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Project title: Innovative yarn structures and their competitiveness as part of the project fibre-reinforced composites for structural applications based on novel, low-twist bast fibre yarns (NF-CompPlus)

Project partner: Institut für Textiltechnik der RWTH Aachen, Aachen

Hochschule Bremen, AG Biologische Werkstoffe, Bremen

INVENT GmbH, Braunschweig

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Mission Statement:

Multiaxial fabrics are often used in industrial lightweight construction as reinforcing structures for fibre-reinforced composite structures (FRP) subject to high mechanical loads. Reinforcing fibres are made of glass, carbon or aramid. The production of fibres is associated with a high energy input and therefore results in a poor CO_2 footprint within the production of FRP. Demands for increased resource and energy efficiency are already being called for by legislators and society.
Currently, the use of NFRPs is limited to non-structural components that are subject to low mechanical loads, such as interior door panels in vehicles. However, natural fibres have the potential to be used in highly stressed components, as they have twice the specific stiffness and about half the specific strength of glass fibres in their unprocessed state. In addition to ecological advantages and suitable mechanical properties, the good damping behaviour of NFRP is another advantage of using natural fibres in composite materials.
Up to now, natural fibres have been given sufficient strength for further processing by twisting the drawn fibre package. Due to the ondulation, the high mechanical properties of the natural fibres cannot be used in the composite material. As a result, the mechanical property potential of the NFRP is greatly reduced. The production of low-twist or twist-free yarns is therefore absolutely necessary.

Aim:

Within the NF-CompPlus project, innovative yarn structures made of staple fibres will be developed. These are to be used instead of the long flax fibres previously used in the structural component sector. The yarns developed are to be produced with little or no twist, so that the fibres are oriented in the direction of force in the composite and similar mechanical properties can be achieved comparable to long flax yarns. In order to ensure sustainable and economic development, the individual development stages from the fibres to the composite component are to be combined with ecological and economic considerations. The aim is to develop prototypes from vehicle construction. By using the newly developed natural staple fibre yarns, it is to be shown that NFRPs are more than a simple substitute for conventional

fibre-reinforced plastics. In combination with glass fibres, a prototype composite material for fibre elements made of bast fibres with optimised damping properties is to be developed at the end of the project.

Results:

The project has succeeded in developing a new type of staple fibre yarn from flax and hemp. The fibres in the yarn core have an almost unidirectional (UD) fibre orientation. The reinforcing effect of the developed flax yarn was determined by the production of UD test specimens and compared with the characteristic values of commercially available composites reinforced with flax roving. The results showed that the staple fibre yarn made from flax tow achieves a comparable reinforcement effect. Subsequently, a staple fibre yarn made of hemp was developed in a similar process. Due to the currently lower raw material price, the costs for the semi-finished products could thus be further reduced. The reinforcing effect of the hemp yarn compared to the yarns made of flax could not be fully achieved. However, characteristic values above 90 % of the bending strength and the bending modulus were achieved. A deficit of the hemp yarns is the strengthening effect of the impact strength.

The flax and hemp yarns were then industrially processed into fabrics from which composite laminates were produced using industrially applied processes. In addition, a demonstrator component - a leaf spring for a bogie of a narrow-gauge railway - with improved damping properties was produced. The project goal of developing an alternative, cost-effective yarn for high-quality semi-finished fibre products in the composites sector was successfully achieved.

Abb.1: NFRP demonstrator of a leaf spring for a bogie of a narrow-gauge railway built by NOVACOM Verstärkte Kunststoffe GmbH, Aachen, Germany

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