FLOWER

Flax composites, LOW weight, End of life and Recycling

research • cooperation • performance • flax • biocomposites • recycling • automobile • sailing • advertising • fibre • lightweighting •

Deliverable N°2.5.1.

Prototype of a new car headliner

21/02/2023

PP Leader : Howa-Tramico / EcoTechnilin

Interreg

France (Channel Manche) England

EUROPEAN UNION

European Regional Development Fund

Partners

PP Leader: Howa-Tramico / EcoTechnilin

Content

- Objectives:

The latest industrial tests carried out on the Howa-Tramico production line didn't produce satisfactory headliners. In fact, the headliners deform after hot compression. The headliner therefore don't pass the shape criteria.
Following this observation, we made various observations.
First, we know that the flax veil has a preferential fiber orientation. There are thus more fibers in the machine direction than in the cross direction. EcoTechnilin has therefore worked on the architecture of its veil to get as close as possible to isotropy.
Secondly, we know that the multilayer that makes up the headliner has a direct impact on deformation. In addition, to prevent the fibers from absorbing water, it is necessary to protect the fibers as well as possible. Therefore, Howa-Tramico, UBS and EcoTechnilin have worked together to realize many different architecture possibilities (more than 50) and to determine, by cross-referencing the data, which architecture offers the best compromise between deformability and industrial production.

That's why we add light non woven (spun PP) on the back of the headliner, in order to get a symetric structure. Spun PP similar at that one used to bring catalyst water.

The objective of this report is to describe the different steps of validation on a complete headliner at scale 1. The objective of this trial was to measure the physico-chemical characteristics of a headliner thermoformed with a web flax from Eco-Technilin.
We checked at the different step of the process, the integration of the 2 rolls of flax web on the serial process, the behavior of the headliner after thermoforming and after water jet cutting.
We analysed also the shape of the part in the checking fixture and after that we realized some tests methods asked by the customer to validate the headliner.

The final headliner was produced on February 21st 2023.

- Materials:

The Flax web was provided by Eco-Technilin and will be compared to the actual reinforcement in glass fibers.

Samples	Producer	Fibres	Weight (g/m^2)
Flax web	Eco-Technilin	Flax	100

➢ Description of the manufacturing steps to thermoform headliner :

1- Thermoforming Press with raws materials
2- Water jet Cutting
3- Checking fixture
4- Analysis Part to measure the physico-chemical properties
5- Validation plan.

All theses steps were done to get headliners in order to make comparison with glass fibers and flax fibers.

Step 0 : New veil produced by EcoTechnilin

Objective :

This test set aims to determine the parameters of the Flower line which influence the orientation of the fibers in the veil.
Better knowledge of these parameters will make it possible to better control the orientation of the fibers and therefore to modify the properties of the veil if necessary.

Production Line: Flower Prototype Line

Orientation measurement: Orientation measurement performed by Elouan and Coralie from UBS using an optical method

Methods: Parameters

We are studying new line settings that strongly modify the stretch between the different organs.
By modifying the stretch, we imagine playing on the phenomena of alignment of the fibres.
To verify this theory, we study extreme parameters of the line with min stretches.

Measures : Realised by Coralie Buffet (UBS)

An analysis of the 2 sides of the flax fiber veil (front and back) is carried out. The veil appears to have one smoother surface than the other. This smoother side (recto) corresponds to the part of the nonwoven, which is initially on top. It is the surface which is most in contact with the comber during the formation of the veil and which is intended to be the least oriented.
The less smooth side (back) is the side farthest from the doffer and is therefore the most worked by the large drum. We can assume that this face will be more oriented.

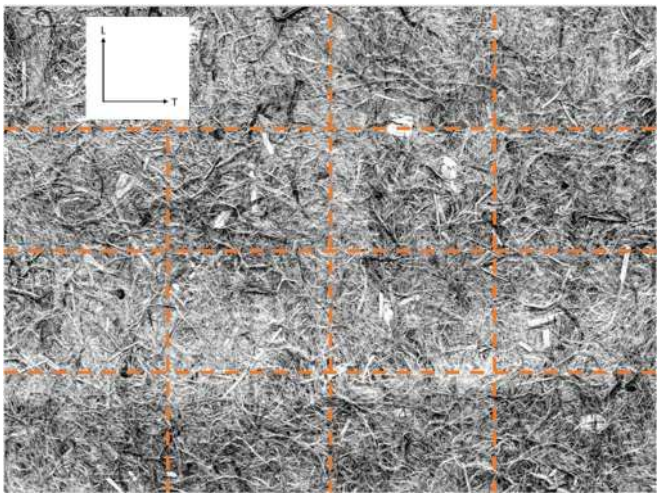


Figure 1 : Surface of the back analysed

Results : min stretch

The curves representing the average relative frequency of these 16 analyzes as a function of the orientation of the fibers are presented in figures 2 and 3. The 90° angle corresponds to the longitudinal direction, that is to say the machine direction (working direction of the rollers).

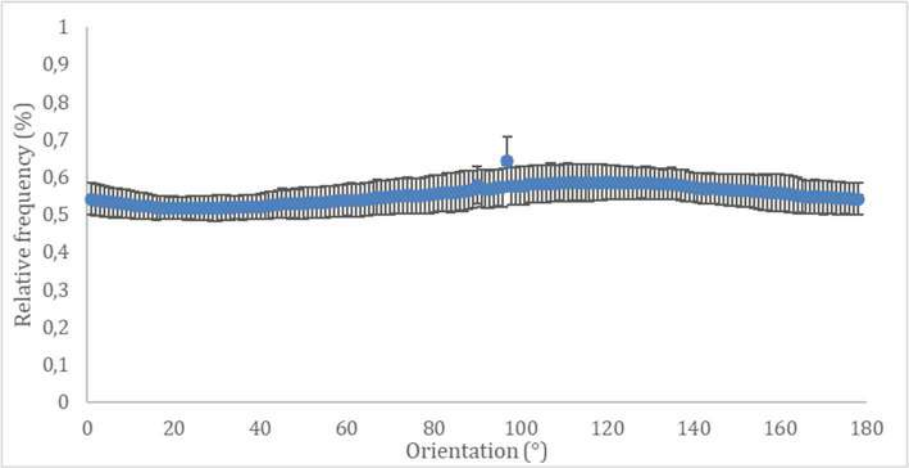


Figure 2 : Fiber orientation distribution obtained for the front of veil with min stretch.

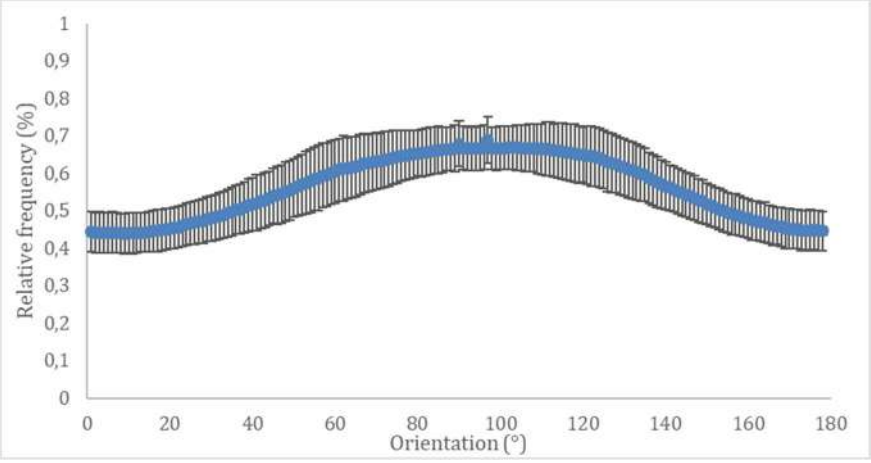


Figure 3 : Distribution of fiber orientation obtained for the back of the veil with min stretch.

Results: Comparison with previous veil (Realized by Elouan)

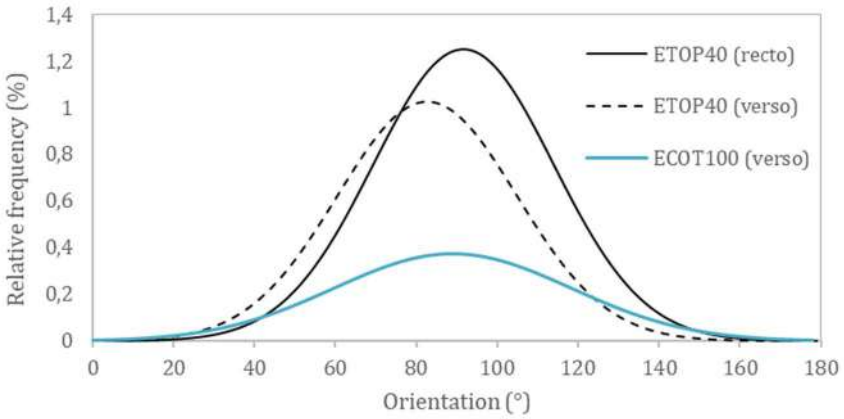


Figure 5 : Comparison of fiber orientation distribution between the 2 veils

Conclusion :

The modification of the stretching on the line strongly influences the preferential orientation of the mat.
The veil is now almost isotropic.

Step 1 : **Thermoforming**

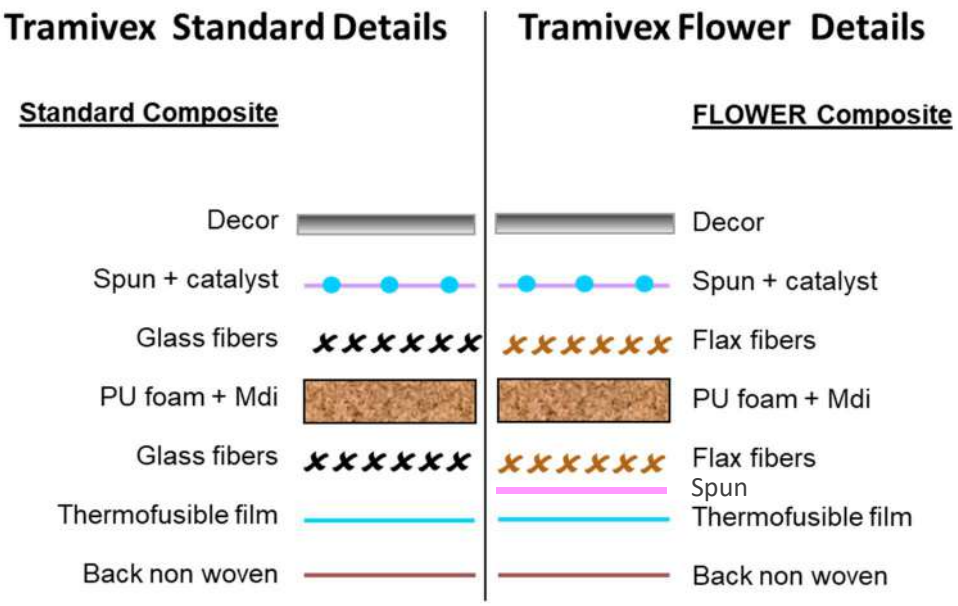
This step allows to validate the integration of the raw material on the machine and the headliner thermoformed.

Raws materials used :

Standard materials for the structure (back non woven, thermofusible film, PU foam, Mdi, Spun + catalyst and decor knitted fabrics.

For the reinforcement, we thermoformed headliners with standard glass fibers and after that we replaced glass fibers by flax web. We add a spun on the back side between the flax web and the thermofusible film.

- Flax web ECOT 80 : fibers 80 mm length.
  2 Rolls width 1500mm made with 3 strips of 500 mm bounded by an hot melt web (20 mm width).



- **<u>1st trial on serial process to thermoform headliner D34TN (Scale1)</u>**

  The process parameters between glass fiber and flax headliners stayed the same (line speed, quantity of Mdi, tool temperature and cycle time).

Step 2 - Thermoforming Process. Integration rolls on the machine.

Step 3 – Water Jet Cutting

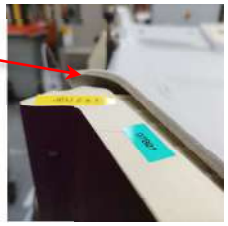
Headliner in position on the cutting support water jet

Part thermoformed before cutting

Operation to cut the thermoformed headliner in a final part

Step 4 - Checking Fixture

Operation for checking all the cutting done on the final part. External and internal cutting.



Corner edge

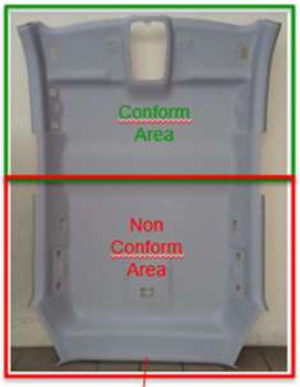
Front Line

Front Line

Back Line

We observed some deformation of the headliner on the back side of the part.

Better behavior on the front area of the headliner than on the back area.



At this stage, we notice a deformation problem that makes the headlining unsuitable for sale. The headliner is not flat, but curves at one end.

In step 5, all the tests were carried out on samples with different parameters in order to find the best ones to avoid this deformation. Around fifty different plates were tested to obtain the best and most accurate data.
The standard method ("Spun") was replaced by MDi spraying and the grammage of the linen voile was 70g, 100g or 150g. Conventional non-woven was also replaced by NT60 or NT40. Below are examples of the sheets that were tested with the best results. All sheets have been ranked from best to worst in a table.

Plaque pour le 27/01/2023
NT40 - Spun - Flax 100 - E2024 - Flax 100 - Spun - Dilour
NT40 - Spun - Flax 100 - E2024 - Flax 150 - Spun - Dilour
NT40 - Spun - Flax 70 - E2024 - Flax 150 - Spun - Dilour
Pulvé NT40 - Flax 70 - E2024 - Flax 150 - Dilour
Pulvé NT60 - Flax 70 - E2024 - Flax 150 - Dilour
Pulvé NT60 - Flax 100 - E2024 - Flax 150 - Dilour
Dilour - Spun - Flax 150 - E2024 - Flax 70 - NT60
NT60 - Flax 70 - E2024 - Flax 150 - Spun - Dilour

Examples of sheets tested during the trials

Résultats	
Pulvé NT40 - Flax 100 - E2024 - Flax 150 - Dilour	3,6
Dilour - Spun - Flax 100 - E2024 - Flax 100 - Spun -NT40	3,9
Pulvé Dilour - Flax 150 - E2024 - Flax 100 - NT40	4,4
Dilour - Spun - Flax 150 - E2024 - Flax 100 - NT(60)	4,6
NT(60) - Flax 100 - E2024 - Flax 150 - Spun - Dilour	4,8
NT40 - Flax 100 - E2024 - Flax 150 - Spun - Dilour	4,9
Dilour - Spun - Flax 150 - E2024 - Flax 100 - NT40	5,8

Example of results from the best sheet to the last

Confidential information

We have succeeded in defining an optimum composition with the lowest deformation rate, which is as follows:

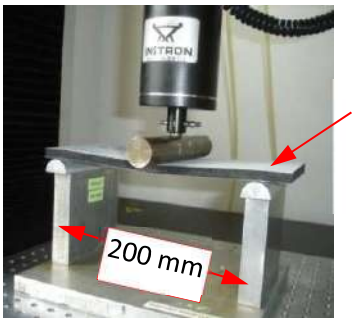
NT40 – Spun – Flax 100 – E2024 – Flax 100 – Spun – Dilour (Confidential results)

The final prototype was produced on February 21st.

Step 5 – Analysis headliner - Equipment

- Tensile and compression device

Peeling Test



Sample Size

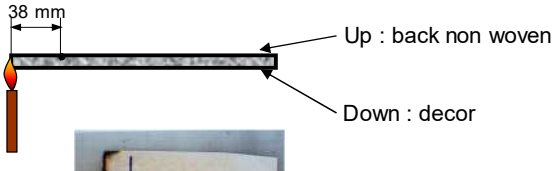
250 x 100 mm

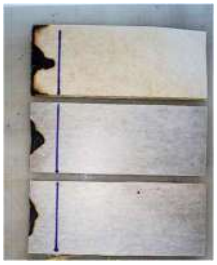
Bending Test

- Combustibility Chamber

Samples tested

Combustibility Test drawing





- Climate Chamber

Heating Chamber for moisture test

30 days at 40°C

(4 x) BF Cycles

1 cycle = (16h at 40°C with 95% relative humidity) +

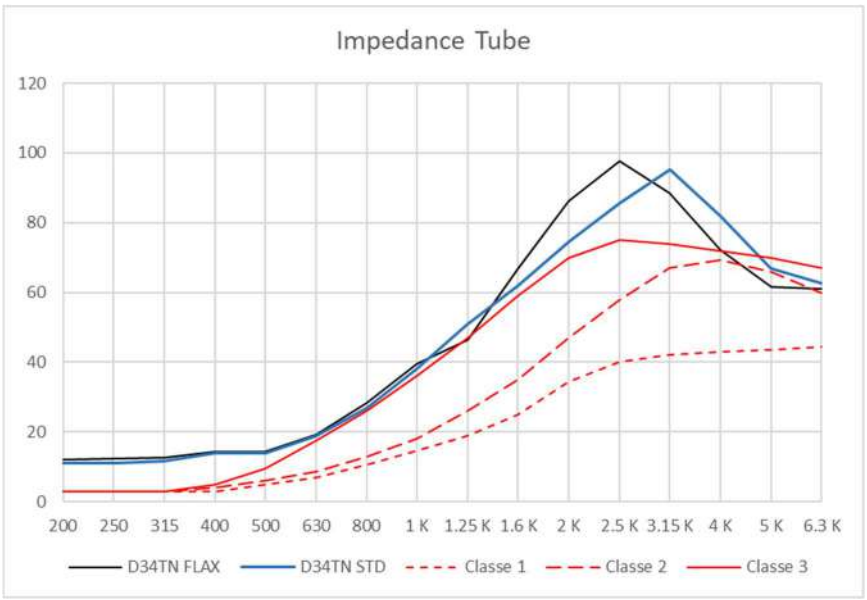
(3h at -20°C) + (6h at 100°C)

- Fogging Device

3 H à 100°C

- Acoustic Devices

Impedance Tube



Step 6 – Results:

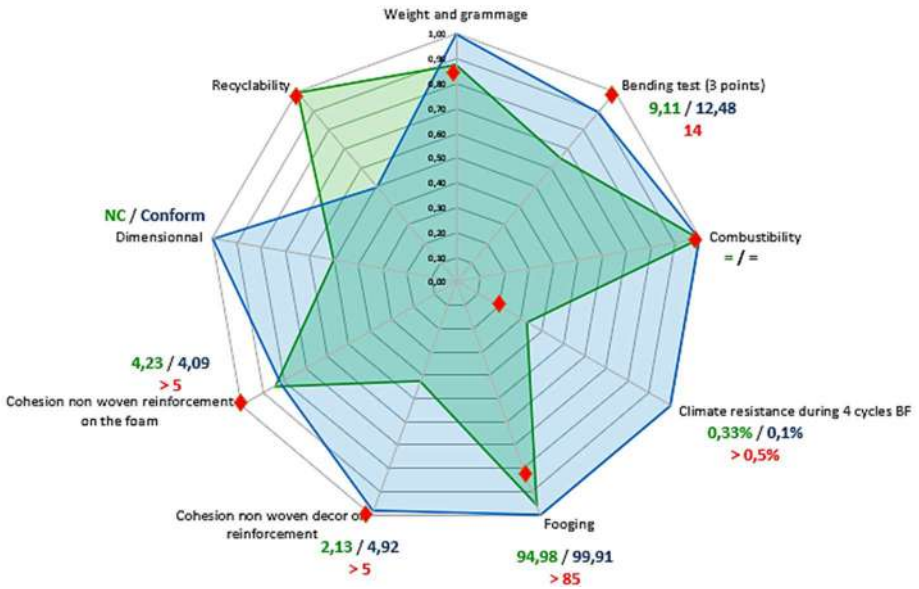
VALIDATION PLAN D34TN - February 23

COMPARISON FLAX / GLASS FIBER

Knitted Fabrics laminated

Specifications Test Method	Tests		Tramivex Flax	Tramivex Glass Fiber
D45 1012	**Weight and grammage**	weight : gr Grammage : gr/m²	- 880	- 813
D41 5110	**Bending test (3 points)**	F=14 +/- 5N - Force in N for a deformation at 5mm	9,11	12,48
D45 1333	**Combustibility**	V < 100 mm/min - Speed in mm/mn Type B - Very good	Type B	Type B
D47 1309	**Climate resistance during 4 cycles BF**	No deformation Dimensionnal variation ≤ 0,5%	0,33%	0,10%
D45 1727	**Fooging**	3h at 100°C - F > 85% EC < 5%	F= 94,98 % EC = 0,54 %	F + 99,12 % EC = 1,52%
D41 1015	**Cohesion non woven decor on reinforcement**	F > 5 N - Average Force (in N) Vertical Peeling	2,13	4,92
	Cohesion non woven reinforcement on the foam	F > 5 N - Average force (in N) Vertical Peeling	4,23	4,09
	Dimensionnal	on Checking Fixture	NC	Conform
	Recyclability			
	Moisture Test	30 days in a humidity environnement at 40°C	Conform - No moisture	

Comparison chart



The real advance of that trial is the improvement of the behavior after climate cycle resistance test.

Conclusion

For the second trial at scale 1, the results are mainly positive. Some actions will be done to resolve the non-conformity observed on few tests.

Howa-Tramico will investigate and carry on the development in order to get in his own product range a new headliner with flax fibers.