4 接合用 InGaAs リアヘテロ接合太陽電池における吸収層厚の最適化

Optimization of base layer thickness in rear hetero-junction InGaAs cell for four-junction applications

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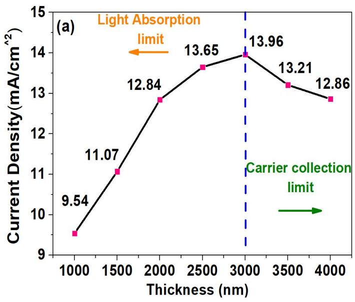
III–V compound four-junction solar cells (MJSC) have the potential for achieving high conversion efficiencies of over 50% and are promising for space and terrestrial applications[1]. However, The highest four-junction solar cell conversion efficiency is only 47.6% under 665-fold concentration of the AM1.5D spectrum[2]. Top two-junction solar cells (GaAs and InGaP), have achieved efficiency over 75% of its (S-Q) limits, however, bottom junctions solar cells (InGaAs and InGaInP) are still with efficiency lower than 75% of its S-Q limits. Rear hetero-junction (RHJ) structure has been applied to InGaAs solar cell, which leads to a suppression of non-radiative recombination and improvement of open-circuit voltage (Voc)[4]. However, because of poor carrier collection, rear hetero-junction resulted in a degraded short-circuit current (Jsc), inducing current mismatch issues in multi-junction applications. Thus, base layer thickness in the RHJ solar cell requires optimization to achieve both high Voc and Jsc.

In this report, InGaAs rear hetero-junction solar cell with a 2500 nm thick base layer was grown by metal-organic vapor phase epitaxy (MOVPE), with performance being measured. SCAPS-1D simulation software was used to extract the optimal thickness in a range from 1000 nm to 4000 nm. The results show that a 3000 nm thick base achieves the highest current density, whereas a degradation of Voc is observed when thickness is over 1500 nm. Thus, the optimal thickness for the base layer is around 2500 nm-3000 nm. In the last, we achieved a RHJ InGaAs cell of 2500 nm base layer thickness with a high Voc (0.437 V) and a current density of 13.65 mA/cm^2, which is appropriate for high performance 4-J solar cell application[2].



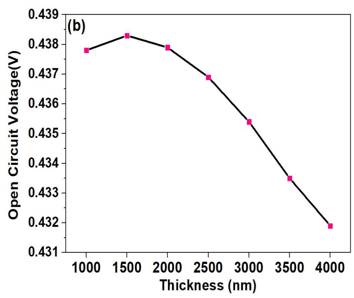


Fig.1 Base layer thickness dependent (a) Current density (in four junction) and (b) Voc.

Reference:

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