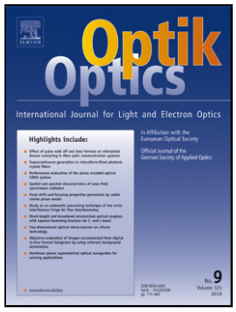

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PII: S0030-4026(18)31274-9
DOI: https://doi.org/10.1016/j.ijleo.2018.08.124
Reference: IJLEO 61421

To appear in:

Received date: 26-6-2018
Accepted date: 26-8-2018

Please cite this article as: Torres-Jaramillo S, Morales-Acevedo A, Bernal-Correa R, Pulzara-Mora A, Optimizing two and four-terminal $CuGaSe_2$/$CuInGaSe_2$ tandem solar cells for achieving high efficiencies, *Optik* (2018), https://doi.org/10.1016/j.ijleo.2018.08.124

OPTIMIZING TWO AND FOUR-TERMINAL $CuGaSe_2$/$CuInGaSe_2$ TANDEM SOLAR CELLS FOR ACHIEVING HIGH EFFICIENCIES

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Abstract

Solar cells based on $CuInGaSe_2$ (CIGS) have attained the highest record efficiency (22.9%) among thin film solar cells. CIGS is formed by the appropriate mixing of $CuInSe_2$ (CIS) which has a bandgap around 1 eV and $CuGaSe_2$ (CGS) which has a bandgap around 1.7 eV. These bandgaps are close to the optimal values for two-junction tandem solar cells. Therefore, CGS on CIGS or CGS on CIS tandem cells should be attractive and viable to achieve high efficiency and cost-effective thin film solar cells. In this work, a simple unified analytical model is used to design two-terminal and four-terminal CGS/CIGS tandem solar cells, establishing a realistic value for the expected efficiency in each case. Short circuit current density (Jsc), open circuit voltage (Voc), fill factor (FF) and efficiency, are determined as a function of the CGS and CIGS acceptor impurity concentrations, back surface recombination velocities, minority carrier diffusion lengths, and absorber layer thickness. It is shown that realistic efficiencies over 30% can be achieved under one sun AM1.5 spectrum for both of the terminal configurations, but the optimum composition for the CIGS sub-cell should be different depending on the respective tandem cell configuration.

Keywords: Tandem solar cell, CGS, CIGS, Thin film solar cell.