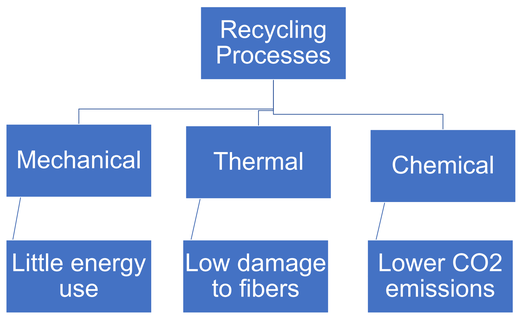
EFFECTS OF FIBER SIZING ON FIBER-MATRIX INTERFACE OF CARBON FIBER

Matthew Blair, (BME)[2], Stephen Wagner, (BME)[3], Munetaka Kubota, (Ph.D.M.S.E.)[1], Joseph M. Deitzel, Ph.D.[1]
University of Delaware | Center for Composite Materials[1] | Department of Mechanical Engineering[2] | Syracuse University, Department of Mechanical and Aerospace Engineering[3]

Introduction

- The rapid adoption of carbon fiber reinforced composites has led to a need for improved recycling processes
- Using a solvent based process, partners at the National Renewable Energy Laboratory recovered fibers from an epoxy based CFRP
- Fibers will be tested to determine if adhesion promoters are needed
- Epoxy sized and unsized Toray T700 fibers will be used for this study
- This study aims to establish a baseline for the fiber-matrix interface of sized and unsized fibers

Figure 1: Image[1] shows current recycling processes



Materials

- Unsized (91N) and epoxy sized (50C) Toray T700S carbon fibers were used
- Epoxy being used in combination with fibers is Axiom 2201 UD

Figure 2: Image[2] shows a spool of carbon fiber

Fiber designation	Sizing Type	Strength [MPa]	Modulus [GPa]	Strain to Failure
T700S-91N	Unsized	4900	230	2.1%
T700S-50C	Epoxy	4900	230	2.1%

Methods

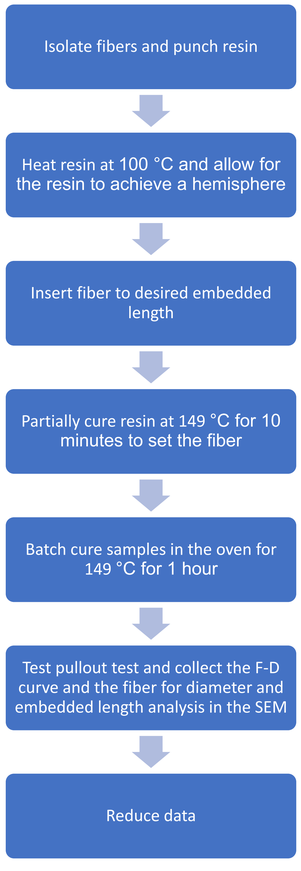


Figure 3: Image shows unmelted sample

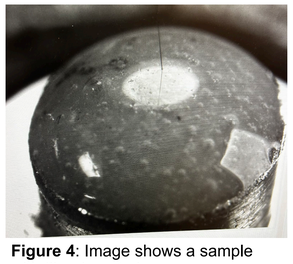


Figure 4: Image shows a sample with fiber inserted

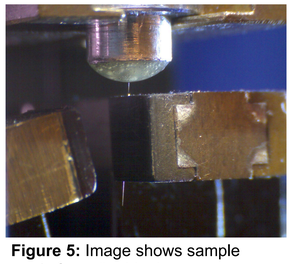


Figure 5: Image shows sample ready for pullout test

Results

- Using the data collected from the pullout test and SEM the Interfacial Shear Strength (IFSS) is determined

$$\tau_{IFSS} = \frac{F_{max}}{\pi D L_e} \qquad [1]$$

  - F_{max} is the maximum force
  - D is the fiber diameter
  - L_e is the embedded length

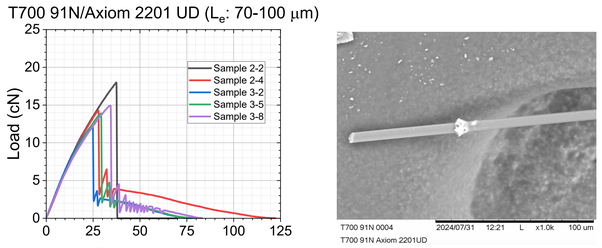


Figure 6: The force vs displacement graph and SEM image of T700-91N fiber

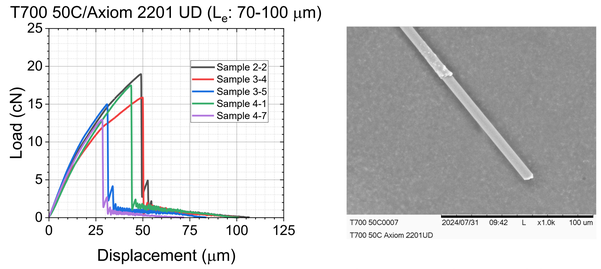


Figure 7: The force vs displacement graph and SEM image of T700-50C fiber

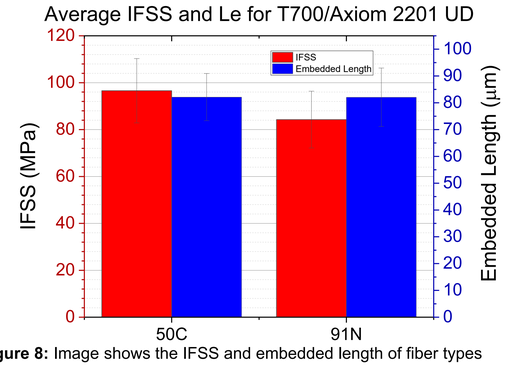


Figure 8: Image shows the IFSS and embedded length of fiber types

- Only samples with embedded length of 70-100 µm are being presented
- The 50C fibers performed moderately better with an average effective IFSS of 97 ± 14 MPa compared to 84 ± 12 MPa

Conclusions

- Fiber sizing only made a small impact on the interface between the T700 fibers and this Axiom epoxy
- Increased sample size is required to have further confidence in the difference
- This data will help determine the effects of the recycling process on the sizing and surface of the fibers and give insight into the need of an adhesion promoter

Path forward

- Evaluate the interface performance of the solvent recycled carbon fiber provided by NREL and compare to the sized and unsized data

References

1. *Recycling of Carbon Fiber-Reinforced Composites—Difficulties and Future Perspectives - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/The-most-usual-procedures-for-recycling-carbon-fiber-reinforced-composites_fig2_353502119 [accessed 1 Aug 2024]*
2. *Toray. (2020). DVN. Retrieved August 6, 2024, from https://www.drivingvisionnews.com/news/2020/06/04/toray-carbon-fiber-for-lower-moldcraft-costs/.*

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