Composite Manufacturing Techniques

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

DuPont.com
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
Questions?

For Questions or comments please visit us at http://rfal.uah.edu and reply via the contact us page.