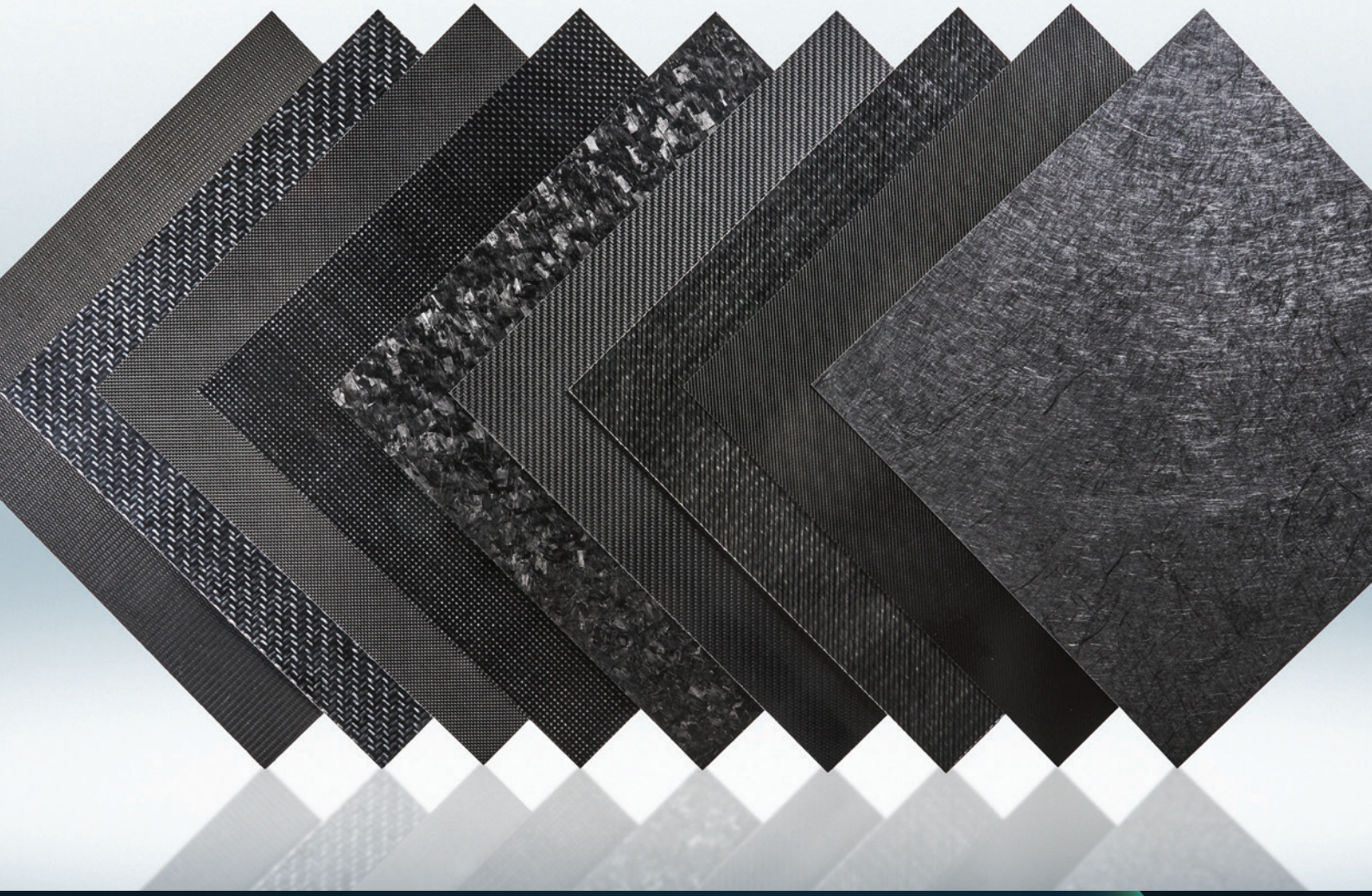


Tepex®

ADVANCED THERMOPLASTIC COMPOSITES

Envalior

Imagine the Future

DEFINING LEADING SOLUTIONS *IN THERMOPLASTIC COMPOSITES*

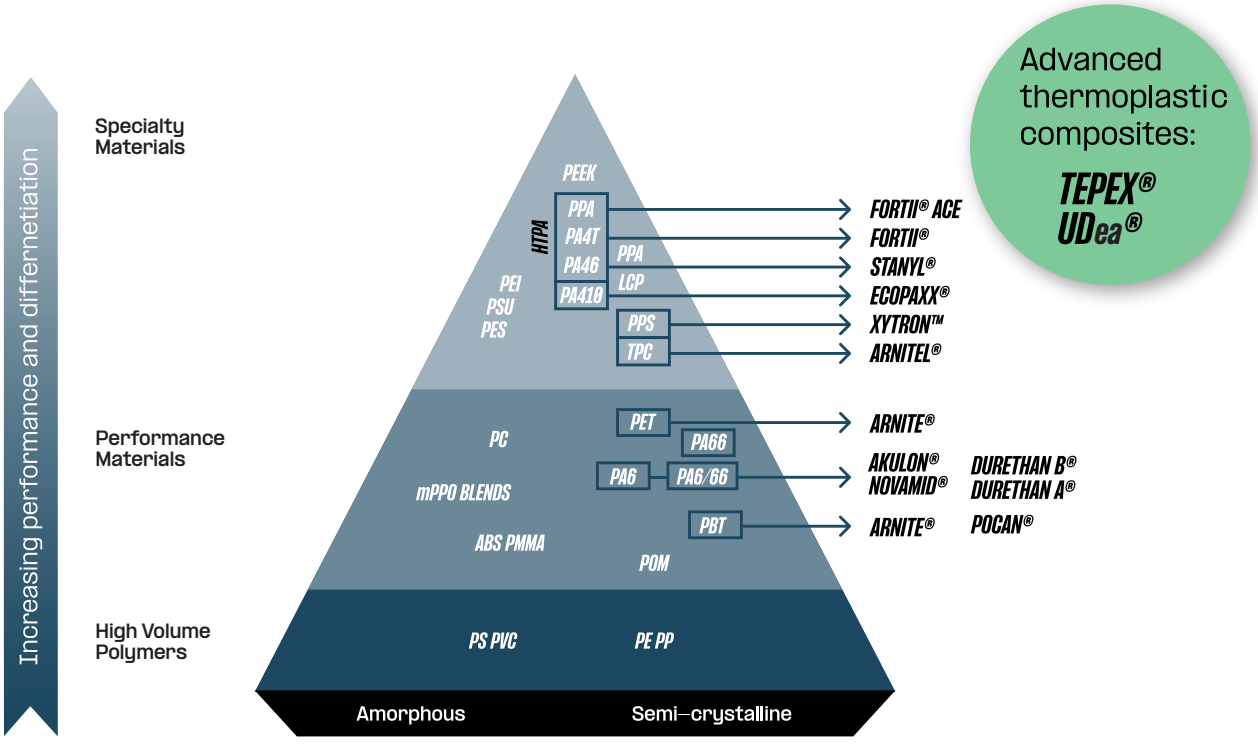
Tepex® refers to a range of innovative thermoplastic semi-finished products made from highly resilient composites, known as organo sheets. They consist of continuous or long fibers in a matrix made from various technical thermoplastics. Fiber materials used include glass, carbon, aramid and flax. They can be deployed in the form of woven fabrics and multiaxial or unidirectional textiles. That structure is what gives the flat semi-finished products their extraordinarily high strength and rigidity and yet extremely low weight at the same time. This enables even very sophisticated components to be manufactured in a cost-effective way. In particular, combining these materials with injection molding as the processing method allows for highly efficient series production.

Providing an effective blend of versatility and high performance, Tepex® is a definitive answer to challenges presented by current megatrends such as the transition to new vehicle technologies. It opens up scope for innovative solutions for custom product designs and characteristics as well as for improving safety, conserving resources and protecting the environment. Wherever there is a need for lightweight design on a production scale and functional integration in a tough and durable solution, Tepex® is the material of choice.

Tepex® thermoplastic fiber composites were developed in the 1990s and have been produced by Bond-Laminates GmbH ever since.

In 2023, the company became a wholly owned subsidiary of Envalior, one of the world's foremost suppliers of high-performance engineering materials. Envalior has attained a position of global leadership in a variety of industries by developing better, smarter, stronger, safer, smaller, lighter, longer-lasting and more sustainable products. As part of the Envalior Specialty Materials group, which now includes Tepex®, we offer not only our Tepex® organic sheets and tapes plus our Durethan®, Novamid®, Pocan®, Ecopaxx®, Fortii®, Stanyl®, Arnitel®, Arnite® A+T and Xytron® high-performance plastics, but also customized combinations of materials to suit specific customer needs.

Our team of Tepex® experts boasts more than 25 years of experience in the development, production and processing of thermoplastic fiber composites. With Tepex®, we have created a customizable range of systems that ensures we can meet the specific requirements of our customers as effectively as possible, from material and component design and testing to efficient series production. Tepex® has an established track record in numerous market segments and in the production of a broad array of components. Our development department works tirelessly to expand the product range and its spectrum of properties and, in the process, deploy tailor-made solutions to open up new applications.



INDIVIDUAL *CHARACTERISTICS*

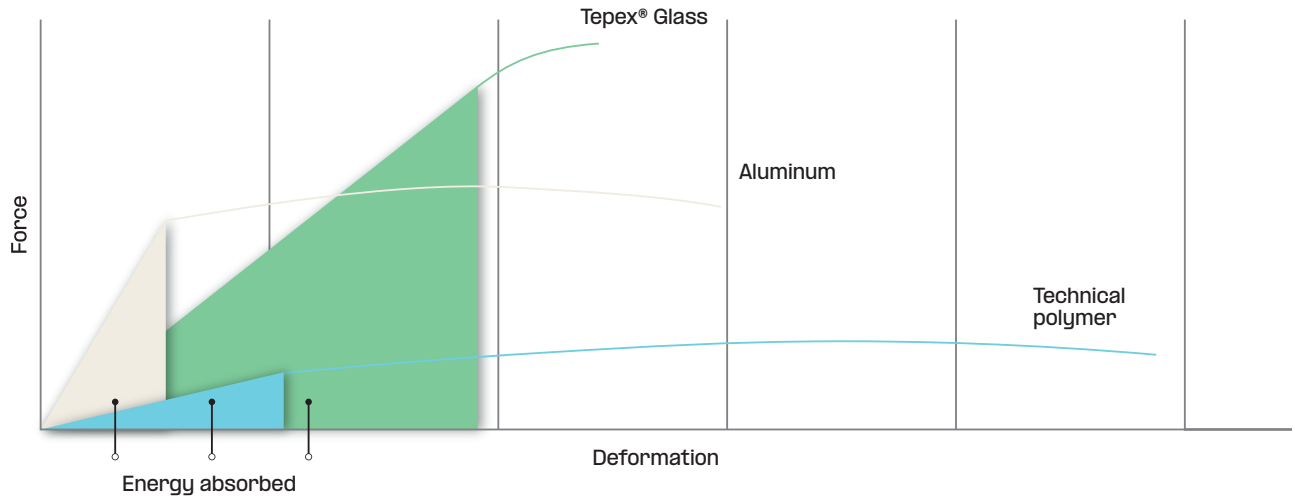
1. Taking inspiration from nature
Wood and bone are examples of lightweight natural materials in which strong fibers help to transfer and absorb forces. Our composites apply the principles of biomimetics in following that example. Variable fiber orientation and complete consolidation with a thermoplastic polymer give them high specific strength and rigidity. With Tepex®, components can therefore be designed with very thin walls and, as a result, exceptionally light weights. We adjust the properties of Tepex® precisely to the requirements of our customers and their components. To do that, we develop custom-made semi-finished products from an assortment of fiber materials and fiber arrangements, as well as various plastics such as polyamide, polypropylene, polycarbonate and specialty plastics such as thermoplastic polyurethanes or high-temperature thermoplastics. The result is a range of superior solutions suitable for almost any application and industry.

2. Lightweight design with no need for compromises
Tepex® provides an exceptional weight-to-performance-ratio offering suitable solutions for all applications that require weight reduction without compromising structural performance.

3. Sustainability
Tepex® lightweight materials are manufactured and processed using solvent-free methods. The thermoplastic matrix allows the creation of integrated recycling loops. As a result, Tepex® is helping industry to be sustainable, climate-friendly and efficient in its use of resources. In addition to the potential for lightweight design and the resultant reduction in carbon footprint that Tepex® provides, the product range of sustainable Tepex® combinations of recycled and bio-based raw materials, such as flax, is growing all the time.

4. Properties designed to order
Depending on material thickness, fiber type and fiber arrangement as well as the thermoplastic matrix material, Tepex® offers an extraordinary wide range of property profiles, from highly flexible to extremely rigid. Fine-tuning these parameters allows for higher specific energy absorption capabilities than other materials. Consequently, Tepex® is ideal for applications that call for good dynamic properties coupled with low component weight.

5. Versatile processing options
Semi-finished products from the Tepex® product family can undergo further processing using all kinds of methods such as thermoforming, compression molding, tape winding or hybrid molding. These can be used to produce complex components in just one single process step. The main benefits of hybrid methods, aside from significantly shorter cycle times, are the enormous freedom that they allow in terms of design and their efficient use of materials. In addition, there is no need to use a separate tool for semi-finished product forming or to conduct any finishing work on the components. That boosts efficiency and productivity. Tepex® is developed for series production and enables reliably high and consistent component quality coupled with short cycle times



ENDLESS POSSIBILITIES — *MARKET PROVEN APPLICATIONS*

Automotive engineering
Cost–effective lightweight design, vehicle dynamics and energy efficiency are essential requirements in the automotive industry, and reducing vehicle weight is the closest thing there is to a silver bullet for those problems – especially in the case of electric vehicles. However, it is crucial to ensure that safety, ride comfort and manufacturing efficiency are not sacrificed in pursuit of that goal. Tepex® offers solutions for structural and semi–structural components so that the seemingly contradictory properties of minimum weight and maximum energy absorption, strength and rigidity can be achieved in one component. That is why Tepex® is already used in underbodies, brake pedals, battery housings and front ends. Tepex® enables short cycle times and cost–effective manufacturing in established, large–volume production processes in the automotive industry. One noteworthy aspect of the use of Tepex® in electric vehicle batteries is that it allows for specialist solutions that reliably delay or prevent thermal runaway and thermal propagation.

Consumer Electronics
Modern electronic devices need to be light, robust and highly functionally integrated. Customized design with strong brand recognition and attractive look and feel are important selling points, especially in consumer electronics. With Tepex®, it is possible to manufacture structural components with very thin walls and yet excellent rigidity. Examples of such components include chassis for smartphones and laptops. The good mechanical properties of Tepex® are complemented by an aesthetically appearance. Furthermore, Tepex® scores a V–0 in UL 94 flammability testing – the best classification for a wide range of wall thicknesses and fiber layer structures.

Sports and leisure
The world of sports equipment is extremely wide ranging, and the same applies to the material requirements for items such as running shoe soles, bicycle components, ski boots, protective clothing and helmets. Tepex® is capable of meeting all these requirements. As a customized product, it provides the basis for lightweight components with optimized properties in terms of impact resistance or the transfer of energy, for example. Additional features include attractive looks and surfaces that create a high–quality appearance.

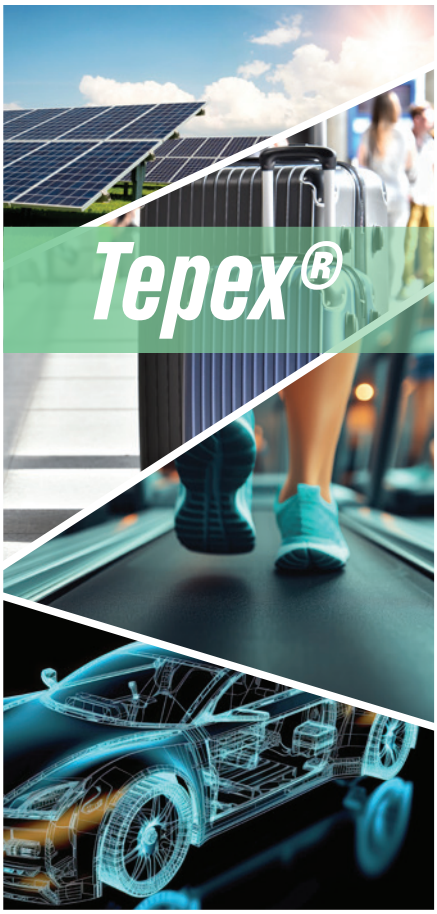
General industrial applications
Industrial processes and applications require energy to be used efficiently. Moving machine parts made with Tepex® fulfill stringent stability requirements despite their relatively low weight. It takes less energy to move and accelerate these lighter objects. The benefits are obvious. Special material characteristics, such as flame–retardant properties, thermal resistance or the ability to absorb kinetic energy, broaden the range of possible uses for Tepex® in all manner of industrial sectors. This applies to textile machinery, public transit, safety applications and the aerospace industry.

STANDARD MATERIALS
FOR NON–STANDARD SOLUTIONS

Tepex® dynalite – maximum strength, minimum weight
Semi–finished products from the Tepex® dynalite product family consists of multiple layers of continuous reinforc–ing fibers in a matrix of technical thermoplastics. The fiber structure is fully consolidated with the polymer and ensures extremely high strength and rigidity in the com–ponent while maintaining a low weight at the same time. Tepex® dynalite is the ideal solution whenever lightweight design needs to meet high mechanical stability. That applies to organo sheet components for vehicles just as much as it does to the soles of running shoes.

Tepex® flowcore – cost–effective compression molding
Similarly to conventional sheet molding compounds (SMC), Tepex® flowcore contains long glass fibers (30–50 mm), but with a thermoplastic polymer matrix. It can be used by itself or for structural optimization in combination with Tepex® dynalite. Formed into reinforcements and ribs, it increases the mechanical stability of components. Tepex® flowcore can be processed with common compression molding methods. It is particularly useful for applications in which injection–molded materials cannot provide the necessary stability and thermoset semi–finished prod–ucts are not suitable.

Tepex® anti–ballistic – maximum energy absorption, effective protection
Tepex® anti–ballistic materials, made from woven aramid fabric, are designed specifically for optimally absorbing and dissipating energy with the aim of protecting people and hardware. As with the other Tepex® families, Tepex® anti–ballistic has an advantageous strength–to–weight ratio, which has beneficial effects in vehicle manufactur–ing and, in particular, in making ballistic body armor more comfortable to wear.



1 02 –RG 600 (4)/47% – black – 2.0 mm

- 2.0 mm → laminate thickness
- black → visible color
- 47% → fiber volume content
- (4) → number of fabric layers
- 600 → textile area weight (g/m²)
- RG → available weaving variations
- 02 → 02 = PA6**
- 1 → 1 = Glass*

* **available fiber reinforcement**

1	Roving Glass (RG) Filament Glass (FG)
2	Carbon (C)
3	Aramid (A)
8	Flax (F)

** **available polymer matrix**

Polyamides	PA66 (01), PA6 (02), PA12 (06), PA46 (09), PA1010 (12), PA410 (16)
Polyolefins	PP (04), HDPE (11)
Others	PC (10) PPS (07), PEI (15) TPU (08), TPC (17) PLA (13), PCL (14)

Yarn type

RG	roving glass
FG	filament glass
C	carbon
A	aramid
F	flax
B	*basalt*

+

Textile type

(–)	balanced weave
UD	unbalanced weave
R	randomized
NW	non–woven
B	*braided*

Materials in the Udea® family are fully impregnated thermoplastic tapes. The reinforcing fibers are entirely aligned with the production direction of the tapes, allowing for the transfer of energy to be directed in the ideal orientation. Udea® tapes boast very high strength in the fiber direction and are particularly well suited to winding processes and to the local reinforcement, or patching, of components.

Udea® tapes, based on Akulon® or EcoPaXX®, are reinforced with unidirectional carbon or glass fibers and have a fiber content of 60% by mass.

From outstanding impact resistance and high heat resistance to exceptional flame–retardant properties, Akulon® PA6 offers characteristics that help customers to manufacture lighter, smarter and more environmentally friendly products. By using EcoPaXX®, we show that when we claim to have a sustainable product range, we truly mean it.

EcoPaXX® is a high–performance, bio–based aliphatic polyamide that combines the advantages of typical short–chain and long–chain polyamides, such as low moisture absorption and high mechanical strength, in a unique way. EcoPaXX® is 70% bio based

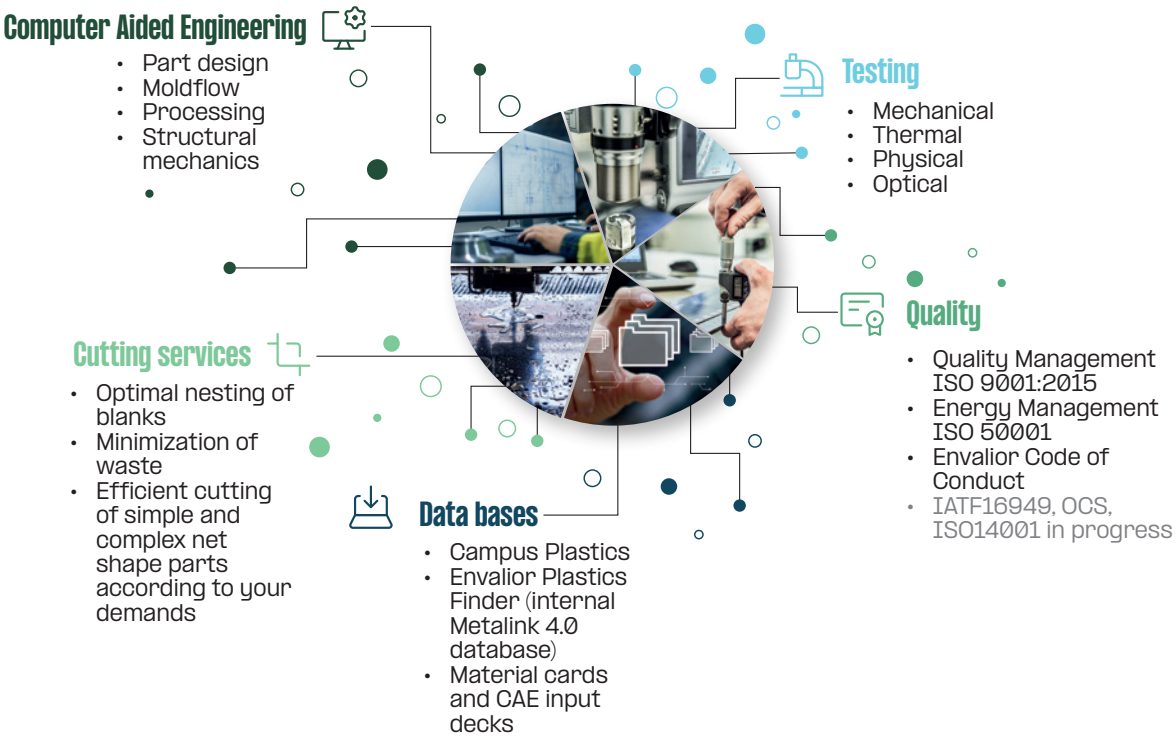
NOT JUST A MATERIAL, *BUT ALSO PART OF YOUR SOLUTION*

Material development
Tepex® is an innovative material system with properties that we can tailor to specific industries, applications and customers. Our material and application developers work closely with customers to select the most suitable material type and adjust it precisely to the requirements of the application in question. Naturally, we respect the intellectual property of our customers and make sure that we protect it throughout our collaborations. Ideally, we prefer to work with customers right from the early stages of product development. That way, they can coordinate their components to suit all requirements during the design phase and optimize the way in which the use of the semi–finished products is integrated into their processing operations. Our goal is to achieve the best possible fiber/matrix combination and the highly automated and thus cost–effective production and quality assurance of the Tepex® components.

Production
Tepex® semi–finished products are produced in a continuous lamination process in line with the specific requirements of each customer. This process is based on our years of experience in the development and manufacture of composites with thermoplastic matrices. It enables each individual filament to be fully consolidated with the matrix material. During production, we monitor the process to make sure that the required material properties are maintained. Tepex® is supplied in panels with standard widths of up to 1,240 mm and variable lengths depending on customer requests.

Cutting
We provide blanks with customer–specific geometries, adjusted to match the further processing workflow. To do this, we work with precision waterjet cutting machines. We start from the drawings supplied by our customers to devise cutting programs that we can use partly to cut waste down to a minimum thanks to some clever nesting and partly to adhere to the required geometric tolerances in the most cost–effective way possible. That benefits both our customers and the environment. The semi–finished products delivered can be fed directly into the further processing workflow, while the offcuts produced are separated out, shredded and recycled as high–quality granules for injection molding.

Processing expertise
Our customers benefit from the fact that we know everything there is to know when it comes to materials and processing in relation to fiber composites with thermoplastic matrices – no matter which application or industry is involved. We are constantly working to expand that expertise. Our highly qualified employees contribute to this, as does our cooperation with external processing specialists and academic research institutes. Envalior is committed to partnerships with its customers based on trust, from the early stages of product development to the successful delivery of components made from Tepex®. That is how we help our customers to manufacture products that provide the very best in design and performance.



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