CAPILLARY EFFECTS ON FLAX FIBERS REINFORCEMENT; COMPARISON OF CHEMICAL AND MORPHOLOGICAL EFFECTS ON THE LOCAL WETTING DYNAMICS

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Keywords: Capillary motion, Sustainable composites, Surface energy.

Introduction

The push for more sustainable materials, either biodegradable or fully recyclable has motivated the composite industry to look increasingly at bio-based reinforcements and resins. Caring about the sustainability of both the reinforcements and the resin implies to avoid some chemical treatments that could generate unhealthy products or wastes. The chemical surface state of the sustainable reinforcements is thus hard to control, but of first importance. Indeed, the use of Liquid Composite Moulding (LCM) for composite manufacturing in the transportation industry is increasing since it is considered as an effective and low cost process to manufacture bio-based composites fitting the quality requirements even for parts with complex shape. However observations of a large amount of voids in bio-based composite call for an improved understanding of the local wetting phenomena that occur during impregnation of the bio-based reinforcements. The purpose of this work is to study the influence of flax fibre surface chemistry on the local wetting dynamics [1].

Experimental methods

Some flax reinforcements have been submitted to a thermal treatment in order to degrade the hemicelluloses that are partly responsible for the hydrophilic behaviour of the flax fibres. Chemical composition of treated and untreated fibres was assessed by an extraction procedure [2]. After each extraction step the remaining mass has been measured (table 1).

Table 1: *Mass and remaining components of untreated and treated flax reinforcement after each main step of extraction procedure. C: cellulose, H: hemicellulose, L: lignin, P: overall pectin, Ps: structural pectin.*

	Remaining components	Untreated flax mass [g]	Treated flax mass [g]
Initial weight	C-H-L-P	1.000	1.000
EDTA – Acid extraction (HCl)	C-H-L-Ps	0.880	0.893
Basic extraction (NaOH)	C-L	0.847	0.847

Previous works on wood [3] have already shown that the thermal treatment creates free radicals from hemicelluloses degradation. The difference in mass loss during selective dissolution (Table 1) shows an effect of these free radicals on the pectin, increasing the amount of structural pectin.

The wetting behaviour of treated and untreated fibres has been analysed using a tensiometric method combined with optical technique. A scheme of the instrumentation is showed in Figure 1. A DCAT11® tensiometer was used to perform static and dynamic wettability testing, and tests were monitored by a camera.

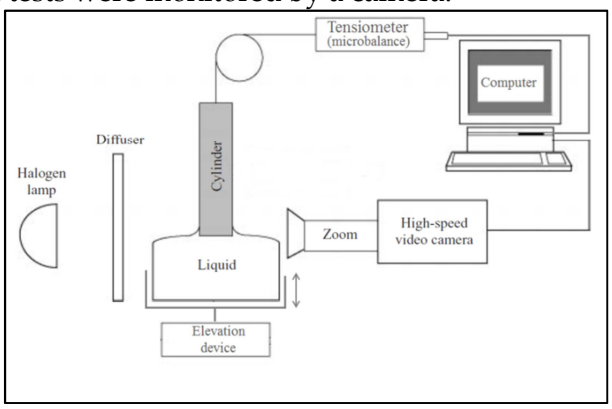

Figure 1: *Scheme of experimental instrumentation.*

Results and discussion

Measurements of static contact angles were carried out through analyses of meniscus profiles (Fig. 2). Modifications of the static contact angle with the fibre treatment have not been found to be relevant. Advancing dynamic contact angles have been characterised using the Washburn method on fibre mats. Results given in Table 2 show a significant effect even if the thermal treatment still has to be optimised. The void contents in 75% bio-based composites processed (flax reinforcements and partially bio-based resin) by LCM with both treated and genuine fibres will be discussed in the communication.

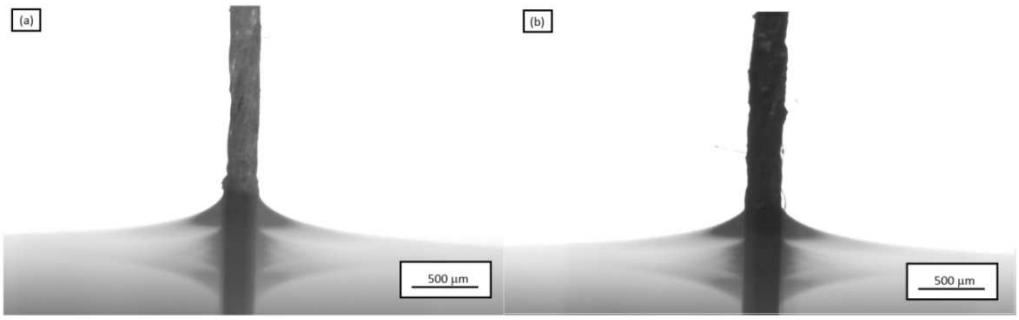

Figure 2: *Observations of meniscus profile for single fibres: a) genuine flax fibre. b) treated flax fibre.*

Table 2: *Advancing contact angles (degrees) between fibre mats and water.*

	Advancing contact angle
Genuine flax fibre mats	69,15 ± 3,44
Treated flax fibre mats	61,45 ± 6,08

References

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