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LECTURE - 8

INTRINSIC SEMICONDUCTOR

AT EQUILIBRIUM

$n_o = p_o = n_i$ } TEMPERATURE DEPENDENT

→ EHP GENERATION

→ ONLY THERMAL EXCITATION

EXTRINSIC

→ DONOR ATOMS → N_d DONORS

↓

$\#/cm^3$

$n_o \approx N_d$

THIS APPROX. SHOULD NOT BE USED TO CALCULATE EXACT CONCENTRATION!

N-TYPE SEMICONDUCTOR

→ ACCEPTOR ATOMS → N_a ACCEPTORS

↓

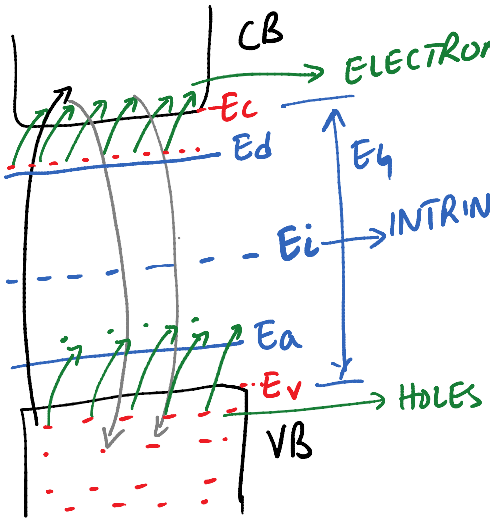
$\#/cm^3$

$p_o \approx N_a$

P-TYPE SEMICONDUCTOR

IF BOTH ACCEPTORS AND DONORS PRESENT

AT 50°K



AT EQUILIBRIUM

AT HIGH TEMP.

TRANSITIONS FROM CB TO VB

EXAMPLE

$N_d > N_a$

$\therefore$ NET # OF ELECTRONS = $N_d - N_a$

$N_d \xrightarrow{e}$ AFTER DONATING ELECTRONS $\rightarrow$

$N_d^+ \rightarrow$ IONIZED DONOR ATOMS

$N_a \xleftarrow{e}$ AFTER ACCEPTING ELECTRONS

$N_a^- \rightarrow$ IONIZED ACCEPTOR ATOMS

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MATERIAL ITSELF IS ELECTROSTATICALLY NEUTRAL

SUM OF { POSITIVE CHARGES
{ HOLES + IONIZED DONOR ATOMS }

=

SUM OF { NEGATIVE CHARGES
{ ELECTRONS + IONIZED ACCEPTOR ATOMS }

$$\therefore \quad p_o + N_d^+ = n_o + N_a^-$$

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EXAMPLE

SAY MATERIAL IS HEAVILY DOPED WITH DONORS (n-TYPE) $(n_0 > p_0)$

AND ALL IMPURITIES ARE IONIZED

$$n_0 \approx N_d - N_a$$

TWO EQUATIONS

(1) $$n_0 + N_a^- = p_0 + N_d^+$$

(2) $$n_0 p_0 = n_i^2$$

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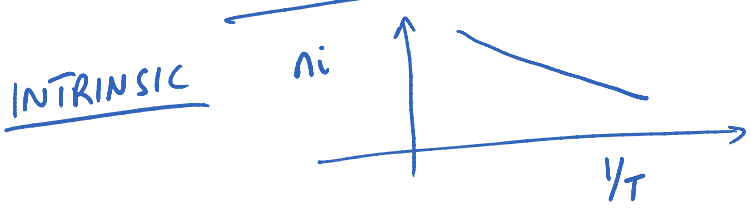
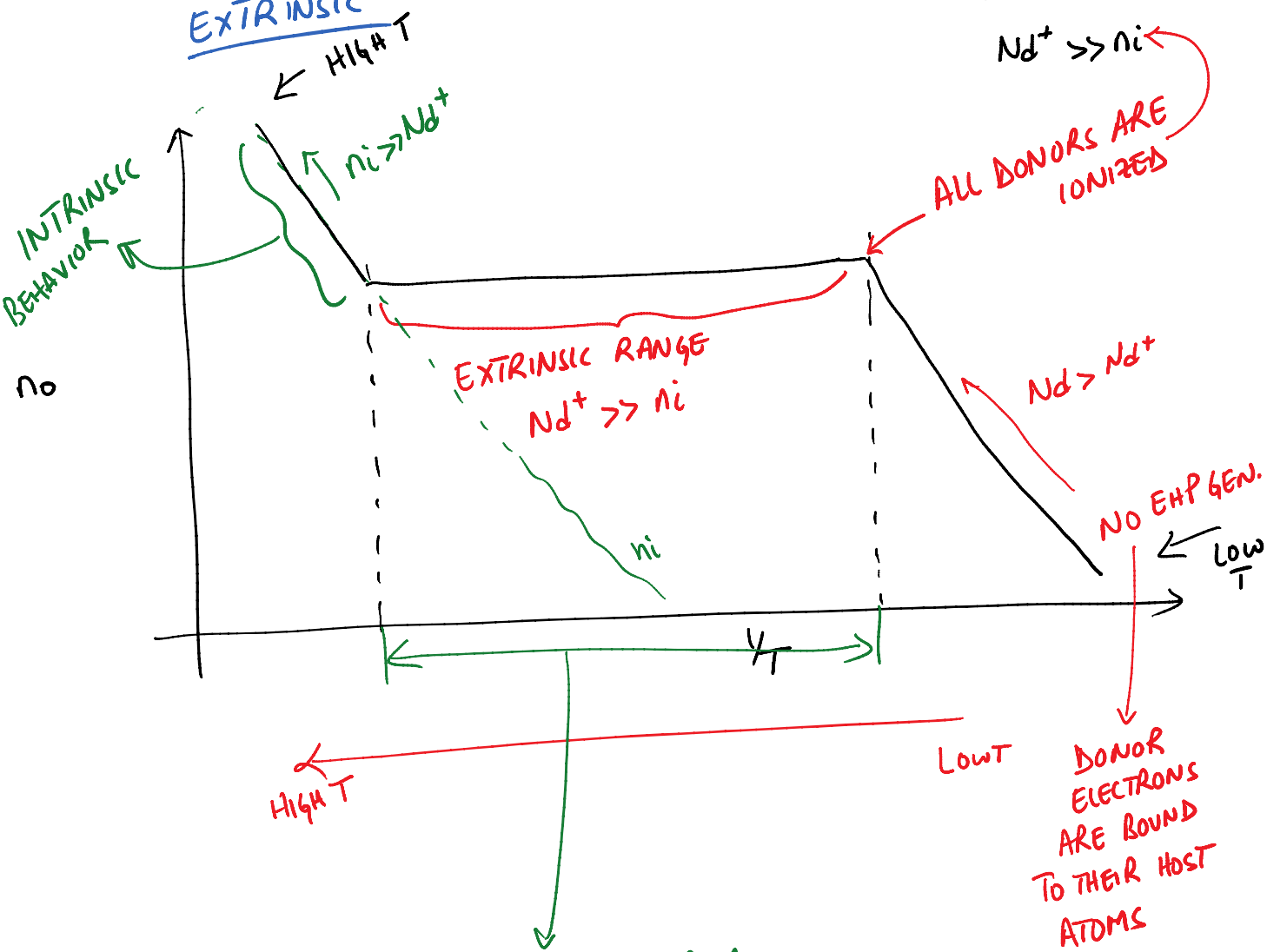
TEMPERATURE DEPENDANCY



DOPING WITH DONORS

Si ni

$N_d^+ >> n_i$



No

TO CONTROL ELECTRICAL PROPERTIES → STAY IN THIS REGION

* DOPE THE MATERIAL SUCH THAT THE EXTRINSIC RANGE EXTENDS BEYOND THE HIGHEST OPERATING TEMPERATURE!