A METHODOLOGIC APPROACH TO IMPROVE RECYCLED FIBER QUALITY PRIOR TO PROCESSING RECYCLED SHORT FIBERS IN THE T*u*FF LINE

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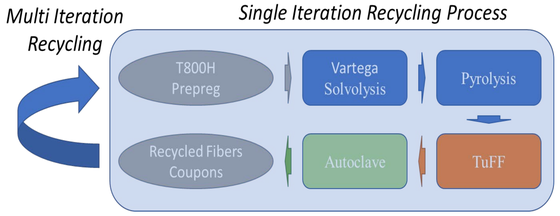
Motivation

- Carbon Fiber Composites (CFCs) recycling is in its infancy as an industry in the US with the key challenges are;
  - The ability to recover both the fiber and polymer content, and
  - Conversion of the recycled material into high-value CFCs

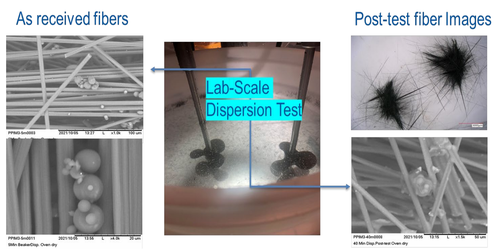
Recycled Fiber Technology

- TuFF enables closed-loop recycling of carbon fiber composites
- TuFF process is key to convert recycled/waste fibers into high-performance parts



- T800 Virgin fibers, solvolysis processed and prepreg solvolysis processed recycled fibers from **Vartega** were used in this study
- Recycled fibers must disperse in water without flocs and fiber bundle formations

As-Received Recycled Fiber Evaluation

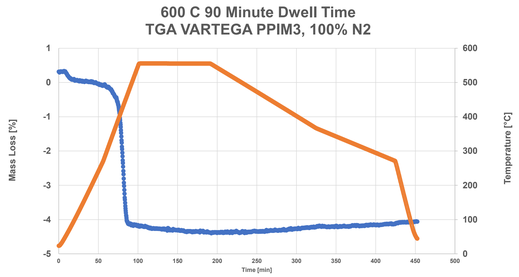


- Persistent residue detected in the sampled as-received recycled fiber batch through microscopy

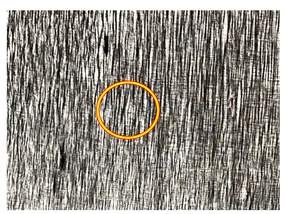
- Lab-scale fiber dispersion test performed but an acceptable fiber dispersion was not observed
- These recycled fibers need extra residue removing steps to move forward with
- Good quality TuFF sheets can be produced with acceptable fiber dispersion at 1/37.5k dilution level

Residue Removal by Pyrolyzing

- By the help of lab-scale tests it was confirmed that residue is persistently existing in the fiber batch
- Recycled fibers were pyrolyzed at 600 ºC for 90 minutes by burning recycled fibers;
  - In the TGA to figure out the level of residue
  - In a GLO oven to process the fibers to be used in the TuFF processing

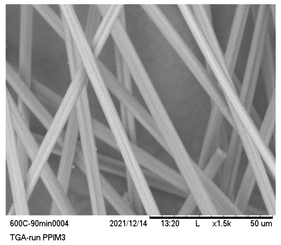


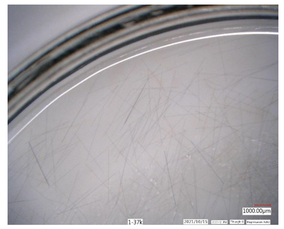
- Fibers burned under full Nitrogen flow with 10 ml/minute rate in both TGA and GLO experiments
- In both TGA and GLO cases, after-test mass loss was between 4.5-9% of tested material



- 90 Minute burn-off processing significantly reduced clumping in the batch and pyrolyzing processing removed remarkable amount of residue

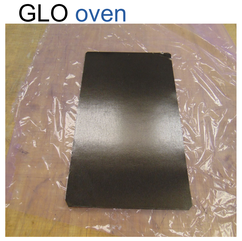
- Resulting T*u*FF sheet and fiber dispersion found satisfactory, and this finding was supported by further SEM and optical microscopic imaging

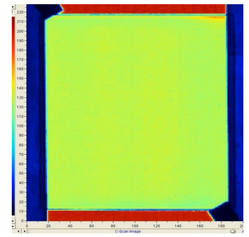




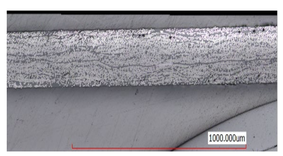
Composite Part Production

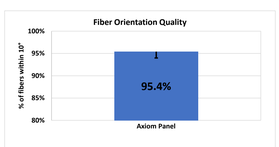
- A composite test panel was produced out of the fibers 90-minute burn-off recycled fibers in the GLO oven





- The fiber/resin areal weight ratio is selected to obtain a ~50 % fiber volume fraction part
- An epoxy resin film (Axiom AX5201 FR-1) is placed on the surface and processed in the autoclave to manufacture a flat coupon
- The resulting C-scan is very uniform



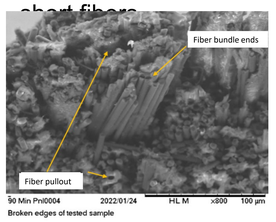


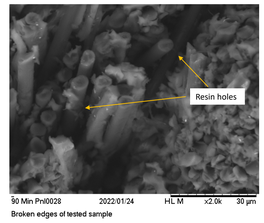
- A cross-section of the panel is taken to identify the microstructure, Porosity levels are low (below 2 %) meeting aerospace quality.
- Fiber orientation quality was calculated as 95.4% within 10 degrees of alignment direction

Mechanical Tests & Results

	FVF	Strength [ksi]	Stiffness [msi]
Toray T800H Datasheet	60%	424	24
	48%	339	19.2
Recycled T800H TuFF	48%	184 ± 18 COV 9%	18.8 ± 0.4 COV 2%
Property Translation		**54%**	**98%**

- Processing of a composite part production by using recycled fibers has been demonstrated
- Recycled CFC shows 100% modulus translation
- Measured 54%Tensile strength is 3x more than any composites produced by using recycled short fibers





- Detected fiber cluster ends via the SEM of broken samples might have acted as stress concentrators and resin holes may be a sign of weak adhesion
- Detected residue possibly coming from the recycling processing in the recycled T800 fibers can be eliminated by burning them off at high temperatures

Future Work

- Strength of the composite panel will be improved by;
  - 120-minute pyrolyzing processing at 600 ºC
  - Using dispersant additives to improve dispersion quality of the recycled fibers

Acknowledgements

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