Theoretical design and performance of InxGa1-xN single junction solar cell

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Abstract: The insertion of optimized Window and a back surface field (BSF) layers on an InxGa1-xN p-n basic single junction (BSJ) solar cell is the chief reason behind the reduction of front and back recombination. In this context, this work is focused on the selection of the suitable parameters including the indium (In) content, thickness and doping concentration for the InxGa1-xN inserted layers, that gives the best photovoltaic performances. At this aim, numerical simulations were performed using the computational numerical modeling TCAD Silvaco-Atlas to design, optimize the InxGa1-xN BSJ and extract the above Window and BSF parameters that enhance the BSJ performances. A short circuit current density (J_{sc}) of 26.15 mA·cm^2 , an open circuit voltage (V_{oc}) value of 0.904 V and a fill factor (FF) value of 79.67 % are obtained under AM1.5G illumination, exhibiting a maximum conversion efficiency (η) of 19.62 %. Other parameters like the external quantum efficiency (EQE), electric field developed, the current density-voltage (J-V) and the power density-voltage (P-V) characteristics are also calculated and plotted for the designed solar cell.

Keywords : InGaN, solar cell, BSF layer, Window layer, simulation, Silvaco