Available onlinewww.ejaet.com

European Journal of Advances in Engineering and Technology, 2022, 9(4s):619-622
International Conference on Tech Trends in Science & Engineering (ICTTSE) 2022
Suryodaya College of Engineering & Technology, Suryodaya Polytechnic, Nagpur, Maharashtra, India

Research Article ISSN: 2394 - 658X

Study of the Transient Regime in a Silicon Photocell with Vertical Junction Serial under Magnetic Field and Constant Multispectral Illumination

Papa Monzon Alassane and Papa Touty Traore

Physics Semiconductor Laboratory at Cheikh Anta Diop University, Dakar Fann, Senegal, 11000

ABSTRACT

The work is a study of the transient decrease obtained between two operating points on the currentvoltage characteristic of a series vertical junction silicon solar cell placed under a magnetic field and constant multispectral illumination. The magneto-transport equations relating to the excess minority carrier density in the base of the solar cell is studied in transient state by the Sturn- Louiville method, taking into account the recombination speeds (Sf) and (Sb) respectively at the junction (n+/p) and on the rear face exponential decay of the charge carrier density are analyzed through the thickness of the base.

Key words: Silicon solar cell-Vertical series junction- Recombination velocities-Magnetic field-Base thickness (p), eigenvalues, decay time constant

1. INTRODUCTION

The efficiency of a solar cell is related to its ability to convert solar energy into electricity. Thus, there are several parameters that contribute to this improvement. Among the most important parameters we can note the coefficient (D) of diffusion [1, 2], the length (L) of diffusion [3] [4], the lifetime (□) [5], and the velocities of recombination at the Sf junction [6] and on the rear face Sb [7] of the minority charge carriers. Added to this are the series resistance Rs and the shunt resistance Rsh as well as the power. The characterization of solar cells by determining the phenomenological and macroscopic parameters can be obtained by different techniques based on the operating regimes that are the static and dynamic regimes. The dynamic regime includes: the dynamic frequency regime and the transient dynamic regime. To produce low-cost solar cells, vertical multi-junction (VMJ) solar cells have been manufactured, allowing on the one hand, incident illumination parallel to the space charge zone, uniform and constant. on all regions and on the other hand, to the excess minority charge carriers of short diffusion length to be better collected. These vertical multi- junction solar cells are of two types depending on the basic connection between the cells (n/p or n/p/p+), in order to improve either the photogenerated current (connection in parallel) or voltage (series connections. In this work, a transient study of a series vertical junction solar cell obtained by variation of the operating point is proposed. The solar cell is maintained under constant multispectral illumination and under magnetic field.

The decay time constant is obtained using the diffusion equation of excess minority charge carriers in the base placed in a magnetic field. The boundary conditions allow us to obtain the transcendental equation [8,9] from which the eigenvalues are obtained. The fundamental mode corresponding to n=0, predominates over the harmonics of order (n0) and the transient regime is then obtained with a single exponential decay term and the time t0 indicates the origin of the exponential type decay time.

2. THEORICAL STUDY

Experimental Devices

The figure 1 represenst the experimental device used to obtain the transient state by variation of the solar cell operating point.

This device includes a generator (Bri8500) which supplies an REP 50n06 type mostet transistor , two adjustable resistor r1 and r2 , a solar cell placed in a magnetic field , a digital oscilloscope, a microcomputer and a multi-spectral light source to illuminate the solar cell.

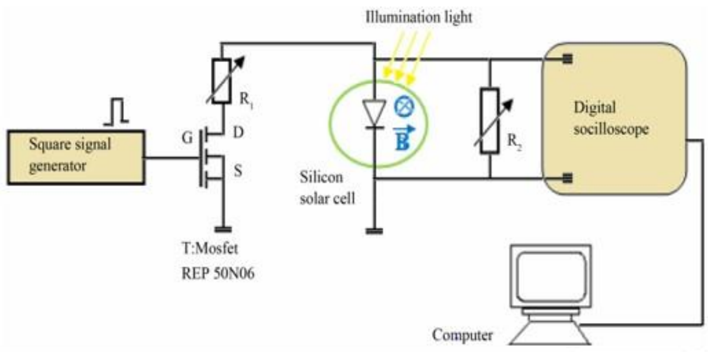

Fig. 1 Experimental device for the characterization of the solar cell

Operating principle of the experimental device at the instant greater than zero (Figure 1), the solar cell being under constant multispectral illumination, the Mosfet transistor is open and the solar cell is charged by the resistor R2 alone: which represents the operating point F2 in steady state [8-9] (Figure At t = 0, the closing of the MOSFET T begins and after a very short time (600-800 ns) the MOSFET is totally closed and the resistor R1 is in parallel with R2. We are at the operating point F1 in steady state (Figure 2). The transient state is obtained between the two operating points in steady state F1 and F2. The transient voltage at the terminals of the solar cell is recorded by a digital oscilloscope (Tektronics) which then transmits it to a microcomputer for processing and analysis.

By varying the resistors R1 and R2, the steady-state operating points F1 and F2 move on the currentvoltage characteristic of the solar cell (Figure 2), which allows us to perform the experiment at any point of this characteristic from open circuit to short circuit and record the voltage or current response of the solar cell under constant multispectral illumination. Figure 2 below gives the plot of the I-V characteristic of the solar cell, under different values of the magnetic field. cited

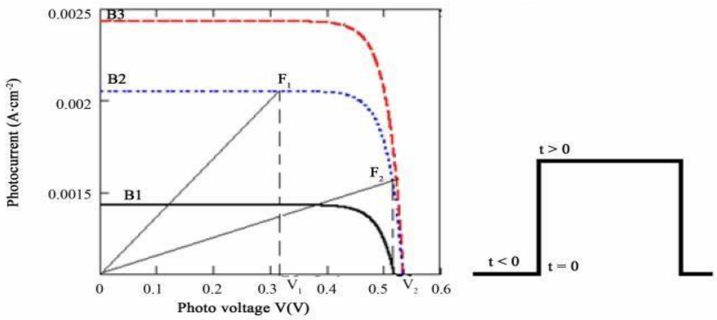

Fig. 2 The I-V characteristic of the solar cell, under different values of the magnetic field. cited.

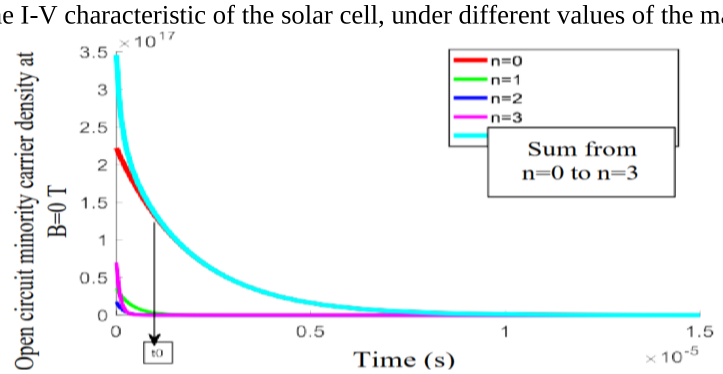

Fig. 3 Open Circuit Solar Cell Minority Carrier Density Profile for aMagnetic Field B=0 T

For the fundamental mode and the various harmonic states in the vicinity of the Open Circuit.

We note at the level of this figure 3 that the density of the carriers decreases to reach the final steady state. It is the same for all the harmonics of order n. However, one can observe that after a time t0, the densities of the other modes or harmonics n≠0 rapidly tend towards 0, while that of the fundamental mode merges with the total density δ(x, t).

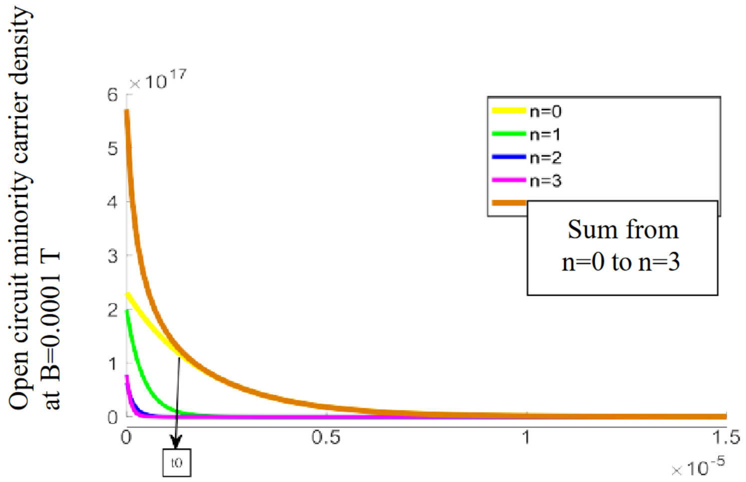

Fig. 4 Open Circuit Solar Cell Minority Carrier Density Profile for a Magnetic Field B=0.0001 T

Figure 4 represents the profile of the density of minority carriers as a function of time for a Magnetic Field B=0.0001 T for the fundamental mode and the various harmonic states in the vicinity of the Open Circuit

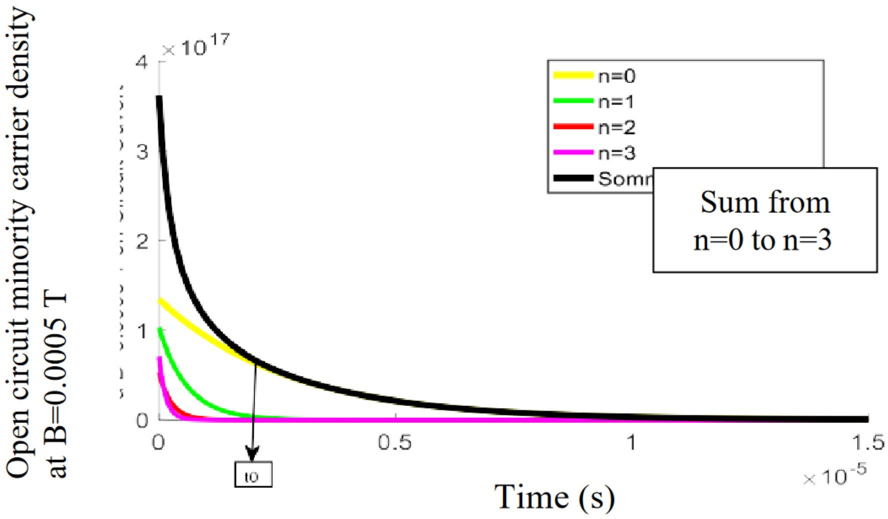

Fig. 5 Open Circuit Solar Cell Minority Carrier Density Profile for a Magnetic Field B=0.0005 T

We note at the level eof figures 3, 4 and 5 that the magnetic field influences the transitory variation of the density of the carriers. Indeed when the field increases, the carrier density decreases and the time variation is faster

We note in these Figures that the densities of the minority charge carriers corresponding to the different values of n decrease and all tend towards the same limit for a relatively long observation time. They are all convergent. The density of the fundamental mode is preponderant and is joined by those of the harmonics which always form the same block and become negligible compared to that of the fundamental mode.

However, we notice that the density of the total minority charge carriers merges with that of the fundamental mode from a time that can be noted t0.

These Figures also show that the density of the carriers decreases with time and after a time to (> 1.8 µs), the densities of the modes other than the fundamental mode become negligible.

Thus, for a given value of magnetic field we feel the same effects.

After having drawn the curves of density of the minority carriers for various values of the Field we also drew the curve of density of the minority carriers for the fundamental mode of all the B together.

CONCLUSION

This study of the transient state obtained from a silicon solar cell was carried out through the transient density of excess charge minority carriers in the base. The graphical resolution of the transcendent equation has been carried out. Thus, the eigenvalues and the decay time constants obtained are dependent on the magnetic field. The eigenvalues obtained for the solar cell in open circuit are relatively lower than those obtained for the short circuit mode. So the decay time is much longer for open circuit to short circuit mode.

REFERENCES

[1]. D. Sontag, G. Hahn, P. Geiger, P. Fath, E. Bucher Two-Dimensional Resolution of Minority Carrier Diffusion Constants in Different Silicon Materials. Solar Energy Materials and Solar Cells, Vol: 72, pp.: 533-539, 2002.

[2]. A. Diao, N. Thiam, M. Zougrana, G. Sahin, M. Ndiaye, G. Sissoko. Diffusion coefficient in Silicon Solar Cell with Applied Magnetic Field and under Frequency: Electric Equivalent Circuits, World Journal of Condensed Matter Physics, vol:4: pp.: 84-92, 2014.

[3]. E. D. Stokes and T. L. Chu, (1977). « Diffusion Lengths in Solar Cells from Short-Circuit Current Measurements » Applied Physics Letters, Vol. 30, N°8, pp.425-426

[4]. M. Rugider, T. Puzzer, E. Schäffer, W. Warta, S.W. Glunz, P. Würfel, T. Trupke, (2007). Diffusion lengths of silicon solar cells from luminescence images. 22nd European Photovoltaic Solar Energy Conferences 3-7, Page 309

[5]. K. Misiakos, C.H. Wang, A. Neugroschel and F.A. Lindholm, (1990). Similtaneous extraction of minority-carrier parameters in crystalline semiconductors by lateral photocurren, J.Appl. Phys., 67(1), 321-333.

[6]. Barro F. I., Nanéma E., Werème A., Zougmoré F. andSissoko G. 2001. Bulk and Surface Recombination Measurement in Silicon Double Sided Surface Field Solar Cell under Constant White Bias Illumination. Proceedings of the 17th European Photovoltaic Solar Energy Conference, Munich. pp. 368-371

[7]. Diasse O., Diao A., Wade M., Diouf M. S., Diatta I., Mane R., Traore Y. and Sissoko G. 2018. Back Surface Recombination Velocity Modeling in White Bias Silicon Solar Cell under Steady State. World Journal of Condensed Matter Physics. 9, 189201

[8]. Zeinabou Nouhou Bako, Hawa Ly Diallo, Aminata Gueye Camara, Moustapha Thiam, Dan Maza Abouzeidi, Madougou saibou and Gregoire Sissoko “Three Dimensional Study of Spectral Response of Polycrystalline Silicon Solar Cells: Vertical Junction Frequency Modulation Scheme” Journal of Energy and Power Engineering 7 (2013), pp: 903-906

[9]. Blood, P. and Orton, J.W “The electrical characterization of semiconductors: Majority carriers and electron” States, Academic Press Limited, London, 1992.

[10]. A.L. Ndiaye, Y. L. B. Bocande, G. Sissoko, D. Lincot, J. Vedel and P. Cowache, “Transient study in n-Cds/p-CIS Solar cell for Excess Minority Carrier Recombination Parameters Determination’’ Word Renewable Energy Congress (1996) 15901593.

[11]. G. Sissoko, E. Nanema, Y. L. B Bocande, A. L. Ndiaye, M. Adj “Minority Carrier Diffusion length Measurement in silicon Solar Cell under Constant White Bias Ligth’’Word Renewable Energy Congress (1996)1594-1597