I Transition Capacitance Derivation / Space charge Barrier Depletion region Capacitance

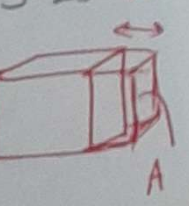
$$W = \left\{ \frac{2\epsilon V_B}{q} \left[\frac{N_A + N_D}{N_A N_D} \right] \right\}^{1/2}$$

①

	Si	Ge
	$2^{-2.4}$	$2^{1.7}$
	5.3	3.25

Assume (if) $N_D \ggg N_A$

$$W^2 = \frac{2\epsilon V_B}{q} \left[\frac{\cancel{N_D}}{N_A \cancel{N_D}} \right]$$



$$\boxed{\therefore \; V_B = \frac{q W^2 N_A}{2\epsilon}} \quad \text{— ①}$$

Total charge density of a P-type material with area of the junction 'A' is given by

$$\left.\begin{matrix}\text{Total} \\ \text{Charge} \\ \text{density}\end{matrix}\right\} (Q) = q N_A \cdot A \cdot W$$

$$\left.\begin{matrix}\text{Per} \\ \text{unit} \\ \text{Volume}\end{matrix}\right\} - q N_A$$

$A \cdot W$ (volume)

$$C_T = \left| \frac{dQ}{dV} \right|$$

concentration

$= q N_A \cdot A \cdot W$

$$\boxed{C_T = A \cdot q N_A \left| \frac{dW}{dV} \right|} \quad \text{— ②}$$

$=$

Differentiating (1)

$$\frac{dV_B}{dV} = \frac{q N_A 2W}{2\epsilon}\left|\frac{dW}{dV}\right|$$

$$\therefore 1 = \frac{q N_A \cancel{2} W}{\cancel{2}\epsilon}\cdot\left|\frac{dW}{dV}\right|$$

$$\boxed{\therefore \left|\frac{dW}{dV}\right| = \frac{\epsilon}{q N_A \cdot W}} \quad \text{— (3)}$$

Subs. (3) in (2)

$$C_T = A \cdot \cancel{q} \cdot \cancel{N_A}\left[\frac{\epsilon}{\cancel{q}\,\cancel{N_A}\,W}\right]$$

$$\boxed{C_T = \frac{A\epsilon}{W}}$$