Advances in Wind Turbine Blade Composites

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July 21\textsuperscript{st}, 2010
What products do we sell into Wind market??
Typical Wind Blade Section

Skins
Biaxial or Tri-axial Fabrics

Spar Caps or Girder
Uni-axial fiber or Fabrics

Shear Webs
Biaxial Fabrics

Used by Permission of Owens Corning
Key Market Drivers

• New materials with improved properties to achieve weight reduction and durability
  • Higher modulus for stiffness
  • Improved strength with lower variation
  • Improved fatigue strength
• New materials with processing flexibility
  • Faster processing time
Improvement in material performance

• Increased Glass Fiber Strength and Modulus
  • Glass Composition and Homogeneity
  • Fiber/Strand Alignment
• Increased Resin Matrix Fracture Toughness
• Increased Fatigue Performance
  • Fiber/Matrix Adhesion
Fiber glass reinforcement
Bonding

- Inter-laminar shear strength is indicative of the bonding (adhesive and cohesive)
- The surface of the glass can be chemically tailored (size) to improve resin-glass adhesion

ASTM D2344
Optimization of sizing

Short Beam Shear Strength (Typical Vinylester resin system)

Size 1 higher shear strength indicates improved resin-glass adhesion
Improved resin matrix fracture toughness

Improved resin fracture toughness increases cohesive bonding enhancing the overall composite shear strength of an optimized resin-glass system.
Good interface bonding

Load carried by reinforcement indicated by fracture of glass at failure

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Good interface bonding

Superior resin to glass bonding indicated by good coating on glass surface

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Poor interface bonding

Load carried by resin indicated by shearing of matrix at failure

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Poor interface bonding

Poor resin to glass bonding indicated by smooth uncoated glass surface

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Improved reinforcement provides higher performance in composite structure.
Improved fabric construction

Epoxy UD fabrics laminate

Optimal fabric construction enables high performance in composite structure

Fabric type 1

Fabric type 2
Improved fabric construction

Conformability to complex contours of blade structure

Optimal resin infusion for process ability
Summary

• Fabric construction enables translation of higher fiber strength and modulus
• Fabric type enables productivity with good conformability and reduces manufacturing defects
• Higher performance fabrics enable higher durability for longer blade life
• Higher modulus reinforcements enable lighter and/or longer wind blades designs
• Resin matrix toughness and higher strength reinforcements with good sizing for interfacial bonding achieve greater strain allowable to enable improved wind blade durability
Thanks!