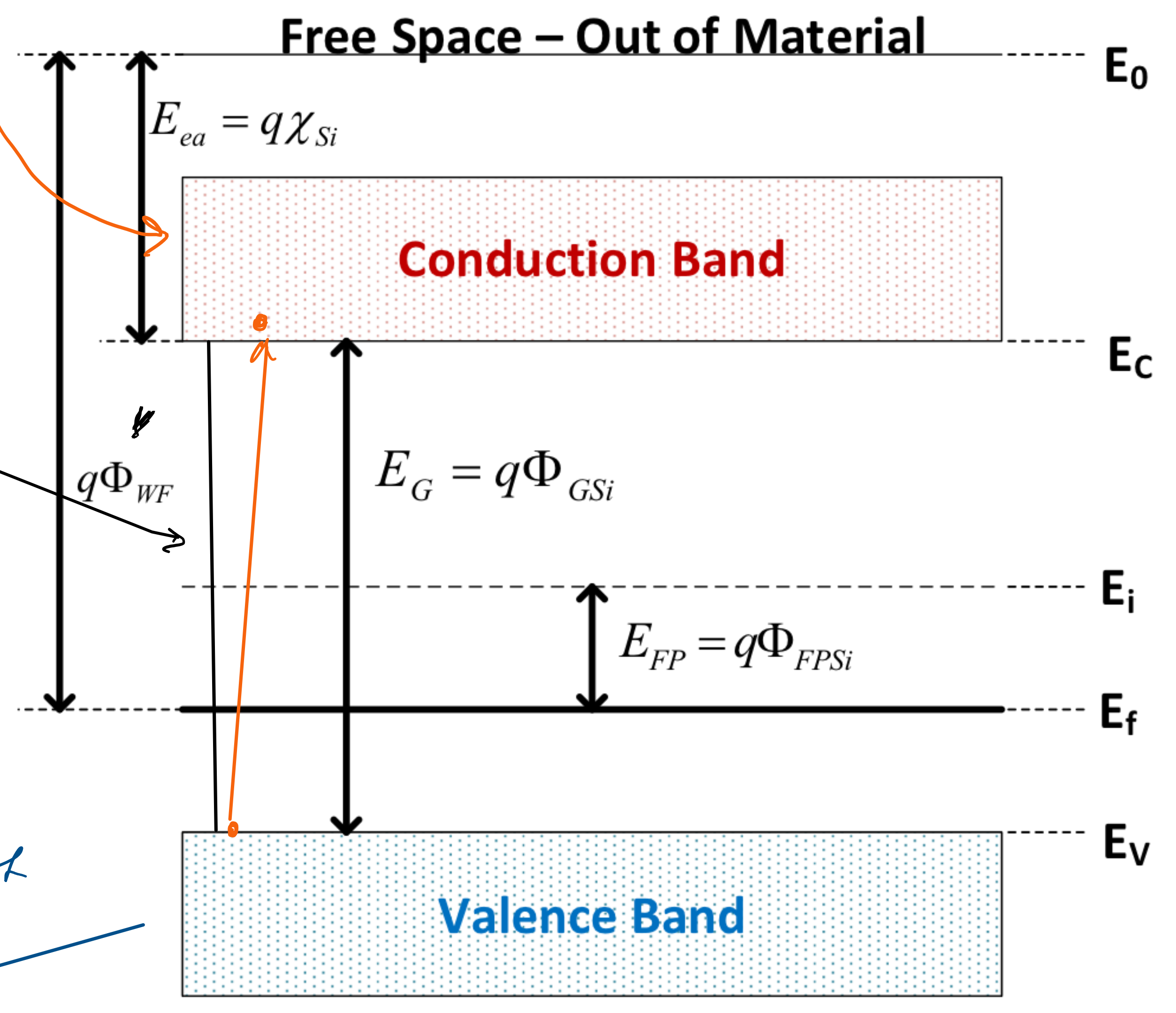
Silicon Energy Band Diagram

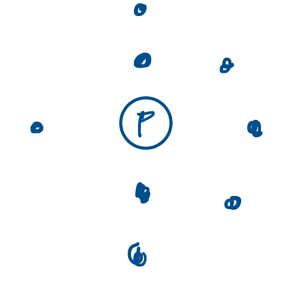
Conduction Band w/ available cond. States (free e)

Energy Bandgap
e must gain E_G to jump from V to C band

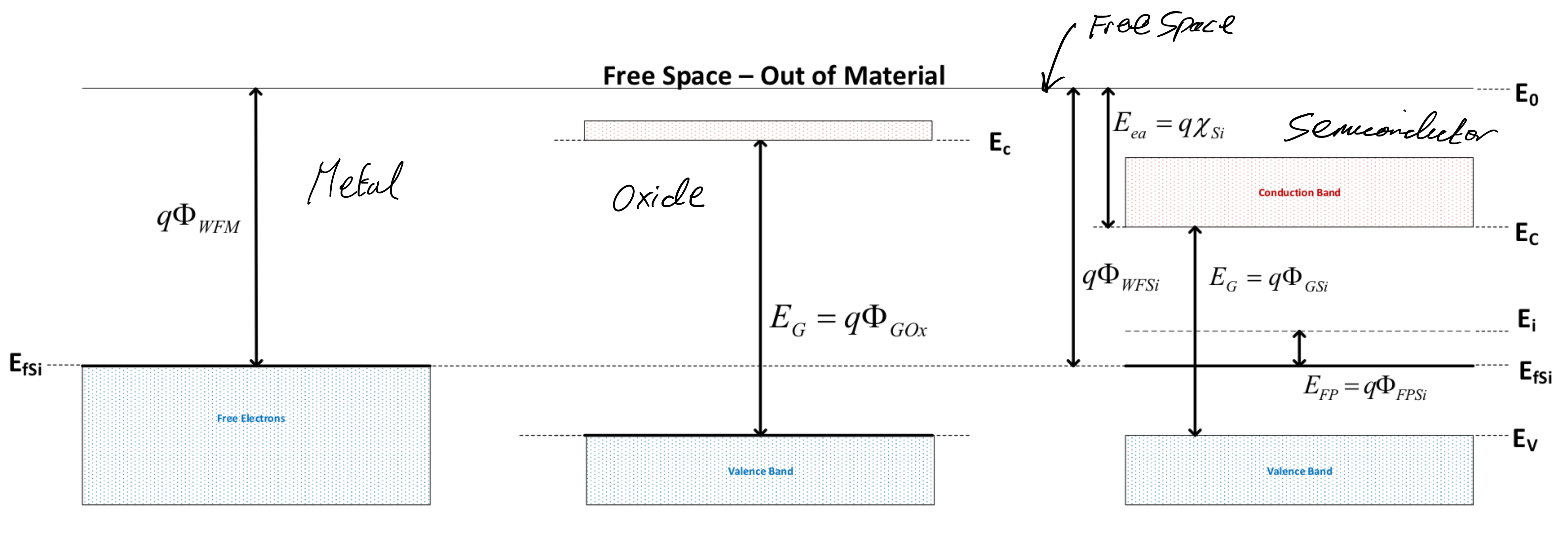
$E_G = 1.12eV$

Valence Band w/ occupied Atomic States





Metal – Oxide – Semiconductor



MOS Combined

- Assume a perfect Oxide
  - Insulator
- Fermi Level of Metal is shifted by gate voltage Vg
  - Vg makes electrons more/less excited (Have more / less energy)
- When there's a fermi level difference
  - Bands @ Si Interface bend
  - Making the interface have more holes or electrons