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Simulation analysis of a high efficiency GaInP/Si multijunction solar cell

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Abstract: The solar power conversion efficiency of a gallium indium phosphide (GaInP)/silicon (Si) tandem solar cell has been investigated by means of a physical device simulator considering both mechanically stacked and monolithic structures. In particular, to interconnect the bottom and top sub-cells of the monolithic tandem, a gallium arsenide (GaAs)-based tunnel-junction, i.e. GaAs(n+)/GaAs(p+), which assures a low electrical resistance and an optically low-loss connection, has been considered. The J–V characteristics of the single junction cells, monolithic tandem, and mechanically stacked structure have been calculated extracting the main photovoltaic parameters. An analysis of the tunnel-junction behaviour has been also developed. The mechanically stacked cell achieves an efficiency of 24.27% whereas the monolithic tandem reaches an efficiency of 31.11% under AM1.5 spectral conditions. External quantum efficiency simulations have evaluated the useful wavelength range. The results and discussion could be helpful in designing high efficiency monolithic multijunction GaInP/Si solar cells involving a thin GaAs(n+)/GaAs(p+) tunnel junction.

Keywords : GaInP/Si, tandem solar cells, power efficiency, numerical simulations