



TEPEX[®] materials, properties and processes



The world of TEPEX®

Superior in motion – maximum performance with minimal resources

Bond-Laminates develops, manufactures, markets and sells advanced thermoplastic composites under the trade-name TEPEX®. Among others, TEPEX® materials offer the following key values to its customers:

1. Minimum weight – maximum performance
2. Superior energy absorption
3. Processing speed – improved quality
4. Energy savings – recyclability

Over twenty five TEPEX® fibre/thermoplastic base material formulations are currently available. These base material formulations are used to create a wide variety of standard and customized TEPEX® laminates. Bond-Laminates' customers work closely with our development engineers as well as our TEPEX® applications development and manufacturing partners, to design the materials and select suitable manufacturing processes. The continuous TEPEX® lamination technology combined with the ease of part manufacturing make the TEPEX® system suitable for high-volume applications where consistent quality and weight savings are critical.



TEPEX[®] – superior in motion

Key benefits of TEPEX[®]

TEPEX[®] is a high-performance composite laminate system made with thermoplastic resins. By virtue of the continuous reinforcing fibres, TEPEX[®] exhibits exceptionally high strength and rigidity, coupled with an extremely low weight. The thermoplastic characteristics of TEPEX[®] enable the use of cost-effective parts fabrication processes, such as thermoforming. Following benefits can be obtained by using TEPEX[®]:

Technical properties

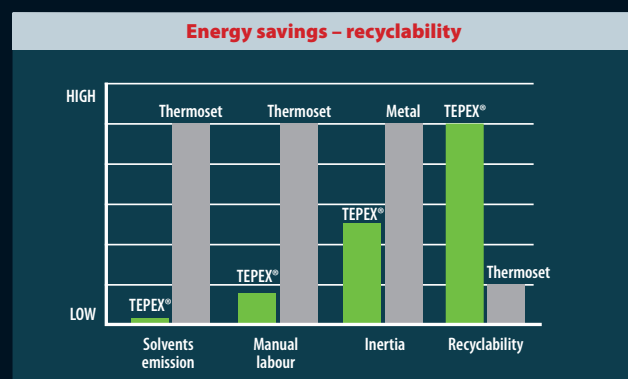
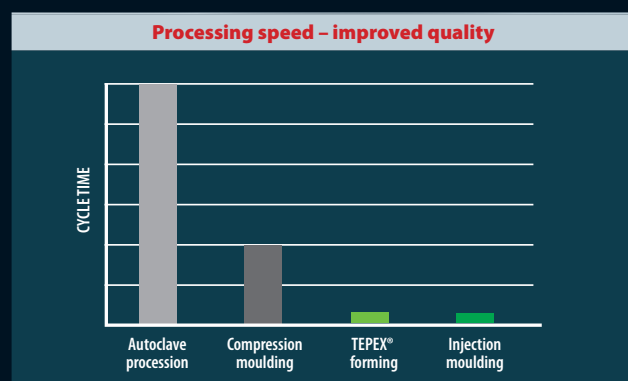
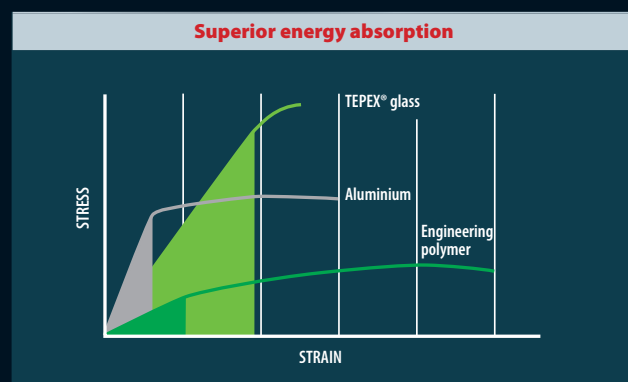
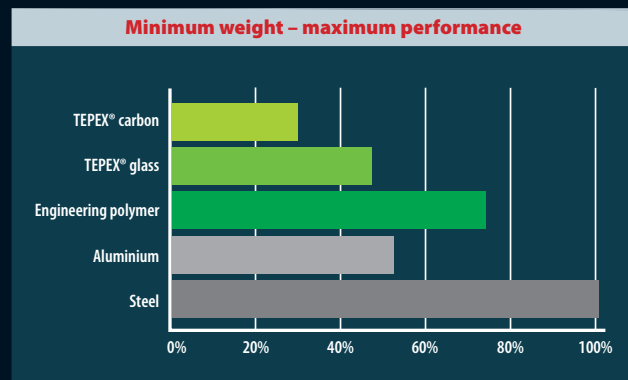
- Outstanding mechanical properties
- Good chemical resistance
- Excellent fatigue resistance
- Excellent crash energy absorption
- Wide range of reinforcing options and finishes available

Processing and economics

- Automated processes, highly consistent quality
- Very short forming cycle times of typically a minute
- TEPEX[®] can be overmoulded, enlarging design freedom
- TEPEX[®] can be welded
- TEPEX[®] is reformable after moulding
- Room temperature material storage

Environmental

- Waste material is being recycled
- No use of solvents in the manufacturing process
- Energy efficient production processes
- End-of-life recyclability



TEPEX® advanced thermoplastic composite materials

Optimised combinations of fibres and thermoplastic resins

A composite is a specific combination of two or more materials that improves the properties of the individual components. Nature itself has demonstrated the principle that high-strength fibres are the most suitable lightweight material to transfer and absorb forces.

Within the TEPEX® material family a range of reinforcing fibres such as glass, carbon and aramid are used, offering outstanding mechanical properties at a low weight. Thermoplastic resins as PP, TPU, PA12, PA6, PA66 and PPS are impregnated into these fibres and make laminate materials robust, easy to mould, weldable and resistant to the application's environment. TEPEX® laminates are typically fully consolidated with a void content below 2%.

TEPEX® laminates are offered in a wide variety of standard formulations and thicknesses. Beyond these standard products, there are applications that call for tailor-made solutions. We can optimise materials to meet many requirements for a specific application. Variations in resin formulations, fibre structures, optimised thickness and adapted fibre content are used to achieve the required result.

Below is an overview of properties offered by the many material combinations. For more detailed material properties and processing guidelines, please see the TEPEX® data sheets.

TEPEX® material	Fibre	Polymer	Density (kg/dm ³)	Fibre Content (vol.%)	Tensile Strength (MPa)	Tensile Modulus (GPa)	Flexural Strength (MPa)	Flexural Modulus (GPa)	Processing temperature (°C)	Temperature in use: – max short term (°C) ¹⁾ – max continuous (°C) ¹⁾	Main application use	
STANDARD MATERIALS												
Fast response time in material selection and manufacturing												
TEPEX® dynalite 101	Roving Glass	PA66	1.8	45	472	23	600	21	280	200	130	automotive, protection, consumer, sports, miscellaneous
TEPEX® dynalite 201	Carbon	PA66	1.4	45	785	53	760	45	280	200	130	automotive, protection, consumer, sports, miscellaneous
TEPEX® dynalite 102	Roving Glass	PA6	1.8	45	405	22	620	19	240	180	120	automotive, protection, consumer, sports, miscellaneous
TEPEX® dynalite 104	Roving Glass	PP	1.7	45	415	20	365	18	190	155	90	automotive, protection, miscellaneous
TEPEX® dynalite 108	Filament Glass	TPU	1.8	45	430	25	530	23	220	120	90	protection, sports, miscellaneous
TEPEX® dynalite 208	Carbon	TPU	1.5	45	710	48	745	41	220	120	90	protection, sports, consumer, miscellaneous
TEPEX® anti-ballistic 300	Aramid	PA	1.4	75	Stanag 2920 FSP up to 750 m/s, FB4, NIJ-III A at 8.2 kg/m ²					xx	120	ballistic protection
TEPEX® flowcore 102	Random Glass	PA6	1.6	35	195	13	260	12	240	180	120	automotive, protection, consumer, sports, miscellaneous
CUSTOM-MADE MATERIALS												
Longer response time for material optimisation and manufacturing than for standard materials inquiry												
TEPEX® dynalite 106	Filament Glass	PA12	1.7	45	400	20	390	18	200	140	90	consumer, miscellaneous
TEPEX® dynalite 107	Filament Glass	PPS	1.9	45	670	27	530	24	310	300	220	aerospace, miscellaneous
TEPEX® dynalite 207	Carbon	PPS	1.6	45	710	55	650	40	310	300	220	aerospace, miscellaneous

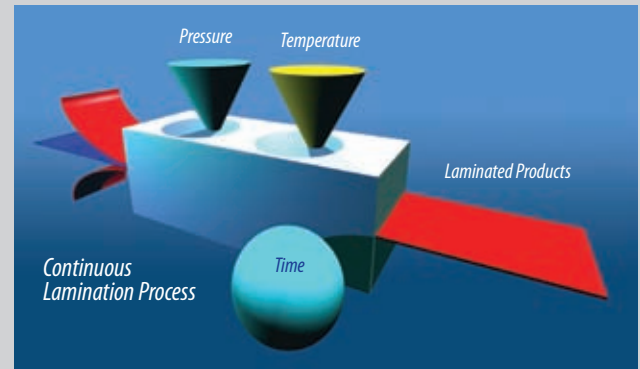
1) Literature recommendation for unreinforced plastics, performance of continuous fibre reinforced plastics typically better

TEPEX® continuous production technology

Mass-manufactured optimised material solutions

Our continuous lamination process enables cost effective and high quality production of TEPEX® laminates. In a proprietary process, the thermoplastic matrix and individual fibre structure layers are fused thoroughly together under high pressure into a single consolidated laminate.

Bond-Laminates produces materials in two standard widths: 620 and 860 mm. Other widths are available on request. Since we produce continuously, the sheet length can be optimised per application. Materials are normally supplied as sheets, but can be delivered on rolls up to a material thickness of 0.4 mm.



TEPEX® material types

TEPEX® *dynalite*

Maximum strength at minimum weight

The TEPEX® *dynalite* range consists of multiple layers of continuous fibre reinforcements in a matrix of engineering thermoplastics. The continuous fibres throughout the thickness provide the maximum available strength and stiffness. These materials are used for industrial and automotive applications and in sporting goods for bicycle components, snowboard bindings, footwear, helmets and body protection to minimize weight.

TEPEX® *anti-ballistic*

Superior protection against ballistics

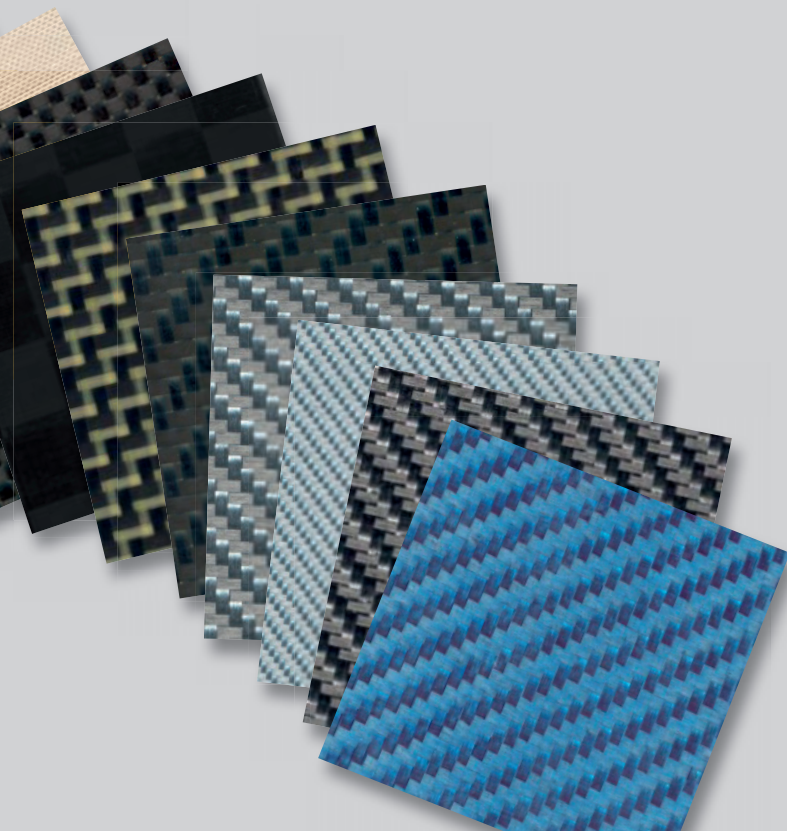
TEPEX® *anti-ballistic* materials made from aramid fabrics are specially designed for optimum anti-ballistic performance. These systems outperform parts made by hand lay-up from traditional thermosetting prepregs in terms of anti-ballistic (or impact) protection, cost and weight. Parts are produced with a fully automated forming system with a very consistent quality. TEPEX® *anti-ballistic* systems are used in protective products, like military helmets and car armouring.

TEPEX® *flowcore*

Cost effective flow moulding

TEPEX® *flowcore* consists of long glass fibres (30-50 mm), similar to traditional GMT materials, with the advantage that they are based on engineering resins.

In optimising design, TEPEX® *flowcore* is often combined with TEPEX® *dynalite* to provide stiffeners and ribs in reinforced structures. TEPEX® *flowcore* materials can be moulded using standard compression moulding tools and are intended for automotive and industrial structures where standard GMT and injection moulded thermoplastics cannot meet higher temperature and structural performance requirements.



TEPEX[®] processing

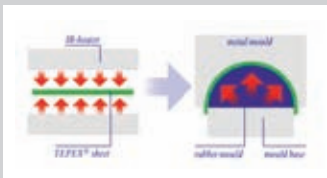
Process advantages of thermoplastic composites

TEPEX[®] thermoplastic composite laminates can be moulded rapidly in cycle times of 1 minute or less. There is no other composite technology offering these cycle times. The TEPEX[®] laminate is heated separately from the forming process. Heating takes place through infrared radiation or contact heating. Shaping the laminate into a product takes place using a press or diaphragm forming equipment. The main forming processes are described below, further processes are available for special materials or applications.

TEPEX[®] materials can be integrated within thermoplastic injection moulding and compression moulding manufacturing processes. Such integrated processes are known as hybrid moulding. Advantages are the efficient material use, elimination of the product trimming step,

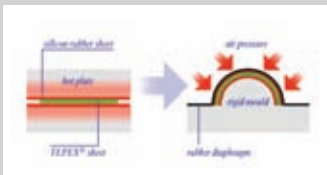
integration of manufacturing processes and freedom of part design. Below processes are used commercially for hybrid moulding of TEPEX[®].

The combination of these technologies offers a rational way of creating local reinforcement, force introduction joints and functional elements, in a single process. This allows a high degree of product integration to be combined with the excellent mechanical properties of the fibre composite material. In addition to ease of moulding, thermoplastic composites offer key processing advantages like welding for integrating the TEPEX[®] material into a final product. Please consult our website and/or our processing guidelines for more information on processing.



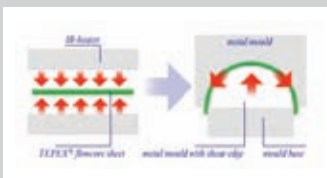
Rubber and matched metal press forming

The press forming process is the most common process for shaping TEPEX[®] laminates into parts. To enable handling and prevent wrinkling, the sheet is held within a clamping frame during heating, transport and forming. The tooling consists of two parts, a positive and negative mould. The moulds can be made of steel, aluminium or resin, depending on complexity and production volume. In many cases, it is advisable to use a rubber positive mould to obtain a homogeneous pressure distribution within the tooling. The tooling is temperature controlled in order to obtain stable part quality, with cycle times of 30-90 seconds.



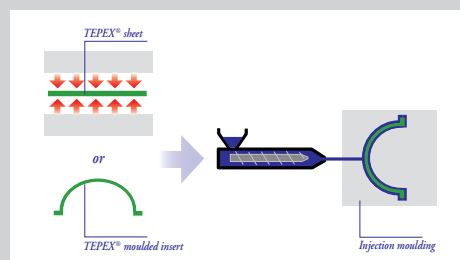
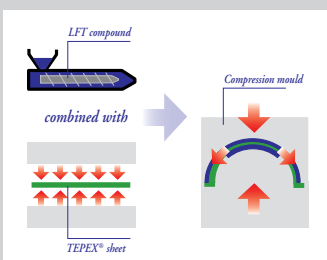
Diaphragm forming

This is a great technique for relatively simple geometries as both the tooling cost and the cycle time are very attractive. The sheet is heated between two reusable release films, normally from silicon rubber. The softened laminate enclosed between the release films is then quickly placed on top of a positive or negative mould, after which an air pressure of around 5 bars is applied. When the material is sufficiently cooled, the product is taken out and the next can be formed. Cycle times are around 40-60 seconds. The necessary equipment takes only small investments. Tooling should be temperature controlled.



Compression moulding

The flow mouldable TEPEX[®] flowcore material enables controlled thickness differences throughout the product and a finished product from the mould. This material should be moulded at high pressures (> 100 bars) with a high press closing speed. During the fast compression of the material, a high resin flow is obtained within the mould. The tooling is very similar to standard GMT toolings and is constructed with shear edges. Cycle times for automated equipment lay around 30-60 seconds. The tooling should be temperature controlled.



Hybrid moulding

TEPEX[®] materials offer a new and exciting possibility for the further enhancement of injection mouldings and Long Fibre Thermoplastic (LFT) and Glass Reinforced Thermoplastic (GMT) compression mouldings. Injection moulding and GMT/LFT structures can be reinforced locally by using TEPEX[®] inserts. Applications designed with TEPEX[®] can be manufactured with complex local design details. The TEPEX[®] reinforcement can be introduced as a heated flat sheet or as preformed part. During moulding the materials fuse together and form a highly integrated part. The injection moulding or GMT/LFT polymer is typically of the same family as the TEPEX[®] matrix material, ensuring a good weld bond. These processes are state of the art.



TEPEX®
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