Livrable n°T2.2.1

FABRICATION DE PLAQUES COMPOSITE

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KAÏROS

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EUROPEAN UNION

European Regional Development Fund

Partners

PP Leader : Kaïros

Partners involved : Portsmouth, UBS, Ecotechnilin

Deliverable N° & name :

- **2.2.1 Manufacturing of a composite laminate**

Content

1 Context of activity 2 – WPT2

In this activity, Kaïros has developed new composite materials, with a monolithic and sandwich structure, using the non-woven preform of slightly oriented flax fibres manufactured by Écotechnilin. These materials are intended for use in point-of-sale advertising. As a result, their surface finishes must be smooth and free of visible defects to meet the aesthetic challenges of this field of application. The environmental footprint of these new materials is reduced thanks to their high recyclability and compostability potential and the use of biosourced raw materials. Kaïros has to ensure that the materials meet the specifications imposed by the POP sector (machinability, aesthetic appearance, light weight, good mechanical strength) while at the same time checking that they can be recycled. These materials are produced using the thermocompression process, which ensures short manufacturing cycle times and low processing costs. Numerous tests, such as mechanical strength tests in different environments, UV ageing tests and scratch resistance tests, are carried out to characterise the new material. The results obtained enable a detailed technical data sheet to be drawn up for the material, enabling it to be compared with conventional petro-sourced materials. The manufacture of composite panels is also intended to produce a prototype of a typical POP product. The production of a piece of POS furniture will demonstrate the robustness of the material in this field of application.

Table des matières

2 Fabrication of a composite plate (Deliverable T2.2.1)

Several prototype composite sheets with a format of 2,500 mm x 1,300 mm, in line with a POS application, are produced.

2.1 Materials used

A biosourced and/or biodegradable composite sheet is any composite material with a monolithic or sandwich structure composed of :

- a biosourced and/or biodegradable reinforcement ;
- a biosourced and/or biodegradable thermoplastic or thermosetting matrix;
- a biosourced and/or biodegradable core.

The biosourced composite sheets comprise the elements described below.

2.1.1 Non-woven preform

The preform, developed and supplied by Ecotechnilin (MT1), is made up of flax reinforcement co-mingled with thermoplastic poly lactic acid (PLA) fibres using a needling process so that the fibres are slightly oriented in the direction of the reel unwind. The proportion of flax in the preform is 40%, while PLA makes up 59%, with the carbon black dye making up the final percentage. The weight of the comélé is 100g/m2. The material shown in Figure 1 is supplied by Écotechnilin.

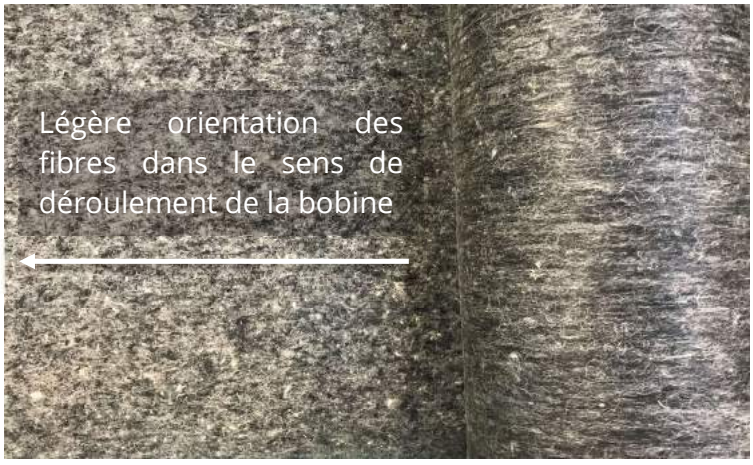

Figure 1 : non-woven preform slightly oriented in the direction of unwinding of the reel

2.1.2 Cork core

One of the sheets manufactured has a sandwich structure with a core of agglomerated, bio-sourced cork. The cork used is 1.5 - 4 mm thick and has a density of 250 kg/m3. The cork core can be present in double or multiple layers in the stacking sequence of the composite sheet and can also be interleaved with the flax/PLA comeles.

2.1.3 PLA film

PLA films are added to the surface of the composite sheet to remedy the problems of porosity on the surface of the composite sheet and to obtain a more aesthetic surface finish. The film has a thickness of 350 - 800 µm and a density of 1.2 - 1.45. In the plate stacking sequence, depending on the final application and the desired quality, several PLA films can be interleaved, alternatively, with the flax/PLA comeles so as to improve the distribution of the matrix in the thickness of the plate and to fill the porosities in the core or to bond the cork with the non-woven preform.

2.2 Stacking sequence

Five stacking sequence plates were produced with the aim of obtaining a smooth, shiny surface with no apparent defects. Their different drapes are detailed in figures 2, 3, 4, 5 and 6 below. The composite sheets are 2400 x 1200 in size after trimming.

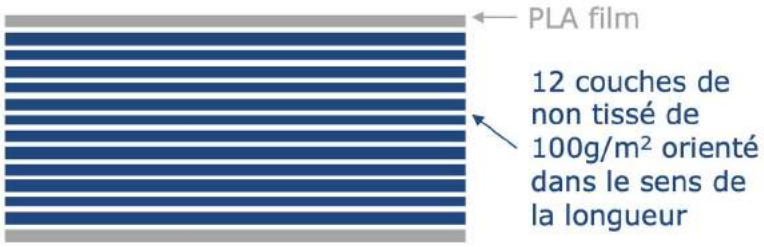

Figure 2 : schéma 2D de la plaque monolithique 1

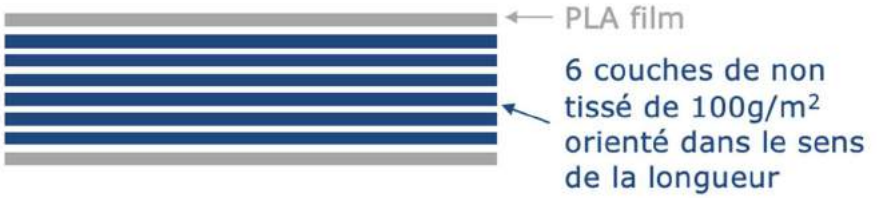

Figure 3 : schéma 2D de la plaque monolithique 2

Figure 4 : schéma 2D de la plaque monolithique 3

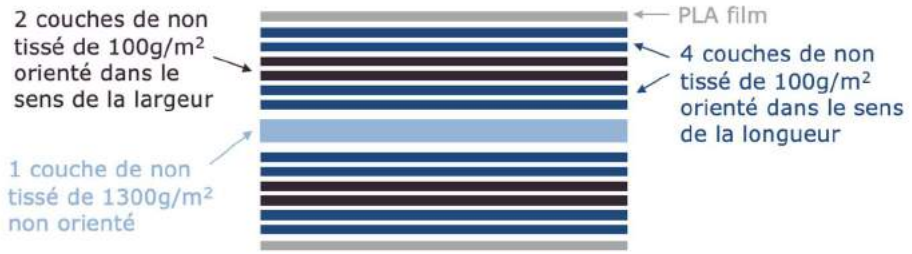

Figure 5 : schéma 2D de la plaque 4

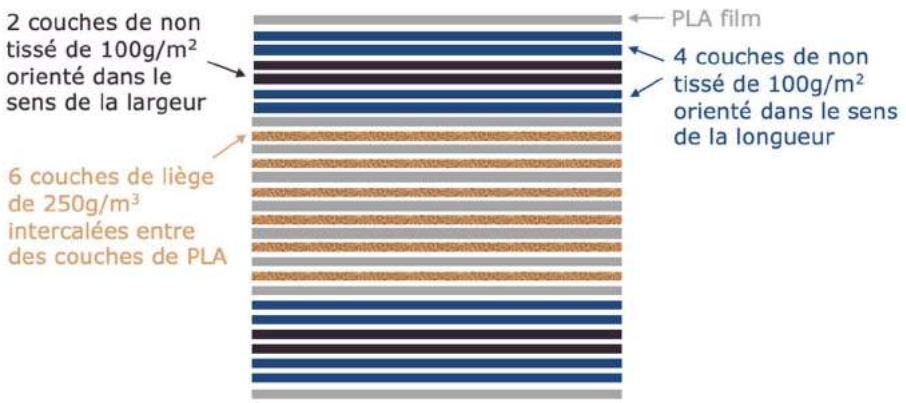

Figure 6 : schéma 2D de la plaque 5 (plaque sandwich)

Figure 7 shows the draping operation carried out on the monolithic plate 3.

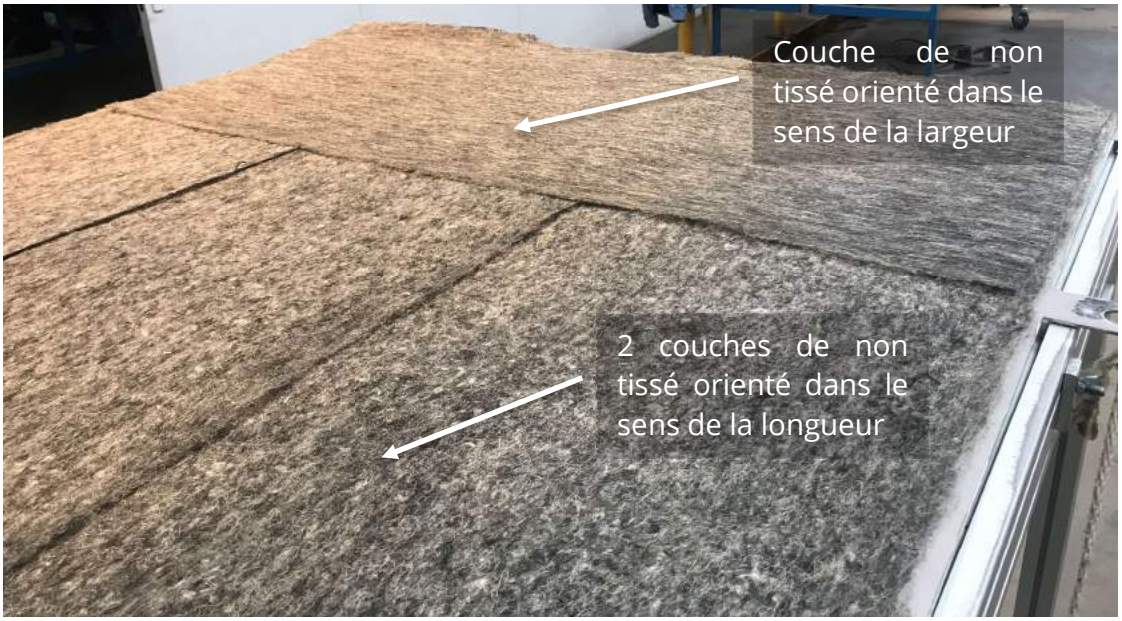

Figure 7 : drapage de la plaque monolithique 3

2.3 Production process

The stacked comelts are inserted between two metal plates and then placed in a hot press to melt the thermoplastic material. The temperature of the press is set according to the melting temperature of the PLA, and must be below the degradation temperature of the flax fibres. The whole assembly is then transferred to a cold-plate press to preserve the amorphous state of the polymer. Optimisation of the process through the acquisition of a chiller has improved the surface finish of the panels through rapid cooling.

The material application phase is divided into three distinct stages:

1. Creation of a stack following the stacking sequences described in 2.2.
2. Inserting the stack between two mirror-polished stainless steel plates.

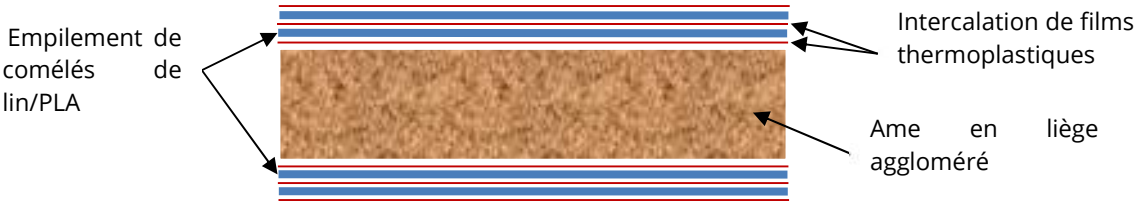

Figure 8 : Constitution of the sandwich structure

3. The whole assembly is heated in an infrared oven to the melting temperature of the thermoplastic. The material is stacked between two mirror-polished stainless steel plates to give the biocomposite material a shiny surface finish and to transfer it from the oven to the compression press.

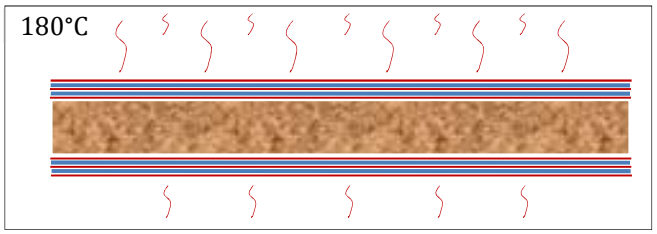

Figure 9 : Heating the unbound sandwich

4. Pressing in a cold mould of the stainless steel plates comprising the skin/core stack to consolidate the sandwich stack.
5. Opening of the press/tooling and demoulding of the stainless steel sheets, including the final biocomposite sheet.

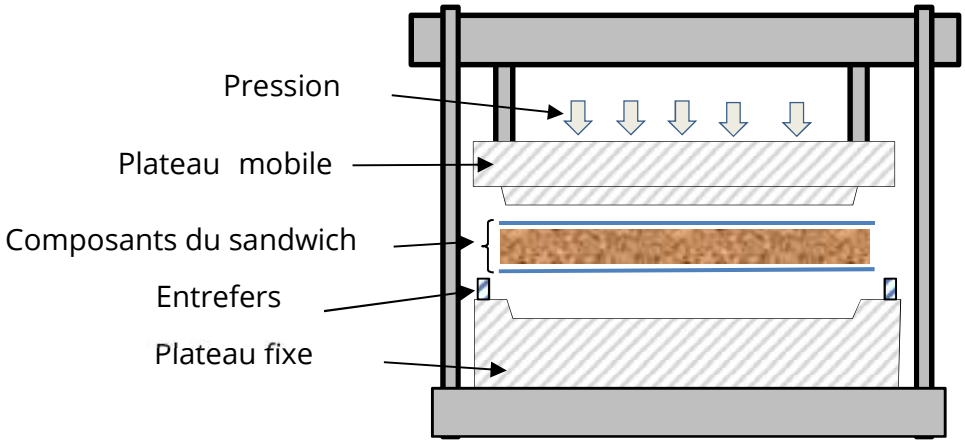

Figure 10 : Sandwich compression for cold consolidation

Figures 11 and 12 show fabricated sheets with a smooth, flawless surface.

Figure 11 : surface appearance of monolithic sheet 3

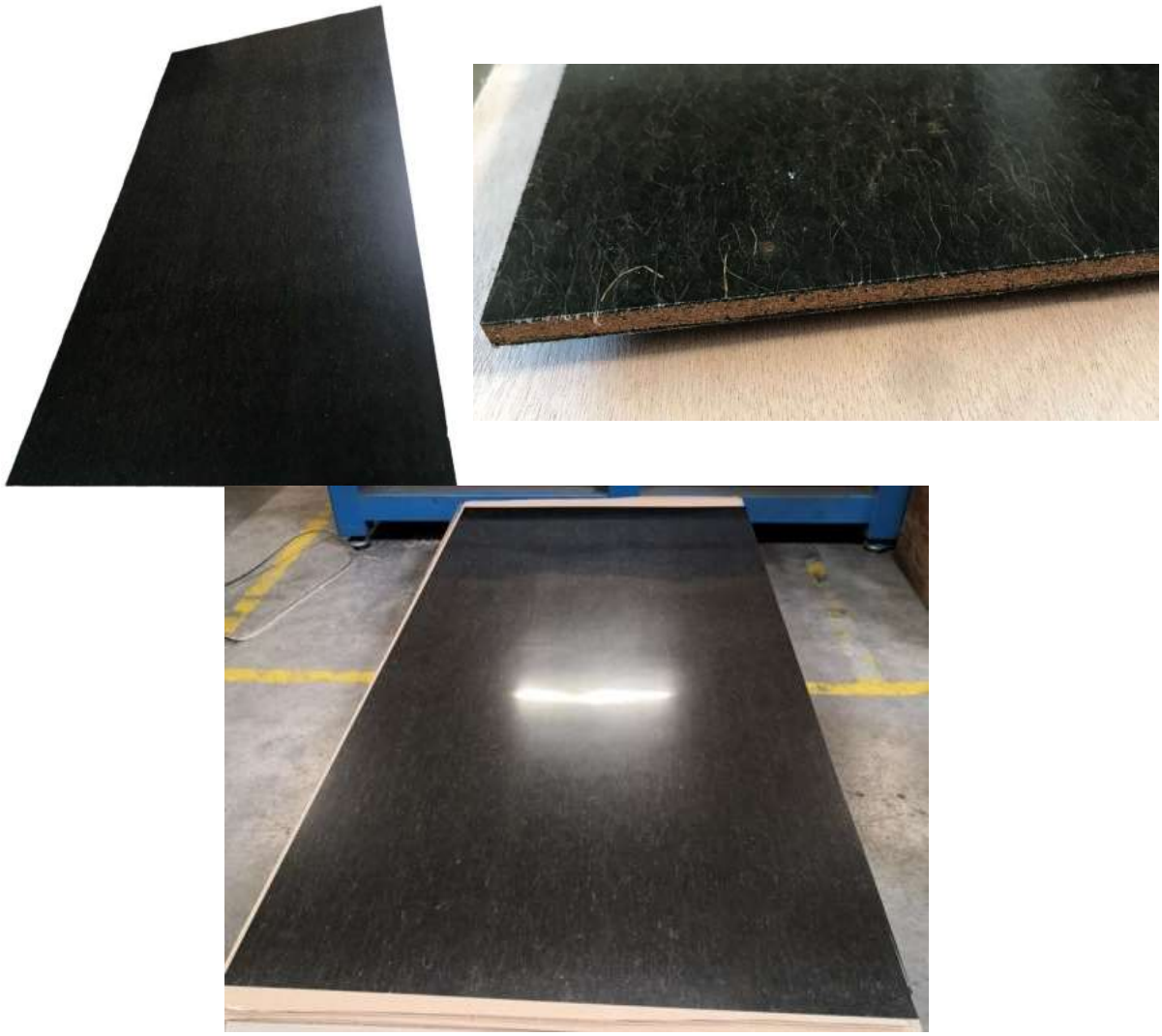

Figure 12 : 5-sandwich sheet, full sheet and surface finish