The Window Layer Doping Effect on the Performance of a SiO_x:H Based Solar Cells

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ABSTRACT

In this work, the conversion efficiency of hydrogenated amorphous silicon oxide (a-SiO_x:H) based solar cells wasanalyzed and designed by SCAPS-1D software. So, we have investigated by numerical simulation the influence of the p-nc-SiO_x:H window layer doping concentration (Na) on the performance of the n-i-p single junction solar cell. However, our calculation was carried out by variyng the doping concentration (Na) between 10^{18} and 3×10^{19} cm^{-3}. The best results obtained with the Na optimizedvalue are V_{OC} = 989 mV, J_{SC} = 13.9 mA/cm², FF = 77.6 % and a conversion efficiency value equal to 10.67%.

Introduction

Because of their diverse microelectronic uses, hydrogenated amorphous silicon oxygen alloy films (a-SiO_x:H) are of great interest [1,2]. We aim in this work tostudy the impact of doping Na of the window layer on a- SiO_x:H based solar cells.

Simulation

The simulated a-SiO_x:H based solar cell structure is illustrated schematically in (Fig. 1). We analyze this cell using the Solar Cell Capacitance Simulator structures (SCAPS-1D). SCAPS solves the fundamental semiconductor equations in one dimension and under steady-state conditions [3,4].

Fig.1: Schematic structure of a-SiO_x:H based thin film solar cell.

Results and Discussion

Fig. 2 plots the different output parameters of the cell, namely the short circuit current JSC, open circuit voltage VOC, form factor FF and efficiency (Eff) as a function of Na doping of the p nc-SiO_x:H window layer. The best values for the output parameters of the cell (J_{SC} = 13.9 $mA.cm^{-2}$, V_{OC} = 989 mV, FF = 77.6% and Eff = 10.67%) are obtained for a doping Na= 3×10^{19} cm^{-3}.

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This is explained by the fact that the increase of the doping of the window layer will increase the space chargearea and the improvement of the collection of photogenerated carriers.

To better understand the origins of these improvements in the solar cell output parameters as a function of the simultaneous variation of Na, we have plotted the energy band diagrams (Fig. 3).

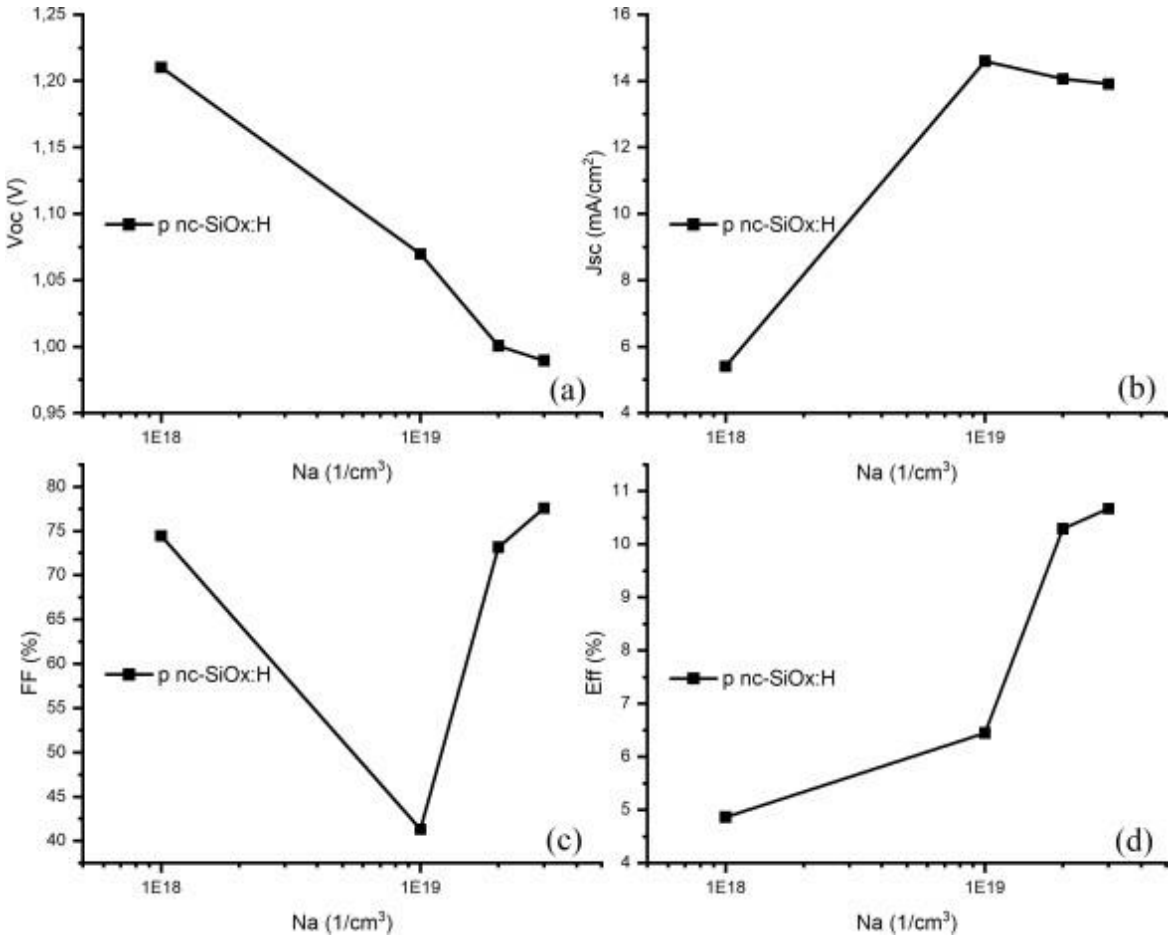

Fig.2: Variations of (a) V_{OC} (b) J_{SC} (c) FF and (d) efficiency with various dopant concentration Na of the window layer and optimized solar cells.

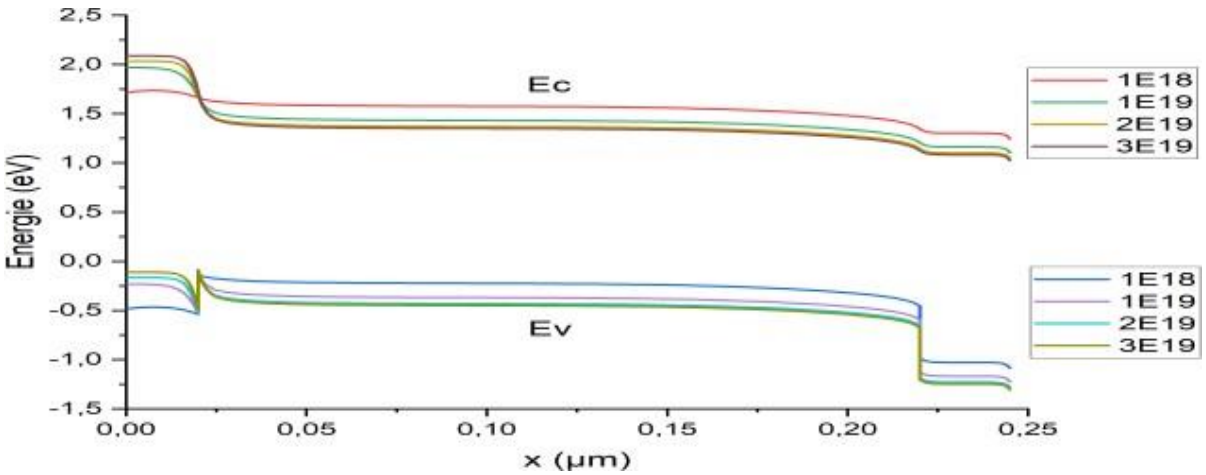

Fig. 3 Band diagram of the solar cell with various dopant concentration (Na) of the p window layer.

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Conclusion

In this investigation, we have studied the performance of the a-SiO_x:H-based solar cells. The photovoltaic parameters (Jsc, η, Voc and FF) have been calculated by using SCAPS-1D .It was found that the optimal value of the doping concentration is 3×10^{19} cm^{-3} for p nc- SiO_x:H window layer. The obtained results are Voc = 989mV, Jsc = 13.9 mA/cm², FF = 77.6 % and the power conversion efficiency is 10.67 %.

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