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Cooperation develops leno-woven carbon fabric for CFRP patient couches

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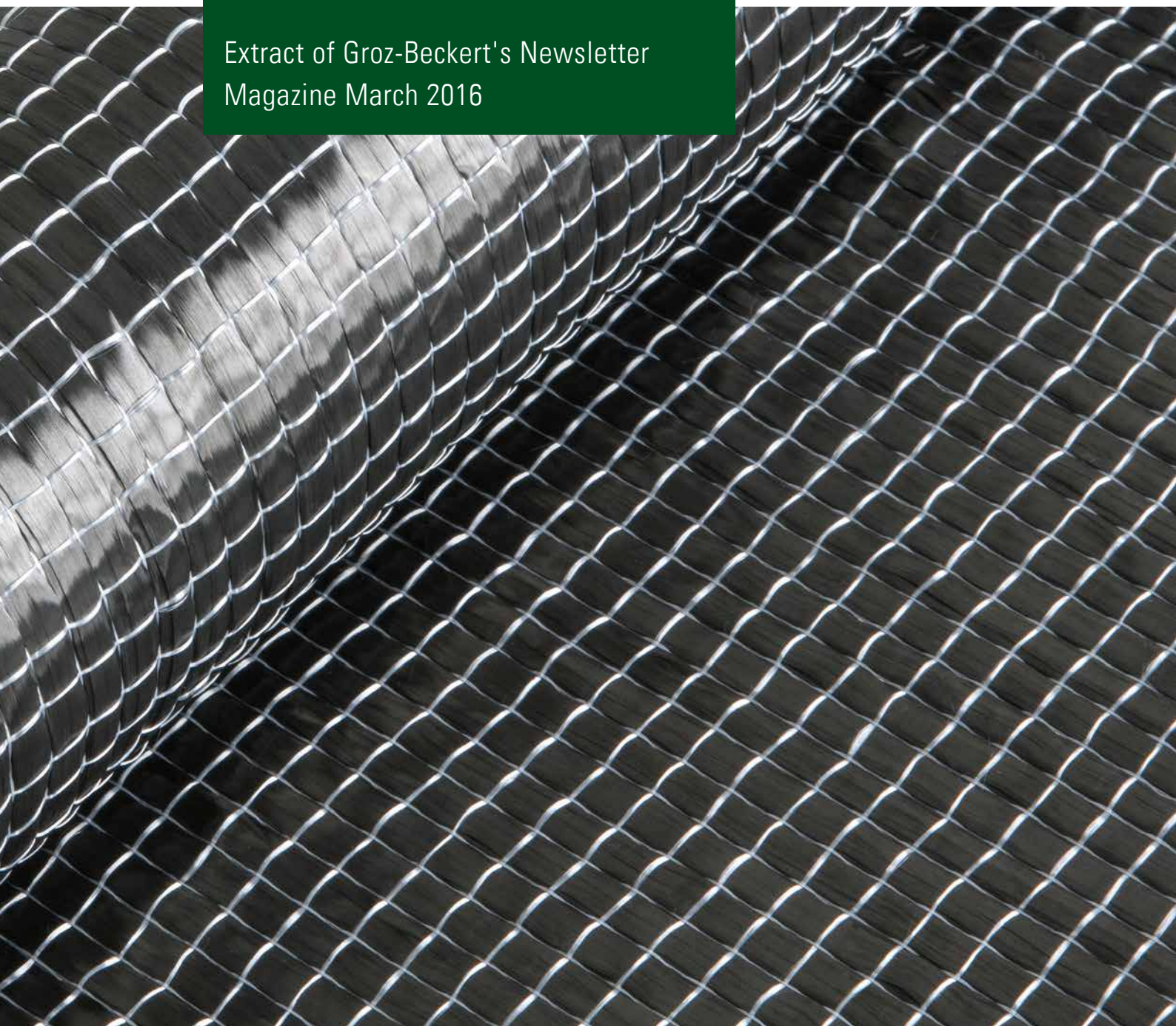


A perfect pairing of partnership and potential – Successful joint venture enables computer-tomography patient couches made from newly-developed leno-woven carbon non-crimp fabric

Research for the textile future – that's the slogan of the Research Institute for Textile Technology Albstadt mbH (FTA) as an industrial institute for fundamental knowledge building. As a part of the Groz-Beckert Group, it makes use of cross-industry expertise and synergies to develop new textile applications. Together with the company of Schmuhl Faserverbundtechnik GmbH & Co. KG, Groz-Beckert has now successfully realized economic optimization in the manufacture of carbon fabric for patient couches in computer tomography.

The basic development

Fiber composites have been manufactured industrially for around 50 years now, mainly for lightweight applications, and are seen as the material of the future. Their special properties promise high growth rates, especially in the field of carbon-fiber-reinforced composite used in industries such as aerospace, automotive or construction.

A challenge in the use of composite is posed by the production costs – these are frequently higher than for metals, especially with very high volumes of components. In the research and development field there are many opportunities to optimize the cost of the product. An important role is played here by process optimization of the different production steps, and also by minimization of material costs.

FTA Innovating Textiles

With carbon fibers in particular, but also with glass rovings, the general rule is that the material price decreases with increasing titer, i.e. the coarser the fiber, the lower the price of the material. In recent years, therefore, so-called heavy-tow carbon yarns (where, for example, 50k corresponds to 50,000 filaments per filament yarn) have been increasingly introduced to the market. These heavy-tow yarns tend to be cheaper than fine carbon filament yarns with a lower titer of 3k to 24k.

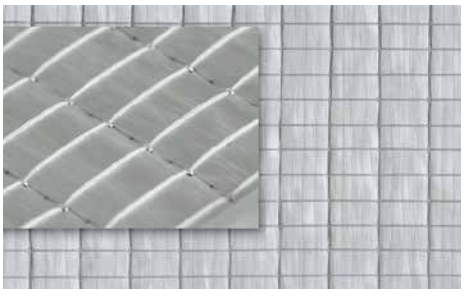
The mechanical properties of the fibers are principally similar to those of low-titer yarns. However, the thickness of the filament yarns results in poorer processability, which is manifested in the later finished part by damage to the filaments and less effective load positioning of the yarns or filaments.

In the Composites development sector of the Research Association for Textile Technology Albstadt (FTA), the goal is to optimize the production of composite components on the basis of textile structures and, as a result, to make it more cost-effective. In cooperation with Groz-Beckert KG, work has therefore been carried out on the processing of coarse reinforcing yarns in order to improve textile structures.

As part of a basic research project, the Groz-Beckert Posileno system for the production of leno fabrics was adapted on a rapier weaving machine to enable production of both unidirectional and bidirectional fabrics (NCF = non-crimp fabrics).

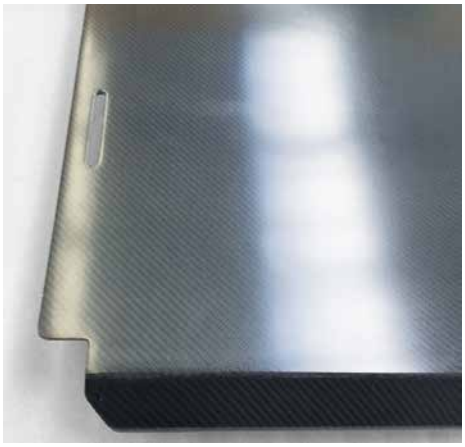
These new textiles have brought some advantages: laboratory tests by the FTA, in collaboration with external institutions, show that the unidirectional fabric in a grammage range of 400-1300 gsm have better drapability, shorter infusion times, and better mechanical properties than the unidirectional fabrics based on conventional multiaxial technology that served as a benchmark. These new textiles have meanwhile been patented by Groz-Beckert.

To evaluate the industrial potential and customer benefits of this technology, applications and also component manufacturers have been identified for testing the new textile surfaces. Here, Schmuhl Faserverbundtechnik GmbH & Co. KG proved to be a competent and innovative partner.



Leno-woven NCF (0° position)

Leno-woven NCF (90° position)



CFRP patient couch

Developing the product

The Schmuhl Faserverbundtechnik (FVT) has more than 20 years of experience in the manufacture of sophisticated plastic products, especially in the area of high-strength composites. The company's competencies lie in the development, prototype construction and mass production of composite products. The products meet the highest requirements regarding tolerances, light weight, strength, and rigidity. Since 1986, extensive expertise in the economically efficient mass production of sophisticated components and systems has been steadily and consistently developed – especially in the area of the RTM (resin transfer molding) manufacturing process. Schmuhl FVT is the ideal partner when it comes to production of complete systems and fiber composite components.

Schmuhl also develops and produces patient couches for computer tomography (CT). The couches have to bear a certain mechanical load while guaranteeing sufficient X-ray transparency. Due to their special properties, carbon-fiber-reinforced plastics (CFRP) are the optimum material in this regard. Schmuhl had to comply with these high requirements.

Currently, such patient couches are of sandwich construction, with a foam core and outer layers of carbon-fiber textiles.

The cover layers consist of 0°/90° fabrics and several unidirectional fabric layers in the middle. The design of the couch features slightly bends in the center as well as at the headboard end. The consequence of this was that so far several unidirectional fabric layers with a maximum weight per unit area of 300 gsm had to be applied in order to fit the geometry of the couch without causing any shifts in position during the insertion process or any folds in the fabric when the mold was closed. This in turn led to increased manufacturing costs.

The objective

To reduce the lay-up time, while maintaining the quality and also realizing a better weight-related cost for the textile, the target was a tripling of the grammage combined with high fabric drapability. At the same time, any adverse effects on the treatability and workability of the textiles and the physical and mechanical properties were to be avoided.

The result

For this requirement profile, and with the help of the specially adapted Groz-Beckert PosiLeno system, a leno-woven NCF with a grammage of 900 gsm made from heavy-tow carbon yarns was successfully developed.

The fabric can follow the component geometry without a problem, so Schmuhl successfully realized lining of the molds with the expected time savings. The textile structure prevents any unwanted shifts in the layers during insertion of the reinforcement materials or during closure of the mold. In addition, the improved treatability was also even detected in the process used by Schmuhl, in the form of shorter infusion times. Additionally, there was a positive influence on surface quality.

The results of the experiments at Schmuhl were so positive that the leno-woven carbon NCFs were selected for the couches and have meanwhile entered mass production. In addition, production is also starting for a second product for use in the medical industry. Here, the material was preferred because of experience gained in prototype production: The component surface can be significantly better realized in comparison to currently available warp-knitted unidirectional materials.

Production of leno-woven NCF is taking place initially at the Technology and Development Center (TEZ) of Groz-Beckert KG until it can be outsourced to an industrial partner. The expertise gained here is not only helping with assessment of production-process stability but also with identification of further optimization potential, which can then be jointly exploited by the TEZ and its partners.

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Statement by the company Schmuhl:

"Thanks to the joint venture with FTA and the TEZ, economical production of the couches was successfully optimized. The lay-up times were significantly reduced. Improved drapability has made handling easier, and has also had a positive effect on mold closure. Better treatability has also shortened our processing times. Moreover, the surface quality of the molded component has also been successfully improved.

In our opinion, the use of these newly developed, leno-woven non-crimp fabrics offers great potential, especially with higher grammages. For us, the joint venture has been a complete success. We look forward to further cooperation.

The textile that was developed is currently being used in two products for the medical industry."