sccer mobility
Swiss Competence Center for Energy Research
Efficient Technologies and Systems for Mobility

In cooperation with the CTI
Energy funding programme
Swiss Competence Centers for Energy Research
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Commission for Technology and Innovation CTI

Thermoplastic composites manufacturing: Direct melt impregnation of fabrics through injection moulding

One approach to reduce the CO_2 emission of automotive transportation is the lightweight design with composite materials. The main disadvantages of composite materials are the long cycle time and high material costs. A process for the direct impregnation of fabrics with thermoplastic on an injection moulding machine is developed. The process has a high potential for fast cycle time and reliable part quality. The feasibility of the process was demonstrated by the characterisation of the used materials, process simulation and model experiments. By using an injection moulding machine, a high production rate and reliability of the process is possible which makes it more attractive for the automotive sector.

Julia Studer, Institut für Kunststofftechnik, Fachhochschule Nordwestschweiz FHNW, julia.studer@fhnw.ch
Clemens Dransfeld, Institut für Kunststofftechnik, Fachhochschule Nordwestschweiz FHNW, clemens.dransfeld@fhnw.ch
Bodo Fiedler, Intitut für Kunststoffe und Verbundwerkstoffe, Technische Universität Hamburg-Harburg, fiedler@tuhh.de

Introduction

Lightweight design in transportation, especially in automotive industry is getting more important with the stricter regulations on CO_2 emissions of the European Union. One way for implementing this is the use of thermoset or thermoplastic composite materials. Compared to thermosets, thermoplastic matrix materials have the advantages of recyclability and high fracture toughness. On the other hand the thermoplastic matrix materials have a higher viscosity than thermoset resins, which makes the impregnation of fabrics more difficult.

Fig. 1: Injection moulding machine [3]

Processing concept

The investigated processing concept is the through thickness impregnation of dry fabrics with thermoplastic melt via injection moulding (Fig.2).
By using an injection moulding machine (Fig. 1), a high production rate and reliability of the process is possible which makes it attractive for the automotive sector.
Aim of this study:

- Understanding of the impregnation mechanism
- Definition of the processing window as a function of matrix material and reinforcement fabric

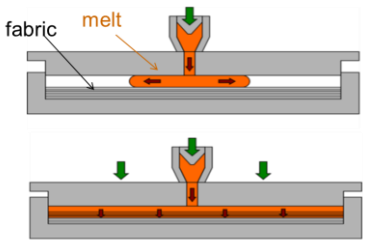

Fig. 2: Processing concept

Materials

Matrix: Low viscosity Polyamide (PA)
Fabric: Glass fiber leno-weave Non-Crimp-Fabric (1280 g/m2, FTA Germany) was used for the impregnation experiments.

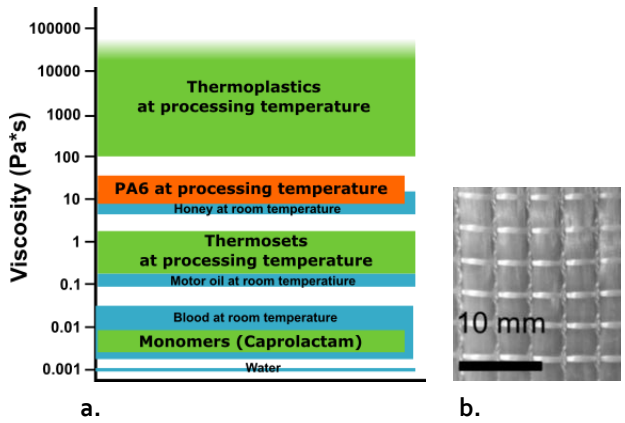

Fig. 3: a. Matrix viscosity; b. Fabric architecture

Impregnation experiment

Impregnation experiments of the fabrics with the PA melt are conducted on a hot press in a closed mould, with the melt flowing only in one direction. The influence of temperature, pressure, and impregnation time is investigated.

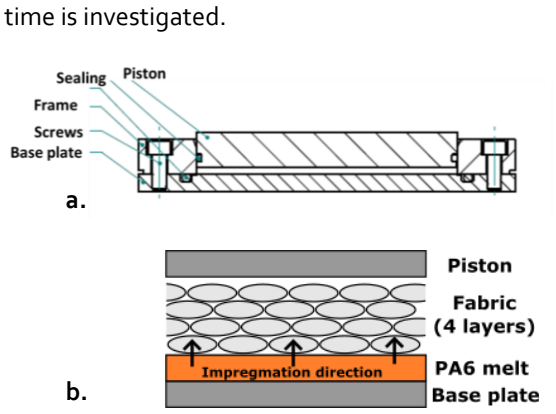

Fig. 3: a. Impregnation tool; b. impregnation mechanism

Characterisation of the plates

The impregnation quality of the plates is then checked with fluorescence photography, pink indicating unimpregnated bundles and voids (Fig. 4). The degree of impregnation of the fibre bundles in each layer is analyzed. This information can then be used as input for process simulation [1,2].
For the investigated material combination a pressure of 20-50 bar, and a temperature of 300 °C leads to complete impregnation of the fibre bundles.

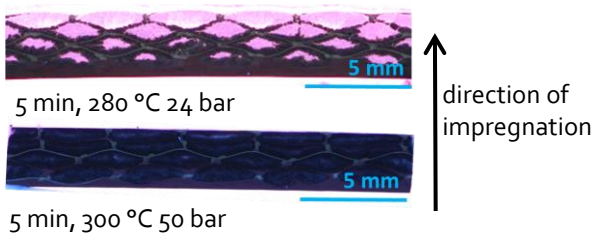

Fig. 4: Fluorescence photographs of plates, pink indicating unimpregnated areas of fibre bundles

Demonstration of a novel processing route of thermoplastic composites for automotive industry with the advantages of:

- One step process to net-shaped parts
- High production rate and reliability
- Integration of functionalities: clips, metallic inserts
- Avoiding of intermediate products (organosheets)
- Extension of the widely used injection moulding process

References

[1] Studer, J., Dransfeld, C., and Fiedler, B. *Direct thermoplastic melt impregnation of carbon fibre fabric by injection moulding*. in *ECCM17 - 17th European Conference on Composite Materials*. 2016. Munich, Germany.

[2] Masania, K.Bachmann, B., Dransfeld, C. *The compression resin transfer moulding process for efficient composite manufacture*. in *The 19th International Conference on Composite Materials*. 2013. Montreal, Canada.

[3] www.arburg.com

Partners