WindSTAR
Wind-Energy Science, Technology, and Research
Industry/University Cooperative Research Center

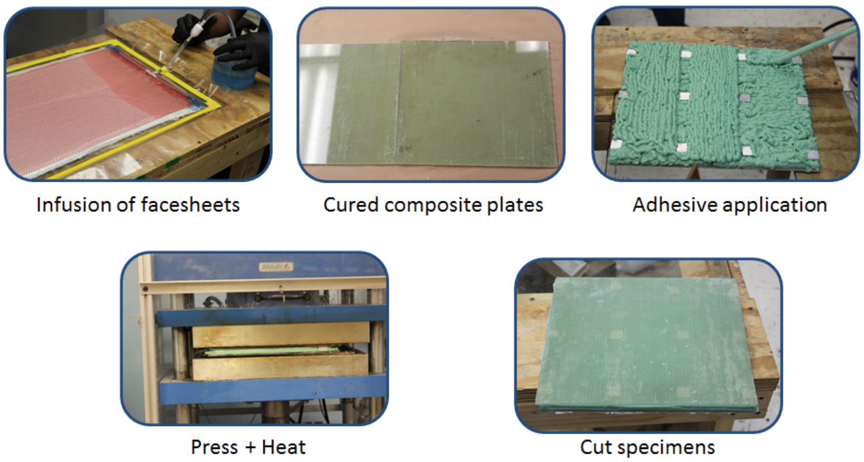
Performance Effects of Adhesive Bond Defects

Principal Investigator:
Scott Stapleton, University of Massachusetts Lowell

Co-Principal Investigator:
Christopher Hansen, University of Massachusetts Lowell

Student Researchers:
Alessandro Cassano, Siddharth Dev
University of Massachusetts Lowell

IAB Mentors:
Nick Althoff, GE Renewable Energy
Paul Ubrich, Hexion



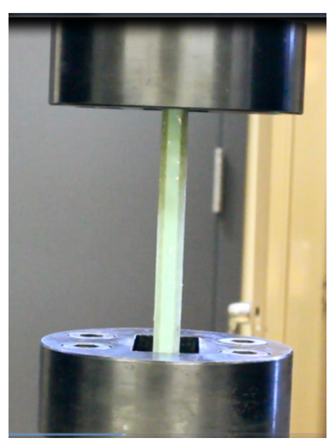
Bonded joint manufacturing process.

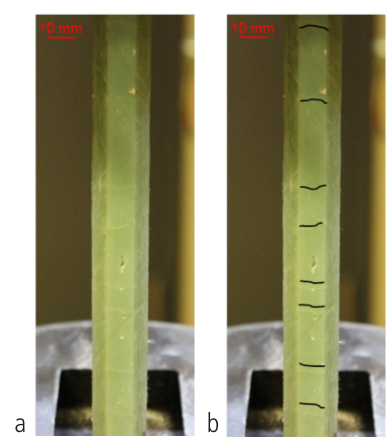
Bondline failure is a key critical failure mode in wind turbine blades. Substantial variation in bondline thickness can result in different thermal histories for the adhesive layer due to the exothermic curing of common adhesives. Predictive guidance regarding the impact of this variability in adhesive cure temperature cycles is extremely limited. Without guidelines of acceptable variability, excess resources may be placed into avoiding damage by processing at excessively low temperatures and longer processing cycles which produce no discernible benefits.

In this research, two studies were carried out to characterize the behavior of thick adhesive bondline. The first study focuses on the mechanical characterization of the adhesive system as a function of the curing temperature. The second study is to describe the curing of the adhesive system and develop a predictive tool to capture the thermal and curing histories for any type of geometry.

The mechanical characterization of the adhesive leads to a better understanding on how the cure temperature effects the stiffness and the strength of the adhesive system. The goal of the research is to find a correlation between mechanical properties and curing temperature. Extensive experimental testing has been performed on neat adhesive specimens in the curing temperature range from 70°C to 180°C.

Due to the high exothermic behavior of thick adhesive bondlines, an FEM model was developed to simulate the cure cycle of the adhesive in a joint configuration. In fact, the temperature in the middle of the adhesive reaches higher values than the imposed cured temperature. Once the kinetic parameters from the resin system are determined and implemented in the model, it will be possible to trace the adhesive thermal and curing histories and the gradients developed through the bondline thickness.


Mechanical testing of 10 mm bonded joint specimen. Tensile test set up.



Mechanical testing of 10 mm bonded joint specimen. a) Crack propagation through the thickness b) Highlighted cracks with marks.

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