



Taparan® Para-aramid

Technical Guide



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Company Overview

Yantai Tayho Advanced Materials Co., Ltd (previously Yantai Spandex Co., Ltd) is located in Yantai City which is one of the first open coastal cities in China and also an important port city in Bohai sea economic rim. At present it has 1500 employees, owns fixed assets of 2 billion Yuan, and occupies an area of 260,000 sq. meters. It is identified as the biggest high-tech fiber industry base in China.

Yantai Tayho specializes in R&D and manufacturing high performance chemical fibers. It is a national high and new tech enterprise, and also one of the 520 key enterprises of China. In 2008, the company's A shares stock (code 002254) was enlisted on Shenzhen Stock Exchange.

Having a state level Tech. Center and a R&D team of passionate scientists and engineers, Yantai Tayho has developed many industrialization technologies and products of its own intellectual property rights. The list of products covers Newstar® spandex, Newstar® meta-aramid, Tametar® electroconductive fiber and Tapanar® para-aramid. It won the National Science and Technology Progress Prize for twice.

Over years of unremitting efforts, the company holds a leading position in company size, economic benefit and comprehensive power in the chemical fiber industry in China. It has been approved as one of the top ten most competitive enterprises in China for years.



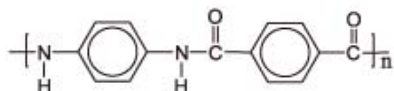
1 Introduction to Taparan® Para-aramid

1.1 About Taparan®

Taparan® is the brand name of para-aramid as manufactured by Yantai Tayho.

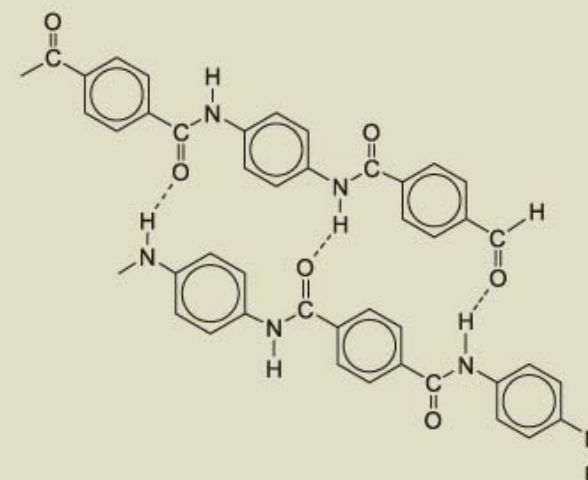
Para-aramid belongs to the aromatic polyamide family. The full name is poly (p-phenylene terephthalamide), abbreviated as PPTA or Aramid-II.

Molecular Formula of Taparan® Para-aramid



Taparan® Filament

Rigidity of polymer chain structure and trans-configuration give high regularity to Taparan® para-aramid. Its molecules are connected by strong hydrogen bond.



Hydrogen Bond of Taparan® Para-aramid

High rigidity of molecules and extended-chain configuration enable Taparan® para-aramid to have a unique combination of high strength, high modulus and excellent thermal stability.

Taparan® para-aramid has good resistance to ordinary organic solvents and salt solutions but poor to strong acid and strong alkaline. It shows the best fatigue resistance and dimensional stability among all organic fibers. It is sensitive to UV (ultraviolet) light and should be prohibited from direct exposure to the sunlight.

1 Introduction to Tapanan® Para-aramid



1.2 Development of Tapanan®

- In 1999, the study and research work on para-aramid started.
- In 2004, Project of "R&D of pilot para-aramid filament & pulp" sponsored by Shandong Province.
- In 2008, the pilot line of 100 t/a started-up.
- In 2008, Project of "Research on p-aramid engineering tech. & application tech." sponsored by 863 program of China SIPO.
- In 2011, the commercial line of 1,000 t/a started.



Tapanan® Para-aramid Production Line



1.3 Certificates

Tapanan® para-aramid does not contain substances that are harmful to human health or the environment.

Here are the Oeko-Tex Standard 100 certificate and SGS test reports.



Oeko-Tex® Standard 100



SGS Test Reports to Tapanan®

1 Introduction to Tapanar® Para-aramid

1.4 Products of Tapanar®

Tapanar® para-aramid includes following items: filament, twisted filament, staple, spun yarn, shortcut and pulp.



■ Tapanar® Filament

■ Tapanar® Twisted Filament



■ Tapanar® Spun Yarn



■ Tapanar® Staple

■ Tapanar® Pulp



■ Tapanar® Shortcut

2.1 Technical Specifications

Tapanar® 529 is available in 840dtex, 930dtex, 1110dtex, 1670dtex, 2200dtex, 3300dtex and 6600dtex.

It consists of four types, namely 529S, 529T, 529F and 529R. Among them, 529S is the standard type. Types of 529T, 529F and 529R are recommended to be used in areas of ballistic protection, optical fiber cables and automobile rubber hoses, respectively.

Specifications of Tapanar® 529 (1110dtex)

Items	Unit	529T	529R	529F	529S
Cross Section		Round	Round	Round	Round
Density	g/cm ³	1.44	1.44	1.44	1.44
CV of Linear Density(1)	%	± 2	± 2	± 2	± 2
Tenacity at Break	cN/dtex	> 21.0	> 20.5	> 19.5	> 19.5
CV of Tenacity at Break	%	< 4.8	< 4.9	< 5.0	< 5.0
Elongation at Break	%	4 ± 0.5	3.5 ± 1.0	2.5 ± 1.0	3.5 ± 1.0
CV of Elongation at Break	%	< 5.0	< 5.0	< 5.0	< 5.0
Elastic Modulus	GPa(2)	85 ± 10	90 ± 15	> 95	90 ± 15
Oil Pick-up	%	0.9 ± 0.3	0.8 ± 0.2	0.8 ± 0.2	0.8 ± 0.2
Moisture Regain	%	2.5 ± 1.5	2.5 ± 1.5	2.5 ± 1.5	2.5 ± 1.5
Specific Electric Resistance	Ω	109	109	109	109
Thermal Shrinkage(3)	%	< 0.2	< 0.2	< 0.2	< 0.2
Degraded Tem.(4)	°C	> 500	> 500	> 500	> 500
Limited Oxygen Index (LOI)	%	> 29	> 29	> 29	> 29

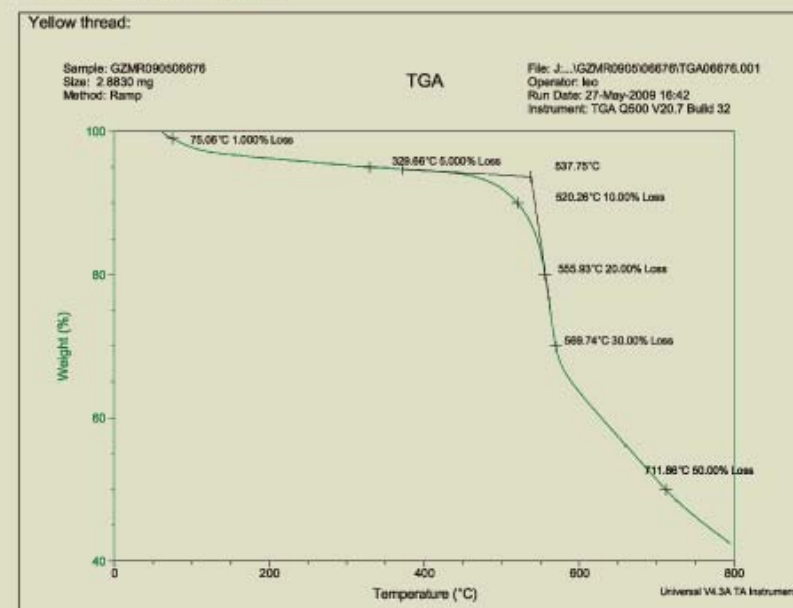
Notes:

- (1) CV of Linear Density is measured on the basis of Nominal Linear Density.
- (2) 1 GPa = 6.9 cN/dtex
- (3) Testing conditions for Thermal Shrinkage: 15 mins under 190°C
- (4) Degradation test is done under N₂ atmosphere.

2.2 Thermogravimetric Analysis

The thermogravimetric analysis of Tapanar® para-aramid is done with reference to ISO11358:1997. As shown in the below Fig. Tapanar® para-aramid decomposes at 537.8°C ; it does not melt.

TGA Curve of Tapanar® Para-aramid



Temperature range: 50~800 °C

Ramp: 10 °C /min

N₂: 100 ml/min

(Continued)

TGA Values of Tapanar® Para-aramid

Test Item	Result
Initial decomposition temperature (°C)	537.8
Wight loss 10% (°C)	520.3
Wight loss 20% (°C)	555.9
Wight loss 30% (°C)	569.7
Wight loss 50% (°C)	711.9

Temperature range: 50–800°C

Ramp: 10°C/min

N₂: 100ml/min

2.3 Chemical Resistance

The chemical resistance of Tapanar® para-aramid is tested under a wide variety of chemical agents at different temperatures and over different periods of time. The results are shown as follows.

Chemical Resistance of Tapanar® Para-aramid

Chemical	Concentration (%)	Temperature (°C)	Time(hr)	Effect on Breaking Strength
Acids				
Acetic acid	99	21	20	None
Acetic acid	40	21	1000	Slight
Acetic acid	40	99	100	Severe
Formic acid	90	21	100	Degraded
Formic acid	40	21	10000	Moderate
Formic acid	90	99	100	Degraded
Hydrochloric acid	37	21	20	None
Hydrochloric acid	10	21	100	Severe
Hydrochloric acid	10	71	10	Degraded
Sulfuric acid	10	21	100	None
Sulfuric acid	10	21	1000	Moderate
Sulfuric acid	10	100	10	Severe
Sulfuric acid	70	21	100	Moderate
Nitric acid	1	21	100	Slight
Nitric acid	10	21	100	Severe
Nitric acid	70	21	20	Severe
Nitric acid	10	21	100	None
Nitric acid	10	21	1000	Slight
Phosphoric acid	10	99	100	Severe
Oxalic acid	10	99	100	Severe
Hydrobromic acid	10	21	1000	Severe
Hydrofluoric acid	10	21	100	None
Salicylic acid	3	99	1000	None
Benzoic acid	3	99	100	Severe
Salicylic acid	3	99	1000	None
Chromic acid	10	21	1000	Severe

Note:

- None: Strength loss less than 10%
- Slight: Strength loss between 11-20%
- Moderate: Strength loss between 21- 40%
- Severe: Strength loss between 41-80%
- Degraded: Strength loss between 81-100%

2 Taparan® Para-aramid Filament



Chemical Resistance of Taparan® (Continued)

Chemical	Concentration (%)	Temperature (°C)	Time(hr)	Effect on Breaking Strength
Alkali				
Sodium Hypochlorite	0.1	21	1000	Degraded
Caustic Potash	50	21	20	None
Caustic Sodium	50	21	20	None
Caustic Sodium	40	21	100	None
Caustic Sodium	10	21	1000	Severe
Caustic Sodium	10	99	100	Degraded
Caustic Sodium	10	100	10	Severe
Ammonium Hydroxide	28.5	21	20	None
Ammonium Hydroxide	28	21	1000	None
Organic Solvent				
Acetone	100	21	20	None
Acetone	100	21	100	None
Trichloroethylene	100	21	20	None
Methanol	100	21	1000	None
Carbon Tetrachloride	100	21	20	None
Chloroethylene	100	21	20	None
Benzene	100	21	1000	None
Benzene	100	21	20	None
Diethyl Ether	10	21	1000	None
Ethanol	100	77	100	None
Ethylene Glycol	50/50	99	1000	Moderate
Freon	100	60	500	None
Kerosene	100	60	500	None
Gasoline	100	21	1000	None
Dichloromethane	100	21	20	None
Methyl Ketone	100	21	20	None
Chloroethylene	100	99	10	None
Toluene	100	21	20	None
Dimethylaniline	100	21	20	None
Pentanol	100	21	1000	None

Note:

- None: Strength loss less than 10%
- Moderate: Strength loss between 21-40%
- Degraded: Strength loss between 81-100%
- Slight: Strength loss between 11-20%
- Severe: Strength loss between 41-80%

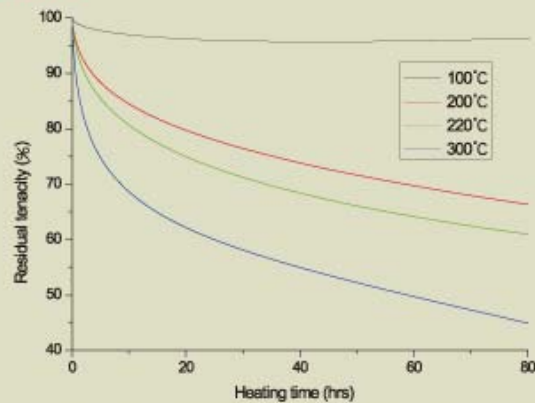
Chemical Resistance of Taparan® (Continued)

Chemical	Concentration (%)	Temperature (°C)	Time(hr)	Effect on Breaking Strength
Salt Solutions				
Cupric Sulfate	3	21	1000	None
Cupric Sulfate	3	99	100	Moderate
Ferric Chloride	3	99	110	Severe
Sodium Chloride	3	21	1000	None
Sodium Chloride	10	99	100	None
Others				
Benzaldehyde	100	21	1000	None
Linseed Oil	100	21	1000	None
PHenol	5	21	10	None
HydroxypHenol	100	121	10	None
ParaffinOil	100	99	10	None
Lard Oil	100	21	1000	None
Seawater	100	21	7500	None
Brine	5	21	20	None
Running Water	100	100	100	None
Formalin	10	21	1000	None
Formalin	100	21	20	None
Brake Fluid	100	113	100	Moderate
Cottonseed Oil	100	21	1000	None

Note:

- None: Strength loss less than 10%
- Moderate: Strength loss between 21-40%
- Degraded: Strength loss between 81-100%
- Slight: Strength loss between 11-20%
- Severe: Strength loss between 41-80%

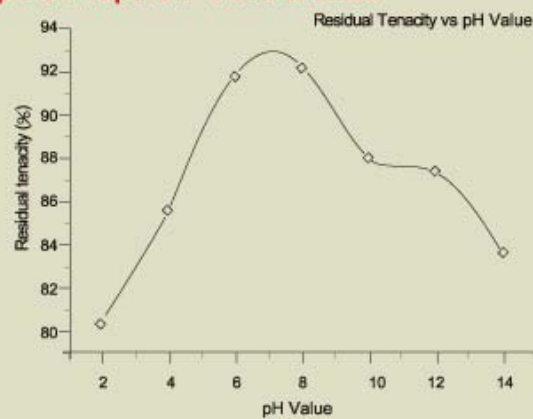
2.4 Heat Resistance



Effect of Elevated Temperatures on the Tenacity of Tapanan® Para-aramid

The above Fig. shows tenacity changes of Tapanan® para-aramid at increasing temperatures and over different periods of heating time. The tenacity remains about the same after heating for 80 hours at 100°C.

2.5 Effect of pH on Tapanan® Para-aramid

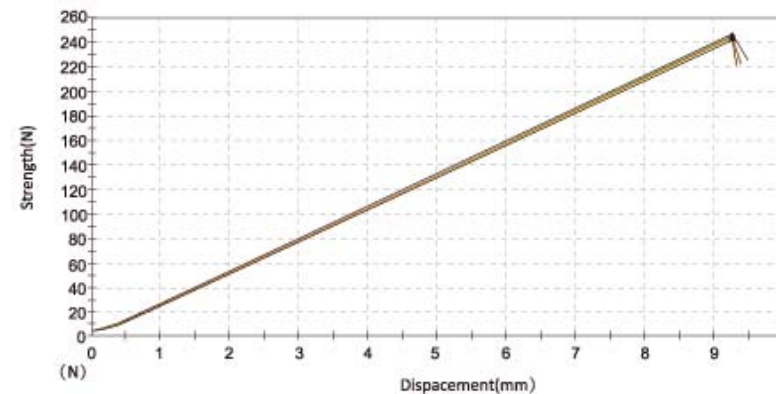


Effect of pH on the Tenacity of Tapanan® Para-aramid

Degradation can occur when Tapanan® para-aramid is exposed to strong acids or strong alkalis. The stronger the acid or alkali is, the greater the loss in tenacity. Acidic conditions cause more severe degradation than basic conditions. At neutral pH, the filament tenacity remains virtually unchanged after exposure at 65 °C for 200 days.

2.6 Stress-Strain Behavior

The stress-strain test on Tapanan® filament 1110dtex is done according to GJB 993-90, testing length of 250mm and stressing speed of 30mm/min.



Stress-Strain Behavior of Tapanan® Filament 1110dtex

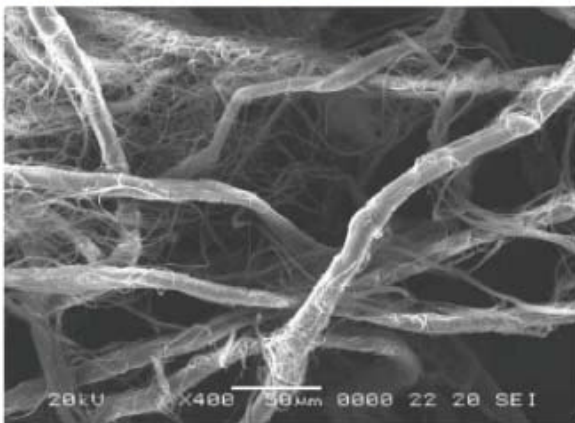
3 Other Forms of Tapanar® Para-aramid

3.1 Tapanar® Pulp

Tapanar® pulp is made from Tapanar® filament (1.5 dpf) by high fibrillation. It is mainly used for friction and sealing materials, composites and aramid paper.



■ Tapanar® Pulp



■ SEM of Tapanar® Pulp

■ Types of Tapanar® Pulp

Types	Fibrillation Degree	Average Length	Application
1628	Moderate	Short	Sealing, Composites, Paper
1427	High	Short	Sealing, Composites
1820	High	Moderate	Sealing, Friction
2820	Moderate	Long	Friction

■ Characteristics of Tapanar® Pulp

Average Length	0.5~1.5 mm
Specific Area	5~12 m ² /g
Moisture content	6.0 ± 2.0%
Color	Yellow

Note: Wet pulp is available with water content of 40-60%.

■ Test Report of the Specific Surface Area of Tapanar® Pulp



3 Other Forms of Tapanar® Para-aramid



■ Tapanar® Staple

3.2 Tapanar® Staple

Tapanar® staple fiber is cut from the crimped filament. It is available in lengths of 38mm, 51mm and 76mm. Due to its good properties in high strength, high modulus, heat resistance and cut-proof, it is widely used for thermal resistant nonwovens, spun yarns, covering yarns, etc.

Characteristics of Tapanar® Staple Fiber

Color	Gold Yellow
Density	1.44 g/cm ³
Decomposition Temp	> 500 °C
Length	38 mm
	51 mm
	76 mm
DPF	1.5
LOI	> 29

3.3 Tapanar® Shortcut

Tapanar® shortcut is cut from Tapanar® filament by special cutting tech. It is available in lengths of 1mm, 3mm and 6mm. It can be used for engineering plastics, friction materials, reinforcement materials and aramid paper.

Characteristics of Tapanar® Shortcut

Color	Gold Yellow
Density	1.44 g/cm ³
Decomposition Temp	> 500 °C
Length	1 mm
	3 mm
	6 mm
DPF	1.5
LOI	> 29

■ Tapanar® Shortcut



4 Applications of Tapanar® Para-aramid

4.1 Reinforcement Materials

Tapanar® para-aramid is widely used in construction and building materials, rubber products, optical fiber cables, etc.

- Building and bridge construction
- Tire cord and fabrics
- Hoses and belts
- Optical fiber cables
- High-strength ropes



4.2 Personal Protection

Tapanar® para-aramid can be used in some special applications which call for ballistic protection, cut-resistance and heat protection. It is the best choice of personal protective materials.

- Ballistic vests, helmets and armoring products
- Cut-resistant gloves
- Heat-resistant protective apparels

4 Applications of Tapanar® Para-aramid



4.3 Composites

Tapanar® para-aramid is widely used in composite materials, often in combination with resin or rubber to dramatically reduce weight and increase effective load.

- Aircraft cabin and engine cowlings
- Radomes
- Outer shells of high-speed trains, automobiles, yachts and vessels
- Wind-driven fan blades
- Circuit boards



4.4 Friction & Sealing

Tapanar® para-aramid can be used for fiber-reinforced friction materials to provide increased wear resistance. Sealing parts made from it are suitable for high temperature working conditions.

- Brake pads
- Clutch discs
- Gaskets
- Packings

4.5 Sports Equipments and Others

Tapanar® para-aramid is popular for sports equipments and other reinforcement materials by composition.

- Skiing kits
- Golf clubs
- Tennis rackets
- Racing helmets
- Racing apparels
- Fishing rods
- Industrial paper



5.1 Technical Support

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