Journal of Materials and Electronic Devices 6 (2020) 18-20

Electrical Characterization of Photodiodes and Solar Cells with FYTRONIX Solar IV Characterization System

Ayşegül Dere

[1]Firat University, Nanoscience and Technology Laboratory, Elazig, Turkey

This paper summarizes the utilization of FYTRONIX solar simulator to determine photovoltaic parameters (short circuit current Isc, open circuit voltage Voc, fill factor FF, maximum power Pmax, maximum voltage Vmax, maximum current Imax, series resistance Rs, shunt resistance Rsh, characterization resistance Rch, analysis of photovoltaic mechanism) of the solar cells such as dye sensitized solar cell, organic solar cell, silicon solar cells, thin film solar cell). In order to determine photovoltaic parameters, FYTRONIX solar simulator automatically measures current-voltage (I-V), power-voltage (P-V), short circuit current- Intensity (Isc-Pin), short circuit current-time (Isc-t), open circuit voltage (Voc-t) under various intensities. In this paper, it is mainly also aimed how to be determined the photovoltaic parameters and possible photovoltaic mechanism in the any solar cell by FYTRONIX Full automatic solar simulator.

Keywords: *Solar cell, Photovoltaic parameters*

Submission Date: 18 October 2020
Acceptance Date: 29 December 2020

**Corresponding author: a.dere@firat.edu.tr*

1. Introduction

The solar simulators have been extensively used in solar cell characterization. There are large varieties of solar simulators to analyze the photovoltaic behavior. The solar simulators are Xenon lamp solar simulator, Tungsten halogen solar simulator, metal halide solar simulator, LED solar simulators. Xenon solar simulator cannot change light intensity by itself and it gives a irradiation of 1 SUN, 1000 W/m2 or 100 mW/cm2. Whereas FYTRONIX solar simulator automatically changes intensity of its from 0.1 mW/cm2 (1 W/m2) to 100 mW/cm2 (1000 W/m2).
In present study, FYTRONIX Full Automatic Solar Simulator is used to determine photovoltaic parameters such as short circuit current, open circuit voltage, maximum current, maximum voltage, maximum power, series resistance, shunt resistance, characteristic resistance and photovoltaic mechanism.

2. Theoretical backgrounds

2.1. I-V characteristics of electronic devices

The photoconducting and photovoltaic parameters of photodiodes, solar cells, phototransistors, photosensors and photodetectors can be determined from current-voltage (I-V) measurements of the cell. These I-V characteristics can be measured using a FYTRONIX 8000 electronic devices characterization system. The current of electronic devices is measured as a function of the applied voltage. Two types of source meter are available for the FYTRONIX SC: the FYTRONIX 7000, which can source/sink up to 500 mA, and the 8000-SMU, which can source/sink up to 1A.
The equivalent circuit of a photovoltaic device is presented by Fig.1. The photocurrent of solar cells is defined by the following relation

$I_{photo} = I_o (e^{qV/kT} - 1)$

Where I_o is the saturation current, I_{photo} is the photocurrent, q is the electronic charge, k is the Boltzmann constant and T is the temperature. The series r_s, and shunt r_{sh} resistances are parasitic resistances. The resistance of metal contacts causes the series resistance. This resistance affects the energy conversion efficiency, short circuit current I_{sc} and open circuit voltage, V_{oc}. When the solar cells are fabricated, this parameter should have lowest value (r_s=0). The r_{sh} is resulted from surface leakage along the edge of the cell. For ideal solar cells, R_{sh} value should have a highest value (r_{sh}=∞).

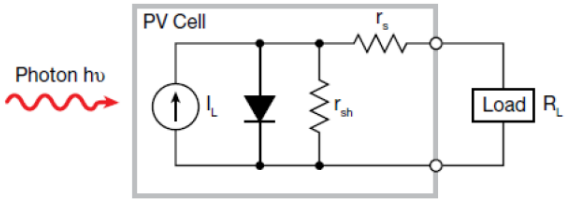

Fig.1. Equivalent circuit of a solar cell

The current-voltage characteristic of the solar cells is shown in Fig. 2.

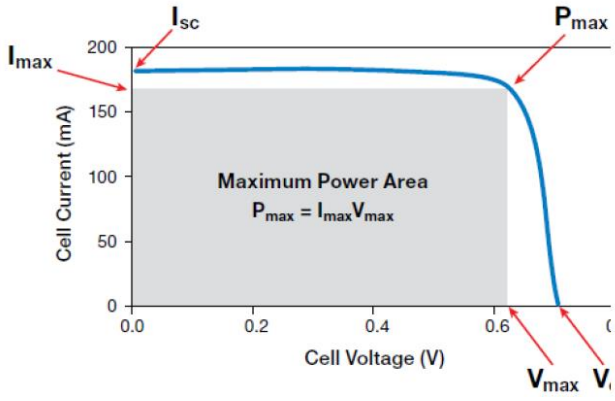

Fig.2. The current-voltage characteristic of the solar cell

As shown in Fig.2, the Isc is the short circuit current, Voc is the open circuit voltage, Imax is the maximum current, Vmax is the maximum voltage and Pmax is the maximum power. The Voc and Isc is determined from Fig.2. The Voc corresponds to the voltage at cell current=0, wheras Isc corresponds to the current at cell voltage=0. The Imax is the maximum current and Vmax is maximum voltage, when solar cell is loaded. The Pmax is the maximum power when the solar cell is loaded. FF and η are respectively energy conversion efficiency, η, and the fill factor FF. The maximum power point is located at the "knee" of the curve in Fig.2. Also, Pmax is determined by Imax. Vmax. The power-voltage (P-V) curve of any solar cell is calculated by multiplying of current with voltage for all bias voltage values as I.V. The current-voltage (I-V) characteristics of amorphous silicon solar cell is measured by FYTRONIX Full Otomatik Solar Simulator with intensity ranging from 10 mW/cm2 to 100 mW/cm2 (1000 W/m2) with step of 1 mW/cm2 and are shown in Fig3.

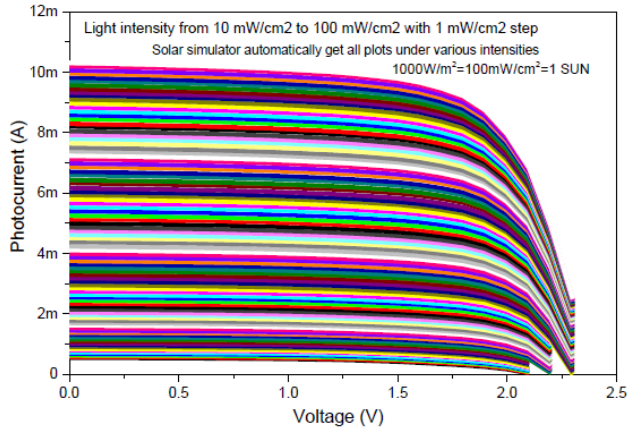

Fig.3. I-V characteristics of amorphous silicon solar cell

As shown in Fig.3, the current of solar cell is increased with increasing intensity. The P-V characteristics of amorphous silicon solar cell is automatically measured via FYTRONIX solar simulator and are shown in Fig.4.

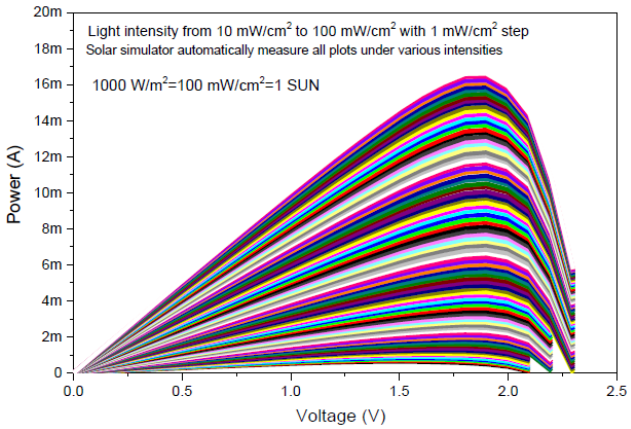

Fig.4. P-V characteristics of amorphous silicon solar cell

Fig.4 shows that P-V curves indicate a maximum point, Pmax. The Pmax corresponds to maximum power when solar cell is loaded. FYTRONIX solar simulator automatically is determined all photovoltaic parameters such as η, Isc, Voc, Imax, Vmax, Pmax, Rs, Rsh, Rch,

FYTRONIX SOLAR SIMULATOR SYSTEM measures the followings

Solar Simulator system is controlled automatically by computer Solar Simulator system adjusts automatically the intensity of light 0.1 W/m2 -1000 W /m2 by any step, for example from 1 W/m2 to 1000 W/m2 with 1 W/m2. Solar Simulator system automatically measures current-voltage (I-V) under various light intensities Solar Simulator system automatically measures power-voltage (P-V) under various light intensities

Solar Simulator system automatically analyses photovoltaic mechanism (I-V) under various light intensities Solar Simulator system automatically measures photo transient current-time (I-t) under various light intensities Solar Simulator system measures automatically open circuit voltage-time (Voc-t) under various light intensities Solar Simulator system measures automatically short current-time (Isc-t) under various light intensities

4. Conclusion

FYTRONIX solar simulator is used to measure the electrical characteristics of a solar cell to determine the device's output performance and efficiency. The FFYTRONIX SM 8000 simplifies cell testingby automating the I-V, phototransient characteristic measurements and provides graphics and analysis. For measurements of currents, FYTRONIX offers SourceMeter that can be used for solar cell measurements. Information on solar simulator and further information on making solar cell measurements can be found on Fytronix's website: www.fytronix.com

References

[1] Bestoon Anwer Gozeh, Abdulkerim Karabulut, Abdulkadir Yildiz, Fahrettin Yakuphanoglu, Solar light responsive ZnO nanoparticles adjusted using Cd and La Co-dopant photodetector, Journal of Alloys and Compounds 732 (2018) 16-24