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RESEARCH ARTICLE

STUDY OF THE SPECTRAL RESPONSE FOR AN INTER DIGITATED BACK CONTACT SOLAR CELL UNDER SEPARATE SPECTRA

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ABSTRACT

In this paper, the spectral response of an interdigitated back contact of solar is studied under different illuminations, sunlight, xenon lamp. The set-up model allows to determine the short-current density and the photon current of a solar cell under separate spectra. The spectrum generate is evaluated for each illumination. The external quantum efficiency related to the spectral response of the interdigitated back contact solar cell is also evaluated in this work. The model is computed under the powerful calculators PV lighthouse. The standard test conditions are applied to the model

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INTRODUCTION

Rear contact solar cells (Verlinden, 1994) achieve potentially higher efficiency by moving all or part of the front contact grids to the rear of the device. The higher efficiency potentially results from the reduced shading (El Hadji Abdoulaye Niass1, 2021) on the front of the cell and is especially useful in high current cells such as concentrators or large areas. There are several configurations. Rear contact solar cells eliminate shading losses altogether by putting both contacts on the rear of the cell. By using a thin solar cell made from high quality material, electron-hole pairs generated (Barnbas AchakpaIkyo , 2015) by light that is absorbed at the front surface (Campbell and Green, 1987) can still be collected at the rear of the cell 1. Such cells are especially useful in concentrator applications where the effect of cell series resistance is greater (Verlinden, 1994). An additional benefit is that cells with both contacts on the rear are easier to interconnect and can be placed closer together in the module since there is no need for a space between the cells. In this work we study the spectral response of the interdigitated back solar cell (Verlinden, 1994) under different illuminations

MATERIALAND METHODS

Material: The interdigitated back solar cell used in this work is shown by figure below.

The instrument that used in this study are:

- Unscaled xenon lam with aescusoft SolSim Single Xe lamp
- Unscaled Sunlight with AM1.5g. (Gue95) model
- Screen-printed front contact for external quantum efficiency solar cell with aescusoft model n ,(7)
- Under standard test conditions

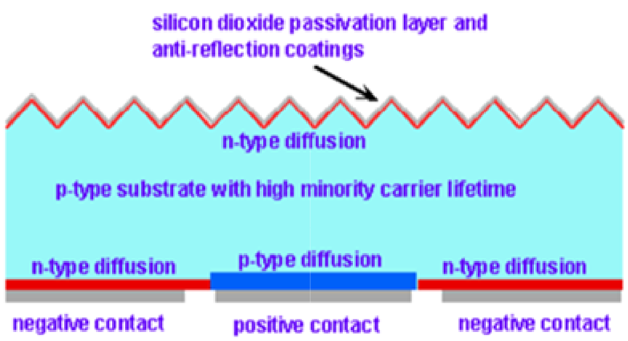

Figure 1. Interdigitated Back solar cell

The model is applied under the powerful software calculator pvlighthouse developed by Keith McIntosh, Malcolm Abb Ben Sudbury and many contributors from the PV industry.(8)

Methods

The spectral intensity S(λ) units are W/m²/nm. The intensity of each spectrum is calculated in two ways:

The total intensity I total is calculated by integrating the spectral intensity over the entire range of wavelengths available in the spectrum library. The bounded intensity Ibounded is calculated by integrating the spectral intensity over the wavelength range defined by the minimum λmin and maximum λmax wavelengths defined by the user under "Options".

Each spectrum is adjusted so that its range is bounded by λmin and λmax, and so that the interval between each wavelength is constant and equal to Δλ, where Δλ is defined by the user under "Options". Each spectrum is scaled by multiplying its spectral intensity S(λ) by one of the following factors (as selected by the user):

Uncalibrated

Scale Factor: scale factor is defined. Total intensity: the intensity defined divided by Itotal. Bounded Intensity: The defined intensity divided by Ibounded. Spectrum A is determined by summing the spectral intensity of its constituent spectra; Spectrum B is determined by adding the spectral intensity of its constituent spectra. The EQE is loaded from the EQE database. The EQE is modified in the same way as the spectra so that it is defined by the user inputs λmin, λmax and Δλ. Finally, the outputs for Spectrum A and Spectrum B are calculated by the following equations:

The intensity is given by the following equation:

$$I = \int_{\lambda_{min}}^{\lambda_{max}} S(\lambda)d\lambda \qquad (1)$$

The photon current density is given by the following equation:

$$J_{ph} = q\int_{\lambda_{min}}^{\lambda_{max}} \phi(\lambda)d\lambda \qquad (2)$$

The short circuit current density is given is given by the following equation:

$$J_{ph} = q\int_{\lambda_{min}}^{\lambda_{max}} \phi(\lambda).EQE(\lambda)d\lambda \qquad (3)$$

where Φ(λ) is the photon flux and equal to S(λ)/E(λ), where E(λ) is the photon energy and equal to h·c/λ, and where h is Planck's constant and c is the speed of light.

RESULTS AND DISCUSSION

The equations above are computed on the powerful software pv lighthouse and the following results are obtained.

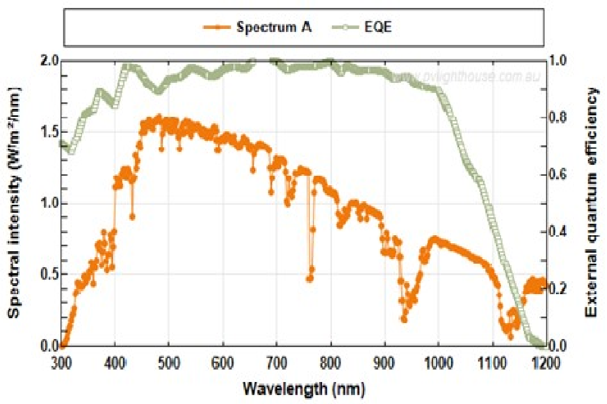

Fig 2. Spectral intensity and external quantum efficiency versus sunlight wavelength

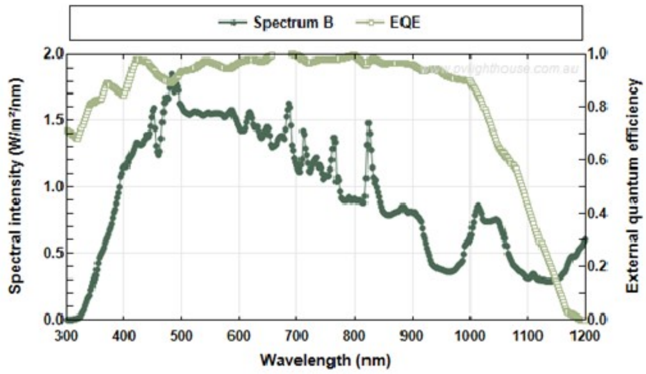

Table 1. Spectral outputs over the range 300nm-1200nm

	Sunlight spectrum (S)	Xenon lamp spectrum (X)	$\frac{\lvert X-S \rvert}{S}$
Intensity (mw/cm^2)	105.7	83.21	21.24%
Photon current (mA/cm^2)	57.53	46.09	19.88%
Short-circuit current density (mA/cm^2)	49.32	40.06	18.78%

Figure 2 and figure 3 shows the spectral responses for both spectra; sunlight and xenon lamp related to the wavelength. The external quantum efficiency is important for both illuminations and practically the same. It increases over the range 350nm and 750 nm and keep almost constant over the range 750nm-850nm.The spectral response does not depend to the illumination. Nevertheless, the spectral intensity is different for both spectra. The spectral response increases exponentially for the xenon lamp spectra over the range 300nm-500nm while the spectra intensity shows many picks in that range. Over the range 500nm-1000nm, the spectral intensity decreases for both illumination, sunlight, and xenon lamp. Xenon lamp spectra show many picks the sunlight illumination as well. The table below shows the electrical parameter for both spectra. The intensity produce by the interdigitated back solar cell under the sunlight spectra is higher than the intensity produces under the xenon lamp spectra. The photo current as well is more important under the sunlight spectra. The short-circuit current is. 9mA/cm^2 more than the illumination under the xenon lamp. The results could be predicted because the sunlight intensity produce more photon than the xenon lamp spectra on the standard test condition. The interdigitated back solar is useful for produce electricity current.

CONCLUSION

The purpose of this work is to show the spectral response of the interdigitated back solar cell under the standard test conditions. Two spectra are used, the sunlight and the xenon lamp. The external quantum efficiency changed over different range of wavelength, but it is similar for both spectra. This work could be enlarged by studying the differences responses between interdigitated back solar cell and screen-printed front contact solar cell and also the external quantum efficiency.

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