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PERFORMANCE OF SIGE SOLAR CELL WITH BSF LAYER EFFECT OF TEMPERATURE AND WINDOW LAYER

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The Silicon-Germanium (SiGe) technology, whose preliminary developments date from the mid-1980s and whose arrival on the market is recent, meets this joint need for economy and performance. In our days solar cells to thin films are increasingly used primarily because of their low cost. In recent decades the performance of these cells were significantly improved. In this work, we studied the temperature effect on performance forSiGe solar cell with BSF layer using software AMPS-1D to analyze some parameters. The temperature is one of most important effect and it plays a key on performance of solar cell.

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1. Introduction

The study of the theoretical performance of solar cells is very important. It shows us the limits to be reached in practice and the different areas of variation of the physical and geometrical parameters that guide us in the realization of the device.The silicon-germanium technology SiGe, whose preliminary developments date from the middle of 1980s.The silicon-germanium (SiGe) alloy, which is compatible with silicon semiconductor technology and has a smaller band gap and a lower thermal conductivity than silicon, has been used to fabricate electronic devices such as transistors, photo detectors, solar cells, and thermoelectric devices [1] . In this work, we present the effect of temperature onSiGe solar cell with BSF layer using AMPS-1D software. The objective of this simulation is to verify the performance of the device by varying the temperature each time. The performance of device is mainly based on the material parameters, the optical parameters, and the electrical parameters of each temperature value on the structure.

2. Device structure

The objectives of numerical simulation in solar cell are testing the validity of proposed physical structures, geometry on cell performance and fitting of modeling output to experimental results. Any numerical program capable of solving the basic semiconductor equations could be used for modeling thin film solar cells [2].The AMPS-1D program has been developed for pragmatically simulate the electrical characteristics of multi-junction solar cells. It has been proven to be a verypowerful tool to understand device operation and physics for single crystal, poly-crystal and amorphous structures. AMPS-1D simulator has been used to stady the effect of temperature on SiGe solar cell structurewith BSF layer. The structure of SiGe solar cell is shown in Fig. 1.

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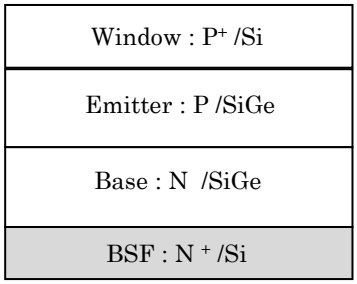


Fig. 1. Solar cell SiGe structure used for the modeling.

Table. 1. Solar cell SiGe parameters for simulation in AMPS-1D [3,4].

	P+ / Si	P / SiGe	N / SiGe	N+ / Si
Thickness (μm)	0.1	7	7	0.1
Dielectric constant, ε	11.9	12.93	12.93	11.9
Electron mobility, μ_n (cm^2/Vs)	1350	2110	2110	1350
Hole mobility , μ_p (cm^2/Vs)	450	812	812	450
Carrier density , n,p cm^{-3}	P : 1e18	P : 3e18	N : 3e18	N : 1e18
Optical band gap E_g (eV)	1.12	0.96	0.96	1.12
Effective density, N_c cm^{-3}	2.8e19	2.5e20	2.5e20	2.8e19
Effective density, N_v cm^{-3}	1.04e19	2.5e20	2.5e20	1.04e19
Electron affinity, χ (eV)	4.05	3.92	3.92	4.05

3. Results and discussion

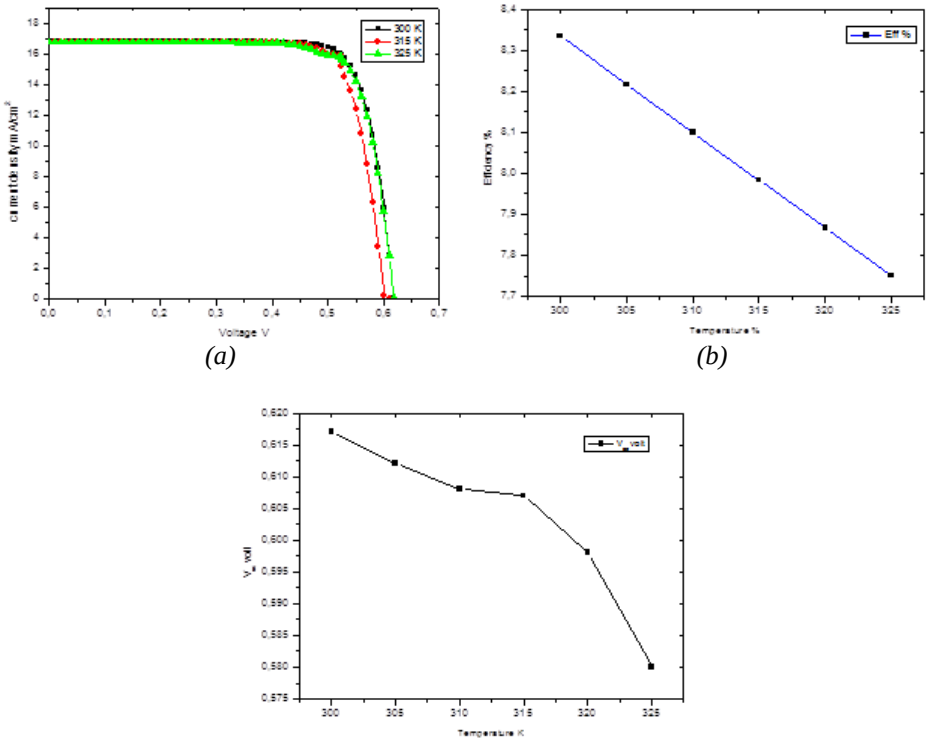
In this paper we study two effects firstthe temperature and thickness of windows layeron the output parameters of the solar cell exposed to AM 1.5. The external parameters are : the short circuit (J_{sc} mA/cm^2) , the open circuit voltage (V_{oc} Volt) and the efficiency $(\eta\%)$

3.1. Influence of temperature

The structure of solar cell was studied under AM1.5spectrum with BSF layer (thickness =100 nm, BSF doping N_d = 6e19 cm^{-3}) and the photovoltaic parameters are shown in Table2. We have tested the effect of temperature on the cell's parameters. The current voltage characteristic and efficiency of solar cell are plotted in Fig. 2.For different value of temperature, we notice that the efficiency and the open current decreases with the increased temperature value.On the other hand, the short circuit current stay constant.

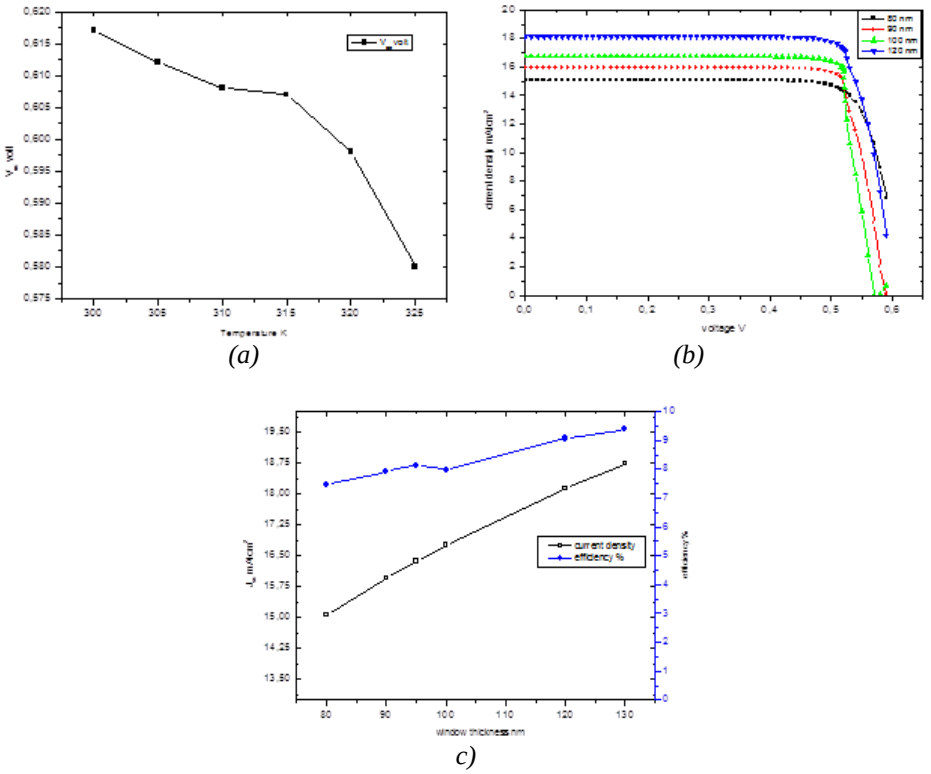
Table 2. Photovoltaic parameters.

Temperature K	**Jsc mA/cm^2**	**Efficiency %**	**FF**	**Voc**
300	16.749	8.333	0.805	0.617
305	16.749	8.216	0.801	0.612
310	16.749	8.099	0.798	0608
315	16.749	7.983	0.794	0.607
320	16.749	7.867	0.790	0.598
325	16.749	7.751	0.786	0.580



(a) *(b)* *(c)*

Fig. 2. (a) Current voltage characteristic; (b) efficiency and (c) open current of SiGe solar cell at different value of temperature.



(a) *(b)*

c)

Fig. 3. (a) Current voltage characteristic; (b) efficiency and current density of SiGe solar cell at different value of thickness window.

3.2. The window thickness effect

In Fig. 3 is shown the current density, efficiency as a function of thickness of window.Accordingto the simulation results, we noticed that when the window's thickness increase, these is a growth in current density and therefore the yield increases.

Table. 3. Photovoltaic parameters.

Window nm	Jsc mA/cm^2	Efficiency %	FF	Voc
80	15.059	7.452	0.807	0.61
90	15.950	7.916	0.806	0.61
95	16.360	8.130	0.805	0.61
100	16.749	7.983	0.794	0.607
120	18.128	9.056	0.803	0.62
130	18.729	9.372	0.803	0.62

4. Conclusion

By numerical simulation the effect temperature and thickness of window with BSF layer on the performance of a SiGe solar cell is studied. The variation was realized by different value of temperature and window's thickness on SiGe solar cell. The effect of variations on Jsc ,Vco and the cell efficiency are plotted. The efficiency, open voltage are decreasing when we change temperature other hand efficiency and current density are increasing when the window layer increase. All those results are for SiGe solar cell with BSF layer. All this results are obtained by using AMPS-1D.

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