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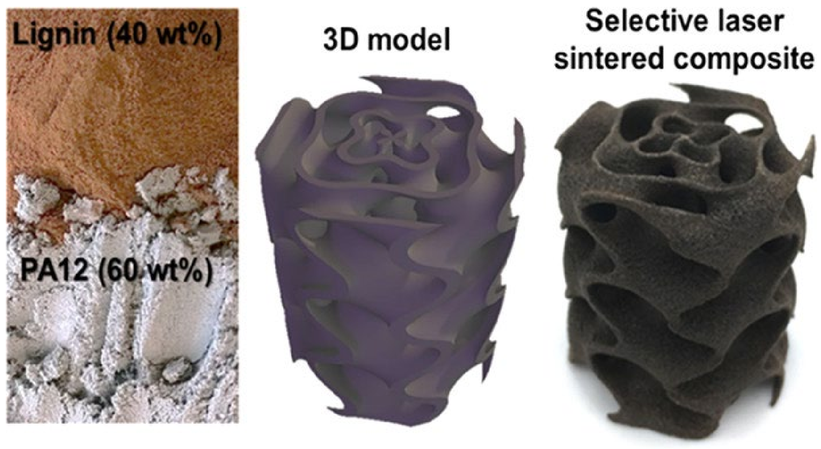
Transforming byproducts into high-value materials: composite utilization of lignin, sawdust, and biochar

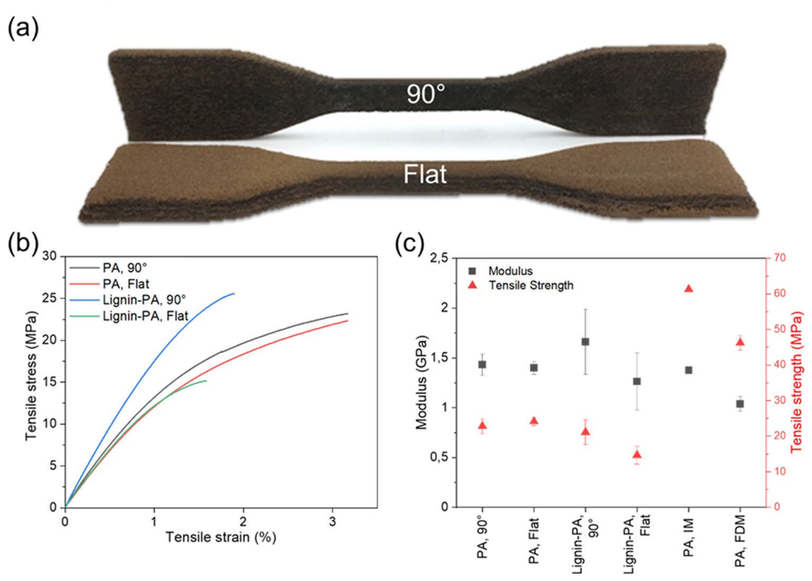
Hossein Baniasadi, Siddharth Jayaprakash, Jouni Partanen, Jukka Seppälä

Objective

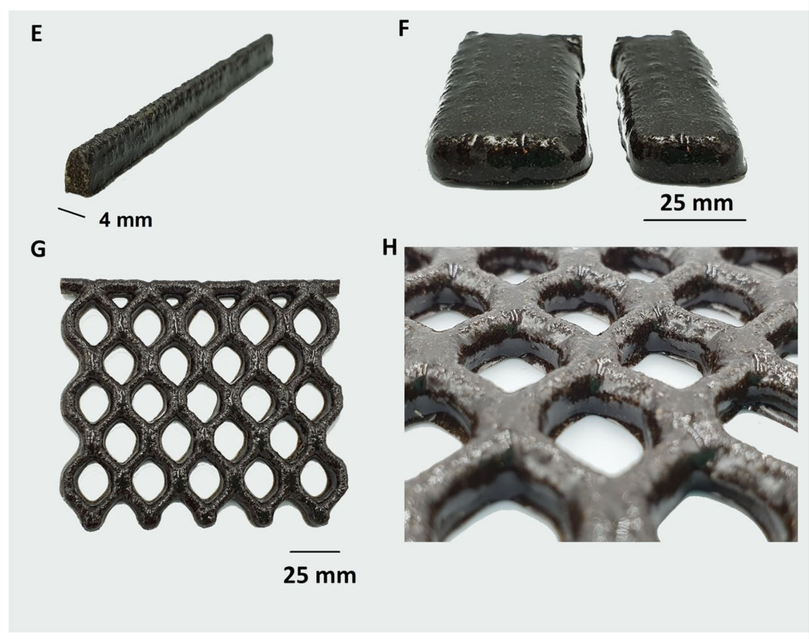
To investigate and demonstrate innovative and sustainable methods for converting lignin, sawdust, and biochar byproducts into valuable composite materials. This research aims to explore the potential applications, properties, and environmental benefits of these composites, contributing to the development of eco-friendly and economically viable solutions for utilizing byproducts from various industries. Through comprehensive analysis and experimentation, the study seeks to offer insights into the optimization of composite production processes and their utilization across diverse fields, including but not limited to materials science, environmental science, and sustainable engineering.



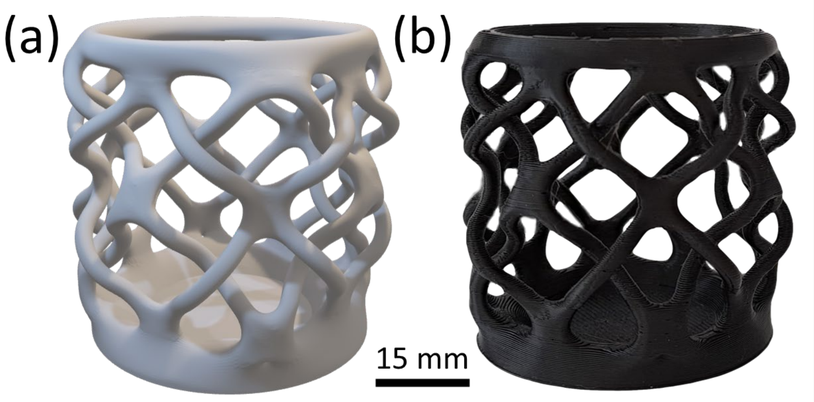
Dog-bone-shaped objects three-dimensional (3D)-printed using different layer deposition directions relative to the platform, from left to right: 90°, flat, and vertical.



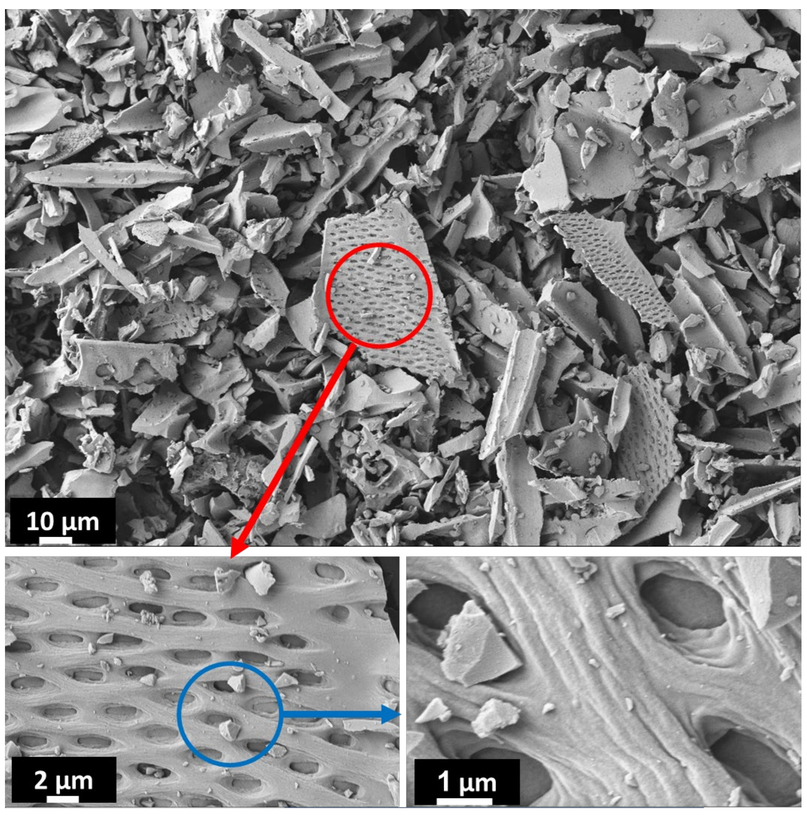
Samples fabricated using 90° and flat orientations and results of mechanical strength (ASTM D638 Type IV tensile testing): (a) lignin/PA sintered composites (lignin/PA 40:60 wt %), (b) tensile strain–stress behavior, and (c) comparison of elastic modulus and ultimate tensile strength of lignin/PA in 90° and flat orientations with samples obtained from neat PA using SLS, FDM, and IM.



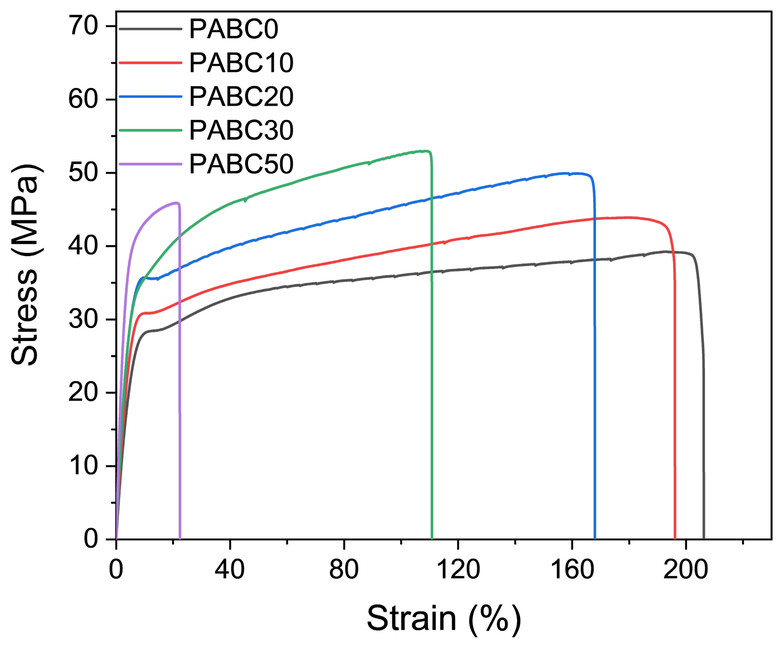
(E) Printed long continuous line, (F) line 3D printing at six and four adjoining lines, and (G, H) lattice scaffold—honeycomb structure. Unless otherwise noted, printed parts are five layers high and one layer wide.

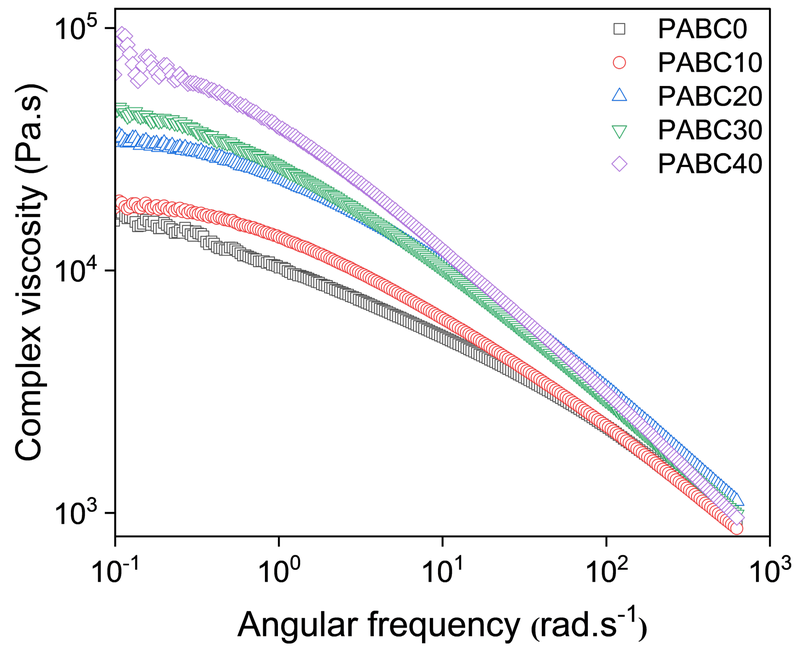


a) The CAD model and b) the digital photograph of the 3D-printed sample (PA11/biochar, in situ polymerization)



Biochar

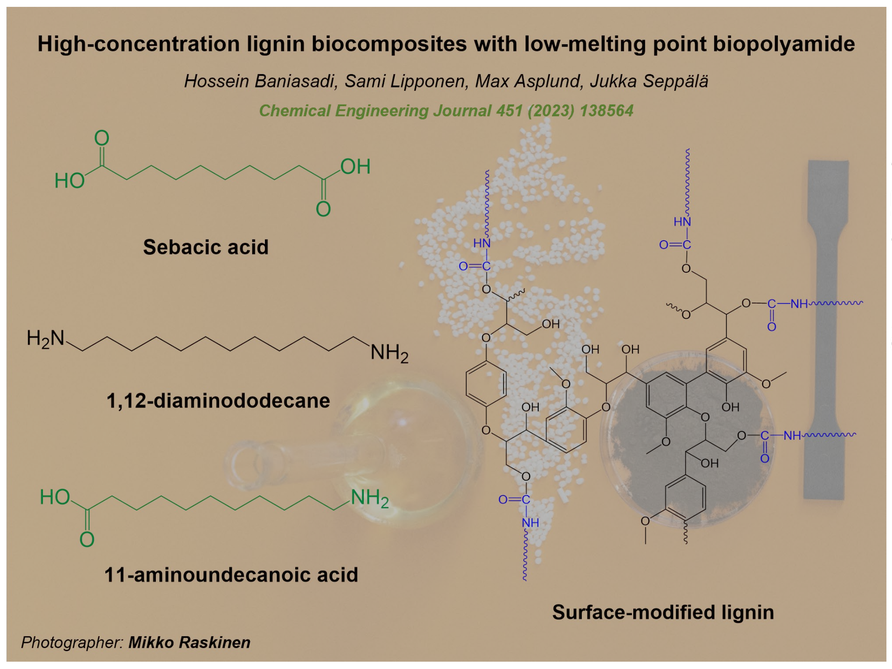


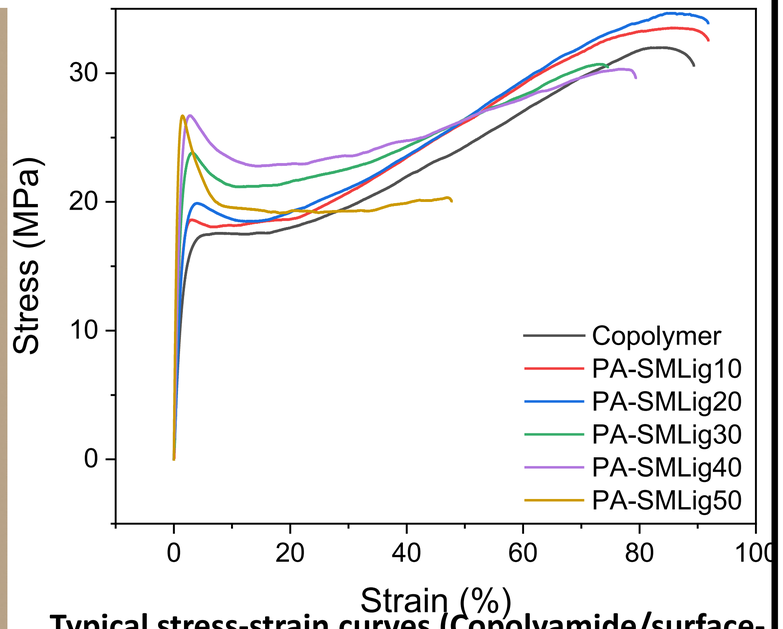


Typical stress-strain curves and b) complex viscosity at 220 °C (PA11/biochar, in situ polymerization)

Future

- **Enhanced composite performance**
- **Scaling up production:**
- **Environmental impact assessment**
- **Market viability and cost analysis**
- **Waste stream utilization**





Typical stress-strain curves (Copolyamide/surface-modified lignin)

Aalto University

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Luke LUONNONVARAKESKUS

LAPIN YLIOPISTO UNIVERSITY OF LAPLAND

ACADEMY OF FINLAND strategic RESEARCH