acr austrian cooperative research

Bark-Derived Nanocelluloses for Sustainable Heavy-Duty Plywood Coatings

Wood Coatings Congress

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Softwood bark

antioxidant

self-healing

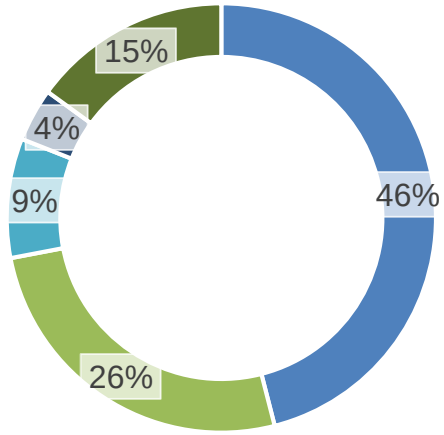
weather resistant

resistant to microbial attacks

Motivation

Softwood bark:

- sidestream of the forest industry
- >14 M tons/year in EU
- mostly burned for energy

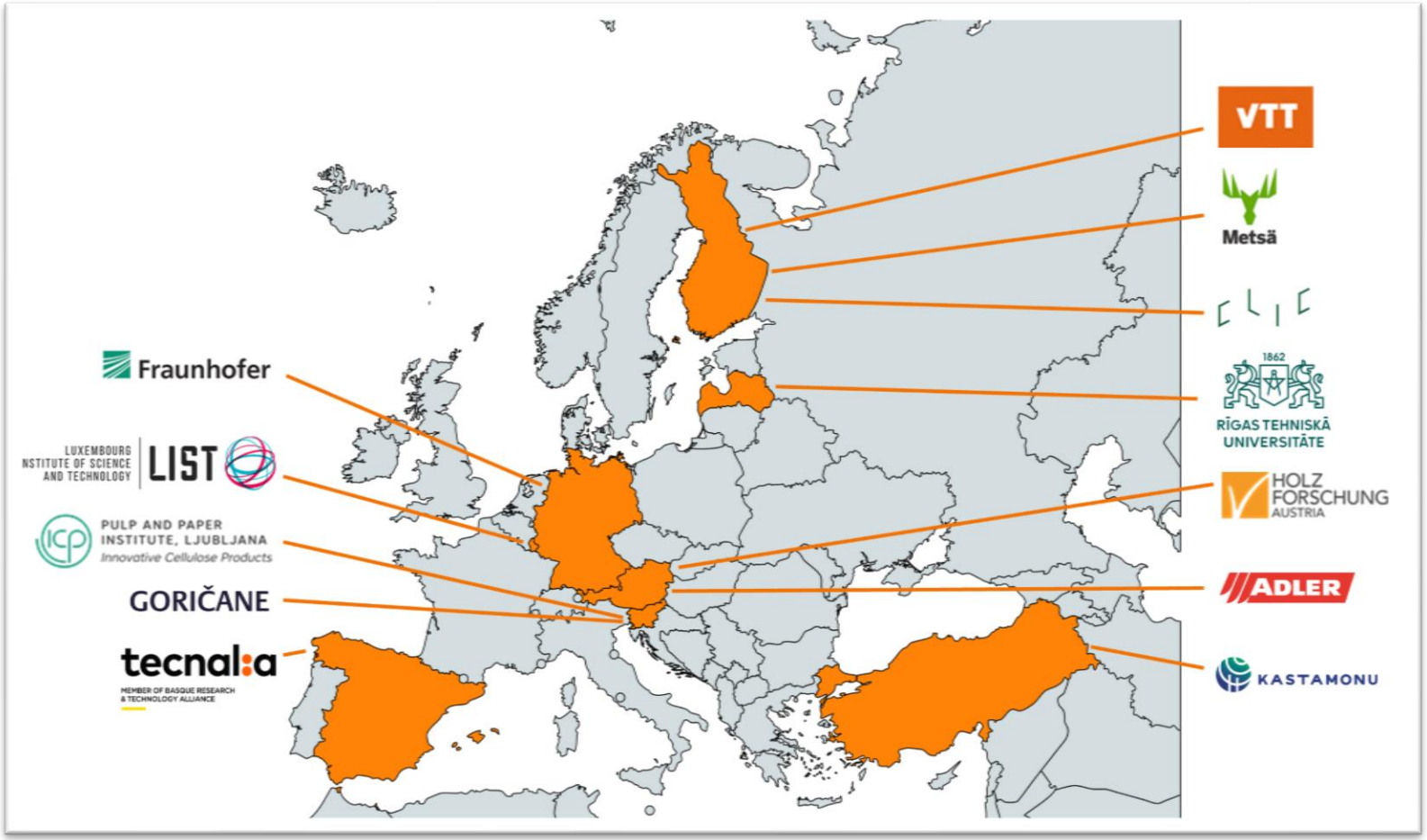


SuperBark idea:

Use softwood bark as source for functional **>95 % bio-based** components for adhesives and coatings

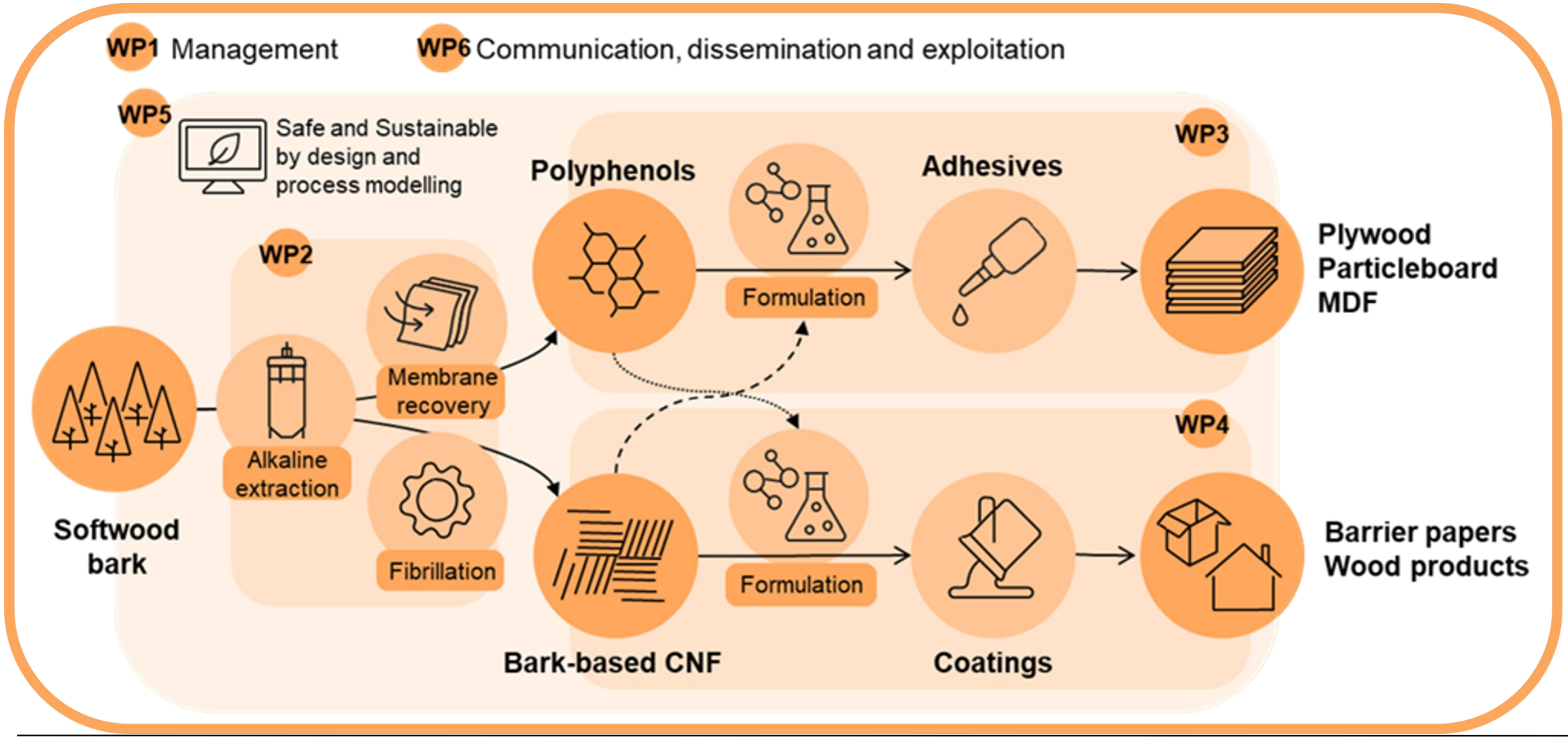
- Tannins
- Polyphenol-rich Cellulose Nanofibers (CNF)

SuperBark



- 12 partners
  - 8 European countries
  - 4 industrial partners
  - 6 research and technology organizations
  - 1 small and medium size enterprise
- 2023-2027

The SuperBark Project

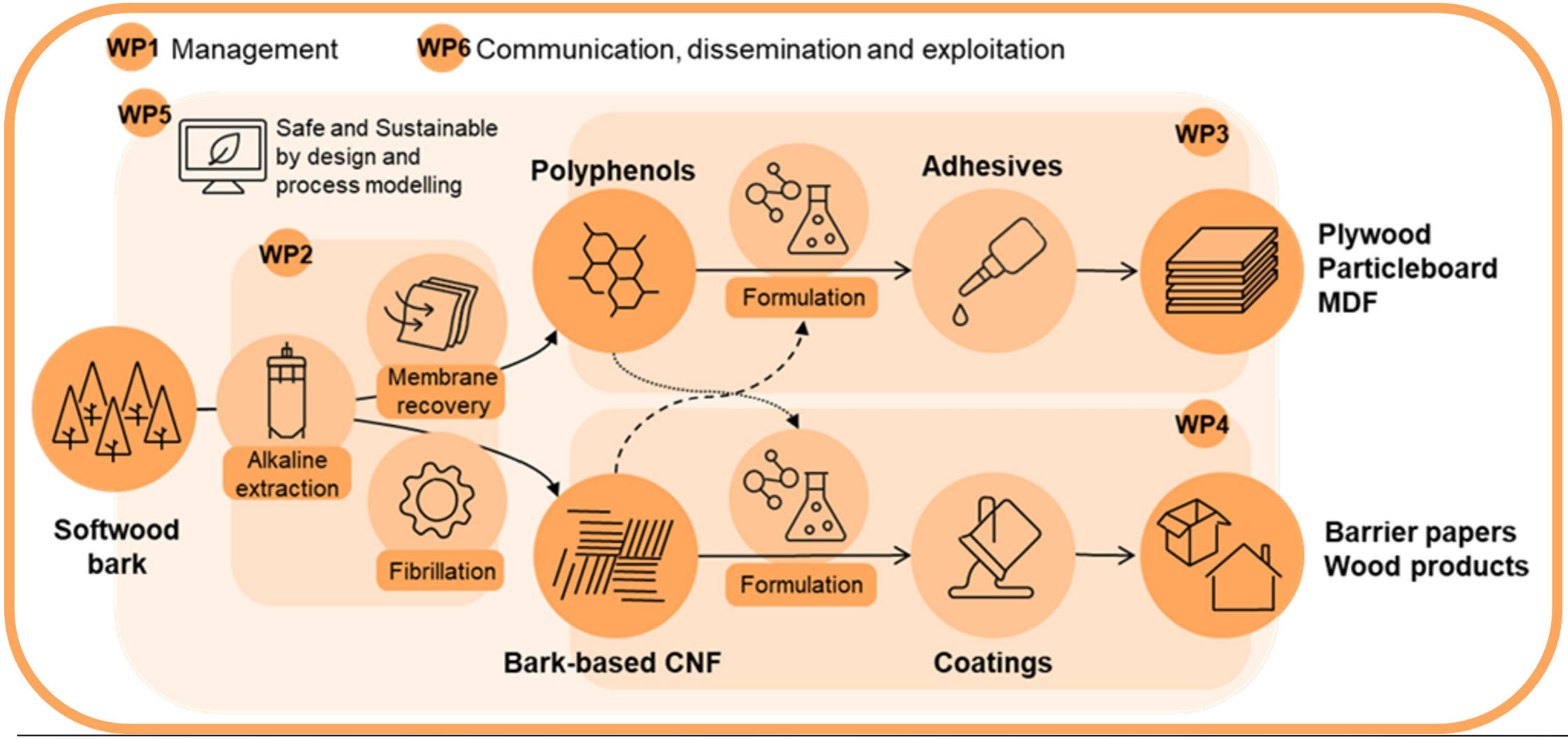


Components from spruce bark

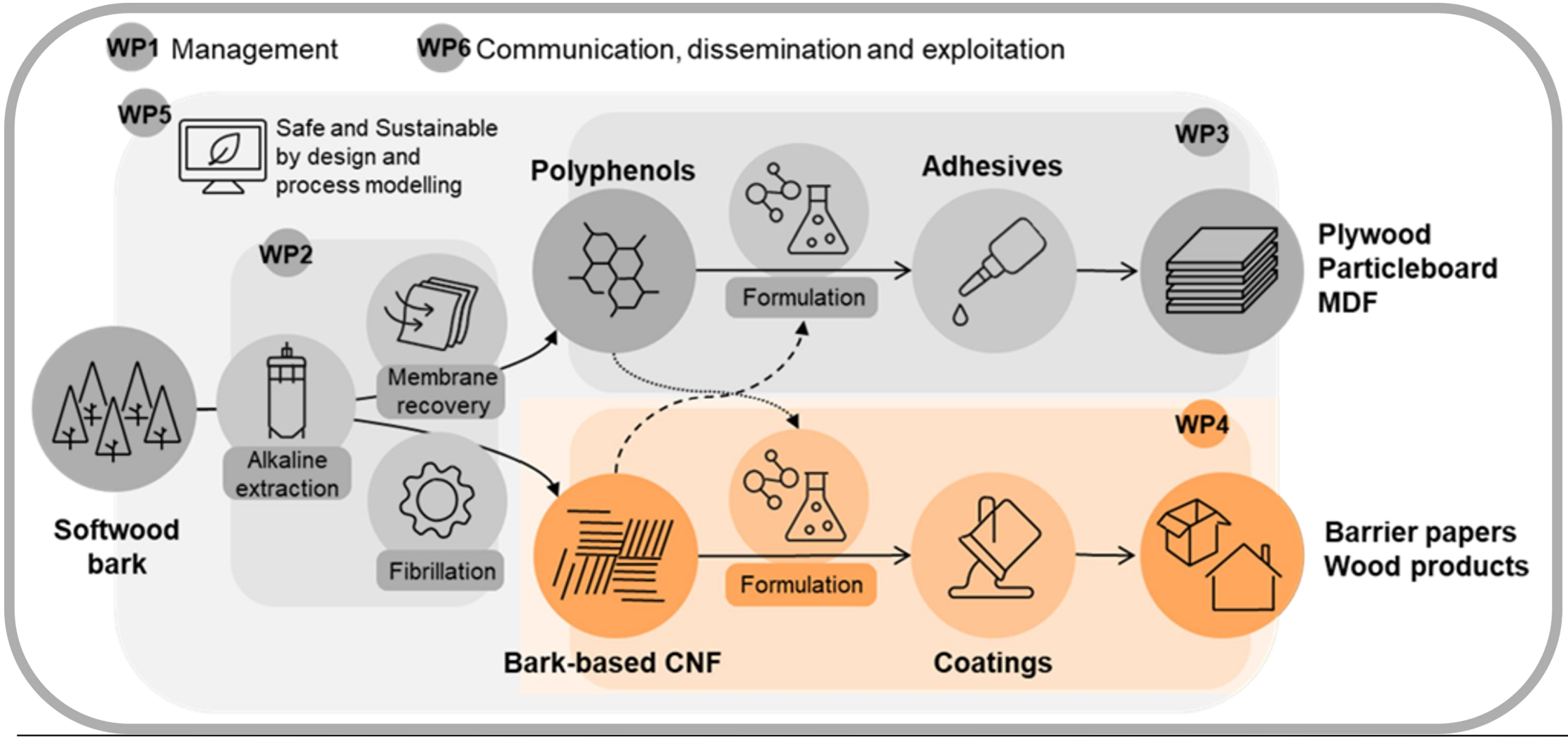
© Anna Kalliola, VTT

- Processing of softwood bark at VTT research center
- Alkaline extraction of softwood bark yields polyphenols used for adhesive development
- Bark residue: Polyphenol-rich cellulosic material, can be fibrillated to produce CNF

The SuperBark Project



The SuperBark Project



Application: Metsä Transportation plywood

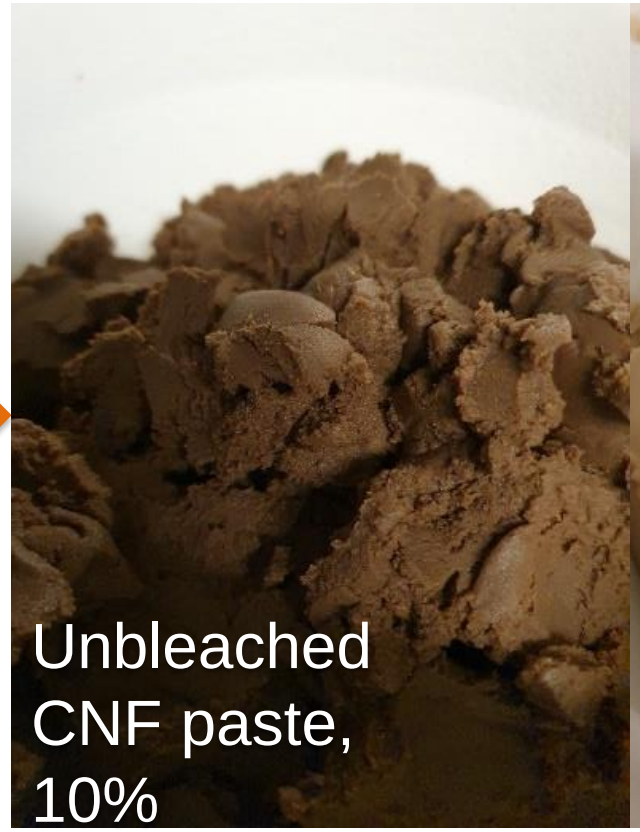
Currently used for this use case:

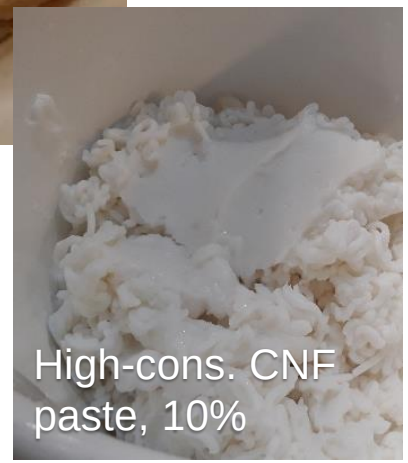
- Phenol formaldehyde impregnated paper overlay

Requirements:

- Coating/impregnation (with or without overlay) with
  - Brinell hardness of 3-4
  - Abrasion resistance of 225 to 450+ rotations according to EN 438
  - Scratch resistance of Level 4+ according to EN 438

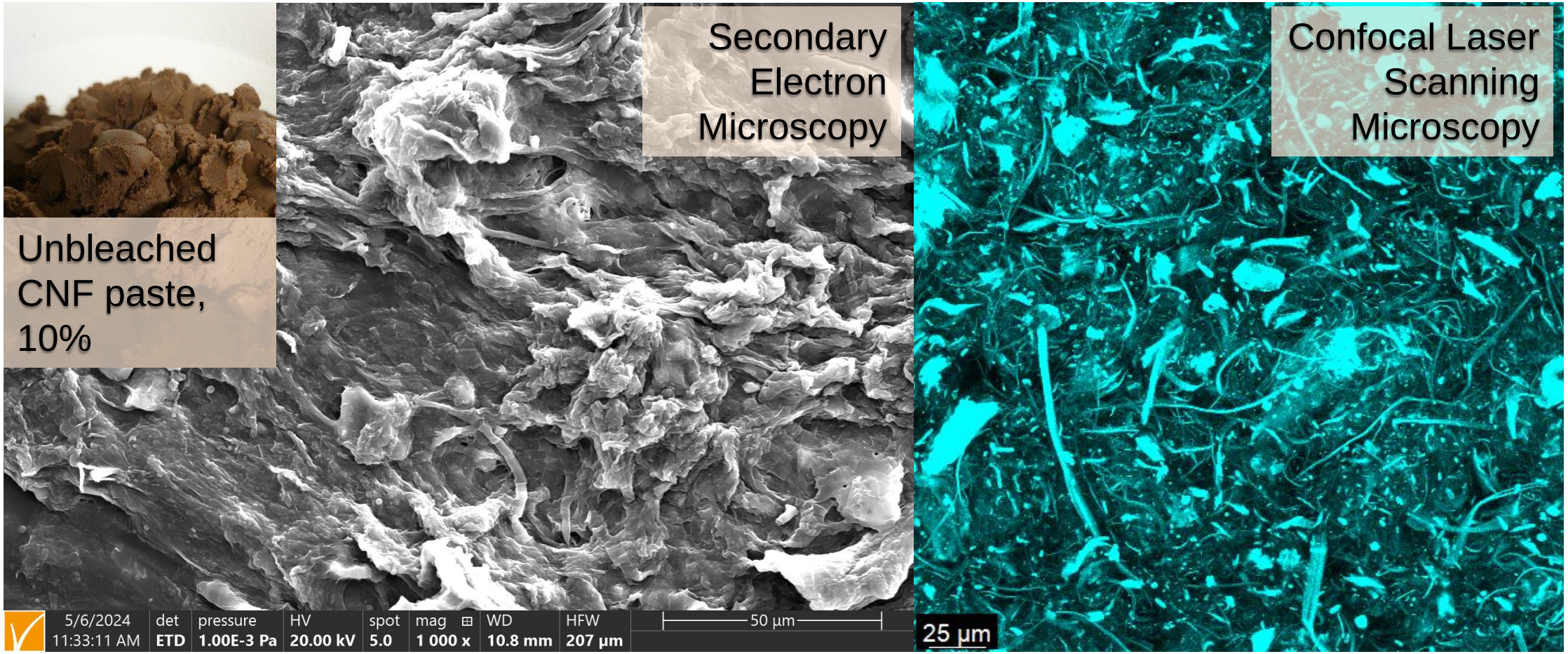
Bio-based functional fillers: The Nanocellulose



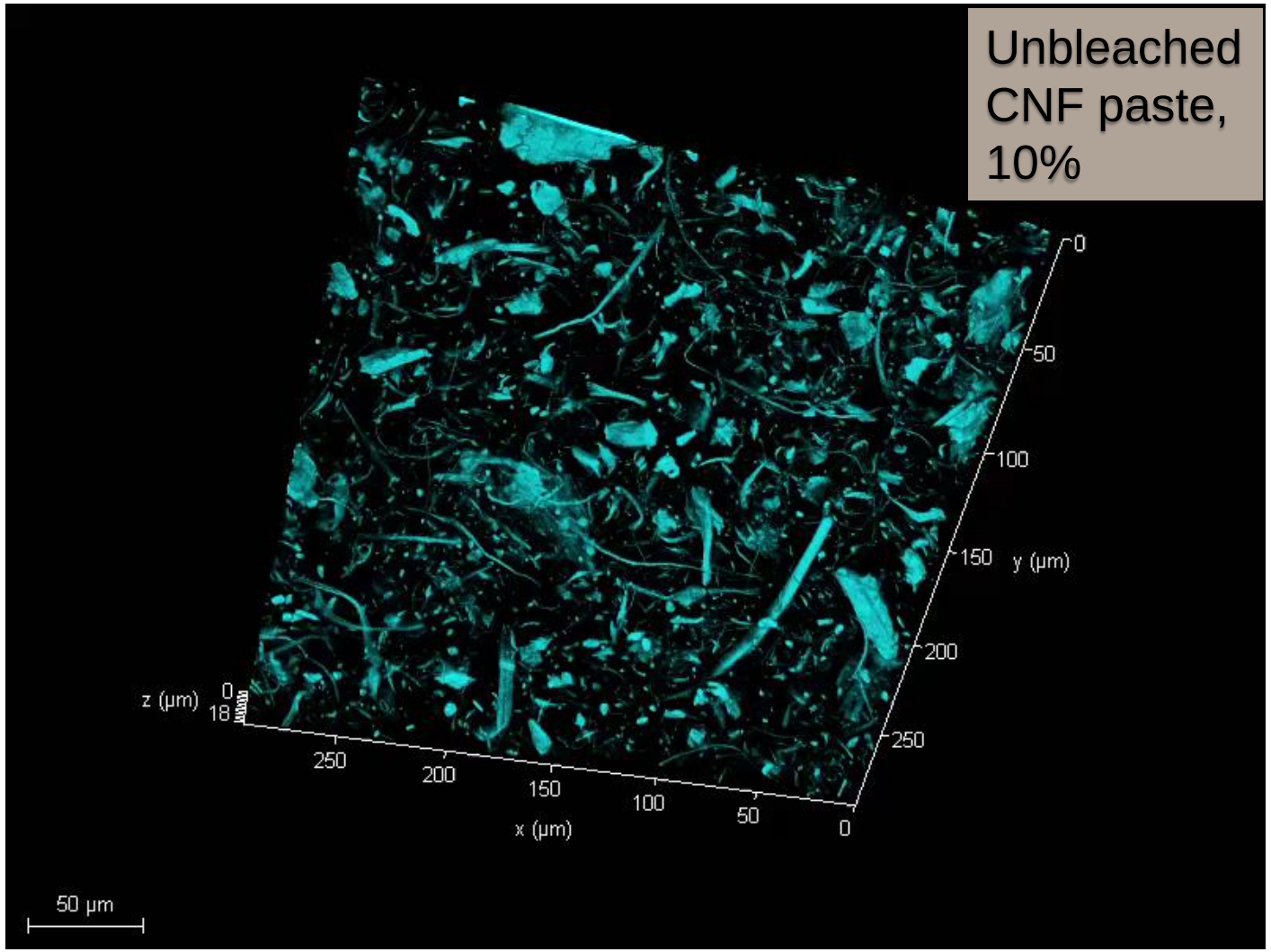


- Unbleached and delignified CNF paste produced by VTT from spruce bark
- High consistency softwood bark as a reference

Bio-based functional fillers: The Nanocellulose

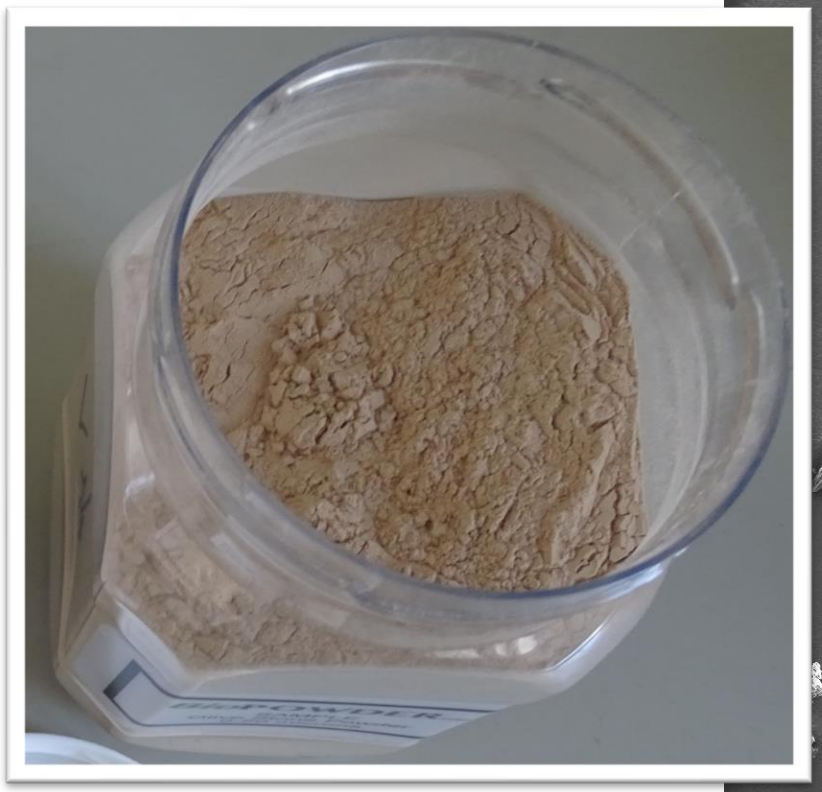


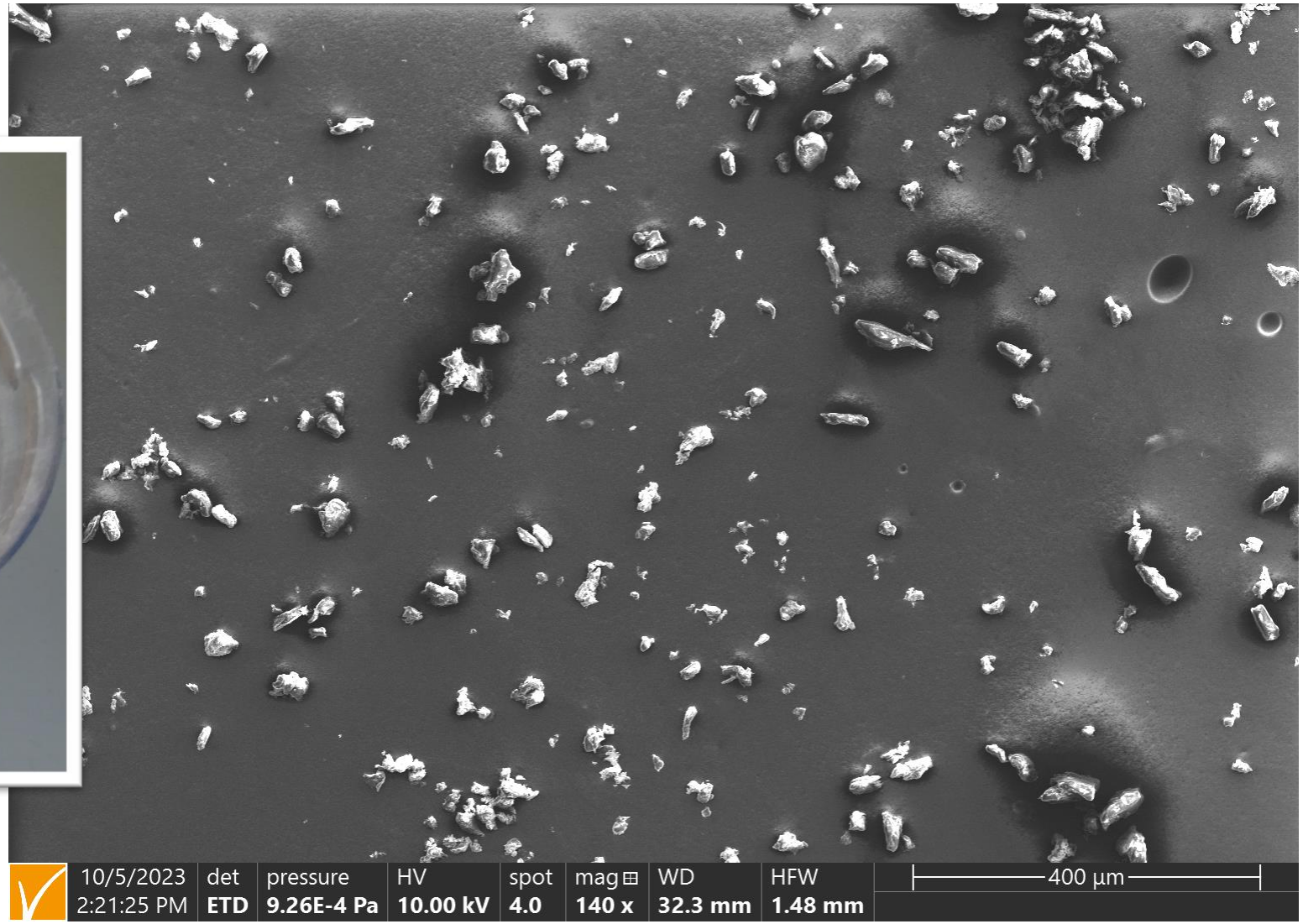
Fluorescence CLSM – unbleached CNF



Bio-based functional fillers: Olive stone powder

Size distribution: 0-25 µm





Small scale coating trials

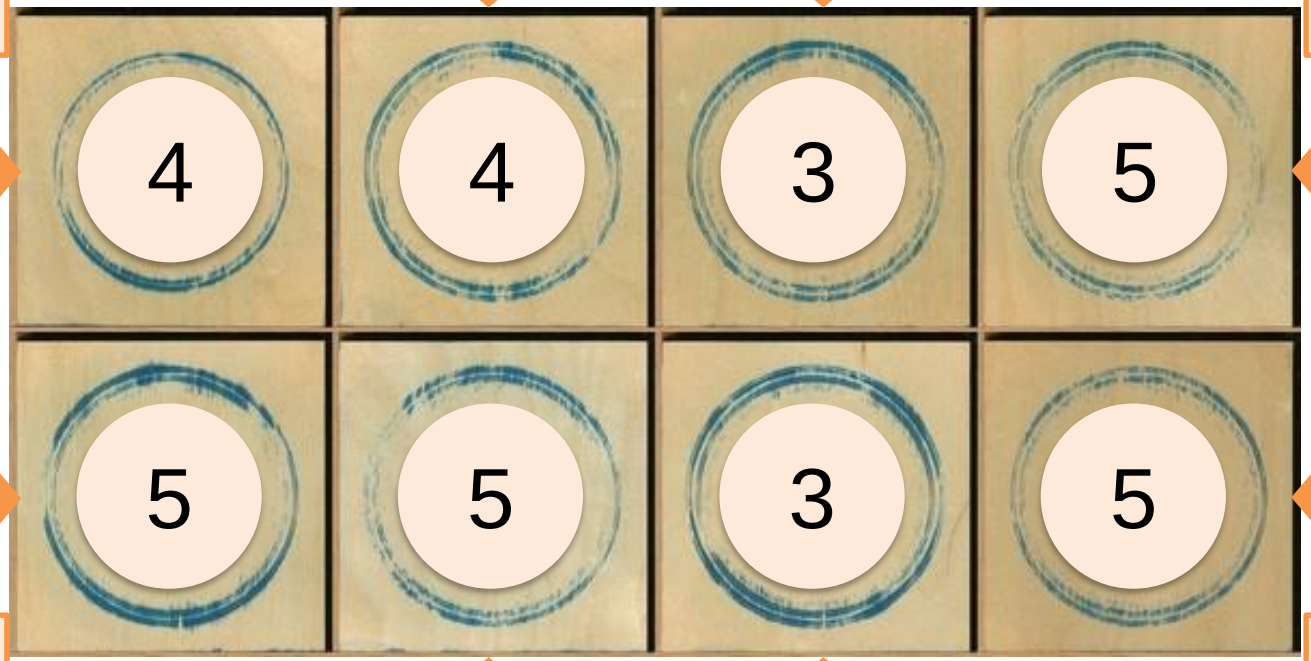
Cellulose nanofibers in water-based coating

water-based system reference

5 m% bark CNF, unbleached

10 m% bark CNF, unbleached

15 m% bark CNF, unbleached



Target scratch resistance: 5

15 m% bark CNF, bleached

15 m% high consistency CNF, bleached

15 m% bark CNF, unbleached + 1% olive stone powder

15 m% bark CNF, unbleached, base coating

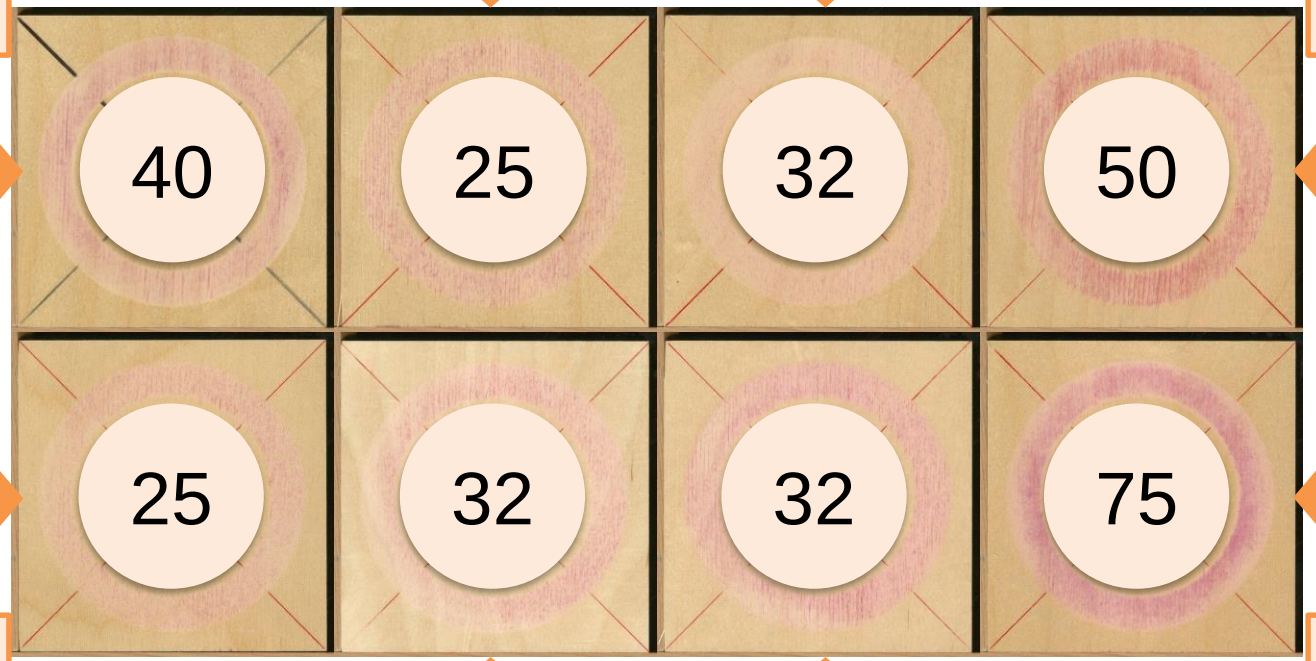
Cellulose nanofibers in water-based coating

water-based system reference

5 m% bark CNF, unbleached

10 m% bark CNF, unbleached

15 m% bark CNF, unbleached



Target abrasion resistance: 225+ rotations

15 m% bark CNF, bleached

15 m% high consistency CNF, bleached

15 m% bark CNF, unbleached + 1% olive stone powder

15 m% bark CNF, unbleached, base polymer

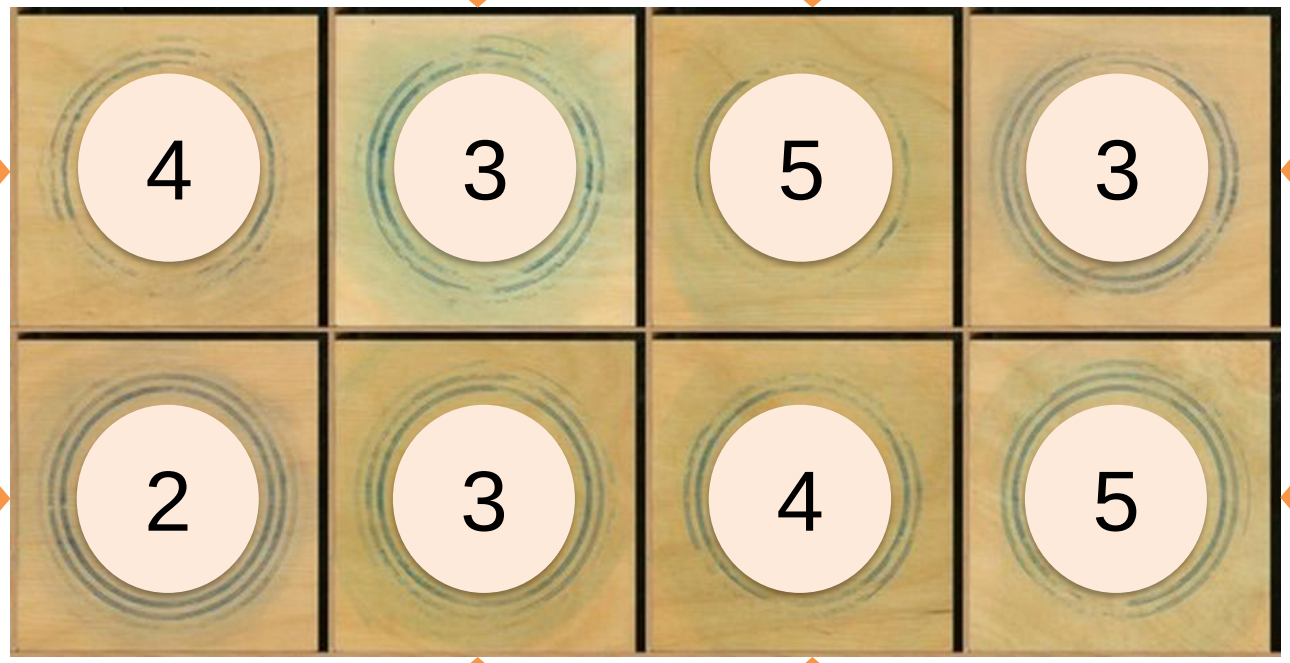
Cellulose nanofibers in solvent-based coating

solvent-based system reference

solvent-based reference +acid hardener

10 m% bark CNF, unbleached

20 m% bark CNF, unbleached



Target scratch resistance: 4+

30 m% bark CNF, unbleached

1% olive stone powder

2% olive stone powder

5% olive stone powder

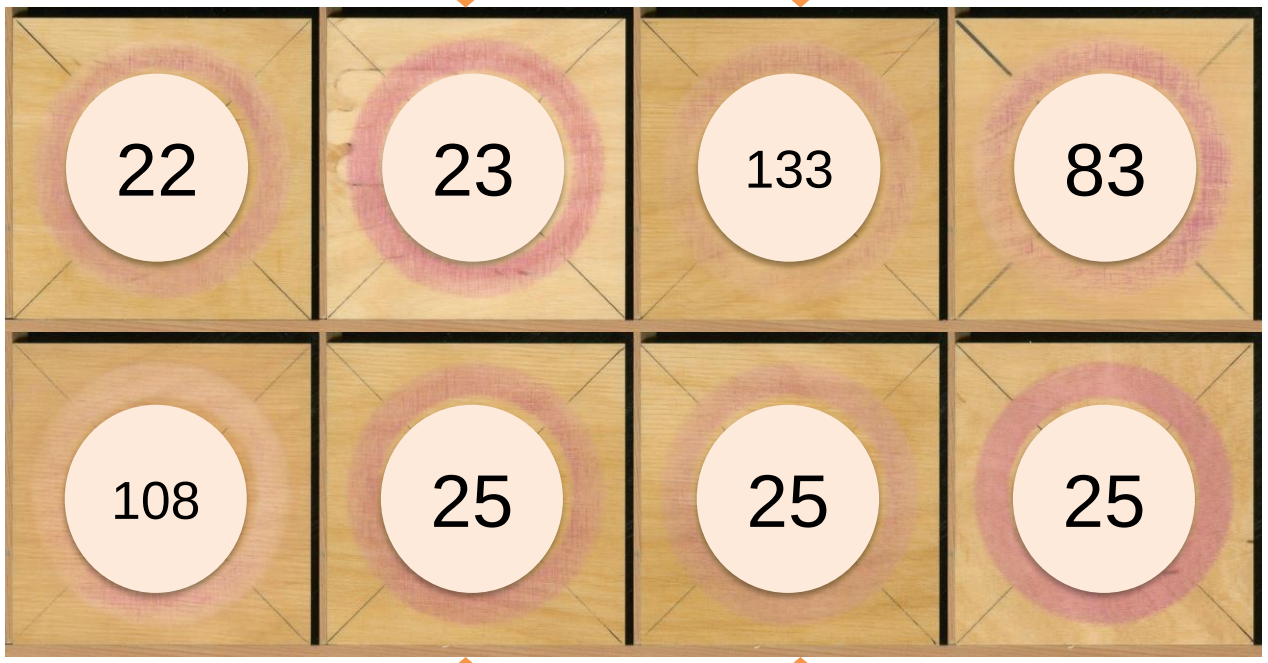
Cellulose nanofibers in solvent-based coating

solvent-based system reference

solvent-based reference +acid hardener

10 m% bark CNF, unbleached

20 m% bark CNF, unbleached



Target abrasion resistance: 225+ rotations

30 m% bark CNF, unbleached

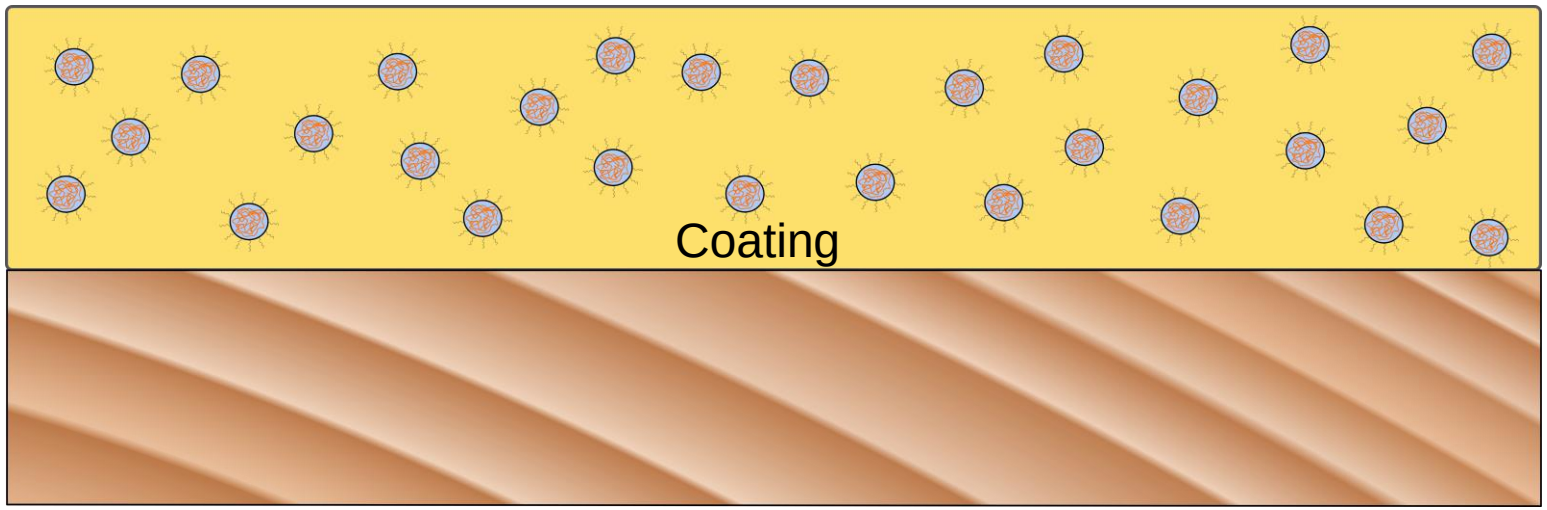
1% olive stone powder

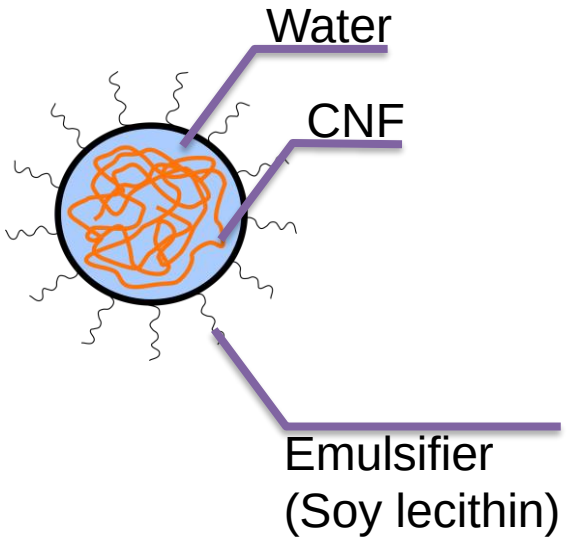
2% olive stone powder

5% olive stone powder

Compatibility issues

- Used coatings are solvent-borne
- To mix wet nanocellulose into the coating formulation, an emulsifier is required: soy lecithin





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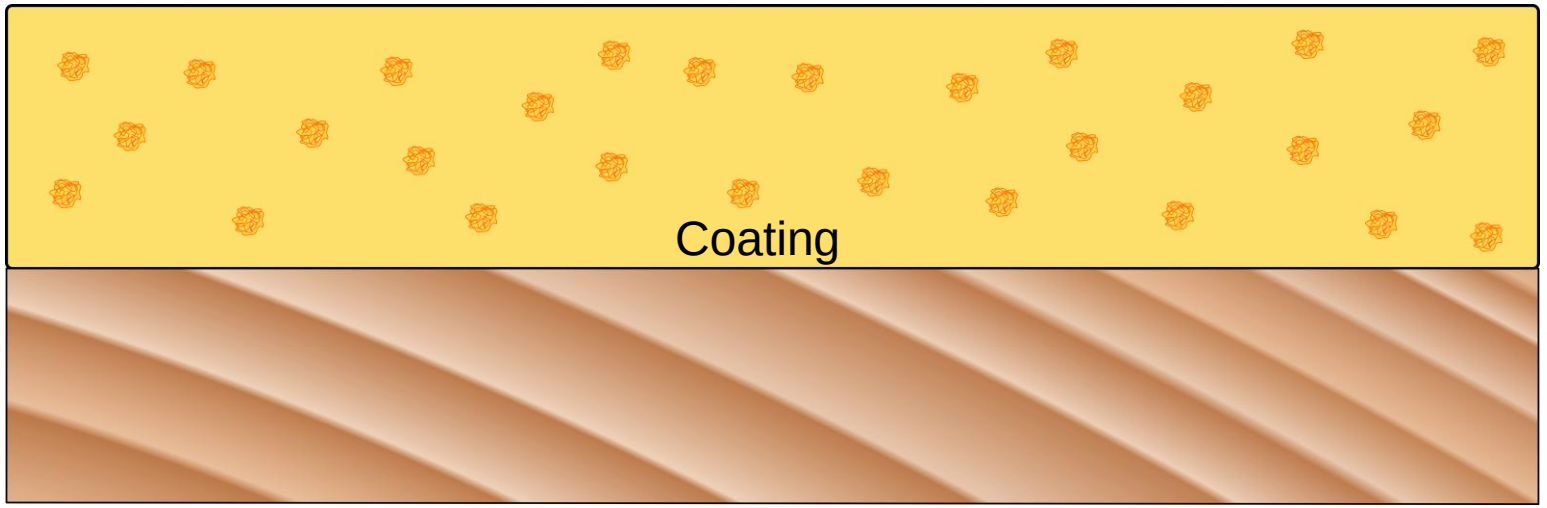
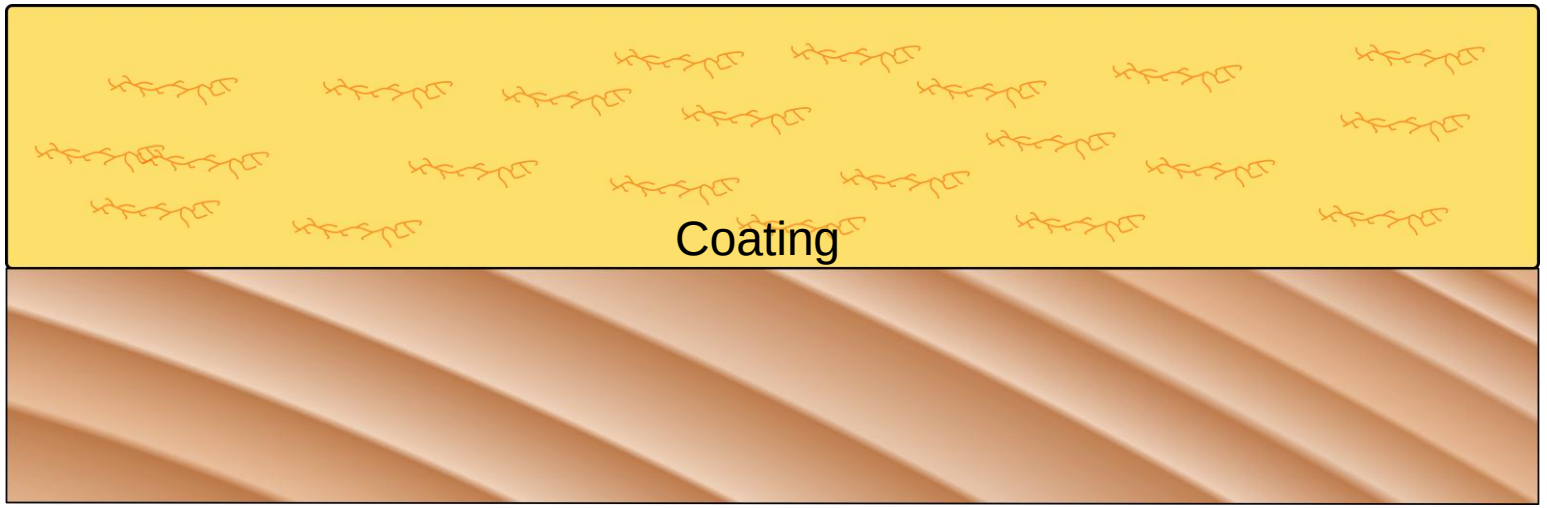


Hypothesis:

- Entangled CNF particles in coating after drying

Compatibility issues

- Used coatings are solvent-borne
- To mix wet nanocellulose into the coating formulation, an emulsifier is required: soy lecithin



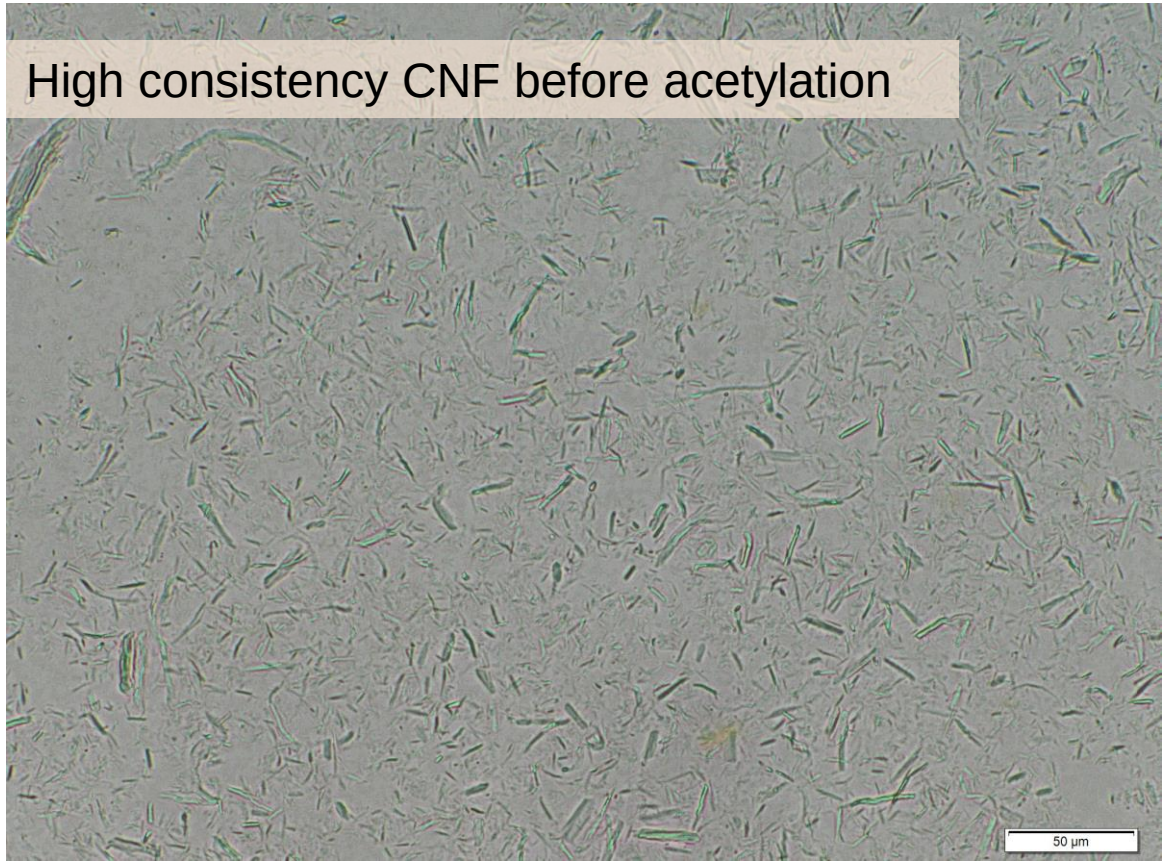
Hypothesis:

- Better reinforcing in the untangled state

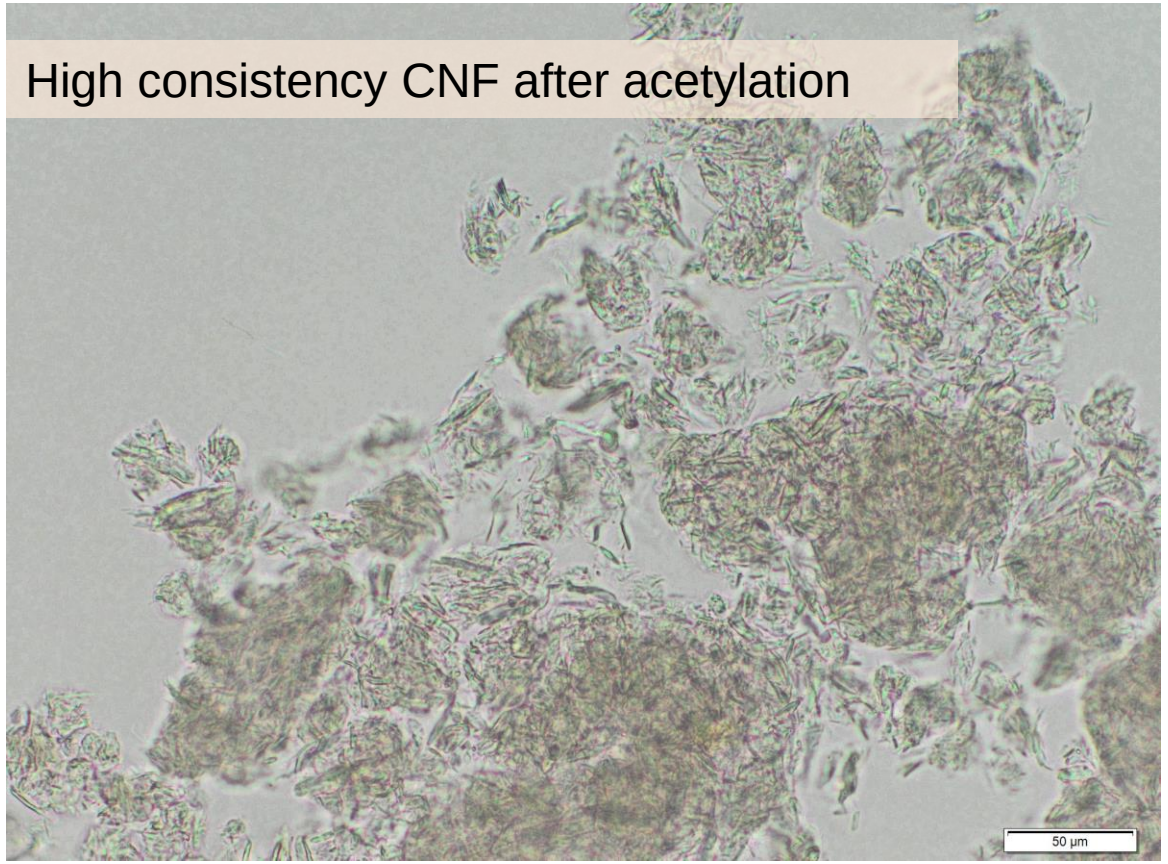
Proposed solution: **Chemical modification of CNF**

Acetylation with acetic anhydride IV (Ashori et al. 2014)

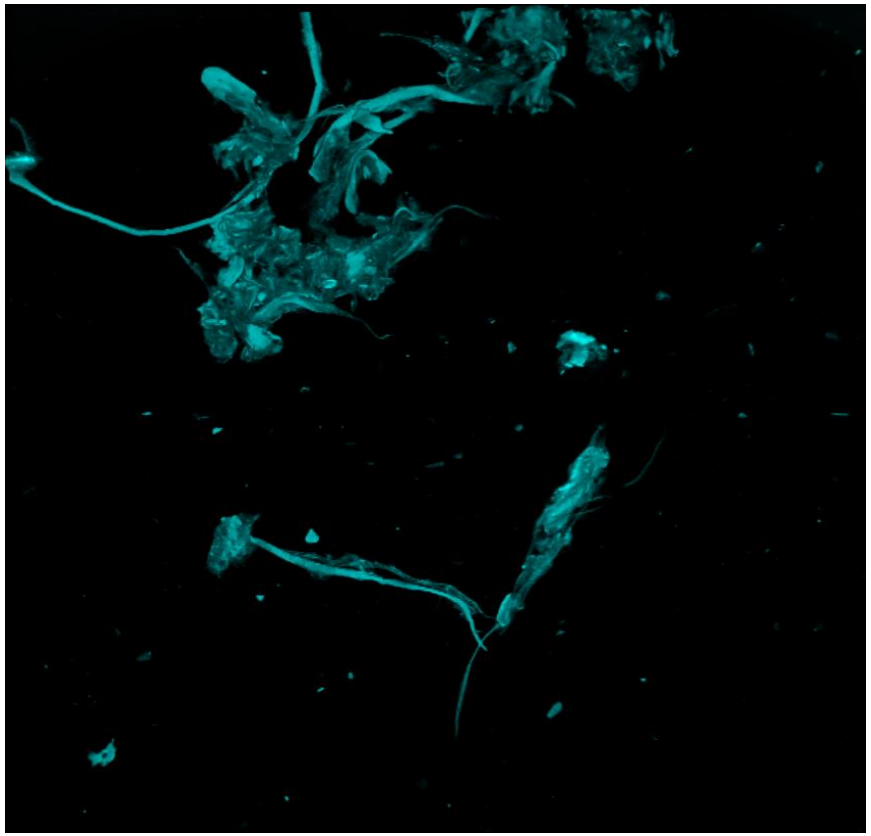
High consistency CNF before acetylation

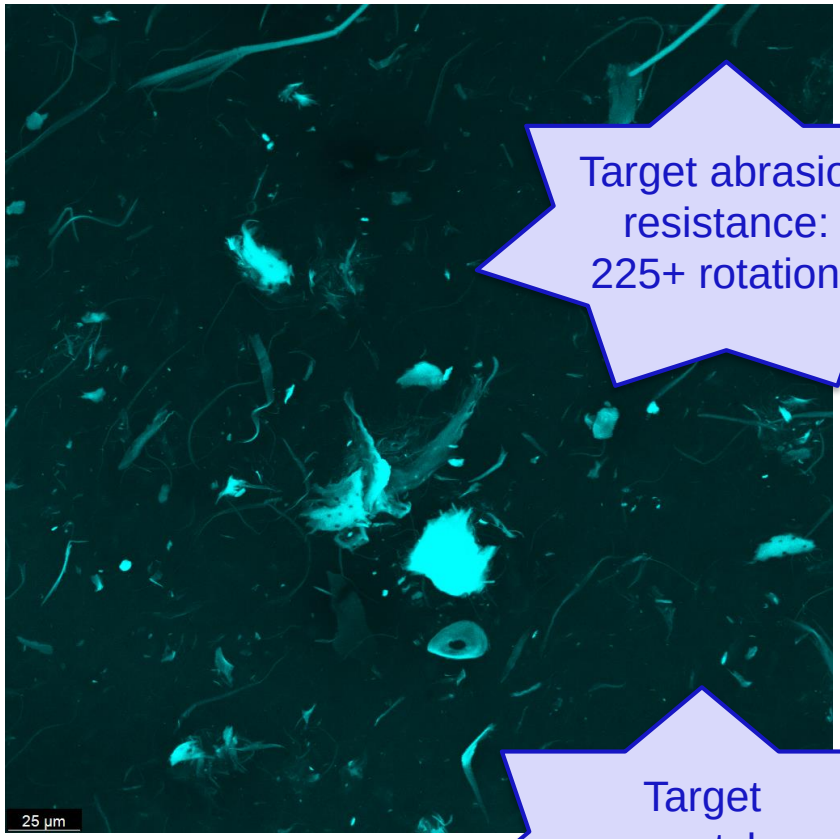


High consistency CNF after acetylation



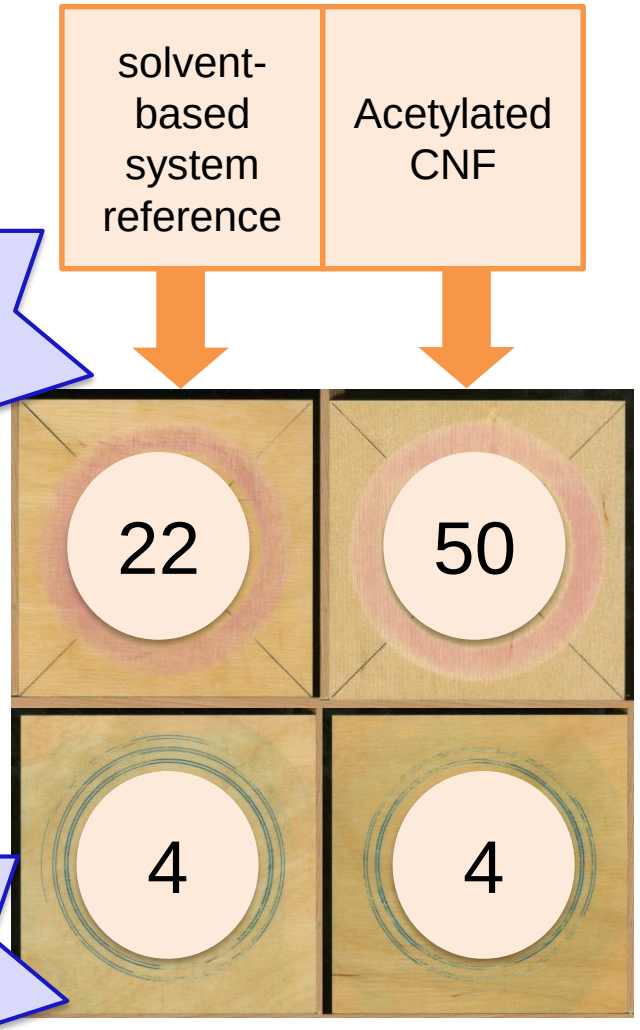
CNF before and after modification – better distribution in solvent-based coating





Target abrasion resistance: 225+ rotations

Target scratch resistance: 4+



Summary and Outlook

- Some indications that CNF could improve the machanical properties of coating systems
- Compatibility issues between water-based cellulose paste and water-free coating bases
- Modification: improves distribution, effect on mechanical properties not yet sufficiently studied


Standort Stetten


Standort Arsenal

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