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Photovoltaic parameters extraction of InGaP/InGaAs/Ge triple junction solar cell for space applications

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Abstract:

In recent years, multijunction solar cells have attracted increasing attention for application in concentrator photovoltaic systems owing to their very high conversion efficiency. Actually, The III-V based triple junction solar cell is the most promising realization of this approach in space applications.
The InGaP/InGaAs/Ge solar cell can reach a conversion efficiency of up to 41.1% under AM1.5D because of her ability to match bandgap energies with the solar spectrum and for consequence reduce thermalization losses. The top junction is built from InGaP, and has the largest bandgap of the three junctions and absorbs the photons in ultraviolet and visible part of the solar spectra (300 nm to 620 nm). The middle cell InGaAs has medium sized bandgap and absorbs near infrared light (620 nm to 870 nm). Finally the bottom Ge has smallest bandgap and receives all the photon energies in the infrared (870 nm to 1800 nm).
In this work, we developed a model with structure permit to extract the photovoltaic parameters from the characteristic J(V) under AM1.5D spectrum. The current voltage relation for a triple junction solar cell was calculated by using an equivalent circuit model of InGaP/InGaAs/Ge solar cell. The effects of the series (Rs) and shunt (Rsh) resistances on the behavior of the J(V) characteristic, the power debited by this solar cell and fill factor were also studies here. The characteristics of the triple junction solar cell were evaluated with simulation programs with Borland C++. The open circuit of the triple junction solar cell was the sum of voltages from three subcells, it was 3.13V and the short current was limited by the smallest subcell photocurrent, it was 13.1mA. By varying series resistance and shunt between 25bmΩ to 5 Ω, and 150bΩ to 30 kΩ respectively, we obtain a maximum power of 35 mW and maximum fill factor of 86% when Rs was equal to 25mΩ and Rsh was 30 kΩ.