



EFFECT of LIGHT on VOLT-AMPERE CHARACTERISTICS of p-n JUNCTION

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Abstract

In this work, the effect of light on the characteristics of p-n junction diodes is studied. The volt-amp characteristic of the p-n junction diode is observed to shift down under the influence of light.

Key word: electric current, volt-ampere characteristic.

Introduction

We will see how the volt-ampere characteristic of a p-n junction diode changes when light is applied to it [1].

$$J = J_n + J_p = J_s \left(e^{\frac{qu}{kT}} - 1 \right) \quad (1)$$

$$J_s = \frac{eD_p \cdot p_{n0}}{L_p} + \frac{eD_n \cdot n_{p0}}{L_n} \quad (2)$$

Here, D_p , D_n are hole and electron diffusion coefficients, p_{n0} is the initial concentration of holes in the n field [2], n_{p0} is the initial electron concentration in the p field, L_p , L_n are the diffusion lengths of holes and electrons, and they are determined using the following expressions [3].

$$L_p = \sqrt{D_p \tau_p} \quad L_n = \sqrt{D_n \tau_n} \quad (3)$$

Here τ_p , τ_n are holes and the average residence time of electrons is equal to $\tau_p = 8.4 \cdot 10^{-10} \text{ c}$, $\tau_n = 3 \cdot 10^{-10} \text{ c}$ [4]. If we put expressions (2) and (3) into (1), we get the following expression [5].

$$J = J_s \left(e^{\frac{eu}{kT}} - 1 \right) \quad (4)$$

This expression determines the volt-ampere characteristic of a p-n junction semiconductor without any external influences [6].



As a result of the non-generation of electric current in diodes without the influence of light, it follows that the electric current is $E=0$. In fact, the diode is in thermodynamic equilibrium when $I=0$ and $U=0$ [7]. There will be no electric current [8]. As we know, the photocurrent generated under the influence of light in p-n junction semiconductors is related to the volt-ampere characteristic as follows [9].

$$J = J_s \left(e^{\frac{eU}{kT}} - 1 \right) - J_f \quad (5)$$

Here, J_f is the photocurrent generated under the influence of light and it can be expressed as follows [10].

$$J_f = \frac{e\beta I\alpha}{h\nu} \quad (6)$$

Here β is the quantum absorption, it is equal to $\beta=1$, I is the intensity of light falling on the surface unit [11], h is Planck's constant, ν is the light frequency, and α is the light absorption coefficient [12]. From the expression (11), (10) can be written as follows [13].

$$j = j_s \left(e^{\frac{eU}{kT}} - 1 \right) - \frac{e\beta I\alpha}{h\nu} \quad (7)$$

and if we replace the numerical values, it is observed that the graphic position of the volt-ampere characteristic moves down [14].

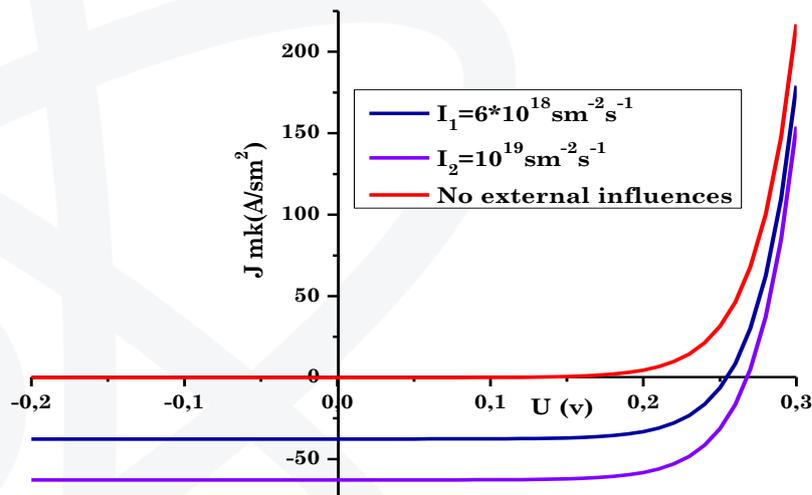


Figure 1



In the graph above [15], A) the case where there is no external influence on the diode. V) the diode is affected by the intensity $I=6 \cdot 10^{18}$. C) the diode is affected by the intensity $I=10^{19}$. In this case, if the electric current is calculated, 0.26 v for the intensity $I=6 \cdot 10^{18}$ and 0.27 v for the intensity $I=10^{19}$ will be obtained [16].

conclusions

It can be seen that using the differences between the graphs of volt-ampere characteristic under the influence of light, we can determine the photoelectric driving force generated by the influence of light in p-n junction diodes [17].

If we see the effect of light on p-n transition semiconductors, we know that the absorbed photon energy is equal to the bandgap energy $\hbar\omega=E_g$, and this is the red limit of the photoeffect [18]. If the condition is $\hbar\omega < E_g$, the internal photoeffect is not observed. When the condition $\hbar\omega > E_g$ is fulfilled, electrons and holes start to be generated [19].

If the band width is not changed by an external influence, the red threshold frequency will not change, otherwise it will be possible to control the absorption of light by changing the band width [20].

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