UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

RFAL
RELIABILITY AND FAILURE ANALYSIS LABORATORY

Composite Manufacturing Techniques

UAHuntsville
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Objective

- What factors should I be concerned with?
- What are the basic materials needed?
- What are the basic techniques?
- How has this information already been applied?

Important Variables

- Volume Fraction
  - Over/Under Saturation
- Consolidation
  - Poor bonds between layers
- Cure Cycle
  - Small Variations
- Manufacturing accuracy
  - Weave alignment

Fibers

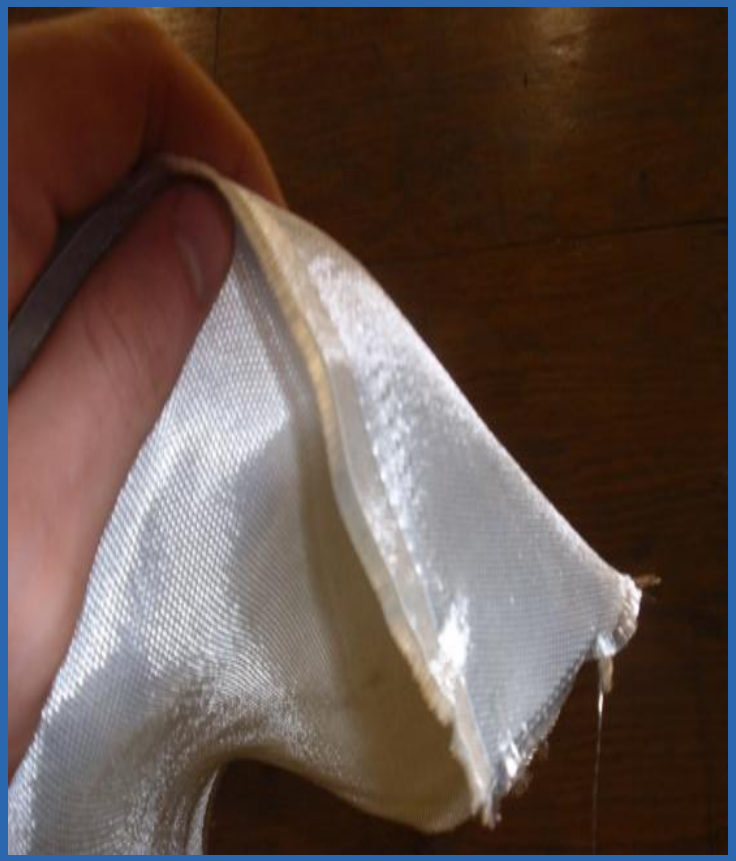
- Carbon Fiber
  - Continuous strands of graphite called tow or filament
  - Woven into sheets
  - Pros
    - High strength
    - Thermal properties
  - Cons
    - Expensive
    - Radio Interference
  - Uses
    - High temperature applications
    - High strength applications
    - Aerospace
    - Automotive
    - Fishing rods and reels
    - Golf shafts and heads
    - Marine Community

Fibers

- Kevlar
  - Invented and made by DuPont
  - Aramid Fiber
    - Degrades at 400C
  - Pros
    - Strength
    - High deflection
  - Cons
    - Expensive
    - UV degradation
  - Uses
    - Aerospace and Defense
    - Body Armor
    - Ropes and Cables
    - Strengthening fiber optic cables
    - Fire resistant mattresses

Fibers

- Fiberglass
  - Pros
    - Cheap
    - Availability
    - High deflection
  - Cons
    - Strength
  - Uses
    - Thermal and electrical insulation
    - Heat and corrosion resistant
    - Automobiles
    - Aerospace
    - Medical casts
    - Irish step dance shoes



Resins

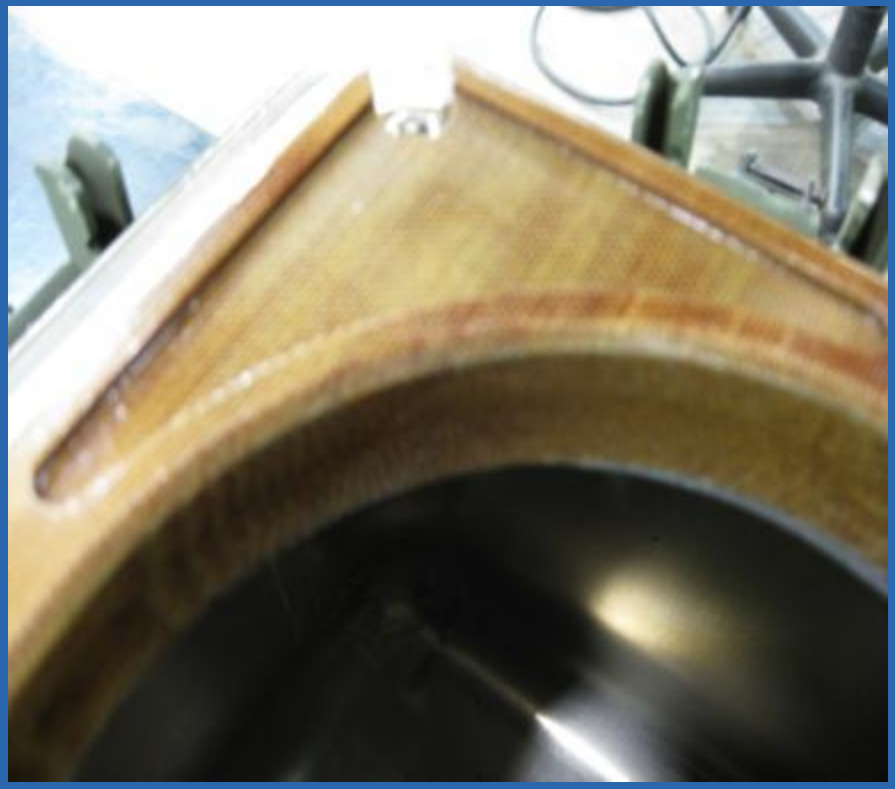
- Polyester
  - Pros
    - Cheap
    - Available
  - Cons
    - Structurally weak
    - Trouble bonding

Resins

- Epoxy
  - Pros
    - Long work time
    - Structurally strong
    - Resistant to micro fractures
  - Cons
    - Expensive
    - Availability

Resins

- Phenolics
  - Thermosetting
  - High Temperature
  - Examples:
    - Rocket motors
    - Rocket bodies
    - Textiles



Additives

- There are many things you can add to a resin to affect its cured state
  - Fillers
    - Micro Beads
      - Small air filled glass spheres to increase volume while keeping weight low
    - Powders such as graphite and Teflon for a slicker surface
    - Thickeners such as silica and talc
    - Pigments and glitterflakes
      - These cause your resin to take on a color
      - Glitterflakes are generally made from polyester

Manufacturing Techniques

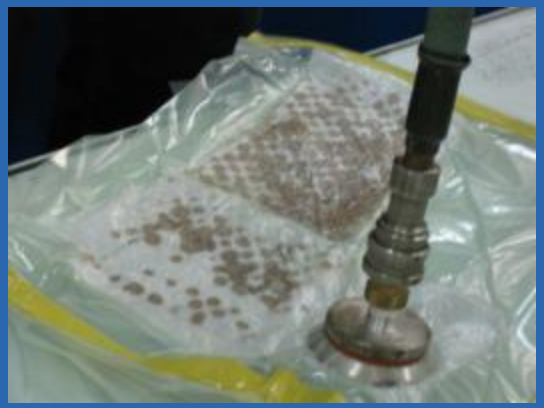
- Wet Lay-up
  - Pros
    - Simple
    - Cheap
    - Easy
  - Cons
    - Oversaturation
    - Resin Flow

Manufacturing Techniques

- Pre-Impregnated
  - Pros
    - Strongest strength to weight ratio
      - Ideal fiber to resin ratio
    - Aesthetics
  - Cons
    - Price
    - Can be difficult to work with
      - Necessary curing temperature
      - Hard to work with once warm
    - For best results, should be compression molded, vacuum bagged, or put in an autoclave.

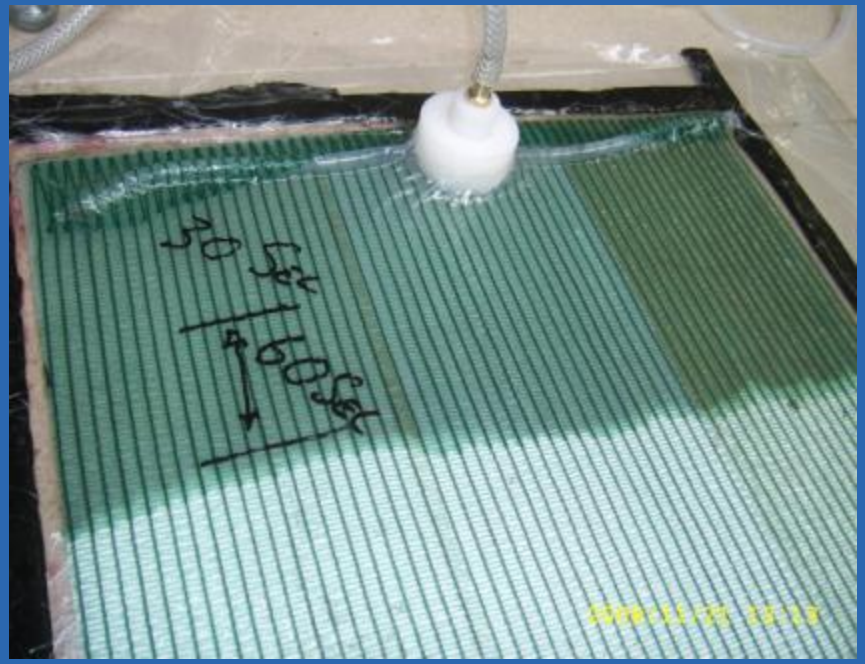
Manufacturing Techniques

- Vacuum Bag
  - Pros
    - Improves both wet and pre-impregnated techniques
    - Pulls out excess resin out of wet lay-ups
    - Creates pressure and strong inter-laminar bonds.
  - Cons
    - Price
    - If done improperly air bubbles can become stuck in your part



Manufacturing Techniques

- Resin Infusion
  - Pros
    - Creates a better resin/fiber ratio
  - Cons
    - More complex than previous methods
    - More expensive than previous methods (short term)



Manufacturing Techniques

- Compression Molding
  - Pros
    - Strong inter-laminar bonds
    - Stronger strength to weight ratio than wet layup and vacuum bag, comparable to autoclave
    - Good for molding awkward shapes
  - Cons
    - Sufficient equipment needed ($)
      - Press or weights
      - Mold

Examples

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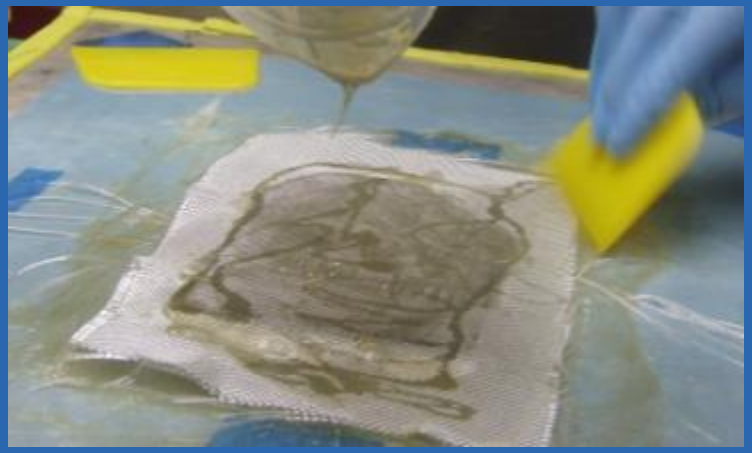
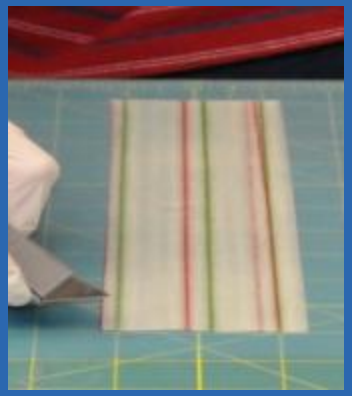
Examples





Questions?

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