Law of mass action

The law of mass action states that the product of number of electrons in the conduction band and the number of holes in the valence band is constant at a fixed temperature and is independent of amount of donor and acceptor impurity added.

Mathematically it is represented as

$$np = n_i^2 = \text{constant}$$

Where n_i is the intrinsic carrier concentration,

n is number of electrons in conduction band,

p is number of holes in valence band

Law of mass action for extrinsic semiconductor

The law of mass action is applied for both intrinsic and extrinsic semiconductors. For extrinsic semiconductor the law of mass action states that the product of majority carriers and minority carriers is constant at fixed temperature and is independent of amount of donor and acceptor impurity added.

Law of mass action for n-type semiconductor

The law of mass action for n-type semiconductor is mathematically written as

$$n_n\, p_n = n_i^2 = \text{constant}$$

Where n_n= number of electrons in n-type semiconductor
p_n = number of holes in n-type semiconductor

The electrons are the majority carriers and holes are the minority carriers in n-type semiconductor.

In n-type semiconductor, as the number of electrons (majority) in the conduction band increases the number of holes (minority) in the valence band decreases.

Therefore, the product of electrons (majority) and holes (minority) remains constant at fixed temperature.

Law of mass action for p-type semiconductor

The law of mass action for p-type semiconductor is mathematically written as

$$p_p \, n_p = n_i^2 = \text{constant}$$

Where p_p = number of holes in p-type semiconductor

n_p = number of electrons in p-type semiconductor

The holes are the majority carriers and electrons are the minority carriers in p-type semiconductor.

In p-type semiconductor, as the number of holes (majority) in the valence band increases the number of electrons in the conduction band (minority) decreases. Therefore, the product of holes (majority) and electrons (minority) remains constant at fixed temperature.