CFRP
Carbon Fiber Reinforced Plastics

COMPOSITES UNITED

Fact Sheet on Carbon Fiber Reinforced Plastics

Helicopter made of CFRP by Airbus

WHAT IS CFRP?

CFRP

Carbon fiber reinforced plastic is the combination of carbon fiber and plastic. In the component, the carbon fibers carry large fractions of the occuring loads, the plastic protects and encases the carbon fiber and keeps it in shape. Depending on the application, different carbon fibers with different plastics can be combined.

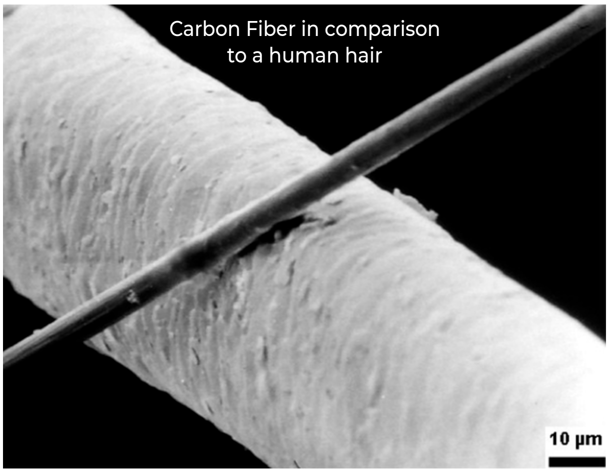
FIBERS

There are a variety of fiber types. Basically, fibers can be distinguished by application: High-modulus fibers with a high stiffness are graphitized fibers, which are mainly used in aerospace applications. High-tensile-strength (HT) fibers do not need to be graphitized and are thus less expensive. HT fibers are mainly used in the automotive industry. As the reinforcing material, fibers may be used as chopped short fibers, continuous fibers directly from the roving or as a tape or two-dimensional textiles such as fabrics, braids or many more.

MATRICES

The plastics in fiber-reinforced plastics are commonly called matrices (singular: matrix). There are two main systems of matrices used in CFRP: thermoset and thermoplastic. Thermoset matrices are, for example, epoxy resin, vinylester resins or polyester resins. These resins are mostly liquid at room temperature and can wet the fibers easily. Thermosets cure by the addition of hardeners or heat. Thermoplastic matrices are, for example, polyamide, polypropylene or polyetheretherketone. Thermoplastic resins are usually solid at room temperature. The combination with the carbon fibers occurs at high temperatures (with the thermoplastic in the molten state) and with the help of additional pressure.

THE CARBON FIBER

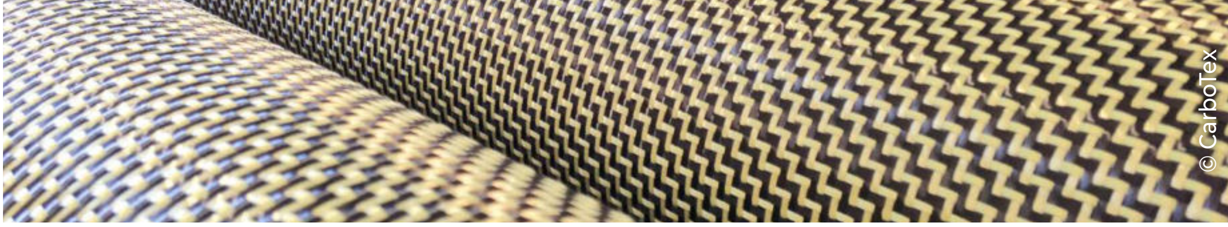


The basic material of the carbon fiber is petroleum. Refining processes similar to synthetic textile technology yield to polyacrylonitrile (PAN). Through the process of stabilization (about two hours at 250 °C), almost all non-carbon material is removed from the former PAN fiber. The stabilized fiber then passes through the process of carbonization at about 1200 °C for several minutes. Up to 50,000 of the individual carbonized fibers are wound on spools in bundles, so called tows.

The carbon fiber is electrically conductive and brittle. There are carbon fibers with high tensile strengths (HT) or high moduli of elasticity (HM). The properties of carbon fiber (e.g. of a high-tensile-strength vs. high modulus fiber) are:

	HT Fiber	HM Fiber
Diameter	6 µm – 9 µm	6 µm – 9 µm
Tensile strength	3.5 GPa	3.0 GPa
E-Modulus	230 GPa	400 GPa
Density	1.8 g/cm³	1.8 g/cm³
Elongation at break	1.5 %	1.1 %

FACTS



MECHANICAL PROPERTIES

CFRPs have very high specific tensile strengths and specific stiffnesses compared to metallic materials or fiberglass, meaning very high mechanical properties related to their weight.

CHEMICAL PROPERTIES

CFRP is inert, corrosion resistant and resistant to many chemicals. Therefore, it is ideal for use in harsh environments, e.g. marine or off-shore technology.

RECYCLING

CFRP can be recycled today. First, the fiber is separated from the matrix by pyrolysis. Following this, new components can be produced using yarns, non-wovens or tapes made from recycled fibers.

PRODUCTION COSTS

The production costs of carbon depend on the number of parts, the area of application, the production process and the size of the component. Today's production methods already allow prices of less than € 16 per kilogram / component.

QUANTITIES AND ECONOMY

CFRP can be used for both small and large quantity part production. Wherein large quantities (> 40,000 units per year) fully automated production lines generate a positive business case, the use of CFRP in small and very small quantities (> 1 piece per year) can be worthwhile. Especially in small-batch productions, procedures can be used that can avoid expensive investment costs. At the same time there are the greatest possible degrees of freedom in the design.

ADVANTAGES FOR OFFSHORE USE

With carbon individual shapes can be produced economically in small quantities. In addition to excellent mechanical properties, carbon also offers outstanding chemical properties, making the material ideal for offshore use.

APPLICATIONS

Applications of carbon fiber reinforced plastics are: automotive, aviation, maritime, sports, mechanical engineering and many more.

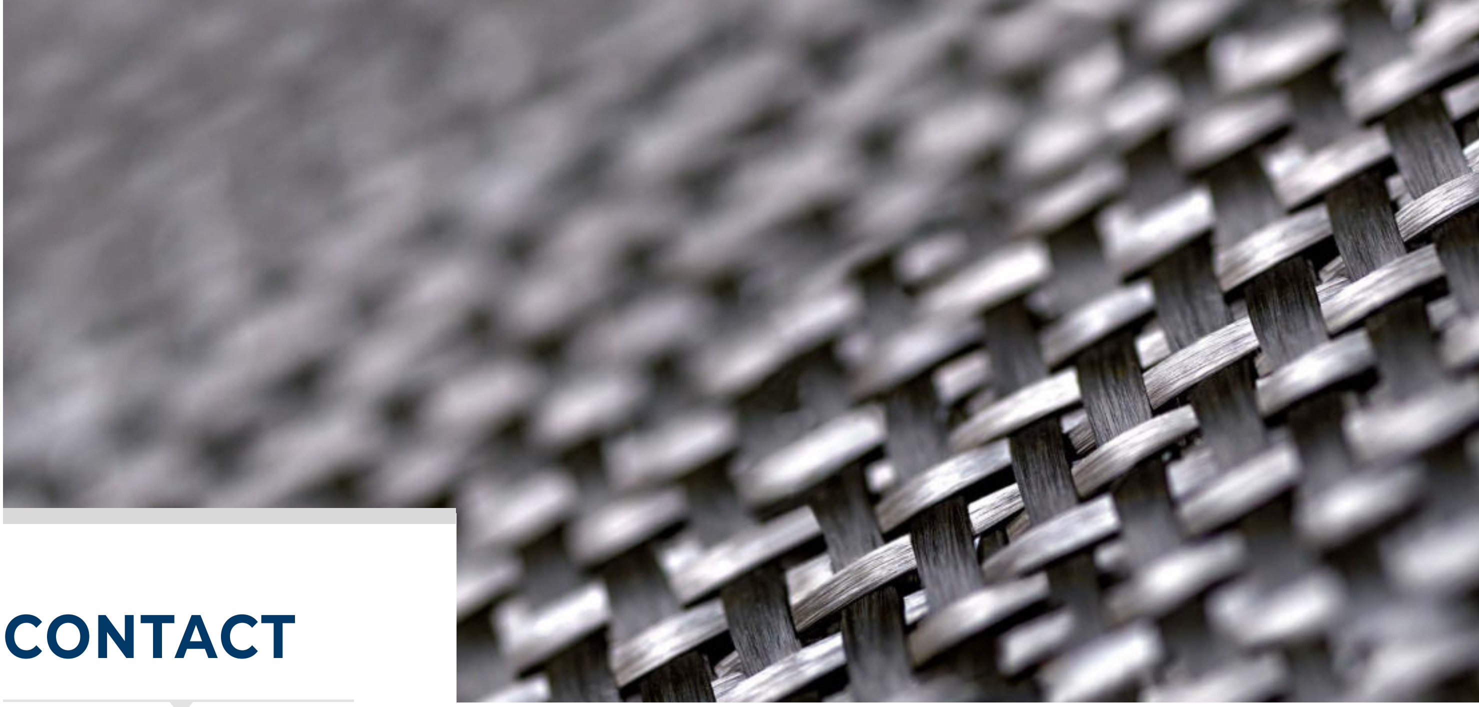

Mechanical and plant engineering


Aviation


Wind energy


Automotive


Boat building



CONTACT

Dr. Tjark von Reden
CEO Composites United e.V.

Oranienburger Str. 45
D-10117 Berlin

phone +49 (0) 821-26 84 11-0
info@composites-united.com

www.composites-united.com

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