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.

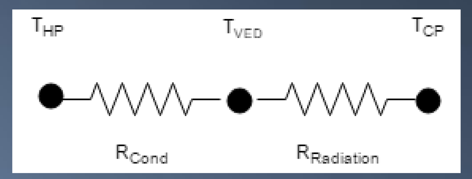
Objectives:

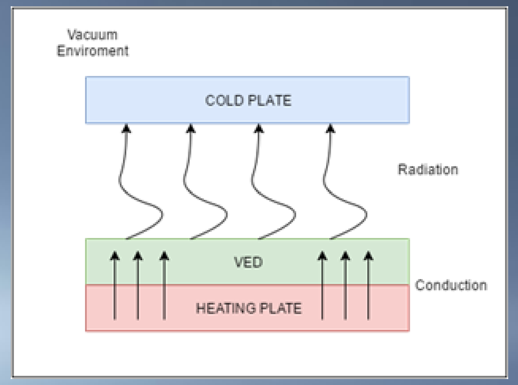
Setup procedures to test for unknown emissivity.

Find emissivity values of prototype and working model.

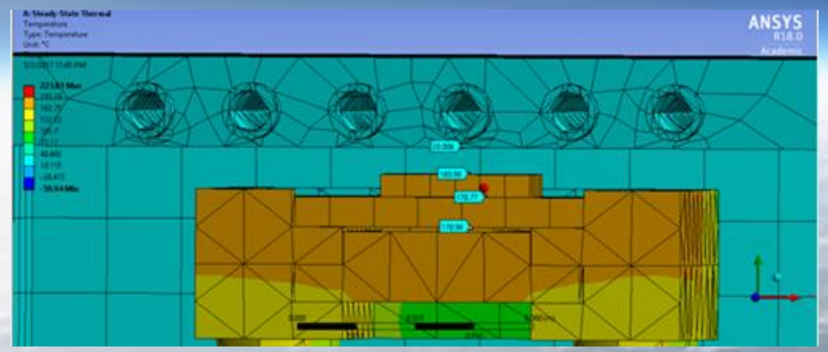
Simulate thermal model on FEA Software (ANSYS).

Document all results.





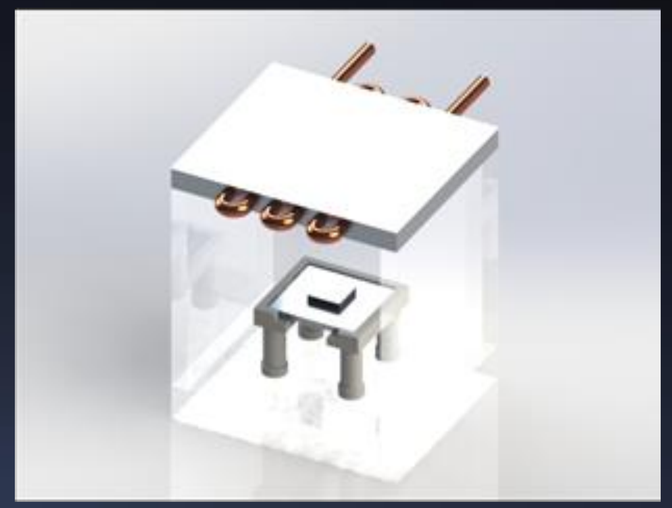
$$\epsilon_{sample} = \left(\frac{T_H - T_{sample}}{T_{sample} - T_{CP}}\right)\left(\frac{1}{R_{H-VED}\sigma(T_{sample} - T_{CP})(T_{sample}^2 - T_{CP}^2)Area}\right)$$

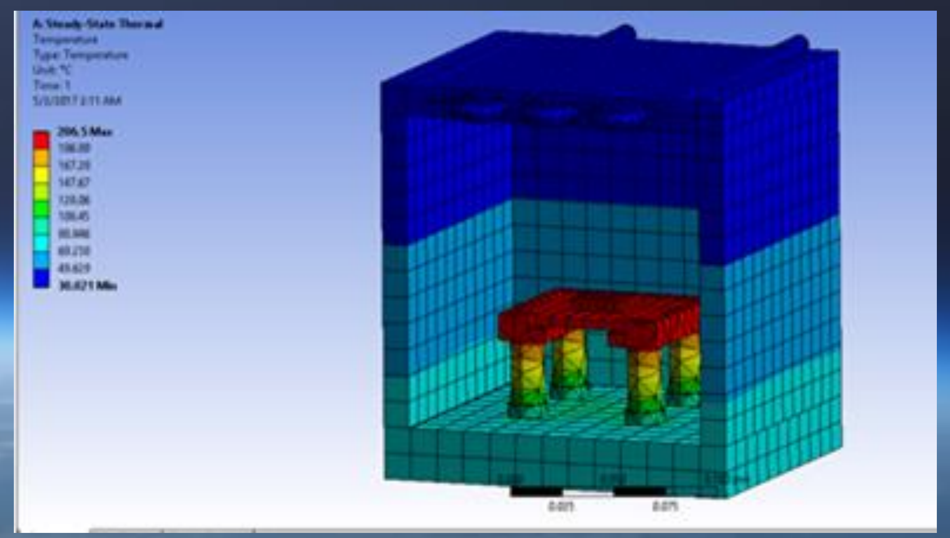


Testing

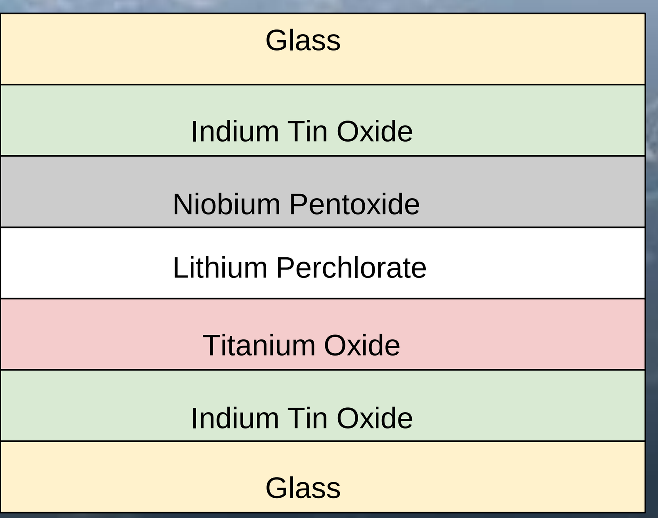
Emissivity Analysis

- Using Energy Balance Eqs specifically circuit analysis we will solve for emissivity.
- Introduce Vacuum Environment conditions to control heat loads.
- Vacuum Chamber will only have Radiation and Conduction Present.
- Will Compare results to Leading Industry film and theoretical values given by ANSYS software..





Film Properties:



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

Layer One - Indium Tin Oxide **(Conductive Layer)**

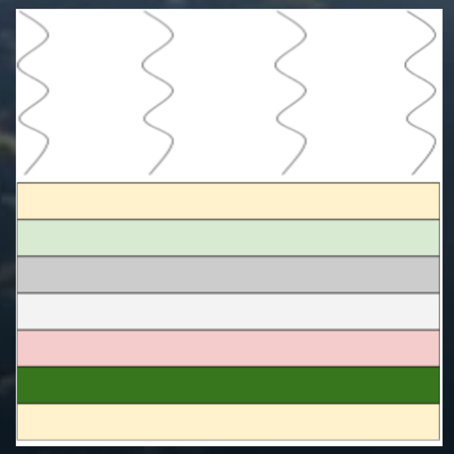
Layer Two - Niobium Pentoxide **(Anode)**

Layer Three - Lithium Perchlorate **(electrolyte)**

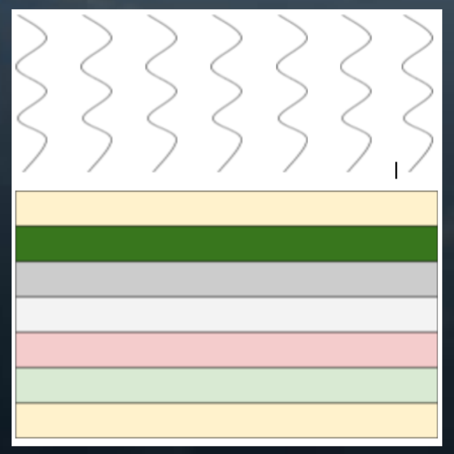
Layer Four - Titanium Oxide **(Cathode)**

Layer Five - Indium Tin Oxide **(Conductive Layer)**

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

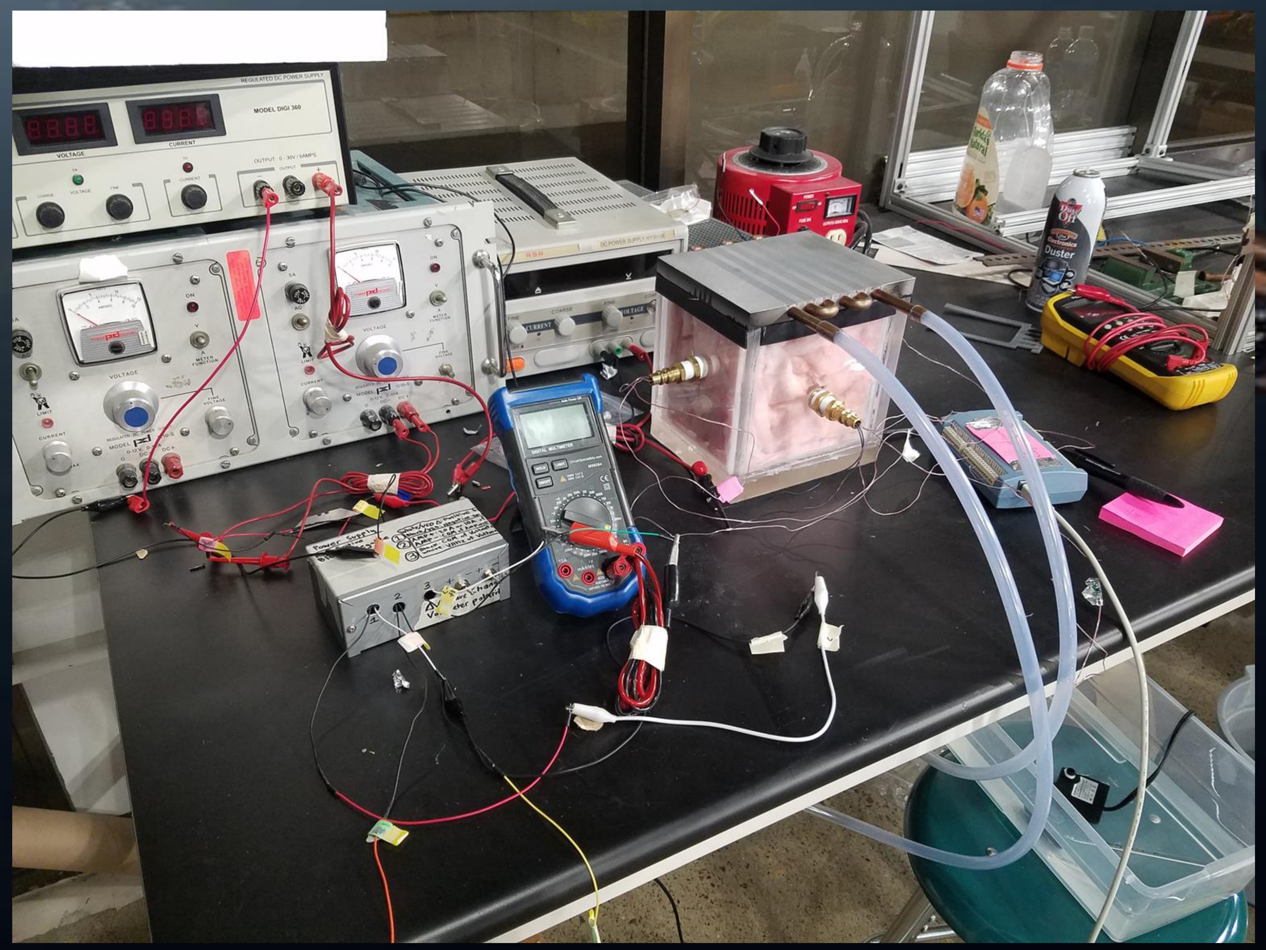


High Emissivity, Absorptive

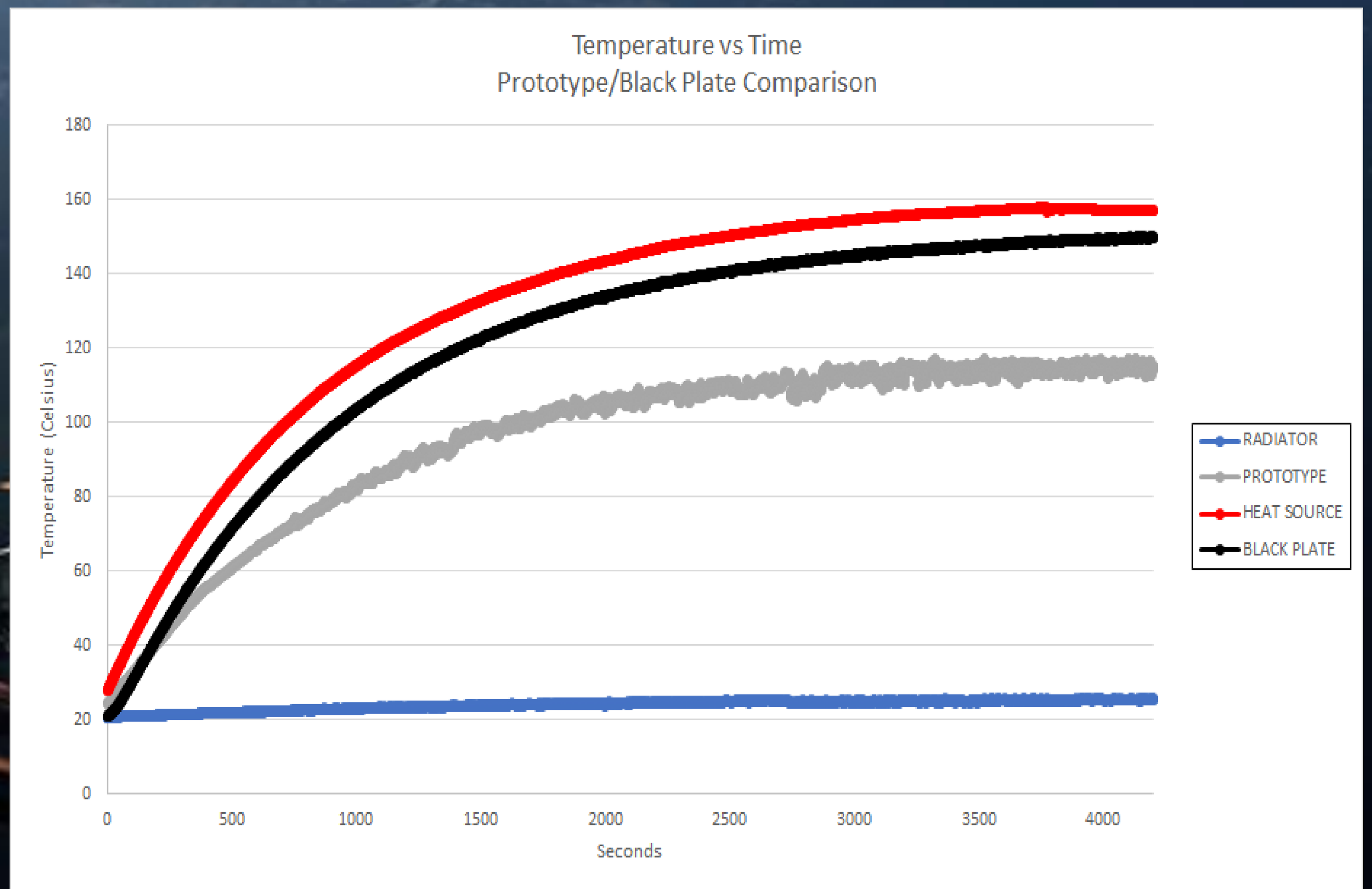


Low Emissivity, Reflective

Experimental Setup:



Temperature Plot of Experimental Setup:



From the data that was taken we can conclude that the prototype has a lower emissivity than the black plate, but there are no clear indications of behavior of a variable emissive film.

Contact Information

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