Measurement and analysis of spatial transport efficiency inhomogeneities in multi-junction solar cells

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III-V multijunction solar cells are currently leading in efficiency among all types of solar cells, and tandems on silicon are extensively investigated for next generation low cost devices. However, the current transport in such devices is not straightforward, including tunnel junctions in 2 terminals architectures, and various lateral spreading layers in 4 terminals. In this paper, we provide a method for measuring the transport efficiency f_T in multijunction by luminescence imaging with a CCD camera [1], which is faster than Light Beam Induced Current (LBIC) setups currently used for such measurements.

Our method is applied on a InGaP/GaAs/GaNAs triple junction from Solar Junction, and validated against LBIC measurements. We find that the transport efficiency in the top and middle cell are anticorrelated (Figure 1). A quasi-3-D simulation using SPICE is used to reproduce the transport efficiency images. We find that the perimeter recombination in the GaAs middle cell plays a critical role in the global transport efficiency of the cell. Fitting the collection efficiency profiles, we find perimeter saturation current of 1.48e-12 A/cm, in good agreement with values reported in the literature.

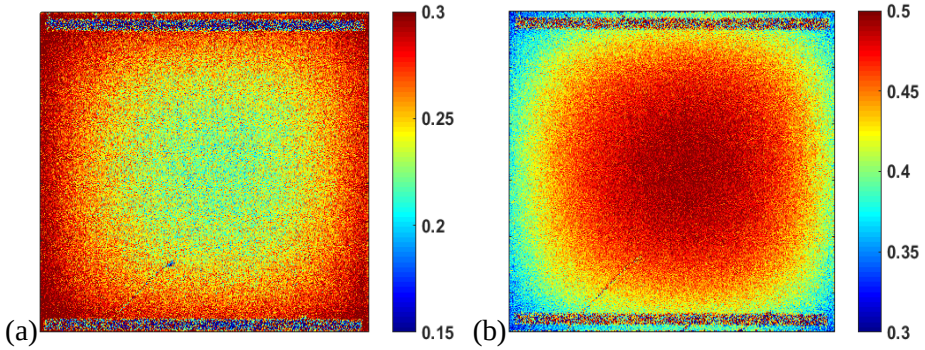

Figure 1 Transport efficiency (a) in the InGaP top cell and (b) in the GaAs middle cell, under illumination and a voltage of 2.85V.

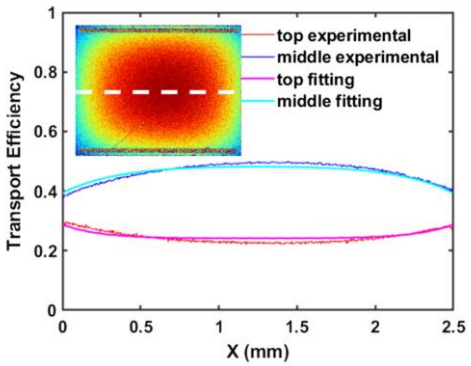

Figure 2 Transport efficiency of the top subcell and the middle subcell at 2.85 V is investigated along the x-axis in the center of the transport efficiency map (white dashed line in the inserted figure). A SPICE simulation is used to fit the parabolic variation.

[1] H. Xu *et al.*, "Current transport efficiency analysis of multijunction solar cells by luminescence imaging," *Prog. Photovolt. Res. Appl.*, Jul. 2019.