THE RECYCLABILITY OF A FLAX FIBER REINFORCED POLYMER (FFRP) COMPOSITE

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Motivation

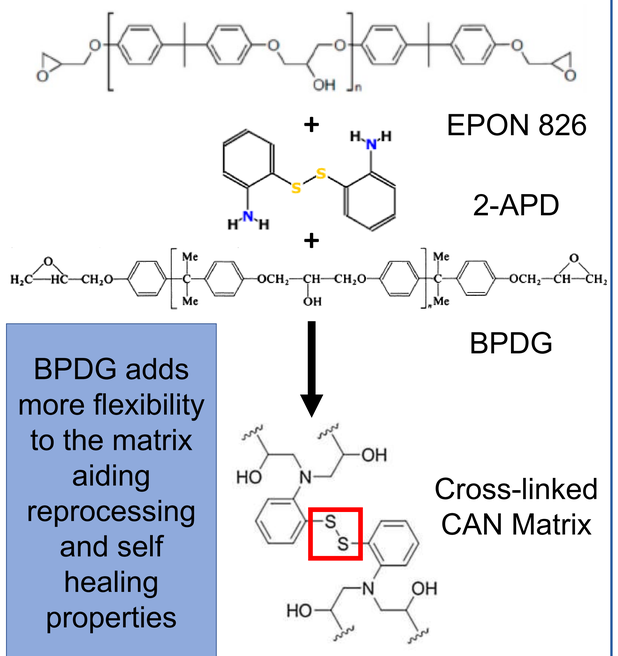
- Composites with thermoset matrices are difficult to recycle
- Covalent Adaptable Network (CAN) matrix can be healed and recycled while retaining thermoset properties
- Growing market for renewably sourced and recyclable composites.

Figure 1: Fiberglass composite wastes at a German recycling facility

Objectives

- Evaluate mechanical properties of an FFRP composite manufactured with recycled flax fabric.
- Determine effects of solvolysis chemicals on flax fabric

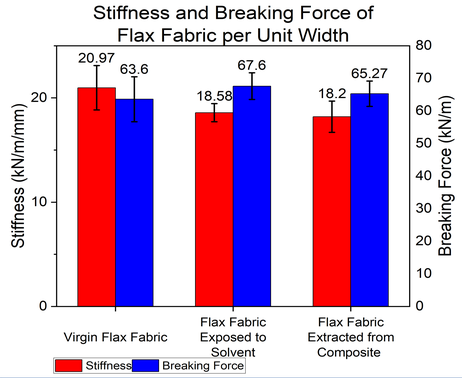
CAN Matrix



BPDG adds more flexibility to the matrix aiding reprocessing and self healing properties

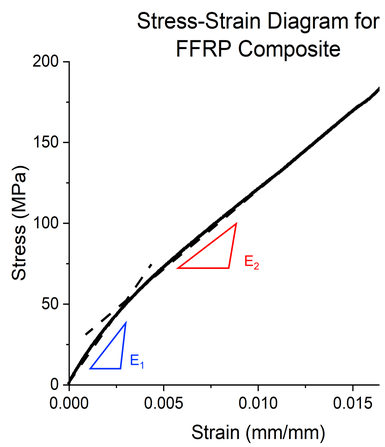
Flax Fabric Testing

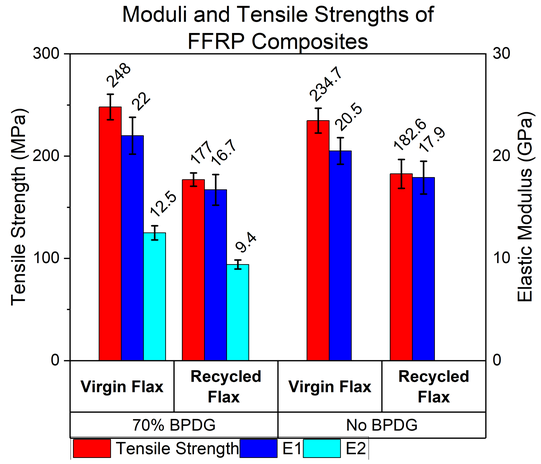
Tensile Testing (ASTM D5035)



- No statistically significant change in stiffness
- Breaking force appears to increase possibly due to residue left on fibers

FFRP Composite Panel Testing

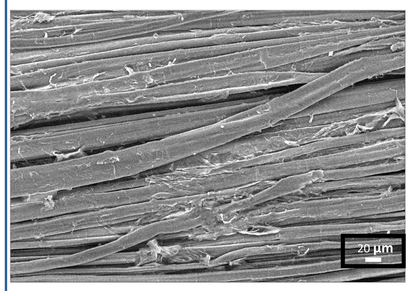




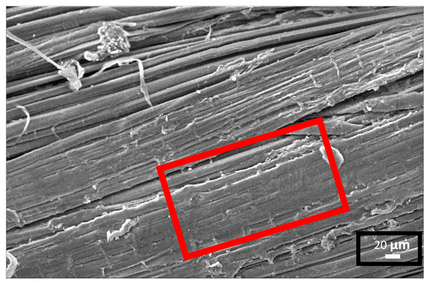
- 70% BPDG composite retained 76% modulus and 72% strength
- Recycled BPDG panel exhibited 20% increase in thickness, "No BPDG" recycled panel exhibited 60% increase

Microscopy

Virgin Flax Fabric

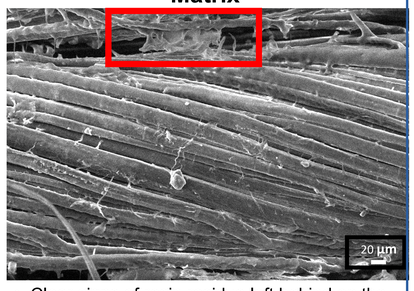


Flax Exposed to Solvolysis Chemicals



- Fibers appear to be "fused" together
- Solvolysis chemicals left behind some residue on the fibers

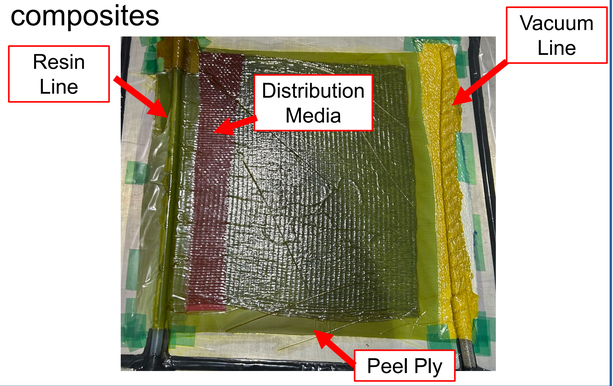
Flax Extracted from Composite Matrix



- Clear signs of resin residue left behind on the fibers

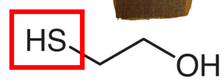
Composite Fabrication

- Vacuum assisted resin transfer method (VARTM) was employed to manufacture the composites



Solvolysis

- DMF and 2-mercaptoethanol successfully cleaved disulfide bonds in matrix



2-mercaptoethanol

Conclusions

- Exposure to solvolysis chemicals showed an increase in breaking force and no change in stiffness
- Composite made with recycled flax retained 76% and 72% of elastic modulus and tensile strength.
- Solvolysis of the 70% BPDG panel was more successful than that of the "No BPDG" panel

Acknowledgments

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References
1. Figure 1: Black, Sara. "Reselling, Reusing Composite Materials and Parts." *CompositesWorld*, CompositesWorld, 3 July 2014, www.compositesworld.com/articles/reselling-reusing-composite-materials-and-parts.
2. ASTM D5035 (2019). "Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)." ASTM International, West Conshohocken, PA, USA.