

WOOD+ – EDU2 - Innovations & potential new technologies -
the uncharted possibilities of utilizing the European LKWS in the
bio-based products
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Liquefied wood as a bio-based product

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INTRODUCTION

- **Liquefied wood (LW)**
 - Wood converted into liquid state via thermo-chemical process.
 - Product obtained from wood diluted in a certain solvent at elevated temperature.
 - Composition: Hydrocarbons, high molecular weight oils, gases and fenols.



■ General properties of LW

- Depend on input raw materials and liquefaction process (p, T, t).
- Dark brown/black colour.
- Viscosity: Low or high, depends on the share of remained solvent.
- Acidic odour.
- Liquefaction yield: 60% - 95%
- Strongly acidic.
- Becomes solid at $T \geq 130$ °C.
- Hygroscopic/hydrophilic.

▪ **Process of wood liquefaction**

- 1. Wood preparation**, by grounding wood into small pieces or chips.
- 2. Dissolvement of wood** in solvent (ionic liquids, polyethylene glycol, glycerol, ethylene glycol etc.)
- 3. Liquefaction of wood particles**, by mixing in solvent at high temperature (100 and 200 °C).
- 4. Filtration/separation**, by removing remaining solid wood particles from the liquid mixture.



Dried wood particles
0.237 mm
(102 °C, 24 h, $u \approx 0\%$)



Mixture of wood, EG,
 H_2SO_4 in reactor



Reactor in oil bath
($T = 180\text{ °C}$)



Heating and stirring
($T = 180\text{ °C}$, $t = 90\text{ min}$)



Filtration ($p = 25\text{ mbar}$)



Evaporation of solvents
($p = 25\text{ mbar}$, $T = 55\text{ °C}$)



Final liquefied
product

- **The potential of LW**
 - Substitute to petrol and petroleum derivatives based on natural resources.
 - The use of wood waste and other biomass.



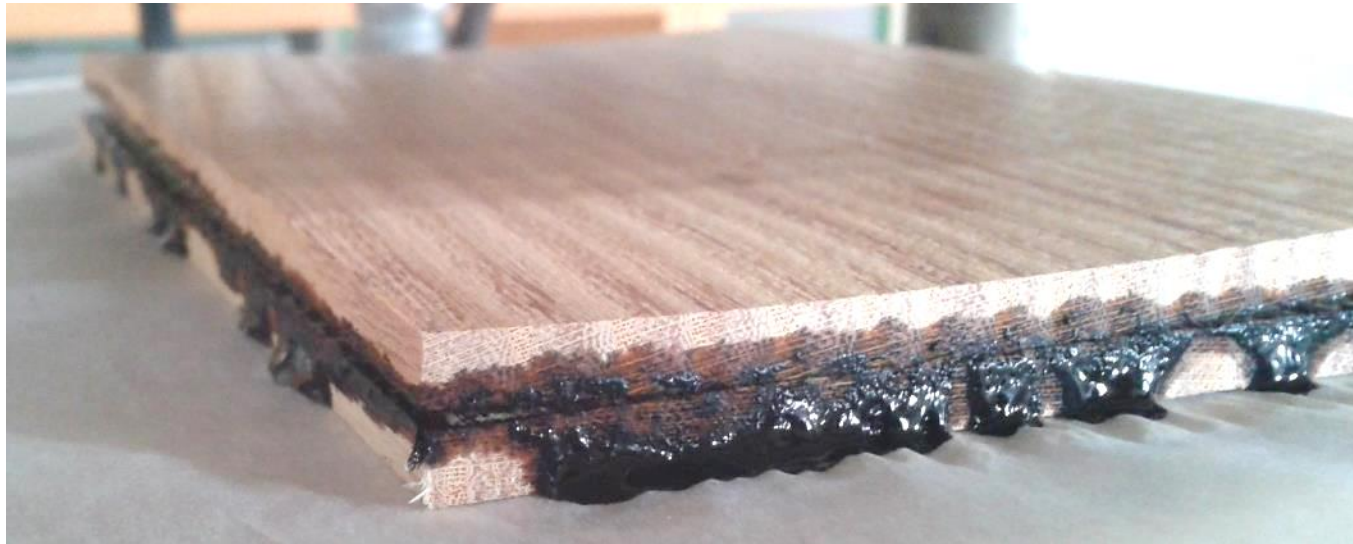
■ Areas of application

1. Packaging materials: Films, molded packaging
2. Textile industry: Fiber production, dyeing
3. Biofuels
4. Medical industry: Biocompatibility and antibacterial properties.
5. Agriculture: Antifungal properties, Soil conditioner.
6. **Building materials**

- **Building materials**

- 1. Adhesives (1)**

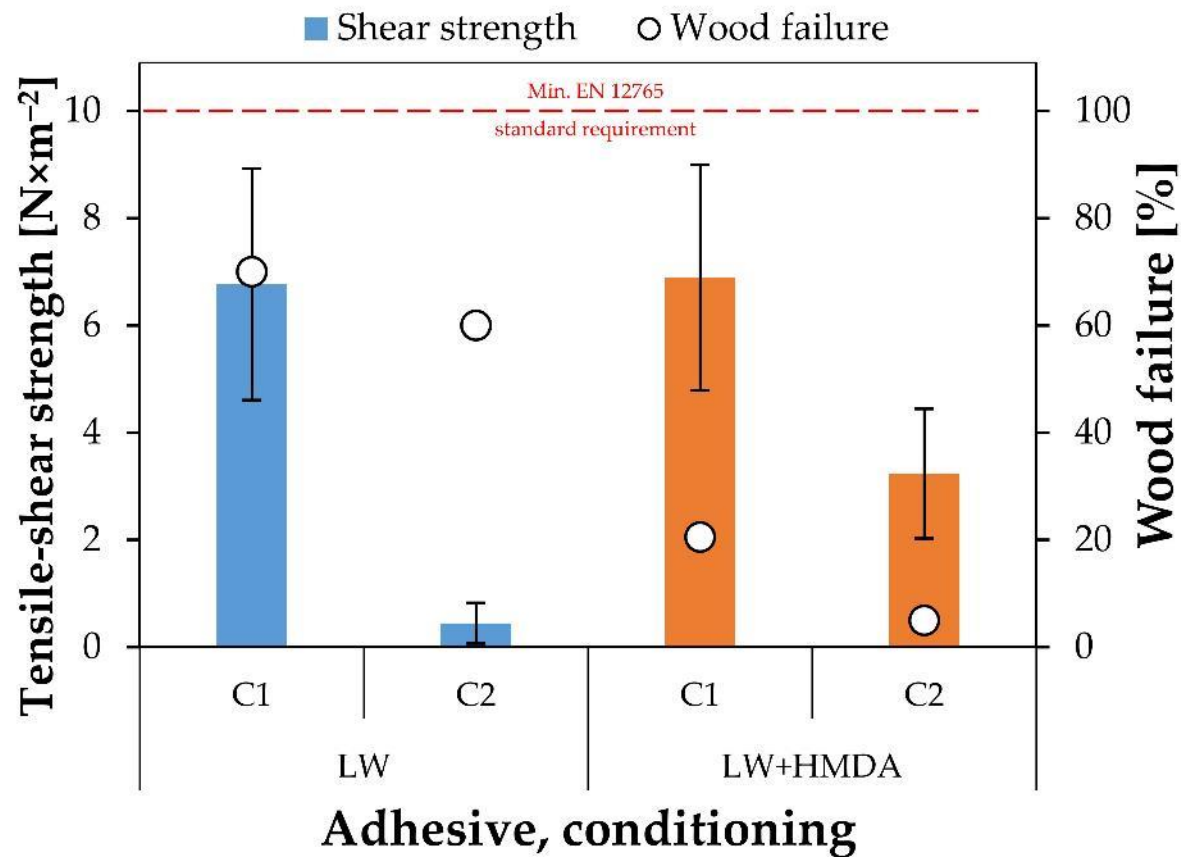
- a) A raw component for the synthesis of LW-based adhesives
 - b) LW as additive
 - c) LW independent bonding agent



■ Building materials

1. Adhesives (2)





- Relatively low mechanical properties.



▪ **Building materials**

1. Adhesives (3)

- No water resistance.

Adhesive type	LW	LW+HMDA	
Condit. procedure	C1		
	C2		

Areas of application

■ Building materials

2. Composite materials (1)

- LW combined with wood, plastics or resins.
- Used for particleboard, plywood, WPCs.

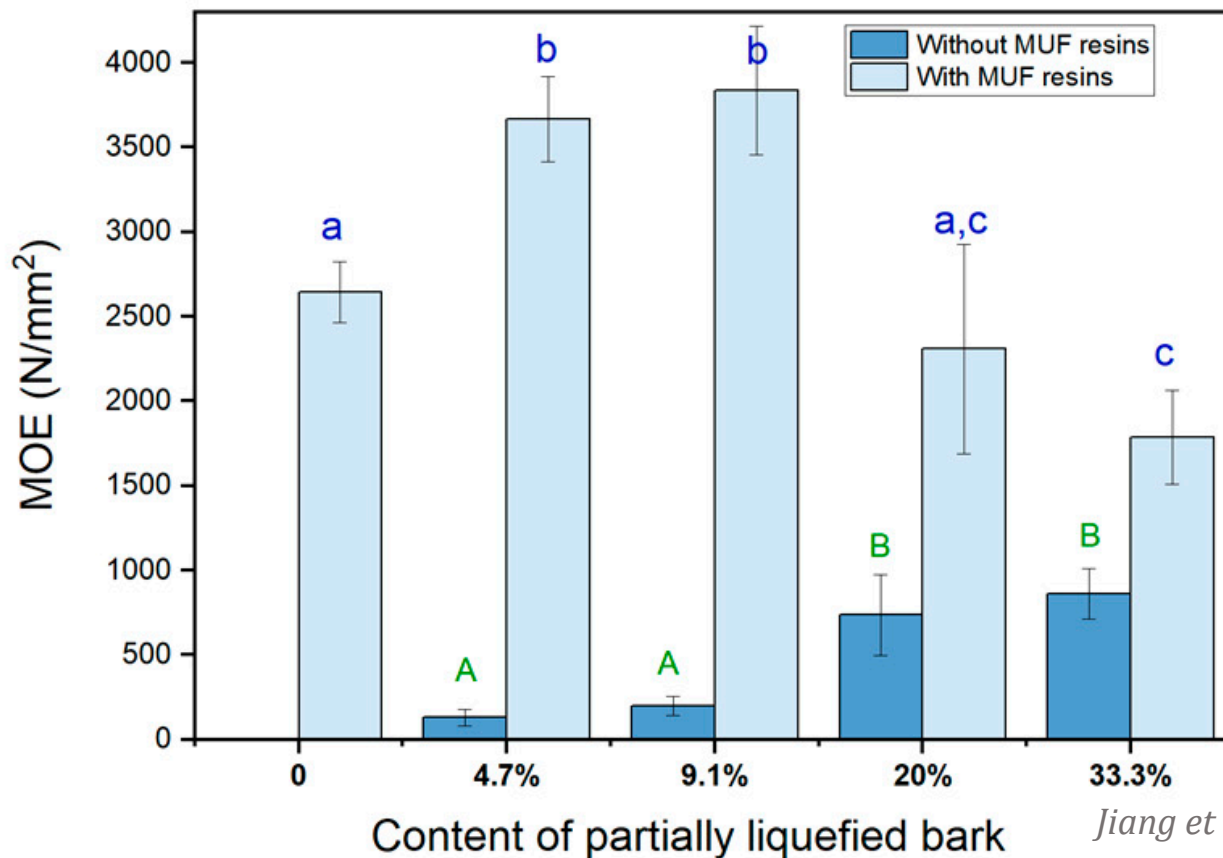


Jiang et al., 2020

- **Building materials**

- 2. Composite materials (2)**

- Relatively low mechanical properties.

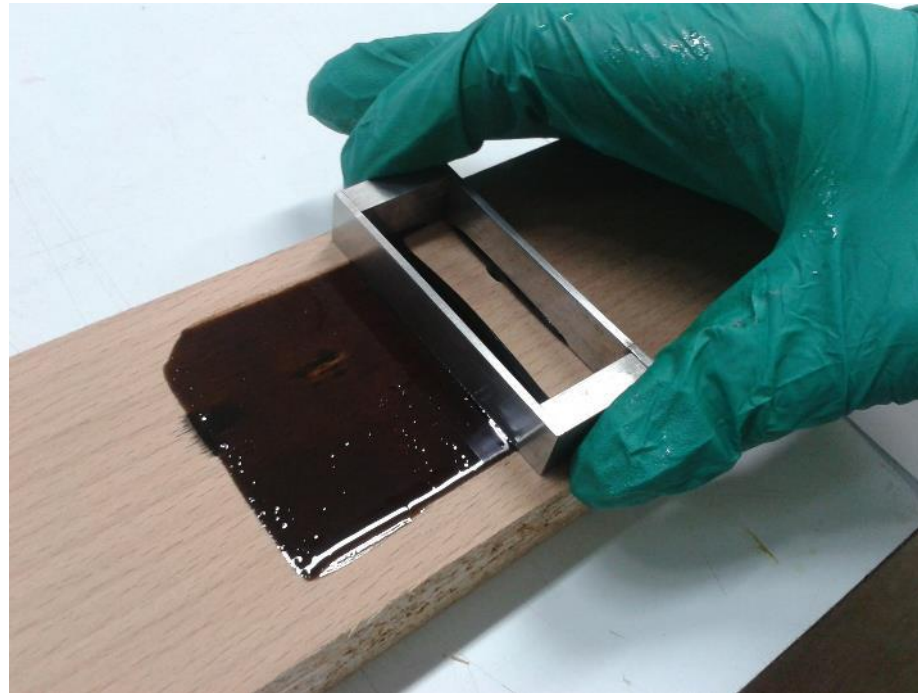


Jiang et al., 2020

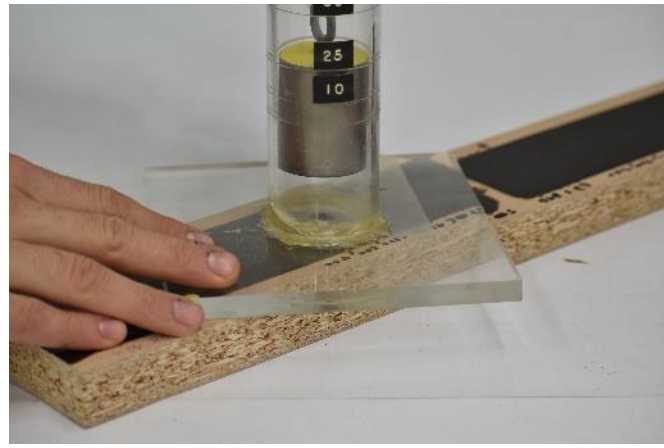
- **Building materials**

- 3. **Coatings (1)**

- „Hybrid“ coatings, e.g. LW combined with polyurethane.



- **Building materials**
 - 3. Coatings (2)**



Areas of application

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▪ **Building materials**

3. Coatings (3)

- Relatively promising properties.

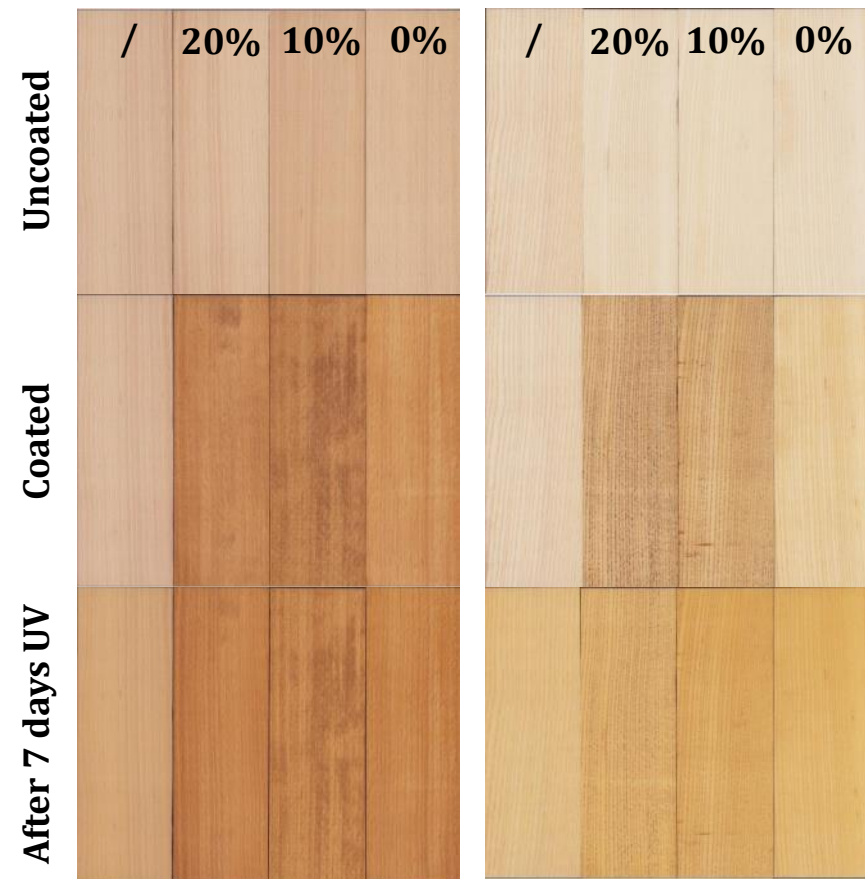
Type of wood	Content of LW	Adhesion strength [MPa]	Resistance to impact			Scratchnig resistance [N]
			100 mm	200 mm	400 mm	
<i>Acer negundo</i>	10 %	3.62	4	3	2	6
	20 %	3.87	3	3	2	6
<i>Robinia pseudoacacia</i>	10 %	3.37	4	3	2	7
	20 %	3.59	4	3	2	6
<i>Aesculus hippocastanum</i>	10 %	2.55	4	3	2	7
	20 %	2.37	3	2	2	6

Areas of application

■ Building materials

3. Coatings (4)

- LW for pigmentation of oils.
- Compatibility of LW with natural oils.
- Decorative effect.



- **Building materials**

- 4. **Insulations (1)**

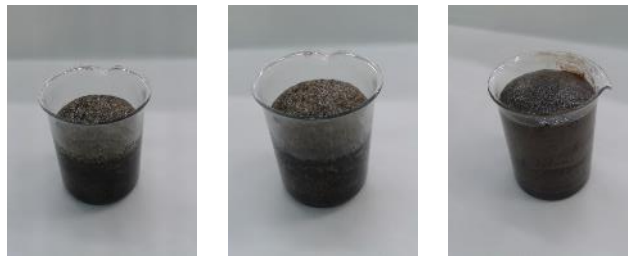
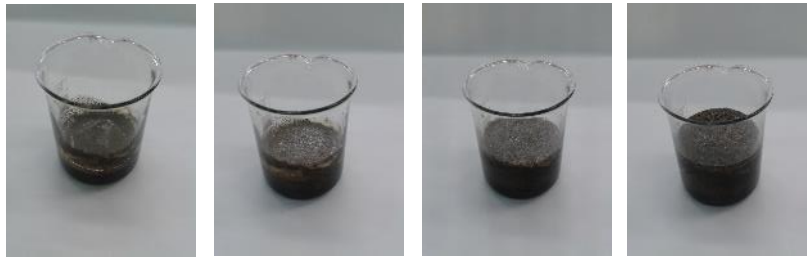
- Foams based on LW and polyurethane
 - LW+isocyanate+water



- **Building materials**

- 4. Insulations (2)**

- The ratio between components defines porosity and other properties.



CONCLUSIONS

- LW as a substitute to petrol and petroleum derivatives based on natural resources.
- Added value given to waste wood and biomass.
- Properties of LW depend on input raw materials and liquefaction process (parameters).
- Many areas of (technical) applications.
- Promising bio-based product
 - As additive
 - Independent

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Thank you for your
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