Sächsisches Textilforschungsinstitut e.V. (STFI) An-Institut der Technischen Universität Chemnitz
Annaberger Straße 240 · 09125 Chemnitz · Germany
Managing Director: Dr. Heike Illing-Günther
Phone: +49 371 5274-0 · Fax: +49 371 5274-153 · E-Mail: stfi@stfi.de

SusComTrab

Flame retardant sustainable composites

Motivation and objective

Within the CORNET-project “SusComTrab” in cooperation with three research partners Centexbel (Ghent, Belgium), Sächsisches Textilforschungsinstitut e.V. (STFI), Chemnitz and Leibniz-Institute for Composite Materials GmbH (IVW), Kaiserslautern, sustainable fiber reinforcements (based on natural fibers, basalt fibers and recycled carbon fibers) combined with benzoxazines or bio-based epoxy resins were investigated.

Experiments and results

In addition to modifying the epoxy resin system with regard to flame retardancy and the viscosity of the resin, the research partner Centexbel also dealt with the use of a suitable adhesion promoter system to optimize fiber-matrix adhesion. Using ammonium polyphosphate (APP) and aluminum trihydrate (ATH), the bio-based epoxy resin was optimized with respect to flame retardancy. By adding 30 % APP and additional rheological additives to the resin system, the flame retardant properties of the bio-based epoxy were optimized and a limiting oxygen index (LOI) of 32 % was achieved. The flame retardant finishing "Flame-Fixe™-process" (Co. Veramtex S.a., Brussels) of flax woven fabrics caused an improvement of the LOI from originally 20 % to 30 %. Silane-based adhesion promoters were used to optimize the fiber-matrix adhesion of basalt woven fabrics to the epoxy resins.

As an alternative to the flame-retardant flax woven fabrics and basalt woven fabrics used, STFI developed various nonwovens. The production of suitable basalt fiber or carbon fiber nonwovens was investigated using the airlay or carding process and bonded by needling or the stitch-bonding process (Maliwatt type). For the nonwovens, recycled basalt fibers from fabric offcuts or basalt fiber strands (spinning cakes from basalt fiber production by Deutsche Basaltfaser GmbH, Sangerhausen) were used as starting material. In terms of recycling-friendly design, carded, cross-laid nonwovens were stitch-bonded for a longitudinal reinforcement with a 100 % basalt sewing thread (developed by the subcontractor Alterfil Nähfaden GmbH, Oederan) using the stitch-bonding method (type Maliwatt) with fringe-tricot-bonding. This increased the maximum tensile strength by 80-90 % in the longitudinal direction, so that 90.91 N could be achieved for a basalt fiber nonwoven with a longitudinal strength of originally 4.54 N.

The project partner IVW dealt with the development of an application process suitable for modified resin systems. In addition to the RTM process and hot-pressing process, towpreg trials were carried out. In cooperation with M & A Dieterle GmbH, Ottenbach, CF towpregs with benzoxazine powder were developed. The modified resin systems could be processed into composites either with the developed nonwovens or the treated woven fabrics. The developed composites were extensively characterized at the project partners IVW and Centexbel and tested with regard to their flame-retardant properties (including fire protection standard UL94). Here, nonwoven-based composites in combination with a bio-based epoxy resin system modified with 30 % APP achieved the classification "V0" according to UL94. Due to a filter effect occurring during impregnation in the classic injection process, the composites were impregnated in a vacuum-supported hand lay-up process. This influenced the achievable fiber volume content negatively, which is why an optimization of the process would have to be carried out in the project follow-up.

Contact: Dr. rer. nat. Anna Große Phone: +49 371 5274-282 E-Mail: anna.grosse@stfi.de
Katharina Heilos, M. Eng. Phone: +49 371 5274-227 E-Mail: katharina.heilos@stfi.de

Sächsisches Textilforschungsinstitut e.V. (STFI) An-Institut der Technischen Universität Chemnitz
Annaberger Straße 240 · 09125 Chemnitz · Germany
Managing Financial Director: Dipl.-Ing.-Ök. Andreas Berthel
Phone: +49 371 5274-0 · Fax: +49 371 5274-153 · E-Mail: stfi@stfi.de

Demonstrators

During the project, a first demonstrator ("suitcase corner", fig. 1) was produced using the resin infusion process on the basis of basalt fiber nonwovens at Alpha Sigma GmbH, Zwickau. Furthermore a mold from Alpha Sigma GmbH, Zwickau, which is a part of a C-pillar, was used for demonstrator purposes. In the vacuum infusion process, various demonstrators were created on the basis of the developed reinforcement structures, with the nonwovens being particularly convincing due to their good drapability. The drapability prevented wrinkles at the curvatures of the mold and thus enabled good surface quality (see figure 2).

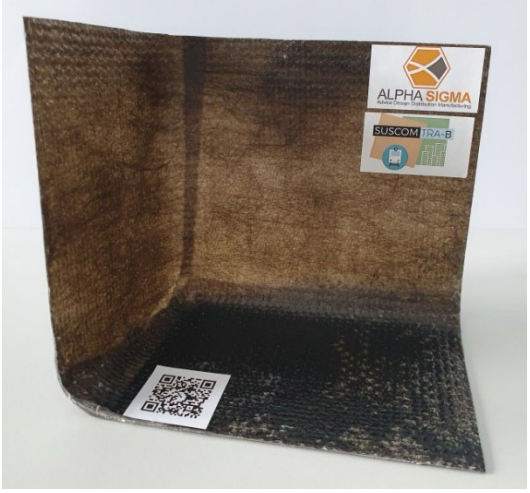

Fig. 1 Demonstrator "suitcase corner" developed in cooperation with Alpha Sigma GmbH

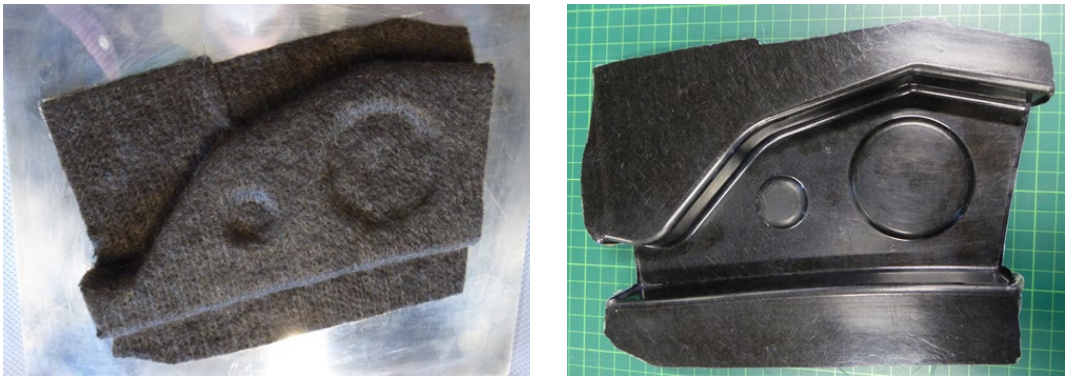

Fig. 2 Part of a C-pillar from the automotive sector of Alpha Sigma GmbH, left: Preform (nonwoven made of basalt and carbon fibers) draped in the mold, right: nonwoven-based composite (after impregnation with bio-based epoxy resin in a vacuum infusion process).

The final report of the project is now available at STFI.

Acknowledgements

The IGF research project 226 EBG of the research associations Forschungskuratorium Textil e.V. and Flanders Innovation & Entrepreneurship was supported via the AiF for promoting the Industrial Collective Research (IGF) of the German Ministry of Economic Affairs and Energy (BMWi), based on a resolution of the German Parliament.
We would also like to thank the user committee, in particular the companies Alpha Sigma GmbH, Zwickau, ASGLAWO technofibre GmbH, Hilbersdorf, Deutsche Basaltfaser GmbH, Sangerhausen, EFK Karsten Müller UG, Chemnitz, M & A Dieterle GmbH – Maschinen und Apparatebau, Ottenbach and TENOWO GmbH, Hof, who supported us in the implementation of the project.

Contact: Dr. rer. nat. Anna Große Phone: +49 371 5274-282 E-Mail: anna.grosse@stfi.de
Katharina Heilos, M. Eng. Phone: +49 371 5274-227 E-Mail: katharina.heilos@stfi.de

www.stfi.de
11.05.2021