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MODELLING OF THE MONOCHROMATIC PHOTON-TO-CURRENT EFFICIENCY OF SOLAR CELLS USING MATLAB

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ABSTRACT
The performance of solar cells depends on their monochromatic photon-to-current efficiency. In this study a model of the monochromatic photon-to-current efficiency (MPCE) was develop following the relation: MPCE = J_{sc} x V_{oc} x FF / P_i, using matlab.
At the end the mode of operation of the model was explained. The aim of this research is to promote the use of matlab in scientific study.
Keywords: Monochromatic, Photon, Current, Efficiency, Solar cells

INTRODUCTION
Monochromatic photon-to-current efficiency is said to be the power density delivered at a solar cell's operating point as a fraction of the incident light power density, Pi. Mathematically, we can represent it as (Tan, 2008):

$$MPCE = J_{sc} \times V_{oc} \times FF / P_i \quad (1)$$

Where $J_{sc}$is called the Photon-current density, V_{oc} is called the open circuit voltage and FF is called the Fill Factor.

Another way of defining the monochromatic photon-to-current efficiency is:

$$MPCE = LHE \times \Phi_{inj} \times \eta_c \quad (2)$$

Where LHE is called the light harvesting efficiency, Φ_{inj} is called electron injection efficiency and is called: η_c is the electron collecting efficiency at the back contact.

Another name for the monochromatic photon-to-current efficiency is: External Quantum Efficiency (EQE). It relates the internal quantum efficiency (IQE) by the relation:

$$EQE = IQE \times LHE \quad (3)$$

DEFINITION OF TERMS
The following terms are defined below:

Internal Quantum Efficiency (IQE): This refers to the efficiency in which Photons that are not reflected or transmitted out of the cell can generate collectable carriers.

Light Harvesting Efficiency (LHE): The light harvesting efficiency is defined by the relation: $LHE = 1 - 10^{-\Gamma\sigma\lambda}$ (4)

Where Γ is the number of moles of the sensitizer per cm^2; σ is the absorption cross section of the sensitizer molecule, λ is the wavelength of the incident photon.

Fill Factor (FF): The fill factor is defined as the ratio:

$$FF = J_m.V_m / J_{sc}.V_{oc} \quad (5)$$

Where V_m is the voltage at which the power density of the cell reaches maximum and J_m is the corresponding current density. The fill factor describes the square ness for the plot of current density against potential difference (voltage).

ABOUT MATLAB AND SUMULINK

MATLAB is a high performance language for technical computing. The name MATLAB implies 'matrix laboratory'. MATLAB has been in existence for many years now, and have been receiving inputs from many users (www.mathworks.com). MATLAB incorporates another software package called: simulink, which can be used extensively for simulation. There are various toolboxes that could be found under this software package. Some of them include: communication toolbox, fuzzy logic toolbox, wavelets toolbox, e.t.c. All these toolboxes allow one to use MATLAB environment for various specialized applications. For the communication toolbox, there are various interactive blocks that were developed and stored in the library browser by the MATLAB engineers. Each of these interactive blocks is designed to serve a specific purpose in communication. It is left for the user to study them and know how to use them to achieve his purpose. Now we say briefly that simulink is a software package for modeling, simulating, and analyzing dynamic systems. It turns our computer into a laboratory for modeling and analyzing systems.

AIM OF RESEARCH

The aim of this research is to enhance/promote the use of matlab in scientific research study and analysis.

METHODOLOGY

The relation that was modeled is equation (1). The following blocks where employed in the model: Input blocks, Product blocks, Divide block and Display block. There were four input blocks that were used is the model, each of them taking up inputs: J_{sc} , V_{oc} , FF, and P_i . Also, two 'Product' blocks, one 'Divide' block and one 'Display' block were used in the model (See fig. 1)

RESULT

The finished model gave the result of the work. The following model was obtained after putting the blocks together:

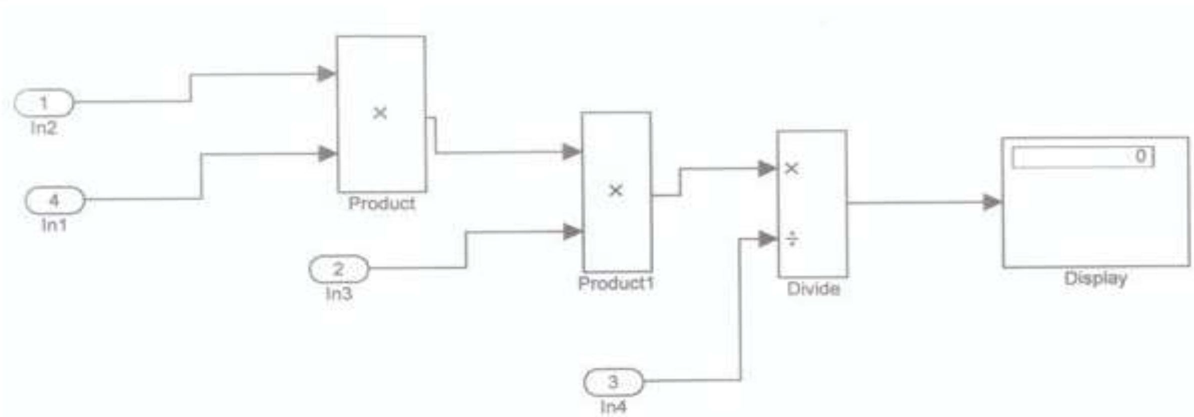

Fig. 1: A model of the monochromatic photon-to-current efficiecy

THE WORKING OF THE MODEL

The input block labeled In1 takes up values of J_{sc} ; that labeled In2 takes up values of V_{oc}; that labeled In3 takes up values of FF and that labeled In4 takes up values of P_i . The first product block multiplies values from In1 and In2. The second product block multiplies the result from the first product block to value from In3. The divide block performs the division of the entire products with values from In4. Lastly, the display block displays the result of the operation.

CONCLUSION

The model presents a vivid operation of the parameters of the monochromatic photon-to-current efficiency. Skills that are developed in modeling like this can transmit into developing sophisticated models that could transform the world. So the use of matlab in scientific study should be encouraged.

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