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THE DOPING EFFECT OF BSF LAYER ON PERFORMANCE SiGe PHOTOVOLTAIC CELL

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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 simulated a solar cell (P^+ Si / P SiGe / N SiGe / N^+ Si) using software AMPS-1D to analyze some parameters. In particular, the properties of BSF layer (doping) play a key on performance of solar cell, and in order to optimize them, their influence on the photovoltaic parameters of the solar cell has been studied.

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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 study of the SiGe 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 doping of the BSF layer each time. The performance of device is mainly based on the material parameters, the optical parameters, and the electrical parameters of each layer used in the structure.

2. Optimal device structure

The major objectives of numerical modeling and simulation in solar cell research 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 very powerful tool in understanding device operation and physics for single crystal, poly-crystal and amorphous structures.AMPS-1D simulator has been used to stady the effect of doping BSF layer on SiGe solar cell structure. The

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structure of SiGe solar cell is shown in Fig. 1. The base parameters used for different structures adopted from some standard references are shown in Table1.

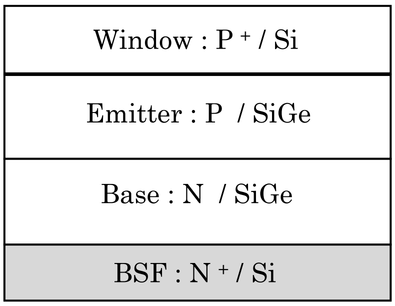

Fig.1.Solar cell SiGe structure used for the modeling.

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

	Window: P+ / Si	P / SiGe	N / SiGe	BSF : 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(cm²/Vs)	1350	2110	2110	1350
Hole mobility , μ_p (cm²/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 the effect of the doping BSF layer on 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 level doping BSF layer on J_{SC} and efficiency

The results are plotted in Fig. 2 and Fig. 3.

It was found that J_{SC} and efficiency are increasing when the level doping BSF layer increases. This effect due to the generation of

Electric field on rear surface of the cell therefore the minority carriers generated near the surface are escaping from recombination process by the electric field. [5].

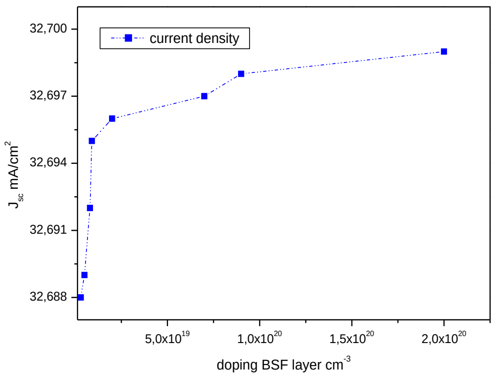

Fig. 2.Effect of doping level BSF layer to short circuit current

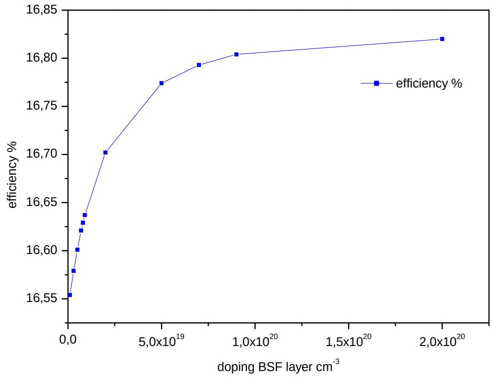

Fig.3.Effect of doping level BSF layer to efficiency

3.2. Influence of level doping BSF layer on V_{CO}

In Fig. 4 is shown the open circuit performance as a function of doping level BSF layer. According to the simulation results, we noticed that when the doping level BSF layer increase, there is a growth in the open circuit increase in circuit voltage and therefore the yield increases.

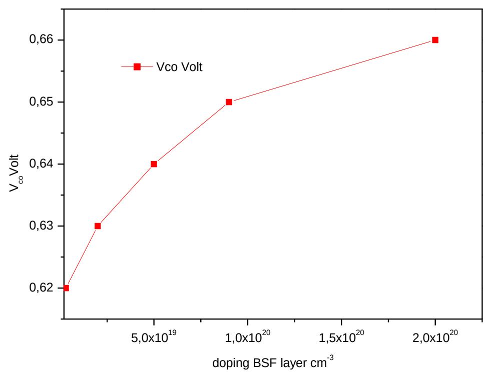

Fig. 4.Effect of doping level on BSF layer to open current.

4. Conclusion

By numerical simulation the effect of doping level BSF layer on the performance of a SiGe solar cell is studied. The BSF layer was realized by implanting highly doped on back surface of the SiGe solar cell. The effect of doping level BSF layer on J_{sc}, V_{co} and the cell sufficiency is plotted. The short current, open voltage and efficiency are increasing when the doping level BSF layer increases. All this results are obtained by using AMPS-1D.

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