Dynamic Cryothermal Measurements of Variable Emittance Coatings with Optical Heating

Chloe Stoops, Aerospace Engineering
Dr. Liping Wang, Associate Professor
School for Engineering of Matter, Transport, and Energy

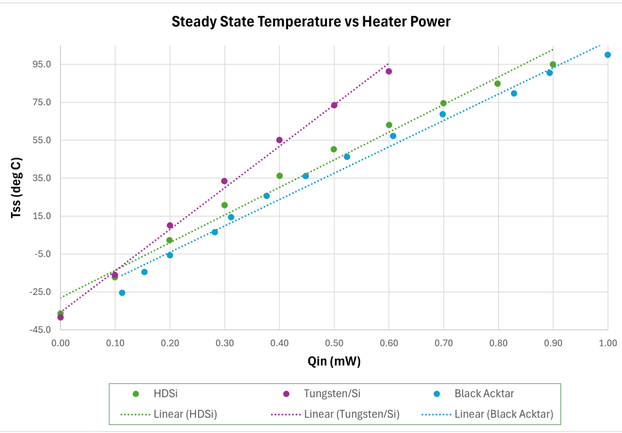
Abstract

The purpose of this experiment is to determine how a variable emittance coating behaves in a cold space environment with constant heating by sunlight and variable internal heating, as well as how tungsten doping affects its performance with lower phase transition temperature ranges. The results of this experiment will show how a variable emittance coating performs under cryostat testing conditions in order to determine its radiative cooling properties.

Experimental Setup

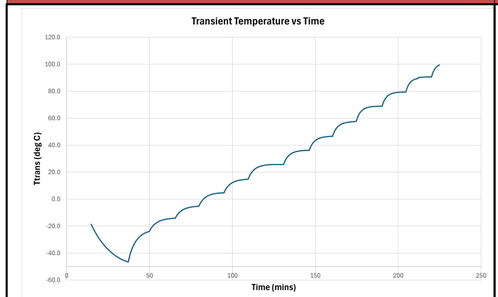
The cryostat replicates the environment of space, providing a high-vacuum, and cryogenic temperatures around 80K. The heater mimics internal heating from the spacecraft, and the optical lamp represents heating from sunlight.

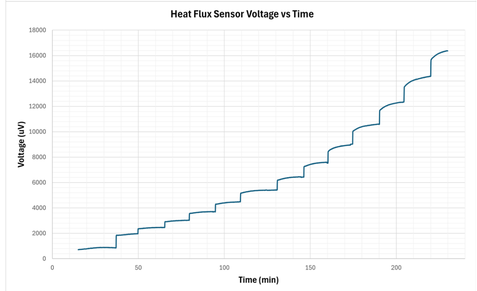
Steady State Data



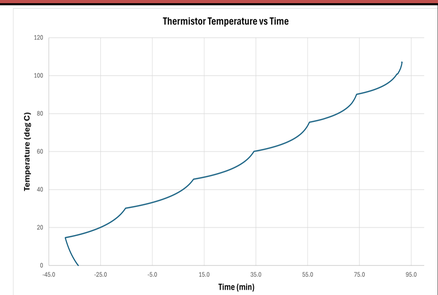
Transient Data

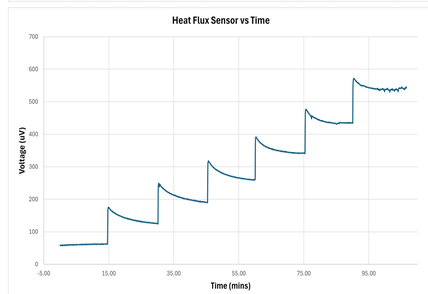
Black Acktar



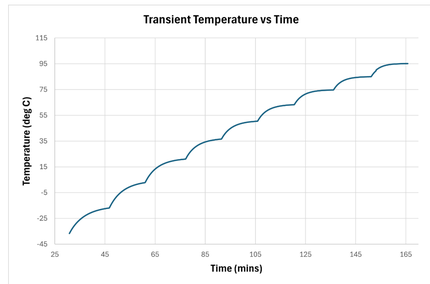


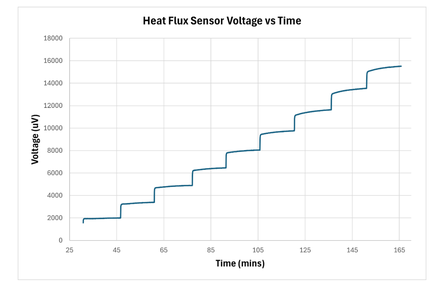
Tungsten/ Silicon



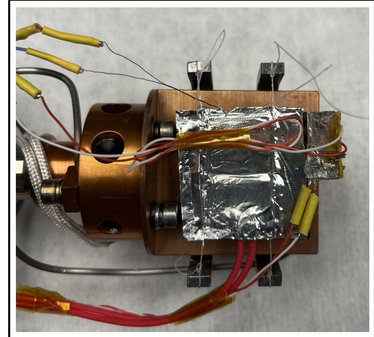


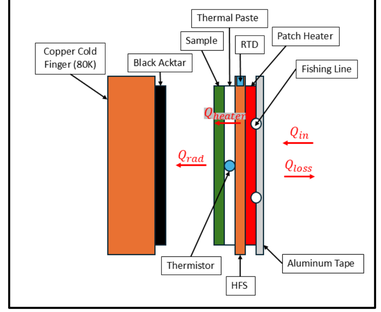
High Doped Silicon





Sample Setup





Objectives

- Develop an improved testing apparatus using fishing line to hold the sample in order to lower the time necessary to reach steady state conditions.
- Measure emissivity and thermal properties of common spacecraft materials to compare to variable emissivity coatings.
- Demonstrate improved phase range temperatures for variable emissivity coatings with different levels of doping.

Results

- Successfully updated apparatus, thus lowering time to reach steady state to 15 minutes.
- Measured transient and steady state data of Black Acktar, Tungsten/Silicon, and Highly Doped Silicon for reference and future verification.
- Reference samples were all found to behave as expected.

Future Work

This calibration data enables the future analysis of the variable emissivity coatings. The next steps are to test 0%, 1%, and 2% doped Silicon samples to show how the phase range temperatures change, as well as apply optical heating to simulate heating by sunlight.

Acknowledgements

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Ira A. Fulton Schools of Engineering
Arizona State University