Densified Cellulose Materials

A new fibre reinforced material for sustainable engineering

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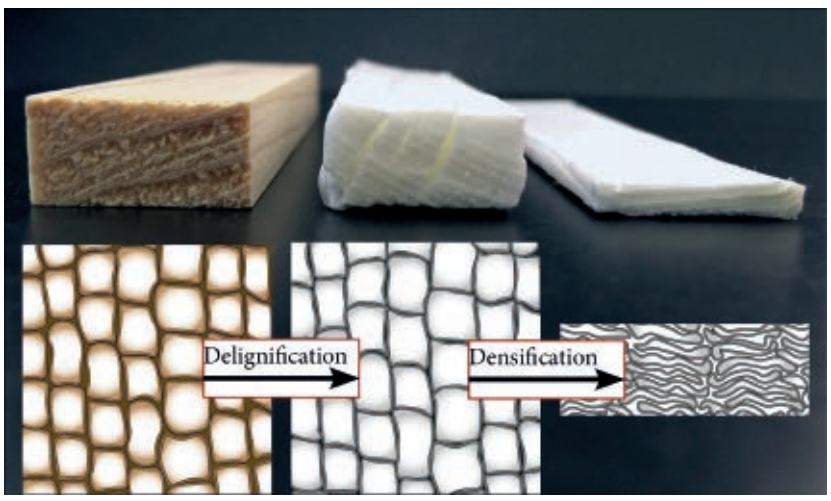
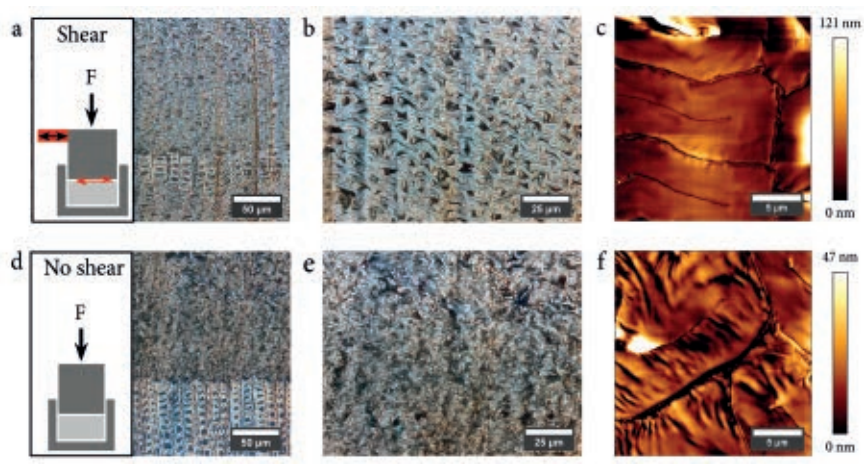
1 Introduction

We present a novel concept for the production of a high-performance cellulose material based on the delignification of wood and a subsequent densification step. Thereby, the highly beneficial structural directionality of wood is preserved and the obtained material possesses high strength and stiffness.



2 Fabrication

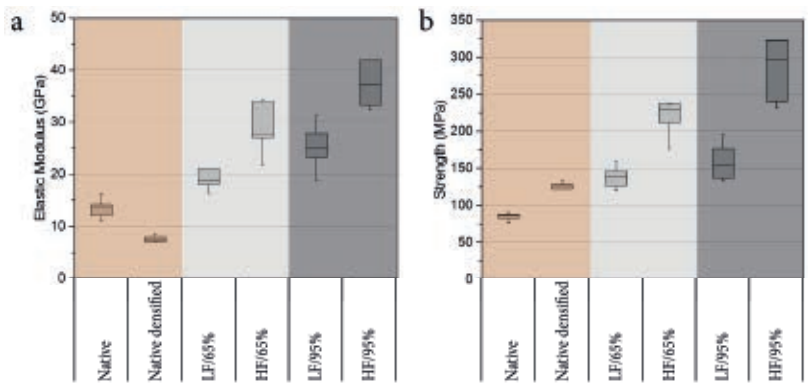
Spruce wood is fully **delignified** in an acidic delignification procedure based on hydrogen peroxide and acetic acid. The cellulose scaffold is **densified** while simultaneously lateral shear is applied.



A zoom into the earlywood region **(b,e)** shows that the folding of earlywood cells is more homogenous when lateral shear is used during densification. AFM images of latewood cells after densification with shear in **c** and without in **f** reveal the smoothening effect of shearing on the cell wall-level.

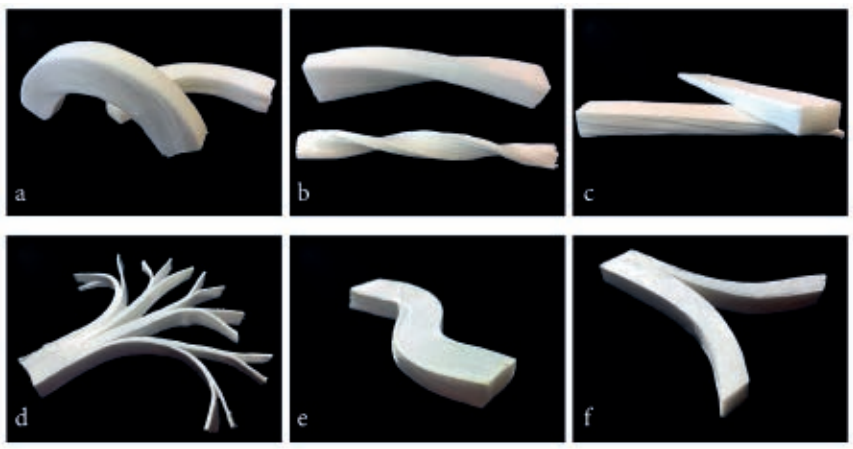
3 Tensile Properties

Densification with high force (HF) at high humidity (95%) result in the best values, for strength **(b)** and stiffness **(a)**. Compared to native wood, the elastic modulus and the strength are increased up to 3 times.



4 Shapeability

Elements of different shapes and geometries with perfectly oriented fibres can be obtained by simply shaping the cellulose scaffold in wet state after delignification. Mechanically robust curved or twisted structures are obtained upon drying.



5 Conclusion

The densified cellulose scaffolds possess highly desirable material properties, such as high strength up to 300 MPa and a stiffness up to 40 GPa. The infiltration with a matrix system or functionalization of the cellulose scaffolds offer the possibility to produce bio-inspired fibre-reinforced composites with high performance based on the renewable resource wood.

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Functional Wood Materials Characterization

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