Spacecraft Thermal Management Systems
Variable Emissivity Radiator Design Project

UCI Samueli School of Engineering

Introduction: A satellite's thermal management system controls the amount of heat absorbed or rejected through radiation in space environment. There are thermal cycles as the satellite orbits around the Earth's shadow creating various thermal loads that must be controlled and dissipated.

Goal: To develop an electrochromically controlled film that can variably absorb or reflect radiation for a Satellite at low-Earth Orbit.

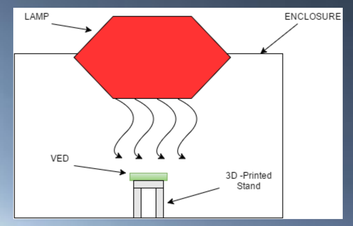
Objectives:

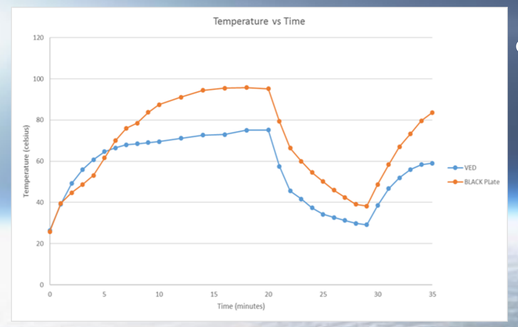
Setup procedures to test for unknown emissivity.

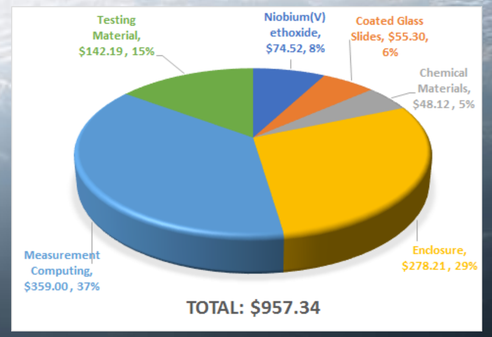
Find emissivity values of prototype and working model.

Simulate thermal model on FEA Software (Ansys)

Document all results and data



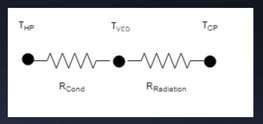


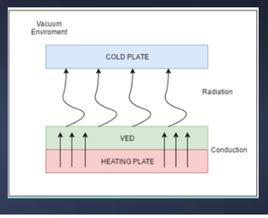


Testing

Emissivity Analysis

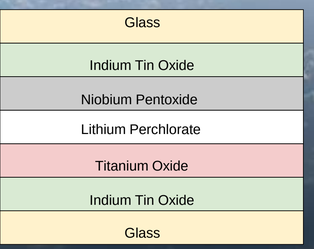
- Using Energy Balance through circuit analysis we will solve for the emissivity
- Introduce Vacuum Environment to control heat loads
- Test the sample to ensure it follows the trend that a Variable Emissive Device should follow





Component/ System	Operating Temperature (C)	Survival Temperature (C)
Digital electronics	0 to 50	-20 to 70
Analog electronics	0 to 40	-20 to 70
Batteries	10 to 20	0 to 35
IR detectors	-269 to –173	-269 to 35
Solid-state particle detectors	-35 to 0	-35 to 35
Momentum wheels	0 to 50	-20 to 70
Solar panels	-100 to 125	-100 to 125

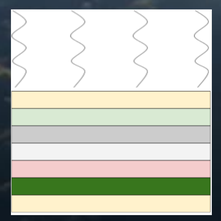
$$\varepsilon_{VED} = \frac{(T_{HP} - T_{VED})}{\sigma A_{VED} R_{cond} (T_{VED} - T_{CP})} * \frac{1}{(T_{VED}^2 + T_{CP}^2)(T_{VED} + T_{CP})}$$



Light-weight electrochromic plates that can change emissivity with the application of current.

The electro chromic film features five layers of electro chromic materials.

Layer One - Indium Tin Oxide (**Conductive Layer**)
Layer Two - Niobium Pentoxide **(Anode)**
Layer Three - Lithium Perchlorate **(electrolyte)**
Layer Four - Titanium Oxide **(Cathode)**
Layer Five - Indium Tin Oxide **(Conductive Layer)**



High Emissivity, Absorptive

Low Emissivity, Reflective

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Faculty Advisor

Team Breakdown:

- Daniel Lapp, Chem Team Lead
  - Edward No
- Pedro Salcedo, MAE Team Lead
  - Data Logging: Victor Cabanas, Christian Rodriguez
  - Manufacturing: William Berrios, Waleed Dahbour
  - Data Logging: Joseph Rivera, Keegan Sullivan

Timeline:

- **March (Late)**
  - Finish Model Setup for Testing
- **April (Late)**
  - Make Necessary Adjustments to Make More Accurate
- **May (Late)**
  - Begin Testing Samples for Emissivity and Make Adjustmants
- **March**
  - Develop Procedure For Testing For Emissivity
  - Prepare Precursor Solution for Prototype
- **April**
  - Begin Calibrating Procedure and Enclosure With Known Emissivity
- **MAY**
  - Begin Production of Early Prototype
  - Make Preparations for Vacuum Environment
- **June**
  - Prepare For Fall Design Review

Contact Information

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