ENHANCING WOOD-SHELLAC BONDING THROUGH PLASMA SURFACE TREATMENT

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PROBLEM STATEMENT

Shellac has low water resistance when bonding wood

↓ Plasma treatment improves surface wettability which promotes adhesion



+

↓ Citric acid (CA) can crosslink shellac and improve water resistance

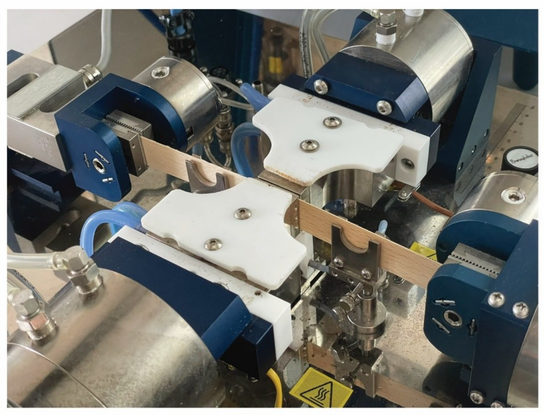


MATERIALS & METHODS

ABES bond strength development → Standard evaluation EN 204:2016 and EN 205:2016

Neat shellac (SH) 175 °C

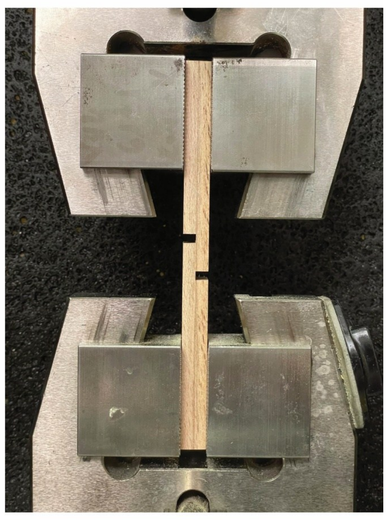
CA-modified shellac 175 °C



ABES device ASTM D7998 - 19

D1
dry contitions

D2
occasional high moisture



Plasma treatment sped up bond development and improved water resistance.

RESULTS & DISCUSSION

WATER CONTACT ANGLE (WCA)

- WCA decreased from >100° to ~0°.
- Surface changed from hydrophobic to highly hydrophilic.
- Increased wettability resulted from impurity removal and the introduction of polar functional groups.

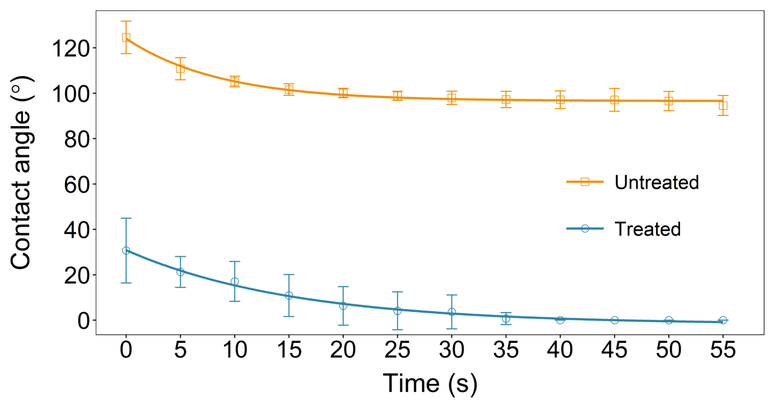


Figure 1: Water contact angle (WCA) of untreated and plasma-treated beech veneers.

BOND STRENGTH DEVELOPMENT

- Plasma treated veneers had faster bond strength development.
- Reduced variability in bond strength, especially at short curing times.
- Plasma treatment improved adhesion.

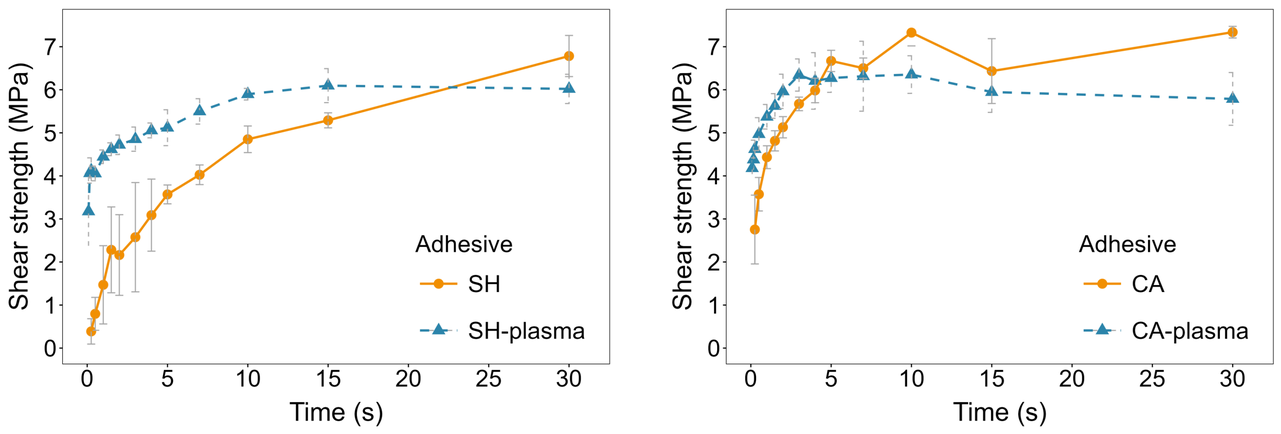


Figure 2: Bond strength as a function of curing time for neat shellac (SH) and CA modified shellac (CA).

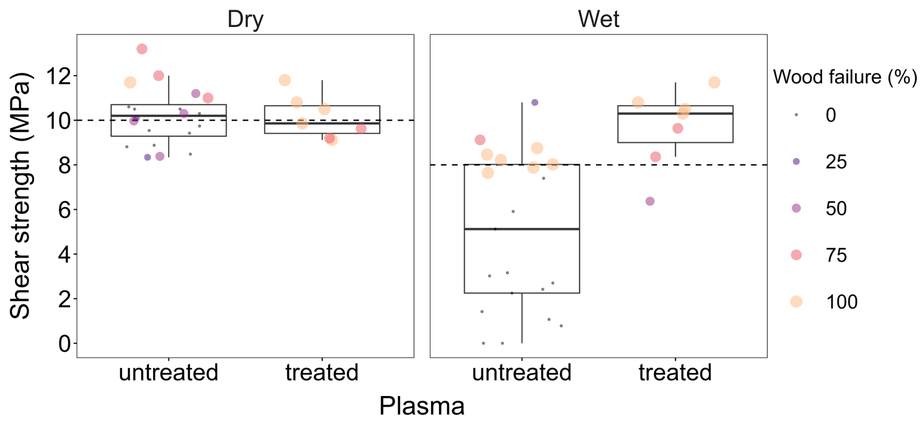


Figure 3: Dry and wet bond strength of CA-modified shellac (EN 204:2016).

BOND PERFORMANCE

- Dry bond strength remained similar (~10 MPa) for treated and untreated samples.
- Wet bond strength increased from 4.8 MPa to 9.7 MPa after plasma treatment.
- Plasma treatment significantly improved moisture resistance of the bond.
- Bonds fulfilled EN 204 D1 and D2 requirements.

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