Semi conductors

Electrons absorb & radiate photons

Photon energy: \( E = h \nu = \frac{h c}{\lambda} \)

\( E = 0 \)

\[ \begin{align*}
3p^2 - \{3 \} & \rightarrow 4e^- \\
3s^2 & \rightarrow \\
2p^6 & \rightarrow 10e^- \\
1s^2 & \rightarrow N \text{ atoms}
\end{align*} \]

14 protons 
2 atoms 
N atoms

Conduction band empty

Valence band full

Electron current

Hole current

Thermal excitation

Photon
Contrast w/ metals

partly overlapping

partly full

Doping

empty

full

Add boron
hole
positive conductor
p-type material

add phosphorous
negative conductor
N-type
positive voltage - reduces barrier
- big current

negative voltage - increases barrier
- no current

\[ I_D = I_S \left( e^{\frac{V_D}{V_{TH}}} - 1 \right) \frac{K_B T}{q} \]

thermal voltage
\[ V_{TH} = 2.6 \text{ mV} \]

10x increase in current for 60mV increase in \( V_D \)

photo-induced (generated) current

\[ I_D = \frac{I_S}{\mu A \text{ mm}^2} \]

0.6 - 0.7 \( V_D \)