VliesSMC – Processing of recycled carbon fiber nonwovens in sheet molding compound

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VliesSMC

Abstract:

In the series production of fiber reinforced plastic components, several hundred tons of carbon fiber containing woven and knitted fabric production waste is generated every year. This corresponds to up to 40 % of the material used in the processes. The potential for cost savings by returning the waste materials to new high-quality applications is significant. Therefore, within the research project VliesSMC, the suitability of different types of nonwovens based on recycled carbon fibers (rCF) for processing in the sheet molding compound (SMC) process chain is investigated. In particular, open questions regarding the different textile manufacturing processes, production and handling of SMC semi-finished products, as well as the flowability in the compression molding process are addressed.

Figure 1: Nonwoven development at STFI (© STFI/D. Hanus)

Main research topics within the project:

- Development of adapted nonwovens made from recycled carbon fibers
- Investigations on the influence of different web formation methods on the impregnation quality and the flowability of the SMC semi-finished product
- Equipment and process development with the aim of automated processing of rCF-nonwovens in the SMC process chain
- Exploring the limits of part complexity in the molding process of rCF-SMC depending on the achievable fiber volume content
- Carry out cost analysis and economic feasibility study of the VliesSMC recycling process

Figure 2

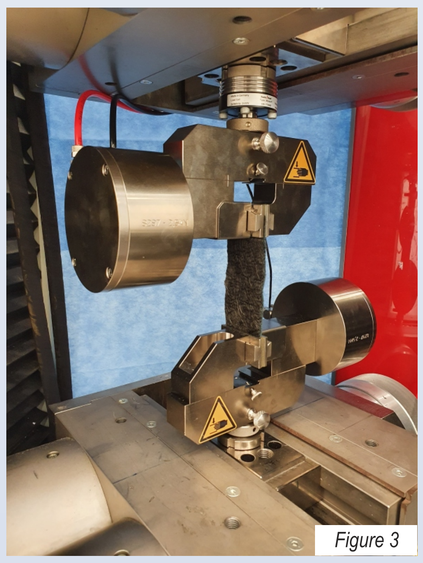

Figure 3

Figure 2: Feeding of unbonded carbon fiber web into the SMC process (© STFI)

Figure 3: Characterisation of carbon fiber nonwoven (© STFI)

Experimental and Results:

- **Waste Treatment and fiber opening**
  - Different kinds of waste (dry textile waste and pyrolyzed fiber material) were prepared by using a modified cutting and tearing process
  - Waste characterization (e.g. fiber length distribution, fiber strength, fiber fineness etc.) by using suitable analytic methods (FiberShape, Favimat+, SEM, etc.) was carried out
- **Semi-finished textile goods**
  - Obtained fiber waste was processed into various nonwovens by using airlay or carding technology (fig. 1)
  - Inline bonding of nonwovens by using needle-punch technology and also winding of unbonded web in combination with transport paper by using a in the project developed method (fig. 2)
  - Nonwoven properties like fiber orientation (isotropic or anisotropic nonwoven structure), fiber length (50 mm - 110 mm) or area weight (300 – 600 gsm) were optimized for the following SMC process
  - Developed nonwovens were characterized regarding elongation at break and tensile strength
- **SMC process and composites**
  - Handling and impregnation methods for the nonwovens were developed
  - Adaption of an automatic, speed-controlled unwinding station ensures that the fabric was fed into the SMC system without tension (fig. 4)
  - Rheological characterizations supported the development of semi-finished SMC products (fig. 5)
  - Impregnation quality was ensured by a complete monitoring of the system parameters as well as microscopic examinations of the semi-finished products and cured materials
  - Flow tests were carried out to determine the maximum flow distance
  - By using in-mold sensors, pressure and material progress in the mold were monitored

Figure 4: SMC line at Fraunhofer ICT with needle-punched nonwoven roll good (© Fraunhofer ICT)

Figure 5: SMC roll good based on carbon fiber nonwoven (© STFI)

Acknowledgements:

The IGF project "VliesSMC" (No. 21124 BG) of the research associations DECHEMA Society for Chemical Technology and Biotechnology e.V. and Forschungskuratorium Textil e.V. is funded by the Federal Ministry for Economic Affairs and Climate Action through the AiF as part of the program to promote industrial community research (IGF) funded by a resolution of the German Bundestag.

DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V.

Forschungskuratorium textil

AiF Forschungsnetzwerk Mittelstand

Supported by: Federal Ministry for Economic Affairs and Climate Action on the basis of a decision by the German Bundestag