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Sustainpack

Innovation and sustainable Development in the Fibre Based Packaging Value Chain

Instrument: **IP**

Deliverable 5.54

Report on the impact of the deposition of inorganic phases on cellulose fibres (hybrids) on water uptake and mechanical properties of 3D composites (Month 38) (UA)

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Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

SUSTAINPACK

WP5.1. – Fibre Modification

Deliverable 5.54

Report on the impact of the deposition of inorganic phases on cellulose fibres (hybrids) on water uptake and mechanical properties of 3D composites (Month 38) (UA)

1. Composites preparation (UAVR, in collaboration with EFPG)

Composite materials were prepared using selected hybrid compositions of SiO₂, TiO₂ and CaCO₃/cellulose and commercial biodegradable polyester Mater-Bi. The description of the preparation methods was already reported in Deliverable 5.29. The composition of the composites studied is presented in the following table.

Table - Composition of the composites

Inorganic phase		Method	Inorganic content (% w/w)	% of hybrid in the composite (w/w)
none	B1	Blank	-	20
	B2	Blank	-	30
	B3	LbL	-	30
TiO ₂	T1	In situ	19	20
	T2	In situ	14	20
	T3	LbL	9	20
	T4	LbL	11	20
CaCO ₃	C1	In situ	8	30
	C2	LbL	6	30
	C3	LbL	7	30
	C4	LbL	10	30
	C5	LbL	16	30
SiO ₂	S1	In situ	25	20
	S2	LbL	5	20
	S3	LbL	7.5	20
	S4	LbL	19	20

2. Results on water uptake and mechanical properties of 3D composites

The composites were tested by dynamical mechanical analysis (at EFPG, Grenoble) and water absorption studies (UAVR).

2.1. Water absorption studies (UAVR)

The results of water uptake of the composites are graphically represented in the next figures.

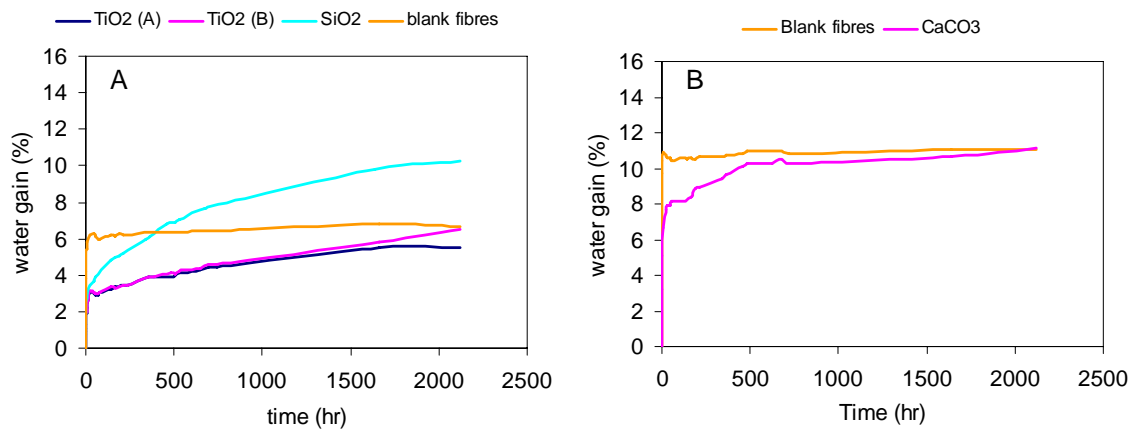


Figure 1. Composites prepared with hybrids obtained from in situ synthesis. A) 20 % reinforcement; B) 30 % reinforcement.

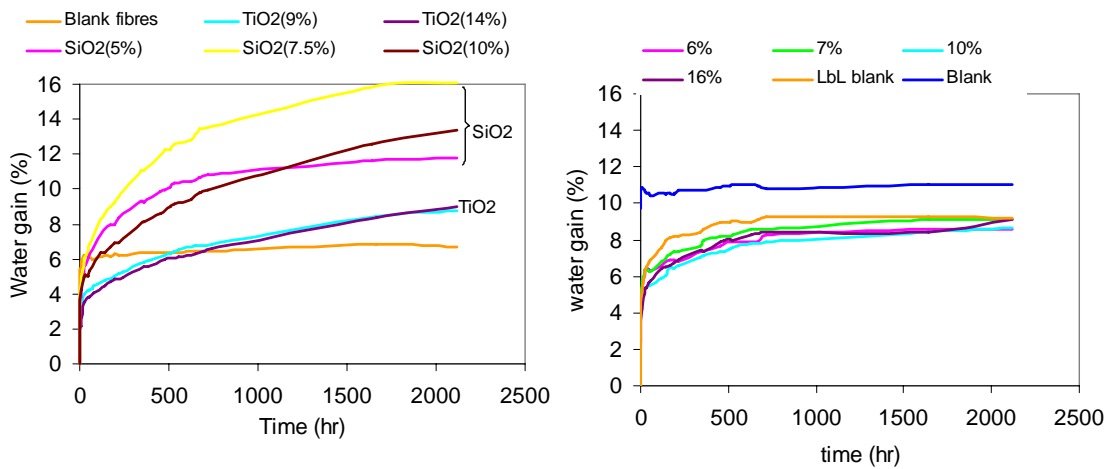


Figure 2. Composites prepared with hybrids obtained from in situ synthesis. A) 20 % reinforcement; B) 30 % reinforcement.

From these results, some tendencies can be outlined:

- The water uptake increases with the fibre load (comparison between 20 and 30%). For the same load, the treatment of the fibre with polyelectrolytes (without mineral particles) decreases the water uptake;
- The composites prepared with hybrids synthesised *in situ* confer less ability for water uptake than the composites prepared with hybrids obtained from the LbL approach;

- For some hybrids, the deposition of inorganic particles onto fibres, retard the penetration of water in the early stages (250-750 h) of immersion of composites in water but, later, the uptake of water increases with respect to blank fibres.
- During the period studied, the composites prepared from TiO₂/cellulose hybrids synthesized *in situ* are the unique that absorb less water than the equivalent blank composite.
- The composites prepared with SiO₂/cellulose fibres, particularly those prepared by the LbL approach, present the higher percentage of water uptake.

2.2 – DMA analysis (EFPG)

The DMA results obtained for the nanocomposites are represented in Figure 3.

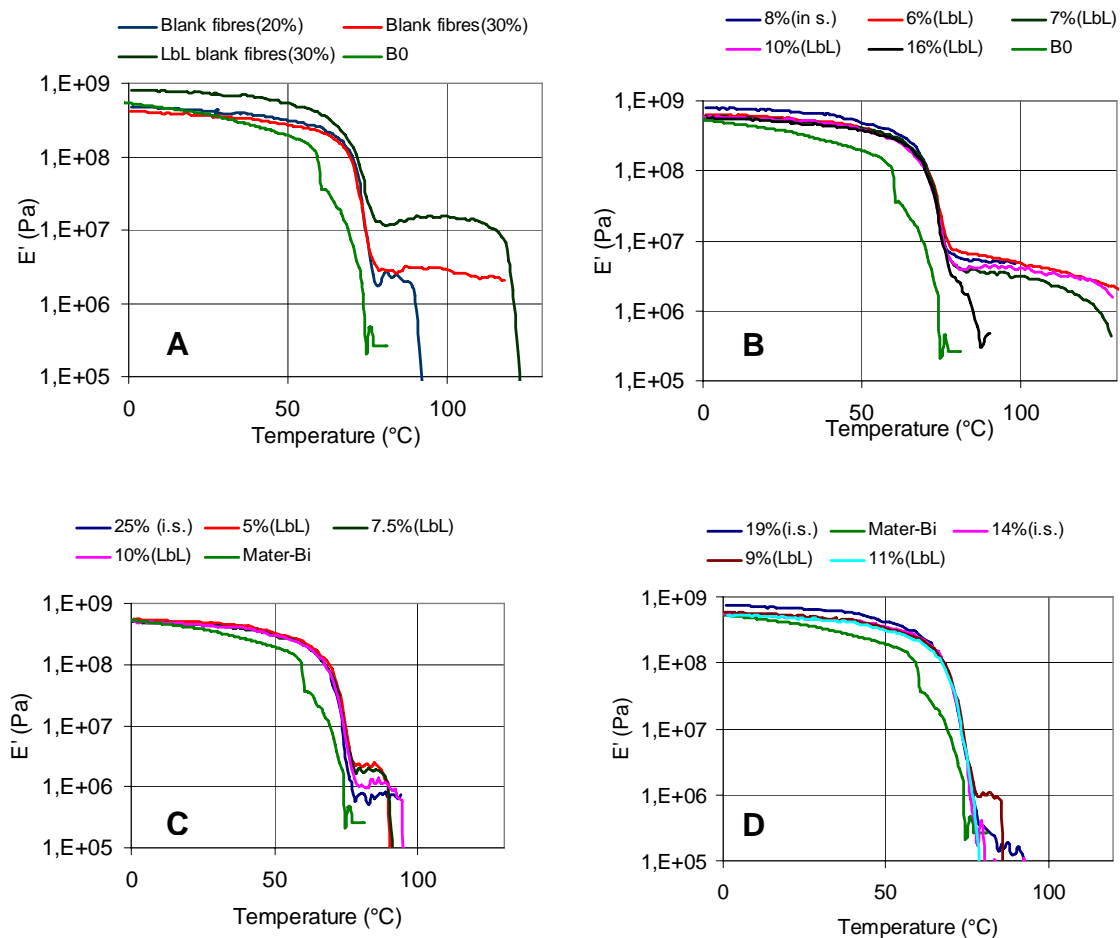


Figure 3. DMA analysis of A) References; B) CaCO₃/cellulose hybrid; C) SiO₂/cellulose hybrid and D) TiO₂/cellulose hybrid

The mechanical reinforcement due to the fibres incorporation in the polymer matrix is observed when compared to blank polymer. Composites prepared with 30% of reinforcement are denser

than composites prepared with 20%, conferring higher interaction between fibres and the mechanical properties are superior.

3. Conclusions

Composites prepared with hybrids synthesised *in situ* confer less ability for water uptake than the composites prepared with hybrids obtained from the LbL approach, thus increasing the dimensional stability in wet environments.

During the period studied, the composites prepared from TiO₂/cellulose hybrids synthesized *in situ* absorbed less water than the other hybrids and than the equivalent blank composites.

Generally, composites show better mechanical properties than the polymer itself due to fibre load, but the increase of particles load at fibre surface show an opposite effect.