Simulation Result of Gallium Indium Nitride Solar Cells

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InGaN can reach all values of bandgap from 3.42 to 0.7eV, which covers almost the entire solar spectrum. This study is to understand the influence of each parameter of the solar cell for an improved optimization of performance. The yield obtained for a reference cell is 12.2 % for optimal values of doping of the layers. For generation and recombination, performance of the cell varies with these settings. III nitrides have a high absorption coefficient, a very thin layers of material are sufficient to absorb most of the light.

1.Introduction

III-N semiconductors are interested materials with a high thermal conductivity and a high melting point, and a direct band gap. They currently represent ideal materials for the development of light emitting-diodes (LEDs) operating in the visible, UV ranges, and laser diodes etc [1-5]. The band gap of these ternary or quaternary materials can be adjusted to absorb the light from infrared to ultraviolet makes these materials very useful for other applications such as photovoltaic and photodiode applications because of the possibility of achieving high efficiency [6-8]. Additionally, III-Nitrides also exhibit other interesting photovoltaic properties such as low effective masses of charge carriers, large absorption coefficients, and high mobility as compared to other materials such as GaAs [9-13]. III-V nitrides has demonstrated its ability to demonstrate its ability for applying in optoelectronic devices, which confirms its potential for high efficiency photovoltaics. [14].

2. Properties of InGaN used in the simulation

In this paper, we used PCID software to simulate the model, a freely available for public use [15- 16]. The alloy used for simulation consists of $\text{In}_{0.4}\text{Ga}_{0.6}\text{N}$, which has a bandgap of 2.1 eV and 1mm² cell was chosen in area for the p-i-n homojunction device and was n-type doping of $1 \times 10^{18}/\text{cm}^3$. The InGaN dielectric constant, the intrinsic concentration at 300K were fixed at 9.52 and 90.9 cm^{-3} , respectively. For carriers mobility the simulator offers two choices to the user, the first one is the carrier constant mobility, while the second considers mobility through its internal model at 300K.

3. Simulation results

Results are obtained using the file excitation (1 Sun) with PCID software and the characteristics of I-V and the power of the cell are represented by Fig. 1 and Fig. 2 below:

Fig. 1. I-V characteristic of the reference cell

Fig. 2. The maximum power of the cell as a function of substrate doping for n-substrate p-InGaN.

From Figure Fig. 2, both carriers lifetime mobility degrades while the Shockley-Read-Hall and Auger recombination rates increase. This causes a significant decrease in performance for a heavily doped substrate. III-V nitrides show a very low diffusion length due to the high dislocation density in currently available materials, especially those relevant to this work where high In% InGaN layers are required. But, III-nitrides have a high absorption coefficient thus requiring very thin layers of material to absorb most of the incoming photons.

Conclusion:

InGaN based solar cells have a low diffusion length may due to the high dislocation density in present materials with the highest reported minority carrier lifetime. Thus, the materials issues are resolved and lower dislocation InGaN layers become available and III-V nitrides an important candidate in the development of high efficiency photovoltaic and other important devices.

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