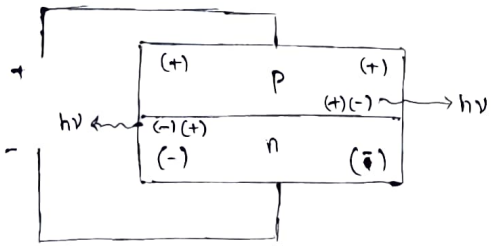
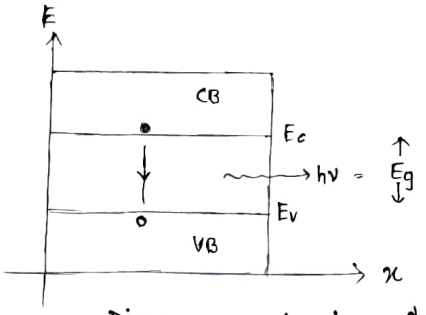
LIGHT EMITTING DIODE (LED).

A LED is a semi-conductor diode made by creation of a junction with n-type and p-type materials. When the diode is forward biased, e^- & holes enter the depletion region and recombine.

Unlike the case of regular diode these recombinations produce light. The recombination in the case of regular diode is called non-~~reactive~~ radiative.





Direct recombination in $GaAs$.

When a free e^- wandering around in CB, if a crystal meets a hole, it falls into this low energy empty e^- state. This process is called recombination.

* Intuitatively, recombination corresponds to the free e^- finding an incomplete bond with a missing e^-. The e^- then enters and completes this bond. The free e^- in CB and free hole in VB are consequently annihilants. On energy band diagram, the recombination process is represented by returning the e^- from CB (where it is free) into the hole in VB (where it is in a bond).

Responsivity (R) and Quantum Efficiency (η)

* This is regarding P-I-N photodiode.

* The input for a photodiode is light power. We denote it as P. The output current is known as photocurrent which is denoted by I_p.

* The photocurrent is proportional to the light power.

$$I_p \propto P$$

(or) $$I_p = RP$$

↳ proportionality const. known as responsivity.

* We know the photocurrent is the no. of e^- (Ne) times the charge of e^- (e) per unit time i.e.

$$I_p = \frac{N_e e}{t}$$

* On the other hand, light power is light energy per unit time, where the light energy is equal to energy of photon (E_p) times the no. of photons (N_p) over time.

$$P = \frac{N_p E_p}{t}$$

* By substituting $E_p \left(\equiv h\nu \equiv \frac{hc}{\lambda}\right)$, we have following result.

$$R = \frac{I_p}{P} = \left(\frac{N_e}{N_p}\right)\left(\frac{e\lambda}{hc}\right) = \eta\left(\frac{e\lambda}{hc}\right)$$

$$\therefore \boxed{R = \eta \frac{e\lambda}{hc}} \ A/W.$$