National Aeronautics and Space Administration

FY23 Strategic Initiatives Research and Technology Development (SRTD)

Solar Array Technology for Venus Cloud Environments

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Strategic Focus Area: Technologies for Venus Cloud Environments / Venus In-Situ Aerosol Measurement Technologies **|**
Strategic Initiative Leader: James A Cutts

Objectives:

Develop a solar array technology that survives and operates effectively in the clouds above Venus. Achieve > 20% efficiency, > 40 W/kg specific power and operate for > 100 Earth-days. Specific objectives for the second year of this task (FY23) included:

1) Demonstrate < 25 um corrosion depth for down-selected encapsulants after exposure to an aerosol environment containing $2 \cdot 10^{-5}$ mg/cm^3 H_2SO_4 for 96 hours.
2) Fabricate a pilot solar panel test article capable of demonstrating 40 W/kg specific power and 20% efficiency in the Venus cloud environment.

Background:

- Intended to enable long-duration exploration in the Venus atmosphere using a high altitude balloon, or “aerobot”
- State-of-practice solar arrays would not survive in Venus’ sulfuric acid clouds.
- Survivable solar arrays for the Venus clouds can recharge a battery repeatably to greatly extend the mission.

Approach and Results

1) Solar cells were designed at SolAero technologies, optimized for the Venus cloud spectrum at 51.5 km altitude. The target cell-level output at 28 deg C, 15^o solar zenith angle, is 36.8 mW/cm^2. The first batch of cells was fabricated and initial testing of the cells showed an average output of 35.7 mW/cm^2, within 3% of the target.
2) A pilot test panel, shown in Fig. 1, was fabricated incorporating four of the Venus-optimized cells from SolAero on a honeycomb sandwich panel from Northrop Grumman. The panel was coated with Parylene F and underwent initial performance testing at JPL (prior to acid exposure). Preliminary results are shown in Fig. 2.
3) The design would achieve a panel-level efficiency at operating temperature of 21.4% and a specific power of 41.0 W/kg (exceeding the goals of 20% and 40 W/kg), assuming the target cell efficiency is reached. Based on cell-level test data from the first batch of cells, the estimated efficiency is 20.8% (exceeding the goal) and the specific power is 39.8 W/kg (approaching the goal).
4) A test method was established for exposure of protective encapsulants and solar panel test articles in an aerosol test chamber currently under development at Caltech (rescheduled for FY24).

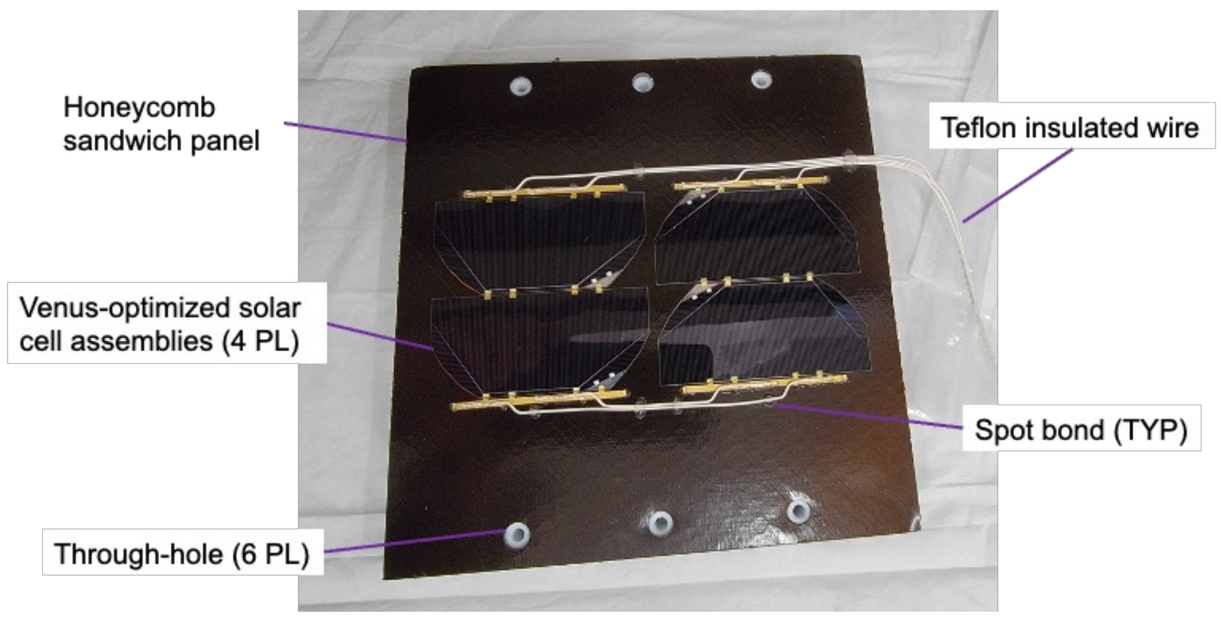

Figure 1. Pilot Solar Panel Test Article. The pilot solar panel comprises four Venus-optimized solar cells installed on a honeycomb sandwich panel, Parylene encapsulation and Teflon-insulated wiring.

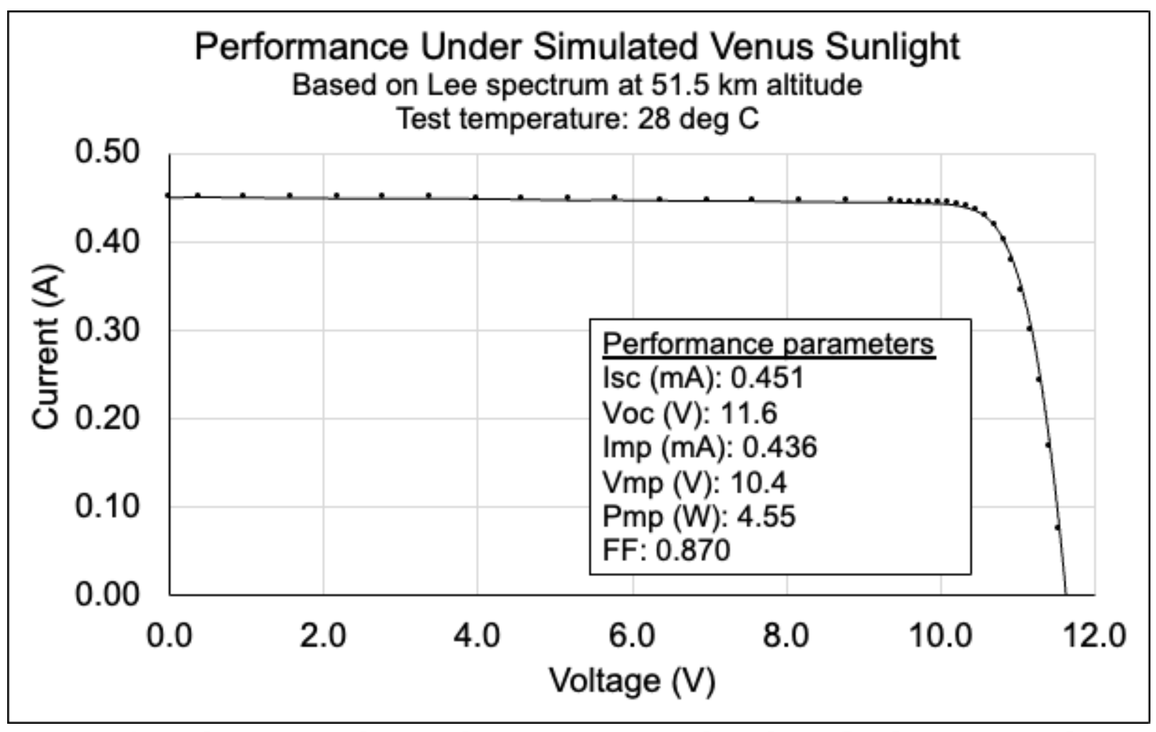

Figure 2. Electrical Performance of Pilot Solar Panel. A preliminary I-V curve measurement at 28 deg C is shown for the pilot solar panel under the simulated Venus cloud spectrum (at 51.5 km, 15 degree solar zenith angle). Simulation of the Venus cloud spectrum is under development.

Significance/Benefits to JPL and NASA

- Demonstrated the feasibility of fabricating solar cells optimized for the Venus cloud light spectrum.
- Key step towards enabling an aerobot mission to Venus with a sustainable power system

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