Spacecraft Thermal Management Systems

Variable Emissivity Radiator Design Project

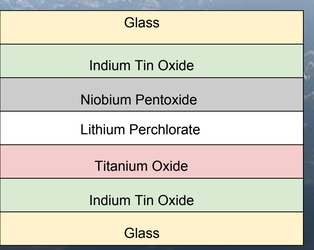
UCI Samueli School of Engineering

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:

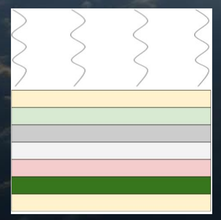
- Setup procedures to test for unknown emissivity.
- Find emissivity values of prototype and working model.
- Simulate thermal model on FEA Software (Ansys).
- Document all results and data



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)**



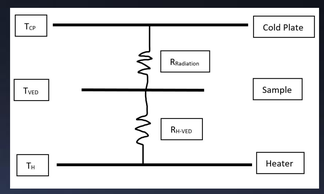
High Emissivity, Absorptive

Low Emissivity, Reflective

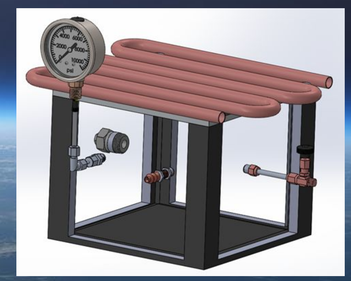
Testing

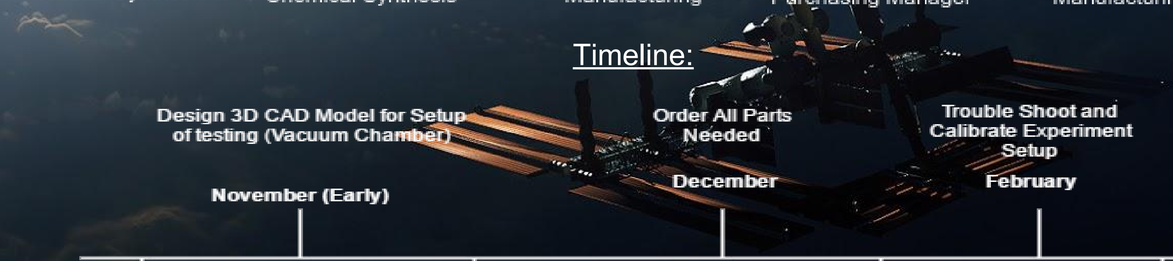
Emissivity Analysis

- Using Energy Balance through circuit analysis we will solve for the emissivity
- Introduce Vacuum Environment to control heat loads
- Vacuum Chamber will only have Radiation and Conduction Present.
- Will Compare results to Leading Industry



$$\epsilon_{sample} = \left(\frac{T_H - T_{sample}}{T_{sample} - T_{CP}}\right)\left(\frac{1}{R_{H-VED}\sigma\left(T_{sample} - T_{CP}\right)\left(T_{sample}^2 - T_{CP}^2\right)Area}\right)$$





Team Breakdown:

Khalid Rafique
krafique@uci.edu
Faculty Advisor

Daniel Lapp (CHEM)
dlapp@uci.edu
Chemical Team Lead

Pedro Salcedo (MAE)
salcedop@uci.edu
Mechanical Team Lead

Koi Trinh (CHEM)
Chemical Synthesis

Edward No (CHEM)
Chemical Synthesis

Keegan Sullivan (MAE)
Manufacturing

William Berrios (MAE)
Purchasing Manager

Waleed Dahbour (MAE)
Manufacturing

Nathan Chan (CSE)
Safety Manager

Timeline:

October
Develop Procedure For Testing For Emissivity
Prepare Precursor Solution for Prototype

November (Early)
Design 3D CAD Model for Setup of testing (Vacuum Chamber)

November (Late)
Write Proposal For UROP
Research Material Needed For Vacuum Chamber
Complete Liquid Electrolyte Trails

December
Order All Parts Needed

January
Begin Production of Early Protoype
Begin Manufacturing of Vacuum Chamber

February
Trouble Shoot and Calibrate Experiment Setup

March
Test Sample From Industry
Finalize Prototype Production

Spring Quarter
Test Prototype and Compare With Industry

Contact Information

Faculty Technical Advisor: Professor Khalid Rafique
For more information, please contact:
MAE Team Lead: Pedro Salcedo (salcedop@uci.edu)
Chemical Team Lead: Daniel Lapp (dlapp@uci.edu)