Local device parameter extraction of a concentrator photovoltaic cell under solar spot illumination

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Abstract

Focused sunlight can act as a localized source of excess minority carriers in a solar cell. Current signal generated by these carriers gives considerable information about the electrical properties of the cell's material. Point by point current–voltage data were measured for a back point-contact concentrator photovoltaic cell when illuminated by focused sunlight. Two numerical curve fitting procedures: a non-linear two-point interval division and particle swarm optimization algorithm were then applied to extract local parameters (i.e. as function of position) from the current–voltage data at each measurement point. Extracted parameters plotted yields relative spatial information about the electrical properties of a solar cell in a two or three dimensional mapping. The curve fitting routines applied to current–voltage data reveal that performance parameters: short circuit current, open circuit voltage, maximum power and fill factor show distinct variations in the vicinity of the observed current reducing feature. The relative values of the diode ideality factors, series resistance, shunt resistance and reverse saturation currents from both methods showed no significant measurable features that could be distinguished. This shows that the observed reduction in photo-induced current was due to severe recombination in the bulk or around the highly diffused point contacts and not the quality of the multiple p–n junctions of the cell. These approaches allow one to obtain a set of parameters at each local point on the cell which are reasonable and representative of the physical system.