



Environmental Effects on Deformation, Strength, and Degradation of Glass Fiber Reinforced Polymers: A Micromechanics-Based Study

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Sponsor: US Army Research Office
Dr. Larry Russell (POC)

Start: October 1, 2006

Ends: September 30, 2008

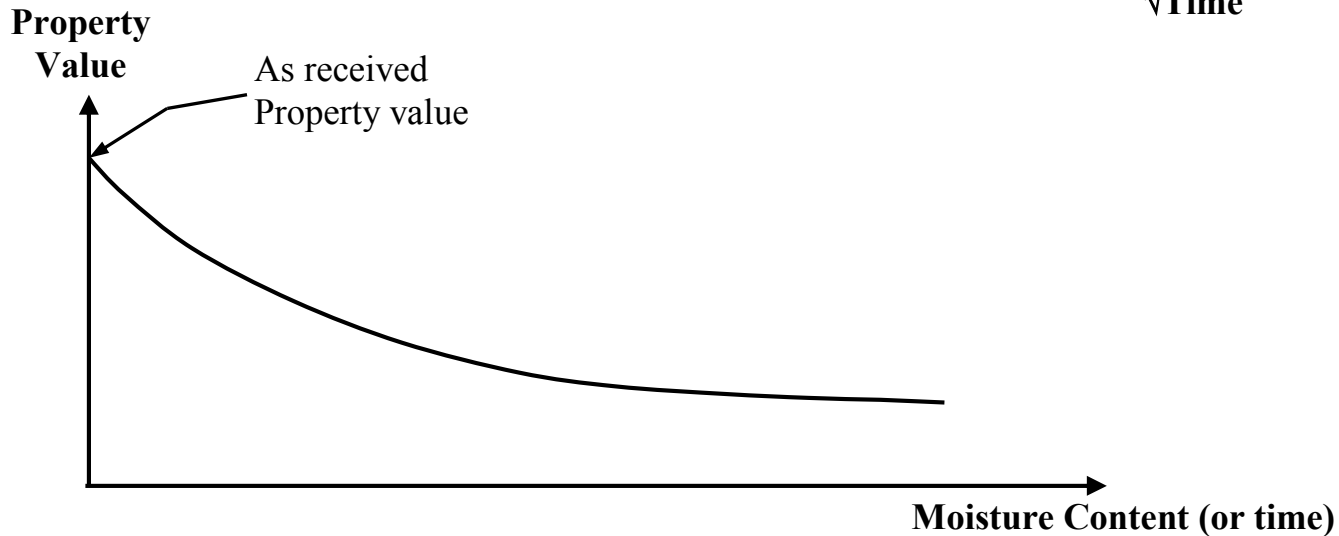
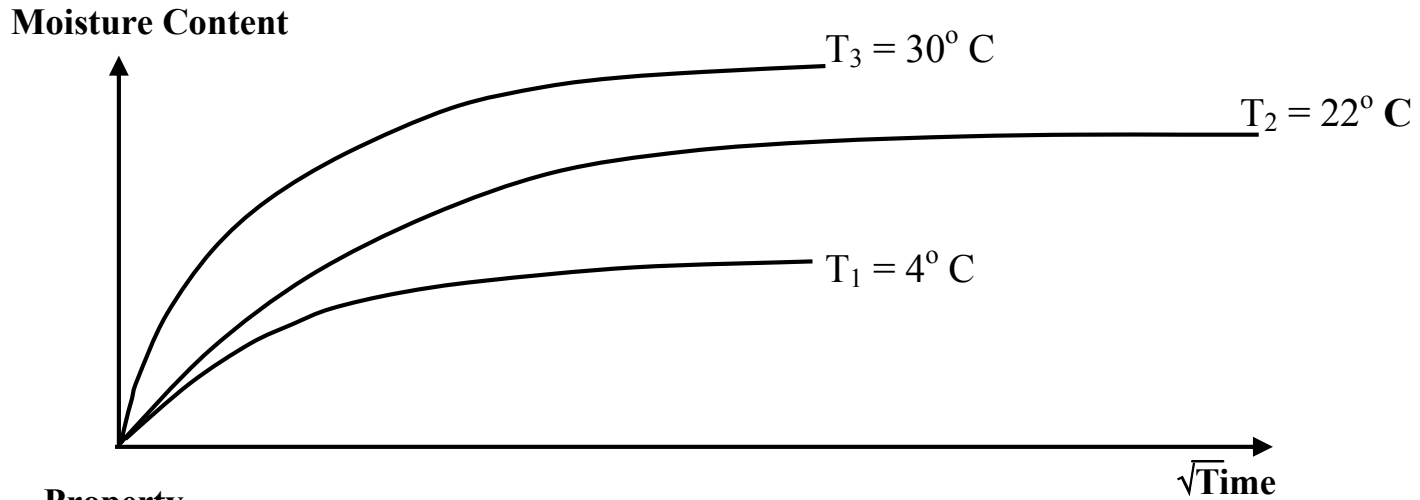


Purpose

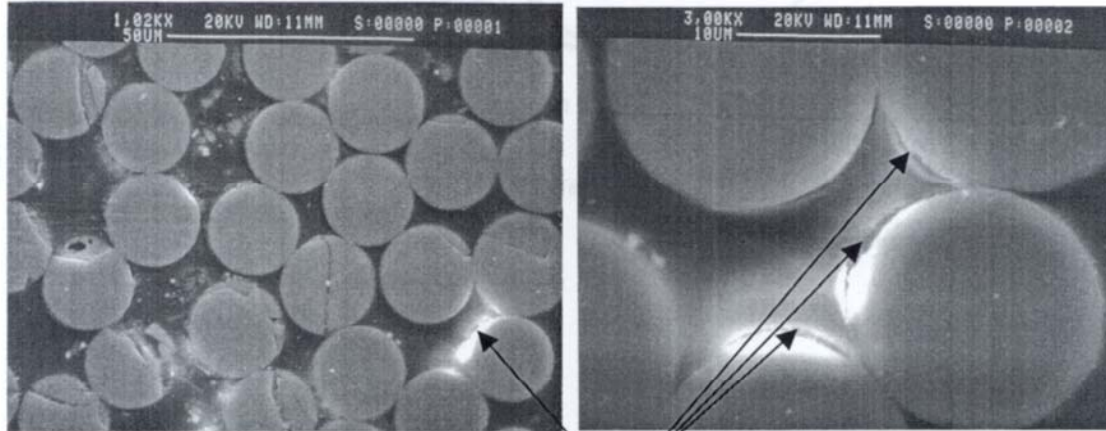
- To investigate fundamental degradation mechanisms of FRP composites due to environmental effects (Hygrothermal) at the micromechanical level based on the basic degradation mechanisms involved.
- Develop of a predictive tool for long term behavior for FRP composites



The Problem of Hygrothermal Ageing



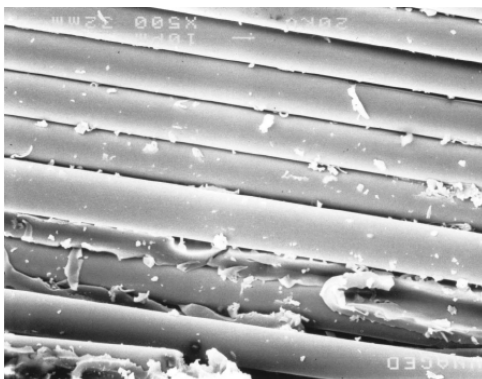
The Problem of Hygrothermal Ageing (Cont.)



(1.02 K X)

(3.0 K X)

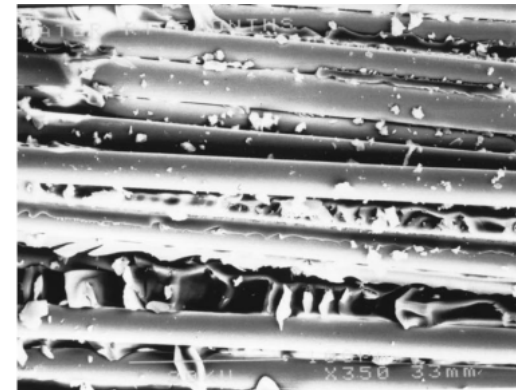
Cracks at Fiber-matrix Interface



(a)



(b)



(c)



Objectives

- Experimentally and analytically identify the fundamental damage degradation mechanisms of glass FRP composites at the constituent level (i.e. fiber, resin and their interface).
- Develop a computational assessment tool based on micromechanics to serve as basis for life prediction models.



Tasks to Perform

- **Develop publication database**
 - Hygrothermal ageing of polymer composites
 - Micromechanics of unit cell including interface
 - Other ...
- **Analytical Model**
 - Finite Element
 - Cellular Automata
 - Diffusion problem



Tasks to Perform (Cont.)

- **Base Material Mechanical Characterization**
 - Tension
 - Fatigue
 - Flexural
 - Impact
- **Material Characterization as Function of Time**
 - 50, 100, 200, 300, 400, 500 days
- **Dynamic Mechanical Analyzer and Microscopy Analysis**
 - Chemical and physical changes



Schedule

Table 1: Schedule of the Activities Designed for the Proposed Work.

Activity	Performance period in Quarters (Proposed start date 9/1/2006)							
	1	2	3	4	5	6	7	8
1. Literature Review	■	■		■			■	
2. FRP panels purchasing & sample preparation	■							
4. Mechanical testing		■	■	■	■	■	■	
5. Analytical model development	■	■	■	■	■	■	■	
6. Analytical model calibration		■	■	■	■			
7. Report & dissemination				■			■	■



Team and Preliminary Tasks

- **Dr. Luis Godoy**
 - Victoria Mondragon: Micromechanical modeling of the hygrothermal ageing development. Model of the fiber/matrix interface in FEM implementing user subroutines in ABAQUS.
- **Dr. Miguel Pando**
 - Juan Carlos Obando: Gathering publications related to composite materials aging and related publications
 - Possible Topic: Diffusion of water in epoxy resins
- **Dr. Felipe Acosta**
 - Irene Mejias and Ruth Roman: Material characterization (Micro and Macro)