LOW VELOCITY IMPACT TESTING AT EXTREME TEMPERATURE CONDITIONS: DURABILITY AND INFLUENCE OF INTERLAYERS

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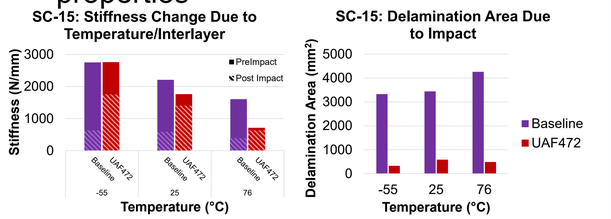
Introduction

- Composites used in **armor for ground vehicles**, as structural backing plate
- Subjected to **wide range of temperatures**

Background:

- First investigated **SC-15 epoxy resin with interlayer UAF472**
  - **Improved residual stiffness** post-impact
  - **Decreased delamination** area due to impact
  - **Poor performance at elevated temperatures**, stiffness loss due to TPU properties



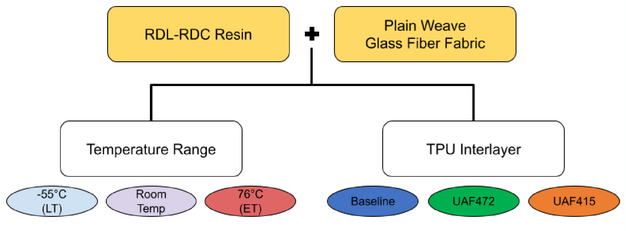
Stiffness (left) and delamination (right) results from the previous study of the effect of an interlayer on composite panels using SC-15 resin

Objectives:

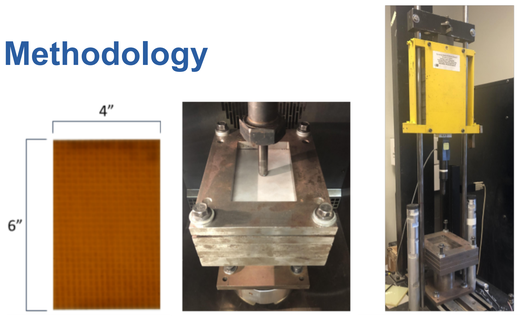
- Improve residual **stiffness after impact**
- Maintain performance across temperature range of **-55°C to 76°C**

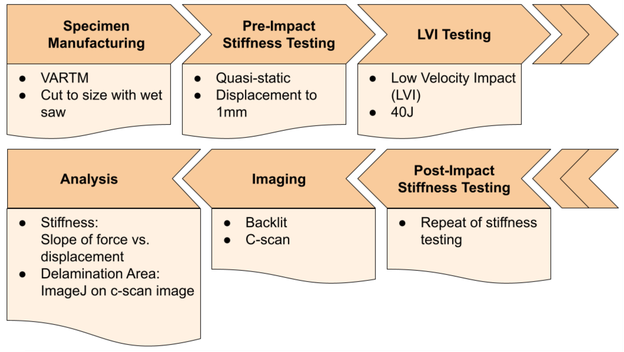
Problem Specification

- Investigate composite panels made with **RDL-RDC resin**
- Effect of different **TPU interlayers**
- Effect of **temperature**



Methodology

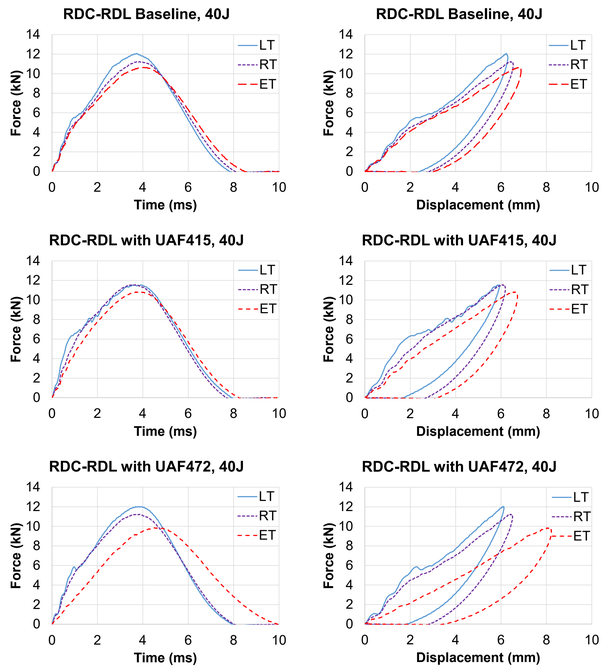




Results and Discussion

LVI:

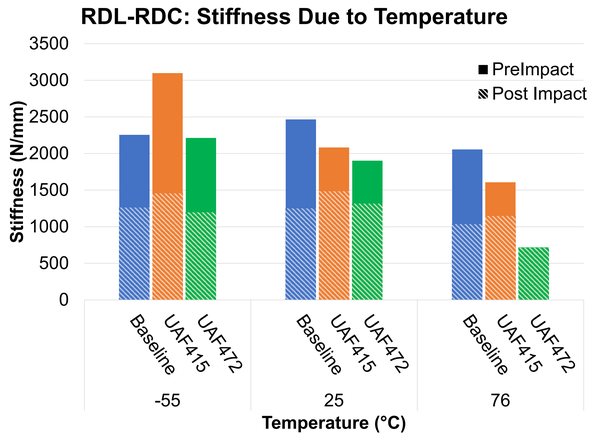
- **Impacts were comparable** across the specimens



Force vs. Time (left) and Force vs. Displacement (right) of the LVI tests for the RDC-RDL baseline (top), with UAF415 (middle), and with UAF472 (bottom) compared across the temperature range

Stiffness:

- Stiffness plotted against temperature
  - Compare **pre-impact and post-impact stiffnesses** of all specimens

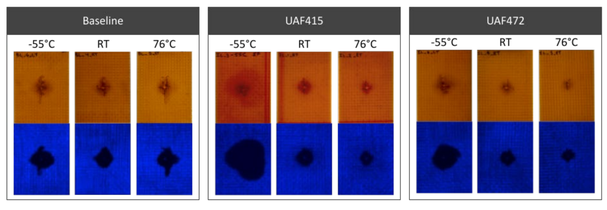


Stiffnesses of the specimens before impact (solid + striped) and stiffnesses after impact (striped) compared across temperature

- Baseline RDL-RDC panels had a **consistent performance** across the temperature range
- RDL-RDC with UAF415 interlayer panels had consistent post-impact stiffness
  - It had a **53% change in stiffness at -55°C** due to impact damage
- RDL-RDC with UAF472 interlayer performed poorly at elevated temperatures even before impact
  - **70% decrease in stiffness** compared to baseline at room temperature
  - Similar performance to SC-15 panel with UAF472 interlayer.

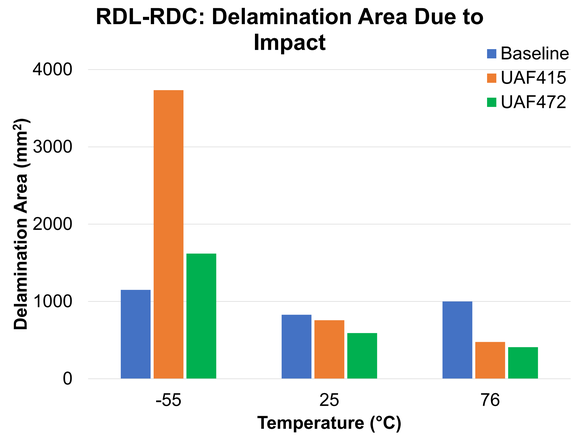
Delamination Area:

- Backlit optical images and c-scan images of the test panels
  - View the **delamination due to impact**



Backlit optical images (top) and C-scan images (bottom) of the specimens showing the delamination area due to impact

- C-scan images analyzed using ImageJ software to find the area of the delamination



Delamination Areas of the specimens compared across temperature

- Delamination of baseline **consistent** across temperature range
- **Larger delamination** areas correspond to **larger changes in stiffness** due to impact
  - UAF415 panel at -55°C: **53% change in stiffness, 3700 mm² delamination**
- Smaller delamination areas correspond to smaller change in stiffness due to impact

Summary and Conclusion

- **RDL-RDC resin composite had smaller delamination areas** across the temperature range compared to the SC-15 **TPU interlayers reduce delamination areas the reduction in stiffness** due to impact damage
- UAF472 interlayer performs poorly at high temperatures: 70% reduction in stiffness compared to baseline at room temperature
- UAF415 interlayer had a 53% change in stiffness due to impact damage and 3700 mm² delamination area at -55°C

Acknowledgements

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