Performance of wide band gap amorphous silicon alloys as passivation layer in graded band gap solar structure

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Research Article

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Abstract

This work investigates the behaviour of two amorphous silicon wide band gap alloys: amorphous silicon nitride ($aSiN_x$) and hydrogenated amorphous silicon carbide ($aSi_xC_{1-x}H$) as passivation layer in previously designed band gap tailored single junction photovoltaic structure: $p + aSi_xC_{1-x}H/i-aSi:H/n + aSi_{1-x}Ge_xH$. The work involves fabrication of PECVD made $aSiN_x$ samples followed by detailed optical characterisation on band gap tailoring in terms of mole fraction, x . A rigorous study is made on the current density-voltage (J-V) characteristics as well as on the Internal Quantum Efficiency (IQE) characteristics of the recommended band gap tailored solar structure using $aSiN_x$ and $aSi_xC_{1-x}H$ as passivation layers. The progressive band gap tailored solar cell structure using $aSi_xC_{1-x}H$ passivation layer accomplishes conversion efficiency of 15.59 % while similar structure having $aSiN_x$ passivation layer delivers an efficiency of 15.32 %. By virtue of the obtained results, it is observed that $aSi_xC_{1-x}H$ with high carbon content is more efficient than $aSiN_x$ to be considered as passivation layer. The work presents the performance of continuously band gap graded amorphous silicon alloy as passivation layer in single junction photovoltaic structures for the first time.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

Tauc's plot obtained for different fabricated samples of aSiNx with varying mole fraction, x

(a)

(b)

Figure 2

(a) Investigations made on the basis of optical characterisation of the fabricated aSixC1-x:H films with varying mole fractions, x done by Ambrosone et al. [10] (b) Findings on dependence of mole fraction on band gap of aSixC1-x:H films based on the experiments made by Lukianov et al. [11] and Tabata et al.[12]

Figure 3

Proposed p+aSixC1-x:H/i-aSi:H/n+aSi1-xGex:H graded band gap single junction solar cell structure using (a) aSiNx as passivation layer (b) aSixC1-x:H as passivation layer

Figure 4

Energy band diagram of proposed p+aSixC1-x:H/i-aSi:H/n+aSi1-xGex:H graded band gap single junction solar cell structure using (a) aSiNx as passivation layer (b) aSixC1-x:H as passivation layer

(a)

(b)

Figure 5

Comparison of of proposed p+aSixC1-x:H/i-aSi:H/n+aSi1-xGex:H graded band gap single junction solar cell structure using aSiNx and aSixC1-x:H as passivation layers (a) J-V characteristics (b) IQE characteristics