

VliesRTM: Investigation of High Pressure Resin Transfer Molding Process Chain with Recycled Carbon Fiber Nonwovens



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Abstract

Within the project "VliesRTM" the use of nonwoven fabrics based on recycled carbon fibres for the high pressure resin transfer molding process (HP-RTM) or wet compression molding (WCM) process will be investigated.

Therefore nonwovens produced by airlay or carding process and bonded with inline methods either needle-punching or stitch-bonding will be examined.

A cooperation between STFI and ICT ensures a complete consideration of a value-added chain from recycled carbon fibres through the semi-finished product up to the rCFRP.

Aim of the project:

- Using different kinds of carbon fibre waste e.g. off-cuts, pre-impregnated semi-finished off-cuts or pyrolysed carbon fibres as starting material for the nonwoven process
- Variations of different webforming technologies (airlay or carding process) and inline bonding technologies (needle-punching and/or stitch-bonding) were tested
- Besides nonwoven fabrics, non-crimp fabrics (in cooperation with Karl Mayer Technische Textilien GmbH) based on rCF-nonwovens are tested
- Two different methods "wet compression molding" and high pressure transfer molding" to impregnate the semi-finished products of rCF into recycled composites are used

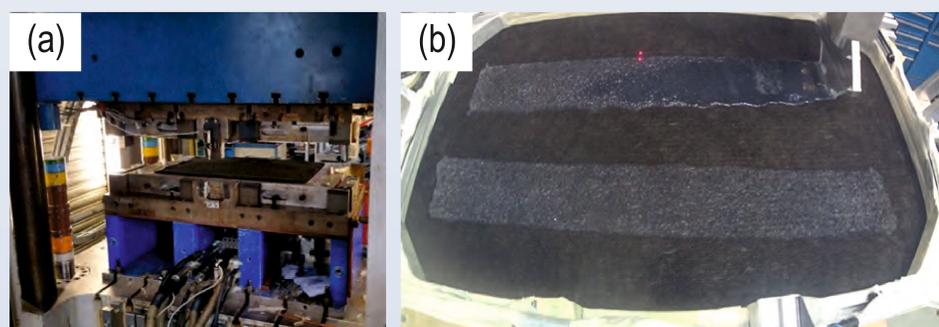


Fig. 1 (a) HP-RTM Process (b) WCM - Process

Experimental and Results:

- **Waste Treatment and fibre opening**
 - Different kinds of waste were prepared by using a modified cutting- and tearing - process
 - Waste characterization (e.g. fibre length distribution, fibre strength, fibre fineness etc.) by using suitable analytic methods (FibreShape, Favimat+, SEM, etc.)
- **Processing of semi-finished products**
 - Obtained fibre waste is processed into various nonwovens by using airlay or carding technology in combination with different inline bonding methods either needle-punching or stitch-bonding method
 - Nonwoven properties like fibre orientation (isotropic or anisotropic nonwoven structure), fibre length (50 mm - 110 mm) or area weight (300 – 600 gsm) are optimized for the following impregnation process
 - Nonwovens made of pre-impregnated semi-finished offcuts, i.e. material with binder, were produced to examine the processability during the nonwoven manufacturing process and the drapability afterwards (shown fig. 2)
 - First tests of producing "bindered" nonwovens were partly successful but show still room for improvement, especially considering the tack, due to the binder, during the web forming process
 - Furthermore non crimp fabrics based on rCF-nonwovens were produced by Karl Mayer Technische Textilien GmbH to achieve even better mechanical properties and load-optimized reinforcement

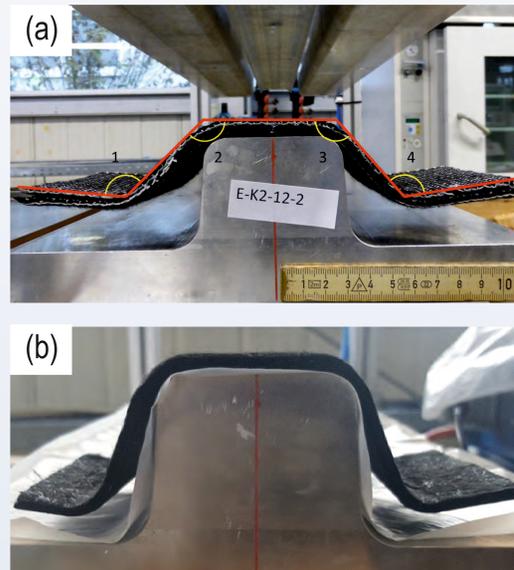


Fig. 2 test set up for the examination of drapability

(a) drapability of two layers carded, stitch-bonded nonwoven with powder binder (K2)

(b) drapability of a carded nonwoven based on bindered waste

• Impregnation and production of fibre reinforced composites

- Impregnation of the obtained rCF-nonwovens in an automated WCM or HP-RTM process route at the Fraunhofer ICT (shown in fig. 1)
- A variety of composites with different fibre volume content (FVC) were produced and tensile strength up to 393 MPa and flexural strength up to 551 MPa in fibre orientation with carded nonwoven fibre content of 38 vol.% were achieved (shown fig. 3)

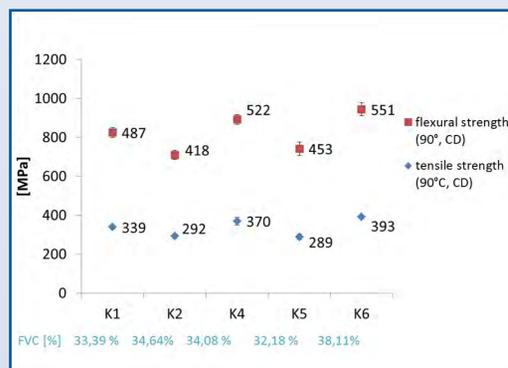


Fig. 3 tensile strength and flexural strength of composites based on carded nonwovens with different FVC

table 1 parameters of carded nonwovens for composites

Sample	webforming process	bonding technology	area weight [g/m ²]
K1	Carding	needle-punching	300
K2	Carding	needle-punching + stitch-bonding	300
K4	Carding	needle-punching	600
K5	Carding	needle-punching + stitch-bonding	600
K6	Carding	needle-punching	600

Outlook:

- Obtained non crimp fabrics based on rCF-nonwovens will be impregnated by using HP-RTM or WCM
- Nonwovens based on 50% pyrolysed carbon fibres / 50% carbon off-cuts will be investigated and remold
- Continuous binder application after the nonwoven manufacturing process will be tested

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