Transforming wood waste into value: Exploring the potential of PLA sustainable biocomposites

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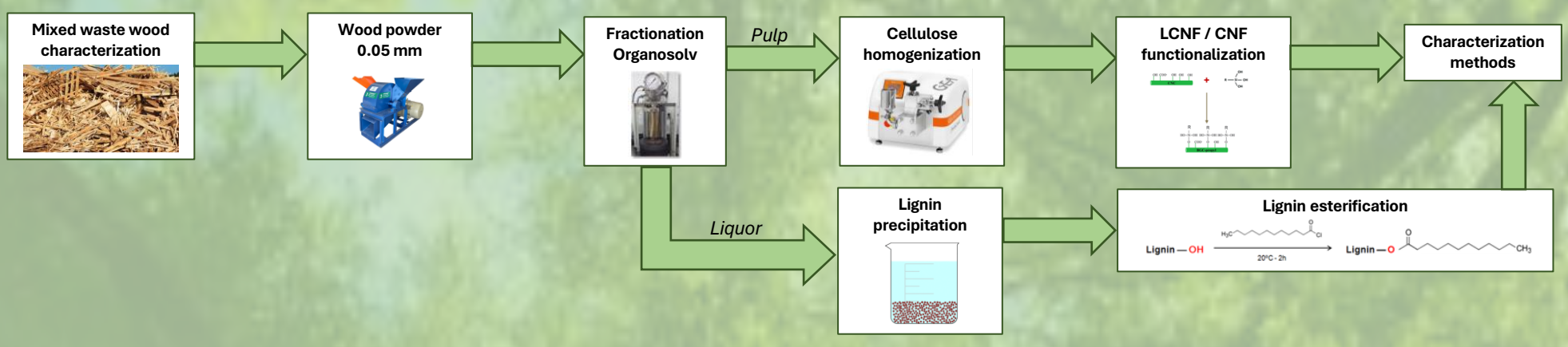
Wood2Wood

SCOPE

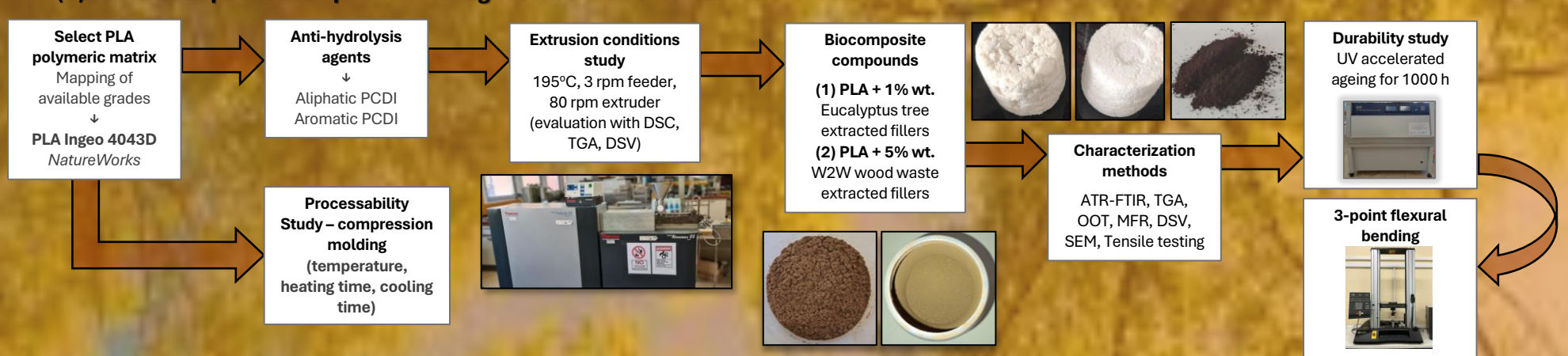
In the plastics sector, new and more strict landfill regulations are voted, while more waste reduction programs appear, in an attempt to better meet the goals of circular economy. Therefore, an effort of developing polylactic acid (PLA) biocomposites compounds from wood waste is herein investigated. A bio-based and rather green polymer like PLA, can serve as a matrix for incorporating lignocellulosic materials, extracted from wood waste (value added filler products) with the aim to further enhance thermo-oxidative stability and/or mechanical properties. The most effective PLA formulation will be used in a larger-scale production, which will contribute to the development of sustainable materials for the construction industry, while reducing environmental impact through waste valorisation and use of renewable resources.

EXPERIMENTAL METHODS

(A) Organosolv Fractionation of wood waste & Optimization for LCNF, CNF and lignin isolation

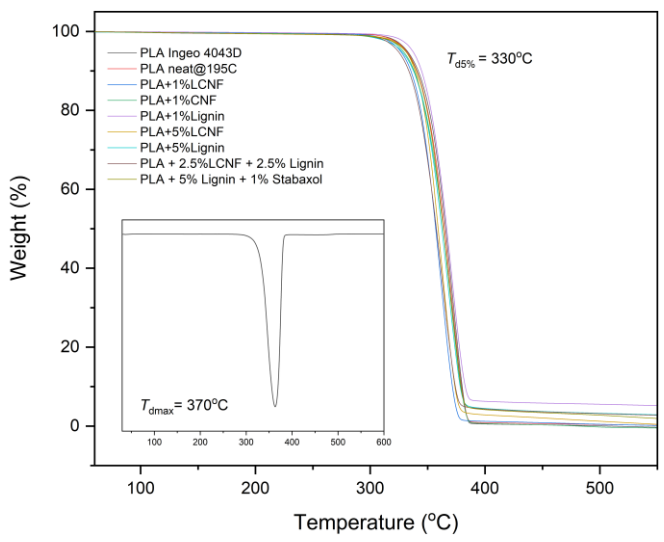


(B) PLA biocomposites compounds with lignocellulosic filler materials from wood waste

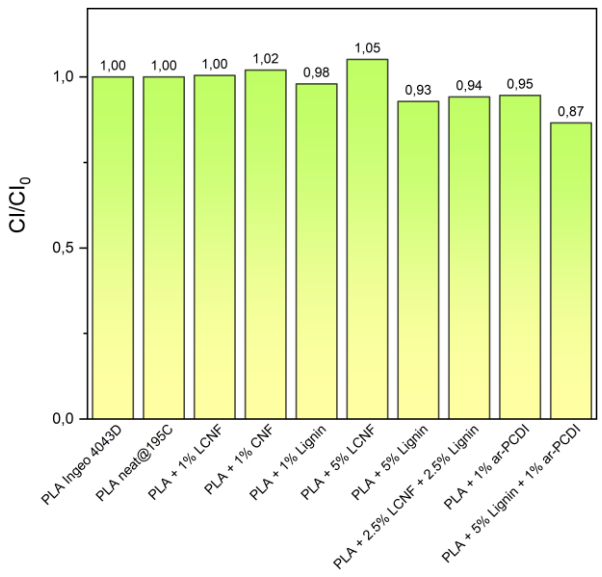


RESULTS & DISCUSSION

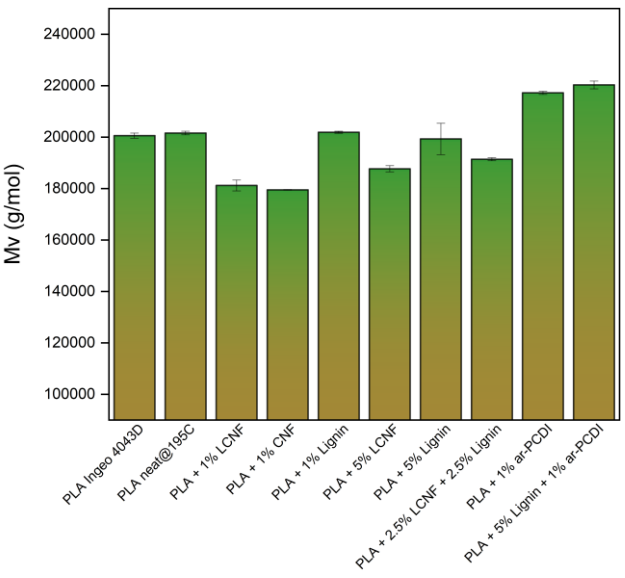
TGA



ATR- FTIR



DSV



Melt flow rate (MFR)		
Materials	**MFR conditions**	**MFR [g/10 min]**
PLA Ingeo 4043D	210°C 2.16 kg	7.3 ± 0.4
PLA neat@195°C		10.0 ± 0.5
PLA + 1% LCNF		10.4 ± 0.4
PLA + 1% CNF		11.4 ± 0.4
PLA + 1% Lignin		8.3 ± 0.4
PLA Ingeo 4043D	190°C 5 kg	8.2 ± 0.2
PLA neat@195°C		11.4 ± 0.3
PLA + 5% LCNF		6.1 ± 0.4
PLA + 5% Lignin		13.3 ± 0.6
PLA + 2.5% LCNF + 2.5% Lignin		13.3 ± 0.9
PLA + 5% Lignin + 1% ar-PCDI		6.0 ± 0.2

Experiments	Experimental conditions					Results	
	m (g)	Temperature (°C)	Heating time (min)	Pressure (bar)	Cooling time (min)	Dimensions (cm x cm)	Ave. Thickness (mm)
1	28	190	20	170	15	15 x 15	0.8
2		190	20		20		1.0
3		180	20		20		0.8
4		170	20		20		1.0
5		180	25		20		1.0
6		180	30		20		0.9
7		180	35		20		0.0

CONCLUSIONS

1. **ATR- FTIR**
   - lignin formulations with the lowest CI
   - PLA + 5% Lignin + 1% ar-PCDI, most positive synergistic effect
2. **DSC/TGA**
   - similar thermal properties
   - T_{dmax} retained, $T_{d5\%}$ increased in lignin formulations (both air, N_2)
3. **MFR**
   - different behavior depending on concentration of fillers
   - lignin's lubricant effect at higher concentrations
4. **DSV**
   - lignin formulations preserved the MW
   - PLA + 5% Lignin + 1% ar-PCDI, most positive synergistic effect
5. **Mechanical properties**
   - maintained for all formulations, even after ageing at 1000 h
6. **Up to 5% wood waste** as value-added fillers in PLA products with **retained properties** and slightly **enhanced** for lignin formulations
7. **Processability study** indicated best plaques production *via* compression molding for experimental set parameters **No 7**

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