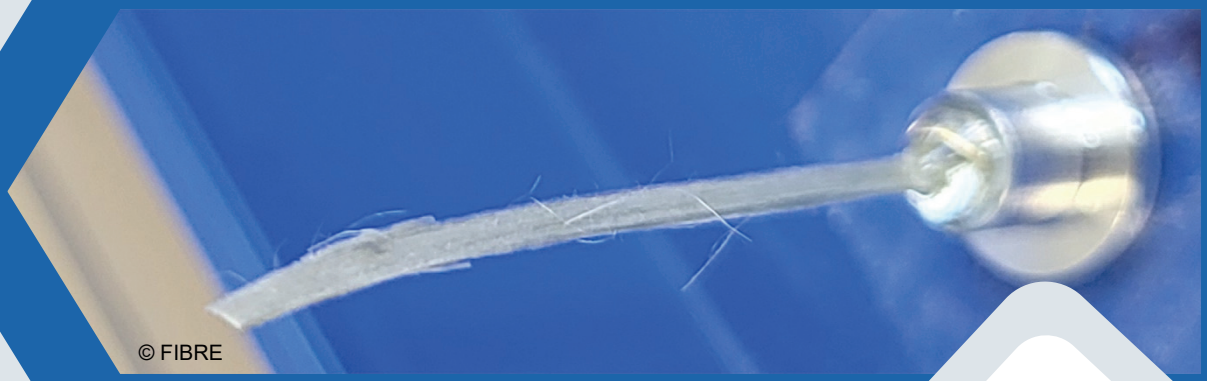


ENZYMATIC SURFACE ETCHING OF BIOGENE HEAVY TOWS (BHT) TO ENHANCE BHT-MATRIX INTERACTION IN HIGH-PERFORMANCE COMPOSITES

Background: The project 'EnTreHeaT — Enzymatic Surface Treatment of Biogene Heavy Tows (bHT) for use in High-Performance Composites' aims to improve the surface interaction between non-retted green peeled hemp bark stripes and common thermoset matrices.
A biotechnological approach has been selected to uncover the surface-near hemp fibres in the hemp bark by a type of 'enzymatic etching'. This enables a direct coupling between the hemp single fibres at the hemp bast surface and the applied composite matrix to ensure high mechanical performance. The enzyme system is optimized to preserve the function of the natural binders of hemp barks stripes, which contributes to the optimal mechanical / physical properties of the reinforcement. The process can be performed by a modified spray method using minimal amounts of liquid compared to standard enzyme-driven reactions.
This poster describes the set-up of an adapted analytical method using a modified pull-out test and the results of enzyme screening.

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Project partners and tasks:

- FIBRE is developing a method to assess hemp bark stripe-Matrix interaction and performs the Enzyme test in laboratory scale to validate the enzyme's effect.
- STFI is focusing on all steps of processing hemp bast barks to semi-finished products. After the enzymatic treatment by the research partners STFI produce the composites and test the mechanical properties of all the samples.
- INOTEX works on enzyme development and scale-up of the corresponding processes.
- Coordination by WNR e.V. (DE) and CLUTEX (CZ)

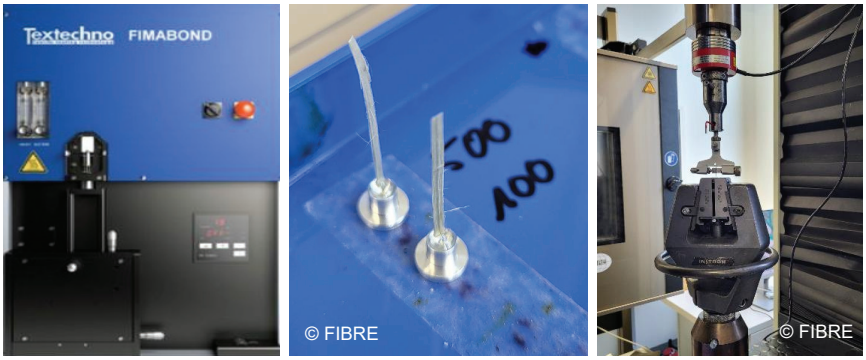


Figure 1. Test setup with Textechno FIMABOND (left), bHT sample specimen (middle) and pull-out in Zwick tensile tester (right).

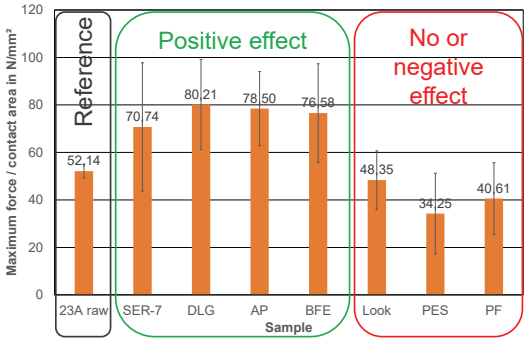


Figure 2. Pull-out test results on bHT for the enzymes in test compared to the raw variant 23A. Source: FIBRE.

Results. A pull-out test has successfully been developed (cf. Fig. 1) based on a modified FIMABOND device (Textechno, Mönchengladbach, DE), combined with a Zwick Z250 universal tester (ZwickRoell GmbH & Co. KG, Ulm, DE), equipped with a 10 kN load cell (resolution 0.1 N). bHT sample specimen are cut manually using a scalpel in a width range of 1.0 – 1.7 mm. These are embedded in epoxy resin (Epikote 135 / Epikure 137, HEXION) under permanent nitrogen purging with an immersion depth of actually 200 µm at 105 °C for 2h and subsequent cooling to 40 °C. The tensile test (acc. to ISO 527-4) is performed in a wedge grip with inserts for round specimen (downside) and a manual fibre clamp (top) for the bHT at 0.1 mm/min[1]. The maximum force is recorded and divided by the contact area. The resulting bHT-matrix adhesion is expressed in N/mm².

A series of different InoTEX TEXAZYM enzymes has been used to treat bHT samples of variant 23A. The results of the pull-out test are displayed in Fig. 2 compared to the reference 23A. A positive effect on the bHT-matrix interaction is clearly visible on three of the enzymes. DLG, AP and BFE display a similar pull-out force of approx. 80 N/mm², roughly 60% more than the reference. In addition, SER-7 is at 70 N/mm², roughly 40% more than 23A — but with a much larger variance and a high number of failing specimen. The outer surface of bHT consists to a large extent of pectins and hemicellulose. Three more enzymes do not improve the bHT-matrix interaction: Look, PES & PF slightly reduce the bHT-matrix interaction.
Ongoing work is to optimize enzyme formulation and application parameters, followed by production of demonstrator composite parts.
The final results are expected at the end of the project in mid of 2027.

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