A Theoretical Novel Approach of Reverse Photoresistor Device

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Abstract — *An investigation into the effects of the structures and applications of a novel device, which is named as reverse photo resistor. The main potential matter of this device is the resistance variation with illumination. This device is mainly stands upon the photo electricity effect of metals. Severally the photo-electronic device shows the internal resistancedecreasing phenomena with increasing of the light illumination. But here the design of this device have done in such a way, that with increasing of light illumination the device will enhance the internal resistance itself. Because of having the reverse phenomena compared to photoelectric device, this is named as Reverse Photoresistor Device.The intellectual calculations regarding this device have given in this paper to justify properties the device characteristic, by fully theoretically. Mainly the author focused on the electric field generation and current flowing criterion due to external power supply of this device.*

Keywords—*Reverse Photo Resistance, Reverse Photo Diode, Reverse Photoelectric Diode, Negative Resistance Diode, RPR.*

I. Introduction

As the technology needs to be more and more superfast and versatilefor that all the technical fundamentalequipments should to be more integrated.Here a very new kind of device is proposed theoretically, which is Reverse Photo-resistor Device. Here the proposeddevice is based upon the photo electricity concept [1]-[3].Due to photo-electricity the interatomic resistance of any metal always decreases. But here a reverse phenomenon has shown. On the application of the device it would be seen that with illumination of the photons on the surface of the photo-sensitive material the device resistance would be enhanced much [4], [5].

Some basic concept about the photo-electric devices have used here to achieve the main motivation of this work. This device contains one solar diode (solar cell) and another one is normally doped p-n junction semiconductor diode. Two diodes are connected in such a way that they would be able to reduce down the net current flowing through the p-n diode, while illumination occurs on the solar cell [6].The results of this paper will contribute to new information for both photo resistor device manufacturers and system designers toward the optimization of the light energy technology.

II. Motivation and Description of the Device

From the basic quantum physics of Einstein photo electricity theory it is known, if illumination occurs on the metallic surface that produces some amount of the photoelectric current continuously [7]. Which is related with the intensity of incident photons. The equation is given as:

$eq = h\nu - h\nu_0$;

While ν the frequency is higherthan ν_0, then the incident energy would be much effective to accelerate the atomic electrons by providing some extra energy to them [8], [9]. For that the current flowing occurs randomly.

This phenomena have used to establish the device current criteria. Basically this device contains one solar cell and one p-n junction diode[10], [11]. As shown in the figure 1, the p-n junction diode is in heavily doped condition. This heavily doping protects the waste of the device power. If the semiconductor segments are not doped heavily then the minority carriers in the doped semiconductors would be recombined with the majority carriers. Hence the device would not be able to perform properly [12].

The next segment of the device is the solar cell, as figure (1). This is designed in such a way that the generated current from the solar cell will oppose the current flowing through the p-n diode. When the solar cell would be illuminated much thenthe generation of the photo current would occur and the net electric field would be gradually increased inside the solar cell. For that the photoelectric current would oppose the flowing of current through the p-n diode, which is connected with solar cell. This approach is successfully verified by the equations 3, 6.

III. Prospective Calculations of Current Variation Accordance with Electric Field

From the figure 1, the equation for the electric field can be written as:

$E_d = E_v - E_p$

$\underset{1}{\Rightarrow} eV_d = E_v - E_p$

$\underset{2}{\Rightarrow} eI_d R_d = E_v - E_p [R_d \text{ is internal resistance of diode}]$

$\underset{3}{\Rightarrow} I_d = E_v - E_p / eR_d [e \text{ is electronic chrge}]$

If the input potential of the device if kept at a fixed value, then it is clear to say that E_v is constant, because ofa constant voltage supply V towards this device. That time the Diode current is to be equal withI_d. So ideally there would not to have any current dissipation through the p-n diode. This can be considered as a primary current through the diode, while the photoelectric voltage is zero i.e. no illumination occurred [13]. Now as far the illumination is increases the development of the photovoltaic effect also increases inside the solar cell. As a result the current through the solar cell would be increased [14]-[16]. Hence the developed current by photoelectric effect would be the major reason of reducing the diode current I_d . As the I_d decreases the developed electric field E_d also decreases accordingly [17]. By reference of this it's clear to say that thediode voltage output (V_d) decreases with this phenomena. And the required performance of the device gets high.

$$E_d = E_v - E_p$$

$$\underset{4}{\Rightarrow} J_d/\sigma_d = \left({J_v}/{\sigma_v}\right) - \left({\emptyset p}/{d}\right)$$

$$\underset{5}{\Rightarrow} \boldsymbol{I_d = \sigma_d A_d \left\{\left({J_v}/{\sigma_v}\right) - \left({\emptyset p}/{d}\right)\right\}}$$

$$\begin{bmatrix} \sigma_d \text{ and } \sigma_v \text{ are conductivities of diode and} \\ \text{source respectively} \\ A_d \text{ is area of depletion energy} \\ J_v \text{ conduction current density of source} \end{bmatrix}$$

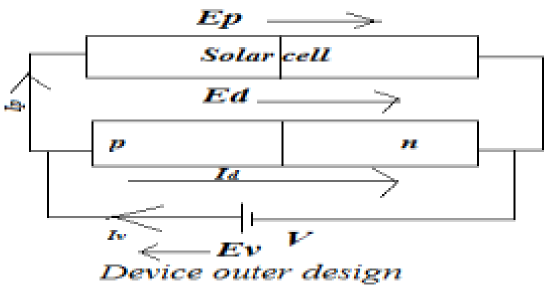

Fig. 1. The device outer design

This equation (5) shows the variation of I_d due to photovoltaic effect. As light illumination increases, the $\emptyset_p$ increases accordingly, as a result I_d decreases. Hence the diode current decreasing effect is noticed.

IV. DIODE CURRENT VARIATION FOR PHOTOELECTRIC VOLTAGE

Here I_d is the effective current through the diode as figure (1) and Id is the current due to external power supply I_p is photovoltic current.I_s is taken as the reverse saturetion current of the respectiove diode [18], [19]. From schokely diode conduction eqation it is said to be as follows. All the calculations are taken in room temparature 27 K. for Si: 2 and for Ge: 1.

$$I_d = I_v - I_p = I_v - I_s\left(e^{eV - e\emptyset_p/\text{KT}} - 1\right)$$

$$= I_v - I_s\left(e^{eV - e\emptyset_p/\text{KT}} - 1\right)$$

$$\underset{6}{\Rightarrow} I_d = I_v - I_s\left(e^{V - \emptyset_p/\text{KT}/e} - 1\right)$$

$$= I_v - I_s\left(e^{38.61(V - \emptyset_p)/} - 1\right)$$

Hence from this derivations it is said to that as much the photo voltage $\emptyset_p$ increases the net current through the diode I_d decreases. Hence I_v is taken as a constant supply [20], because of the constant voltage supply V. This calculation satisfies that with increasing of the photoelectricity the diode current I_d gets decreased. Behalf of this statement it is also can be said that the device resistance gets increased.

V. REPRESENTATION OF INPUT AND OUTPUT CHARACTERISTIC

According to the figure 1, as theaccelerated electrons come from the photocell to the diode terminals,then at the left side of the diode electron accumulation starts. According to the solid state device physics, at that moment concentration of electrons would be very high and the concentration of the holes would be started to decrease [21].The opposite phenomena will occur at another side of the diode i.e. holes accumulation and electron depletion. During this time all the minority carriers would be started to recombine with the majority carriers. This recombination causes reducing of effective width of the diode junction. Hence the diode starts to undergo into a reverse region.The forward characteristic of the diode escapes gradually. At this moment according to the atomic energy band theory, [22]-[24], it is clearly to say that an inversion layer would be appeared in the both sides of the diode due to thephotovoltaic effect. Hence as a precise conclusion it is said to be that the energy band gap become thicker than the previous stage and the junction width gets decayed. Due to lengthyforbidden energy gap between the *p* and *n* region the device will show a negative conduction phenomena. So for that the conductivity of the diodedecreases gradually [25]. And the current passing through the diode$I_d$alsoreduces. Here it is seen that V_d (the effective potential difference through the terminals of the diode) decreases and V_{in} (supply voltage) is fixed, if as a condition the photo volt $\emptyset_p$ is increased. At the initial time it gives the maximum voltage output and then after when the $\emptyset_p$ is increases gradually with the illumination, and the V_d is decreases accordingly [26]. Now as much the value of $\emptyset_p$could be increased the I_d through the diode would be decreased. Hence it can be said that the device resistance increases with the applied potential, which phenomena is purely reverse of the photoelectric devices.

VI. CONCLUSION

The proposed concept of the reverse photo resistor device is a very new approach on the solid state device. Where it is seen that the device current decreases with the photon illumination on the device photo-sensitive surface. This phenomena is a reverse type of phenomena compared to photo-electric devices.

In this paper one solar cell have used to achieve the device performance. To enhance the performance multiple numbers of solar cell could be used.For that the device sensitivity could be much enhanced.If some rectifying contacts can be used, which will protect the reverse currents and also will be used to keep the device safe from reverse effect of the currents. The all calculations provided an ideal validation of the device. This device could be applied for the prospect of the optical devices.

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