The further consolidation of the industrialization of flax reinforced thermoplastics

By

Marc Audenaert
Vice-president, FiMaLin
R&D partnerships Manager – Arkema

Eleven industrial partners from all along the technical flax-fibre supply chain joined forces with four laboratories in Fiabilin collaborative project to develop sustainable applications using high-performance biosourced thermoplastic composites.

The five-year Fiabilin project has a budget of €17.7 million, partly financed by the French investments for the future programme with support funds mustered by the French government and the Upper Normandy and Brittany regions. The project, initiated by the FiMaLin® association, is the most significant contribution to setting up a new agro-industrial supply chain in France for the use of technical flax fibre in the composite industry.

The project relies on the work of FiMaLin, which is financed in Upper Normandy by the French government and the European Regional Development Fund (ERDF), along with FiMaLin's growing number of members in France. Its industrial members have observed that manufacturers that use composite materials recognize the suitability of flax-fibre mechanical properties for technical purposes in materials, as the properties are close to those of glass fibre. Due to its low density, flax fibre is also eminently suitable for the production of lighter composites. However, for these user manufacturers, the upstream supply chain suffers from the lack of 1) information about the available qualities, quantities and prices, and 2) a guarantee that the qualities available now will also be available in future years, as the applications continue to be commercialized.

Interesting flax properties

France produces 70% of the flax fibres used worldwide. Flax fibre production represents 85% of all natural fibre (flax, hemp, miscanthus) production in France. However, in past centuries, flax fibre was used uniquely for textile applications. For a very long time, therefore, flax fibre properties have been meeting the requirements of that sector, which are not sufficiently high for the composite industry.

Table 1 shows the properties of fibres used routinely in the composite industry, compared to those of flax fibres. Two things stand out: the low density of flax fibres compared to glass fibre (which has comparable mechanical properties), and the high variability of the mechanical properties for flax.

Reliable supply

When comparing these data, downstream manufacturers have to wonder what industrial quality of flax fibres could be supplied – and in what quantities, for how long, and at what price. How can a supply chain that starts upstream with a plant crop and ends downstream in the form of composite parts become organized to deliver high-quality products to manufacturers consistently over time?

Tab. 1: Comparison of flax fibres with current fibres used in composite materials (Source: Fibres naturelles de renfort pour matériaux composites, Christophe Baley, 2004, REF AM 5 130, Techniques de l'Ingénieur.)

Fibres	E(GPa)	A(%)	σ_r(MPa)	Density
Glass (E)	72-73	4,6-4,8	3200-3400	2.54
Carbon	203	1.5	3530	1.7-1.9
Aramid	124	2.9	3620	1.44
Flax	12-85	1-4	600-2000	1.54

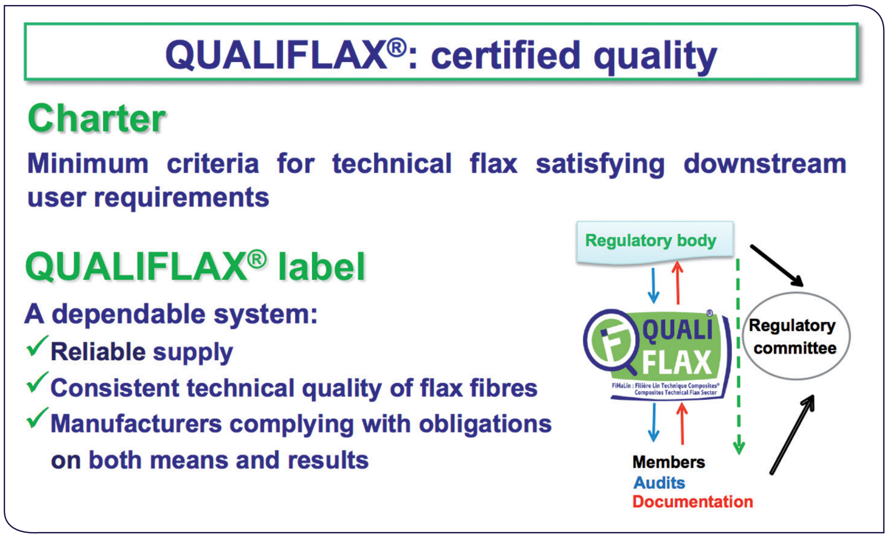

Fig. 1: Key features of the Qualifax label

This is the question that must be raised on the issue of what industrial vision is required for technical flax used in composites.

FiMaLin, which brings together manufacturers who are aware of the advantage of and need for a reliable supply chain to sustain their development, has been focusing on such issues since 2009. Partner laboratories, technical centres and engineering departments have also joined the association to help develop sustainable applications as part of the collaborative projects initiated by manufacturer members.

The technical means for achieving a reliable supply are a matter primarily for flax fibre producers, at least for those aspiring to commercialize their raw materials for composite applications. For them, FiMaLin proposes a quality system whereby the fibre supply is certified by an independent organization in terms of performance and of ensuring a reliable supply over multiple years. The certification has been given a label, called Qualiflax®. For downstream manufacturers, this should eliminate the risk of suffering shortages of high-quality fibres (Figure 1).

For FiMaLin's industrial members, it also rapidly became obvious that assigning agricultural plots dedicated to composites and developing processes adapted to specific composite requirements would make it possible not only to guarantee correct traceability and to stabilize quality and prices, but also to move forward on the production of flax fibres with higher performance than that required in the textile field.

Expanding technical applications

The Fiabilin project is helping to make the transition between a past where the demand for natural fibres did not really need steps to secure a reliable supply, and the future, where applications will develop insofar as the risks linked to the variability and availability of a plant-based raw material are completely under control. The goal of the project is to innovate all along flax fibre value chain, from upstream all the way to downstream (as illustrated in Figure 2) in order to industrialize high-performance composites that are mostly biosourced, for applications in the automotive, aerospace, boating, construction and sports & leisure sectors.

These new, sustainable applications that turn to plant-based raw materials are ones which require the use of more lightweight composite materials.
It has been shown that creating a composite using a combination of flax-fibre reinforcement and a polymer like polyamide 11 allows a potential 10-15% weight saving over a composite created with glass fibre and the same polymer, for equivalent mechanical properties. This was calculated for flax fibres with an elastic modulus of 45 GPa, a value that can be achieved currently at the industrial scale. But the higher the fibre's elastic modulus, the greater the weight savings, as shown in Figure 3 below,

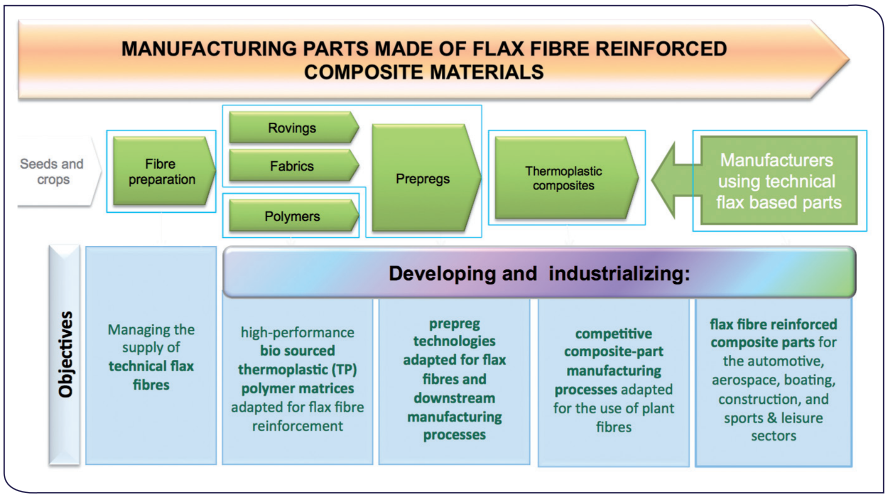

Fig. 2: The value chain for technical flax composites

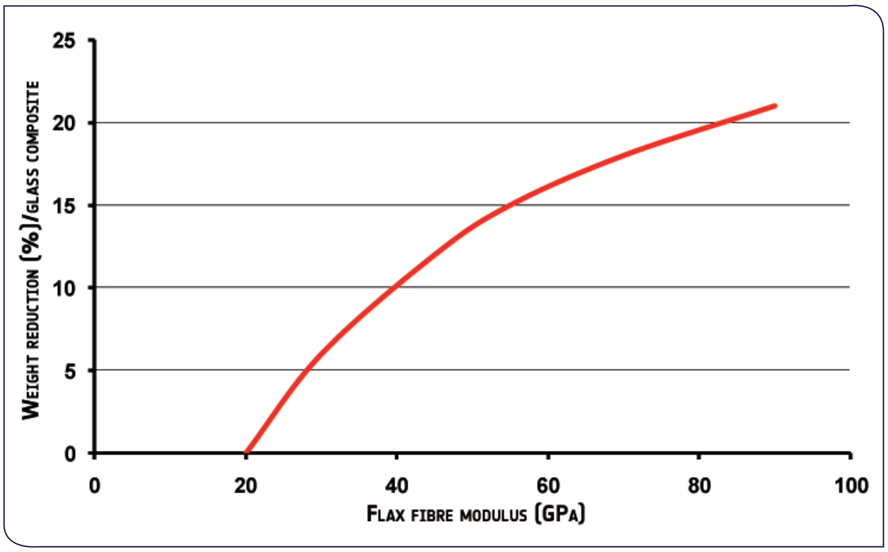

Fig. 3: Weight reduction compared to glass fibre based composites as a function of flax fibre modulus

illustrating the expected weight reduction when switching from glass fibre to flax fibre.
A further goal of the Fiabilin project is therefore to develop fibres with higher elastic modulus. New varieties with potential for higher modulus and productivity are being studied.

These should broaden the field of technical possibilities. However, it will also be necessary to ensure a reliable supply for each of the different qualities of flax fibre that will be available for composite applications. Over the long term, this will also concern semi-finished products. ■

More information:
www.fimalin.com

Contact:
contact@fimalin.com

Aknowledgements
FiMaLin would like to thank all Fiabilin partners : Arkema, Terre de Lin, Dehondt Technologies, Dedienne Multiplasturgy Group, Fibroline, Schappe Techniques, Coriolis, Saertex, C&D Adder, Magna Steyr, SPBI Beneteau, Armines, LIMATB, LGCIE, CETIM.