

# DAMAGE TOLERANCE AND DURABILITY OF THICK SECTION COMPOSITES

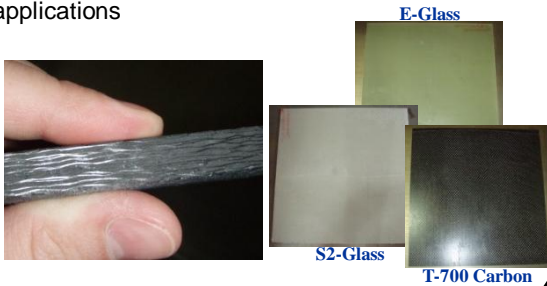
## Development and Characterization of Novel Materials

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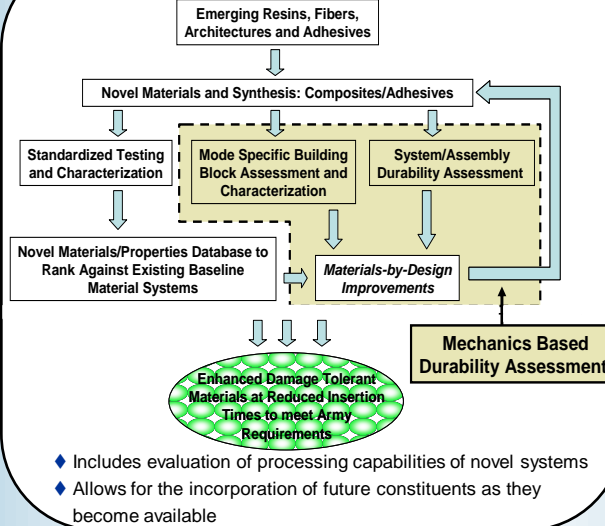
### PROJECT GOALS AND OBJECTIVES

- ◆ **Development of the next generation of lightweight damage tolerant composite materials.**
  - ◇ Focus on thick-section composites for structural applications
- ◆ Integration of emerging resin systems for target applications



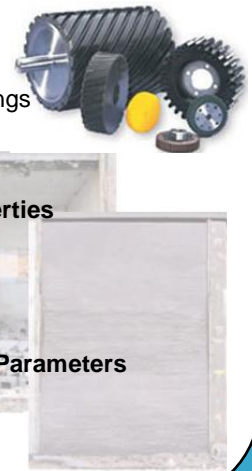
Polyurea Matrix Composite Test Panels

### PROJECT STRATEGY



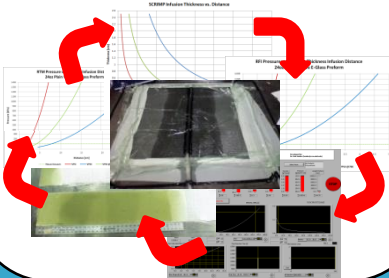
### EMERGING SYSTEMS Polyurethane/ Polyurea Resins

- ◆ **Traditional Uses:**
  - ◇ Cast Elastomers
  - ◇ Spray-on Protective Coatings
    - ◇ Truck bed liners
    - ◇ Blast walls
- ◆ **Pros: Great Range of Properties**
  - ◇ Durable
  - ◇ Tough
  - ◇ Damage Tolerant
- ◆ **Cons: Difficult Processing Parameters**
  - ◇ High/Variable Viscosity
  - ◇ Short Gel Times



### PROCESSING

- ◆ Development of Processing Envelope for novel systems
  - ◇ "Processability Parameter" defined for new systems based on unique viscosity profiles
  - ◇ Manipulations of Darcy's Law for current executable infusion models



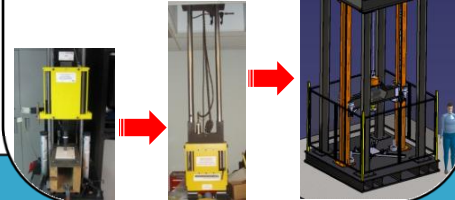
### BALANCE OF PROPERTIES

- ◆ Tradeoffs may exist between impact and structural performance
- ◆ **Damage Tolerance:**
  - ◇ Ability to withstand an/multiple impact or blast event(s) without considerable degradation in structural integrity or mechanical performance.
- ◆ **Compliant/energy absorbing matrix... → poor material stiffness**
  - ◇ Matrix governed fiber buckling
  - ◇ Compressive failure
- ◆ **Possible Solutions:**
  - ◇ 2D/3D/Matrix/Tow/Weave/Layer Hybridization



### PERFORMANCE EVALUATION

- ◆ Testing should show: extent of damage clearly reduced in the new materials
- ◆ **Study effects of polyureas in composites**
  - ◇ Standardized (CAI)
  - ◇ Non-Standardized (Multi-Hit)
- ◆ **Multi-scale impact testing**
  - ◇ Varying energy levels
  - ◇ Small, medium, large towers



### MATRIX TAILORABILITY

- ◆ **Collaboration with Air Products materials development teams**
  - ◇ New experimental systems with specific property improvements for target applications
  - ◇ Development of more easily processable systems
- ◆ **Alteration of cure cycle (temp/time)**
  - ◇ Multiple "systems" from one resin mix
  - ◇ Ideal baseline for material improvement evaluations

### ACKNOWLEDGEMENTS

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