* Hole Concept

Lec 03
15/7/15
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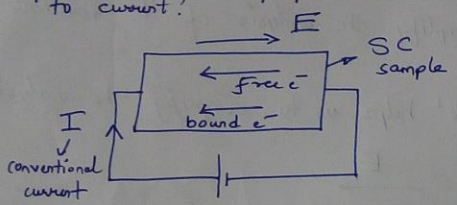
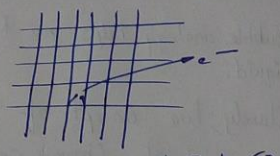
So far, hole is a absence of e^- in a bond in Si-Si atom (vacancy)

Q. why shld such vacancy participate in conduction process & give rise to current?





2D representation of Si

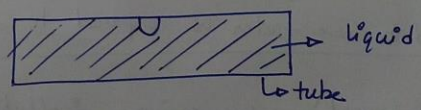
- Valence e^-s taking part in bonding process are "bound e^-s."

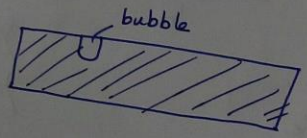
→ The e^- which are already participating in bonding process, even they can contribute to current because of presence of vacancy. This is current attributed to "hole" current.

Let's understand with an analogy:

Bubble analogy

Liquid ⟷ electrons.
bubble ⟷ vacancy or holes





As liquid in tube moves down, bubble moves up.

Here, movement of the liquid is captured by movement of bubble in opp. direction.

⇓ Exactly similarly, bound e^-s which are present in Si crystal, they tend to move via vacancies. in response to E-field.

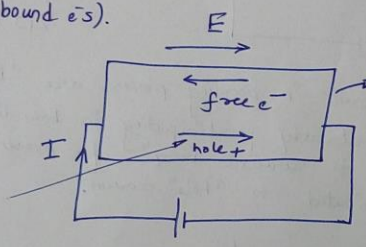
Ans: It makes no sense ⇓ under thermal

- That is how, bound e^-s will tend to move via vacancies & contribute to current.

→ It is current becoz of bound e^-s can be very easily captured by "movement of vacancies"

⇒ Bubble analogy helps you to simplify the analysis of the movement of liquid.

Similarly, here concept of 'hole' helps us to simplify the analysis of movement of (bound e^-s).



Vacancy move in directn opp to that of e^-s.

hole is a fictitious concept actually only it is e^-s which are moving

But it also helps us to analyze the situation in better understanding.

→ Movement of holes (bound e^-s) under E-field is different than movement of free e^-s.

i.e free e^-s tend to move faster as compared to bound e^-s (holes)

To capture this information ⇒ we assign "effective mass".

$m_n < m_p$

m_n → effective mass of e^- in crystal.

m_p → effective mass of hole in crystal.

Hole is heavier than e^- in conductivity situation, i.e. in domain of current

Note: In an intrinsic semiconductor, $n_i^0 = p_i^0$

n_i^0 → conc^n of e^-s

p_i^0 → conc^n of holes.

Ans: It makes no sense

under thermal