Analysis of the voltage and current distribution in a low bandgap tandem solar cell

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The standard IV curve measurement under simulated solar illumination gives a rather generic picture of the internal operation of a multijunction solar cell. Whereas for single junction cells it is at least possible in most cases to extract meaning full values for shunt and series resistances and saturation current densities, such an analysis is much less useful for the multijunction counterpart. When dealing with low bandgap devices (Eg<=1eV) in particular, the additional problem arises, that the IR part of the solar simulator spectrum is typically much less matched to sun's spectra and special care is needed for calibration [1]. In the need for a suitable method to analyze our InGaAs/ InGaAsP tandem cells, we have developed an apparatus that allows for a fast and convenient evaluation of cell performance and current and voltage distribution within the cell for illumination intensities equivalent up to 50 suns. The experimental setup makes it possible to measure all relevant data with the sample mounted on a semiconductor probe station. For optical biasing of the cell, 2 high power laser diodes are used which address each subcell of the tandem individually. The light coming from the 2 laser diodes is brought to the sample using a unique optical fiber bundle that also transmits the tunable light coming from the output of a low power, high purity monochromatic light source, comprising of a double monochromator with filterwheel and a tungsten lamp.

In this talk we will show first results obtained with the new setup. In particular 2 main aspects of the tandem cell analysis will be presented, firstly the measurement and evaluation of the performance of each individual cell within the tandem, and secondly a powerful type of data analysis by means of contour plots generated by scanning the LD power. With this we are able to obtain a fairly complete picture of the current and voltage distribution of the solar cell under any operating condition. Fig.1 shows an example contour plot of a tandem cell under short circuit condition where the short circuit current is color coded. One thing that easy recognizable from this kind of plot is the

current matching condition given by the corner point of the 90° angle transition of the contours. We will show other examples that demonstrate how to identify and extract shunts and how simulations can further help in the analysis.

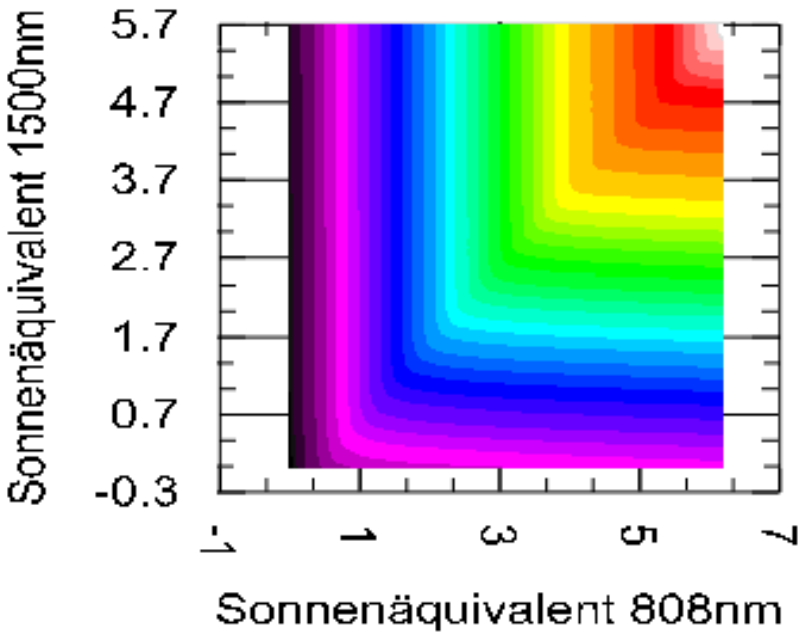

Fig.1 Contourplot of a tandem cells short circuit current as a function of the illumination level of the subcells

[1] M. Meusel, R. Adelhelm, F. Dimroth, A.W. Bett, and W. Warta, “Spectral mismatch correction and spectrometric characterization of monolithic III-V multi-junction solar cells,” *Progress in Photovoltaics: Research and Applications*, vol. 10, 2002, pp. 243-255.