

On the Performance of MAPbI₃ in the Space Environment

Timothy J. Peshek¹, Kaitlyn VanSant², Kyle M. Crowley², William Delmas³, Jennifer Williams⁴, Sayantani Ghosh³, Joseph Luther⁵, Lyndsey B. McMillon-Brown¹

1. NASA Glenn Research Center, Cleveland, Ohio.
2. NASA Postdoctoral Program, Glenn Research Center, Cleveland, Ohio.
3. University of California at Merced, Merced, California.
4. Wilberforce University, Wilberforce, Ohio.
5. The National Renewable Energy Laboratory, Golden, Colorado

Abstract

We show that an encapsulated MAPbI₃ film has survived the space environment on the International Space Station for a total of approximately 10 months on orbit with little to no chemical degradation.

This effort is part of our ongoing efforts to determine the feasibility of MAPbI₃-bearing solar cells for space applications.

This sample was part of the thirteenth flight of the Materials International Space Station Experiment (MISSE-13), which flew from mid-March, 2020 until mid-January, 2021.

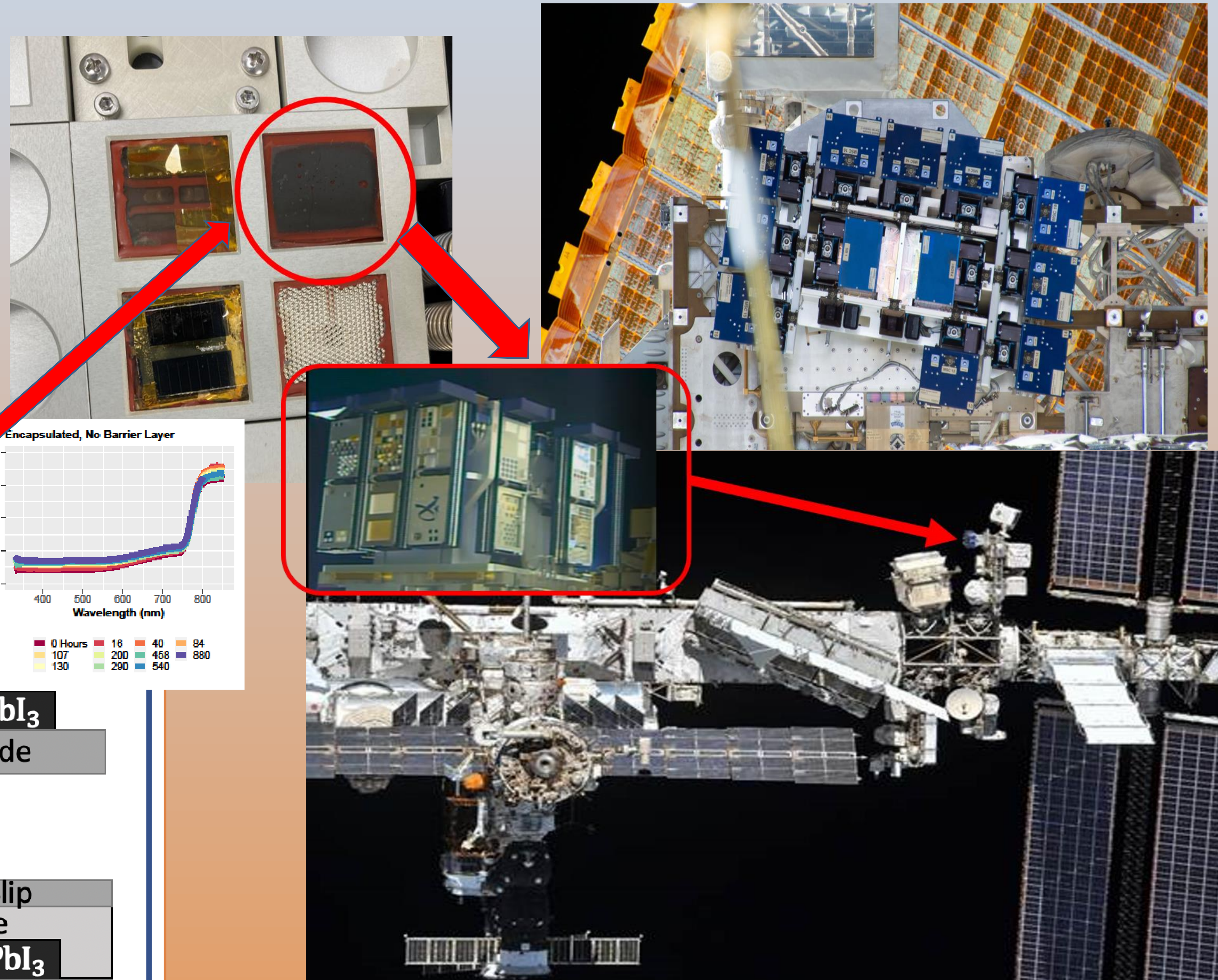
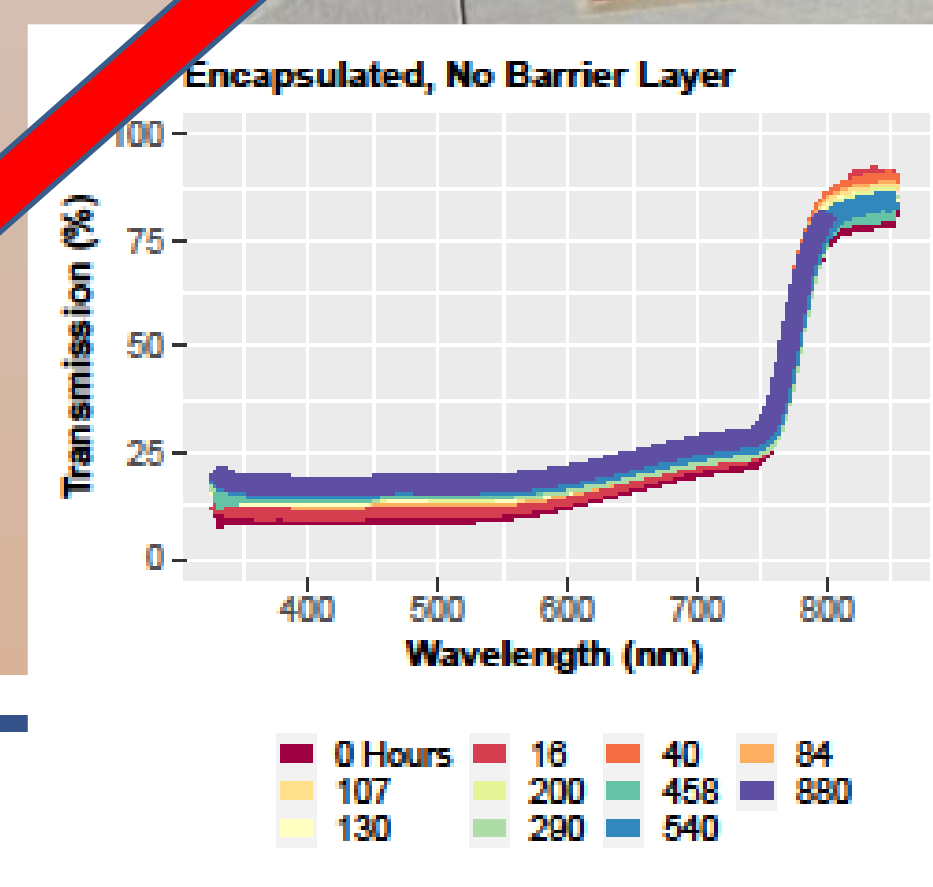
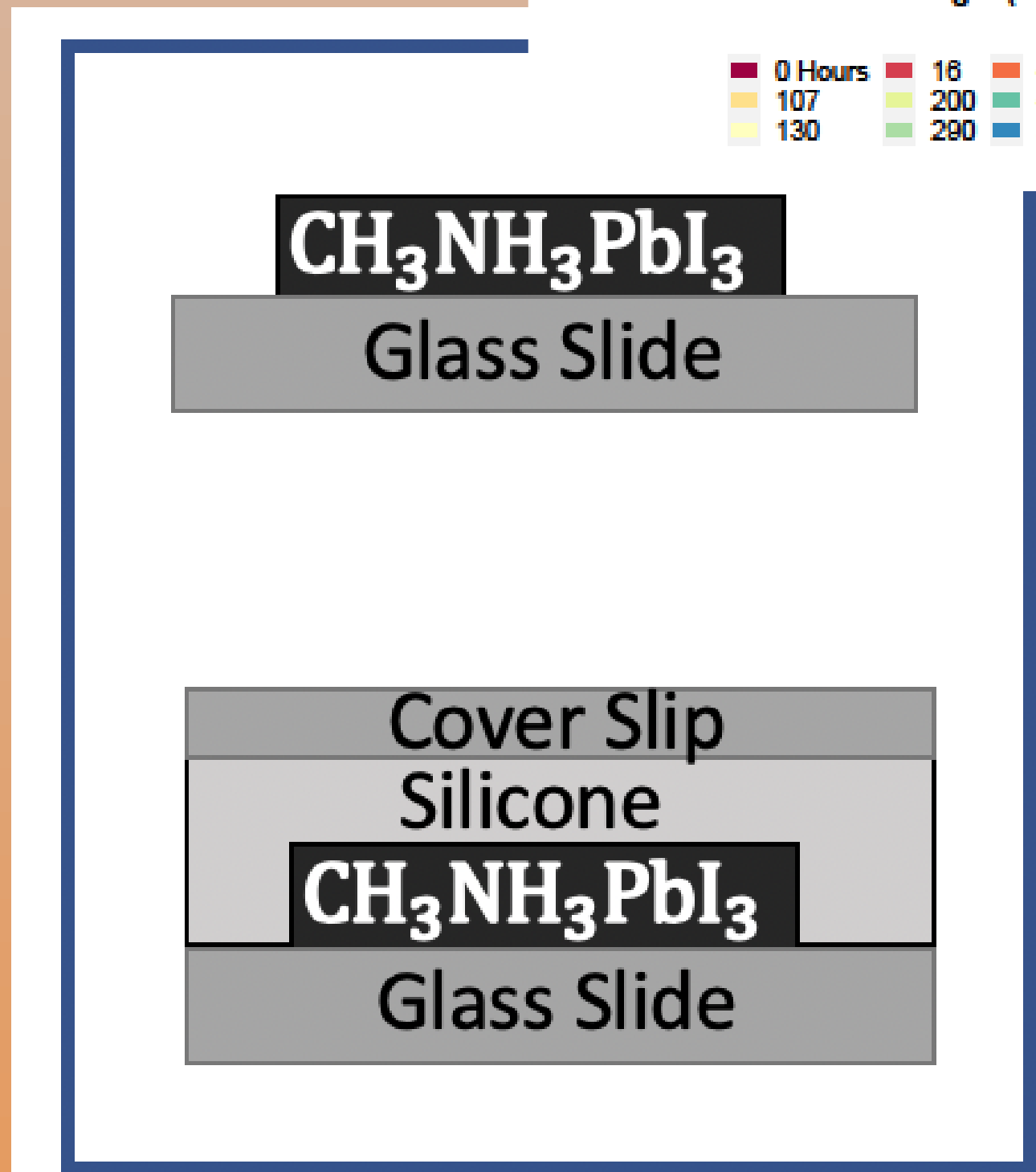
We determined the robustness of the material through the use of transmission spectrophotometry.

To our knowledge this report represents the longest known flight in space of a MAPbI₃ film.

Fabrication:

All of the following steps were performed in a nitrogen purged glove box:

- Drop cast 30 ul of ink onto a 1" by 1" borosilicate glass microscope slide (1mm thick)
- Spin at 2000 RPM for 90 seconds
- Anneal on a hotplate at 100 degrees Celsius for 10 minutes.
- The encapsulant DC-93500 is a two-part silicone, mixed thoroughly in a 10:1 ratio and then degassed.
- The encapsulant is applied to the perovskite layer
- A matching 1" by 1" borosilicate glass microscope slide is laminated to the perovskite/glass substrate by pushing into the wet bed of silicone encapsulant.
- %T spectra were collected over time in a 30C, 95% RH environment, up to 880 hours.



Results

The %T spectrum allows for a proxy measurement of chemical stability since the MAPbI₃ and degradation reactant, PbI₂, have distinct absorption spectra.

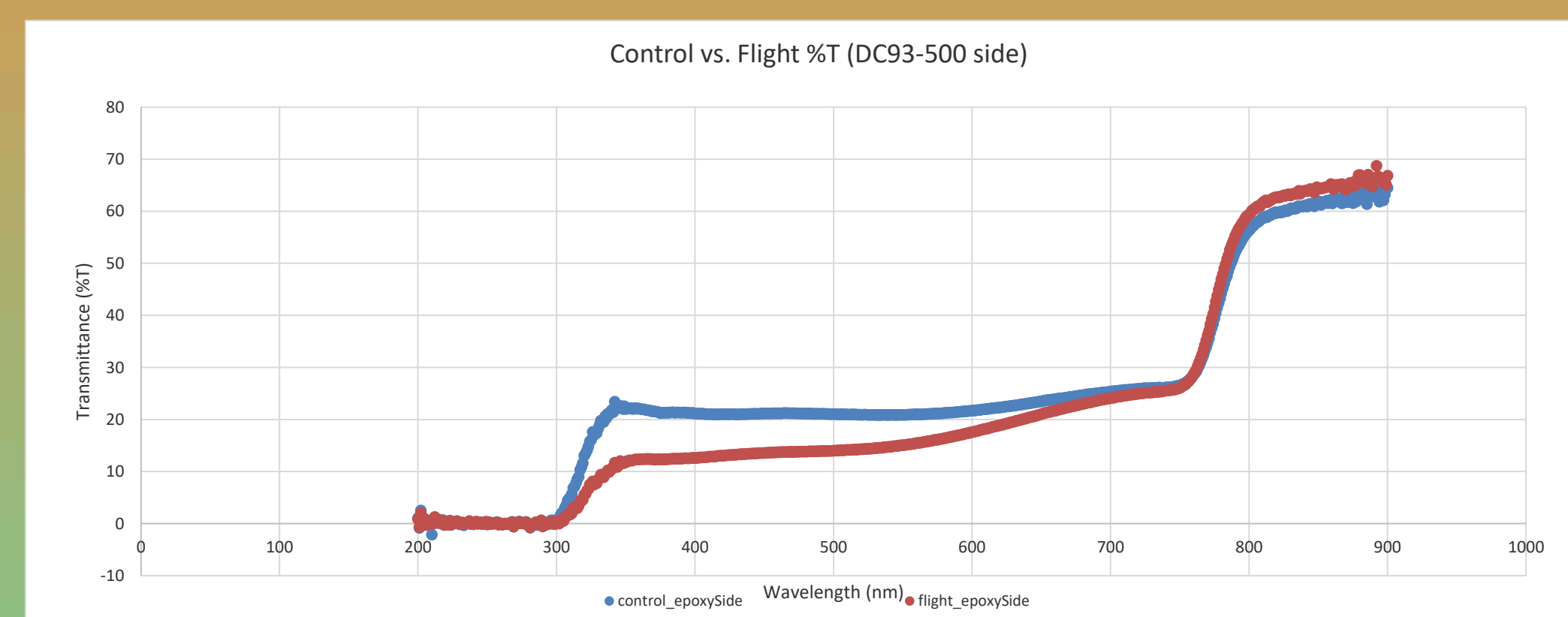
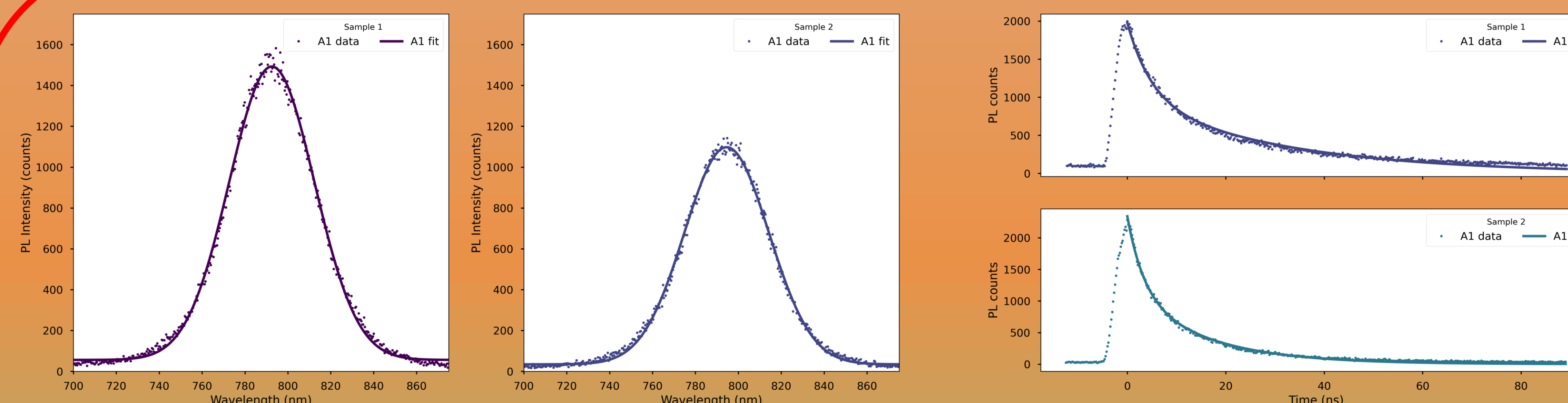
Very little degradation is observed over time as evidenced by minimal changes in the transmission spectra.

These data were presented at the 47th PVSC

Samples were then laminated to a FR4 carrier sheet and integrated into the MISSE flight facility

Launch occurred on March 7, 2020

On orbit operations were approximately 10 months, leading to ~6000 thermal cycles



RESULTS!

Photoluminescence, time resolved photoluminescence and transmission spectra all indicate no significant change in performance or chemistry for the flight sample compared to a control sample that was stored on the ground in Cleveland, Ohio.

acknowledgements: With gratitude,

- CWRU MORE CENTER, OHIO THIRD FRONTIER PROGRAM
- ALPHA SPACE TEST AND RESEARCH ALLIANCE, LLC
- NASA STMD CENTER INNOVATION FUND
- NASA STMD EARLY CAREER INITIATIVE
- MATERIALS ISS EXPERIMENT (MISSE) PROGRAM OFFICE
- SEVERIN HABISREUTINGER FOR DATA COLLECTION
- YOU, DEAR READER.