Simulation Chamber for Space Environment Survivability Testing

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There are certain characteristics of the space environment that are critical for a true simulation. These critical characteristics are electron flux, electromagnetic radiation, radiation, and temperature. The electron flux is critical because the solar winds through space bombard spacecraft. The electromagnetic radiation has certain critical aspects in itself. As can be seen in figure 10, the electron flux has a broad range from the Visual/Infrared to Ultra Violet, specifically the Hydrogen Lyman alpha emission at 121.6 nm. A vacuum is a means of separating various particles. The temperature is critical because it changes drastically depending on proximity to the sun. Things not covered by this chamber are photons, ions, and atomic oxygen.

**Simulation Chamber for Space Environment Survivability Testing**

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**Space Environment Characteristics**

**In Situ Analyzability**

- UVVIS/NIR Reflectivity—Two fiber optic spectrometers (F) measure reflectivity and UVVIS/NIR (200-1080 nm) NIR (850-1700 nm) ranges with <1 nm resolution.
- Integrating Sphere—A 2.5 cm diameter integrating sphere (H) can be attached over the samples with a retractable probe, linear translation stage (T). The sample stage can be rotated to position different samples under the probes. Light from a deuterium/Halogen calibrated light source enters the integrating sphere through one fiber optic connection; reflected light from the sample exits through another fiber optic spectrometer.
- IR Emissivity—Measured with retractable probe (4 μm to 15 μm)
- Pressure—Absolute pressure monitored with Convection and ion gauges (I)
- Sample Stage—Sample stage (M) connected to a large thermal reservoir (Q) and resistance heaters (P) attached to a large thermal mass help maintain stable thermal.

**Experimental Test Chamber Design**

**A vacuum chamber was designed and built that simulates the space environment making possible the testing of material modification due to exposure of solar radiation. Critical environmental components required include an ultra high vacuum (10^-9 Torr), a UVVIS/NIR solar spectrum source, an electron gun and charge plasma, temperature extremes, and long exposure duration. To simulate the solar spectrum, a solar simulator was attached to the chamber with a range of 200nm to 2000nm. The exposure time can be accelerated by scaling the solar intensity up to four suns. A Krypton lamp imitates the 120 nm ultraviolet hydrogen Lyman alpha emission not produced by the solar simulator. A temperature range from 100K to 450K is achieved using an attached cryogenic reservoir and resistance heaters. An electron flood gun (mono-energetic, 20 eV to 1keV) is calibrated to replicate solar wind at desired distances from the sun. The chamber maintains 98% uniformity of the electron and electromagnetic radiation exposure relative to the center. The chamber allows for a cost-effective implementation of multiple small-scale samples. An automated data acquisition system monitors and records the reflectivity, absorptivity, and emissivity of the samples throughout the test. An integrating sphere and an IR absorptivity/emissivity probe are used to collect this data. The system allows for measurements to be taken while the samples are still under vacuum and exposed to radiation. With these accurate simulations we can closely predict the material’s behavior in near proximity to the sun. This information is vital in determining materials for satellites, probes, and any other spacecraft.**

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**Versatile Sample Holder Design**

**Acknowledgements/References**