INVESTIGATION OF TENSILE STRENGTH OF UHMWPE FIBERS EXTRACTED FROM COMPOSITE PANELS

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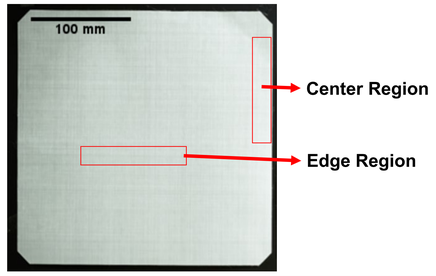
Introduction

- HB210 composite panel (15"x 15" x .045") 100°C, 290 psi, 10 mins |125°C, 3 ksi, 30 mins
- Filaments extracted from top, middle and bottom sublayers of the center and edge regions.

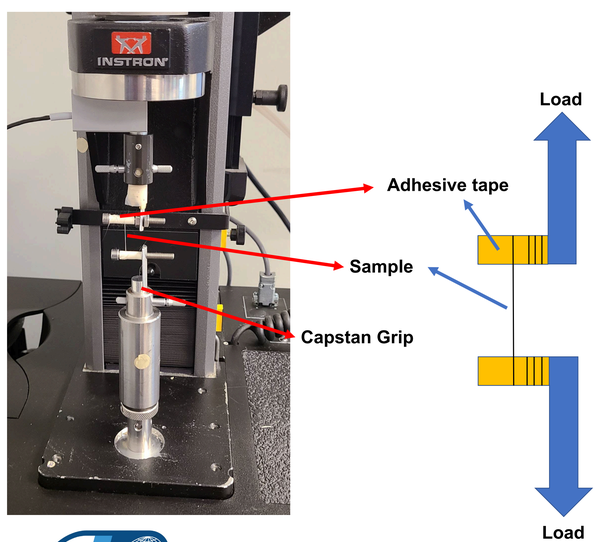


Objective

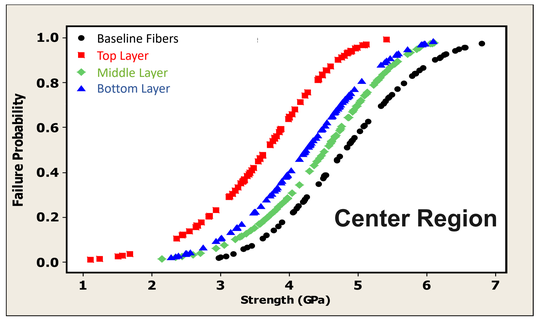
Test fibers in each region; compare them to virgin fibers to determine the effect of processing parameters on strength

Tensile Testing

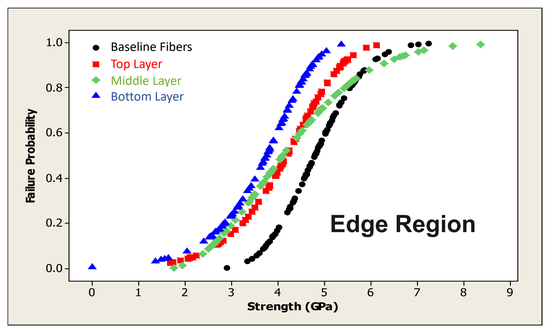
- Test frame is equipped with a 5 N load cell.
- Single fibers are tested using a gauge length of 25 mm and a cross-head speed of 5 mm/min.
- Tests were conducted on virgin fibers and fibers extracted from the three sublayers (top, middle and bottom) cut from center and edge locations.



Failure Probability Distributions (FPD)



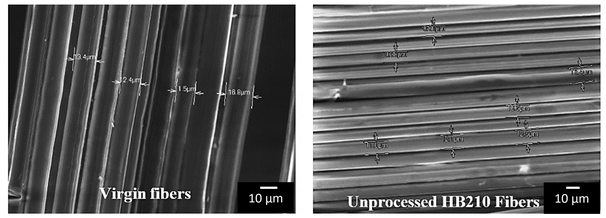
Fiber	Strength (GPa) at 50% probability	Reduction in strength
Virgin	4.81	
Top layer	3.65	24%
Middle layer	4.50	6%
Bottom layer	4.26	11%



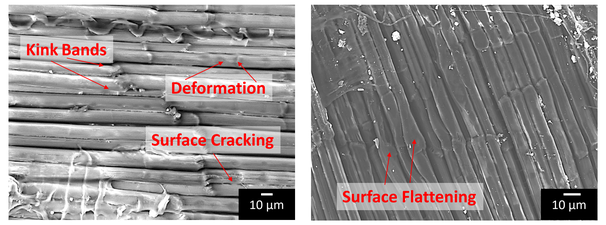
Fiber	Strength (GPa) at 50% probability	Reduction in strength
Virgin	4.80	
Top layer	4.20	13%
Middle layer	4.16	13%
Bottom layer	3.74	22%

- Top-center locations show the highest reduction in strength (24%)
- Bottom-edge locations display the second highest reduction in strength (22%)
- Middle-Center locations exhibit the lowest reduction in strength (6%)

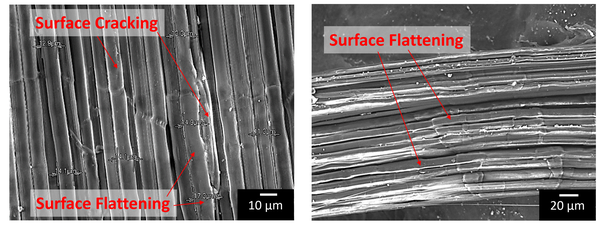
Microdamage Modes-SEM Images



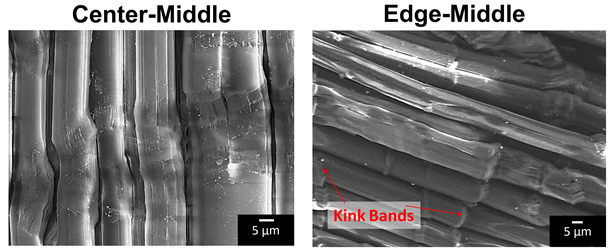
Baseline fibers



Center-Top | Edge-Top



Center-Middle | Edge-Middle



Center-Bottom | Edge-Bottom

Kink Band Spacing Table

Layer	Center Region - µm	Edge Region - µm
Top	37	69
Middle	63	93
Bottom	48	29

- Baseline fibers are free from damage
- Damage modes on fibers include kinking, buckling, surface flatting, and surface cracks
- The degree of damage modes is highest for top-center and bottom-edge

Summary and Conclusion

- FPD Strength data correlates with SEM imaging
- Fibers from center-top and edge-bottom exhibit the highest strength reduction and degrees of micro damage modes experienced by the fibers.
- Fibers from edge-middle exhibit a double strength reduction compared to center-middle
- Fibers from edge-top and center-middle exhibit some degree of surface flattening. Additionally center-middle exhibits surface cracks

Path Forward

- Investigate the processing parameters:
  - Temperature
  - Pressure
  - Time
- Optimize processing parameters to achieve higher performance
- Investigate the mechanisms that cause micro damage:
  - Compression of fibers due to negative co-efficient of thermal expansion (CTE)
  - Differences in CTE of resin and fiber
  - Microdamage of fibers caused by the resin distribution into voids

Acknowledgements

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