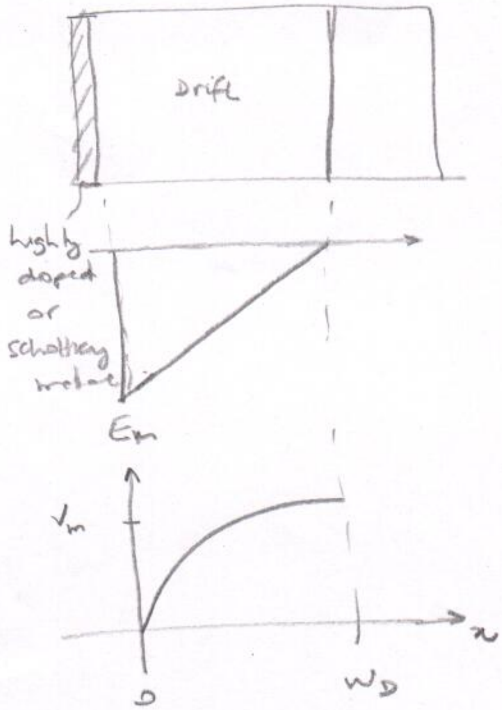
Course 24

$$R_{ON,sp} = \frac{W_D}{q N_D \cdot \mu_e} \qquad [\Omega \, cm^2]$$



$$V = \frac{E_m \cdot W_D}{2}$$

But for $\underset{\text{critical } \vec{E}}{E_m = E_{cr}} \Rightarrow \underset{\text{breakdown voltage}}{V = V_{BV}}$

thus

$$W_D^* = \frac{2 V_{BV}}{E_{cr}}$$

Poisson's equation

$$\frac{d^2V}{dx^2} = -\frac{dE}{dx} = -\frac{Q(x)}{\varepsilon_s} = -\frac{q N_D}{\varepsilon_s}$$

$$E(x) = -\frac{q \cdot N_D}{\varepsilon_s}(W_D - x)$$

$$V(x) = \frac{q N_D}{\varepsilon_s}\left(W_D \cdot x - \frac{x^2}{2}\right)$$

$$V_a = \frac{q N_D W_D^2}{2 \varepsilon_s} \underset{W_D = W_D^*}{\Rightarrow} \cancel{V_{BV}} = \frac{q \cdot N_D \cdot \cancel{4}^{2} \cancel{V_{BV}^2}}{\cancel{2} \varepsilon_s \cdot E_{cr}^2} \Rightarrow N_D^* = \frac{\varepsilon_s E_{cr}^2}{2 q \cdot V_{BV}}$$

But we would like to find a figure of merit that does not depend on doping or depletion width:

$$W_D^* = \frac{2 V_{BV}}{E_{cr}} \qquad N_D^* = \frac{\varepsilon_s E_{cr}^2}{2 q \cdot V_{BV}}$$

$$R_{ON,sp} = \frac{W_D^*}{q \cdot N_D^* \cdot \mu_e} = \frac{2 V_{BV}}{E_{cr} \cdot \cancel{q} \cdot \mu_e} \cdot \frac{2 \cancel{q} V_{BV}}{\varepsilon_s E_{cr}^2}$$

$$\therefore \boxed{R_{ON,sp} = \frac{4 V_{BV}^2}{\varepsilon_s \cdot \mu_e \cdot E_{cr}^3}}$$

Depends only on material properties.

Baliga's figure of merit: $\boxed{BFOM = \frac{4 V_{BV}^2}{R_{ON,sp}} = \varepsilon_s \cdot \mu_e \cdot E_{cr}^3}$