

| | |
|-----|---------|
| Sp1 | 7.4 °C |
| Sp2 | 15.7 °C |
| Sp3 | 19.5 °C |
| Sp4 | 21.2 °C |
| Sp5 | 16.4 °C |
| Sp6 | -2.8 °C |

15.0



| | |
|-----|---------|
| Sp2 | 7.0 °C |
| Sp1 | 35.5 °C |
| Sp3 | -2.5 °C |

40.0



Borealis Wind

Preliminary Investigation into Shear Web Behaviors under Thermal Load from IPS

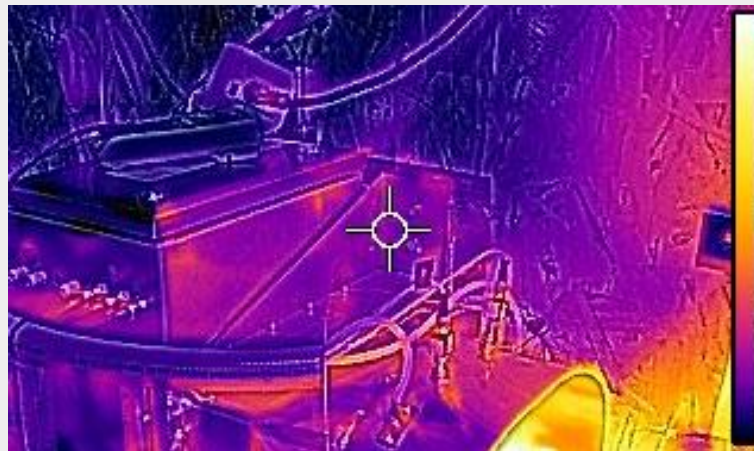
Important Factors Considered

- Glass transition temperature (T_g)
- Micro-cracking and voids
- IPS hot-spots

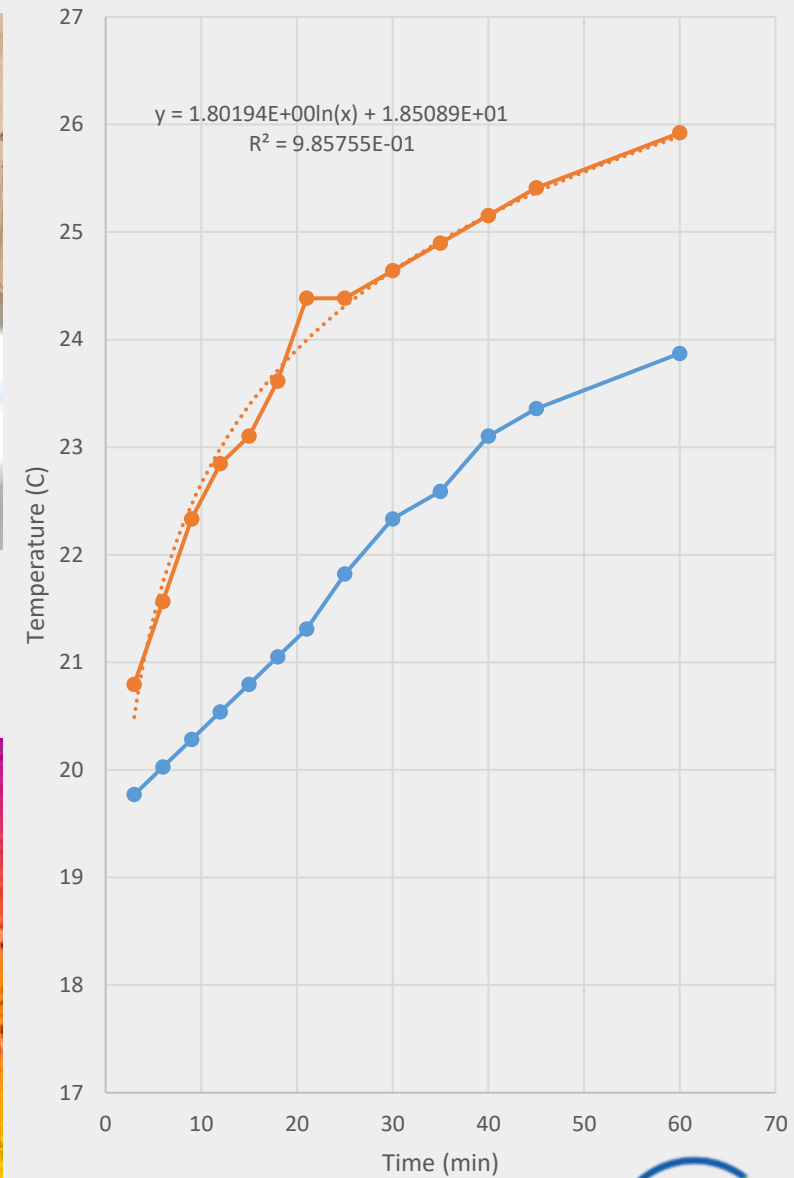


Figure 2: Optical micrograph of a [90_s/0_s]_z laminate showing microcracking after 400 thermal cycles (100X)

[Ref] Dharia, A., Hayes, B., Seferis, J., Evaluation of microcracking in aerospace composites exposed to thermal cycling: effect of composite layup, laminate thickness and thermal ramp rate, SAMPE Seattle, 2001

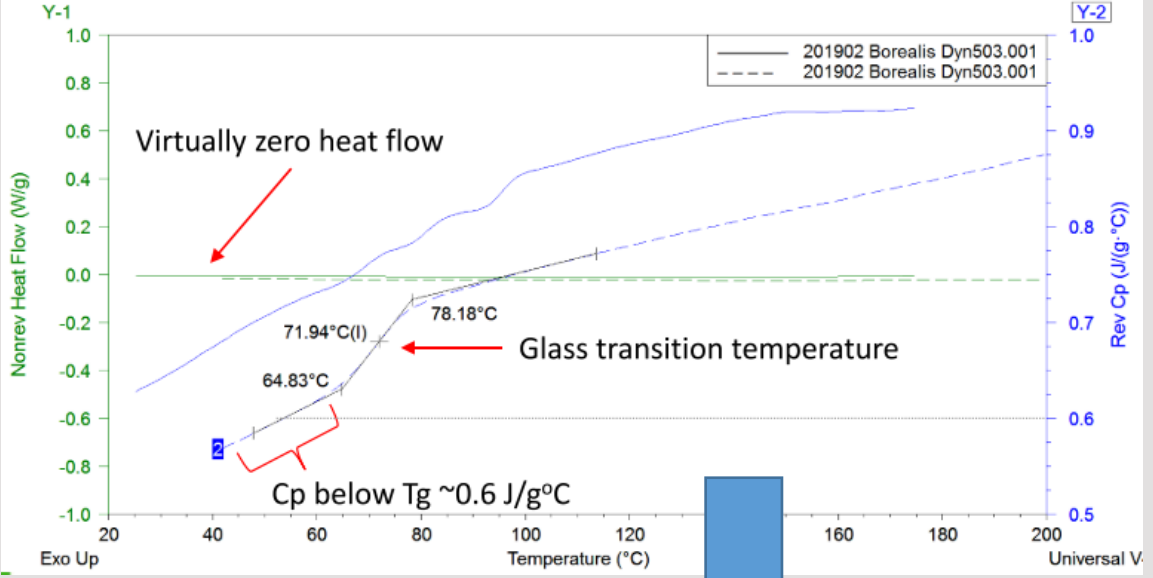


SAMPLE Insulation Temperatures vs Time



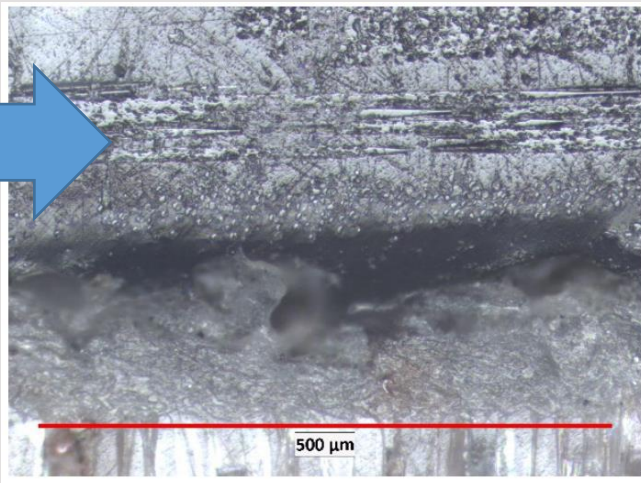
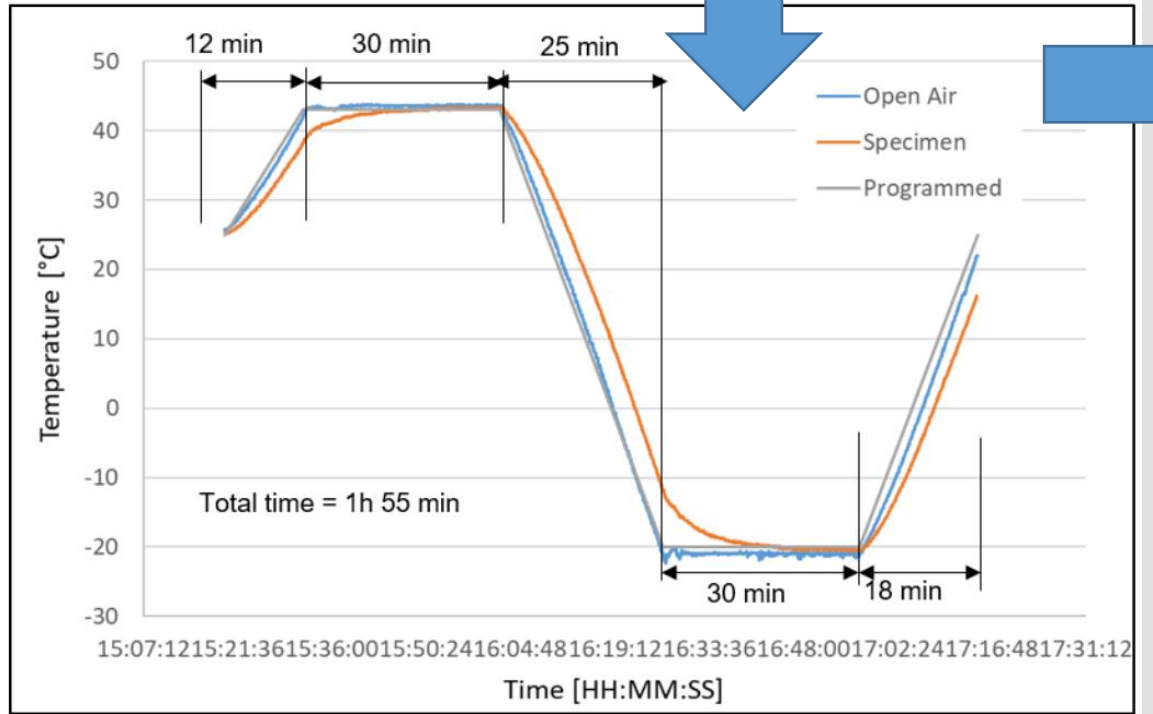
- Insulation CS Temp(Celsius)
- Insulation HS Temp (Celsius)
- Log. (Insulation HS Temp (Celsius))



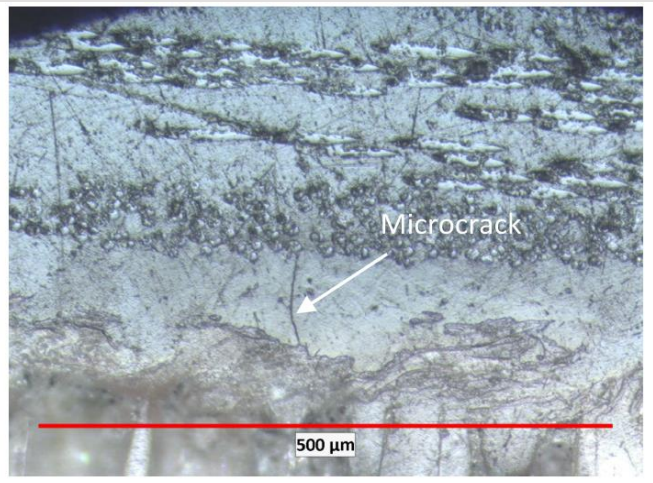


Detailed Investigation

- Burn-off, Thermo-Mechanical Analysis (TMA), Differential Scanning Calorimeter (DSC)
- Polished microscopy



(a) Void at the interface (close-up from Figure 8(a))



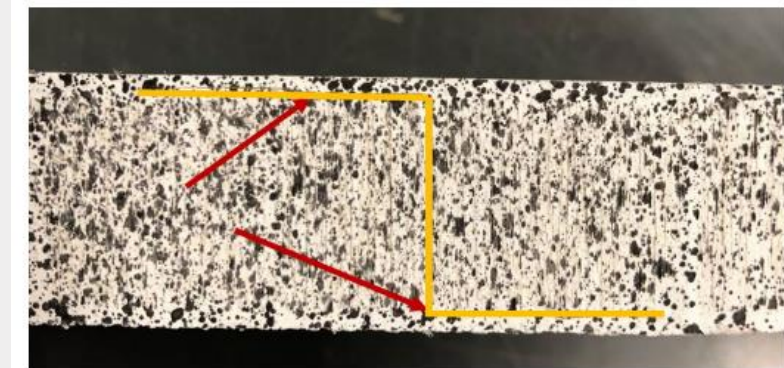
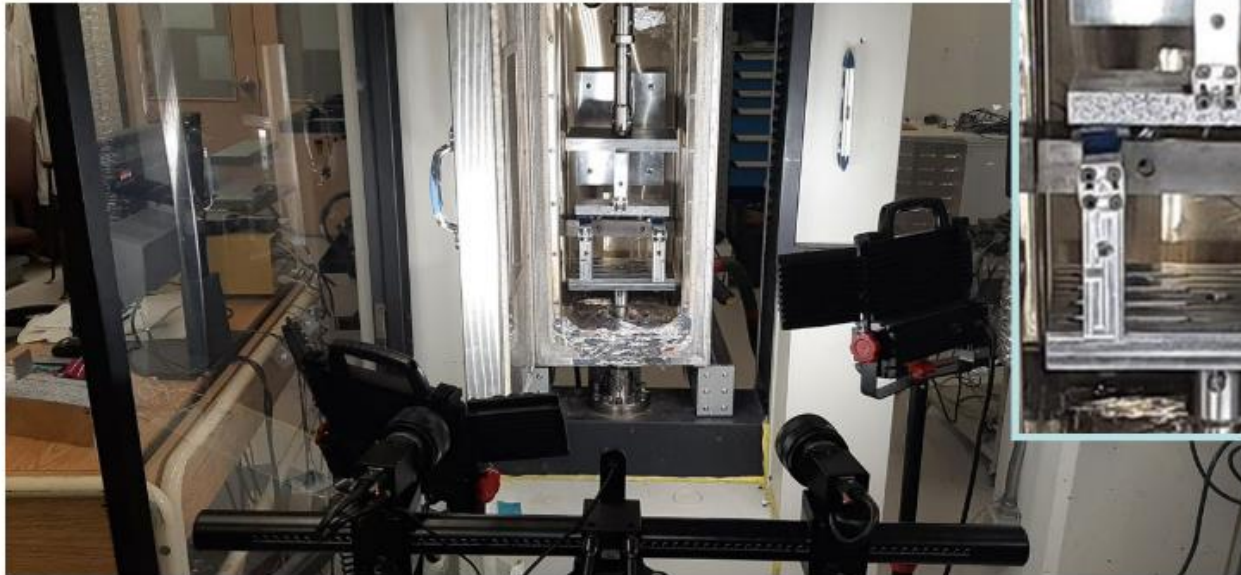
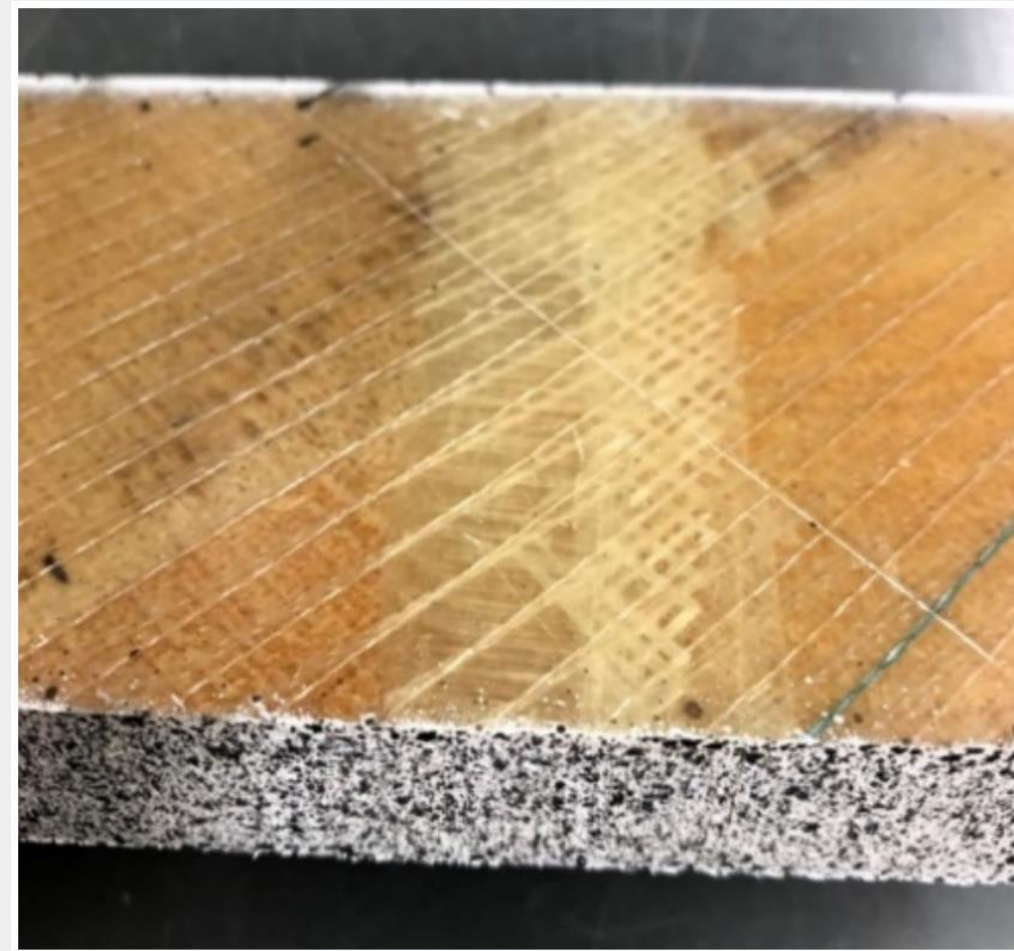
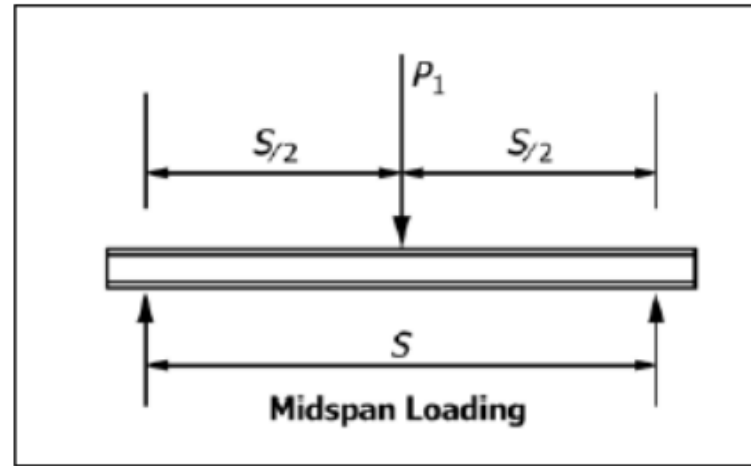
(b) Microcrack (close-up from Figure 8(c))

| | | | |
|---------------------------------------------|-------|-----|------|
| Number of Cycles | 0 | 700 | 1400 |
| Voids in percentage of interface length (%) | 49.84 | 58 | 38 |



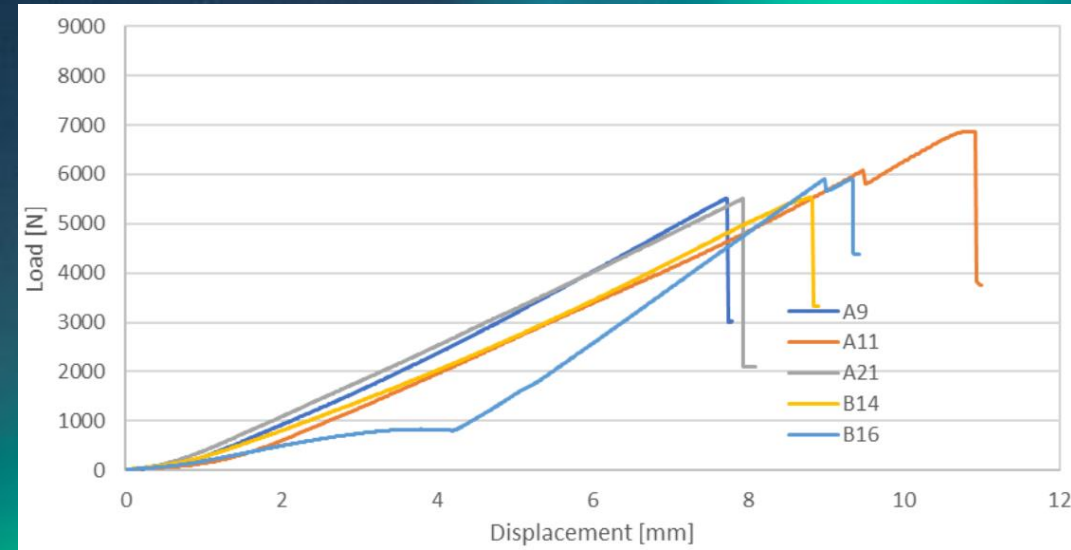
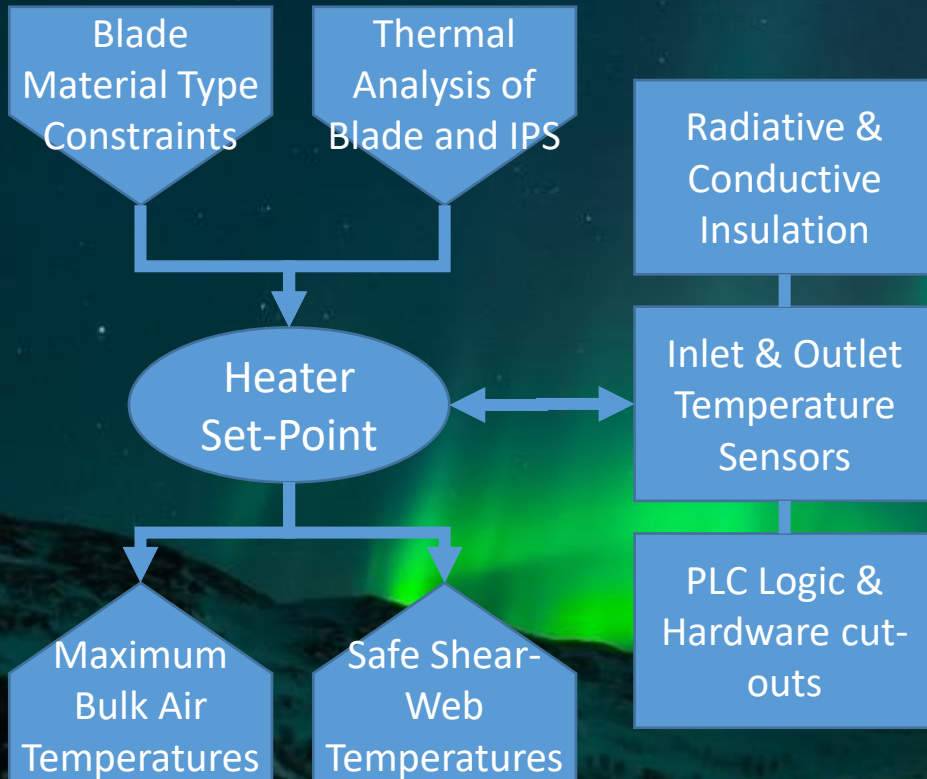
Testing of Cycled Samples

- 3 Point Bending ASTM C393M-20
- Held at 23C, 30C, and 43C when loaded

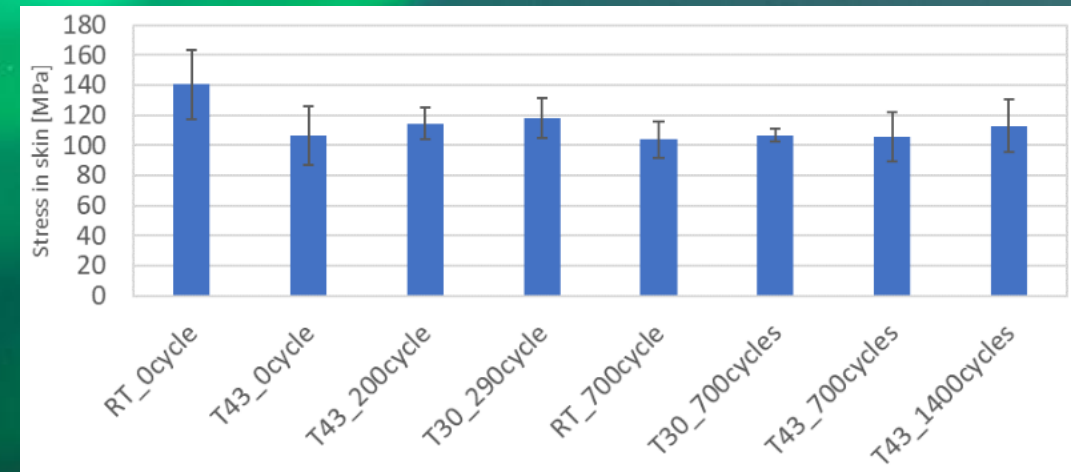


Observations

- Large scatter across samples
- No statistical difference in microstructure can be observed between un-cycled materials and materials cycled 1400 times
- Reduced material rigidity observed after the 1st cycle
- No significant reduction in material rigidity observed after the 1st cycle up to the 1400th cycle
- No significant change was observed when comparing 23C, 30C, and 43C tests
- Radiative and convective insulation minimizes hot-spot near heater to ~10C increase



43C Load Displacement Curves after 1400-cycles



Average Skin Ultimate Stress

