University of Delaware

Department of Electrical and Computer Engineering

ELEG620: Solar Electric Systems

Homework #5: Series Resistance

Introduction

The goal of this Homework is to design a grid pattern of a silicon solar cell, given realistic constraints in the metallization on the solar cell.

The series resistance is determined by the geometry of the grid pattern and the thickness and resistivities of the base and emitter in the solar cell. For this assignment, you may neglect the contribution of the base resistance (except in problem 1). You may assume that the minimum width of the grid line is 150 microns, and the maximum height is 10 microns. The solar cell has two bus bars, and the fingers must be integral multiples widths of the fingers – the height does not change. The solar cell area is 10×10 cm². The resistivity of the top surface metal paste is typically several times higher than the bulk resistivity of the metal. The resistivity of silver is 1.59×10^{-8} Ωm, so use 4.8×10^{-8} Ωm as the resistivity of the screen printed silver. Unless specified otherwise specified, use a short circuit current of 35 mA/cm² (does not include reduction due to metallization) and a sheet resistance of 50 Ω/□.

1. Derive the equations for the power loss for the emitter, base and fingers of the top grid.
2. Optimize the top grid pattern (the finger spacing) for the silicon solar cell. In order to get credit for you work, you must explain give the equations you are using tp optimize, and explain the trade-offs. You must also explain how you performed the optimization.
3. Analyze the contributions from the base, emitter and grid fingers – which is dominant and is this what you would expect?
4. Determine an equation for the impact of series resistance on solar cell efficiency.
5. Examine the sensitivity of you optimization to critical design parameters in you solar cell.
    a. Change the minimum finger width to 50 μm instead of 150 μm – what difference does this make in the overall performance?
    b. Change the aspect ratio (height: width of the metallization) from 0.667 to 5. What impact does this have on efficiency?
    c. Change the emitter sheet resistance to 30 Ω/□. What difference does this make in the overall performance? What negative features in terms of collection and open circuit voltage would the lower sheet resistance have?