



MICRO-SCALE CHEMICAL, MORPHOLOGICAL, AND MECHANICAL CHARACTERIZATION OF POLYMER-MATRIX TEXTILE COMPOSITES

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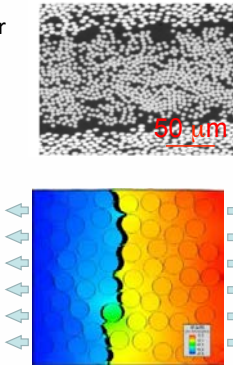


Motivation

Understanding the chemical and structural variability of Polymer Matrix Composites and its influence on mechanical properties

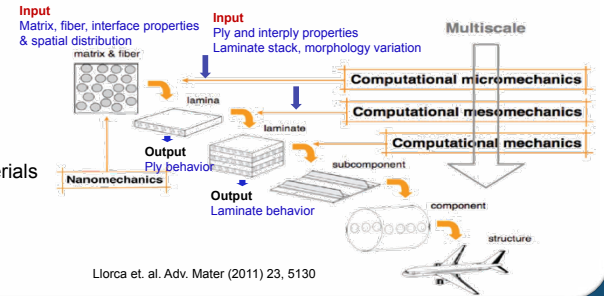
Overall Objectives

- Develop knowledge of effects of geometric & material state variability on strength & damage in 3D textile composites
 - Geometric: fiber volume fraction & direction, tow & fabric variations
 - Material State: resin cure extent & distribution
- Develop an integrated set of advanced simulation tools to address the variations of interest
 - Micro-scale & tow-scale variability
 - Multi-scale damage evolution
 - Advanced chemo-mechanical simulation method



Challenges

- Lack of understanding on
 - Effect of processing on chemistry and mechanics of the composite
 - Effect of materials variability on the property
- Lack of experimental techniques to evaluate the property at nanoscale level
- Proper transitioning of experimentally evaluated materials properties into multi-scale simulation



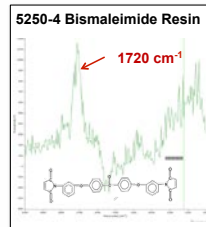
Llorca et al. Adv. Mater (2011) 23, 5130

Approach

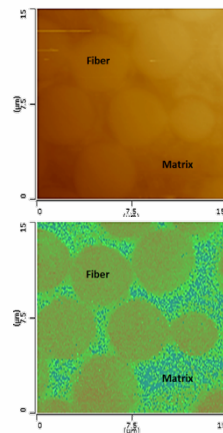
Experimental Effort

- Characterization of interphase/interface around fibers within tows as well as around tows.
- Fiber distributions within laminate plies and textile tows.

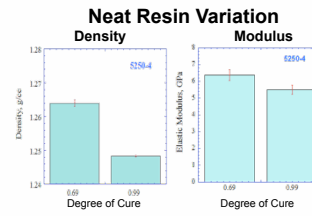
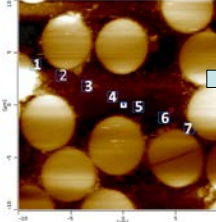
Material	Degree of Cure	Fiber Sizing
5250-4	0.69	-
5250-4	0.99	-
IM7/5250-4	0.76	Sized
IM7/5250-5	0.99	Sized
MVK-14 ^M	0.99	-
T650-35/MVK-14 ^M	0.99	Unsize
T650-35/MVK-14 ^M	0.99	Sized
5292 (Generic BMI)	0.99	-



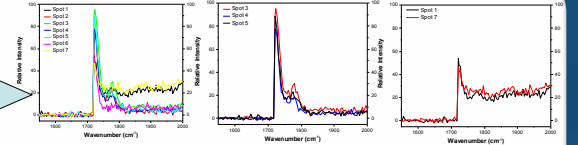
AFM images showing height & chemical mapping of IM7/5250-4 unidirectional laminate



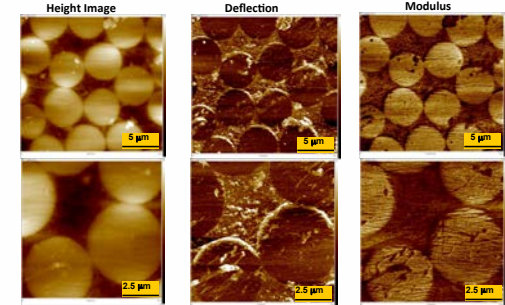
AFM Height Image Spots For Chemical Mapping



Chemical Mapping Showing Heterogeneity



Modulus Mapping Showing Heterogeneity



Summary and Future Outlook

Chemical and structural variability and its corresponding effect on properties of laminated and textile PMCs (IM7 / 5250-4) are shown using nanoscale characterization techniques combining spectroscopy, microscopy, and mechanical testing.

Future Work

Challenges associated with lack of exact chemical information inhibit the detail understanding. Future work are targeted for known material systems.

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