Department of Mechanical Engineering
THE UNIVERSITY OF UTAH

L3HARRIS

Electrically Conductive Coatings

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Background

The Electrically Conductive Coatings project was company sponsored by L3 Harris Technologies in order to experiment with potential replacements for an aluminum RF shield.

Our team was tasked with completing two separate objectives:

- Modify the design of an existing RF shield to match mechanical performance of an aluminum counterpart.
- Test the environmental effects on various combinations of 3D printed substrates coated with electrically conductive paints.

The goal behind this experimental design was to determine if there is a cost effective replacement for an aluminum RF shield. This replacement would need to provide the necessary strength and protection for the interior circuitry.

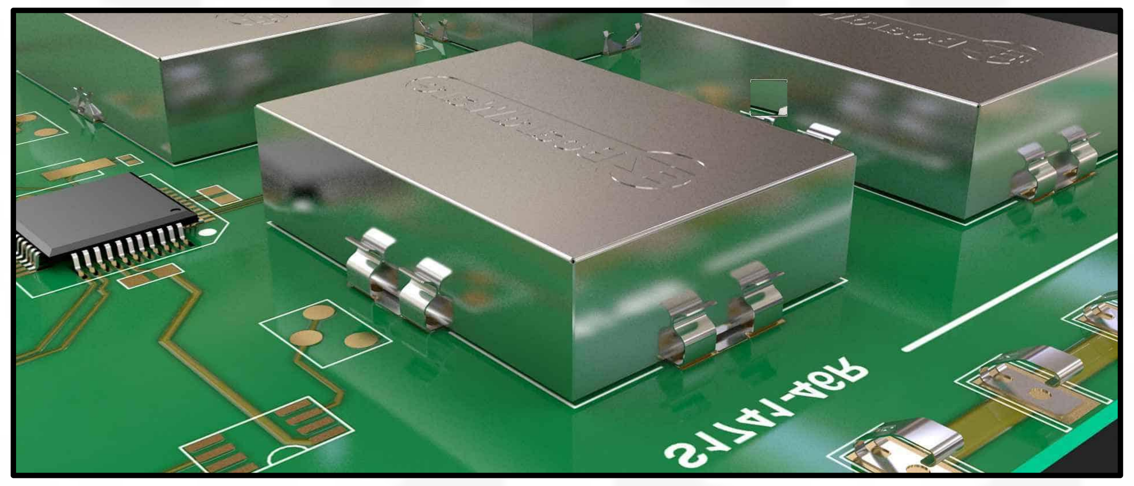

Figure 1: Sample aluminum RF shield used on a PCB board.

Project Scope

- Design a set of experiments to test the effects of temperature, humidity, and pressure on a number of predetermined coating/substrate combinations.
- Modify the design of a 3D printed RF shield and perform mechanical simulations to compare to a baseline aluminum RF shield.
- Make a substrate/coating recommendation based on the results of our experiments.

Objective	Metric	Design Solution
Provide surface resistivity data of the combinations.	> 3 repeat samples for each unique combination.	4 repeat samples
Test the effects of temperature cycling on each combination.	Temperatures > 70C and < -53C.	Tests we conducted at 71C and -54C.
Test the effects of altitude on each combination.	Altitude >= 60,000 ft.	Tests were conducted at 60,000 ft.
Project does not exceed budget	Project Budget <=$5,000	Project Budget = $4,852.29
Reduce weight of RF shield.	<70% of aluminum RF shield weight.	Recommended substrate is 44% the weight of aluminum.
Designed RF shield CDI	CDI < 0.7.	Maximum CDI of 1.32e-3.

Figure 2: Project objectives and solutions.

Design and Simulations

Figure 3: Final RF shield design

The objectives of the first part of the project:

- Determine mechanical attributes of the assembly with an aluminum RF cover
- Find said attributes for the assembly with each substrate material
- Simulations were completed in Ansys.
- The areas of interest were resonant frequency, fatigue and shock analyses.

The results of the simulations were margins of safety. The results of these simulations would allow us to determine how our geometry needed to be changed. In the figure to the right, the parts of the assembly that can be altered are shown (only on the inside of the RF cover).

Test Methods

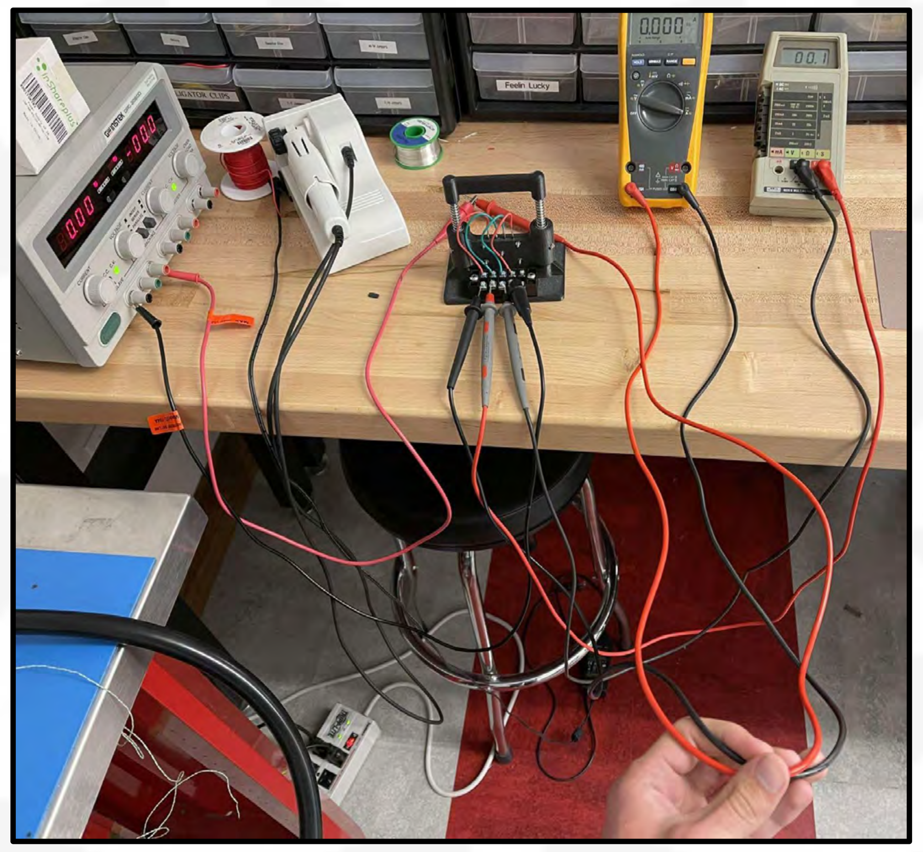

Figure 3: Four probe test method setup.

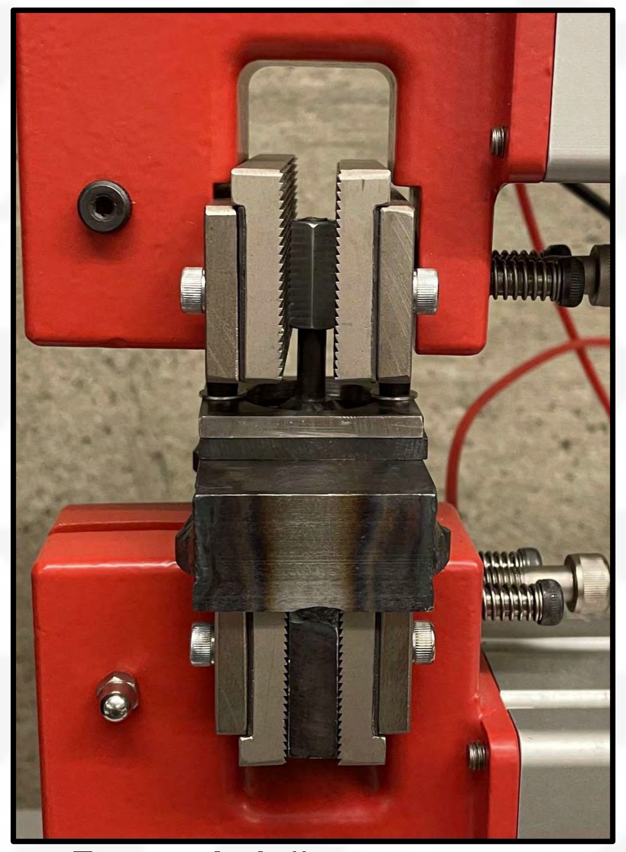

Figure 4: Adhesion testing setup in tensile tester.

- Used environmental testing chamber at the U of U Center for Medical Innovation and pressure chamber at L3Harris.
- Tested adhesion at the end of each type of test using a tensile tester.
- Tested sheet resistivity using four-point probe method after each set of cycles.
- Sheet resistivity equation shown below:

$$R_s = \frac{\pi}{\ln(2)} * \frac{\Delta V}{I}$$

Source: https://www.pveducation.org/pvcdrom/characterisation/four-point-probe-resistivity-measurements

Results

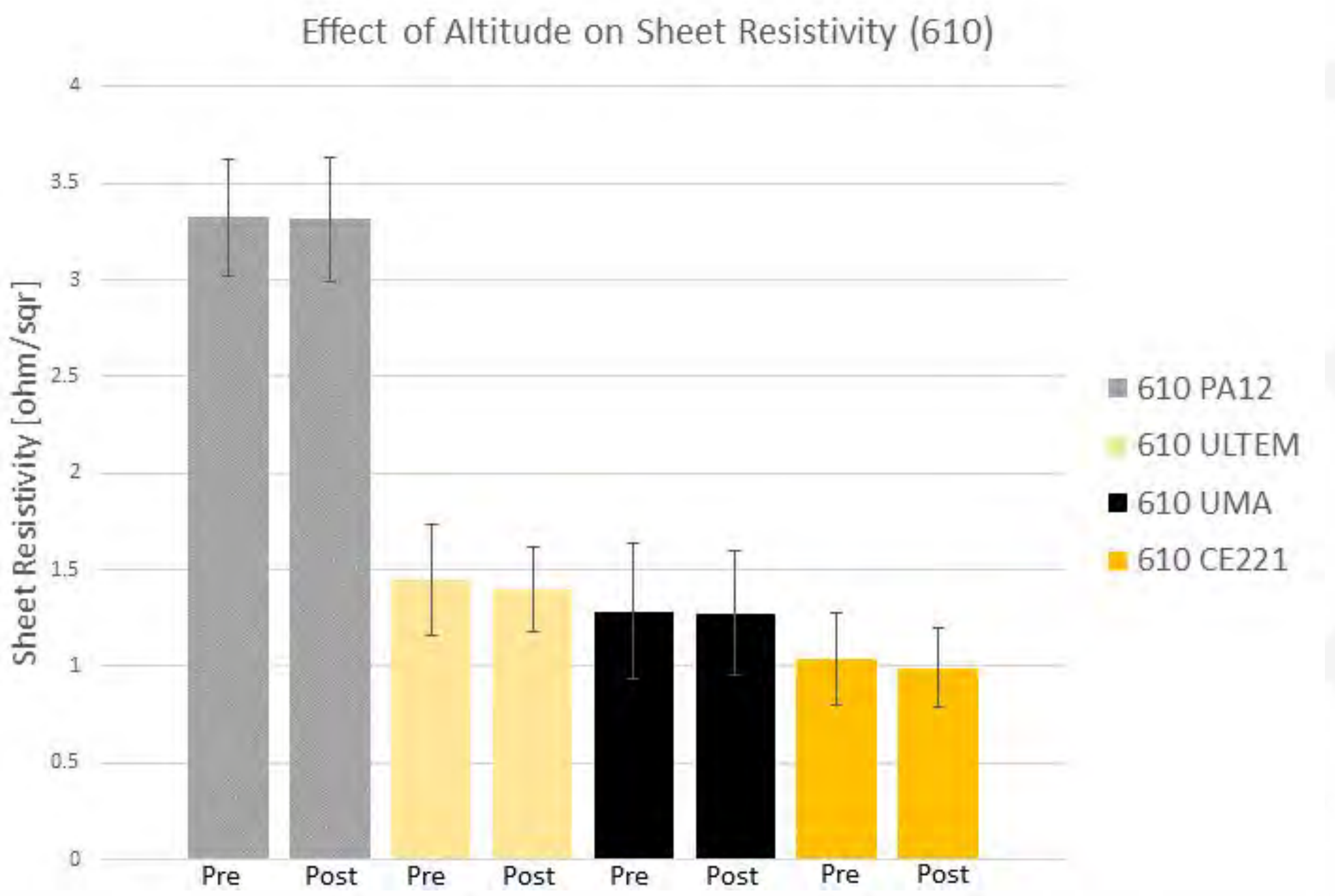

Figure 5: Graph of the effects of temperature on the adhesion of CHO SHIELD 610.

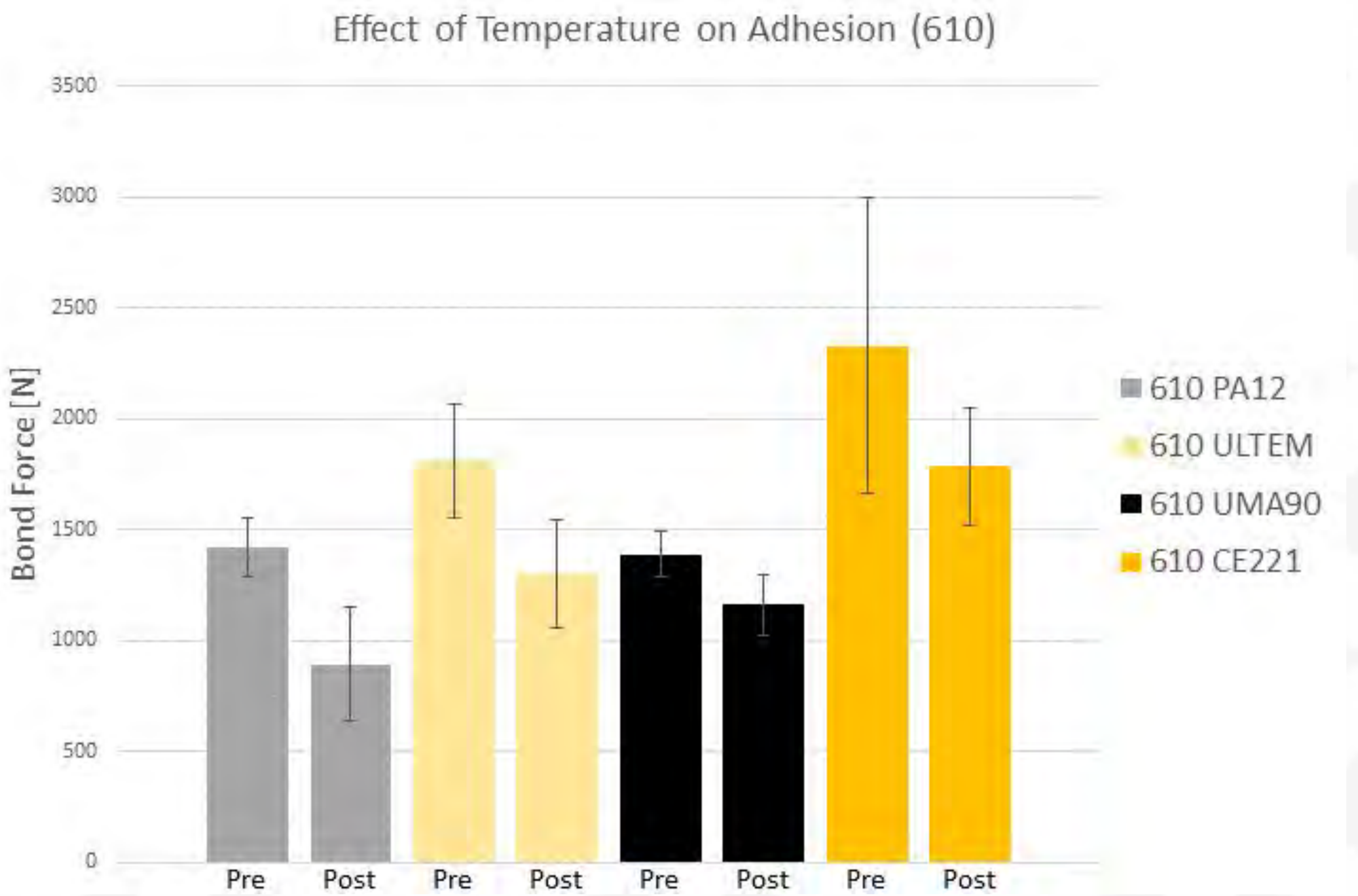

Figure 6: Graph of the effects of altitude on the performance of CHO SHIELD 610.

Conclusion

The results of our vibration and strength simulations indicate that all of the 3D printed materials are an adequate alternative to aluminum. The results of our environmental experiments indicate that certain coating/substrate combinations exhibit a deterioration in shielding performance when subject to certain environmental conditions, but many of the combinations show potential for a replacement for the aluminum housings. Moving forward, we recommend that these environmental experiments be repeated again with more repeat samples, a higher budget, and more sophisticated instrumentation before any mission-critical conclusions can be drawn.