SPACE WEATHERING ON THE MERCURIAN SURFACE: SHEDDING LIGHT ON THE DARKENING

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Motivation

We see evidence for carbon present on the surface today from excavations of low-reflectance materials (LRM) outlined in Klima et al. 2018 [1], but how is this theorized carbon intermixed with the regolith? Could the presence of carbon in the regolith and a harsh space weathering environment cause nanophase carbon to form on particle rims?

We aim to investigate these questions in a laboratory study featuring low- to Fe-free analogues, multiple opaques, and the Space Weathering Environment for Exploring Planetary Surfaces (SWEEPS).

SWEEPS (Figure 1)

- **Measurement Chamber (1)**
  - UHV (~10^{-9} Torr)
  - Bidirectional diffuse reflectance setup, operates from 0.4-25 µm
  - **i = 0° , e = 30°, a**llows direct comparison to other remote observations
- **Custom Cryostat (3)**
  - Extended copper sample holder
  - Can be heated up to 1000 K
- **UV source (5)**
  - Allows for simulation of distance-specific UV photon flux
- **QMS (6)**
  - Built-in pressure gauges

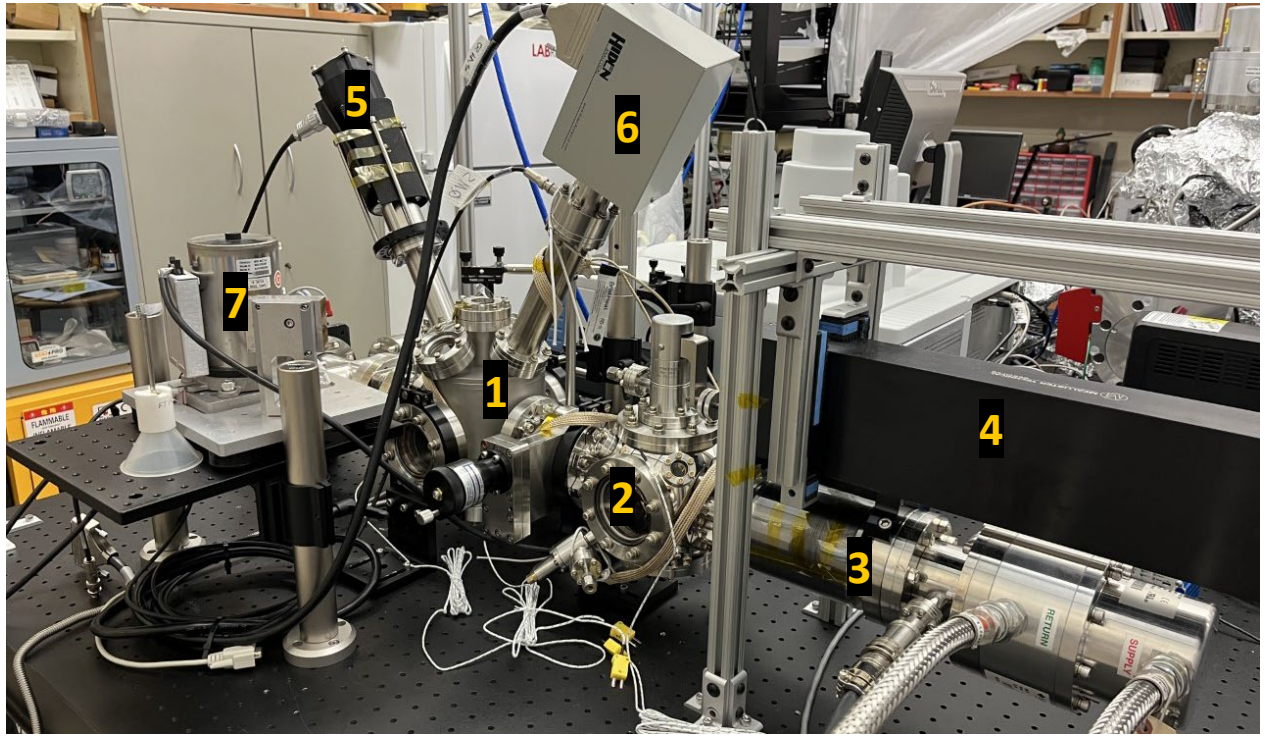
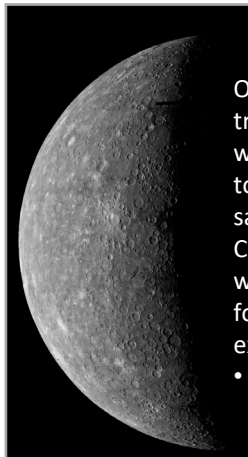


Figure 1: SWEEPS main components labeled. 1: Measurement chamber. 2: Sample preparation chamber. 3: Custom cryostat. 4: Linear actuator. 5: UV Source. 6: Quadrupole Mass Spectrometer (QMS). 7: External MCT-B detector.

Analog Surface Materials

To simulate Mercury's regolith, we will use low- to Fe-free silicate minerals (particle fractions of < 80 µm) and opaques added in increments of 1, 2.5, and 5 weight percent (wt.%), as typical LRM exposures are thought to have 2-2.5 wt.%, and up to 4.5 wt.%, of excess carbon [1].

- **Analogues:** San Carlos Olivine, pure forsterite, and pure enstatite.
- **Carbon opaques**: Carbon black, Coal [2], and Graphene[1].



Simulation Methods

Our experiments will require several trials to discern how long we will need to weather our samples with the UV source to achieve uniformity throughout the sample. This study will begin with the San Carlos olivine samples, and these trials will serve as the basis for a set procedure for our forsterite and enstatite experiments. For each trial, we plan to:

- Characterize any changes in mineral phase in the vapor and melt layers of our samples with TEM and SEM analyses.
- Take reflectance spectra before, during, and after irradiation.
- Take thermal infrared emissivity spectra of our samples using the Planetary Analogue Surface Chamber for Asteroid and Lunar Environments, or PASCALE [3].

Want to learn more about the Space Weathering Environment for Exploring Planetary Surfaces?

Meet me in GatherTown at the MExAG 2023 Poster Session on February 2nd at 11:40 AM EST!

[1] Klima, R. L., et al. (2018). Geophysical Research Letters, vol. 45, no. 7, pp. 2945–2953. [2] Hendrix, A. R., and F. Vilas (2019). Geophysical Research Letters, vol. 46, no. 24, pp. 14307–14317. [3] Donaldson Hanna, K. L., et al. (2021). JGR: Planets, vol. 126, no. 2.