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

Alex Schneider (B.M.E.), Dr. Sagar M. Doshi (P.D.), Dr. Joseph M. Deitzel
University of Delaware | Center for Composite Materials | Department of Mechanical Engineering

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

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

- 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

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

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

This research was sponsored by the U.S. Army CCDC Army Research Laboratory and was accomplished under Cooperative Agreement Number W911NF-18-2-0299. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Army Research Laboratory or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation herein.