BY: S. VISHAL

CH3052 ASSIGNMENT-2 CH18B020

(1)

$E_{VB} = -6eV$ / vacuum.

Given Bandgap - $2eV$

$\Rightarrow E_{CB} - E_{VB} = 2eV$

$\Rightarrow E_{CB} = -4eV$ / vacuum.

For an intrinsic semiconductor (since no. of holes = no. of e^-s), the fermi level lies exactly in the middle.

$E_{CB} = -4eV$ / vacuum

$E_{Fermi} = -5eV$ / vacuum

$E_{VB} = -6eV$ / vacuum

Banddiagram of intrinsic semiconductor.

To make it n-type, we need to increase the number of -ve charge carriers (e^-s), so that Fermi level is up sufficiently, and e^-s can get excited to E_{CB}. ($E_{CB} - E_{Fermi} < kT$ & $\Rightarrow$ barrier for e^-s to move up)

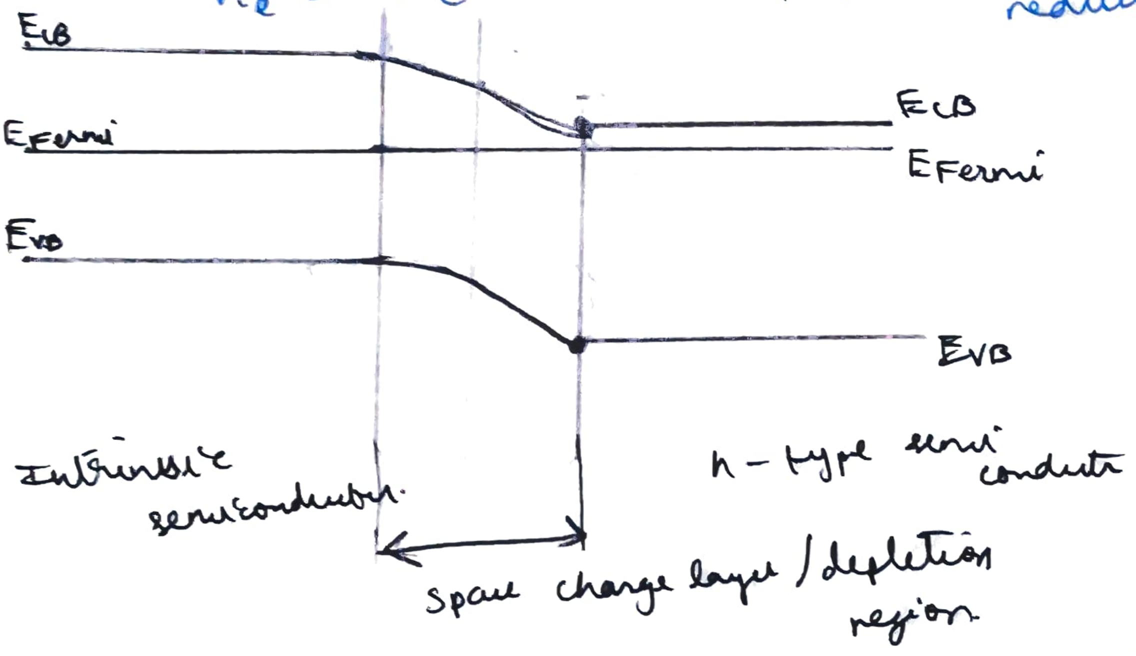
★ To introduce e^-s we need to dope the semiconductor with material having higher valency than that of the semiconductor.

Let the semiconductor be M_A, and let its valency be $n+$. We can add a dopant B with valency $(n+1)+$ to introduce e^-s.

$$\phi \rightleftharpoons B^{+}_{M} + e' \quad \text{(An } e' \text{ is introduced!)}$$

Thus, this is the general way of introducing n-type semiconductivity.

[Also note as we ↑se n_{e^-}, by the relation $n_e = N_c e^{-\left(\frac{E_c - E_F}{kT}\right)}$, $E_c - E_F$ also reduces!]



Band Diagram of Intrinsic semiconductor in contact with an n-type semiconductor [forming a junction]

Intrinsic ('n')   n-type ('N')

$M \longrightarrow M^{+} + e^{-}$

$N + e^{-} \longrightarrow N^{\ominus}$

From the Band diagram, we see e's can flow from conduction Band of intrinsic semiconductor to conduction Band of n-type semiconductor and holes flow from ~~V.~~ valence Band of n-type semiconductor to Valence band of intrinsic semiconductor.

One more method to introduce n-type semiconductivity is via ~~as~~ by creating anion vacancies. Consider TiO_2

$$\phi \rightleftharpoons V_O^{++} + 2e^{-}$$

$\Rightarrow$ When a vacancy of anion O^{2-} is created we get $2e^{-}$

Hence, we can also introduce n-type conductivity through this method.

Also, the dopant Fermi level should be close to that of the conduction band of the intrinsic semiconductor. ($\Delta E < kT$)
this is to ensure that the extra $\bar{e}$ donated by dopant can rise up to the conduction band of the intrinsic semiconductor to enable n-type conductivity.

(2) Temperature of cryogenic Liquid Nitrogen = $-196°C$

But glass transition temp. T_g = $-70°C$

$\Rightarrow T_{N_2} < T_{g,\text{rubber band}}$

So initially the rubber band will be in brittle condition

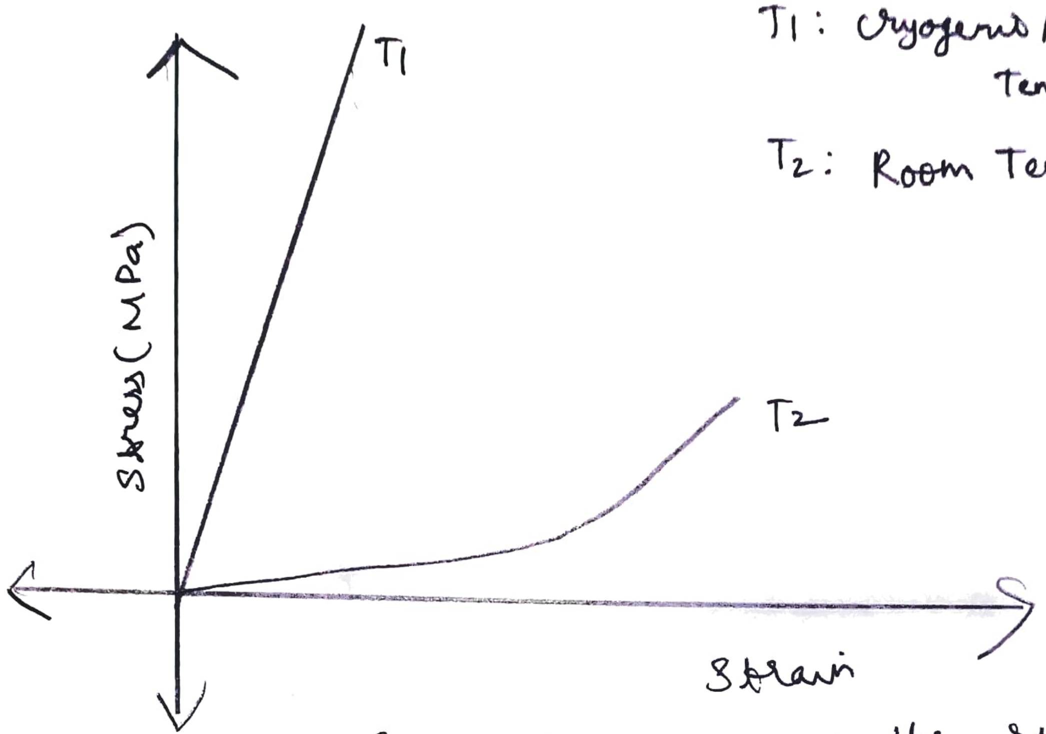
After heating back to room temp.,

$T_{g,\text{rubberband}} < T_{\text{room, temp}}$.

$\Rightarrow$ the rubber band will be back to elastic / rubbery state.

T_1 : Cryogenic Nitrogen Temperature

T_2 : Room Temperature



Stress - strain curve of the rubber band at different temperatures

Since at T_1 it is brittle, we have a straight line.

And, since at T_2 (room temperature), rubber band is a highly elastic material (elastomer), we get the above curve.

[Note that before glass transition temperature, material is brittle/plastic, after that at $T > T_g$, the material ~~is~~ becomes rubbery/flexible]