INVESTIGATING THE INFLUENCE OF ENVIRONMENTAL CONDITIONING ON EPOXY RESIN PROPERTIES AT HIGH STRAIN RATES

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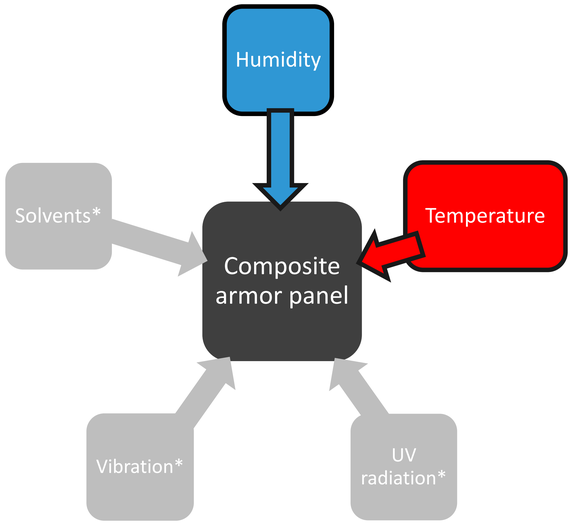
Abstract/objective/goals

- Epoxy resin systems used in ground vehicle armor can see temperature extremes ranging from -55°C to 76°C with humidity levels as high as 88% [MIL-STD-810G]
- The effects of external environmental conditions on the mechanical properties and interfacial strength for fiberglass-epoxy composite armor panels are not fully understood, especially at high strain rates

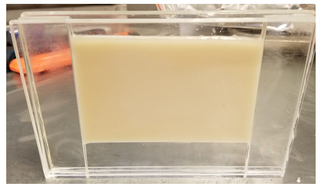


*Plans in place to test these factors in the future

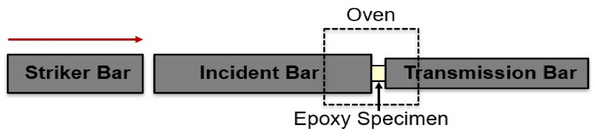
- The goal becomes to characterize epoxy resin's ability to withstand high strain-rate loading and how these mechanical properties are influenced by:
  - Operating temperature
  - Relative humidity

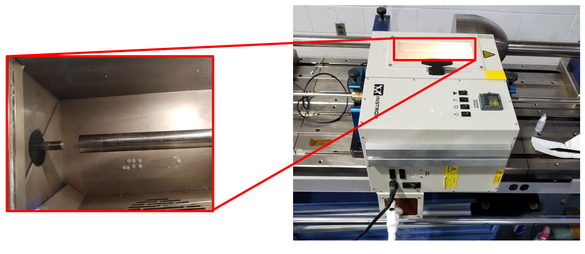
Methodology

- Two epoxy resin systems were considered in this test: SC-15 (widely used in the field) and RDL-RDC (Huntsman)
- The epoxy resins were cast into coupons and core drilled to make cylindrical specimens 5mm in diameter and at various lengths



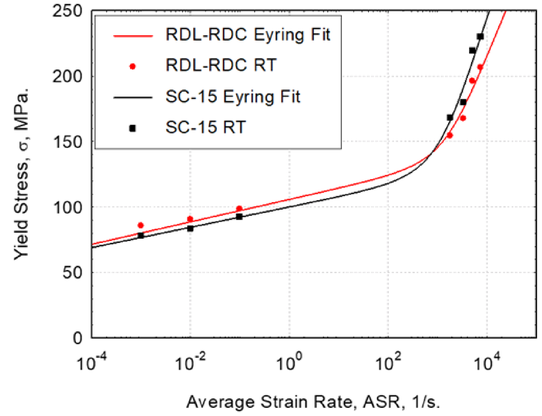
- Specimens of each resin were divided into two groups:
  1. Conditioned in a desiccator (~0% RH) at room temperature (~25°C)
  2. Conditioned in an environmental chamber at 76°C 88% RH to promote moisture absorption
- Specimens were tested at high strain rates on a Split Hopkinson Pressure Bar with an environmental chamber which allowed for testing at various temperatures



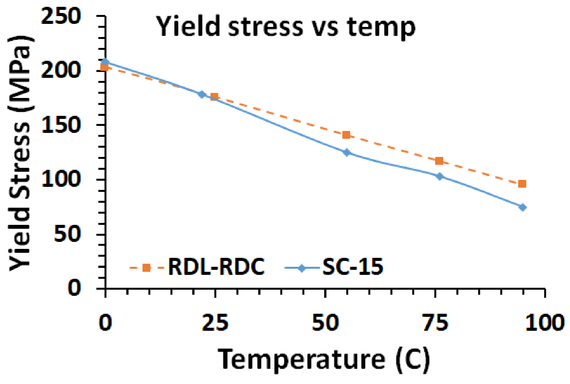


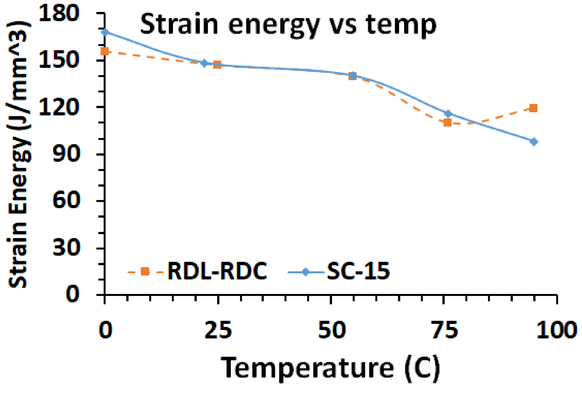
Results and Discussion

- Increases in strain rate resulted in an increase in yield stress and exhibited a bi-linear behavior and this is believed to be due to a molecular mechanism



- Increases in temperature resulted in a decrease in yield stress as well as strain energy for both resin systems





- Supplemental tests on a DMA using an environmental chamber showed that moisture significantly lowered the T_G, bringing it within the operating temperature of the resin system

Conclusions and Future Work

- Results show a significant degradation in yield stress and strain energy, which are key factors in an armor panel's ability to absorb impact energy
- Existing armor using SC-15 may be susceptible to performance degradation in warm, humid environments
- S2 fiberglass/epoxy resin interface testing is underway with plans for performing environmentally conditioned fiber pullout tests at varying temperatures and rates
- Future tests are planned for gauging other environmental factors, including UV radiation and solvents

Acknowledgements

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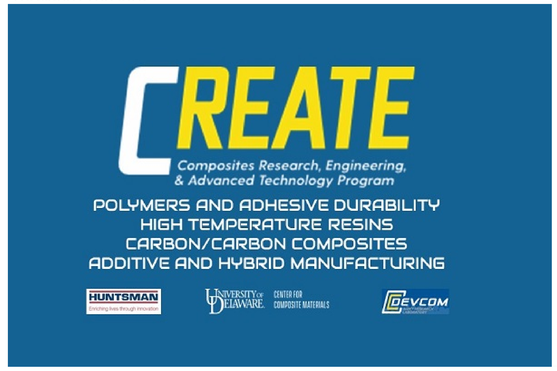

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