



Biobased Multilayered Films based on Cellulose and Chitin Nanofibers for Food Packaging

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15.06.2021

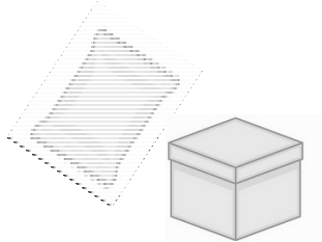
LGP2, Grenoble, France
Aalto University, Finland

TAPPI Nano 2021 Virtual Conference
15-16 June 2021



Food packaging

Life
time



Months/ Year

VS



Millions of Years

>



Years

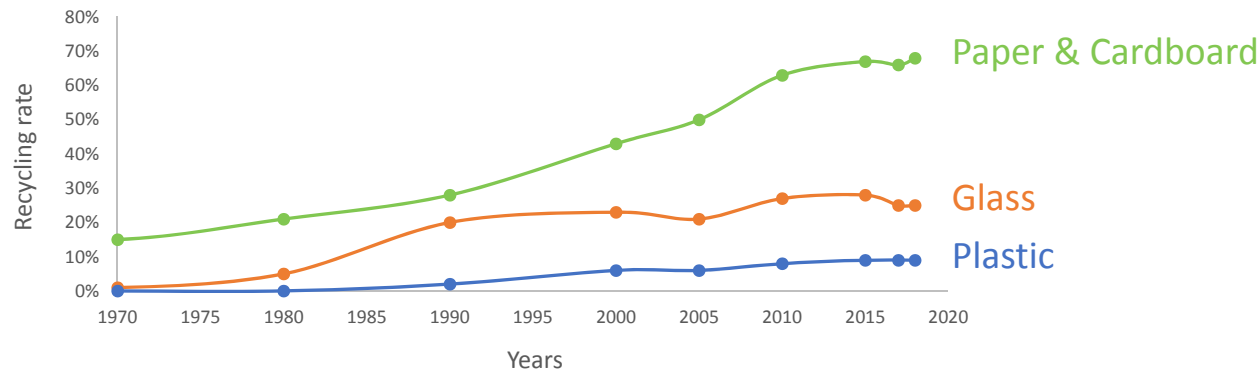
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< Year



Recycling and composting of municipal solid waste in the US



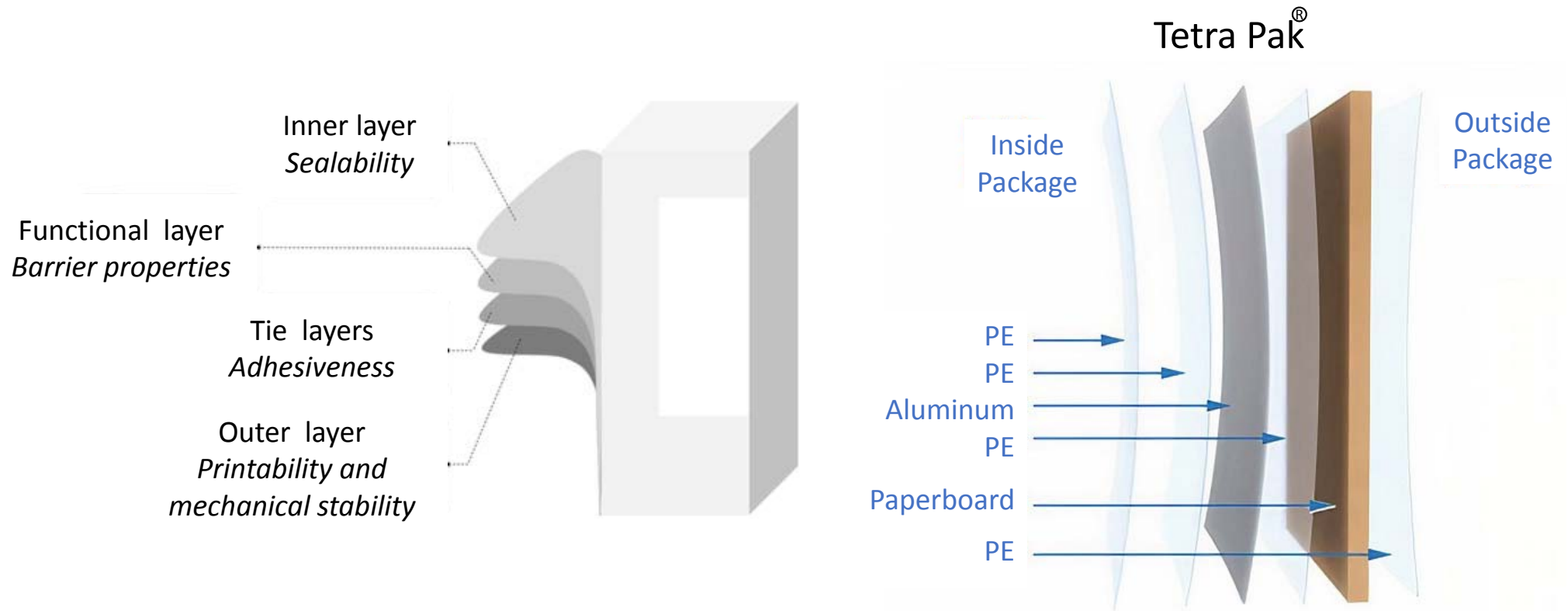
Limitations of cardboard packaging:

- ✗ transparency
- ✗ wet strength
- ✗ oxygen and water vapor barrier

<https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials>

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Inspiration from existing Multilayers



Multilayered materials

Could we engineer these multilayers only with biobased materials?



UV barrier: lignin particles



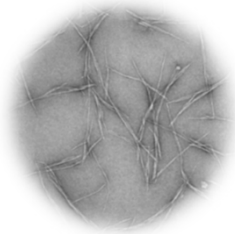
Water vapor barrier: wax



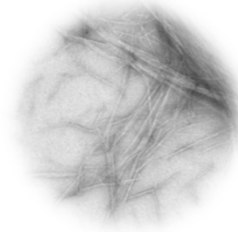
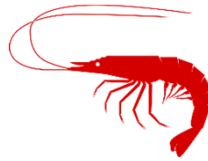
Oxygen barrier: cellulose nanofibers

Multifunctional high
barrier material

Components used in film formation



Cellulose nanofibers
(CNF) from hardwood



Chitin nanofibers
(ChNF) from shrimp
shell

100% biobased
No chemical modifications

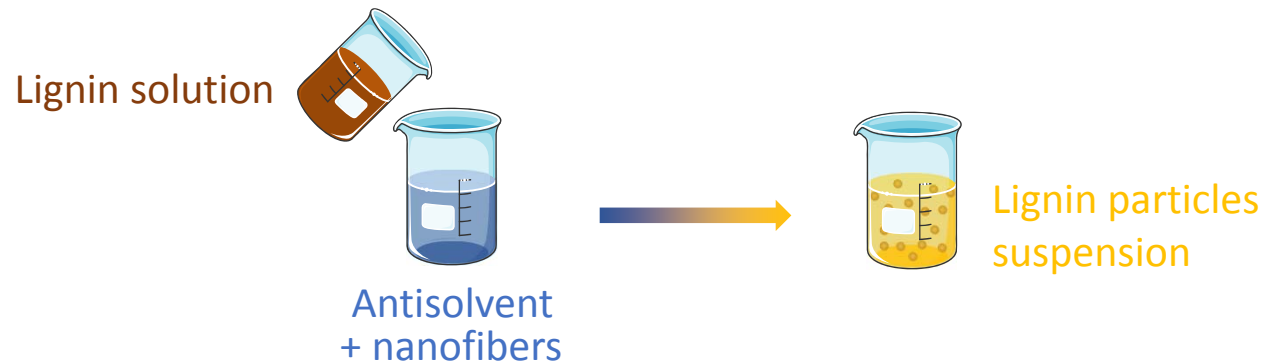


Lignin from softwood



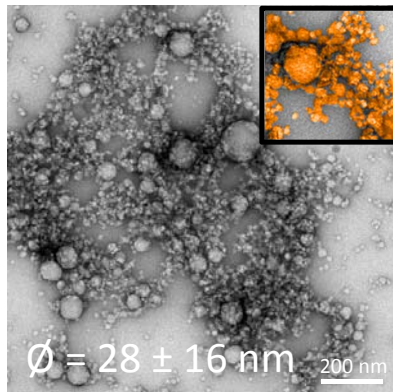
Wax from Carnauba tree

Lignin particles preparation with solvent shifting

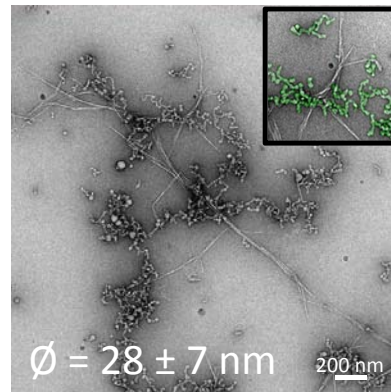


Antisolvent:

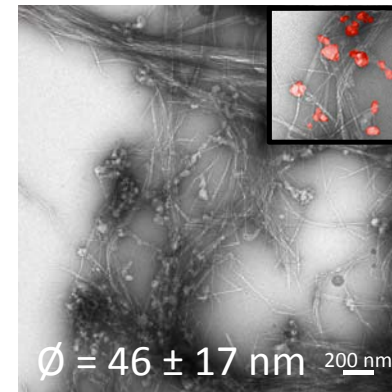
Water



Cellulose nanofibers



Chitin nanofibers



Pasquier et al., *Biomacromolecules*, **2021**, 22, 2, 880–889

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Lignin particles – nanofibers interactions

Samples after centrifugation

Lignin particles - CNF

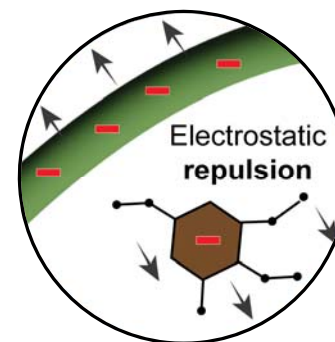
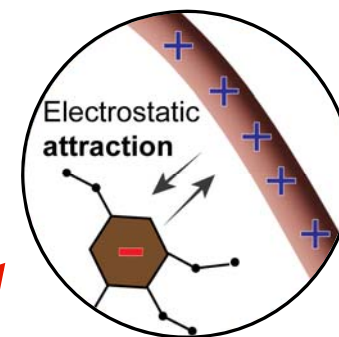


Sediment Supernatant

Lignin particles - ChNF



Sediment Supernatant

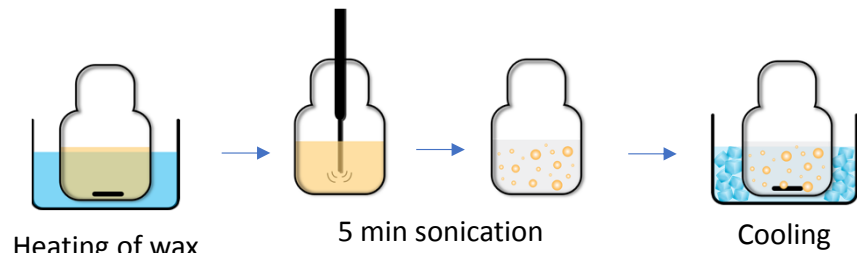


Pasquier et al., *Biomacromolecules*, **2021**, 22, 2, 880–889

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A! LGP₂

Wax particles preparation



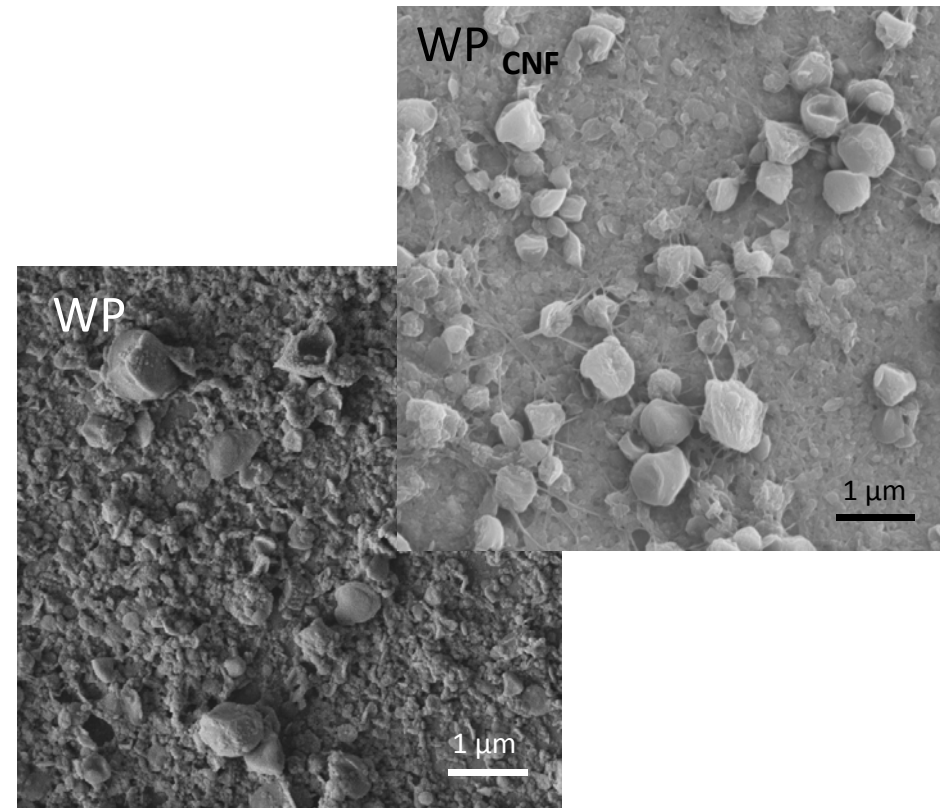
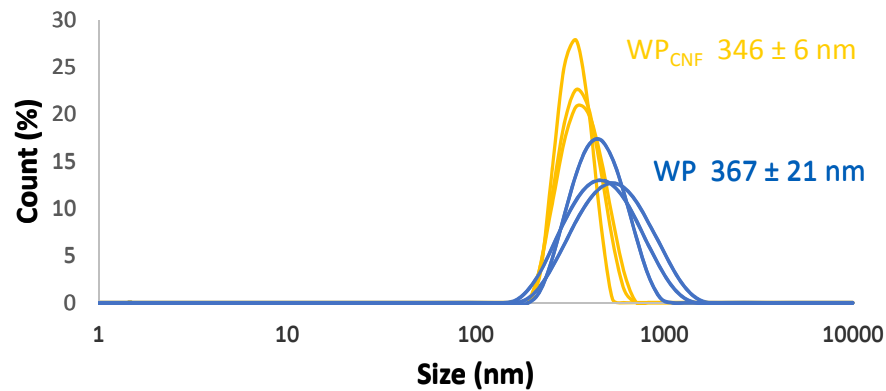
Heating of wax solution

5 min sonication

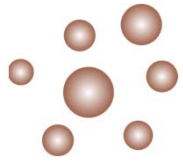
Cooling

+ 9 % CNF

DLS of WP



Our Strategy



Nanoparticle's suspension



1st Layer: Lignin particles-based layer

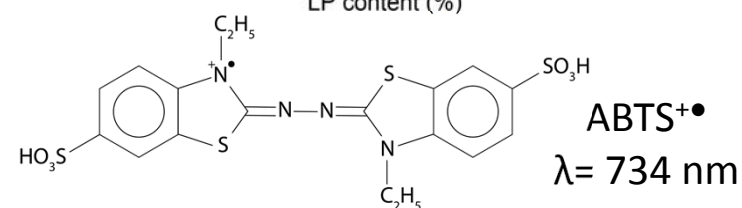
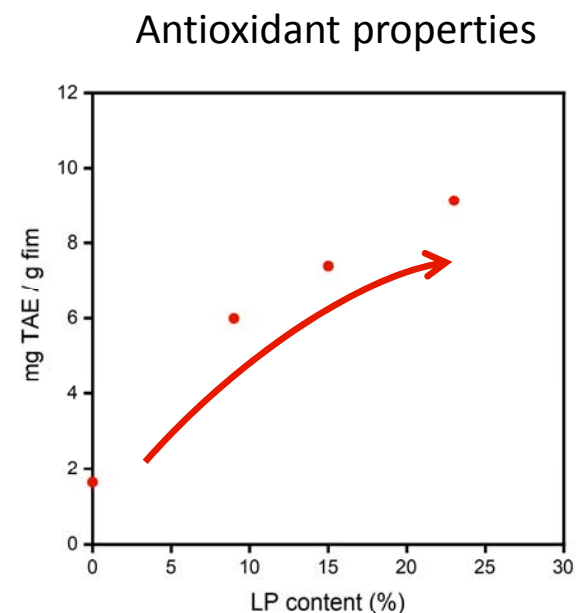
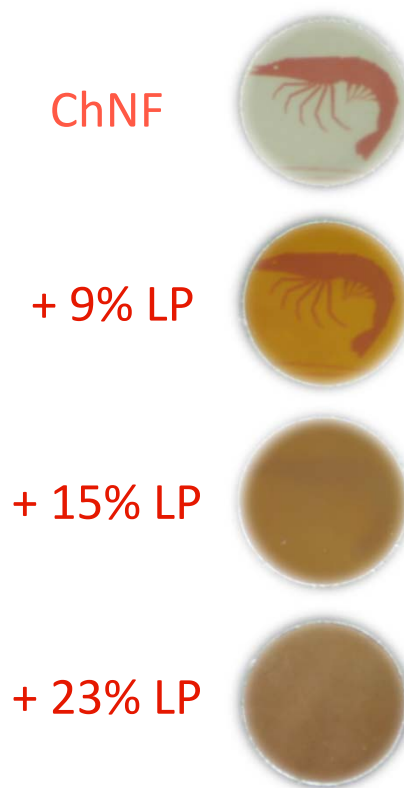
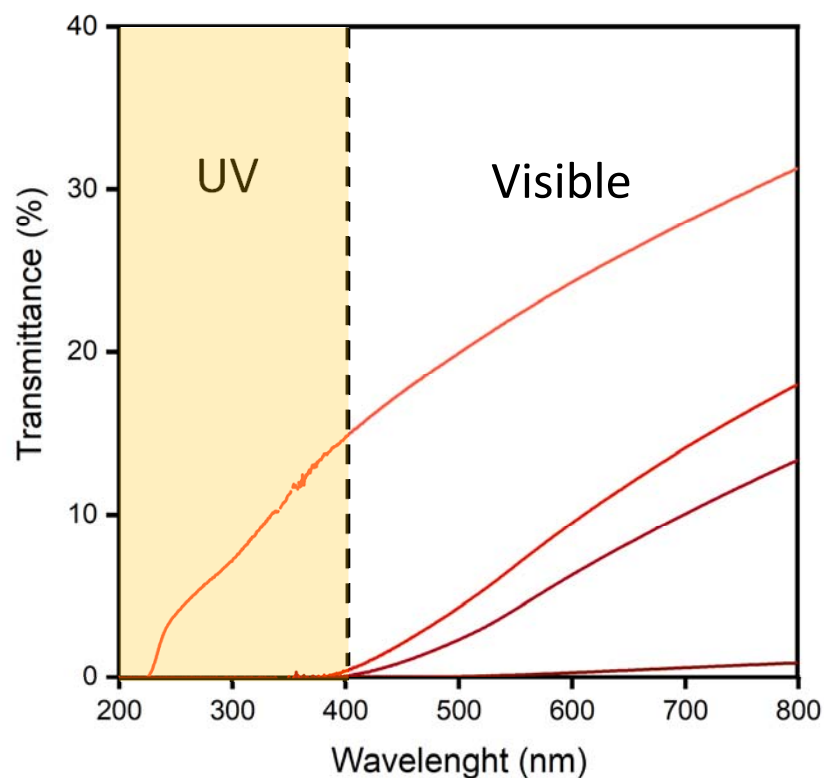


2nd Layer: Wax based layer



Multilayers

Film of lignin particles-chitin nanofibers



Pasquier et al., *Biomacromolecules*, **2021**, 22, 2, 880–889

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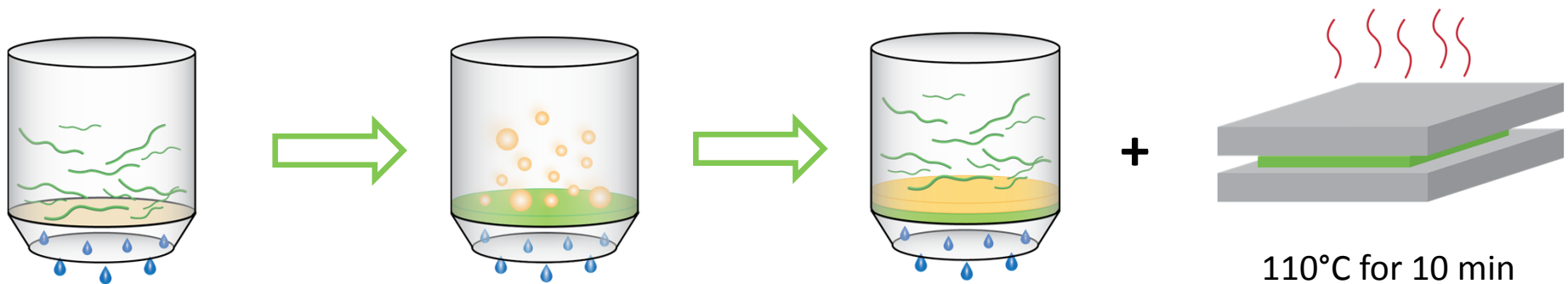
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Wax based layer

Sandwich: CNF + WP + CNF



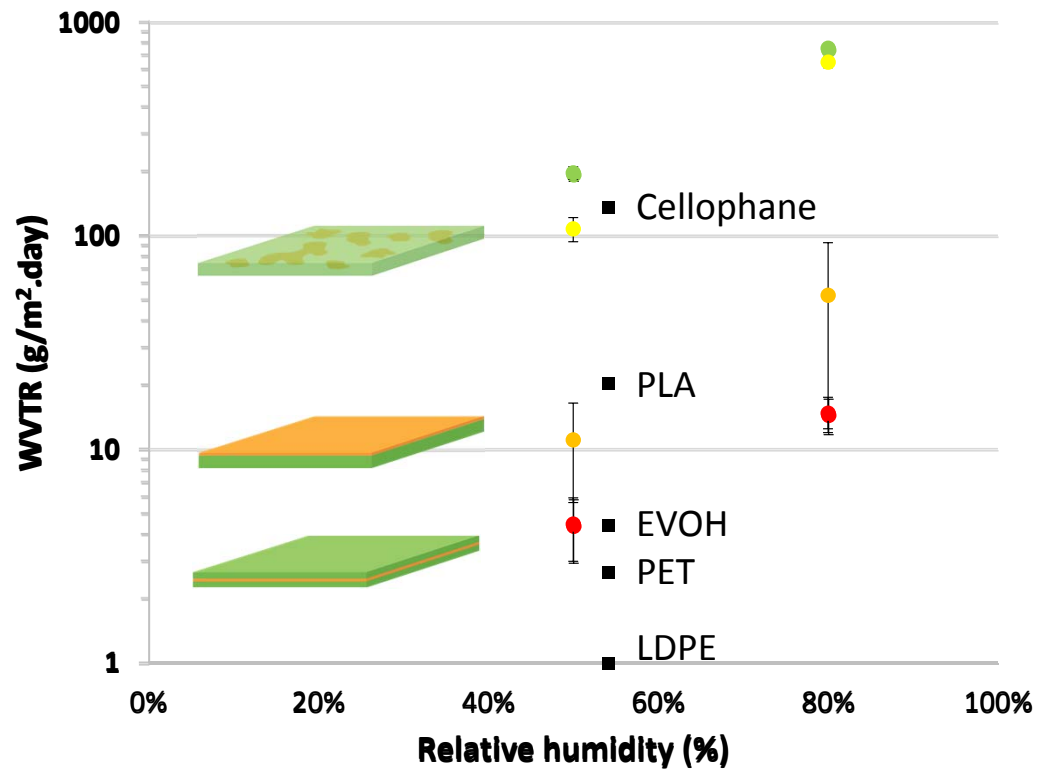
Process: Filtration + Hot Press



Wax based layer

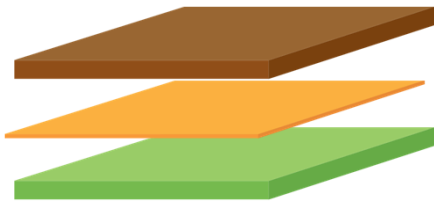


35-36 μm



- CNF
- CNF
- CNF + WP mix
- CNF + WP top layer
- CNF + WP sandwich
- CNF + WP sandwich

Assembly in Multilayer



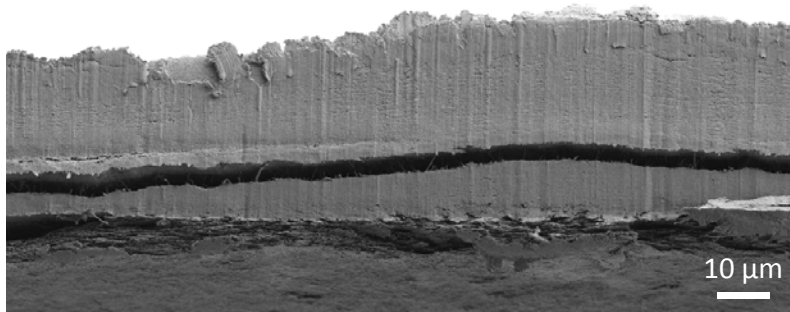
Chitin nanofibers + Lignin particles

Wax

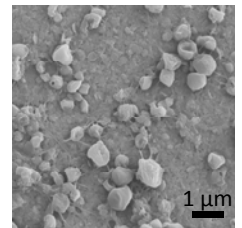
Cellulose nanofibers



SEM cross-section

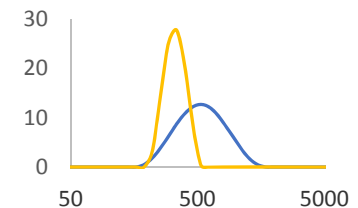


New challenges: → layers adhesions → use of WP-CNF
→ conservation of the individual layers' properties



Conclusion & Perspectives

Addition of nanofibers allows controlling the size and dispersion of NPs



Optimization of single layers :



UV shielding + antioxidant



Water vapor barrier properties

Successfully prepared multilayers



Perspectives

Characterization of the multilayers

Upscaling of the process: coating, spraying...

Acknowledgements



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Thank you



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