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Project title: „Preformtransport" - Development of a process for the automated production of preforms using particle foam technology

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Homepage: www.AutoPreFoams.de

Mission Statement

One of the greatest challenges facing the composite industry today is to achieve the same production standards as with conventional materials in the automation of manufacturing processes. An extra price for the best strength-to-weight ratio compared to metallic materials is only accepted if the higher investment costs pay for themselves over the lifetime of the component or the function is only made possible by the weight savings achieved. In order to reduce manufacturing costs, the focus is particularly on processing the textile semi-finished products into near-net-shape fiber preforms, the so-called preforms. This industrially established stamp forming process is susceptible to fiber displacement, thickness jumps and other preform defects. In addition, full-surface punch forming is characterized by a high fiber blend of the high-priced reinforcing semi-finished products.

The implementation of process chains for the automated production of textile preforms in the stamp forming process has so far not been economically viable for small and medium-sized enterprises (SMEs) due to the high investment costs, small batch sizes and variable geometries.

This problem was addressed with the innovative approach developed in this research project (see Fig. 1) by using the particle foam technology in combination with tufting technology for the production, processing and handling of high-quality preforms.

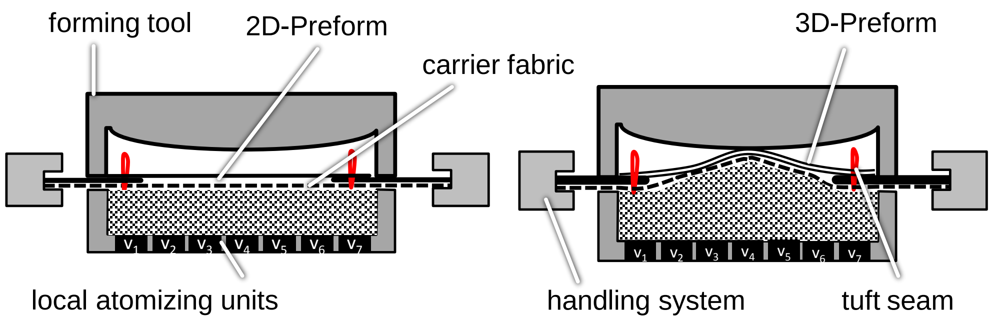

Fig. 1: Use of particle foam technology for forming preforms

Aim & Solution

The aim of the project was to develop and investigate the novel preforming process chain for the sequential production of textile 3D preforms using particle foam expansion in combination with a textile material feed strategy.

Part of this process chain are initially two FE simulation models for predicting the ideal draping behaviour during forming and for determining the optimum process parameters for foam expansion. The models were used to calculate optimum draping retention forces along the reinforcing textile, the injection kinematics of the individual mould chambers of the automatic moulding machine and the material parameters for the polystyrene granulate in the chambers. Thus, a profound understanding of the process and a methodical procedure for the application of the new manufacturing process could be developed. With the newly developed periphery of the automatic moulding machine, a specific control of the individual chambers via a graphical user interface during the foaming process is possible for the first time. In the subsequent technological and economic technology evaluation, the fundamental potential for error-reduced forming of complex preforms was demonstrated. Fig. 2 shows a preform using tufting technology for material feeding after the forming process.

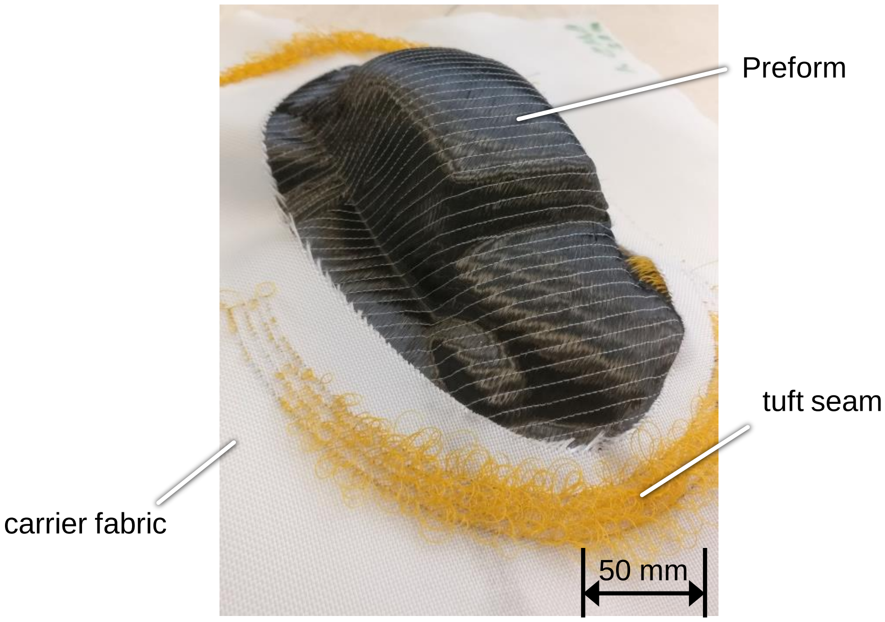

Fig. 2: Preform produced using tufting seam for material feed

During technology validation, important process-specific characteristics of foam forming were identified. On the one hand, the sequential control of the expansion chambers due to interaction effects of the water vapour in the too small tool did not lead to a significant improvement of the forming results. A larger tool with smaller individual chambers is therefore absolutely necessary in order to implement the geometry-specific foaming. On the other hand, the so-called clamping effect could be identified which, due to the isotropic expansion of the EPS foam, clamps the reinforcing against the mould that the target geometry is not completely achieved. The degree of the clamping effect correlates with the aspect ratio of the component geometry, which must be taken into account when designing the tool.

A direct comparison with the stamp forming process established in the industry shows that the preforms produced with the foam expansion process show significantly fewer forming errors, but less geometrical accuracy. With a production volume of 10,000 preforms per year, the production process developed as part of the APF project can be classified as competitive.

Acknowledgement

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