Extreme Environments Capabilities at Glenn Research Center

Venus and Beyond

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Extreme Environments Capabilities at Glenn Research Center

Venus and Beyond

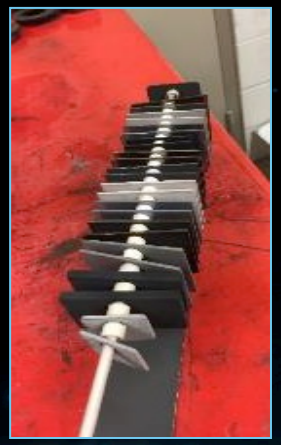
1. Venus atmospheric and surface investigations
   - A (brief) introduction to GEER
   - GEER status
   - Upgrades in progress
2. Other extreme environments capabilities

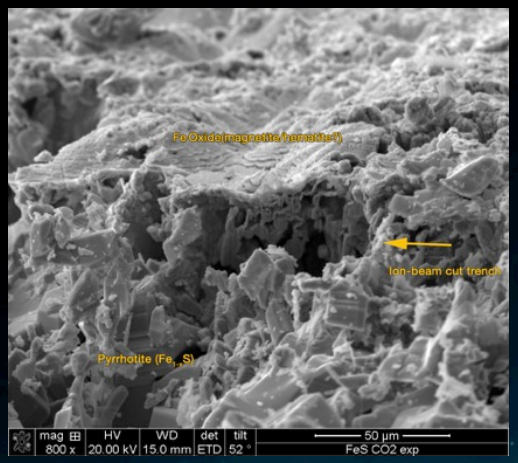
Venus in a Bottle:
The Glenn Extreme Environment Rig (GEER)

Two facilities combined:

A. 10 ton pressure vessel
- Certified to 100 bar at 500° C
- Corrosion resistant 304 SS
- Many user ports
- ~ 1 m^3 volume

B. Programmable gas bank
- Configurable via visual interface
- Controlled to PPM (or better)
- 9 independent gas streams

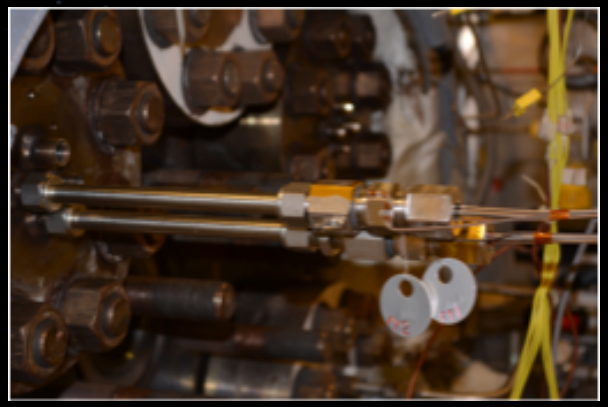




Recent Accomplishments

- Over 90 days of operation at Venus surface conditions
- Creation of extensive engineering catalog of materials performance
- Geological science investigation for atmosphere-surface interaction
- Successful operation of power/data feed-throughs
- Initial journal publications in preparation

New Capabilities and Upgrades in Progress



- General purpose interior probe
- Optical window
- Co-located mass spectrometer
- In-line gas chromatograph
- In-line FTIR
- Improved thermal control
- More precise control over gas injection

GEER available for users

- Science and engineering investigations
- GEER team will work with users to meet schedule and technical requirements and provide cost estimates
- Customization of vessel will require proposal-supplied funds
- All test runs are coordinated to maximize science and technical return
  - Can support several experiments at the same time

GEER available for users

- Customer interface document being finalized
- Website: https://geer.grc.nasa.gov/
- Primary contact is Dan Vento at:
  daniel.m.vento@nasa.gov

Currently seeking volunteers for science advisory board
contact Jeff Balcerski (*jeffrey.balcerski@nasa.gov*)

Other Extreme Environments Capabilities

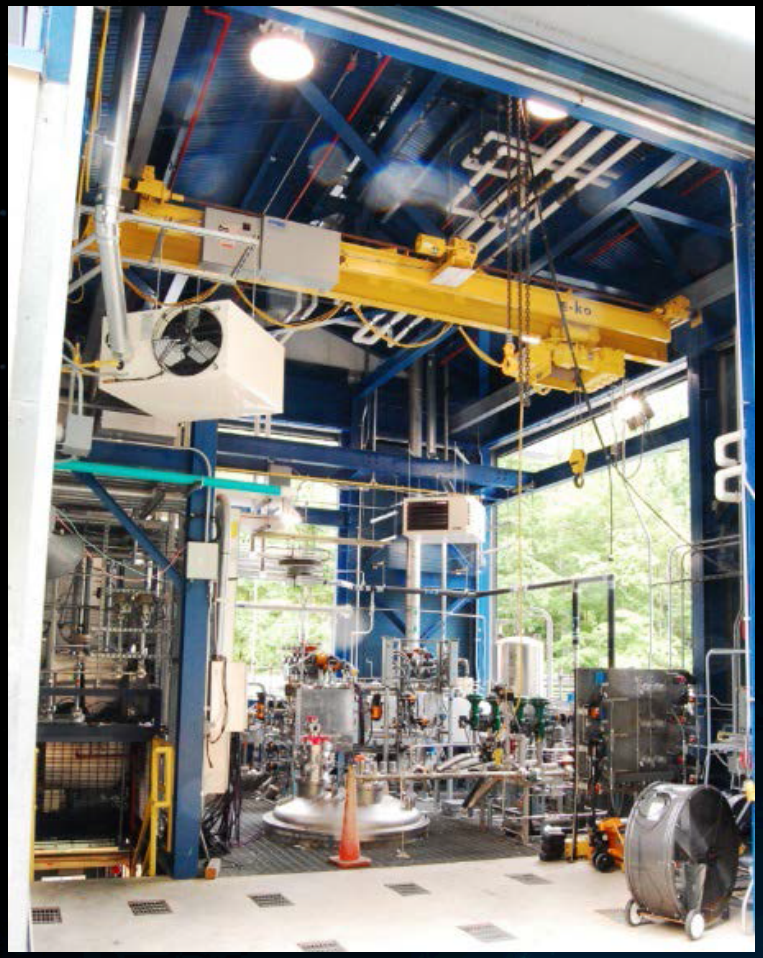
Out of the frying pan… *Into the freezer*

Cryogenics Facilities at GRC

Cryogenics Facilities at GRC

- Maintain $1x10^{-6}$ torr
- Liquid He, H_2, N_2, Ar, O_2, CH_4
- Can accommodate a 1.1 x 1.6 m test article
- Ascent profiling: 760 to 1 x 10^{-2} torr in 2 min.
- Programmable thermal shroud: 100 to 390 K to simulate diurnal cycles
- Can emulate conditions of Titan's lakes

Cryogenics Facilities at GRC



Numerous pressure vessels ranging from 0.2 ft^3 (0.006 m3) to 58 ft^3 (1.6 m3) with pressures up to 500 psi (34.5 bar)

- Primary contact is Lori Arnett *lori.arnett@nasa.gov*

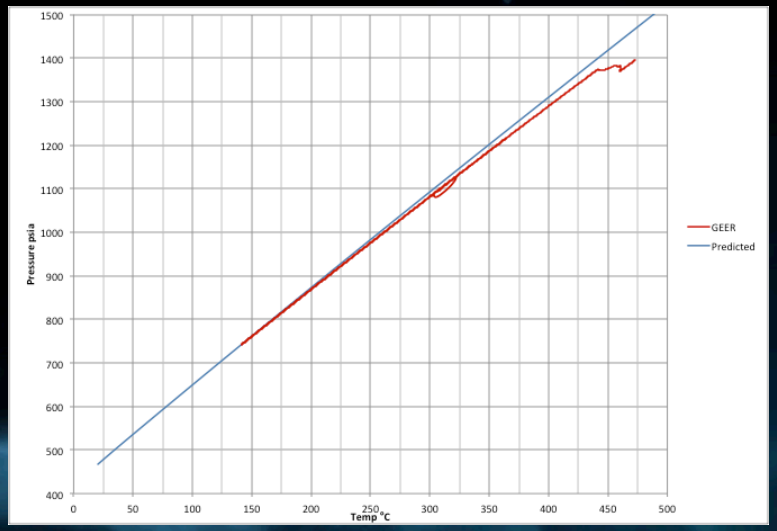
Backup Slides

Glenn Extreme Environment Rig (GEER) Specs

- 304SS vessel - 3' dia x 4' long inside dimensions (28.3 ft^3 or .8 m^3)
- Max conditions pressure 103 bar at 500 degree C
- Eight ports - including a couple at opposing ends
- Nine separate gas streams
  - Each of these can handle pure or mixed gases
  - Ppm accuracy or better
- Re-boost pumping system
- Supporting infrastructure sized to handle multiple or a much larger chamber if ever needed
- Currently verify chemistry through mass spectroscopy (regular sample)

Gas	Moles	Grams
CO2	1237.1107	54445.24191
N2	44.8693	1256.96857
SO2	0.2307564	14.782255
HCl	0.00051279	0.0186954
HF	0.00006409	0.001282
OCS	0.00564071	0.338843
CO	0.02948554	0.825919
H2O	0.0384594	0.692885

Tested with predicted chemistry near Venus surface



Early test run

Operating Details

- Temperature ramp rate 7 degree C /hour
- Average temperature controlled to 1 degree C
- Pressure can be boosted
- Large volume may offer opportunity to explore stratification