Antenna Profile of a Solar Array

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***Abstract*— Solar Arrays make up a large portion of the surface area for many satellites. This research is the first of a two stage effort in investigating how standardized unaltered cells interact with the RF spectrum from 1 GHz-10 GHz. This publication will also investigate how strings of cells that make up an array perform and address coupling effects. Results from this multi-staged effort in investigating the RF characteristics of solar arrays will help developers to enhance the antenna properties of solar arrays.**

I. Introduction

Recently, several attempts have been made to create multifunctional solar cell arrays for cubesats [1]-[4]. Researchers have looked at a variety of methods of enhancing the capabilities for a satellite's communication or power harvesting potential by enhancing its solar arrays. Much of this research requires a redesign of the accepted standards for solar arrays and meets a great deal of resistance for transitioning.

In this approach, we chose to take standardized unaltered solar cells layered on top of space-craft honeycomb to simulate flight ready physical conditions and thus, creating ideal antenna characterization conditions.

The subsequent paragraphs will investigate a.) The reflection coefficient of the test cells b.) Radiation patterns of the test cells c.) The significance of the test cell's wiring on the overall RF response of the solar cell.

II. Experimental Setup

A. Solar Cell Samples

Solar cells used in this experimental effort were standard BTJM and ITJ triple junction cells. Each type of solar cell had two different soldering configurations used. (See Fig.1)

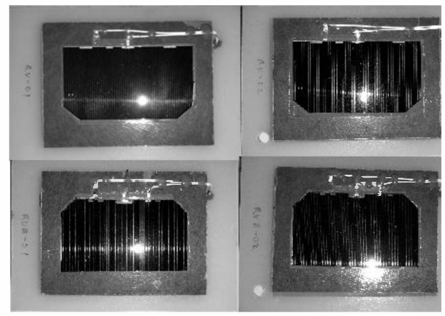

Fig. 1. Four single cell samples showing two types of soldering convention for each type of triple junction solar cell.

B. Blank Sample Cell

Given the structural design of the test cell configurations (Fig. 1.); we also chose to investigate the RF impact of the current carrying wires of the test cells. Which theoretically, should act like a dipole antenna.

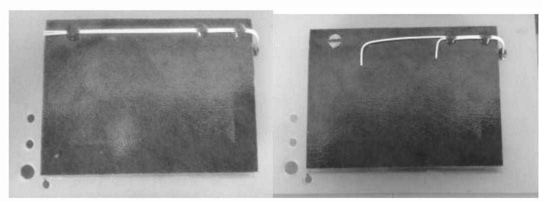

Fig. 2. Sample with no cell but with current carrying wires used for solar cells. (Two different configurations)

III. Results

Reviewing the experimental results of the four test solar cells; all of the cells produced very similar results, henceforth we shall represent all four test cells as the SC-01 solar cell.

A. Reflection Coefficient

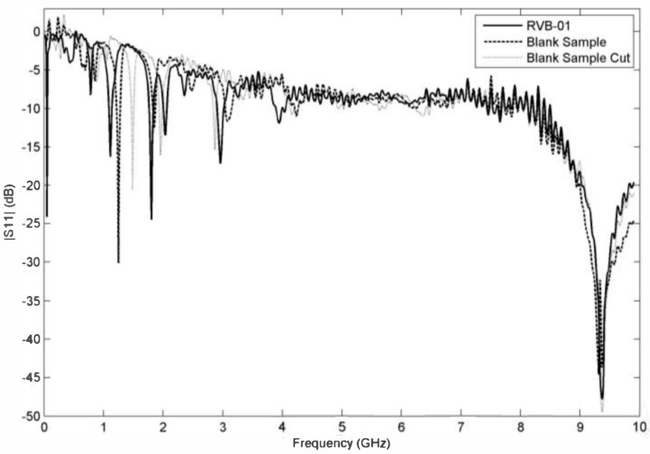

Fig. 3. Return loss results (1 -10 GHz)

Fig. 3, respectively, shows return loss characteristics for both the solar cell (Fig. 1) and blank sample (Fig. 2). The measured return loss for the solar cell and blank sample were nearly equal, but slightly out of phase. A modified blank sample (See Fig. 2) was made to determine if the wire placement had any contribution to the return loss. As indicated in Fig. 3, one can see the resemblance between the three sample's return loss results, which shows the correlation between wire placement and return loss.

B. Radiation Pattern

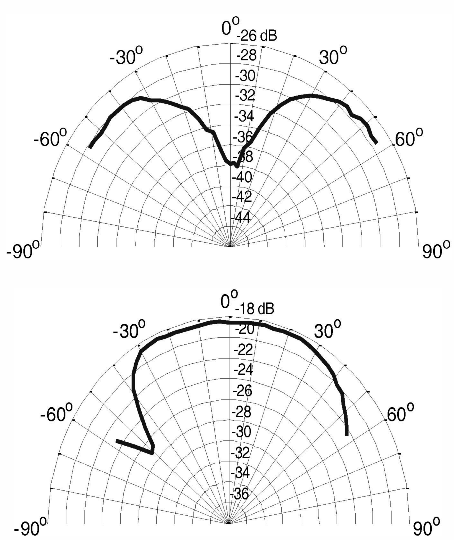

Fig. 4. Radiation patterns for blank sample cell at ~ 2GHz (H-top, E-bottom)

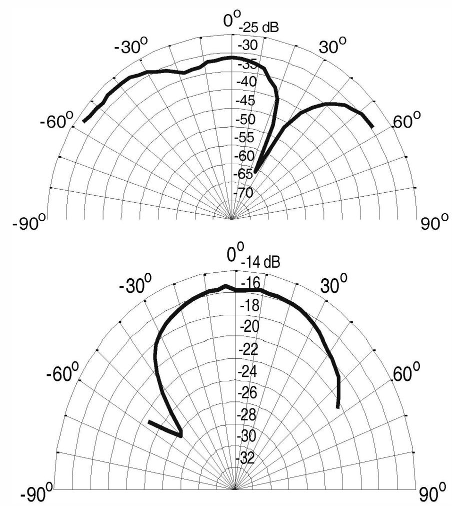

Fig. 5. Radiation patterns for SC-01 sample cell at ~ 2GHz (H-top, E-bottom)

Figs. 4 and 5, show the H & E-plane radiation patterns at ~2 GHz for the SC-01 solar cell and the blank sample respectively. As indicated above, both the solar cell and blank sample resemble dipole antenna radiation patterns. The solar cell shows a slightly better main lobe of -16dB, compared to the blank sample's -18dB lobe.

IV. Conculsion

In this publication, the experimental results of an indivdual triple junction solar cell have been presented and discussed. Preliminary test results indicate that a standardized unaltered solar cell produces dipole like antenna properties, with large noticeable attenuation loss within the solar cell. We believe that the wiring of the solar cell produces a greater response than the cell. This is mostlikely due to a mismatch of impedances.

Future work will focus on characterizing the coupling impact of multiple solar cells and their wiring harness on the overall antenna properties of the solar array. This will also inculde creating a matching network for a single cell, and noting the improved response, if any.

References

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