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Revisiting and disprove of evaluation of solar cell parameters and Einstein photo electric effect through reasoning and analysis and probable solution

Syed Mahboob[1] and Rizwana[2]
[1]*Department of Physics, Osmania University, Hyderabad-500007, Telangana, India*
[2]*Institute of Aeronautical Engineering, Dundigal, Hyderabad 500043, Telangana, India*
(Corresponding author e-mail:- mahboob1978@yahoo.com)

Abstract:

In the present paper revisiting and disprove of evaluation of solar cell parameters and Einstein photoelectric effect have been done through calculation, reasoning and analysis. The results on these calculations, reasoning and analysis are presented in this paper. The equations for evaluation of solar cell parameters are wrong and the probable correct solutions are presented in this paper and these results are shown through equations which are appropriate and also with figures. Similarly is the case with Einstein photoelectric effect It has been proved wrong through plots relating to different type of current (I, I_{SC}), voltage and number density as a function of frequency.

Keywords: Solar cell, Einstein photoelectric effect, disprove of solar cell parameters and Einstein photoelectric effect.

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1. Introduction:

In the present manuscript, revisiting of solar cell evaluation of parameters and Einstein photoelectric effect have been done and have disproved these through reasoning and analysis. The results have been presented in this paper in section entitled "Reasoning and analysis of evaluation of solar cell parameters and Einstein photoelectric effect and probable solution". The equation and figures of solar cell parameters and parameters related to Einstein photoelectric are given below in two sub sections.

1.1 Solar cell parameters equations [1-5]

$$I = I_0[\exp(\frac{qV}{2K_BT})-1]-I_L \quad (1)$$

$$I = I_L - I_0[\exp(\frac{qV}{2K_BT})] \quad (2)$$

$$V = \frac{2K_BT}{q}\ln(\frac{I_L - I}{I_0}) \quad (3)$$

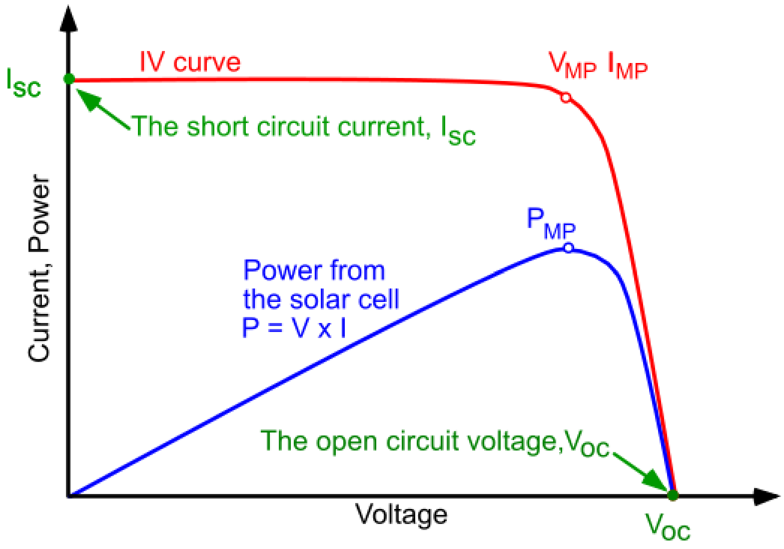


Figure 1. Current voltage (IV) cure of a solar cell. To get the maximum power output of a solar cell it needs to operate at the maximum power point, P_{MP}.

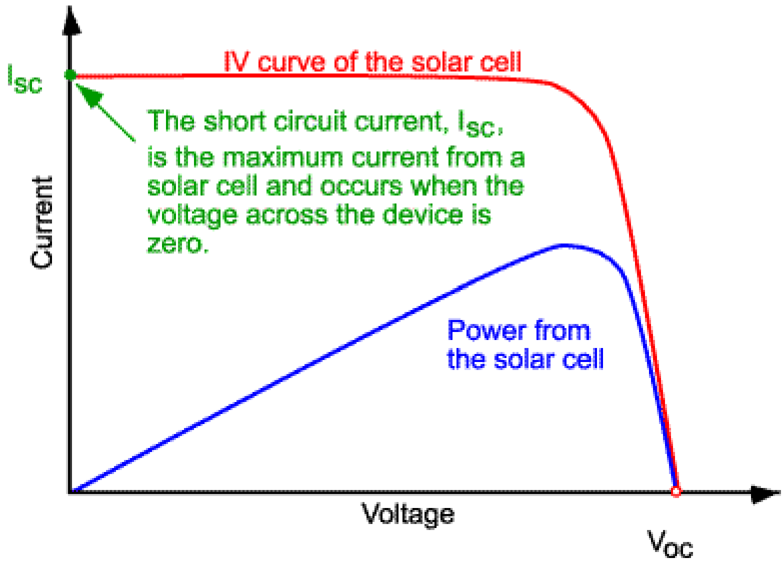


Figure 2. IV curve of a solar cell showing the short-circuit current.

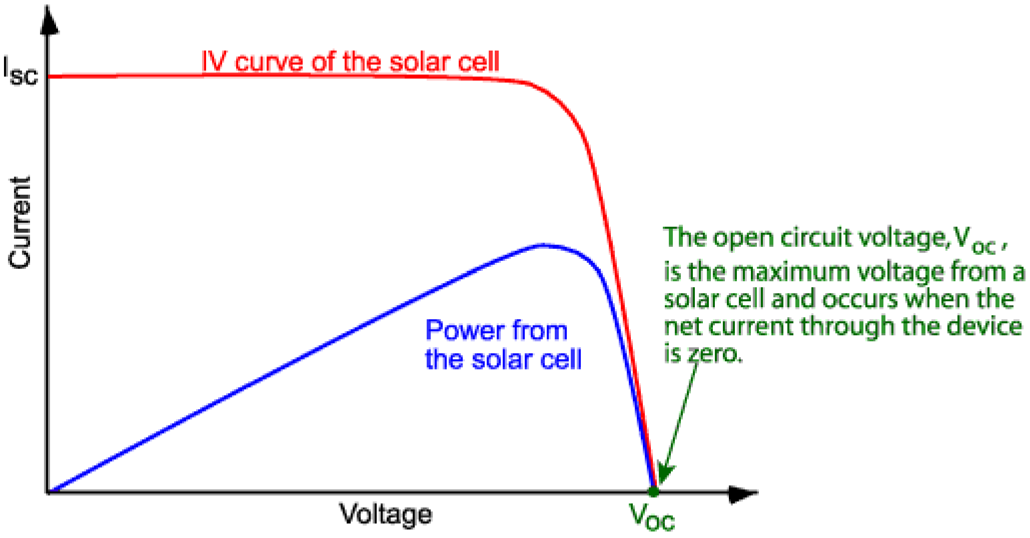


Figure 3. IV curve of a solar cell showing the open-circuit voltage.

$$J_{SC} = qG(L_n + L_p) \quad (4)$$

$$I_{SC} = J_{SC} A \quad (5)$$

$$V_{OC} = \frac{2K_B T}{q} \ln(\frac{I_L}{I_0} + 1) \quad (6)$$

$$FF = \frac{V_{MP} I_{MP}}{V_{OC} I_{SC}} \quad (7)$$

$$V_{MP} = V_{OC} - \frac{2K_B T}{q} \ln(q \frac{V_{MP}}{2K_B T} + 1) \quad (8)$$

$$FF = \frac{V_{OC} - \ln(V_{OC} + 0.72)}{V_{OC} + 1} \quad (9)$$

$$V_{OC} = \frac{q}{2K_B T} V_{OC} \quad (10)$$

$$P_{\max} = V_{OC} I_{SC} FF \quad (11)$$

$$\eta = \frac{V_{OC} I_{SC} FF}{P_{in}} \quad (12)$$

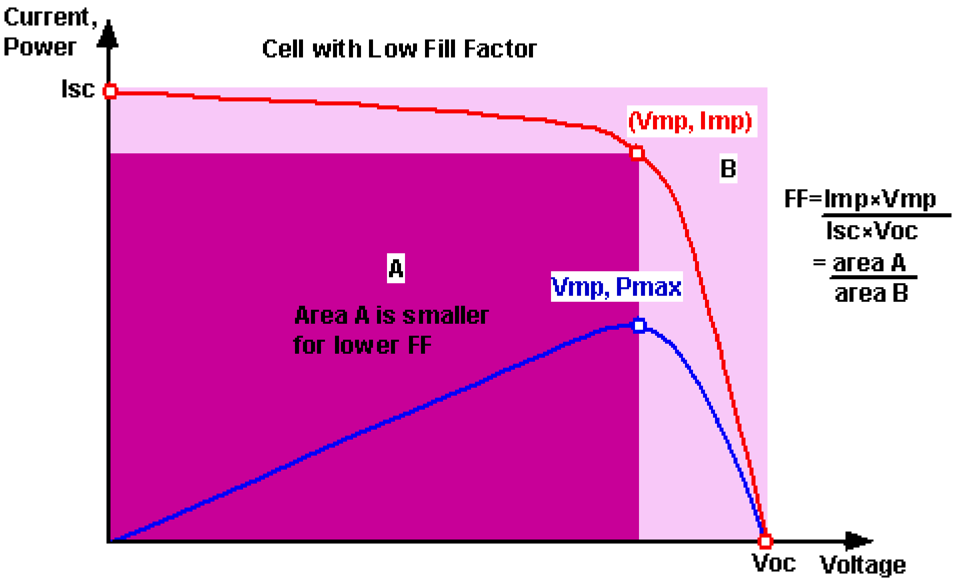


Figure 4. Graph of cell output current (red line) and power (blue line) as function of voltage. Also shown are the cell short-circuit current (I_{sc}) and open-circuit voltage (V_{oc}) points, as well as the maximum power point (V_{mp}, I_{mp}). Click on the graph to see how the curve changes for a cell with low FF.

Here I is the current, I_0 is the preterm exponential current, q is the charge of electron, V is the voltage, I_L is the current due to illumination of light, K_B is the Boltzmann's constant, J_{SC} is the short circuit current density, I_{SC} is short circuit current, A is the area, V_{OC} is the open circuit voltage, FF is the fill factor, V_{MP} is the maximum voltage, I_{MP} is the maximum current, P_{max} is the maximum power, η is the efficiency.

1.2 Einstein photoelectric effect [6]

The maximum kinetic energy of the electrons that were delivered this much energy before being removed from their atomic binding is

$K_{max}=h\upsilon-W$ (13)

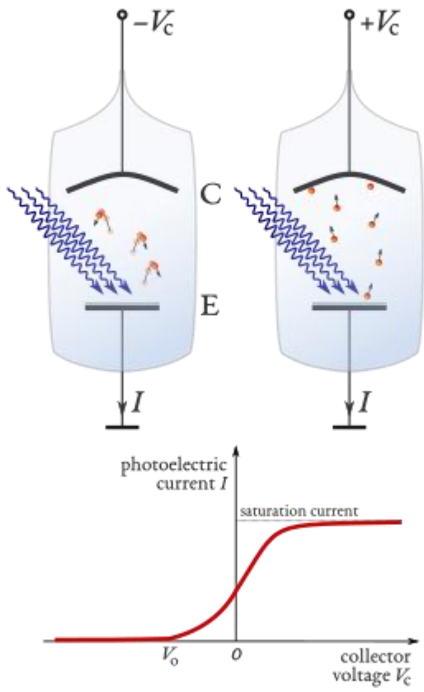


Figure 5. Collector voltage Vs. Photoelectric current

where W is the minimum energy required to remove an electron from the surface of the material. It is called the work function of the surface and is sometimes denoted φ. If the work function is written as

W= $h\upsilon_0$, the formula for the maximum kinetic energy of the ejected electrons becomes

$K_{max}=h(\upsilon-\upsilon_0)$

Kinetic energy is positive, and $\upsilon>\upsilon_0$ is required for the photoelectric effect to occur. The frequency υ_0 is the threshold frequency for the given material. Above that frequency, the maximum kinetic energy of the photoelectrons as well as the stopping voltage in the experiment $V0=h(\upsilon-\upsilon_0)$ rise linearly with the frequency, and have no dependence on the number of photons and the intensity of the impinging monochromatic light.

Here K_{max} is the maximum kinetic energy, h is the plank's constant, W is minimum energy required to eject electron from metal surface by incident light, V_C is the collector voltage, I is the photoelectric current, υ is the frequency, υ_0 is the preterm frequency or scattered frequency of light.

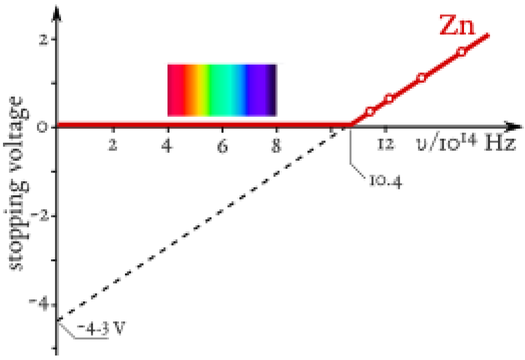


Figure 6. Diagram of maximum kinetic energy as a function of the frequency of light an Zinc.

2. Reasoning and analysis of evaluation of solar cell parameters and Einstein photoelectric effect:

2.1 solar cell parameters

The equation for current under the illumination of light is

$$I = I_0[\exp(\frac{qV}{2K_BT})-1]-I_L \qquad (1)$$

This can be rewritten as

$$\frac{(I+I_L)}{I_0} = \exp(\frac{qV}{2K_BT})-1$$

$$\frac{(I+I_L)}{I_0} = 1+\frac{qV}{2K_BT}-1 \textit{where} \ \exp(\frac{qV}{2K_BT}) = 1+(\frac{qV}{2K_BT})$$

$$\frac{(I+I_L)}{I_0} = \frac{qV}{2K_BT}$$

$$V = \frac{2K_BT}{q} * \frac{(I+I_L)}{I_0} \qquad (14)$$

According to equation(3) V is as given below and this wrong and the correct equation is equation (14). The figures 1-4 are wrong and the correct figures are figure 7 and 8.

$$V = \frac{2K_BT}{q}\ln(\frac{I_L-I}{I_0})$$

If we plot V and $\frac{(I+I_L)}{I_0}$ then the figure is as shown below

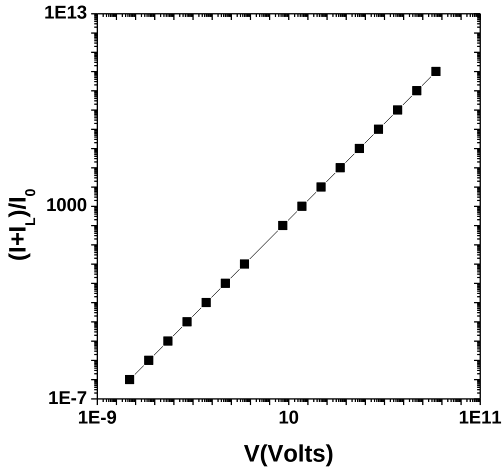
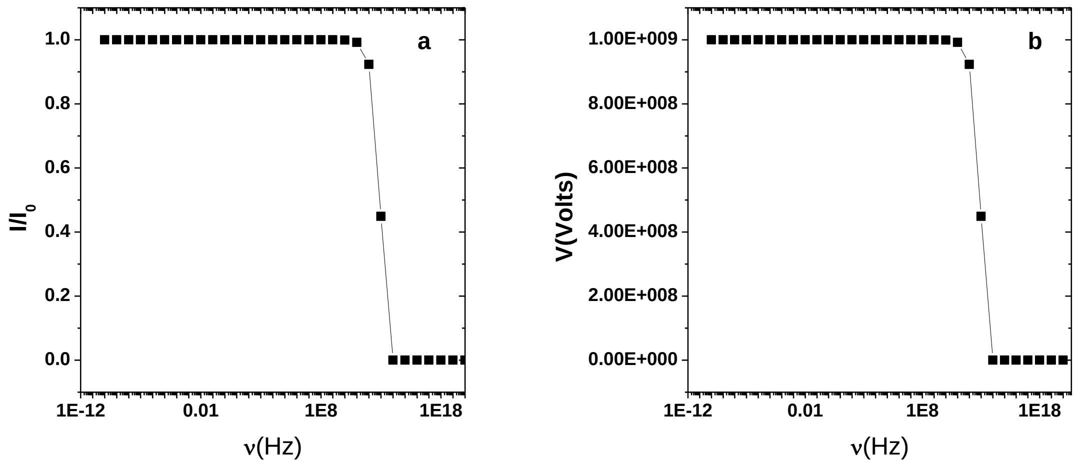


Figure 7. $(I+I_L)/I_0$ Vs. V

The figure 1 showing the plot I Vs. V is wrong and the figure showing (I+IL)/I0 Vs V is correct similarly the figure 2 and figure 3& 4 are wrong. The equation 1 is wrong which shows relationship between I and V. The correct equation is as given below i.e equation 15 which shows relationship between I and ν . In solar cell one measures current under the illumination of light with frequency ν . This is the correct method of doing so.



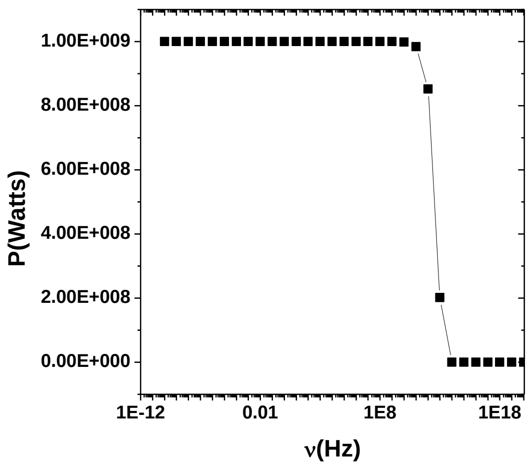


Figure 8. (a) I/I0 Vs. Frequency, (b) V Vs. Frequency and (c) Power Vs. Frequency.

$$I = I_0 \exp(\frac{-h\nu}{2K_B T}) \qquad (15)$$

This equation is rewritten as

$$\frac{I}{I_0} = \exp(\frac{-h\nu}{2K_B T})$$

If we plot figure with I/I0 Vs ν the figure is as shown in figure 8.

If we take resistance 1e9 Ohms then the V can be obtained from ohms law and the equation is $(I*R)/I_0$. Then again the power is obtained by equation V*I. The figure showing the plots between V Vs. ν and P Vs. ν are shown in figure 8 (a-c).

The equation to estimate the efficiency as given by equation (12) is wrong and the correct equation to estimate the efficiency is given as below

$$\eta = 100 - (\frac{P_{in} - P_{out}}{P_{in}})*100$$

2.2 Einstein Photoelectric effect

According to Einstein the Maximum kinetic energy attained by electron with the incident of the photons with frequency ν is given by equation $K_{max}=h(\nu - \nu_0)$ and also according to him the stopping voltage is given by equation $V_O=h(\nu - \nu 0)/e$ where e is the charge of electron. The photocurrent Vs. Stopping voltage and also the plot between stopping voltage and frequency are given in figures 5 and 6. These figures are wrong and the correct figures are figures 9(a-d).

In the present manuscript we have estimated the stopping voltage as a function of frequency and is shown in figute 9a. If we take resistance 1e6 Ohms (for insulating) and 1e-6 (for conducting) Ohms then the I and I_{SC} can be obtained from ohms law. The figure showing the plots between I Vs. ν and I_{SC} Vs. ν are shown in figure 9(b,c). The number density of photons incident on metal surface and number of electrons (N) ejected from the metal surface are given by equation $N = N_A \exp(\frac{-h\nu}{2K_B T})$ where N_A is the Avogadro number. The figure between N and ν is shown in figure 9d.

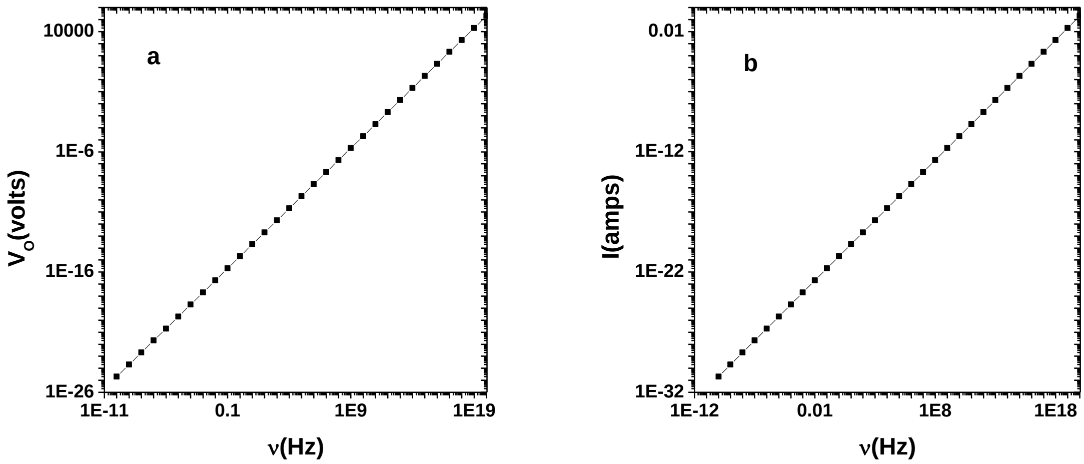


Figure 9. (a) Vo Vs. Frequency and (b) I Vs. Frequency

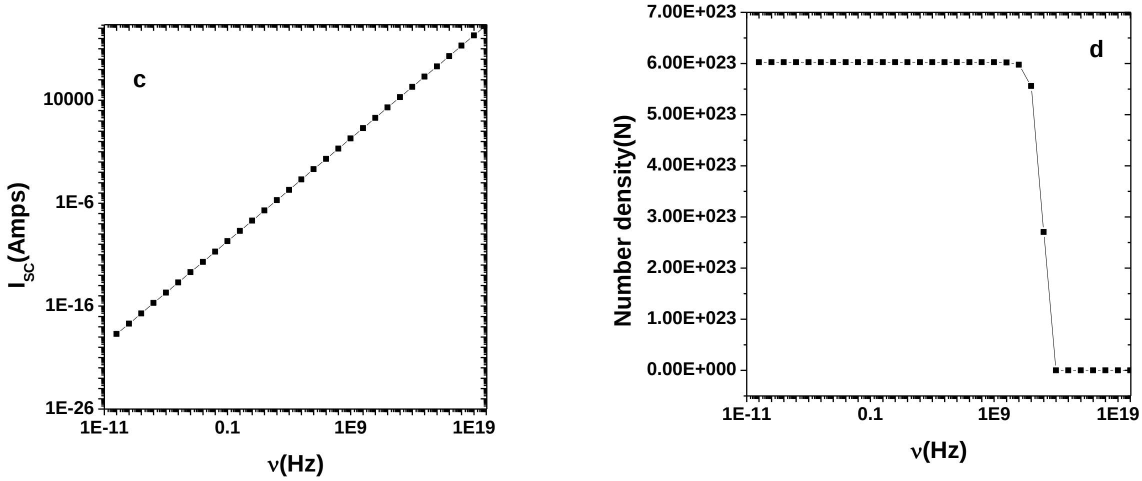


Figure 9. (c) I_{SC} (for semiconducting) Vs. Frequency and (d) N Vs. Frequency

3. Conclusions:

In the present paper revisiting of solar cell parameters and Einstein photoelectric effect have been done through calculation, reasoning and analysis. These equations have been proved to be wrong through calculations and analysis. The probable correct solutions of solar cell parameters are presented in this paper which is appropriate. Similarly is the case with Einstein photoelectric effect. It has been proved wrong through plots relating to different type of current (I, I_{SC}), voltage and number density as a function of frequency.

References:

[1]. https://www.pveducation.org/pvcdrom/solar-cell-operation/iv-curve
[2]. https://www.pveducation.org/pvcdrom/solar-cell-operation/short-circuit-current
[3]. https://www.pveducation.org/pvcdrom/solar-cell-operation/open-circuit-voltage
[4]. https://www.pveducation.org/pvcdrom/solar-cell-operation/fill-factor
[5]. https://www.pveducation.org/pvcdrom/solar-cell-operation/solar-cell-efficiency
[6]. Wikipedia contributors. (2022, October 6). Photoelectric effect. In *Wikipedia, The Free Encyclopedia*. Retrieved 07:24, October 14, 2022, from https://en.wikipedia.org/w/index.php?title=Photoelectric_effect&oldid=1114489343