CLOSED LOOP RECYCLING OF CFRP INTO HIGHLY ALIGNED, HIGH PERFROMANCE SHORT FIBER COMPOSITES USING THE *TUFF* PROCESS: FIBER RECOVERY THROUGH PYROLYSIS

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Introduction

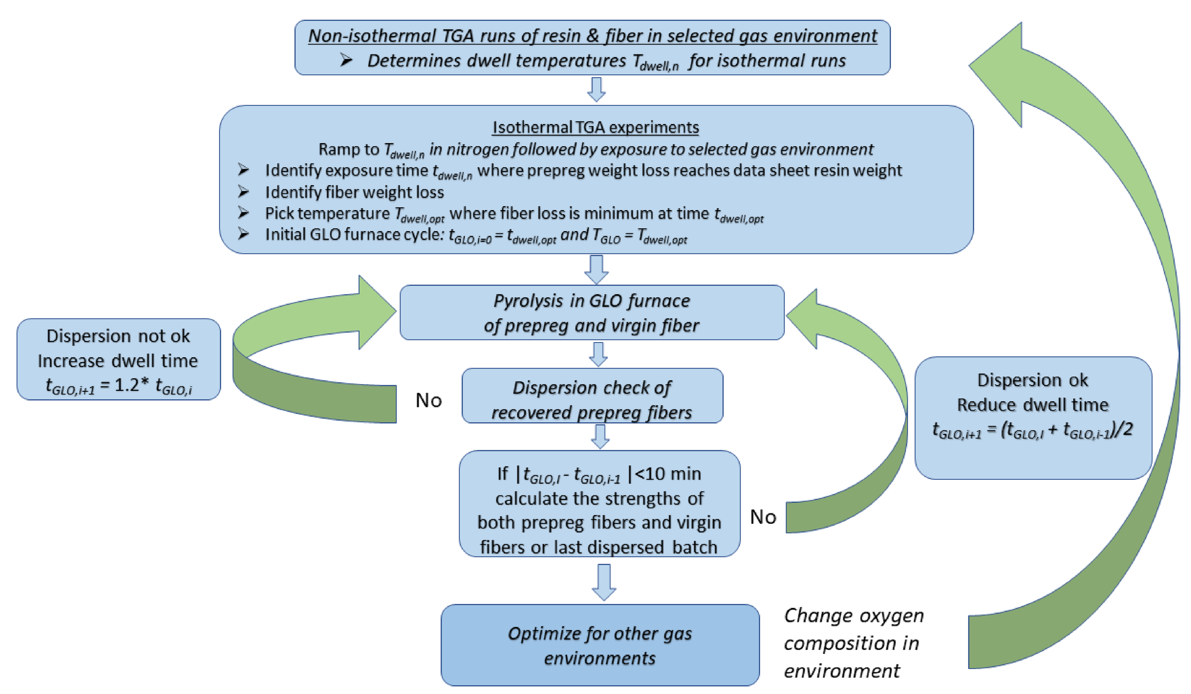
- Producing carbon fibers is an energy-intensive and expensive process
- Recovery solutions such as solvolysis and pyrolysis exist in order to recycle fibers from composite scrap
- Pyrolysis will be used, which involves decomposition at high temperatures
- Recovered fibers must exhibit high:
  - Modulus
  - Strength Retention
  - Interfacial Shear Strength to the polymer
- Goal is to retain 90 – 95% of virgin fiber properties, and to use fibers in the Tailored Universal Feedstock for Forming panels

Problem Specification

- Finding the ideal temperature for pyrolysis
- Temperature must allow for minimal fiber degradation and high rate of dispersion of fibers
- Need to develop a closed-loop, iterative pyrolysis cycle at ideal temperature

Methodology

- An iterative loop was developed:



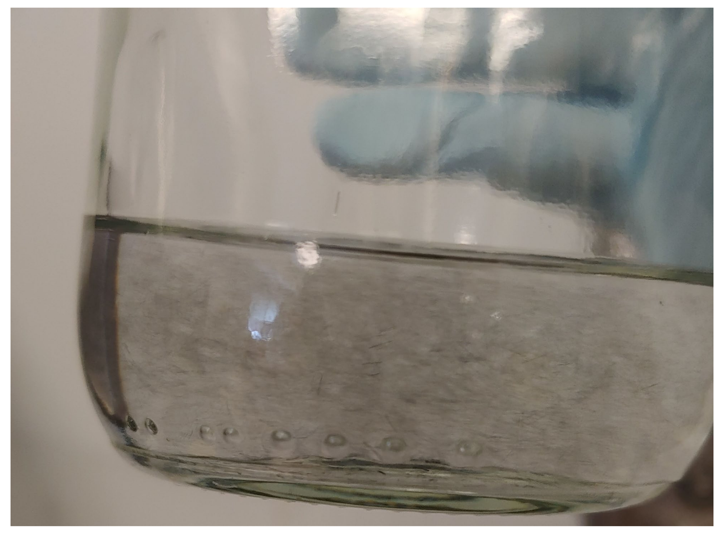
- A prepreg fiber is placed in a Thermogravimetric Analysis (TGA) to find the ideal dwell temperature
- Once the temperature is found, the pyrolysis is to be carried out in a GLO furnace
- Fibers are placed under a Nitrogen environment when heating up to the ideal temperature to avoid premature fiber degradation
- Dwell time refers to the amount of time the fibers are exposed to an air environment once the ideal temperature is reached
- The air environment allows for oxidation occur, which removes and residual remains of the burned resin from the fibers
- After the dwell time, the fibers are again subjected to a Nitrogen environment as they cool to the setpoint of 30 °C
- Dispersion of fibers is then checked via submersion in 99.9% isopropyl alcohol
- Once perfect dwell time is found, strengths of fibers are tested and then are to be optimized for other gas environments

Results and Discussion

- Found 500 °C to be the ideal dwell temperature
- GLO runs were conducted starting at the initial dwell time from the preliminary TGA run, 69 minutes
- Iterated through dwell times of 69 minutes (a), 83 minutes (b), and 100 minutes (c)
- Dispersion analysis:

(a)

(b)



(c)

- The 100 minute run showed significantly better dispersion of short fibers than the previous two runs
- Fibers still not **fully** dispersing at 100 minutes

Summary and Conclusion

- Higher dwell time leads to higher percentage of fibers dispersing
- 100 minute dwell time run exhibited best dispersion overall
- For the future:
  - look at additives that would help improve dispersion of fibers
  - manufacture TuFF panels with the dispersed fibers to investigate their composite properties

TuFF Tailored universal Feedstock for Forming

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