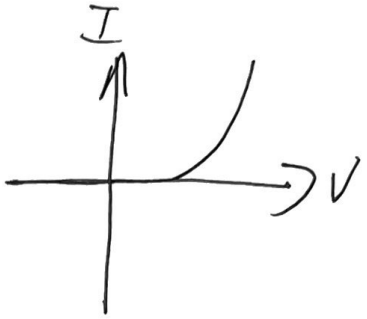
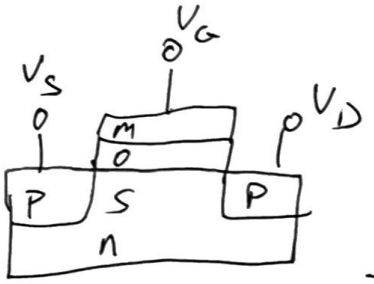
What are semiconductors

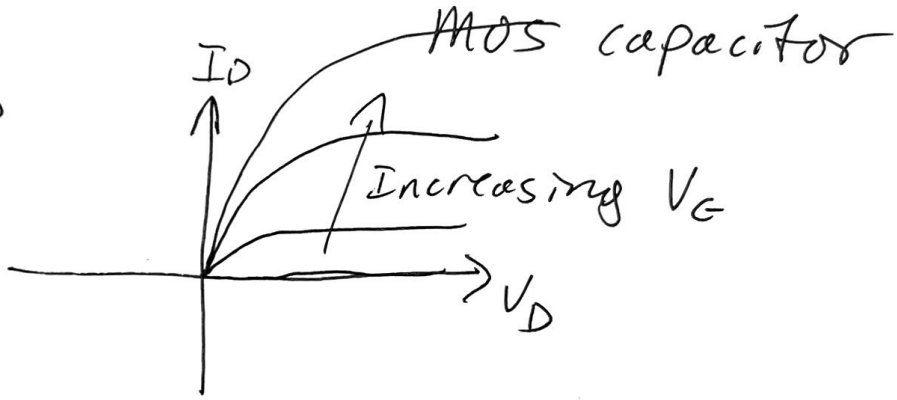
We can chemically & electrically & optically change mobile charge concentration.

Diodes → pn junctions

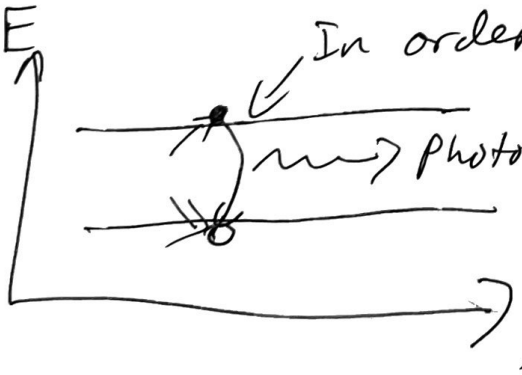


Transistors → MOS FET → pn junctions + a MOS capacitor





Absorption of photons



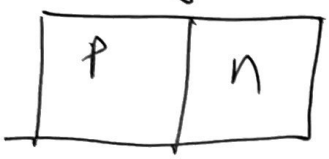
they need to be @ the same momentum.

In Si the e^- & h^+ have different momentum

In compound semiconductors the eletrons & holes have the same momentum

Red Led

$E_g = 1.8eV$

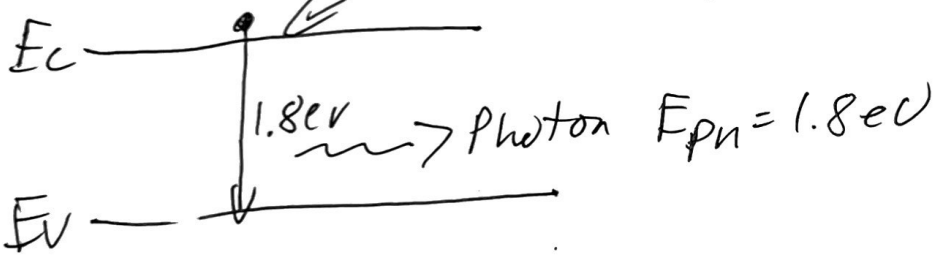


Blue LED

$E_g = 3.1eV$

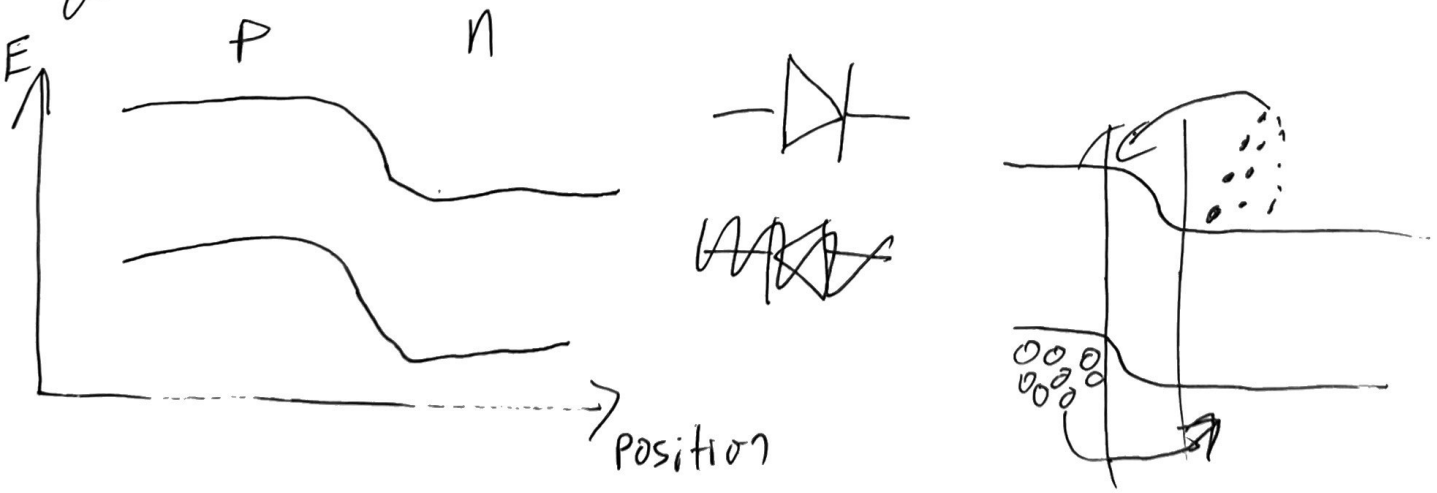
How are photons generated in an LED?

Fundamental Process to emit light → Process is called recombination. (radiative)



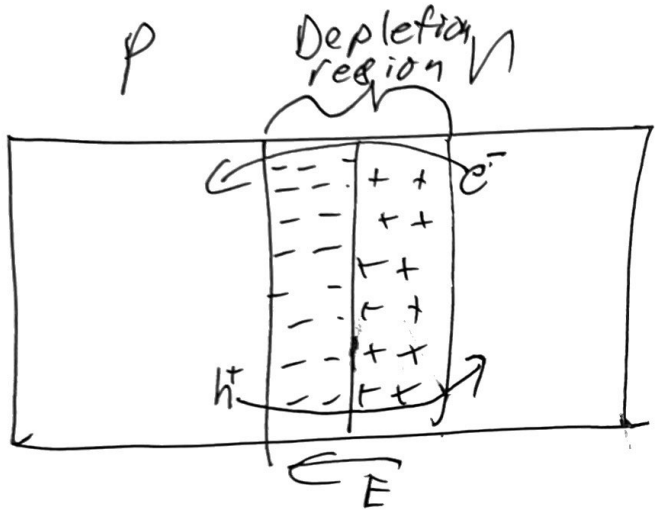
Based on this we need more radiative recomb. to emit more photons (aka light).

Let's go back to our understanding of diodes



In forward bias we have holes injected from the p-side into n-side.

And e^- injected from n-side into p-side



Because we have excess electrons on the p-side & excess holes on the n-side, they will recombine.

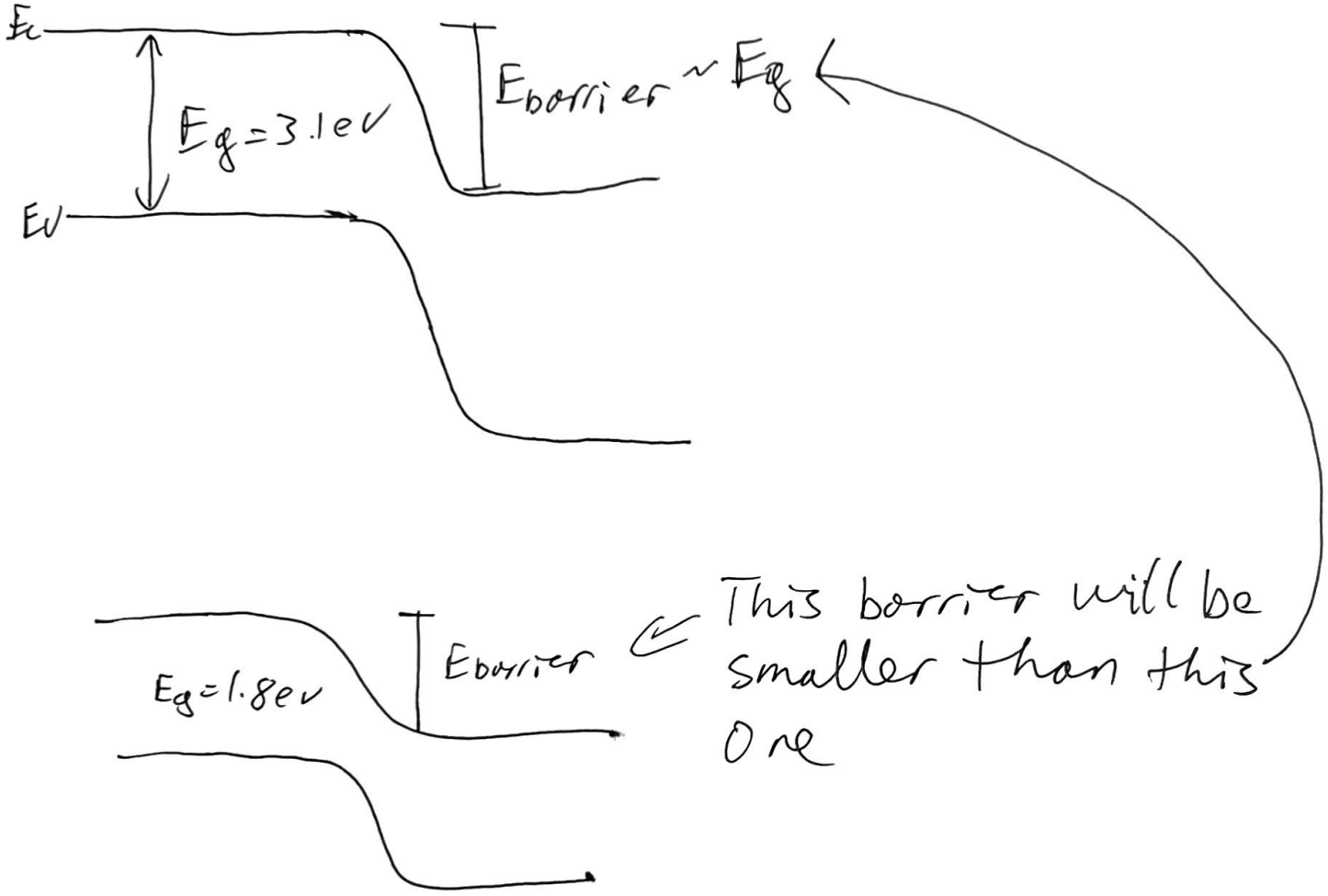
In an INDIRECT semi (e.g. Si) we get heat (mostly) from this recombination.

In a DIRECT semi (e.g III-V compound semiconductors) we get light.

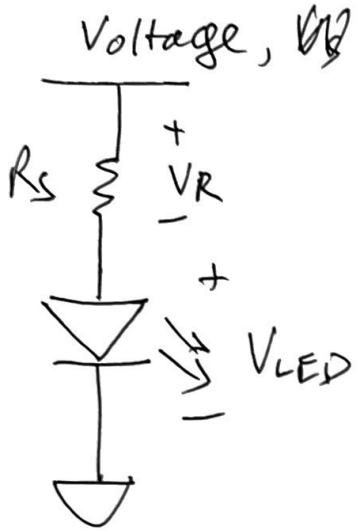
more current = more light (photons)

In an LED or diode current is going to be related to the barrier height. Smaller barrier height → more current.

Larger bandgap semiconductor LEDs generate larger barrier height



If current is proportional to borrier height, then the smaller Eg diode will require less applied voltage to have the same amount of current flowing.



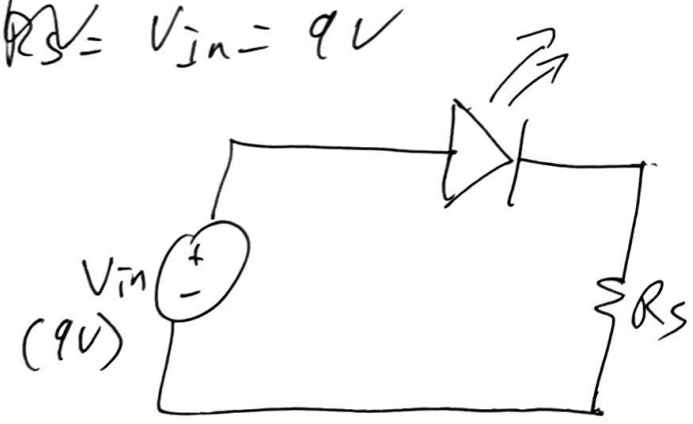
$$V_R + V_{LED} = V_{in}$$

$$V_R = I \cdot R_S$$

$$I_{LED} = \frac{V_{in} - V_{LED}}{R_S}$$

20mA @ 1.8V

$R_S = V_{in} = 9V$



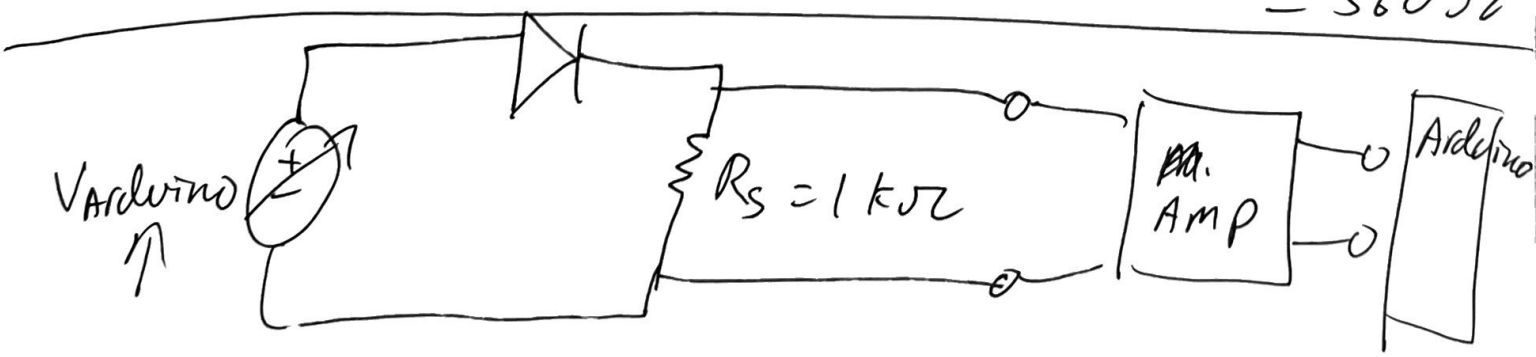
$$V_{in} = V_{LED} + I_{LED} R_S$$

$$9V = 1.8V + (20mA) R_S$$

$$\frac{7.2V}{0.020A} = \frac{7.2}{2 \times 10^{-2}} = \frac{3.6}{10^{-2}}$$

$$= 3.6 \times 100$$

$$= 360\,\Omega$$



You apply a voltage & you read a voltage across the Rs

How do we figure out V_D ($V_{Arduino}$)