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Comparative study on Spectral response and external quantum efficiency between Interdigitated back contact solar cell and Passivated Emitter Rear Locally diffused solar cell

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ABSTRACT

The spectral response is conceptually like the quantum efficiency. The quantum efficiency gives the number of electrons output by the solar cell compared to the number of photons incident on the device, while the spectral response is the ratio of the current generated by the solar cell to the power incident on the solar cell. The aim in this work is to compare the external quantum efficiency and the spectral response between the interdigitated back contact solar cell and passivated emitter rear locally diffused solar cell. The photocurrent delivered by the solar cell is highlight for each illumination. The work environment is the power simulation software PV Lighthouse.

Key words: Spectral response, external quantum efficiency, solar cell.

1. INTRODUCTION

The spectral response [1] and the quantum efficiency [2] are both used in solar cell analysis and the choice depends on the application. The spectral response uses the power of the light at each wavelength whereas the quantum efficiency uses the photon flux. The "external" quantum efficiency of a silicon solar cell includes the effect of optical losses [3] such as transmission and reflection [4]. However, it is often useful to look at the quantum efficiency of the light left after the reflected and transmitted light has been lost. "Internal" quantum efficiency refers to the efficiency with which photons [5] that are not reflected or transmitted out of the cell can generate collectable carriers. By measuring the reflection and transmission of a device, the external quantum efficiency curve can be corrected to obtain the internal quantum efficiency curve.

In this work the spectral response and the external quantum efficiency are both observed for the interdigitated back contact solar cell and passivated emitter rear locally diffused solar cell. This study shows more the difference between these two types of solar cell.

2. MATERIALS AND METHOD

2.1 Materials

In this work the two materials used are given by the following figures

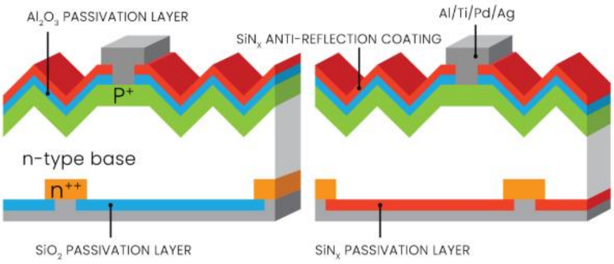

Fig. 1 Passivated emitter rear locally diffused solar cell

PERL, an abbreviation for **Passivated Emitter Rear Locally diffused solar cell,** combines both the advantages of **PERC and PERT**. Like the PERC cells [6], both the front surface as well as the rear surface of the monocrystalline cell are passivated, but the main difference is that the rear is locally diffused only at the metal contacts to minimize recombination rate while maintaining good electrical contact.

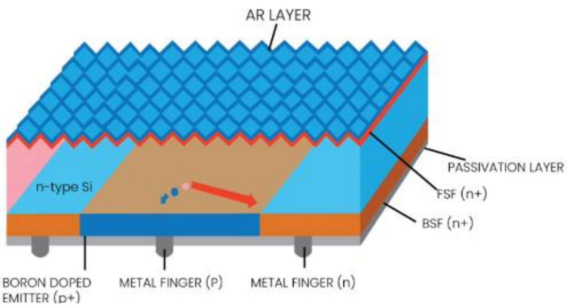

Fig. 2 Interdigitated back contact solar cell

Rear contact solar cells [7] have the ability of preventing all shading losses by placing both contacts on the rear of the cell. The pairs of electron hole generated by the light that is absorbed at the front surface of the cell can still be collected at the rear of the cell, using a thin solar cell manufactured from high quality material. Such cells are especially useful in the concentrator applications, where the cell series resistance [8] effect is much greater.An additional benefit of these cells is that cells with both of the contacts on the rear can be interconnected easier and can be placed closer together in the module because there is no need for any space between the cells.

Method

In this work ,we use the following model based on PV lighthouse calculator.

1. Unscaled xenon lam with aescusoft SolSim Single Xe lamp
2. Unscaled Sunlight with AM1.5g. [Gue95] model
3. Screen-printed front contact for external quantum efficicency solar cell with aescusoft model n ,
4. Under standard test conditions

The external quantum efficiency is given by

$$EQE = \frac{I_{ph}(\lambda)}{q\,\Psi_{ph,\lambda}} \qquad (1)$$

where q is the elementary charge and $\Psi_{ph,\lambda}$ is the spectral photon flow incident on the solar cell. Since Iph is dependent on the bias voltage [9], the bias voltage must be fixed during measurement. The photon flow is usually determined by measuring the EQE of a calibrated photo diode under the same light source.

The spectral response is done with the following formula:

$$SR = \frac{q\lambda}{hc} QE \qquad (2)$$

Where SR is the spectral response , EQE the external quantum efficient , q is the elementary charge , h plank constant and c speed of light.

3. RESULTS AND DISCUSSION

The results shown are obtained by using the equations (1) and (2) unscaled sunlight and unscaled xenon lamp on the solar cells.

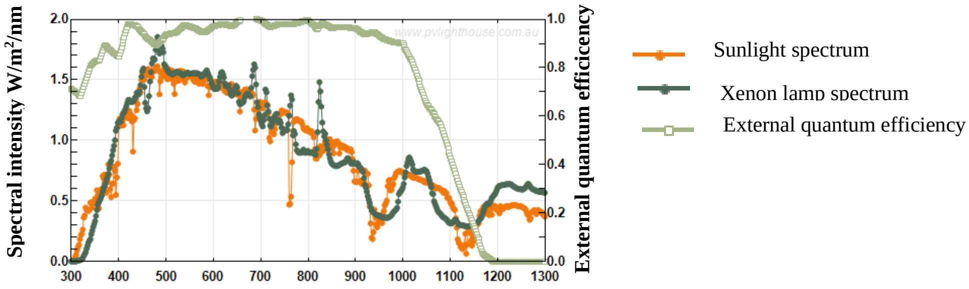

Fig. 3 Spectral intensity and external quantum efficiency versus sunlight wavelength

The fig 3 shows the spectral response and the external quantum efficiency for the interdigitated back contact solar cell under sunlight and xenon lamp illumination.
The spectral response of the interdigitated back contact solar cell for both sunlight and xenon lamp changes on the same range of wavelenght ;
Over the range 300nm-500nm, the spectral response of the solar cell increases for both types of light source.Nevertheless at some specific wavelenght , the sunlight sprectrum, shows some peaks.
The growth response is due to front surface recombination.
Over the range 500nm-1200nm , the spectral response decreases for both illumination.Over that range the respones show some minimum and maximum value at specific wavelenght.The decay response is due to rear surface recombination.
For wavelength greater than 1200 nm the spectral responses are quasi-constant. That means the recombination are weak.
The external quantum efficiency is quasi static over the range of 500 nm and 900 nm. In that range EQE reach its maximum value approximately 0.95.for the more 1200nm the external quantum efficiency is approximatively equals to zero.

Table -1 Spectral response over ther range 300nm-1300nm for the interdigitated back contact solar cell

	Sunlight spectrum response (SSR)	**Xenon lamp spectrum response (XSR)**	$\frac{\mid XSR - SSR \mid}{XSR}$
Inteensity (mW/cm^2)	83.37	83.21	(0.1927%)
Photon current (mA/Cm^2)	46.30	46.09	(0.4479%)
Short-circuit current density (mA/Cm^2)	40.46	40.06	(0.9981%)

The table 1 shows the spectral responses over the range 300nm-1300nm.
We observe the short current densit due to the sunlight spectrum is approximatively equal to the one due to xenon lamp spectrum.We confirm that by evaluating the relative between these two values.We can the xenon lamp illmunition in laboratory to test the solar spectrum responses.

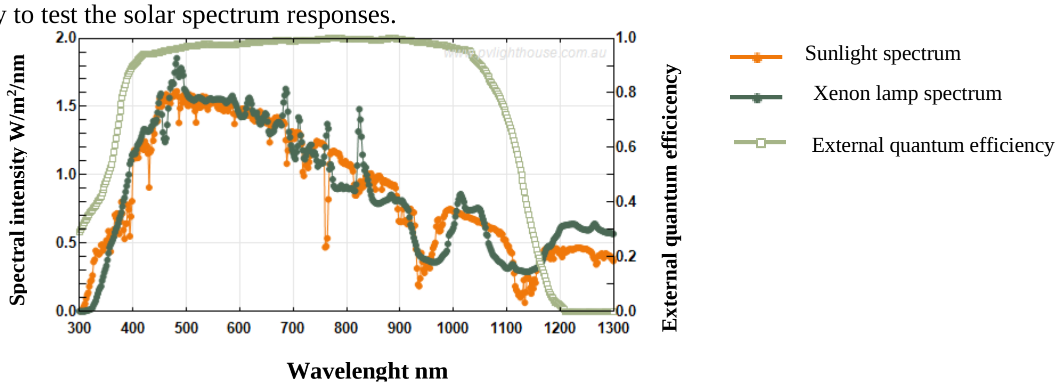

Fig. 4 Spectral intensity and external quantum efficiency versus xenon lamp wavelength

The fig 3 shows the spectral response and the external quantum efficiency for passivated emitter rears locally diffused solar cell under sunlight and xenon lamp illumination.
The spectral response of the passivated emitter rears locally diffused solar cell for both sunlight and xenon lamp changes on the same range of wavelenght
The spectral responses of the passivated emitter rear locally diffused solar cell is approximatively the same as the interdigitated back contact solar cell.The main difference is observed on the external quantum efficiency responses.
Over the range 300nm-500nm the external quantum efficiency increases exponentialy for the passivated emitter rears locally diffused solar cell compared to the the interdigitated back contact solar cell where the external quantum efficiency response shows many peaks over that range.

Table 2 Spectral response over ther range 300nm-1300nm for passivated emitter rear locally diffused solar cell

	Sunlight spectrum response (SSR)	Xenon lamp spectrum response (XSR)	$\frac{\mid XSR - SSR \mid}{XSR}$
Intensity (mW/cm^2)	83.37	83.21	(0.1927%)
Photon current (mA/Cm^2)	46.30	46.09	(0.4479%)
Short-circuit current density (mA/Cm^2)	42.41	42.04	(0.8604%)

The table 2 shows the spectral responses over the range 300nm-1300nm. The spectral response of the passivated emitter rear locally diffused solar cell shows values greater than the spectral response of the interdigitated back contact solar cell.We photo current delivered for PERL is higher than those deliveres in the interdigitated back contact solar cell.Nevertheless the intensity, the photo current and the short-circuit current density are approximatively equal for both illuminations.

4. CONCLUSION

In this work shows that the passivated emitter rears locally diffused solar cell produces more photo current compared to the interdigitated back contact solar cell.Nevertheless the spectral response such as the photo current ,the short circuit current density and the intensity are approximatively equal for botth sunlight and xenon lamp illumination.End that apply for both types of solar cell.The

Extrernal quantum efficiency are very weak close to zero for wavelenght grester than 1200nm.That also apply for both types of light of illmunitions.

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