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Continuity Equation

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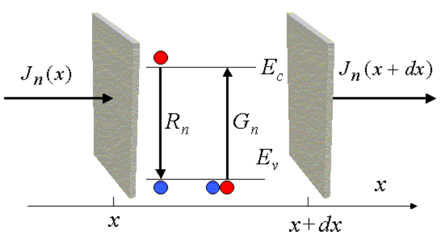
I.Abstract

The continuity equation is basically describes the transport of a conserved quantity. This equation is a stronger, local form of conservation law which says ‘’ ENERGY CAN NEITHER BE CREATED,NOR BE DESTROYED’’. It moves from one place to another. In terms of semiconductors, we can say that it satisfies the condition that particles should be conserved. Electrons and holes cannot mysteriously appear or disappear at a given point, but must be transported to or created at given point via some type of carrier action. This equation gives us the relation between the incoming and outgoing charge carriers with the generation and recombination of carriers.

II.Introduction

- *Continuity equation*

In semiconductors, we can say that continuity equation describes the change in carrier density over time is due to the difference between the incoming and outgoing flux of carriers, plus the generation and minus the recombination.



Electron currents and possible recombination and generation processes.

- *Continuity equation in 1D*

The rate of change of the carriers between x and x + dx equals the difference between the incoming flux and the outgoing flux plus the generation and minus the recombination:

$$\frac{\partial n(x,t)}{\partial t} A\,dx = \left(\frac{J_n(x)}{-q} - \frac{J_n(x+dx)}{-q}\right)A + (G_n(x,t) - R_n(x,t))\,A\,dx$$

where n(x,t) is the carrier density, A is the area, Gn(x,t) is the generation rate and Rn(x,t) is the recombination rate.

Thi equation can be formulated as a function of the derivative of the current:

$$\frac{\partial n(x,t)}{\partial t} = \frac{1}{q}\frac{\partial J_n(x,t)}{\partial x} + G_n(x,t) - R_n(x,t)$$ *for electrons*

$$\frac{\partial p(x,t)}{\partial t} = -\frac{1}{q}\frac{\partial J_p(x,t)}{\partial x} + G_p(x,t) - R_p(x,t)$$ *for holes*

This is continuity equation in 1D.

Similarly, we can write the equation for two or three dimension.

CONTINUITY EQUATION IN 4D

The equation can be written for four dimension as follows:

Let we take four dimensions as x,y,z,w with respect to time 't', so the continuity equation become.

$$\frac{\partial n(x,y,z,t)}{\partial t} = \frac{1}{q}\vec{\nabla}\vec{J}_n(x,y,z,t) + G_n(x,y,z,t) - R_n(x,y,z,t)$$

Diffusion equation:

The time-dependent diffusion equations for electrons in p-type material and for holes in n-type material:

$$\frac{\partial p(x,t)}{\partial t} = D_p \frac{\partial^2 p_n(x,t)}{\partial x^2} - \frac{p_n(x,t) - p_{n0}}{\tau_p}$$

The general solution to these second order differential equations are:

$$n_p(x \le -x_p) = n_{p0} + Ce^{-(x+x_p)/L_n} + De^{(x+x_p)/L_n}$$

$$p_n(x \ge x_n) = p_{n0} + Ae^{-(x-x_n)/L_p} + Be^{(x-x_n)/L_p}$$

where L_n and L_p are the diffusion lengths given by:

$$L_n = \sqrt{D_n \tau_n}$$

$$L_p = \sqrt{D_p \tau_p}$$

$L_p = (D_{p\,p})^{1/2}$ *associated with minority carrier holes in n-type materials*

$L_n = (D_{n\,n})^{1/2}$ *associated with minority carrier electrons in p-type materials*

III.CONCLUSION

We use the continuity equation in different fields. Here, we use it to describe the movement of change carriers in semiconductors. We conclude that the change in carrier density is actually related to the flux difference between incoming and outgoing carriers. It increases with the increase in no. of generation and decreases with increase in recombination of charge carriers.

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REFERENCES

- *file:///J:/Continuity%20equation.htm*
- *J.B.GUPTA*
- *www.google.com*