INFLUENCE OF BIO-BASED TREATMENTS ON FLAX/PLLA INTERFACIAL BONDING PROPERTIES

A. Le Duigou*, A. Bourmaud*, P. Davies†, C. Baley*

* : LIMATB (Laboratoire d’Ingénierie des Matériaux de Bretagne)
Université de Bretagne Sud – F – 56321 Lorient CEDEX
e-mail : antoine.le-duigou@univ-ubs.fr, alain.bourmaud@univ-ubs.fr; christophe.baley@univ-ubs.fr
† : IFREMER, Centre de Brest, Materials and Structures group
– F – 29280 Plouzané CEDEX
e-mail : peter.davies@ifremer.fr

Key words: natural fibre, bio-based treatments, interfacial properties

Previous work has demonstrated that common glass/polyester composites can be substituted by flax/PLLA biocomposites. It has been shown that in addition to being bio-based biocomposites can be recycled [1] at end of use and composted at end of life [2]. Moreover their environmental impacts are lower than those of glass/polyester composites [3]. From a mechanical point of view, microbonding tests have highlighted that the apparent shear strength ($\tau_{\text{app}}$) of the flax/PLLA bond without any treatment is as high as those of glass/polyesters [4]. Thermal residual stresses have also been shown to influence interfacial properties. However even if the macroscopic rigidity of flax/PLLA biocomposite is satisfactory compared to glass/polyester composites [5, 6], their tensile strength is lower. Moreover, ageing studies have highlighted that the interfacial area is a preferential zone of degradation [7].

Hence work needs to be performed in order to increase the interfacial properties and especially to create a durable bond between flax and PLLA matrix. Unlike what is mostly done in published work with silane or isocyanate treatments, the purpose of the work presented here is to develop a new bio-based treatment with low environmental impact. Two categories of treatments have been carried out : the first one is based on the work of Bourmaud et al[8] who use water treatments to clean the surface of flax fibres. Table 1 shows the results of microbond tests for untreated and water treated flax/PLLA bond compared to glass/polyester.

<table>
<thead>
<tr>
<th>Material</th>
<th>Special fibre treatments</th>
<th>$\tau_{\text{app}}$ (MPa)</th>
<th>$\tau_{\text{friction}}$ (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLLA/Flax</td>
<td>No</td>
<td>15.3 ± 3.3</td>
<td>7.7 ± 1.5</td>
</tr>
<tr>
<td>PLLA/Flax</td>
<td>Water 72h at 23°C</td>
<td>18.8 ± 3.2</td>
<td>8.4 ± 1.1</td>
</tr>
<tr>
<td>Polyester/Glass</td>
<td>Sizing + curing at 65°C during 14h</td>
<td>14.2 ± 0.4</td>
<td>4.4 ± 0.7</td>
</tr>
</tbody>
</table>

Table 1 : Comparison of interfacial properties untreated, water treated flax fibre/PLLA bond and glass/polyester bond
Even though standard deviations are high, water treatment does appear to influence the debonding and friction properties.

The second step is a functionalization of the fibre surface by means of bio-mimetism approach such as using polydopamine which is a sticky protein from mussels and xyloglucan which is known for its binding ability with cellulose.

Treatment effects are evaluated by TGA and FTIR analyses and mechanical characterization using tensile tests and microbond analysis.

References: