ForestValue
StrongComposite

Biomimetics in Wood Adhesives

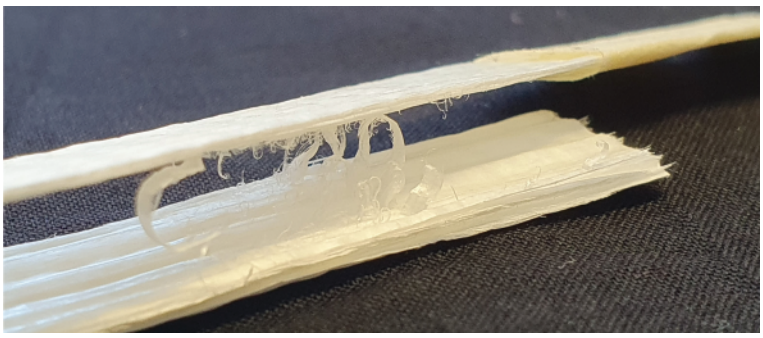

Figure 1. Lap shear sample from delignified wood and biomimetic spider silk protein.

Utilizing biomimetic spider silk as an ecological wood adhesive to create tough and strong composites

Wood waste can be efficiently recycled and used to produce new products by using delignification. This gives the possibility to modify the shape of the old wood while the beneficial microstructure of the wood remains intact, hence it offers still very good mechanical properties. However, further processing and upscaling require stacking and gluing of individual layers by an adhesive component to achieve strong and tough laminates.
Biomimetic spider silk shows outstanding strength and toughness and can be produced in large scale by bacteria. Therefore, spider silk is highly suitable as a basis for a new bio-sourced adhesive. At the same time, it is biocompatible and fully recyclable and thus enables easy and environmentally friendly recycling of the newly created products.

We used an engineered version of the dragline silk ADF3 from the common garden spider Araneus diadematus which is modified with cellulose binding modules on each end. Lap shear experiments with delignified wood show high tensile shear strength of up to 10.4 MPa and an excellent average shear strength of 6.7 MPa. Studies of the fracture area indicate that the level of infiltration is important for reaching a high tensile shear strength. A high level of infiltration would result in a good entanglement over the lap shear bond.
We were able to show that biomimetic spider silk offers great possibilities as an adhesive for delignified wood. Furthermore, we got a deeper understanding of the interaction of biomimetic proteins and cellulose and how the infiltration affects the strength of the materials.

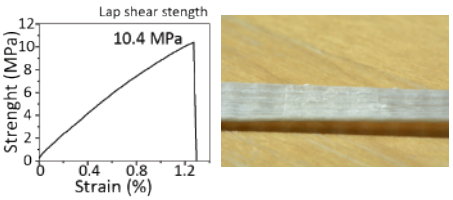

Figure 2. Stress-strain curve of delignified wood and silk lap shear sample and fracture area.

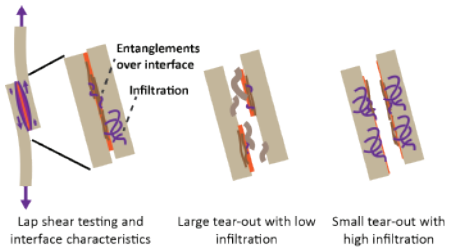

Figure 3. Hypothesis of the relation between tear-out in the fracture area, infiltration depth and entanglement.

Further information:
Lemetti et al. 2022. Recombinant Spider Silk Protein and Delignified Wood Form a Strong Adhesive System. ACS Sustain. Chem. Eng. Fig. 2 and 3 were modified from this reference. Published under creative commons license.

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