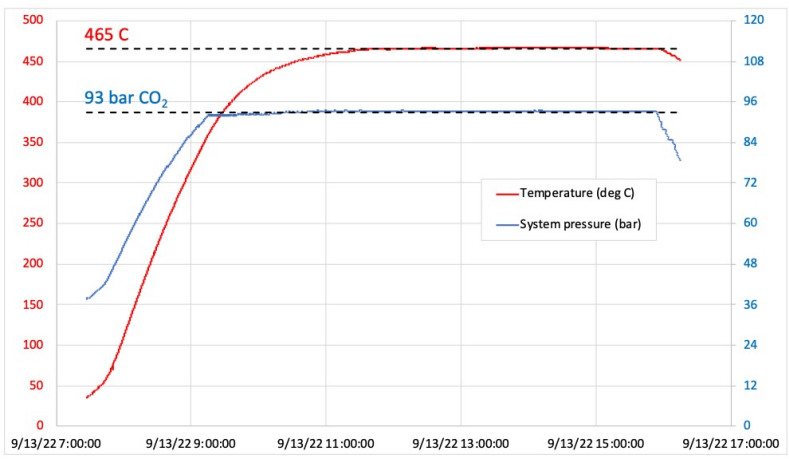
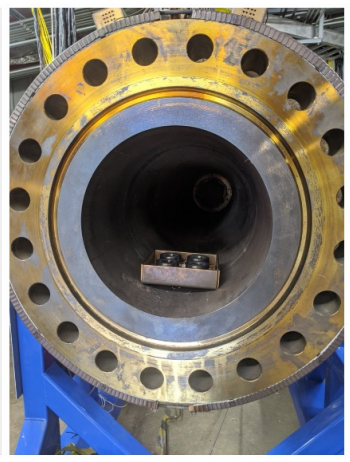
National Aeronautics and Space Administration

High-Temperature Solar Array for Venus Surface Missions

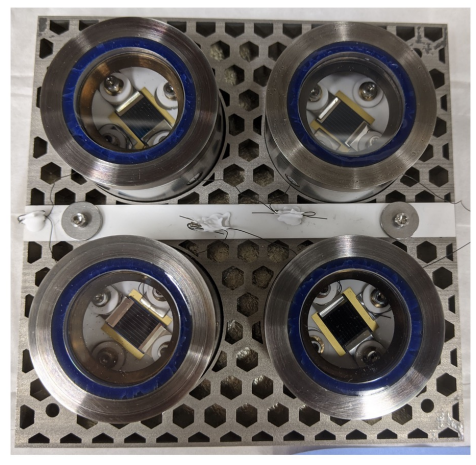
Principal Investigator: Andreea Boca (346)
Co-Investigators: Clara MacFarland (346), Joel Schwartz (346), Brian Phan (513), Su Chi (346)

Program: FY22 R&TD Topics
Strategic Focus Area: Power Generation





Combined-effects environmental test at JPL's Large Venus Test Chamber (LVTC) facility: temperature and pressure data acquired in-situ during test (left); Venus-Surface Solar Array test article in LVTC after exposure (right)



Venus-Surface Solar Array prototype, before (left) and after (right) LVTC environmental exposure: no visual changes noted in "puck" solar cell assemblies other than minor discoloration; windows, seals appear intact

Overall objectives:

- Develop and demonstrate Venus-Surface Solar Array: ~4 W/m^2 target power production capability over a 1-month duration in the Venus surface environment of 465 °C temperature, 70 W/m^2 incident irradiance, zero-altitude red-rich spectrum, 93 bar atmospheric pressure, and corrosive compounds including 150 ppm SO_2
- Array-level power degradation in combined environments: within 2% of bare cell degradation due to temperature alone at 465 °C

FY22 objectives:

- Test a solar array hardware prototype in a laboratory environment representative of the Venus surface
  (1) Document test requirements and setup subcontract with test facility
  (2) Obtain safety/travel approvals and ship test article/equipment
  (3) Complete environmental exposure and pre-vs-post functional testing
  (4) Write report summarizing environmental test results

Background:

- Will enable long-lived landers to operate on Venus for up to one solar day (58 Earth days)
- Could also be used to power aerial platforms at higher altitudes

Approach and Results:

(1) Subcontract setup
- Environmental test was completed in house (GEER not available for array-level test), no need for subcontract

(2) Safety and logistics
- No travel/shipping required, FLASH approvals for in-house Large Venus Test Chamber obtained during FY22-Q4

(3) Environmental test
- All test requirements were met at LVTC: temperature ≥ 465 °C, CO_2 pressure ≥ 93 bar, duration ≥ 4 hours
- Visual inspection: no puck changes other than minor discoloration of inner chamber wall; no detectable shifting of internal components; no change in window/seal appearance; wire spot bonds and external bolts loosened
- Electrical string performance: significant degradation, P/P_0 = 37% for one puck, ≤ 1% for the other three
- No evidence of assembly-induced functional performance degradation, root cause may be internal to cell devices

(4) Report writing
- Final report for FY22 summarizes combined-effects test conditions and results; written and submitted to IFR portal

Significance/Benefits to JPL and NASA:

- Met all FY22 milestones and objectives; valuable lessons learned from prototype fabrication process and environmental test
- Follow-on: NASA-funded HOTTech "Venus Surface Solar Array" task has a 2025 objective of TRL-5, after which technology will be ready for immediate infusion into flight-mission opportunities such as Discovery, New Frontiers or Flagship-class

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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

PI contact information: Andreea.Boca@jpl.nasa.gov

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