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The experiment of double solar energy by reflection light method

S. Julajaturasirarath¹, W. Jonburom², N. Pornsuwancharoen³

¹Nano Photonics Research Group, Department of Electrical Engineering, Faculty of Industry and Technology, Rajamangala University of Technology Isan, Sakon Nakhon Campus, Sakon Nakhon, 47160, Thailand
²Advance Research Center for Photonics, Faculty of Science, King Mongkut’s Institute of Technology Ladkrabang, Bangkok, 10520, Thailand

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Abstract

This paper we propose a novel conception design that can be used to generate double power the new optical solar energy using reflection solar light propagating within photo voltage PV system. By the four mirror reflection upon the solar cell occurs the solar energy have double energy for 10 W to 20 W. The temperature effect relation the power solar energy in this paper have clear concept the heat by water sink and winding flow for under solar cell in discussion section.

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1. Introduction

Solar cells are often electrically connected and encapsulated as a module. Photovoltaic modules often have a sheet of glass on the front (sun up) side, allowing light to pass while protecting the semiconductor wafers from abrasion and impact due to wind-driven debris, rain, hail, etc. Solar cells are also usually connected in series in modules, creating an additive voltage. Connecting cells in parallel will yield a higher current; however, very significant problems exist with parallel connections. For example, shadow effects can shut down the weaker (less illuminated) parallel string (a number of series connected cells) causing substantial power loss and even damaging excessive reverse bias applied to the shadowed cells by their illuminated partners. As far as possible, strings of series cells should be handled independently and

* Corresponding author. E-mail address: jeewuttinun@gmail.com.
not connected in parallel, save using special paralleling circuits. Although modules can be interconnected in series and/or parallel to create an array with the desired peak DC voltage and loading current capacity, using independent MPPTs (maximum power point trackers) provides a better solution. In the absence of paralleling circuits, shunt diodes can be used to reduce the power loss due to shadowing in arrays with series/parallel connected cells. The optimization of the energy in a solar cell works as follows.

Double layer SiNx:H films for passivation and anti-reflection coating of c-Si solar cells [1], Effects of metal electrode reflection and layer thicknesses on the performance of inverted organic solar cell [2], Low temperature deposited boron nitride thin films for a robust anti-reflection coating of solar cells [3], The effects of a double layer anti-reflection coating for a buried contact solar cell application [4], Double exposure flat-plate collector and Determination of the optimum orientation for the double exposure flat-plate collector and its reflectors [5-7]. Energy management in solar thermal power plants with double thermal storage system and subdivided solar field and Energy sufficiency potential for combination system of solar energy and electricity system in north-East of Thailand [8-9]. The application for double energy instance as the enhancement of energy gain of solar collectors and photovoltaic panels by the reflection of solar beams [10], experimental investigation of high temperature congregating energy solar stove with sun light funnel [11], concentration ratios for flat-plate solar collectors with adjustable flat mirrors [12] and theoretical and experimental assessment of a double exposure solar cooker [13].

In this paper, we present theory and background, Math-model of solar cell, the Laws of reflection and summary of results from experiments and used as an alternative fuel technology a little more simple and uncomplicated.

2. Theory and Background

The characteristic of solar cell can be description by curve has shown be relation current and voltage of solar cell (IV-Curve) which the solar cell curve can be show 3 types the cell side, module side and array side use to this curve show in Fig. 1. [9]

- Maximum current value ($I_m$) is the maximum current of solar cell with load.
- Maximum voltage value ($V_m$) is the maximum voltage of solar cell with load.
- Short-circuit Current value ($I_{sc}$) is the current of solar cell short circuit.
- Open-circuit Voltage value ($V_{oc}$) is the voltage of solar cell short circuit without load.
- Maximum power value ($P_m$) is the maximum power output of solar cell without load.
- Fill Factor value ($F.F$) is ratio of the maximum power to the Current short circuit value multiple the voltage of solar cell short circuit with show that equation (1).
The solar cell should be has field factor more than is 0.7 for the maximum efficiency power.

-Maximum Efficiency ($\eta_m$) is ratio of maximum power to total output power of solar cell so that equation (2)

$$\eta_m = \left[ \frac{P_m}{A_m G_T} \right] \times 100\%$$

where $A_m$ is area solar light (m$^2$)

$G_T$ is intensity of solar energy (W/m$^2$)

3. Math-model of solar cell

The solar cell can be show equivalent circuit is shown in Fig. 2. Which are consist of the diode and the inner resistor parallel connecting ($R_p$ and the series resistor $R_s$) has effect for characteristics and property of solar cell.

![Equivalent circuit of solar cell](image)

In Fig. 2 show the equivalent circuit has the output current variable follow up the voltage of solar cell which the Equation (3) can be written as:

$$I = I_{ph} - I_D = I_{ph} - I_{sat} \left[ e^{\frac{V + J R_s}{V_T}} - 1 \right]$$

where $I_{ph}$ is the current of photonic.

$V_T$ is the thermal voltage.

$I_{sat}$ is the saturation current of diode.
In the status of short circuit condition in Fig. 3(a), which can written the relation of the current of photonic to the equation (2) is shown as:

\[ I_{ph} = I_D + I_{sc} \]  

(4)

For case short-circuit status of solar cell, the current diode have a little more less we can neglects. The current of photo can be written as in equation (5)

\[ I_{ph} (G_a, T) = I_{scs} \frac{G_a}{G_{as}} \left[ 1 + \Delta I_{sc} (T - T_s) \right] \]  

(5)

where  
\( G_a \) is intensity value (W).  
\( T \) is absolute temperature (Kelvin).  
\( I_{scs} \) is standard short-circuit current (STC).  
\( G_{as} \) is standard of intensity value (1000W/m²).  
\( \Delta I_{sc} \) is the short-circuit current variable the temperature value (A).  
\( T_s \) is standard temperature value (298 K).

In the case of open circuit condition from equivalent circuit in Fig. 3 (b) can be calculation the open-circuit voltage is shown in equation (6).

\[ V_{oc} (T) = V_{ocs} + \Delta V_{oc} (T - T_s) \]  

(6)

where \( V_{ocs} \) is open-circuit voltage value on standard and \( \Delta V_{oc} \) is open-circuit voltage at variable coefficient of temperature, from equivalent circuit can be fine the current path of diode show in equation (7) and (8).

\[ I_{ph} (G_a, T) = I_D (G_a, T) \]  

(7)

\[ I_D (G_a, T) = I_{sat} (G_a, T) \times \left[ \frac{V_{oc}}{e^{V_{oc}/V_T}} - 1 \right] \]  

(8)

The voltage of pole solar cell is  
\[ V(T) = \frac{A k T}{q} \]  

where  
\( A \) is ideality Factor value
$I_{sat}$ is the saturation current of diode variable intensity.

$q$ is capacitance value $1.602 \times 10^{-19}$ coulomb.

$k$ is Boltzman Constance value $1.38 \times 10^{-23}$J/K

Replace the equation (5) and (6) for finding the saturation current of diode $I_{sat}$ show in equation (9).

$$I_{sat}(G_a, T) = \frac{I_{ph}(G_a, T)}{e^{\left(\frac{V_{sat}(T)}{V_i(T)}\right)}} - 1$$  \hspace{1cm} (9)

In the Fig. 2 we can be written the equation (10) and (11) with find the current maximum ($I_{mpp}$) relation to voltage maximum ($V_{mpp}$). By replace the equation (7) into equation (8) for current maximum show in equation (11).

$$I_{mpp} = I_{ph} - I_{sat} \left[ e^{\left(\frac{V_{mpp}+IR_t}{V_t}\right)} - 1 \right]$$  \hspace{1cm} (10)

$$I_{mpp} = I_{ph} - \left[ e^{\left(\frac{V_{mpp}+IR_t}{V_t}\right)} - 1 \right] I_{ph}$$  \hspace{1cm} (11)

The equation (9) we can finding relation between the resistance series ($R_s$) and Thermal Voltage ($V_t$) written as

$$V_t \ln \left[ \left( 1 - \frac{I_{mpp}}{I_{ph}} \right) e^{\left(\frac{V_{mpp}}{V_t}\right)} + \frac{I_{mpp}}{I_{ph}} \right] - V_{mpp}$$

$$R_s = \frac{1}{I_{mpp}}$$  \hspace{1cm} (12)

where the thermal voltage ($V_t$) is effect to the ideality factor ($A$) and temperature value relation to series resistance at power maximum point of solar cell so that $\frac{dP}{dV} = 0$ when $P = VI$ and we can written as

$$\frac{dI}{dV} + \frac{I}{V} = 0$$  \hspace{1cm} (13)

Replace the equation (13) into the equation (11) show on equation (14) and (15).

$$\frac{dI}{dV} = -I_{sat} \left\{ e^{\left(\frac{V+IR_t}{V_t}\right)} \left[ \frac{1}{V_t} + \left(\frac{R_s}{V_t}\right) dV \right] \right\}$$  \hspace{1cm} (14)
\[
\frac{dI}{dV}
= \frac{I_{\text{sat}} \frac{V_{\text{mpp}} + IR_s}{V_i} - I_{\text{sat}} e^\frac{V_{\text{mpp}} + IR_s}{V_i} \left(1 + \frac{R_s}{V_i} e^\frac{V_{\text{mpp}} + IR_s}{V_i}\right)}{V_i}
\]

(15)

From equation (12) is calculation the \(\frac{dI}{dV}\) on the maximum power point when compare to the \(\frac{I_{\text{mpp}}}{V_{\text{mpp}}}\).

The characteristic of output solar cell has dependent on Ideality factor value (A) and the series resistance \(\bar{R}\).

4. The Laws of reflection

A light ray is a stream of light with the smallest possible cross-sectional area. (Rays are theoretical constructs.) The incident ray is defined as a ray approaching a surface. The point of incidence is where the incident ray strikes a surface. The normal is a construction line drawn perpendicular to the surface at the point of incidence. The reflected ray is the portion of the incident ray that leaves the surface at the point of incidence. The angle of incidence is the angle between the incident ray and the normal. The angle of reflection is the angle between the normal and the reflected ray.

- The angle of incidence is equal to the angle of reflection.
- The incident ray, the normal, and the reflected ray are coplanar.

Specular reflection (regular reflection) occurs when incident parallel rays are also reflected parallel from a smooth surface. If the surface is rough (on a microscopic level), parallel incident rays are no longer parallel when reflected. This results in diffuse reflection (irregular reflection). The laws of reflection apply to diffuse reflection. The irregular surface can be considered to be made up of a large number of small planar reflecting surfaces positioned at slightly different angles. Indirect (or diffuse) lighting produces soft shadows. It produces less eye strain than harsher, direct lighting.

\[
\theta_i = \theta_r
\]

(16)
In Fig. 6 show the normal experiment set up the solar cell plant for result. The installation of solar cells, it should be good to have a tilt angle of 15 degrees of south for the intensity of the sun and solar energy as possible. As shown in Fig. 6 (a) and (b).

Fig. 7. shows the experiment of solar cell double energy setup

Fig. 7 shows the structure of mirrors to reflect light in a trial basis. By using a solar cell panel is designed with a reflector 4 sides and the intensity of light from the sun is reflected through a mirror at an angle of 60 degrees with solar cells. When the light intensity increased the current from solar cells has increased in the equation (8) and equation (9). When the increased intensity of sunlight 4 sides added the current of solar cells compared to the current of normal solar cells. The resulting solar cells have twice the energy, which the results are shown in Fig. 8.

5. Result and Discussion

Experimental optimization of a solar cell with a glass of light is to install a solar cell panel by panel, 10W 2 is a panel that uses mirrors to reflect light for increase the intensity of light. And keep records of current and voltage of solar cells and solar cells for comparison with the traditional model.
In Fig. 8 shows the performance comparison is to increase the double power of solar cells. The red line is the current obtained from the collection of solar cells. A normal measurement is 0.58 amps. The blue line show the current is derived from the results of solar cells. Modeling, optimization of solar cells by using mirrors to combine the two as a light measurement is 1.360 amps which increases the energy of the solar cell is doubled.

In Fig. 9 is an illustration of the efficiency of the voltage of the solar cell. The red line graph show the voltage from the collection of solar cells can be measured voltage to 20 volts. The blue line show the voltage output from the panel model, which the optimization of solar cells by using mirrors in the light. We can measure the voltage at 19.5 volts, the voltage at which it will be similar.

In Fig. 10 is an illustration of the comparative efficiency of electric power capacity of solar cells. The red line graph show the watts of electrical power is derived from the results of solar cell can measure the average power is 10.41 W and the blue line show the watts of electrical power is derived from a panel of model optimization of solar cells by using a mirror reflection of light. We can measure the average power is 25.12 W, which increases the energy of solar cells is doubled as of 08/12/2010.

In Fig. 11 shows the average electric power obtained from the experimental results, the energy of solar cells. The solar cell panel 1 is a 10 watt panel as the panel model 2 is the optimization of solar cells by
using mirrors reflection of light. The experiment and collect data and test results from December 8, 2010 to December 14, 2010, there were seven days of treatment, the panel model, the optimization of solar cells by using mirrors reflection of light. Solar cells can increase the energy of the double is 10 watts of average power is increased 22 watts average power and show that on 12/12/2010 the date of the Thunderstorm, fog or no sun at all.

6. Concussion

We present a new technique designed to increase energy generation from solar cells. The reflectivity of the mirror can provide more energy than traditional panels. The experimental data collected during 7 days from the date of December 8, 2010 to December 14, 2010 from the experimental results it was found that the watt average solar panels that use mirrors to reflect the past more than doubled to the watts of power from the solar panel to normal. This research although we are able to add energy to the panel, the real star hotels of the mirror reflectivity. But we have not studied the lifetime of the solar cell and other affected or not, because the effect of light will cause the temperature in the solar cell is higher. The efficiency of solar cells has efficiency in converting light energy into electrical energy low reduction. However, if the new use of this and we can save money to buy solar cells in near future.

References