Stitch-bonded carbon nonwovens

A new technical lab just for carbon fiber processing.

Since 2010, Tenowo GmbH has processed carbon fibers from different sources – new and recycled – to successfully produce new nonwovens.

Recycled carbon fibers (rCF)

Due to the increasing interest in carbon fibers and their use as carbon-reinforced plastics, especially in lightweight design, automotive and aerospace, waste products are increasing as well. There is also a discrepancy between demand and supply. In addition, the government is handing down increasingly stringent disposal guidelines. For instance, thermal disposal by burning fibers is largely prohibited and does not conserve resources.

For these reasons, the interest in carbon fiber recycling is growing rapidly. Web and textile waste can be mechanically prepared and processed into staple fibers or short cut fibers. Carbon fibers from CRP products – defective or end-of-life parts – can be processed with chemical, thermal or similar methods to render them reusable (Figure 1).

By recycling carbon fibers, staple fibers are available in increasing volume. These can be used in Sheet Moulding Compound (SMC), Bulk Moulding Compound (BMC), as filler or they can be processed into nonwovens.

In the nonwovens segment, companies are developing wetlaid, aerodynamic and airlay nonwovens, as well as carded nonwovens based on recycled carbon fibers (rCF). Needlepunching or chemical bonding for wetlaid as well as stitch-bonding can be used for bonding these products. The latter process (Maliwatt) is a production process employed by Tenowo GmbH.

First nonwoven development

Since 2010, Tenowo has conducted first tests with rCF on a nonwoven line. Since 2012, the company has stepped up their development and build a separate technical lab dedicated to processing carbon and special fibers.

For bonding the nonwovens, a Malimo stitch-bonding machine used for the Maliwatt process was modified. Preliminary tests were conducted in cooperation with the Saxon Textile Research Institute Chemnitz (Sächsischen Textilforschungsinstitut Chemnitz, STFI).

Advantages of stitch-bonding

The stitch-bonding method, which is based on creating loops in a textile structure, is used in multi-axial web forming machines and others. The layers are bonded with sewing thread. Tenowo uses the Maliwatt process. The loose fibers are stitched down with thread and thus bonded into a nonwoven fabric. In addition to bonding the individual web layers, the nonwoven fabric is strengthened depending on the bonding technique and sewing thread material in both directions (MD/CD).

Advantages are better handling and drape, especially for lightweight nonwovens based on rCF. With several soaking and saturation methods, better resin penetration can be achieved, since the needles create “channels” in the nonwoven.

Another advantage of stitch-bonding is that this method, unlike chemical bonding, does not need a dryer, foulard or similar technology. This means that the line takes up less space, and the nonwoven does not contain additional chemicals.

Unlike needlepunching, stitch-bonding minimally alters the fiber direction during bonding. Fibers are not reoriented in a z-direction, which reduces damaged fibers. Because of this advantage, the bonding method is considered to be gentle on the fibers.

As a disadvantage, foreign matter can be introduced into the nonwoven or might be already present from the fiber recycling process. However, the amount introduced and the foreign materials are known and can be determined.

Figure 2: Nonwoven samples made from rCF (a), blend with PA6 (b) and rCF (c) (left to right)

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Abbildung 2: Vliesstoffmuster aus rCF (a), Mischung mit PA6 (b) und rCF (c) (von links nach rechts)

Other development steps

In late 2012, the company built a technical lab for carbon fiber processing. Following the establishment of the technical lab and the modification of the nonwoven line, the company was able to run the first trials and small batches. Nonwovens based on recycled carbon fibers can be made with a production width of 75 cm and a base weight of 80 to 350 g/m².

Blends of carbon fibers e. g. with polyester or polyamide can be produced with a base weight between 65 g/m² and 300 g/m2. Chart 1 shows the minimum and maximum values of technical data of nonwovens made from rCF, blends and special fibers.

Figure 2 shows nonwoven samples made from rCF (a and c) and a mix of rCF and PA6.

It was possible to achieve a wide range of different material variations – from fiber combinations to stitch length and binding to the application of lightweight carrier structures on the top or bottom layer.

First results from the production of a UD sheet with UP resin showed maximum