National Aeronautics and Space Administration

High-Efficiency Lightweight Solar Array for Deep Space Missions

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Program: FY21 R&TD Strategic Initiative **Strategic Focus Area: System Level Integration for Small Satellite Components**

Overall objective:

Develop a solar array with ~3W/kg end-of-mission specific power at Saturn, and demonstrate its performance in the relevant environment (TRL-5).

FY21 objectives:

(1) Write interface control document and test specification

(2) Design Final coupon i.e. Deep-space Solar Array test article

(3) Fabricate Final coupon including lessons learned, enhanced processes

(4) Demonstrate performance in relevant environment, complete TRA

Background:

- Offers 5x mass reduction relative to state-of-art solar array
- 2x mass, 6x cost reduction for Saturn missions as compared to radioisotope thermoelectric generator (MMRTG) power sources
- Enabling technology for deep-space small spacecraft to Saturn and possibly beyond, enhancing for larger mission classes

Approach and results:

(1) All interface, design and test requirements for the Final coupon were defined, and the associated documents were finalized and released

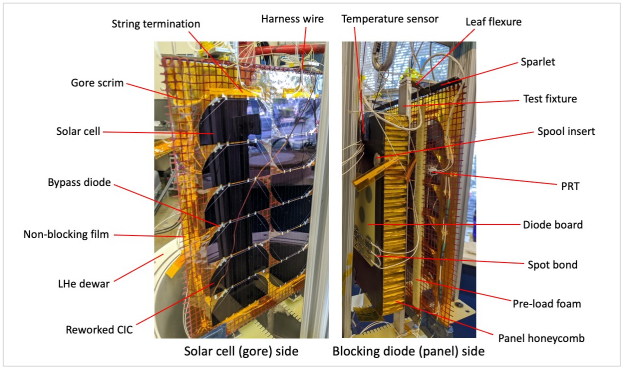
(2) Fabrication-ready drawings of the coupon substrate, fixturing and electrical-component layouts were generated, reviewed and released

(3) Substrate and fixturing fabrication was completed by NG; cell fabrication and add-on component laydown by SolAero; assembly by JPL

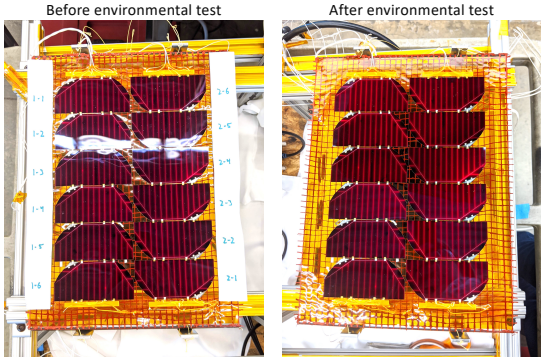
(4) Environmental test was completed successfully:

- Room-temperature functional data: no change post- vs. pre-test
- Visual inspection: no delamination, debonding or other damage
- Continuity: no loss of electrical connection in solar cell strings
- Dark-IV: no performance change at Saturn operating temperature

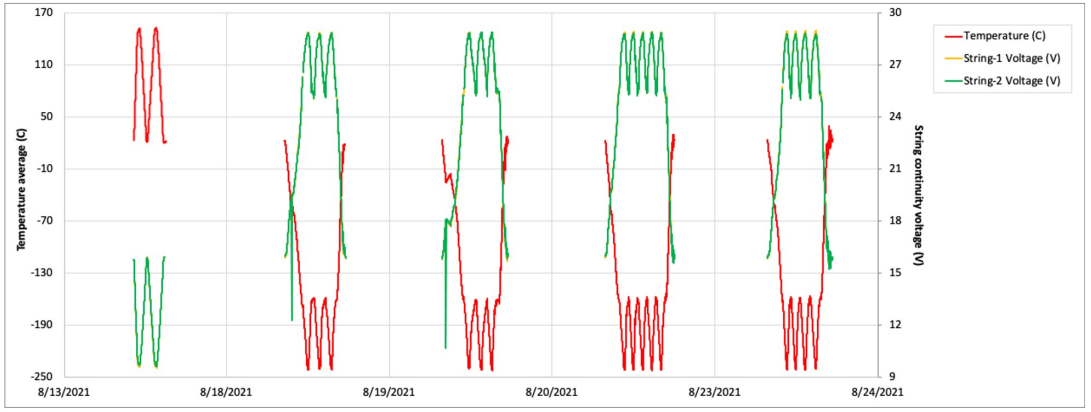
A technology readiness assessment meeting was held on 9/22/2021, and the unanimous decision of the review board was that the Deep-space Solar Array had reached TRL-5.



Deep-space Solar Array TRL-5 test article (a.k.a. "Final Coupon")



Final Coupon solar cell electroluminescence inspection



In-situ solar cell string continuity voltages (monitored at constant current) during Final Coupon environmental test

Significance / benefits to NASA:

- Successfully met overall and specific objectives for FY19-21 task
- The Deep-space Solar Array is capable of 2.93W/kg end-of-mission specific power at Saturn
- Performance in relevant environment was demonstrated by test and analysis, thereby reaching a technology readiness level of TRL-5
- Now ready for infusion into flight missions

Publications:

[1] A. Boca, C. MacFarland, J. Schwartz, J. Grandidier, M. McEachen, J. Spink, M. Eskenazi, C. McPheeters, L. Fesler, and B. Cho, "Development of a high-efficiency lightweight solar array for deep-space missions", Proc. 48th IEEE Photovoltaics Specialists Conference, 2021.

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