By-Pass Diode Temperature Tests of a Solar Array Coupon under Space Thermal Environment Conditions

Kenneth H. Wright (University of Alabama – Huntsville)
Todd A. Schneider and Jason A. Vaughn (NASA Marshall Space Flight Center)
Bao Hoang, Frankie Wong, and Gordon Wu (Space Systems Loral, LLC)

Introduction

- By-Pass diodes are a key design feature of solar arrays and system design must be robust against local heating, especially with implementation of larger solar cells.
- By-Pass diode testing was performed to aid thermal model development for use in future array designs that utilize larger cell sizes that result in higher string currents.
- Testing was performed on a 56-cell Advanced Triple Junction solar array coupon provided by SSL.
- Test conditions were vacuum with cold array backside using discrete by-pass diode current steps of 0.25 A ranging from 0 A to 2.0 A.

Experiment Setup

- MSFC chamber dimensions: 1m dia. and 2 m length.
- Vacuum: Oil-free pumping to reach in the 10⁻⁵ Pa (10⁻² Torr) range.
- LN₂ Cold Plate facing coupon backside.
  - Test 1: 3.8 cm gap between coupon and cold plate with LN₂ and 150 C limit.
  - Test 2: coupon and cold plate in direct contact with LN₂ and no temperature limit.
  - Test 3: coupon and cold plate in direct contact without LN₂ and no temperature limit.
- Thermocouples mounted on coupon front and back continuously monitored during test.
- Periodic IR thermal images obtained when diodes reach ~ thermal equilibrium.

Calibration of thermal image system

- FLIR SC655 IR Camera.
- Calibration performed with same attributes as used in the test.
  - Same optics (coverglass and ZnSe viewport).
  - Same separation distance: (1) camera-to-viewport at 2.5 cm and (2) viewport-to-coverglass at 58 cm.
- Mikron M340 blackbody used for known temperature reference.
  - Range: -20 C to 150 C with active cooling so that equilibrium times are short for scanning in both directions.

Test Results

- Test results were used to correlate thermal analysis and to determine design limits of array designs with larger solar cells. Coupon backside facing deep space.

SSL Thermal Model

- Data from Test 1
- Cold plate temperature maintained at -182 C.

- Data from Test 2
- Cold plate temperature maintained at -182 C.

Reference