TEIJIN



Ballistic materials handbook

Twaron® Endumax®

Aramids by Teijin

Be sure.



Teijin Aramid and ballistic protection

The intensity of threatening environments for law enforcement, emergency responders and defense forces around the world is becoming higher and the people operating in these hostile environments need to take greater care than ever. This growing threat of violence has led to an increasing demand for ballistic protection.

At Teijin Aramid we are dedicated to providing this protection with our high performance para-aramid fiber Twaron® and UHMWPE Endumax® film. With excellent energy absorption properties, tenacity and impact resistance, Twaron® and Endumax® offer effective and comfortable ballistic protection solutions with an outstanding cost-performance ratio. In the more than 30 years that Twaron® has been available on the market, it has helped to save thousands of lives worldwide. Key applications for Twaron® and Endumax® include bullet/fragment/stab/spike resistant vests, helmets and ballistic protection of vehicles, aircrafts and vessels.

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Soft ballistic protection

The threats to modern armies and law enforcement forces have multiplied, creating the need for protection from all kinds of bullets and fragments as well as stabbing with sharp objects. And these days it's not only soldiers and policemen who are facing increased threats; prison guards, cash carriers and private individuals also need to be protected. The market is seeking better protection and greater comfort. Many of today's protective vests are made of Twaron® and Endumax®, which provide enhanced protection, more comfort and advantageous performance to weight ratios.



Helmets

One can hardly imagine a modern soldier or a member of a police special task force without an advanced composite multifunctional helmet in which protection against bullets, shrapnel, grenade fragments, blast effects and mechanical impacts is combined with equipment platform functionality. Ensuring key aspects such as a high degree of ballistic protection, low weight, durability and a long life make this a truly sophisticated product. Benefits for Twaron®- and Endumax®-based helmets also include low Back Face Deformation (BFD).



Hard ballistic protection

Twaron® and Endumax®-based armoring products are successfully used in military and police applications from helicopters to tanks, trucks, vessels, armored personnel Teijin Aramid and ballistic protection carriers and patrol cars. Twaron®- and Endumax®- based ballistic solutions help preserve vehicle, performance and payload. Armored vehicles, vessels and aircraft based on Twaron® or Endumax® will remain light and manoeuvrable: compared to ballistic steel there is a 30-60% reduction in weight. Furthermore, Twaron® or Endumax® spall liners form an extra protective layer inside the vehicle, defending passengers against fragments from secondary fragments from steel or ceramic armoring plates. Twaron® and Endumax® products can easily be installed in vehicles, both during or after construction. There are Twaron® and Endumax® ballistic solutions for multiple levels of threats, from direct fire and shell fragments to high explosives.



Custom-built solutions

At Teijin Aramid, we co-develop custom-built solutions, together with our customers. Thanks to our own dedicated R&D and test facilities, we have been able to develop advanced new materials such as Laminated Fabric Technology (LFT). Over the years we also developed sandwich constructions, which combine ballistic protection with protection against stabbing and front panels tailored to the needs of women soldiers. With deep insight into the market as well as modern production processes, we offer a very high level of technical support, for example when manufacturers are developing new products to meet the needs of tomorrow's high-tech soldiers and law enforcement officers.

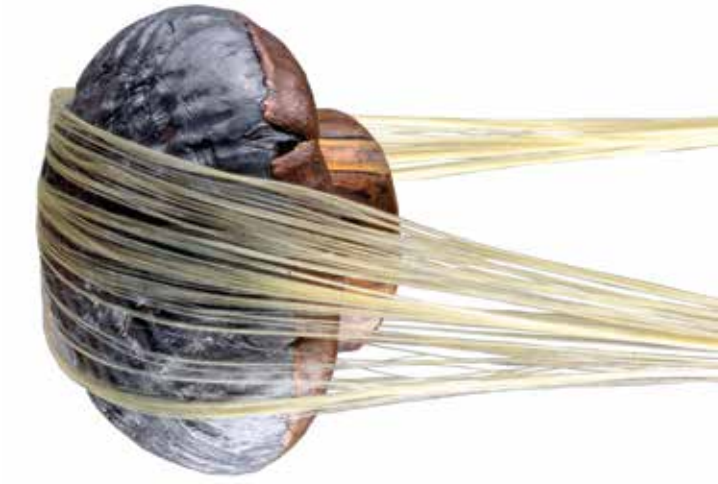


Twaron® ballistic yarns

The history of protecting man against weapons goes back to ancient times. For hundreds of years, metal materials have been used not only for body armor but also for the protection of larger objects such as vehicles, providing what is called 'hard protection'. By the end of the 19th century, softer constructions first began appearing. But these vests could not come close to offering the present level of ballistic protection achievable by Twaron® para-aramid filament yarns and the fabrics that can be made from them.

This extraordinary level of ballistic protection has been made possible thanks to intensive R&D at Teijin Aramid, combined with tens of thousands of empirical evaluations. Twaron® high-tenacity (CT) microfilament yarns represent a milestone in the development of high-performing soft ballistic protection gear. They offer a higher level of protection than ever before, thanks to their unique absorption of the kinetic energy of the intruding projectiles. The myriads of nearly invisible filaments increase the "working" surface of the yarns, so the required stopping power can be obtained with less material. The ultra-fine filaments in the yarn also provide another benefit: they give fabrics an extraordinary softness, translating to a high level of comfort for the wearer.

What's more, countless weaving tests on various creels, warping machines and different weaving machines have been carried out to ensure the optimum processability of Twaron®. No wonder, then, that para-aramid ballistic filament yarns from Teijin Aramid have come to dominate the global markets.



Recently, Teijin Aramid introduced the world's finest filament yarn called Twaron® Ultra Micro 550f1000. This enhanced tenacity, ultra microfilament yarn enables the production of very lightweight ballistic vests and is available in 550dtex with 1000 filaments.

High-tenacity microfilament Twaron® yarns (with counts of 550, 840, 930 and 1100dtex) are used all over the world to provide the highest protection to comfort ratio for ballistic fabric constructions.

The high-tenacity Twaron® filament yarns offer a high protection to economy ratio for various ballistic protection items within both soft and hard (including composite) applications.

The Twaron® standard-tenacity fibers provide a perfect balance of performance and economy, and are an attractive alternative for numerous up-armoring projects within the hard-ballistic protection market.

Compared with other ballistic protection materials, Twaron® para-aramid filament yarns excel in chemical and thermal stability, as well as resistance to various aggressive environments.

The superb quality of all Twaron® para-aramid ballistic filament yarns starts at the very beginning – with the basic chemistry used at the birthplace of Twaron® in Delfzijl, the Netherlands. Here, the monomeric (and later the polymeric) base materials for Twaron® yarns are produced in chemical processes that meet the most stringent quality requirements, generating the highest value possible.

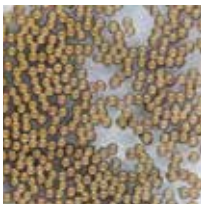
Our spinning and polymer production facilities comply with ISO 9001 and ISO 14001 standards. Multiple quality controls are performed daily, not only to guarantee the high performance and reliability of our products, but also to keep our promise to our customers: 'Perfect protection for safety and satisfaction.'

Twaron® yarn cross sections


550 dtex f500


550 dtex f1000


840 dtex


930 dtex


1100 dtex


1680 dtex


3360 dtex

Twaron® yarn type	Dtex	Key attributes	Primary applications
Ultra Microfilament - Enhanced Tenacity (Twaron® CT)	550	• Highest protection/weight ratio • Very lightweight • Enhanced comfort	Soft protection Dedicated to fragmentresistant vests
Microfilament - High Tenacity (Twaron® CT)	550 840 930 1100	• High protection/comfort ratio • Light weight • High comfort	Soft protection
High Tenacity (Twaron® CT)	1680 3360	• High protection/cost ratio • Standard weight • Good comfort	Soft protection Hard protection
Standard Tenacity (Twaron® T)	1680 3360	Balance between performance and cost efficiency	Hard protection

Yarn list

Linear Density	Filaments	Twaron®-Type	Spin finish content	Strength at Break	Tenacity at Break	Elongation at Break	Chord Modulus
Dtex (effective)	No.			N	mN/tex	%	GPa
550 (570)	1000	2642 Ultra Micro	0.35%	148	2600	3.5	100
550 (570)	500	2040 Microfilament	0.8%	135	2350	3.45	91
840 (860)	1000	2040 Microfilament	0.8%	215	2500	3.50	92
930 (960)	1000	2040 Microfilament	0.8%	225	2350	3.45	89
1100 (1135)	1000	2040 Microfilament	0.8%	267	2350	3.45	91
1680 (1640)	1000	2000 or 2040	0.8%	385	2350	3.45	91
3360 (3460)	2000	1000	0.8%	688	1990	3.70	67
3360 (3280)	2000	2000	0.8%	770	2350	3.45	91

Sewing yarn available: 550dtex, 840dtex

	Type 2000/2040/2642	Type 1000
Tube length x diameter (mm)	290 x 94	216 x 94
Winding height/stroke (mm)	260	192

Packing (bobbins x kg)	Type 2000/2040/2642	Type 1000
550 dtex	90 x 5	
550 Ultra	138 x 2.1	
930 dtex	69 x 6	
1100 dtex	90 x 4.5	
1680 dtex	54 x 9	52 x 9.2
3360 dtex	48 x 10	52 x 9.6



Twaron® ballistic fabrics

Whenever the combination of high functionality, comfort and economy is required, you will find advanced para-aramid Twaron® yarns being used in sophisticated fabric constructions tailored for specific end uses.

In general, ballistic threats emanate either from bullets or fragments. Bullets can be defined as projectiles of various shapes and consistencies shot from weapons such as pistols, revolvers and rifles. Fragments, on the other hand, can originate from explosions (e.g. grenade detonations) or as pellets from shotguns.

The manifold kinetic characteristics and deformation behaviors of such a broad range of bullets and fragments mean that a number of different stopping mechanism are required for full ballistic protection.

Soft-core (e.g. lead) bullets can be stopped with soft panels, i.e. textile fabrics layered on top of one another. However, specifications today often have to cover different types of bullets with different physical characteristics. Some of these require a customized and dedicated textile solution. Thanks to the high flexibility and wearing comfort that is possible today, such solutions can now be incorporated into body armor applications.

Hard-core (AP) ammunition is fragmentized by steel or ceramic plates, and these fragments are then "caught" by resin-impregnated textile layers. While these hard plates can be used in body armor, they are mainly employed for vehicle and other hard-protection purposes.

The available Twaron® fabric styles are designated with the codes CT (high tenacity) or T (standard tenacity), followed by a 3-digit number. This classification, used all over the world, is applied by high-quality weavers that are selected, authorized and approved by Teijin Aramid.



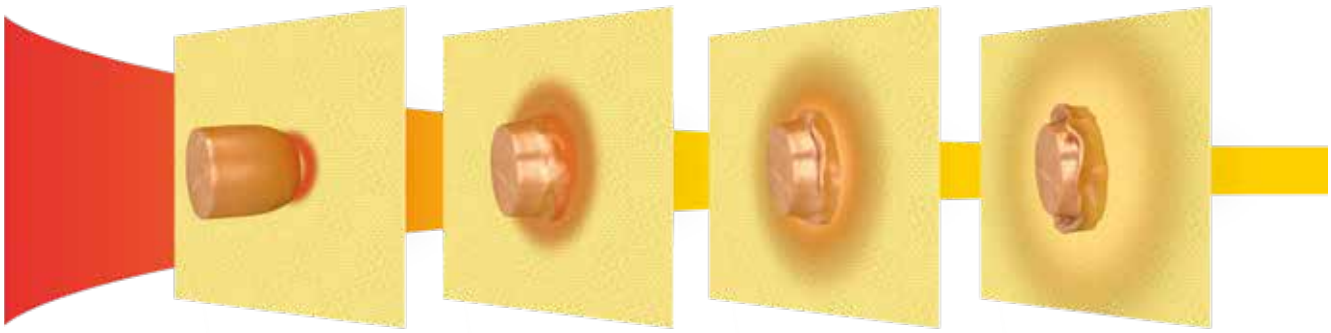
Twaron® Platin PT900

Twaron® Platin PT900

Platin PT900 is the best in class product for strike face dedicated for hybrid ballistic packs. It combines ballistic effectiveness of open satin weaves with structural integrity of plain weaves. It is extremely effective in early bullet deformation, helping to improve ballistic limit as well as improving trauma attenuation. As little as 5 layers can improve the pack's response to bullet's impact significantly depending on the solution used.

The flexibility of this construction outperforms the well-known plain weave, enhancing further the wearer's comfort. The lay-up composition is also flexible. The Twaron® Platin construction makes sure that its ballistic performance stays stable during the life-cycle of the products. Teijin aramid holds a global patent on the Platin construction.

Why a good strike face helps to stop the bullet?



Bullet deforms and impact surface increases

Energy density is decreasing
More material is engaged
Bullet stops earlier in the pack

Reduced trauma
Improved ballistic limit

Most current Twaron® ballistic materials used for personal protection are woven, mainly for the following reasons:

- Fabrics offer excellent flexibility
- Fabrics are resistant to wear and tear and provide good performance stability over the life time
- Fabrics can be finished to be water-repellent, making them superior to other materials when exposed to moisture
- On ballistic impact, threads are not pulled out or pushed aside
- The required production technology is widely available
- A matrix can be easily applied to a fabric, allowing the use of laminates for even higher levels of protection if required.

Ballistic fabrics - a wide variety of solutions

Please consult with Teijin Aramid Sales Representatives to check the appropriate fabric treatments for application as well as availability. The range of ballistic fabrics covers different key attributes and characteristics.

CT 608

550 dtex - Type 2642

Primary application
Body armor

Key attributes/characteristics

- 120 g/m² ballistic fabric, based on the high performing lightweight aramid yarn, Twaron® 550dtex f1000, the world's first ultra-microfilament para-aramid fiber.
- Will meet the most challenging military requirements, both on fragment as on bullet resistance
- Successfully used in military vests, providing a light weight and comfortable solution



CT 612 & CT 613

550 dtex - Type 2040

Primary application
Body armor

Key attributes/characteristics

- CT 612: 120 g/m² ballistic fabric
- CT 613: 135 g/m² ballistic fabric (more dense version)
- Based on one of the thinnest yarns ever made in the para-aramid spinning process
- Dedicated to providing maximum protection against bullets and fragments
- Successfully used in military vests, providing a light weight and comfortable solutions



CT 709

930 dtex - Type 2040

Primary application
Body armor

Key attributes/characteristics

- 200g/m² ballistic fabric, based on unique Twaron® microfilament yarn
- Ballistic protection combined with a high level of comfort
- Good cost/performance ratio
- Proven product, used by countless police departments around the world
- Enables the production of seamless ballistic packages providing the wearer with a surprising freedom of movement combined with high ballistic protection
- Particularly suitable for body armor vests for women



CT 714

1100 dtex - Type 2040

Primary application
Body armor

Key attributes/characteristics

- 190 g/m² ballistic fabric based on first microfilament fibertype
- Excellent fragmentation protection
- Used for fragmentation jackets by most of the armed forces around the world
- Good protection against specific types of projectiles
- Cost attractive solution



CT 716

1100 dtex - Type 2040

Primary application
Body armor

Key attributes/characteristics

- 280 g/m² ballistic fabric based on high-tenacity (CT) Twaron yarn
- This tightly woven fabric offers very good ballistic protection against projectiles combined with advantageous blunt trauma behavior



CT 736 & CT 737

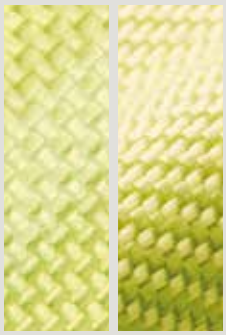
1680 dtex - Type 2000

Primary application

Helmets

Key attributes/characteristics

- 410 g/m² ballistic fabric
- CT 736: Basket 2x2 weave
  CT 737: Twill 2x2 Z weave for better drape-ability in difficult shaped parts
- Used for the production of modern-state-of-the-art ballistic helmets
- Typically used in mine boots sandwich constructions
- Good processability with various resin systems



CT 747

3360 dtex - Type 2000

Primary application

Helmets – for cost-efficient solutions

Key attributes/characteristics

- 410 g/m² ballistic fabric
- Designed for economy-driven ballistic helmet solutions
- Good processability with various resin systems



T 717 & T 730

1680 dtex - Type 1040

Primary application

Body armor - where the weight of the ballistic pack is not a priority

Key attributes/characteristics

- T 717: 280 g/m² ballistic fabric (more dense version)
- T 730: 260 g/m² ballistic fabric
- Plain woven fabric based on standard tenacity (T) Twaron yarn
- Designed for economy-driven ballistic performance solutions requiring good projectile and fragmentation resistance



T 750

3360 dtex - Type 1000

Primary application

Hard Ballistics

Key attributes/characteristics

- 460 g/m² ballistic fabric for resin-coated hard ballistic laminates
- Widely used in hard ballistic applications
- Typically used in spall liners
- Numerous helmet shells are made out of this fabric (wet process)



T 760

3360 dtex - Type 1000

Primary application

Hard Ballistics

Key attributes/characteristics

- 635 g/m² ballistic fabric
- Heavy and very flexible fabric for up-armoring of vehicles
- Excellent shaping possible, therefore suitable for manufacturing process



Fabric list

Style	Linear Density [dtexnom]	Twaron®-Type	Weave	Set [per 10cm]		Set [per inch]		Areal Density		Thickness [mm]	Minimum Breaking Strength [N/5cm x 1000]		Minimum Breaking Strength [lb/in x 1000]	
								[g/m²]	[oz/yd²]					
				Warp	Weft	Warp	Weft				Warp	Weft	Warp	Weft
PT 900	930 f1000	2040	Plain & Satin	105	105	27	27	205	6.05	0.30	8.0	8.50	0.914	0.971
CT 608	550 f1000	2642	Plain	110	110	28	28	120	3.55	0.20	5.0	5.20	0.571	0.594
CT 612	550 f500	2040	Plain	110	110	28	28	120	3.55	0.20	5.0	5.20	0.571	0.594
CT 613	550 f500	2040	Plain	123	123	31	31	135	3.98	0.20	5.0	5.50	0.571	0.628
CT 709	930 f1000	2040	Plain	105	105	27	27	200	5.90	0.30	8.0	8.50	0.914	0.971
CT 714	1100 f1000	2040	Plain	85	85	22	22	190	5.60	0.30	7.7	8.20	0.879	0.936
CT 716	1100 f1000	2040	Plain	122	122	31	31	280	8.26	0.40	10.5	11.10	1.199	1.268
CT 736	1680 f1000	2000	Basket 2X2	127	127	32	32	410	12.09	0.62	15.5	16.60	1.770	1.896
CT 737	1680 f1000	2000	Twill 2X2z	127	127	32	32	410	12.09	0.60	15.5	16.60	1.770	1.896
CT 747	3360 f2000	2000	Plain	63	63	16	16	410	12.09	0.62	15.5	16.60	1.770	1.896
T 717	1680 f1000	1040	Plain	84	80	21	20	280	8.27	0.43	10.5	11.0	1.200	1.256
T 730	1680 f1000	1040	Plain	78	78	20	20	260	7.67	0.40	9.4	10.00	1.074	1.142
T 750	3360 f2000	1000	Plain	67	67	17	17	460	13.57	0.65	16.2	17.40	1.850	1.987
T 760	3360 f2000	1000	Twill 4X4	92	92	23	23	635	18.73	1.05	22.0	23.50	2.512	2.684

Depending on performance requirements fabrics may be used woven, scoured or scoured and Water Repellent Treated (WRT- soft or hard).

Fabric treatment expertise

Depending on our customers' requirements, these fabrics may be woven, scoured, or scoured and Water Repellent Treated (WTR), or produced in the form of ballistic laminates.

Teijin Aramid now has new water-repellent treatments (WRT) for its ballistic fabrics to ensure the best performance level in wet conditions. Recently the company developed two improved WRT-recipes: C6-technology and C6 WRT-hard. These options are more environmentally friendly than the WRT finish that has been used in the past.

These recipes have been checked for textile data as well as for wear resistance and stiffness, and have proven to work under industrial-scale conditions. In addition, very demanding ballistic testing has been used for both dry and wet conditions to prove performance is at least equivalent or superior to current technology.

Contact our experts for more information and tailored advice ballistics@teijinaramid.com



Ballistic laminates & coated fabrics

The past years have brought many improvements in ballistic protection materials. By combining our woven fabrics with functional layers, films or coatings or finishing them by proprietary processes, a new range of ballistic laminates and coated fabrics opened up.

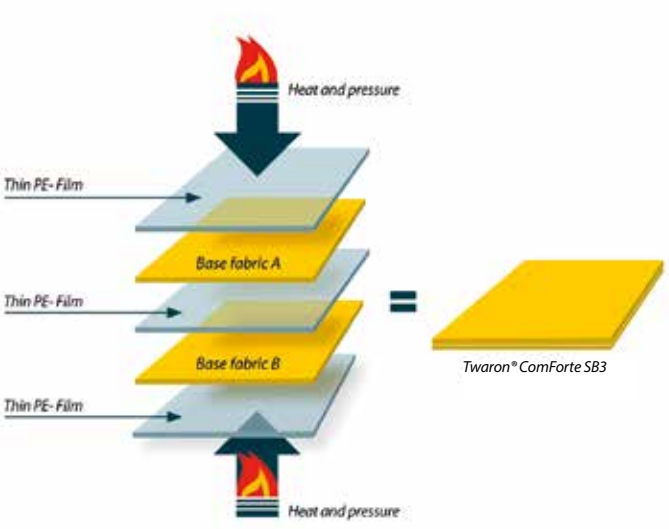
Twaron® ComForte SB3

Teijin Aramid's approach, combining low-crimp woven products with low resin content, has resulted in Twaron® Laminated Fabric Technology (LFT) – a thin, very flexible laminate comprising two fabric layers sandwiched with three layers of ultra-thin PE film. The two fabrics are made from Twaron® para-aramid microfilament yarn running in one direction, and very fine PES threads running in a second direction. This fabric construction system prevents an intruding bullet from pushing the yarns apart – a distinct advantage over typical shield materials.

The Twaron® ComForte SB3 solution delivers lighter body armor with ultimate flexibility and long-term stable performance for law enforcement officers and military personnel. By integrating state-of-the-art Twaron® Ultra Micro yarn, Twaron® ComForte SB3 enables one of the lightest ballistic protection solutions commercially available, that will meet both today's and tomorrow's needs.

Time for more flexible protection

Teijin Aramid's state-of-the-art Twaron® ComForte SB3 solution combines the wear and tear resistance of a woven fabric with the ballistic efficiency of a unidirectional laminate, while also delivering ultimate body armor flexibility.
As such, body armor can be better shaped to the body line,



Production process of Twaron® ComForte SB3

making it more comfortable for soldiers and law enforcement officers who need to use it over extended periods of time. Furthermore, Twaron® ComForte SB3 enables solutions for the increasing number of female law enforcement officers and soldiers.

The materials and the new laminating technology used in Twaron® ComForte SB3 result in a soft surface that offers a relatively high permeability – comparable with tightly woven fabrics. This aids in the sweat management of the wearer and, again, provides added comfort. These sandwiched low-crimp woven constructions will, without a doubt, be the future of ballistic protective fabrics used in high-end body armor.

A next-generation solution for lower weight

Dedicated Teijin Aramid R&D efforts resulted in state-of-the-art material enabling lighter-weight protection. Body armor made of Twaron® ComForte SB3 can achieve outstanding ballistic protection with more flexibility, comfort and mobility for the wearer. It is very effective against high energy semi jacketed projectiles like .357 Mag JSP and .44 Mag SJHP. The material's unique construction, its flexibility combined with high ballistic efficiency and very good trauma attenuation enables designing comfortable and lightweight solutions, meeting demanding protection requirements such as level II and IIIA in accordance with NIJ standard 0101.06.

Long-term performance consistency

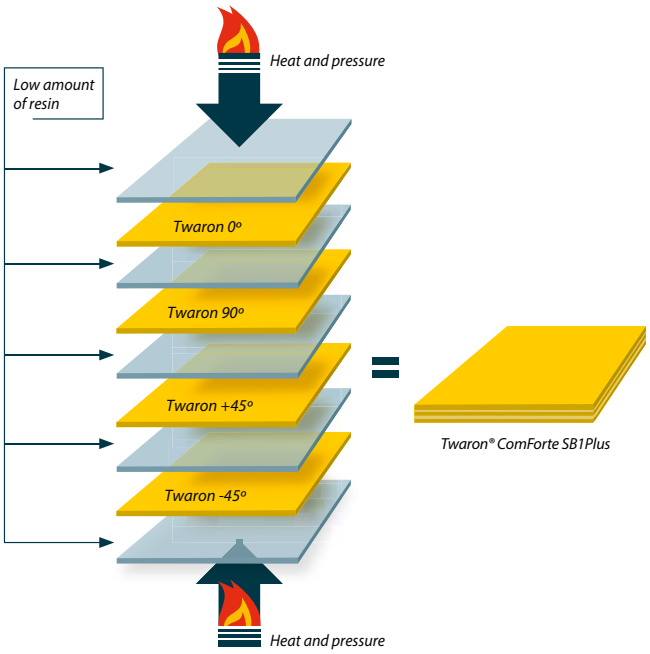
The construction of Twaron® ComForte SB3 ensures that the solution's ballistic performance stays stable. Teijin Aramid's accelerated aging tests using elevated temperature and moisture concentration shows that Twaron® ComForte SB3 body armor performance is hardly affected and offers great ballistic performance at all points of its lifecycle. Twaron® ComForte SB3 will reliably keep law enforcement officers and soldiers protected, flexible and mobile, whenever required.

Twaron® ComForte SB1Plus

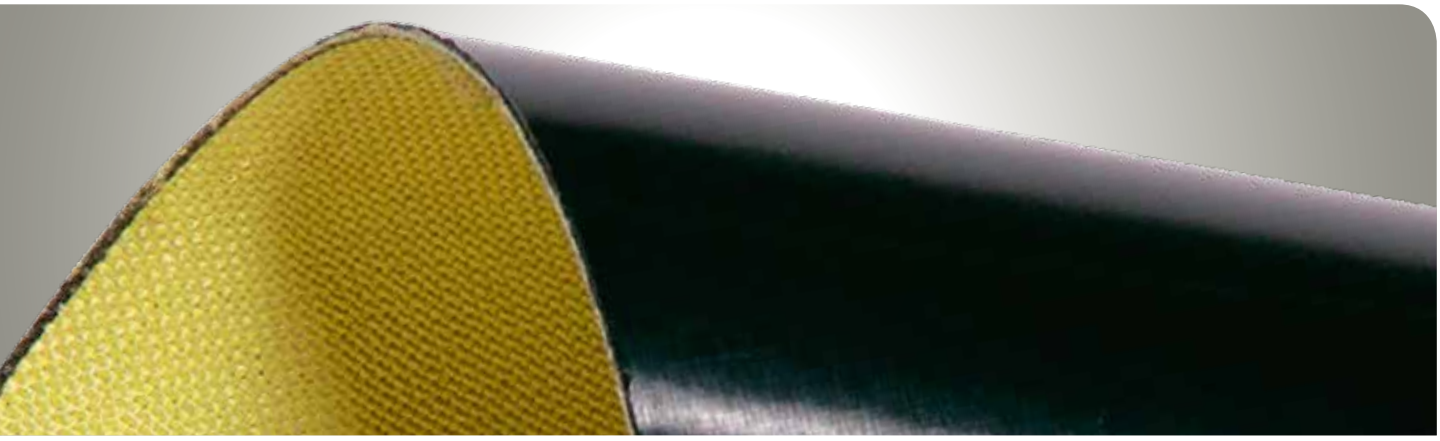
The reduction of Back Face Deformation (BFD) has become a key priority for latest generation soft ballistic vests. That's why Teijin Aramid has developed Twaron® ComForte SB1Plus: an integrated solution that combines high ballistic performance with comfort, flexibility and substantially reduced BFD.

Comforte SB1Plus consists of four layers of Twaron®, arranged in 0°, 90°, +45° and -45° orientations, and laminated together with a small amount of resin. This reduces backface signature (BFS) by up to 30% compared to standard solutions that do not contain an anti-trauma system. At the same time, it offers similar ballistic performance without additional weight.

Twaron® ComForte SB1Plus is a soft and flexible material, offering wearers both protection and comfort – an essential feature when the ballistic vest is worn intensively. Another advantage of Twaron® ComForte SB1Plus is that it can be used either on its own or in combination with other Twaron®-based soft ballistic materials. Hybrids can be created using Twaron® ComForte SB3 or other Twaron® ballistic products to optimize protection against a specific threat.



Production process of Twaron® ComForte SB1Plus



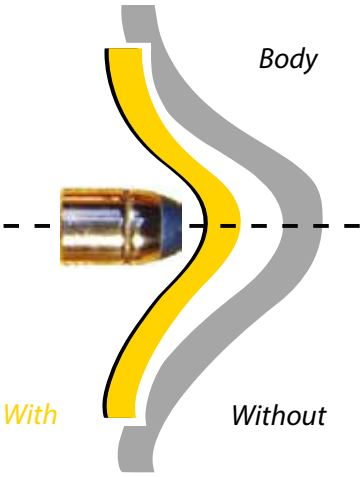
Twaron® LFT-AT/AT Flex

The primary objective of a ballistic pack is clear – to stop the bullet. But in a number of situations, the resultant blunt trauma remains an obvious and unwelcome problem.

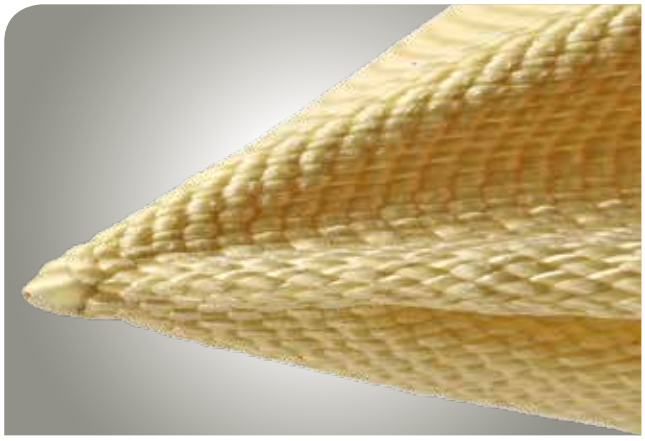
In light of this, Teijin Aramid Ballistic Engineering has developed a material permitting an effective reduction of the impact depth. By combining Curv® (made by Propex Fabrics), an extraordinary hit-resistant polypropylene woven surface, with Twaron® CT 707 high-tenacity fabric, a unique material was created. This material is light, thin and has sufficient flexibility to reduce blunt trauma behind the ballistic pack.

Depending on the type of bullet and its speed, one or two layers of Twaron® LFT-AT/AT Flex may reduce trauma by 30% to 60% – even near the edges of the target. Environmental and functional stability, combined with easy handling, are further benefits of the new material.

Adding only a few hundred grams per square meter to the ballistic pack, Twaron® LFT AT/AT Flex offers the optimum combination of weight, volume and performance currently available.



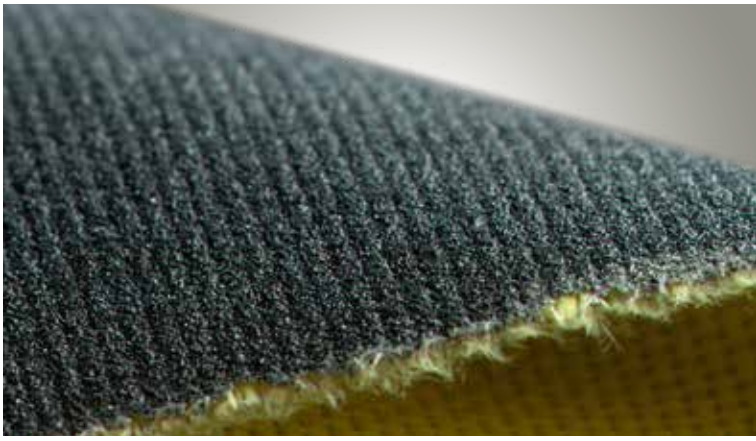
Trauma reduction by Twaron® LFT-AT/AT-Flex



Twaron® Microflex

Specially designed for correctional officers, Twaron® Microflex is a patented puncture-resistant fabric made from Twaron® microfilament yarn (550dtex – Type 2040), woven to stringent specifications and finished by a proprietary process yielding unsurpassed performance against the National Institute of Justice (NIJ 0115) engineered spike.

Furthermore, the extraordinary NIJ Spike Level 3 (E2) 65 Joule strike energy is easily defeated with Twaron® Microflex in a lightweight concealable vest construction. Because it uses a patented process to make it denser without heavy, expensive, fabric stiffening coatings, Twaron® Microflex offers a softer, more comfortable and cost-effective solution than current technology, crucial for correctional officers that are faced with the daily threat of attack by convicted felons with homemade, crude-but-deadly, sharp-pointed weapons known as shanks.



Twaron® SRM

Along with the need for protection against ballistic impact, protection against attacks by sharp and pointed weapons has become a matter of increasing priority. In more and more countries, police officers are facing the growing threat of a wide range of stabbing weapons.

Against this background, Teijin Aramid has developed Twaron® SRM, a unique material providing superior protection against a broad array of weapons. Twaron® SRM incorporates Twaron® CT microfilament fabric with a functional silicon carbide coating that is bonded by a special matrix system. The functional coating absorbs and dulls the thrust from the blade or needle just as if it were solid rock, and the energy from the impact is then absorbed by the high-impact resistance and tenacity of the para-aramid yarn in the fabric underneath. Thanks to the special matrix, the material is flexible and almost as soft as a non-coated fabric. This functionality is achieved by having a density that is only one-quarter of that of current market solutions (e.g. steel).

Ballistic laminates & Coated fabrics

Style	Main Application	Linear Density [dtexnom]	Twaron®-Type	Total weight [g/m²]	Construction
ComForte SB3	Bullet resistant vests	550 f1000	2642	220	2 layers Twaron® woven fabric + 3 layers thermoplastic film
ComForte SB1	Bullet resistant vests	930 f1000	2040	220	2 layers Twaron® woven fabric + 3 layers thermoplastic film
ComForte SB1 plus	Bullet resistant vests Trauma Control	930 f1000	2040	430	4 layers Twaron®, arranged in 0°, 90°, +45° and -45° orientations, laminated with small amount of resin
AT Flex	Anti-trauma	930 f1000	2040	490	Laminate of CT 707 woven Twaron® fabric + PP-Fabrics
AT	Anti-trauma	930 f1000	2040	780	Laminate of CT 707 woven Twaron® fabric + PP-Fabrics
Microflex	Spike resistant vests	550 f500	2040	218	Woven fabric with special densification treatment
SRM	Stab resistant vests	930 f1000	2040	430	CT 709 woven Twaron® fabric + silicon carbide coating



Uni-directional laminates

Solutions based on Twaron® Unidirectional Laminates – or those combining Twaron® Unidirectional Laminates with other Twaron® materials – offer several advantages for engineering these modern ballistic protective vests. They provide enhanced protection against bullets and fragments, as well as more comfort and excellent performance/weight ratios.

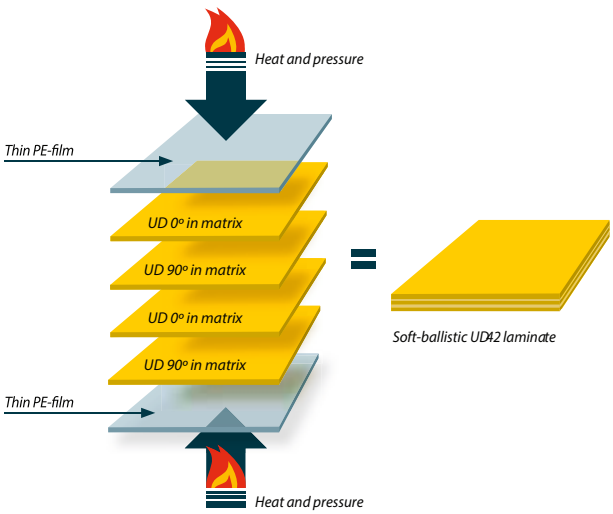
Twaron® UD42 & UD25

Twaron® UD42 is a Unidirectional (UD) laminate suitable for soft body armor. Consisting of four plies of unidirectional Twaron® fiber lines (plied in a 0°/90°/0°/90° configuration). The top and bottom layers are laminated with PE film in order to ensure maximum abrasion resistance.

Twaron® UD25 is a Unidirectional (UD) laminate suitable for soft body armor. Consisting of two plies of unidirectional Twaron® fiber lines (plied in a 0°/90° configuration). The composition of the resin matrix is optimized to ensure maximum abrasion resistance.

Both Unidirectional laminates make full use of Twaron®'s high fiber tenacity and avoids the crimping of typical woven material. Smart UD technology aligns the parallel Twaron® fibers in each layer, and each layer is constructed in a resin matrix.

Hybrid solutions are becoming increasingly important in today's ballistic protection engineering. The complementary qualities of Twaron® Unidirectional Laminates mean that they can be combined with other fabrics, laminates, shields and coated materials – all based on Twaron® – to ensure enhanced performance. That way, Twaron® Unidirectional Laminates can be used in a wide range of state-of-the-art responses to ballistic threats.



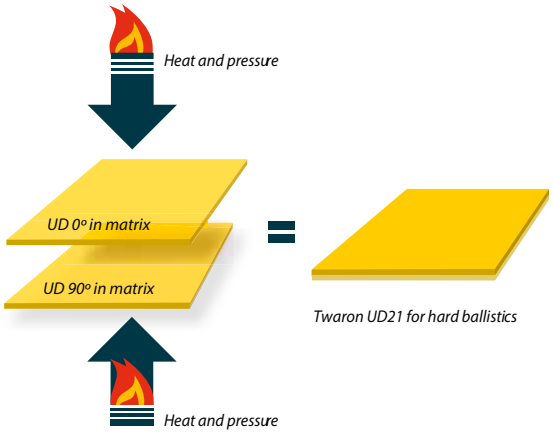
Production process of Twaron® UD42

Twaron® UD21

Today's armored vehicles, aircraft and naval vessels also face a range of blast and ballistic threats. These call for new hard armor solutions that are lighter and stronger. In addition, they need to resist high temperatures and extreme cold.

Teijin Aramid's Twaron® UD21 is a UD laminate hard armor solution designed specifically for armored vehicles. It can be applied internally as a spall liner, or externally as part of bolt-on or add-on armor. It is light enough for use as an add-on solution, but its high stiffness and structural integrity mean it can act as a support for steel or ceramic plates. Furthermore it is resistant to variations in temperature. In fact, Twaron® UD21 offers effective protection against bullets, fragments and projectiles within a wide temperature range.

Twaron® UD21 consists of two layers of unidirectional Twaron® fiber plied in a 0° and 90° configuration, and it makes full use of Twaron®'s high fiber tenacity while avoiding the crimping typical for woven material. In combination with other materials, Twaron® offers protection against bullets, fragments and projectiles according to STANAG 4569, levels 1-4.



Production process of Twaron® UD21

This strong, lightweight laminate also offers customers a whole new world of hybrid ballistic solutions. It is designed for use in combinations with other materials: with steel, ceramic and titanium. These composite armor solutions can be adapted to any need, and offer high levels of protection with better flexibility and far lower weight. This, in turn, contributes to greater vehicle maneuverability and fuel economy.



Ceramic strike face with UD21 backing

Uni-directional laminates (UD)

Style	Main Application	Total weight (g/m^2)	Construction
UD42	Bullet resistant vests	238	4 plies of Twaron® UD in a 0º/90º/0º/90º configuration, constructed within resin matrix and laminated together with thermoplastic film
UD25	Bullet resistant vests	112	2 plies of Twaron® UD in a 0º/90º configuration, constructed with resin matrix and laminated together
GF4	Bullet resistant vests	234	4 plies of Twaron® UD in a 0º/90º/0º/90º configuration, constructed within resin matrix and laminated together with thermoplastic film
UD21	Hard ballistics, shields, inserts	271	2 plies of Twaron® UD in a 0º/90º configuration, constructed with resin matrix and laminated together



Ballistic Prepregs

Today, Twaron® T 750 and Twaron® CT 736 are both the basic fabric styles for light composite up-armoring. Although CT 736 is the more advanced fabric style and is widely used, both fabric styles can be used either neat – in what is called the 'wet process' – or impregnated with PVB resin for composite shell applications so as to offer the highest levels of performance. Impregnated Twaron® fabrics are also part of the range of Teijin Aramid ballistic protection materials.

Twaron® CT 736 is a well-proven fabric for the production of modern state-of-the-art ballistic helmets or hard-ballistic applications. This fabric style is available impregnated with PVB Pure or with PVB Phenolic.

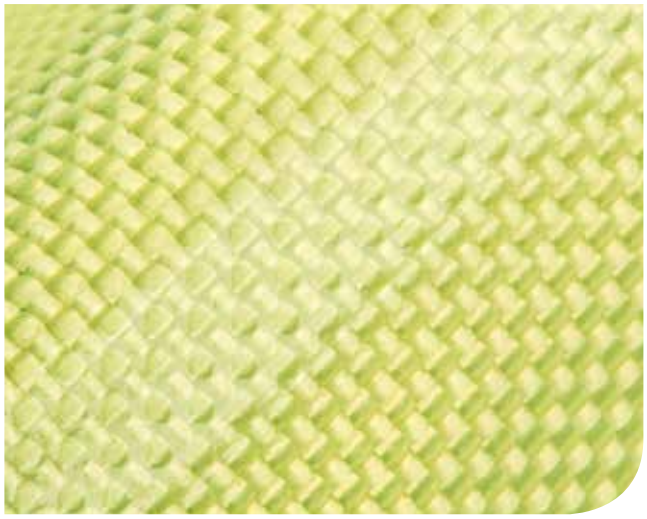
Twaron® T 750 is the ideal fabric for a variety of products for hard ballistic protection, including spall liners, multilayer laminates and lightweight, high-tenacity backings, as well as supporting steel, ceramics and various other front materials in complex composite solutions. T 750 is available with rubber resin impregnation (rubberized) or with PVB Phenolic impregnation.



PVB Pure & PVB Phenolic

The Twaron® PVB Pure prepreg features excellent anti-ballistic performance. Subjected to heat and pressure, it can be shaped into all manner of protective equipment: helmets, insert panels for ballistic vests or shaped panels for vehicle protection. Producers of protective equipment no longer need to install and run expensive refrigerated storage facilities, since the new Twaron® PVB Pure prepreg can be stored under normal conditions for an extended period of time. Systems that are currently used in the industry - based on PVB-modified Phenolic resins - have a very limited shelf life, since they react at room temperature relatively fast and become unusable.

PVB Phenolic	PVB Pure (available in 55 g/m² film or prepreg)
Thermoset	Thermoplastic
Solvent based	Solvent free
Standard shelf life	Prolonged shelf life
Needs to be stored in a cooling chamber	Can be stored at ambient conditions
Short press cycle	Adjusted press cycle

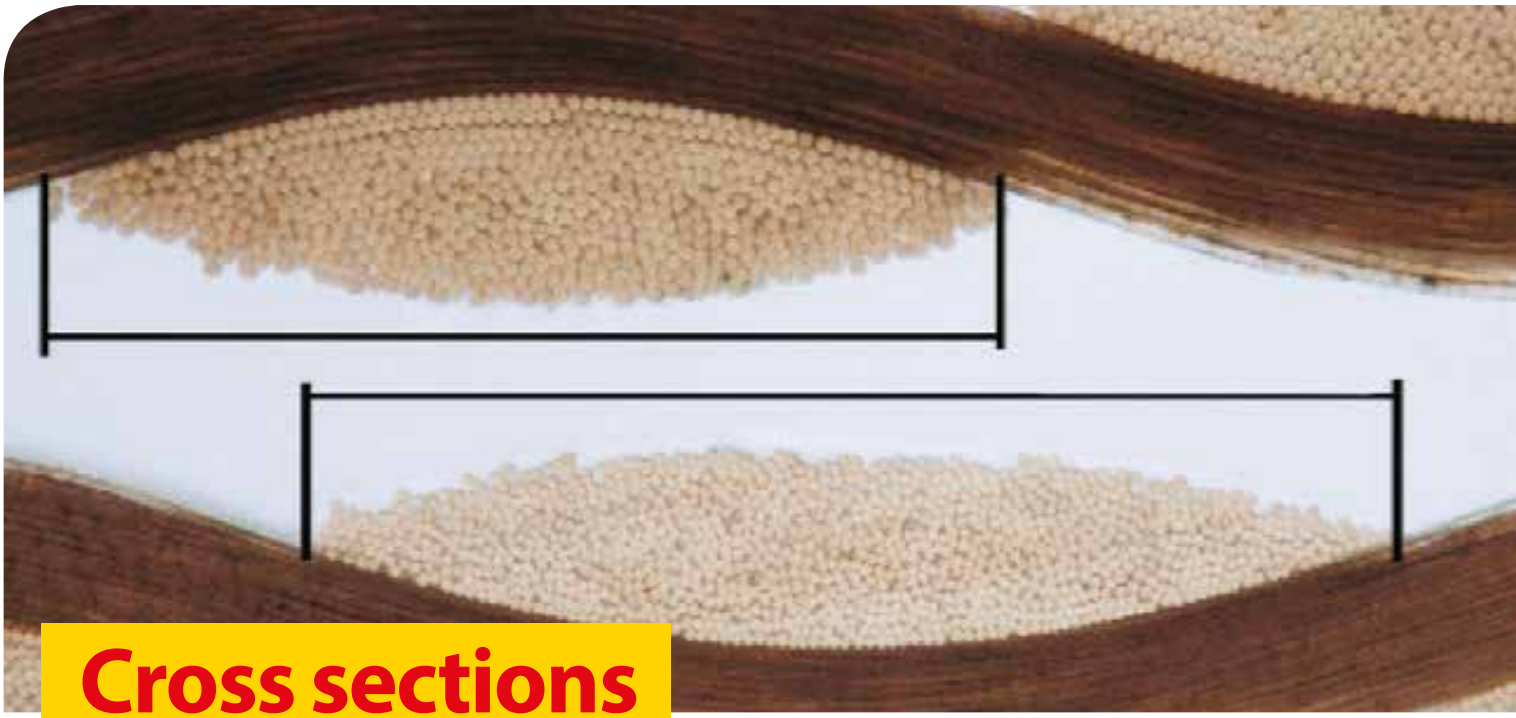


Performance tests have shown that, both in helmet shells and hard ballistic configurations, the Twaron® PVB Pure prepreg ballistic performance against bullets and fragments exceeds that of conventional PVB Phenolic systems. In accordance with STANAG 2920, panels made from Twaron® PVB prepreg have also been tested on temperature tolerance. These tests show very little differences in the ballistic performance between the plates stored at -20°C, +70°C and those stored at room temperature.

With the Twaron® PVB Pure prepreg, a solvent free resin system and therefore more environmentally friendly product is available. Next to the prepreg, the PVB Pure is also available as a film.

Ballistics prepegs

Style	Main Application	Resin Amount (g/m²)	Sides coated	Resin type
CT736	Helmets	55 or 110	1 or 2	PVB Phenolic
CT736	Helmets	55	1	PVB Pure
T750	Hard ballistics	65	1	PVB Phenolic
T750	Hard ballistics	80	2	Rubberized



Cross sections

In order to make the structural differences between standard fabrics, laminated-fabrics and unidirectional laminates more clear, the respective micro-structural cross-sections are presented in the photos below.

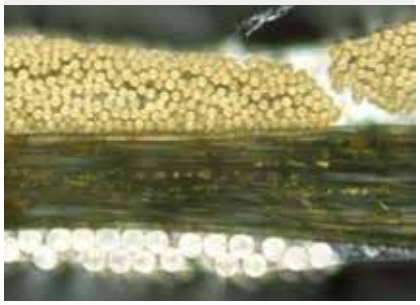
Standard fabric

Cross sections of fabrics (200g/m2) containing standard aramid yarn (upper part) and Twaron® microfilament yarn (lower part)



ComForte SB1 fabric

Cross section of ComForte SB1 fabric containing Twaron® microfilament yarn



Uni-directional

Cross section of unidirectional material. Fourfold structure (shield)



Recyclable

Ballistic materials are recyclable, and at Teijin Aramid we buy them back. We also guarantee the demilitarization of the recycled material. Read more about our recycling and buy back activities on **www.teijinaramid.com/recycling**.

More information on Teijin Aramid's ballistic solutions can be found in the dedicated Body Armor, Hard Ballistics and Helmets leaflets on **www.teijinaramid.com** or through our Sales Department via **ballistics@teijinaramid.com**.



Endumax® Shield

As global security forces experience new and evolving lethal threats, the need to provide enhanced protection at lighter weights has become increasingly important. New armor systems not only have to provide protection to security professionals, but also to the various ground vehicles, maritime platforms and aircraft used in carrying out the required mission.



Endumax® Shield XF33

So how could a ballistic shield solution deliver high levels of protection without compromising user mobility or being too heavy to be integrated into a machine design?

Thanks to the uniquely engineered properties of Endumax® Shield XF33 it is the material of choice for improved survivability designed to meet the highest demands in terms of ballistic protection and low weight. In particular, Endumax® Shield XF33 has a unique material composition of low resin contents combined with high modulus material characteristics, leading to improved structural stability and overall performance.

Superior performance to weight balance

Endumax® Shield XF33 has an inherently low areal density based on low resin contents, enabling superior performance to weight balance for ballistic and survivability solutions. The use of Endumax® Shield XF33 enables weight reduction, leading to enhanced agility and maneuverability, or increased armor protection level with no increase in overall weight.



Larger panels enable design freedom

Complex shapes of ground and air vehicles or maritime vessels may complicate the armor integration design, potentially increasing the need for seams or joints. Thanks to the high level of ballistic performance achieved even with low processing pressures, the use of Endumax® Shield XF33 enables easier fabrication of larger panels with minimum or no seams. As a result, this minimizes potentially vulnerable joints and increases design freedom for optimum panel cuts, thereby making the solution more cost-efficient.

Stable structure in extreme environments

The combination of light weight, mechanical strength and fewer vulnerable joints delivers structurally reliable protection. Endumax® Shield XF33 requires 4-10 times higher mechanical impact energy to deform compared to other UHMWPE materials. In addition, internal testing has shown that Endumax® Shield XF33 retains its original form and protection performance levels relatively better after exposure to temperatures and moisture levels outside ambient conditions.

Lightweight, flexible and with excellent ballistic protection properties, Endumax® is the material of choice for modern protection equipment.

Find out more about Endumax®, or request a sample

Please send an email to **endumax@teijinaramid.com**

Style	Main Application	Endumax® Film Type	Total weight (g/m2)	Construction
XF33	Hard ballistics, shields, inserts	TA33	146	Laminated UHMWPE Film, Cross-ply 2-layered BRICK 90°-cross 2-layered BRICK
XF23	Hard ballistics, shields, inserts	TA23	197	Laminated UHMWPE Film, Cross-ply 2-layered BRICK 90°-cross 2-layered BRICK

Be sure.

At Teijin Aramid, everything we do is guided by our ambition to shape a better future for generations to come. Day after day, we move forward, continuously improving our processes, our technology and ourselves. As market leaders, we drive progress through collaboration and set new standards for high performance. We connect with our customers at every level, wherever they are in the world. Because we believe that, together, we can be something bigger. Together, we can challenge conformity.

From automotive and oil & gas, to civil engineering, ballistic protection and beyond, our products are empowering excellence in diverse markets and applications around the globe. By enabling lighter, stronger and more resistant materials. And by taking durability, protection and efficiency to new levels. Whether you choose Twaron®, Teijinconex®, Technora® or Endumax®, our high-performance materials are an enduring guarantee of reliability. You can be sure of that.

More information

Please e-mail us at:
ballistics@teijinaramid.com
or visit our website.



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Twaron® Endumax®