Performance parameters of PIN - photodetector:

1. Quantum efficiency (η): It is defined as the ratio of number of electron-hole pairs generated to the number of incident photons.

i.e, $\eta = \frac{\text{Number of electron-hole pairs generated}}{\text{number of incident photons}}$

$$\eta = \frac{I_P/q}{P_0/h\nu}$$

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Here, I_P is the average photocurrent, q is the electronic charge, P_0 is the optical power incident on the photodetector and $h\nu$ is the photon energy.

or, $\eta = \frac{r_e}{r_p}$; r_e = corresponding electron rate (electrons per second).

r_p = Incident Photon rate (Photons per second).

2. Responsivity (R): It is defined as the photocurrent generated to that of the incident optical power

$$\text{Responsivity}(R) = \frac{I_P}{P_0}$$

Where, I_P = Generated photo current ($I_P = \eta q$).

P_0 = Incident optical power ($P_0 = h\nu = \frac{hc}{\lambda}$).

Relation between quantum efficiency and Responsivity:

$$R = \frac{I_P}{P_0}$$

$$\eta = \frac{I_P/q}{P_0/h\nu}$$

$$\frac{\eta q}{h\nu} = \frac{I_P}{P_0}$$

$$\Rightarrow R = \frac{\eta q}{h\nu}$$

AVALANCHE PHOTODIODE [APD]

(Reach Through avalanche Photodiode. RAPD)

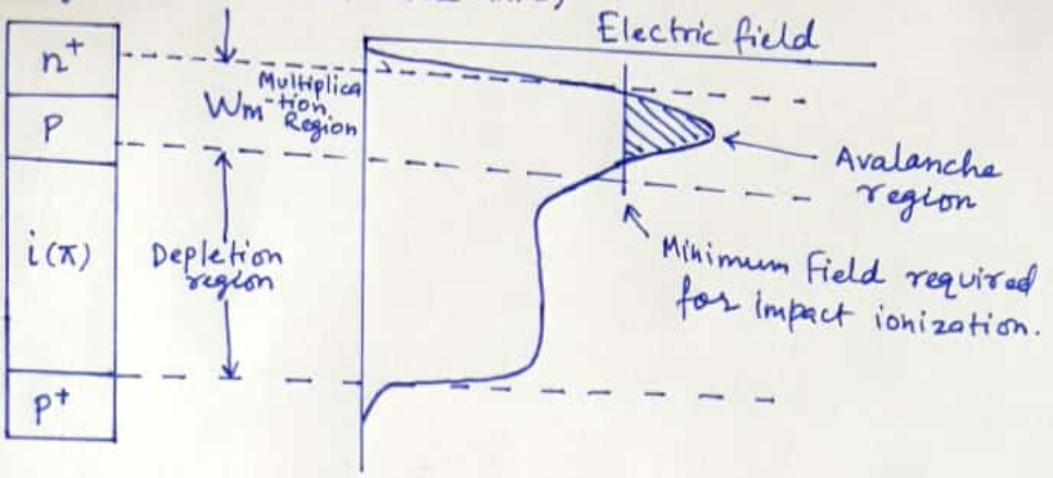

Fig:- Reach-through avalanche Photodiode structure and the electric fields in the depletion and multiplication region.

Avalanche Photodiode is biased at very high reverse voltage so that internal multiplication of electrons takes place resulting into gain of 100 to 500. once the incident Photons generates electron-hole pair in the depletion layer of P-n junction, the carriers moving out of depletion layer due to its internal electric field will produce more electrons and an avalanching process when carriers are traversing a region of very high electric field will ~~produce more~~ set in and large current gain is created by this process. The carrier multiplication mechanism is called as "impact ionisazation". under normal operating bias, the i layer is completely depleted. This is known as Reach through condition, hence APD's are known as Reach through APD's [RAPD]. In APD's n^+ and p^+ regions are highly doped regions. These are low resistance region and have very low voltage drop. The above configuration is known as $P^+ \pi n^+$ reach through structure. APD's uses Avalanche breakdown Phenomenon for its operation. The APD's has its gain which increases its responsivity.

The multiplication Factor M for an carrier generated in the Photodiode is defined as: $M = \frac{I_M}{I_P}$; I_M = Average value of total multiplied o/p current

I_P = Primary unmultiplied photocurrent

The Responsivity of APD is given by:

$$R_{APD} = \frac{M \eta q \lambda}{hc}$$;

M = Multiplication factor

η = Quantum efficiency

$q = 1.6 \times 10^{-19} C$

λ = wavelength

$h = 6.625 \times 10^{-34} JS$; $c = 3 \times 10^8 ms^{-1}$.