TAILORED CARBON FIBRES

Scientists of the Research Center Carbon Fibers Saxony at TU Dresden start their work

Carbon fibres play an increasing role in numerous industrial sectors like the automotive and aerospace industry, in civil engineering, in the medical technology, and in sports. Thus, the Institute of Lightweight Engineering and Polymer Technology (ILK) and the Institute of Textile Machinery and High Performance Material Technology (ITM) of the TU Dresden established the Research Center Carbon Fibers Saxony (RCCF) in April 2016. Now research there has started.

In spite of promising prospects, the potential of carbon fibres is not fully exploited yet since the understanding of the complex mechanisms of the structure formation during the fibre manufacturing process is still relatively low. The scientists at the newly founded RCCF in Dresden analyse the process-structure-property-relations within the carbon fibre manufacturing process across all relevant length scales. For this purpose, they use a cutting-edge manufacturing technology. The key components of the modular flexible carbon fibre production line are a solvent wet spinning device, a bicomponent melt spinning machine and a stabilisation and carbonisation line. The RCCF carbon fibre manufacturing line is designed to develop the process to tailor high performance carbon fibres based on established and novel precursor materials.

How to do it

Currently, the common technology to manufacture precursor fibres is the so called solvent wet spinning technology. The established precursor material polyacrylonitrile (PAN) is used at the RCCF. The solvent wet spinning device is designed in a modular and flexible manner in order to achieve highest precursor fibre qualities. Tailored multi-filament fibres can be spun with suitable spinnerets using storage tanks of 3 l or 70 l, throughputs between 0.3 l/h and 3.0 l/h and filament velocities up to 100 m/min.

Alternatively, the melt spinning technology is focused at the RCCF using a bicomponent melt spinning machine which is designed in a modular way in order to extend the technology towards dry spinning as well as monofilament spinning. A single screw extruder and a twin screw extruder with a maximum temperature up to 450 °C are available to spin thermoplastic filaments.

Close watch – scientist at work at the new Research Center Carbon Fibers Saxony

The stabilisation is the first step of the thermomechanical conversion of the precursor fibre to a carbon fibre. This procedure is the most time-consuming process step of the carbon fibre manufacturing. The conversion takes place in the stabilisation and carbonisation line of the RCCF at temperatures between 220 °C and 300 °C in four different temperature zones. The fibres pass those temperature zones up to seven times and are drawn depending on the temperature zone in order to specifically influence the inner fibre structure.

The carbon fibre structure which is formed during the stabilisation process is continuously modified in the subsequent carbonisation step. This process takes place under inert gas atmosphere (<20 ppm) in a low temperature furnace with 450 °C to 1050 °C and a high temperature furnace with 1050 °C to 1500 °C. Four individual temperature zones can be triggered within both furnaces. Finally, matrix-adapted sizes are applied to the fibres in the following sizing process.

Carbon fibres with custom-fitted properties for different applications can be manufactured in the RCCF carbon fibre line on a laboratory scale. Those fundamental scientific findings can be directly transferred into industrial applications together with industrial partners in the future.

Fibres are set to defined tensions for the sizing process.

Further information:
Dr.-Ing. Robert Böhm,
Research Group Leader, Institute of Lightweight Engineering and Polymer Technology (ILK), TU Dresden,
phone +49 (0) 351/ 463-38080,
robert.boehm@tu-dresden.de,
www.tu-dresden.de/mw/ilk

Dr. rer. nat. Martin Kirsten,
Research Group Leader, Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden,
phone +49 (0) 351/ 20 25 01 75,
martin.kirsten@tu-dresden.de,
www.tu-dresden.de/mw/itm