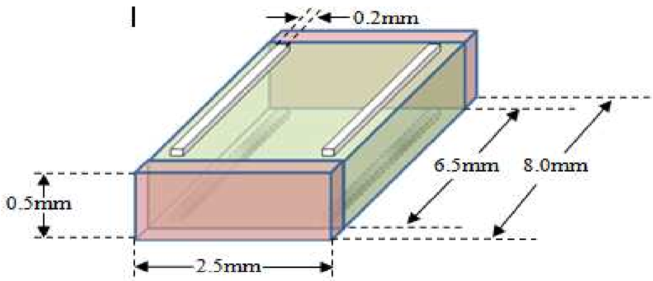
Silicon Solar Cells in Tandem Solar Cell Package for a Mobile Battery Charging Application

Ngwe Soe Zin and Andrew Blakers

The future applications of energy generated from solar cells include domestic households, utility-scale power plant, transportation and mobile electronic applications. The very High Efficiency Solar Cell (VHESC) program funded by Defense Advanced Research Projects Agency (DARPA) formed a consortium for the development of 50% efficient prototype solar cells for a mobile battery charging application [1, 2, 3]. The VHESC program uses the approach of a six-junction tandem cell in which each cell absorbs the appropriate slice of the solar spectrum. As one of the contributors to the VHESC program, ANU has engaged in the development of silicon solar cells, one of the solar cells to be used in six-junction tandem stack. Key challenges to develop the silicon cells are the small dimensions of 2.5x8 mm^2 and the need to transfer light with energy of less than 1.1ev to the cells stacked underneath it.



In this paper, we discuss the design of the silicon solar cell, and critical parameters to be considered for the cell. Modeling was also made to predict the short-circuit current, open-circuit voltage and internal quantum efficiency of the cell. In addition, an evaluation is made of various fabrication techniques and approaches to meet the requirement of the cell's efficiency. Laser dicing was selected to form individual cells out of the host wafer. Two different approaches of dry and wet etching to form the windows of the active emitter region is discussed, including analysis of the lifetime and implied-Voc of characterized cells. Due to the nature of small silicon solar cells having the dimension of 2.5x8 mm^2 to be used for mobile battery charging application, alternate metallization methods to evaporated or screenprinted metal option ware explored. Light-induced plating and electrolyte plating were adopted for forming good metal contact and to minimize resistive losses. Testing of cells with such small dimension has been a challenge due to the need of repeatability and the ability to test multiple cells. A jig specially designed for testing of such small cells was developed and associated resistive loss is discussed. Finally a discussion of cells connections and current-voltage testing is made to reach the targeted efficiency of silicon solar cells.