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Analytical Modeling of Dual-Junction Tandem Solar Cells Based on an InGaP/GaAs Heterojunction Stacked on a Ge Substrate

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Abstract: An analytical model is used to describe the electrical characteristics of a dual?junction tandem solar cell performing with a conversion efficiency of 32.56%under air mass 1.5 global (AM1.5G) spectrum. The tandem structure consistsof a thin heterojunction top cell made of indium gallium phosphide (InGaP) ongallium arsenide (GaAs), mechanically stacked on a relatively thick germa?nium (Ge) substrate, which acts as bottom cell. In order to obtain the bestperformance of such a structure, we simulate for both the upper and lowersub-cell the current density–voltage, power density–voltage, and spectral re?sponse behaviors, taking into account the doping-dependent transportparameters and a wide range of minority carrier surface recombinationvelocities. For the proposed tandem cell, our calculations predict optimalphotovoltaic parameters, namely the short-circuit current density (Jsc), open?circuit voltage (Voc), maximum power density (Pmax), and fill factor (FF) areJsc = 28.25 mA/cm2, Voc = 1.24 V, Pmax = 31.64 mW/cm2, and FF = 89.95%,respectively. The present study could prove useful in supporting the design ofhigh efficiency dual junction structures by investigating the role of differentmaterials and physical parameters.

Keywords : Analytical modeling, tandem solar cell, Spectral response, conversion efficiency