Project title:	**Development of TowPregs from glass, basalt, carbon and aramid fibers for hybrid 3D-wound building structures – HyPreg –**
Partner:	F. A. Kümpers GmbH & Co. KG, Rheine FibR GmbH, Stuttgart Institut für Textiltechnik (ITA) der RWTH Aachen University
Duration:	**12/2019 – 11/2021**
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Univ.-Prof.
Prof. h.c. (Moscow State Univ.)
Dr.-Ing. Dipl.-Wirt. Ing.
Thomas Gries
Director

Max Schmidt, M.Sc.
Scientific researcher

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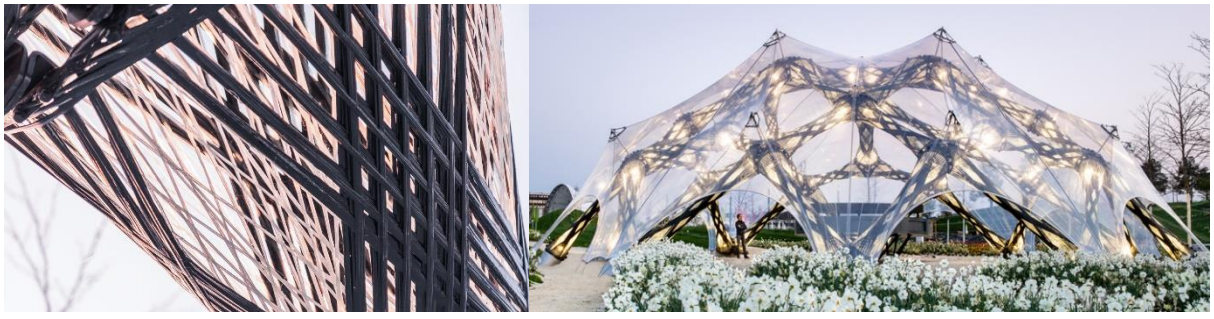
Mission Statement

For the production of fiber composite components, winding processes are widely used cost effective methods with suitability for high volume production. Wet winding is established on the market for rotationally symmetrical components such as pipes and tanks. Up to four carbon fiber or glass fiber rovings are usually drawn from a creel, impregnated with epoxy resin in an immersion bath and then wound onto a core.

Another modern application of wet winding is the robot-assisted 3D winding of filament structures. In this process, reinforcement rovings are also impregnated in an impregnation bath and then individually placed by a robot on a carrier frame, whereby the rovings partially support each other at their crossing points. In this way, complex three-dimensional structures can be created freely in space. The main areas of application are in the building industry, especially as façade elements or for free-standing structures.



3D-wound roofing element of FibR GmbH

A disadvantage of the state of the art is the impregnation process and the limited selection of suitable fibre-matrix combinations for the special requirements in construction and engineering. For dip impregnation directly before placement, the resin system must have a low viscosity in the uncrosslinked state in order to successfully impregnate the roving. However, the amount of matrix application varies considerably with the speed of the web guidance, which fluctuates

greatly, especially in complex depositing processes. This results in rovings of varying degrees of coating or drop formation on the rovings after deposition. In addition, the process must not be interrupted for any length of time due to the limited pot life of the resin. The fibre and matrix combinations available on the market are only suitable to a limited extent for the special requirements of construction and engineering.

Approach:

The aim of the project is the development of so-called TowPregs made of carbon, glass, Basalt and aramid fibres, which are uniformly impregnated with a resin system and can be selectively cured during the winding process directly after deposition. TowPregs are rovings which are impregnated with a resin system and wound on spools before use. The resin is viscous after the impregnation process and cannot drip off. Thus the impregnation process is decoupled from the depositing process and can be carried out continuously and controlled, which increases the quality of the impregnation. In addition, there is more freedom in the depositing process, as material changes and service life are simplified. Due to the completely new development of the resin system, it can be precisely adapted to the desired fiber properties and the innovative curing process during fiber placement.

The specifications for the resin system result from the permissible coefficients of friction (tack, tack), mechanical requirements, curing conditions and storage conditions for the 3D winding process. A new impregnation unit is being developed at ITA. In addition, the nozzle will be designed in such a way that only a single tool component at the outlet of the nozzle needs to be replaced when changing the material. With the customizable nozzle outlets it is also possible to produce TowPregs with different cross sections. In cooperation with the partner F.A. Kümpers, a scaling up to industrial scale will follow.

FibR GmbH will convert its production in such a way that TowPregs with different fiber types can be processed and will extend the winding robot by an energy source for local curing of TowPregs. Furthermore, a depositing process will be developed, in which the TowPregs are guided freely in the room and cured. The goal is to be able to guide and deposit freeforms away from the shortest connection between two holding elements. The process control is especially designed in such a way that crossing points can be cured in a targeted manner

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Contact

Max Schmidt, M.Sc.

max.schmidt@ita.rwth-aachen.de

Institut für Textiltechnik Otto-Blumenthal-Straße 1

52074 Aachen