VfOx: Venus Oxygen Fugacity
DAVINCI's Student Collaboration

Noam. R. Izenberg[1], Sarah M. Hörst[2], David R. B. Kraemer[2], Stergios J. Papadakis[1], James B. Garvin[3], Stephanie Getty[3], Giada N. Arney[3], Natasha Johnson[3], and Erika Kohler[3] [1]Johns Hopkins Applied Physics Laboratory, Laurel, MD, USA, [2]Johns Hopkins University, Baltimore, MD, USA,[3]Goddard Space Flight Center, Greenbelt, MD, USA.

DAVINCI
Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging

Oxygen is a trace gas in the lower atmosphere of Venus, controlled by the CO-CO_2 chemical equilibrium, in turn controlling stable mineralogy on Venus surface

$2CO + O_2 = 2CO_2$

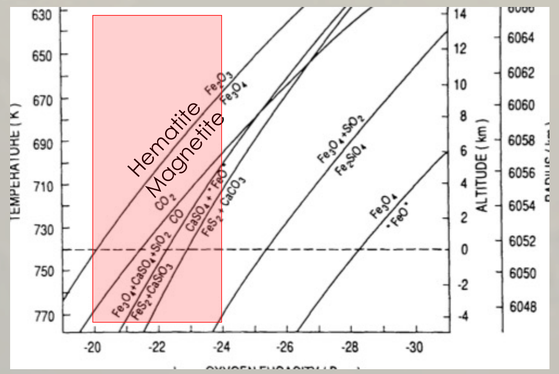
with eq. constant $K = (X_{CO2}/X_{CO})^2 \bullet (1/ fO_2)$

$\log_{10} fO_2 = 18.57 - 29621(\pm 19)/T$

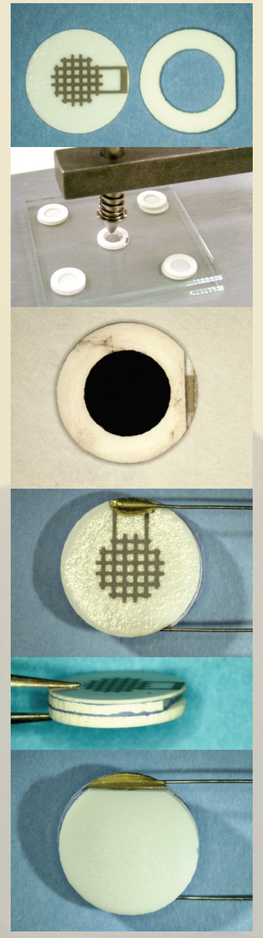
@ 22 km altitude (Fegley and Trieman, 1992). fO_2 can be calculated as a function of temperature (and altitude) (Fegley et al., 1997). At planetary radius and temperature of ~740 K, fO_2 is derived to be ~$10^{-21.5}$ bar.

Lower actual CO values at the surface (i.e. below the 20 ppm measured at 22 km), fO_2 would be higher. Observational and theoretical constraints suggest a CO abundance of 3-20 ppm at the surface of Venus, thus a plausible range for fO_2 would be

~ 10^{-20} bars to ~ 10^{-24} bars



Possible mineral stabilities vs,f fO_2 on Venus surface.



Design reference sensor and manufacturing process

What is VfOx?

A small, solid state sensor for determining fO_2 of Venus' lower atmosphere, to be attached outside DAVINCI's Descent Sphere.

What is the Student Collaboration Experiment?

A program of academic courses and projects in which students will design, fabricate, and test VfOx, conduct experiments, and analyze laboratory and flight data from the sensor, and answer science questions about Venus

A single, basic planetary question

What is the partial pressure of Oxygen near the surface of Venus?

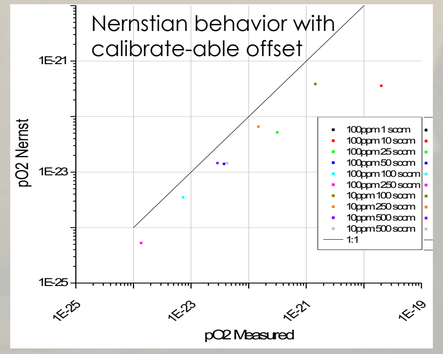
A single, moderately simple observation

Direct measurement of fO_2 from a dedicated small sensor

A High science value answer

Stable mineralogy and gas equilibrium gas chemistry near Venus's surface

- Data collected *Voltage*
- Volume: *1 Hz, ten bits/sec*
- Hardware: *"Button" sensor. Mounted exposed to atmosphere.*
- Accommodation: *2 wires, simple electronics*
- Minimal mass, power



Academic Schedule /Courses / Programs

Seminars, Intros
(JHU, 2022-onward)

Introducing Venus, DAVINCI, and VfOx to students and faculty

Summer Internships
(JHU, GSFC, APL, 2022-onward)

Hands-on student involvement in SCE and DAVINCI-related work at the PI and Co-I institutions.

Spacecraft Instrumentation Project
(JHU, 2022 or 23-onward)

Flagship course. Evolving Topics throughout mission, including Flight Sensor Design, Fab, Test, Data analysis.

Intro. to Space Science and Technology
(JHU, Ongoing)

Spacecraft design, including structural, power, communications, electrical and electronic infrastructure, sensors, guidance and control.

Planetary Atmospheres
(JHU, Ongoing)

Fundamental concepts and basic chemistry/physics principles applied to planetary atmospheres.

Project Management for Space Missions
(JHU, 2024 or 25-onward)

Processes and tools used to optimize and manage projects within the constraints of time, quality, scope, and budget.

Winter session Seminars
(JHU, 2022 or 23-onward)

Special topics, seminars, or projects to supplement academic courses, depending on mission schedule.

Targeting over 120 undergraduate and graduate students over mission duration. Academic and Mission Schedules coordination (Design Reviews and mission milestones.