INNOVATIVE FULLY BIOBASED HYBRID TAPES FOR STRUCTURAL COMPONENTS IN LIGHTWEIGHT CONSTRUCTION – A COOPERATION BETWEEN NORTH RHINE-WESTPHALIA AND FRANCE

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Natural fibers are mainly used as fleece fabrics in fiber reinforced composites in low load applications such as automotive inner door panels. Due to their superior mechanical properties natural fibers can also be used in structural components (Table 1Table 1). To date, the limited application of natural fibers in this field is caused by short fiber length (staple fibers) and anisotropic properties. Fibers must be stretched in load direction to yield their maximum mechanical potential. It is currently state of the art to twist stretched fiber sets to enhance the strength of staple fiber yarns during further processing (e.g. weaving). Twisting fibers leads to a misalignment with the load direction. [RAL+13] Therefore, the twisted yarn must be re-stretched in the composite part before it can bear any load. The necessary extension in structural parts damages the fiber reinforced material because of the matrix material's limited elasticity.

Table 1: Selected properties of flax and E-glass fibers [HM11, BBO+13]

Fiber Material	Flax	E-Glass
Specific Strength σ/ρ [MPa/(g/cm³)]	599	962
Specific E-Modulus E/ρ [GPa/(g/cm³)]	13	27
Density ρ [g/cm3]	1,5	2,6

It is possible to produce non-twisted yarns with alternative spinning methods such as enwind spinning. A drawback with this procedure is a remaining, very light twist. Furthermore, these yarns have a reduced diameter of approximately 1 – 2 mm. Therefore, large amounts of yarns must be produced for a flat fabric of 1 – 2 m width and several meters length. Tape technology delivers flat ribbons (tapes) of approximately 1,5 mm thickness and a width of 50 mm. This technology is to date commonly applied to filaments made of e.g. carbon fiber. The production of classic tapes is a slow (< 20 m / min) and costly process because mostly yarns and rovings are used. Disadvantages in the tape production are leveraged downstream when producing final parts by technological and economic advantages over classic yarn-based processes. For example, flat fabric production is significantly sped up by the large tape width.

Fully bio-based hybrid tapes for use in structural components have been produced for the first time in the project "Ultra Sonic Bio-Based Hybrid Tapes (Sonic Bio-Tapes)" (funding code: ZF4018761EB7) in the funding scheme "The Central Innovation Programme for SMEs – ZIM" by the Federal Ministry for Economic Affairs and Energy (Germany) and in the scope of the second request for proposals for joint research and development projects for small and

medium-sized companies in France and Germany. Bast fibers are aligned in parallel in the mixing process. Bio-based PA 11 is liquified by the heat generated in an ultra-sonic welding process, consolidates the tape, and serves as matrix material in the final part (Figure 1). Two French companies, Sofila SAS, Lyon, France and Safilin SAS, Sailly-sur-la-Lys, France, support this research project. Sofila selects and melt-spins bio-based PA 11 suitable for composite materials. The selection is based on criteria such as fiber-matrix adhesion with flax fibers from Safilin. Hybrid ribbons are produced from flax and PA 11 by Safilin. The Oberhausen, Germany based company EM-Systeme GmbH develops an ultra-sonic consolidation unit for processing these hybrid ribbons. The unit can be installed in conventional fiber processing plants. The Institute for Textile Technology (ITA) at RWTH Aachen University, Aachen, Germany produces tapes from the hybrid card slivers made from flax and bio-based PA 11, which are finally hot-pressed into composite structural components.

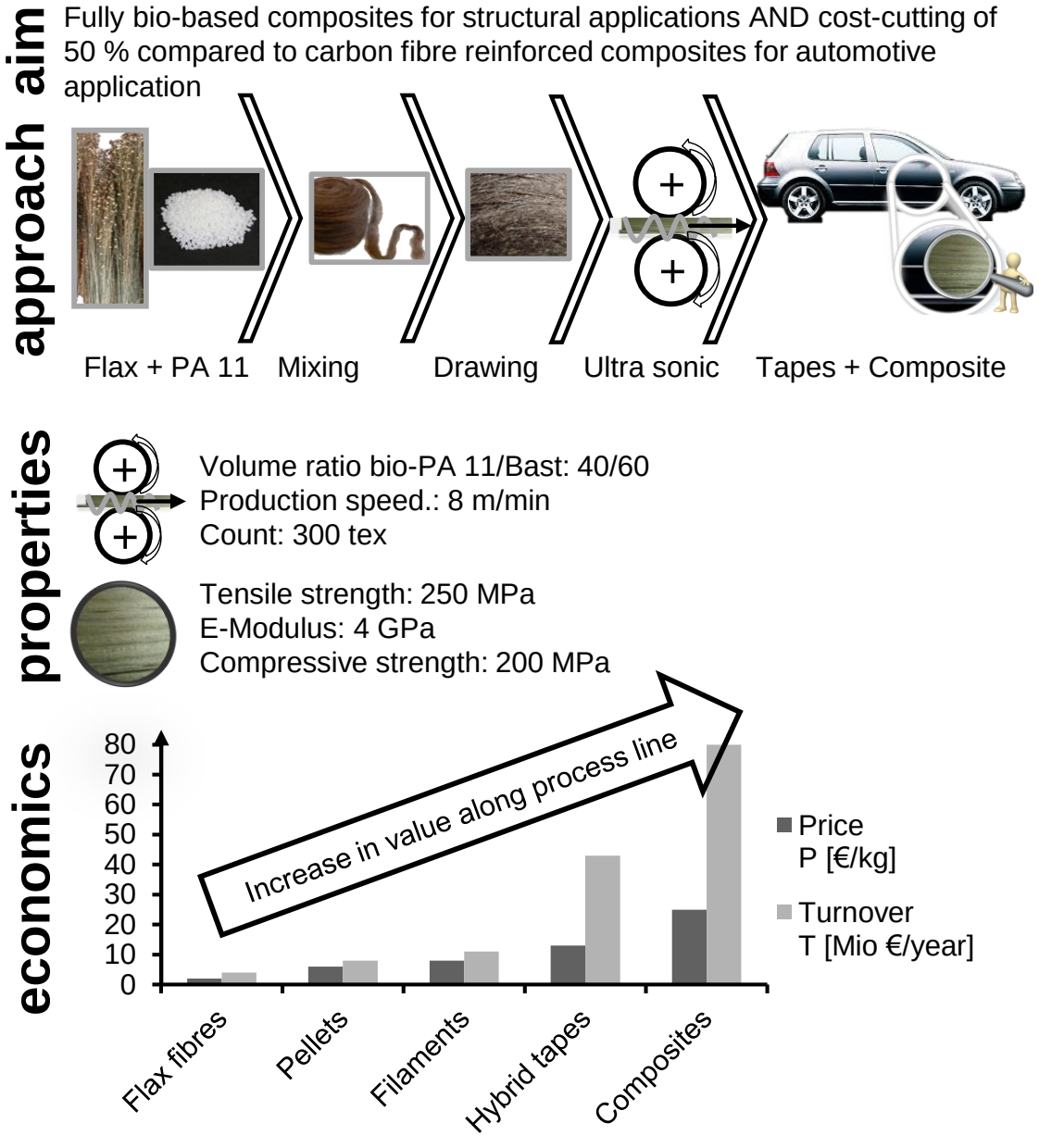

Figure 1: Central illustration of the research project

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