Charge density in Semiconductor Lecture-7

TDC PART -1

PAPER 1(GROUP B)

Chapter -4

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Charge density

- Charge carrier density, also known as carrier concentration, denotes the number of charge carriers in per volume. In SI units, it is measured in m−3. As with any density, in principle it can depend on position.

Charge density in semiconductor

- Charge density is usually calculated in the extrinsic semiconductor,

- i.e. the semiconductor with impurities such as p type and n type

Mass action law

- Addition of n-type impurities to a pure semiconductor results in reduction in the concentration of holes below the intrinsic value.
- Addition of p-type impurity results in reduction in concentration of free electrons below the intrinsic value.

- Theoretical analysis revels that at any given temperature, the product of the concentration 'n' of free electrons and concentration 'p' of holes is constant and is independent of the amount of doping by donor and acceptor impurities. Thus,

- $np = n_i^2$ ....(1)

Charge Densities in Extrinsic Semiconductor

- electron density n and hole density p are related by the mass action law: np = ni2. The two densities are also governed by the law of neutrality.(i.e. the magnitude of negative charge density must equal the magnitude of positive charge density)
- ND and NA denote respectively the density of donor atoms and density of acceptor atoms

- Total positive charge density equals (ND + p).
- Total negative charge density equals (NA + n)
- ND + p = NA + n ….(2) (law of neutrality)

note; (n-type semiconductor with no acceptor doping i.e. with NA = 0, n >>p)

The concentration of holes in n-type material may now be obtained from equation (1). Thus, we get,

$p_n = n_i$^-1/ N_D ….(4)

CONCLUSION

- The density of minority carrier electrons in p-type semiconductor may be obtained from equation (1). Thus, we get,

- $np = ni^2/PP = ni^2/NA$ …..(6)