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Ph.D. thesis (2024-2027)
LGP2 (J. Bras; Q. charlier)

Dry processing methods to manufacture low environmental-footprint bio-based materials

Fabrication en voie sèche de matériaux biosourcés à empreinte environnementale diminuée

Context

1 Environmental issues - Plastic industry

- CO₂ emission during production
- Not biodegradable so a lot of wastes finds itself in landfill or ocean (6900 Mt¹)



2 Scientific advances in our understanding of cellulosic biomass

- Paper and carboard**
 - High energy and water consumption
- Wood panel**
 - Petroleum-based adhesives with formaldehyde, VOCs and health issues
- Bioplastic from biomass**
 - Low biodegradability or recyclability



New challenge : How to substitute plastic with bio-based material that uses less energy, less water, no petroleum based adhesives and that can be biodegradable ? ...

¹ Tony R. Walker et al. Trends in Analytical Chemistry 2023

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<https://anr.fr/Projet-ANR-23-CE43-0002>

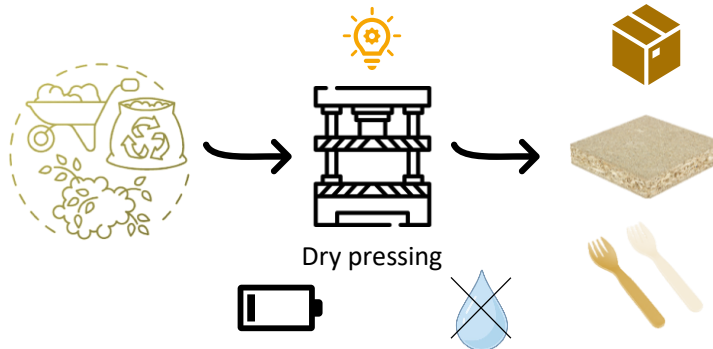


Objectives

... Development of more sustainable dry processes to make material from biomass in order to substitute plastic

Environnemental Process Product

- Reduced carbon footprint
- Sustainable
- Circular economy
- Low energy and water consumption
- Scalable
- High-performance
- Low-cost



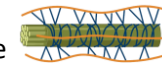
**Understanding adhesion phenomena is key
Use of bio-based binders to enhance mechanical performances**

Methods

"Pure" Material

- to control and understand

- Lignin
- Cellulose
- Hemicellulose



Byproduct

- for circular economy

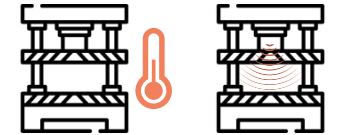
- Agricultural
- Wood industry



→ Different type of material shaping (powder, chip, fiber)

Dry process

- Thermocompression
- Ultrasonic compression molding



→ Different process parameter

→ Adjust input parameters to tailor final properties

Multi-criteria analysis

Creation of a global performance index

Performance	Environmental
<ul style="list-style-type: none"> Mechanical properties Thermal properties Specific product requirements 	<ul style="list-style-type: none"> Dry recyclability Fragmentability Biodegradability Energy consumption LCA

Iterative work

