# ESTIMATION OF PARAMETERS FOR A MODEL OF POLYCRYSTALLINE SOLAR CELLS

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**Abstract**. In many countries of the world the main factor for increasing energy potential and saving environment is applying non-conventional energy. Renewable energy is mostly connected with solar radiation. Above all, mastering solar energy depends on technological advancement. Main goal of scientists is to increase efficiency of photoelectric converting system and decreasing its cost. The parameters are required to be correctly computed from solar cell characteristic or a set of experimental data for control of the photovoltaic (PV) system. However, experimental data or accurate characteristic data (i.e. current-voltage or I-V curve) of a PV module may not be readily available. The present paper describes calculations of solar cell parameters, based on polycrystalline silicon, using experimental and theoretical approaches. Finding appropriate circuit model parameters of solar cells is crucial for performance evaluation, control, efficiency computations and maximum power point tracking of solar PV systems. Based on the conducted review, some suggestions are provided.

## 1. Introduction

Mastering of solar energy is directly connected with development of technology. Main goal of scientists is to increase efficiency and decrease price of photoelectric converter. New structures are introduced based on Silicon, which makes possible to decrease optical and recombination losses [1-3]. A solar cell or photovoltaic (PV) module is electrically represented by an appropriate circuit model with specific parameters. The parameters are required to be correctly computed from solar cell characteristic and a set of experimental data control of the PV system. Efficiency of photoelectric converter is defined by its current-voltage characteristics and it is one of the most important parameters. Based on polycrystalline Silicon, using theoretical and experimental methods we studied following parameters of solar cell: current-voltage dependence, short circuit current ($I_{SC}$), open circuit voltage ($V_{OC}$), fill factor (FF) and conversion efficiency [1-5].

## 2. Theory

Theoretical calculations were made based on standard parameters of crystalline silicon. $I_{SC}$=350 μA, $V_{OC}$=0,67 V. Assuming that the solar cell behaves as an ideal diode, the fill factor can be calculated as a function of open circuit voltage $V_{OC}$ [4-7]:

$$FF = \frac{v_{oc} - \ln(v_{oc}+0{,}72)}{v_{oc}+1} = 0{,}84 \qquad (1)$$

where

$$v_{oc} = \frac{V_{oc}}{k_B T / q} = \frac{0{,}67\,V}{0{,}0258\,V} = 26{,}8 \qquad (2)$$

is normalized voltage.

The conversion efficiency is calculated as the ratio between the maximum generated power and incident power:

$$\eta = \frac{I_{SC} \cdot V_{OC} FF}{I_{in}} = 19{,}7\% \qquad (3)$$

where $I_{in}$ is irradiance of incident light in AM1.5 spectrum.

## 3. Experiment

Experiments were performed on regular solar cell, found on market, with following characteristics: sample manufacturer – NUZAMAS, dimensions - 90x60x2mm, $V_{max}$=6 V, $P_{max}$=0,6 W. Using multi meter we measured $V_{OC}$, $I_{SC}$, $I_{mpp}$ (current at maximum power point), $V_{mpp}$ (voltage at maximum power point) and by changing resistance measured current voltage at different values of external resistance.

As a result: $I_{SC}$=49,9 μA, $V_{OC}$=5,3 V, $I_{mpp}$=34,8 μA, $V_{mpp}$=3,9 V. Using these results fill factor and conversion efficiency (η) were calculated:

$$FF = \frac{(V_{mpp} \cdot I_{mpp})}{(I_{SC} \cdot V_{OC})} = \frac{3,9 \cdot 34,8}{49,9 \cdot 5,3} = 0,51 \tag{4}$$

$$\eta = \frac{I_{SC} \cdot V_{OC} \cdot FF}{I_{in}} = \frac{49,9 \cdot 5,3 \cdot 0,51}{1000} = 0,13 = 13\% \tag{5}$$

Volt-ampere characteristics of the solar cell are shown on Fig.1:

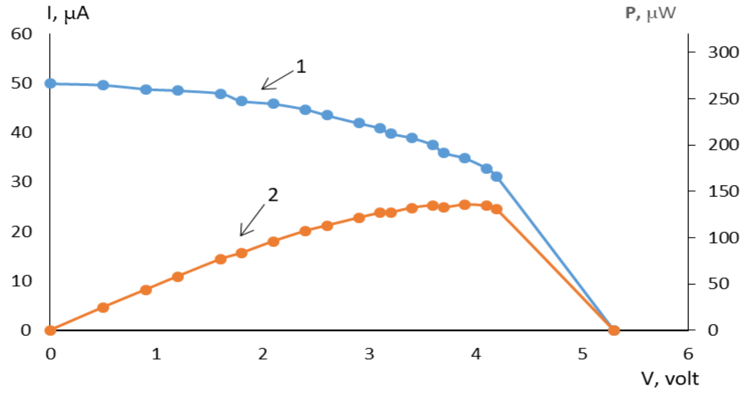


Fig.1. Dependences of the Electric Current (1) and Power (2) on the Voltage for the polycrystalline solar cell.

## Conclusions

Solar cell parameter's dependence on photoelectric properties of semiconductor were studied. Using experimental results, volt-ampere characteristic chart was created and from this chart short circuit current, open circuit voltage, fill factor and conversion efficiency were defined. Polycrystalline Silicon Solar Cell parameters were calculated theoretically. Theoretical and experimental results showed that, ordinary solar cells, found on market, have low fill factor and conversion efficiency and in most cases they produce less electric current and voltage than according to the model description from the manufacturer datasheet. The manufacturer of a PV system usually provides information on open circuit voltage, short circuit current and maximum power points. Though knowing specific parameters (fill factor (FF) or conversion efficiency) of PV cells is crucial for performance evaluation, control, efficiency computations and maximum power point tracking of solar PV systems.

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