Cellulose-Rich Particles Obtained from Wood Waste as a Suitable Filler for Biocomposite Formulations

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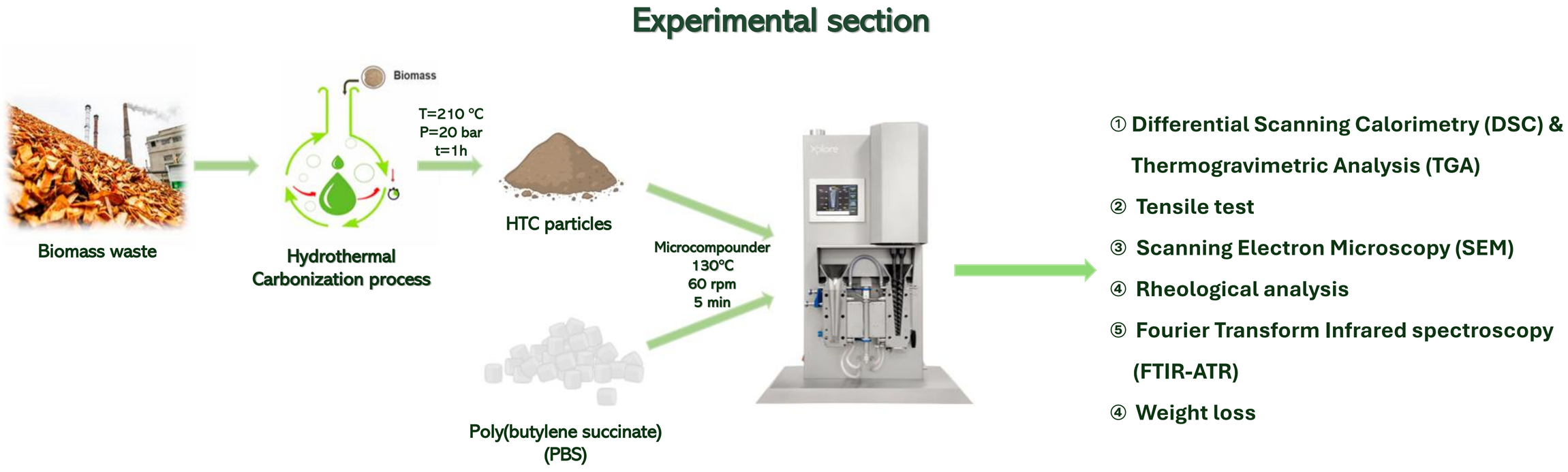
Introduction

Sustainable composites made from renewable materials, industrial wastes and biopolymer matrices are of particular interest due to their potential to reduce environmental impact and promote an efficient circular economy. In this work, sustainable composites based on biodegradable poly(butylene succinate) (PBS) and cellulose-rich particles produced by sustainable hydrothermal treatment of wood waste (HTC) were formulated at different PBS/HTC ratios by micro-compounding. The durability and performance of the composites were investigated considering different environmental conditions. Composite materials were subjected to analysis of their rheological and thermal behavior, morphologies and mechanical properties.

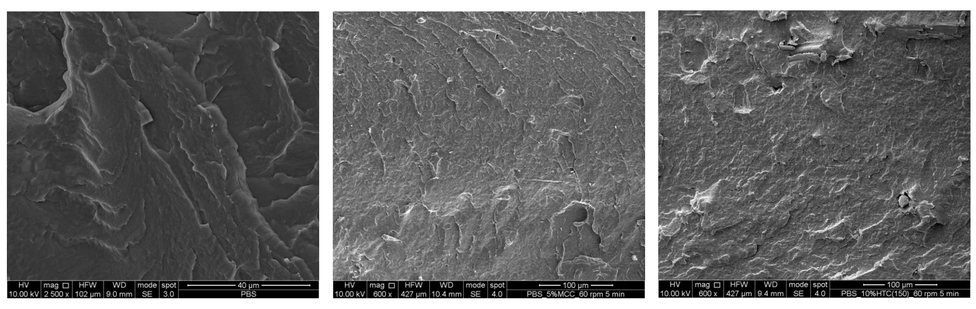
Experimental section



① Thermal analysis

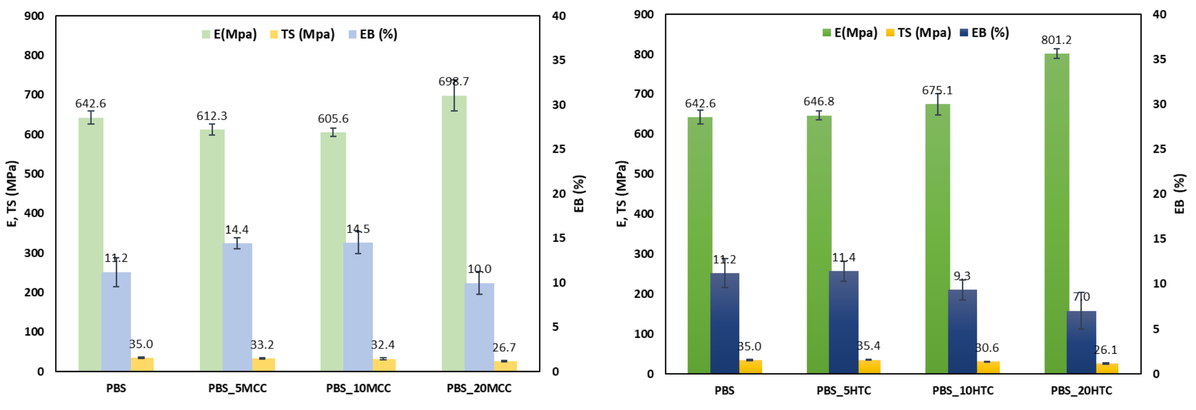
	T_{cc} (°C)	ΔH_{cc} (J/g)	T_m (°C)	ΔH_m (J/g)	T_c (°C)	ΔH_c (J/g)	χ (%)	T_{max} (°C)	$Residue_{700}$(%)
PBS	95.8	-12.31	115.6	76.11	63.6	-73.87	57.85	389.84	2.81
PBS_5MCC	98.2	-11.74	115.9	74.01	69.5	-73.87	59.43	398.36	2.04
PBS_10MCC	98.9	-8.85	116.6	69.62	68.6	-57.15	61.23	402.04	2.52
PBS_20MCC	99.0	-9.26	115.8	66.38	71.4	-62.98	64.74	399.05	2.73
PBS_5HTC	101.1	-12.24	115.8	79.15	74.9	-90.15	63.86	400.21	2.72
PBS_10HTC	101.2	-11.20	115.5	75.96	75.7	-87.36	64.25	398.33	3.40
PBS_20HTC	101.6	-10.40	115.5	72.00	76.5	-82.23	69.82	396.42	4.91

③ Scanning Electron Microscopy (SEM)



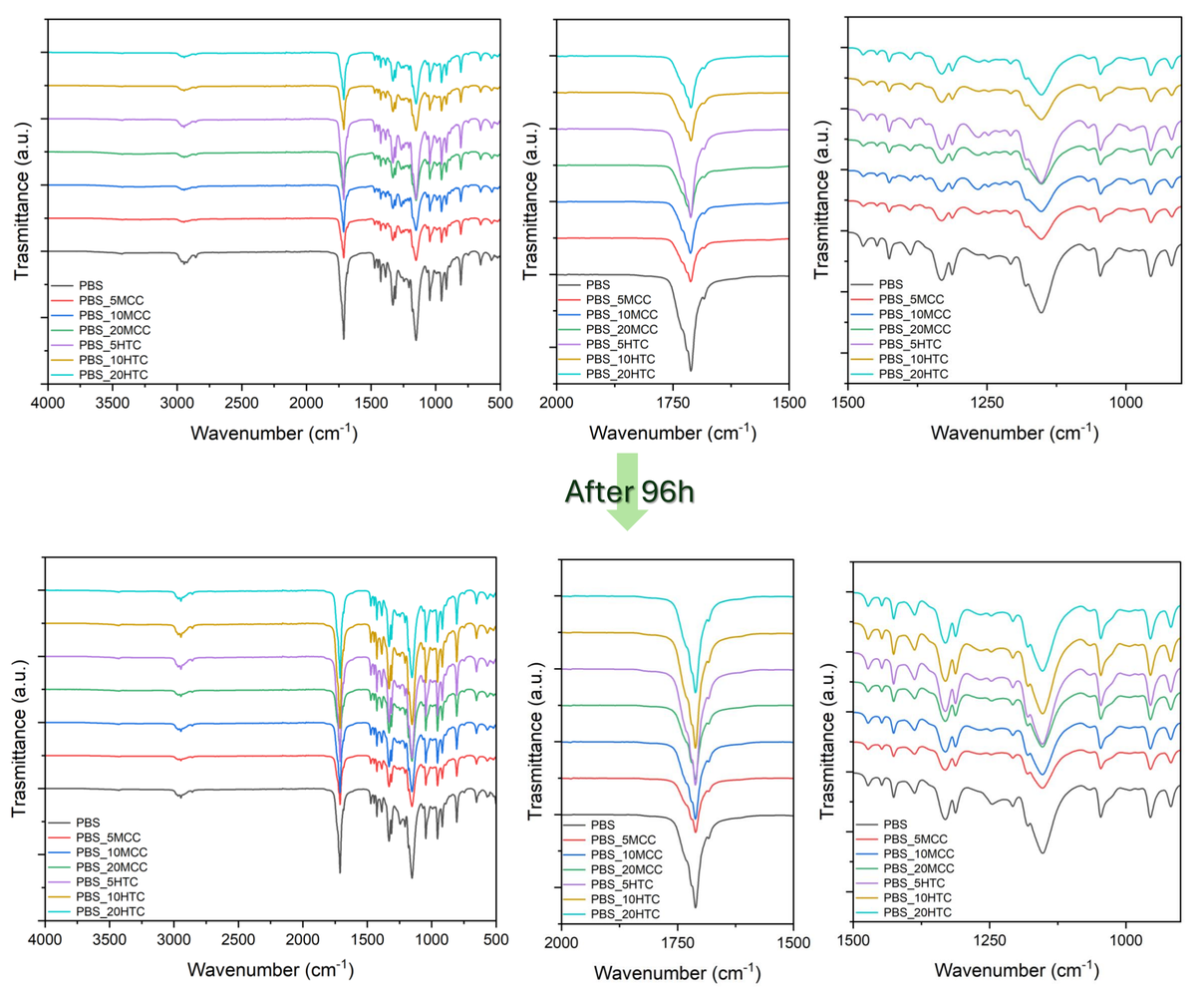
Morphological analysis of PBS, PBS_MCC and PBS_HTC.

② Mechanical properties

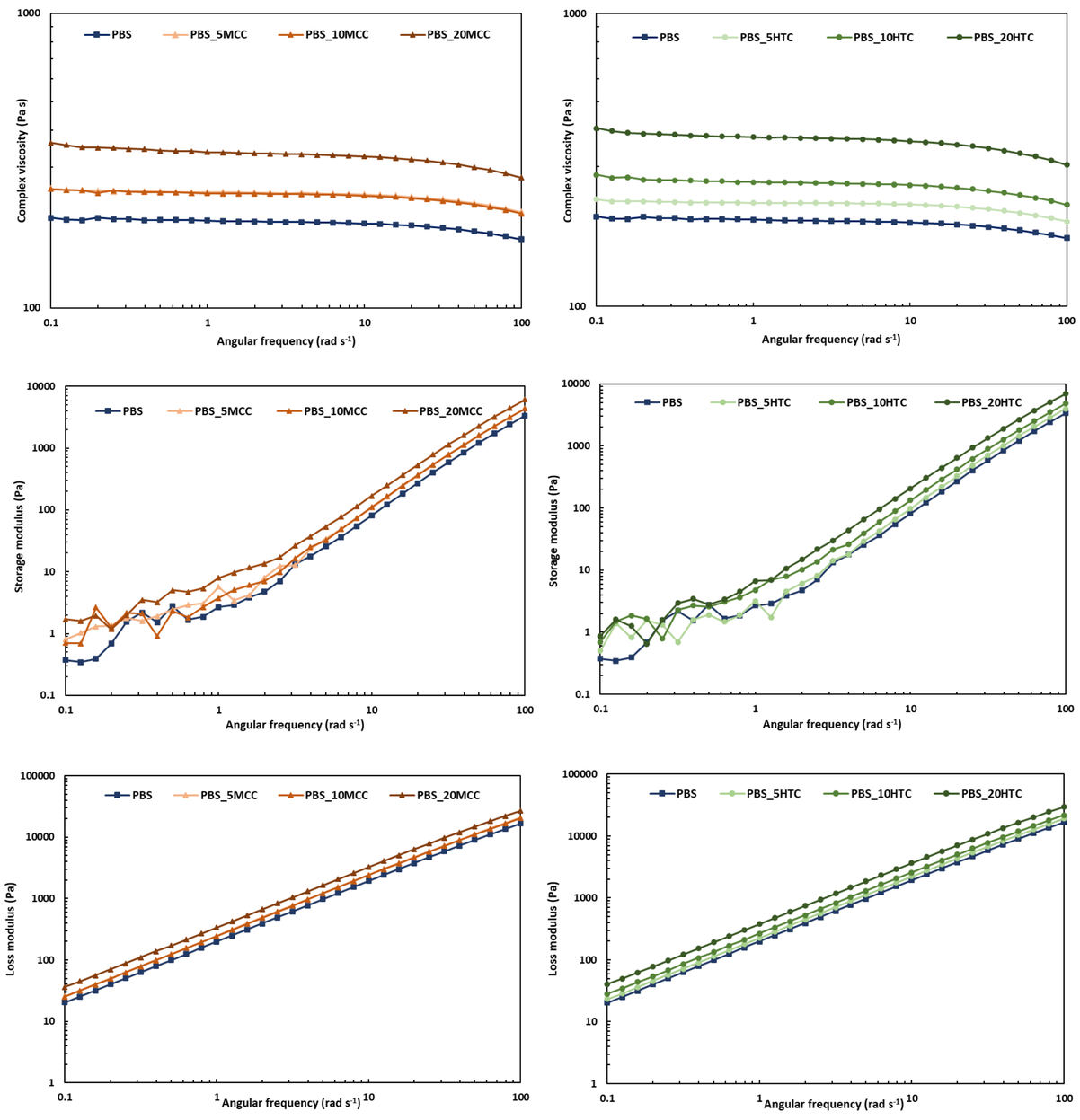


Average values of main mechanical properties of PBS and PBS composites at different ratio of MCC and HTC: elastic modulus (green) (MPa), tensile strength (yellow) (MPa), and elongation at break (blue) [%].

⑤ Photodegradation - Fourier Transform Infrared (FTIR-ATR)



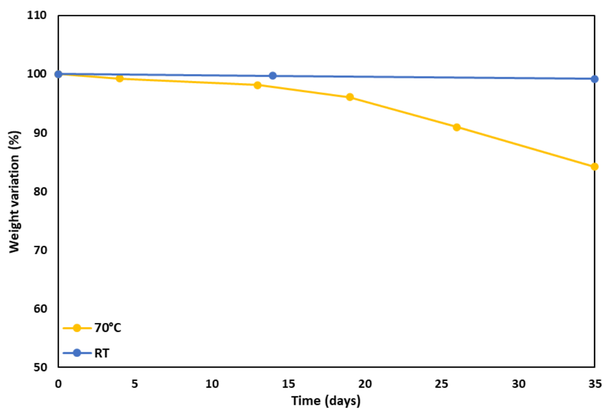
④ Rheological analysis



Rheological behavior of bio-composites: complex viscosity, storage modulus and loss modulus of PBS and PBS composites at different ratio of MCC and HTC.

⑥ Biodegradation analysis

The biodegradability of the composites were investigated in soil and fresh water. However, PBS composites exibite a low biodegradation rate at room temperature. Additionally, a biodegradation process was carried out in water at 70°C and after 35 days there was a reduction of 25% of the initial weight.



Discussion and Conclusions

Cellulose rich-particles were obtained from wood waste through a soustainable process and were used for the formulation of PBS based composites. A comparison with composites based on PBS and a commercial microcrystalline cellulose (MCC) was carried out.

The results highlight a good properties but a low biodegradation rate of PBS in soil and water.

Moreover, the incorporation of particles from wood waste can support the transition from a linear to a more efficient circular economy.

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