back side recombi tion vel shunt resistances[5] and t cellôs efficiency Conside of magnetic and ectric fi electrieclall psaorlaamre te rs a In [3], authors ed the c concluded that thsolarce as a plane capacor with t separated by an eens ipends the dynamic junctn veloci boundary recombintion vel study, the primarrole of S point of the solar cell is However, thpeproaluhmonfa the g cell which gives od result the characterizaton and mu orientation can asobe con the control of thar parameters of the so

That is why, this aper aims the transient di us+P -+P bifa cial solar cell. The cacitance orientation of tlgrains c accoounfnt the dynamijunction radius (R) and tlgrain bou (Sgb).

2. Theory

We present in fie 1 an is bifacial silicon olar cell

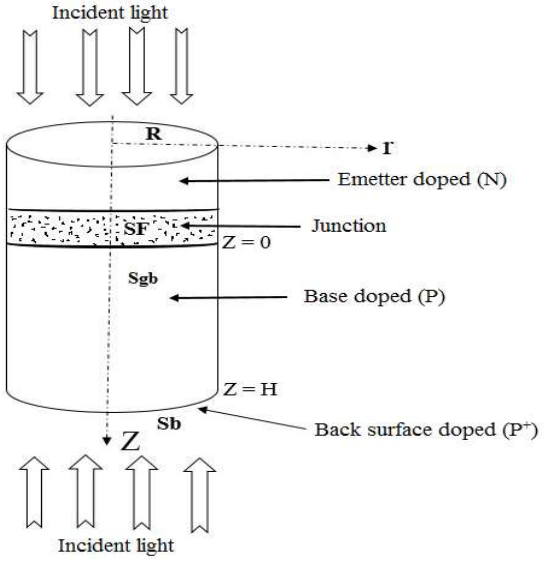

Figure 1. Isolated cylindrical grain

The bifacial solacell is a emitter+, doped N+ doped+P which is sheetwedn the eitter an contact where anher junc strongly. dTohpie dsePond junc very intense electric field towards tsh. baeslee c[3] ical fie recombination at the backs which are mo efficient th- 5].

According to 10], the tra the solar ce aremocontinuity cylindrical coordinates:

$$\frac{\partial^2 \delta(r,z)}{\partial r^2}+\frac{\partial^2 \delta(r,z)}{\partial z^2}+\frac{1}{r}\cdot\frac{\partial \delta(r,z)}{\partial r}-\frac{\delta(r,z)}{L^2}=-\frac{G(z)}{D} \quad (1)$$

As, we have azimuthals processed. Therefore the

$$\frac{\partial^2 \delta(r,z)}{\partial r^2}+\frac{\partial^2 \delta(r,z)}{\partial z^2}+\frac{1}{r}\cdot\frac{\partial \delta(r,z)}{\partial r}-\frac{\delta(r,z)}{L^2}=-\frac{G(z)}{D} \quad (2)$$

δ(r;z): minority carrierôs d
D: electron diffusion coef. s^{-1});
L: electron diffus
G(z) minority arriers gene base [3]
While proceeding by the sep used by [10], we put:

$$\delta = \sum_{k=1}^{\infty} \quad \cdot \quad (3)$$

The solution f the

$$\delta \left[\sum_{k=1}^{\infty} \right] \cdot \quad (4)$$

Coefficients A_k and K_k are ed from the boundaries conditi

- At the juct

$$\frac{\partial \delta}{\partial z}\Big|_{z=0} = \frac{S_f}{D}\cdot\delta \quad (5)$$

- At the grin b

$$\frac{\partial}{\partial r} \quad = -\frac{S_{gb}}{D}\cdot \quad (6)$$

3. Capacitance

The bifacial olar cellôs

$$\left[\delta \quad + \frac{n_i^2}{N_b} \right] \quad (7)$$

q represents t

A method to determine the transient capacitance of the bifacial solar cell considering the cylindrical model of the grain and the dynamic junction velocity (Sf)

4. Results and Discussions

In figures 2, 3 and 4, we plotted the transient diffusion capacitance versus the junction recombination velocity. Figure 2 shows effects of grain boundary recombination velocity. As for the influence of the grain size and wavelength (λ), we considered various radius (R) and wavelength (λ) in figures 4 and 5, respectively.

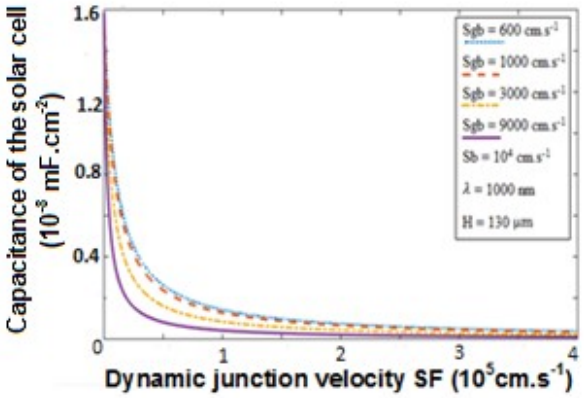

Figure 2. Capacitance of the illuminated solar cell versus SF for various Sgb: R= 0.01 cm.

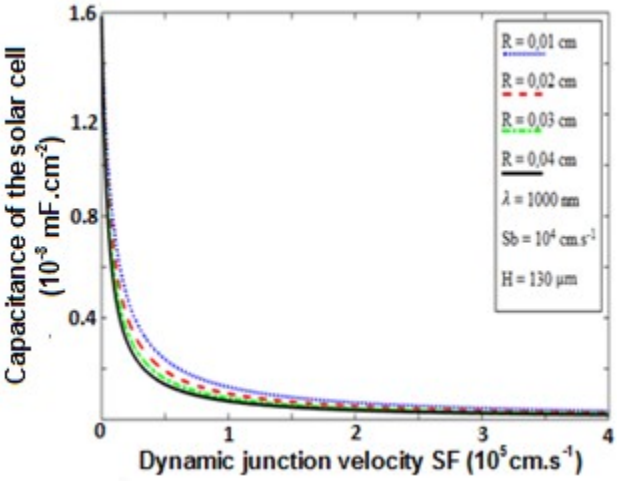

Figure 3. Capacitance of the illuminated solar cell by the front surface versus SF for various radius (R): L = 0.01 cm

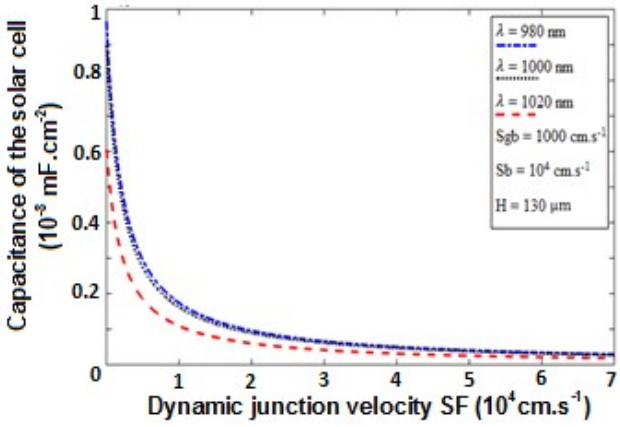

Figure 4. Capacitance of the illuminated solar cell versus SF for various wavelength: L = 0.01 cm and R= 0.01 cm

We remarked in figure 2, for a given solar cell, that:

- the open circuit transient diffusion capacitance is very brief. It can be seen here that there is a difference between the considered model and that of the cubic grains where the range of operating points of the open circuits is sufficiently long [4].
- the short circuit operating points zone is very important and there, the transient diffusion capacitance stretches toward zero ;
- a transient diffusion capacitance, depending on operating point which is related to SF, appears between the open circuit operating to the short – circuit operating points.

The increase of SF corresponds to an increase of the extension region width and hence to the increase of solar cell's photocurrent as shown by [3].

We also noted that the transient diffusion capacitance decreases with Sgb; meaning that increasing of Sgb leads to high recombination in the grain boundary of the solar. In figure 3, we noticed that the variation of the solar cell grain radius (R) leads to increase the transient diffusion capacitances.

Figure 4 shows that when the wavelength (λ) increases in the considered range between 980 to 1020 nm, the transient diffusion capacitance decreases. When the wavelength increases, the energy of incoming photons decreases and less excess minority carriers are extracted in the base of the solar cell.

In figure 5 we represented the solar cell's transient diffusion capacitance versus the dynamic junction velocity (SF) and the solar cell grain radius (R). Indeed, the solar cell's capacitance increases according to the grain radius (R) and decreases with the junction recombination velocity.

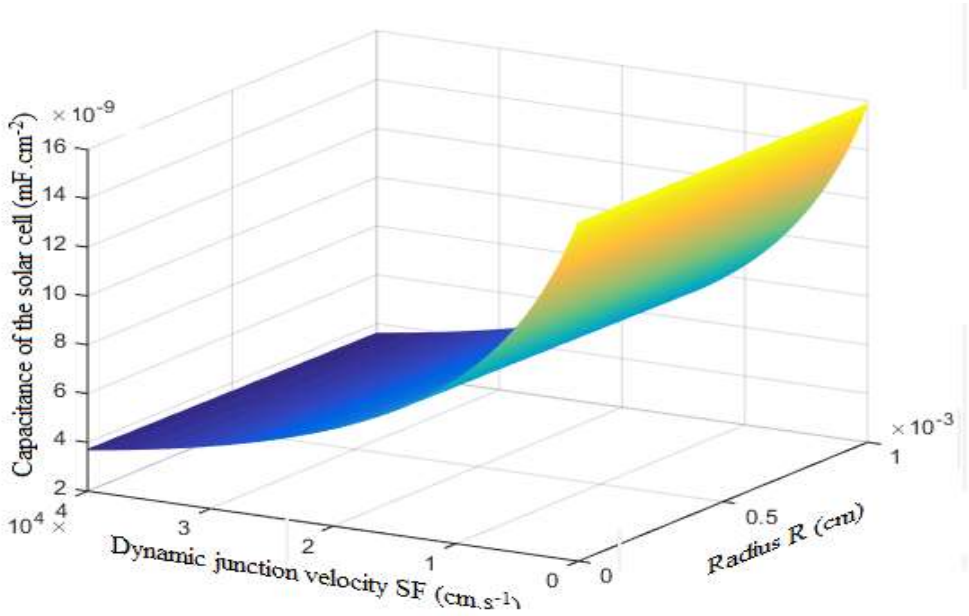

Figure 5. Capacitance of the illuminated solar cell by the front side versus SF and solar cell grain radius (R): λ=1000 nm, Sgb= 1000 cm.s^{-1}, Sb = 10000 cm.s^{-1}, L = 0.01 cm and H=130 µm.

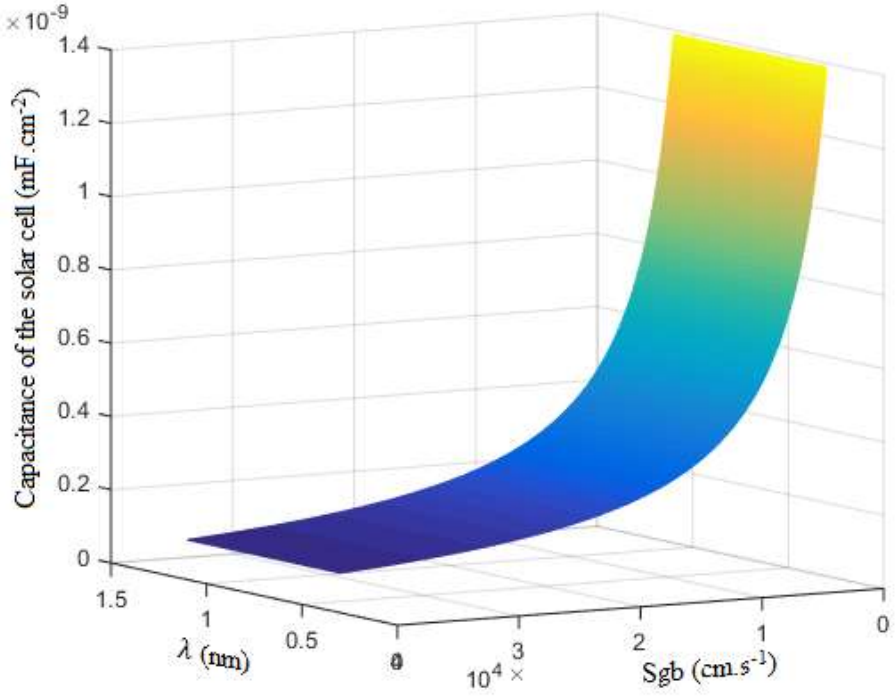

Figure 6. Capacitance of the illuminated solar cell by the front surface according to the grain boundary recombination velocity (Sgb) and wavelength (λ): Sb = 10^4 cm.s^{-1}, L = 0.01 cm, H=130 µm and R = 0.01 cm

In figure 6, we showed the variation of the capacitance according to Sgb and the wavelength (λ). These figures represent the bifacial solar cells transient diffusion capacitance for a fixed solar cell grain radius (R) and for various grain boundary recombination velocities (Sgb) and wavelengths (λ). Effects of these two parameters on the transient diffusion capacitance are the same as for the results of [3].

5. Conclusion

In this paper, we determined the transient diffusion capacitance using the cylindrical orientation of solar cell's grains. We have shown that, as for the columnar isolated grain model, the diffusion transient diffusion capacitance increases with solar cell grain radius (R) and with wave length. It decreases with the grain boundary recombination velocity and the dynamic junction velocity (SF). The approach confirms that best solar cells correspond to high grain radiuses (R) which lead to low grain boundary recombination velocity (Sgb).

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