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# **Meta-aramid Fiber**

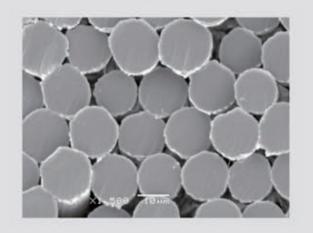
YANTAI TAYHO ADVANCED MATERIALS CO., LTD

### 1.1 About Newstar®

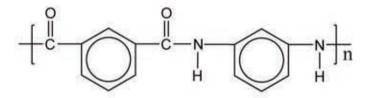
Newstar® is the registered trade mark for the meta-aramid fiber of Yantai Tayho Advanced Materials Co., Ltd. The full name of meta-aramid is polymetaphenylene isophthamide, abbreviated as PMIA. It exhibits numerous excellent properties such as good heat resistance, flame resistance, electrical insulation, resistance to chemicals, radiation resistance, good textile properties, etc.



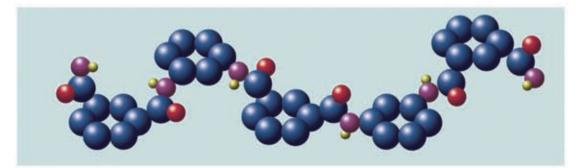
Cross Section Photograph of Newstar® Meta-aramid



Molecular Formular of Newstar® Meta-aramid



Molecular Three-dimensional Structure of Newstar® Meta-aramid



### 1.2 Specification of Newstar®

Density(g/cm <sup>3</sup> )		1.37 - 1.38
Glass Transition Point ("C )		270
Carbonization (°C )		400
Specific Heat at 20 °C , (KJ/(Kg.°C ))		42
Conductivity at 50MHZ	60 °C	4.0 - 4.5
conductivity of Source	180 °C	5.5 - 6.2
Limited Oxygen Index (%)		≥ 28



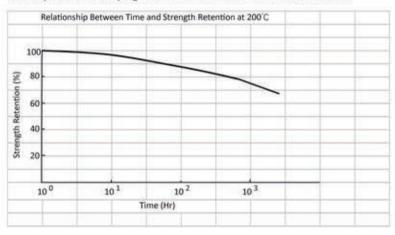


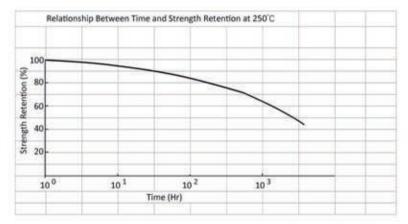
### 2.1 Heat Resistance

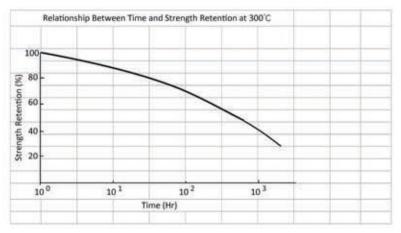
Newstar® Meta-aramid fiber offers outstanding heat resistance, being resistant to melting even after many hours of exposure to heat.

1. Effect of Dry Heat

The relationship between time and strength retention for Newstar® Meta-armid exposed to temperatures varying from 200 °C to 300 °C is shown below.



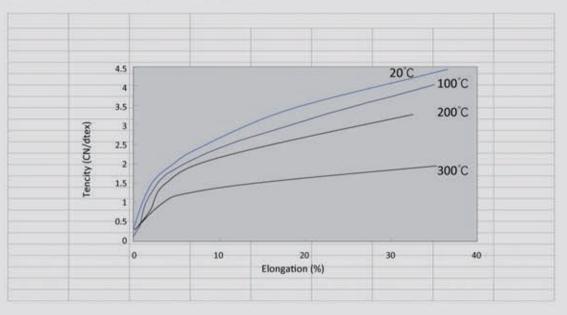




#### 03 Newstar\* and Tametar\* are the registered trade marks of the meta-aramid products of Yantai Tayho Advanced Materials Co., Ltd.

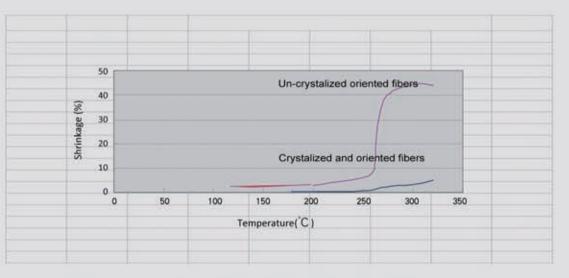
### 2. Fiber Properties at High Temperatures

#### The Stress-strain Curves of Newstar® Meta-aramid



#### 3. Glass Transition Temperature

### The Relationship between Crystallinty and Shringkage

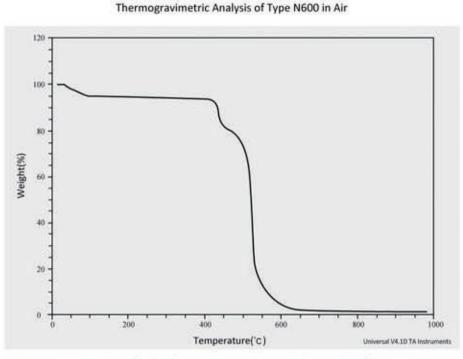


The curves show that the glass transition point of Newstar® Meta-aramid fiber is about 270°C.



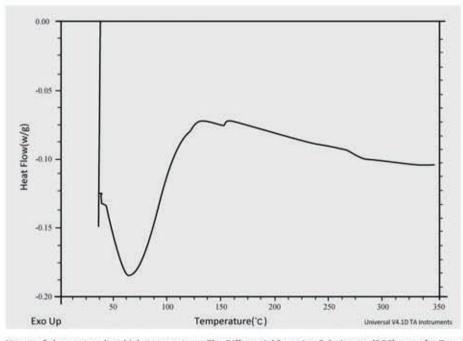


#### 4. TGA and DSC Curves of Type N600



Thermogravimetric Analysis (TGA) of Type N600 shows less weight loss up to 400°C. The rapid decomposition temperature is approximately 450°C.

#### Differential Scanning Calorimeter Curve of Type N600 in Nitrogen



Newstar® does not melt at high temperatures. The Differential Scanning Calorimeter (DSC) curve for Type N600 does not show a defined melting point.

### 2.2 Flame Resistance

not burn, melt or drop in the air.

#### Vertical Flammability Tests on Fabrics of S101

	Gram Weight	Char lengt	h(mm)	Char length(mm)		
Fabric	(g/m²)	Average of warp direction	Average of fill direction	Average of warp direction	Average of fill direction	
S101 Orange	200	45	40	0	0	
S101 Navy Blue	223	44	47	0	0	

### 2.3 Electrical Insulation

Newstar® Meta-aramid has good insulating property.Metastar® paper made of Newstar® Meta-aramid reaches insulation Class H and is widely used to make high grade transformers, electrical insulation motors and etc.

#### Properties of Metastar® Meta-aramid Paper

Test Items		Unit	Numeral	Standard FI3-2004	
Thickness		mm	0.065	0.048-0.066	
Basis Weight		g/m <sup>2</sup>	46.9	≥35.9	
Density		g/cm <sup>3</sup>	0.72	≥0.61	
	MD	N/cm	25.4	≥32	
Tensile Strength	CD	- Try can	18.5	≥13	
220 C	MD	%	5	≥5.7	
Elongation	CD		5	≥4.2	
	MD	%	7.2	1	
Shrinkage at 300 °C	CD		7.5	1	
-	MD		1.5	1	
Tear Strength	CD	N	1.4	1	
Dielectric Strength		kV/mm	17.7	≥13	
Relative Dielectric Constant		1	1.1	<1.6	
Electric Wasted Factor		1	0.004	0.004	

FI 3-2004 is a standard of American National Standard Institute (ANSI) for aramid paper.



### The Limiting Oxygen Index (LOI) of Newstar® Meta-aramid fiber is over 28%. It is a flame resistant fiber that will

## 2.4 Chemical Resistance

Newstar® Meta-aramid exhibits very good resistance to many chemicals. It is resistant to most strong inorganic acid and shows excellent resistance to alkalis at room temperature.

#### Chemical Resistance of Newstar® Type N600

(%)         (C)         (hrs)         100-91         90-76         75-56         55-21         20-0           Hydrochloric         20         50         24         0 <th colspan="2">Name of Chemicals</th> <th>Concentration</th> <th>Temperature</th> <th>Time</th> <th></th> <th></th> <th>letention of St</th> <th>rength (%)</th> <th></th>	Name of Chemicals		Concentration	Temperature	Time			letention of St	rength (%)	
Hydrochloric Acid         20         50         24         o           Acid         35         R.T.         10         o           35         R.T.         200         o           Acid         30         R.T.         100         o           Acid         30         R.T.         100         o           Acid         30         S.O.         24         o           Acid         30         S.O.         24         o           Hydrofluoric         30         S.O.         24         o           Hydrofluoric         10         R.T.         100         o           Acid         10         R.T.         720         o           Acid         10         S.O.         600         o           30         R.T.         360         o         o           Sulfuric         5         95         100         o           Acid         20         50         750         o           Ammonium         5         75         100         o           Hydroxide         20         50         100         o           Sodium         5         75			(%)	(°C)	(hrs)	100~91	90~76	75~56	55~21	20~0
Acid         20         50         24         0           35         R.T.         10         0         0           Acid         35         R.T.         200         0           Acid         30         R.T.         100         0           Acid         30         R.T.         100         0           Acid         30         S.O.         24         0           Acid         10         R.T.         100         0           Hydrofluoric         1         R.T.         100         0           Acid         10         R.T.         360         0           Sulfuric         20         50         750         0           Armonium         20         50         750         0           Hydroxide         20         50         1000         0           Sodium         5         75         100         0           Sodium         5         75 <td></td> <td>- 55 USS - 1</td> <td>10</td> <td>95</td> <td>10</td> <td></td> <td></td> <td></td> <td>0</td> <td></td>		- 55 USS - 1	10	95	10				0	
Acid $35$ R.T.         10         o           Acid $35$ R.T.         100         o           Acid $30$ R.T.         100         o           Acid $30$ R.T.         100         o           Hydrofluoric $30$ R.T.         100         o           Hydrofluoric         10         R.T.         100         o           Acid         10         R.T.         100         o           Hydrofluoric         10         R.T.         720         o           Acid         10         S0         600         o           30         R.T.         360         o         o           30         R.T.         360         o         o           30         R.T.         360         o         o           30         R.T.         100         o         o           Acid         20         50         750         o           Ammonium         20         50         750         o           Hydroxide         5         75         100         o           Sodium         5			20	50	24		0			
Acid         10         R.T.         100         o           Acid         30         R.T.         100         o           Acid         30         50         24         o           Hydrofluoric         60         R.T.         100         o           Acid         10         R.T.         100         o           Hydrofluoric         10         R.T.         720         o           Acid         10         Solitoric         10         Solitoric         o           Acid         5         95         100         o         o           Sulfuric         5         95         100         o         o           Acid         20         50         750         o         o           Atlati         20         50         650         o         o           Atlati         5         75         100         o         o           Sodium         5         75         100         o         o           Sodium         5         75         100         o         o           Sodium         5         75         100         o         o		-	35	R.T.	10	o				
Nitric Acid         30         R.T.         100         o           Acid         30         50         24         o           4         60         R.T.         100         o           Hydrofluoric Acid         1         R.T.         190         o           Acid         10         R.T.         190         o           Acid         10         R.T.         720         o           Acid         10         Sol         600         o           30         R.T.         360         o         o           30         R.T.         360         o         o           30         R.T.         360         o         o           30         R.T.         100         o         o           30         R.T.         100         o         o           60         R.T.         1000         o         o           Arrian         20         50         750         o           Arrian         5         75         100         o           Sodium         5         75         100         o           bxidizing         30         50			35	R.T.	200		0			
Acid $30$ $50$ $24$ $o$ Acid $60$ R.T. $100$ $o$ Hydrofluoric $1$ R.T. $190$ $o$ Acid $10$ R.T. $100$ $o$ Acid $10$ R.T. $720$ $o$ Acid $10$ S0 $600$ $o$ $30$ R.T. $360$ $o$ $o$ $30$ R.T. $100$ $o$ $o$ $30$ R.T. $1000$ $o$ $o$ $Acid$ $20$ $50$ $750$ $o$ $40$ R.T. $1000$ $o$ $o$ $40$ R.T. $1000$ $o$ $o$ $40$ R.T. $1000$ $o$ $o$ $a$ $a$ $0.4$ $20$ $10$ $o$ $a$ $a$ $a$ $a$ $a$ $a$ $a$ $a$ $a$ </td <td></td> <td></td> <td>10</td> <td>R.T.</td> <td>100</td> <td></td> <td>0</td> <td></td> <td></td> <td></td>			10	R.T.	100		0			
Acid         30         50         24         o           Acid         60         R.T.         100         o           Hydrofluoric Acid         1         R.T.         190         o           Maid         10         R.T.         720         o           30         R.T.         360         o           30         R.T.         360         o           30         R.T.         360         o           Sulfuric Acid         5         95         100         o           4         20         50         750         o           60         R.T.         1000         o         o           Armonium         20         50         750         o           20         50         1000         o         o           20         50         1000         o         o           Sodium         5         75         100         o           Sodium         5         75         100         o           Sodium         10         50         90         o           Sodium         0.5         50         500         o <t< td=""><td></td><td></td><td>30</td><td>R.T.</td><td>100</td><td></td><td>0</td><td></td><td></td><td></td></t<>			30	R.T.	100		0			
Acid       1       R.T.       190       o         Hydrofluoric       10       R.T.       720       o         Acid       10       50       600       o         30       R.T.       360       o         Sulfuric       5       95       100       o         Acid       20       50       750       o         60       R.T.       1000       o       o         Acid       20       50       750       o         60       R.T.       1000       o       o         Ammonium       20       50       750       o         Hydroxide       20       50       750       o         20       50       1000       o       o         Sodium       5       75       100       o         Hydroxide       40       R.T.       1000       o         Sodium       10       50       90       o         Sodium       0.5       50       500       o         Hydroxide       0.5       50       500       o         Agent       10       50       500       o		Acid	30	50	24				o	
Hydrofluoric Acid         10         R.T.         720         o           10         50         600         o           30         R.T.         360         o           30         R.T.         360         o           Acid         5         95         100         o           Acid         20         50         750         o           60         R.T.         1000         o         o           Acid         20         50         650         o           Ammonium         20         50         750         o           4klali         20         50         750         o           20         50         1000         o         o           20         50         1000         o         o           20         50         1000         o         o           Sodium         5         75         100         o           Approxide         40         R.T.         100         o           Sodium         10         50         210         o           Agent         Sodium         0.5         50         500         o <td>Acid</td> <td>7</td> <td>60</td> <td>R.T.</td> <td>100</td> <td></td> <td>0</td> <td></td> <td></td> <td></td>	Acid	7	60	R.T.	100		0			
Acid         10         n.n.         120         0           10         50         600         o           30         R.T.         360         o           30         R.T.         360         o           Sulfuric         20         50         750         o           Acid         20         50         750         o           60         R.T.         1000         o         o           Akidi         20         50         750         o           20         50         750         o         o           20         50         750         o         o           20         50         1000         o         o           20         50         1000         o         o           Sodium         5         75         100         o           Akaii         5         75         100         o           Sodium         5         75         100         o           Acid         20         10         o         o           Sodium         10         50         210         o           Sodium         0.5 </td <td></td> <td rowspan="4"></td> <td>1</td> <td>R.T.</td> <td>190</td> <td>0</td> <td></td> <td></td> <td></td> <td></td>			1	R.T.	190	0				
Image: second			10	R.T.	720	0				
Sulfuric Acid         5         95         100         o           20         50         750         o           60         R.T.         1000         o           Alkali         20         50         650         o           Alkali         20         50         750         o           Alkali         20         50         750         o           Sodium Hydroxide         20         50         1000         o           Sodium Hydroxide         5         75         100         o           Sodium Hydroxide         5         75         100         o           Sodium Hydroxide         10         50         90         o           Sodium Hypochlorite         10         50         210         o           Sodium Agent         Sodium Chlorate         0.5         50         500         o           Acetone         100         R.T.         1000         o         Image: Chlorate         0.5         R.T.         1000         o			10	50	600		o			
Sulfuric Acid         20         50         750         o           60         R.T.         1000         o         o           Ammonium Hydroxide         20         50         650         o         o           Alkali         20         50         650         o         o         o           Alkali         Ammonium Hydroxide         20         50         750         o         o           Sodium Hydroxide         5         75         100         o         o         o           Sodium Hypochlorite         5         75         100         o         o         o           Dxidizing and teducing Agent         Sodium Chlorate         0.4         20         10         o         o           Sodium Hypochlorite         0.5         50         90         o         o         o           Sodium Agent         Sodium Chlorate         0.5         50         500         o         o           Acetore         100         R.T.         1000         o         o         o			30	R.T.	360	o				
Acid         20         50         750         o           60         R.T.         1000         o         o           Alkali         20         50         650         o           Alkali         20         50         750         o           Sodium         5         75         100         o           Sodium         50         90         o         o           Sodium         10         50         90         o           Sodium         0.5         50         500         o           Sodium         0.5         50         500         o           Sodium         0.5         8.7         1000         o           Agent         Hyporchlorite         0.5         R.T.         1000         o			5	95	100		0			
Ammonium Hydroxide         20         50         650         o           Alkali         20         50         750         o           Alkali         20         50         1000         o           Sodium Hydroxide         5         75         100         o           Sodium Hydroxide         5         75         100         o           Sodium Hydroxide         6.4         20         10         o           Sodium Hypochlorite         10         50         90         o           Sodium Adeducing Agent         Sodium Chlorate         0.5         50         500         o           Acetone         100         R.T.         1000         o         o			20	50	750				0	
Alkali         Ammonium Hydroxide         20         50         750         o           Alkali         20         50         1000         o           Sodium Hydroxide         5         75         100         o           Sodium Hydroxide         5         75         100         o           Sodium Hydroxide         5         75         100         o           Sodium Hypochlorite         0.4         20         10         o           Sodium Hypochlorite         10         50         90         o           Sodium Hypochlorite         10         50         210         o           Sodium Chlorate         0.5         50         500         o           Acetone         100         R.T.         1000         o			60	R.T.	1000				o	
Hydroxide         20         50         750         o           Alkali         20         50         1000         o           Sodium Hydroxide         5         75         100         o           Alkali         5         75         100         o           Sodium Hydroxide         5         75         100         o           0.4         20         10         o         o           Sodium Agent         0.4         20         10         o           Sodium Hypochlorite         10         50         90         o           Sodium Chlorate         0.5         50         500         o           Acetone         100         R.T.         1000         o		Amountain 7	20	50	650	o				
Alkali         Sodium Hydroxide         5         75         100         o           Hydroxide         40         R.T.         1000         o         o           Dxidizing and teducing Agent         0.4         20         10         o         o           Sodium Hypochlorite         10         50         90         o         o         o           Sodium Chlorate         0.5         50         500         o         o         o           Agent         Hydrogen Peroxide         0.5         R.T.         1000         o         o			20	50	750	0				
Sodium Hydroxide         5         75         100         o           Hydroxide         40         R.T.         1000         o           Sodium Hypochlorite         0.4         20         10         o           Dxidizing and Agent         10         50         90         o           Sodium Hypochlorite         10         50         210         o           Sodium Agent         Sodium Chlorate         0.5         50         500         o           Acetone         100         R.T.         1000         o         o	Alkali		20	50	1000	o				
Au         R.T.         1000         o           Oxidizing and Agent         0.4         20         10         o           Vidizing and Agent         10         50         90         o           Vidizing Agent         10         50         210         o           Hydrogen Peroxide         0.5         50         500         o           Acetone         100         R.T.         1000         o	Alkali		5	75	100	o				
Sodium Hypochlorite         10         50         90         o           and and Agent         10         50         210         o           Hypochlorite         0.5         50         500         o           Hydrogen Peroxide         0.5         R.T.         1000         o		Hydroxide	40	R.T.	1000				o	
Hypochlorite         10         50         90         o           Agent         10         50         210         o           Agent         Sodium Chlorate         0.5         50         500         o           Hydrogen Peroxide         0.5         R.T.         1000         o		Calling	0.4	20	10	0				
and Reducing Agent         10         50         210         o           Hydrogen Peroxide         0.5         50         500         o           Acetone         100         R.T.         1000         o		Hypochlorite_	10	50	90	0				
Agent         Chlorate         0.5         50         500         o           Hydrogen Peroxide         0.5         R.T.         1000         o           Acetone         100         R.T.         1000         o			10	50	210		0			
Peroxide         0.5         R.T.         1000         o           Acetone         100         R.T.         1000         o		Chlorate	0.5	50	500	o				
	NUT 1910	Hydrogen Peroxide	0.5	R.T.	1000	o				
Benzene 100 R.T. 1000 o	Ace	tone	100	R.T.	1000	0				
	Ben	zene	100	R.T.	1000	0				

### 2.5 Textile Properties

non-woven fabrics.

Properties of Spun Yarns Manufactured from Newstar® Type N600

Yarn Count Items	10 <sup>\$</sup> /1	20 <sup>5</sup> /1	25 <sup>\$</sup> /1	30 <sup>5</sup> /1	32 <sup>5</sup> /1	40 <sup>5</sup> /1	35 <sup>\$</sup> /1	60 <sup>\$</sup> /1	80 <sup>5</sup> /1
Twists (turns/10cm)	42	62	65	70	68	80	82	125	160
Yarn Strength (CN)	≥1450	≥700	≥550	≥450	≥400	≥280	≥380	≥175	≥135
Yarn Count Items	10 <sup>5</sup> /2	20 <sup>5</sup> /2	25 <sup>5</sup> /2	30 <sup>5</sup> /2	32 <sup>5</sup> /2	40 <sup>5</sup> /2	42 <sup>5</sup> /2	20 <sup>5</sup> /3	40 <sup>5</sup> /3
Twists (turns/10cm)	42	60	69	72	75	80	82	54	81
Yarn Strength (CN)	≥3000	≥1500	≥1200	≥1000	≥950	≥700	≥700	≥2500	≥1100

### 2.6 Radiation Resistance

Newstar® fiber is exposed at 1000Mrad of  $\beta$  radiation accumulation, it shows no loss of strength.

### 2.7 Technical Specifications

Specifications of Newstar® Meta-aramid Fiber (Taking N601 2.0D as an example)

Items	Unit	Norms
Titre	Denier	2.0
Tensile Strength	g/d	3.5-6.0
Elongation	%	25-40
Initial Modulus	g/de	30-70
No. of Crimps	N/cm	4-5
Moisture Regain (20 'C ×65% R.H.)	%	4.6-5.0
Dry Heat Shrinkage (300 °C ×15 mins)	%	\$5



### Newstar® Meta-aramid fiber's low stiffness and high elongation provides excellent textile properties and characteristics, allowing processing on all types of conventional textile equipments. The staple fiber can be processed into yarns or blended with other fibers for the manufacture of knitted or woven fabrics as well as

## Newstar® Meta-aramid fiber shows good resistance to $\alpha$ , $\beta$ and ultraviolet radiation. For example, when

## 3.1 Newstar<sup>®</sup> Staple Fiber

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Newstar® staple fiber is available in raw white color and solution dyed colors.

Types and End Uses of Newstar® Meta-aramid Fiber Products

	Fiber Type	Availability	Description	Primary End Uses	
	N600	0.8D,1.0D,1.3D,1.5D,1.7D, 2.0D,3.0D with cut lengths of 38mm,51mm,76mm,85mm	Natural bright luster staple fiber High crystallinity High strength Low dyeability Numerous varieties	High strength spun yarns used for sewing thread, protective apparel, zipper tape, narrow fabrics, underwear, etc.	
Raw White Staple Fiber	0.8D,1.0D,1.3D,1.5D,1.7D, N601 2.0D,3.0D, 5.0D,8.0D,10D,12D,13D with cut lengths of 38mm,51mm,76mm,85 mm,102mm		Natural bright luster staple fiber Low dyeability Full range of varieties	High temperature filtration , insulation materials, high temperature conveying felt, etc	
	N602	0.8D,1.0D,1.3D,1.5D,1.7D, 2.0D with cut lengths of 38mm,51mm, 76 mm,85mm	Natural bright luster staple fiber Good dyeability Good color fastness	Protective apparel, Flame-resistant Furnishings, etc.	
	N602-2	0.8D,1.0D,1.3D,1.5D,1.7D, 2.0D with cut lengths of 38mm,51mm, 76 mm,85mm	Natural bright luster staple fiber Low strength Good dyeability Good color fastness	Protective apparel, Flame-resistant Furnishings, etc.	
Solution Fiber	n Dyed	0.8D,1.0D,1.3D,1.5D,1.7D, 2.0D,2.5D,3.0D, 5.0D with cut lengths of 38mm,51 mm, 76 mm,85 mm,102mm	Staple fiber in a range of solution dyed colors High crystallinity High tenacity and medium elongation	Protective apparel, Flame-resistant Furnishings, etc.	





Newstar<sup>®</sup> Raw White Filament



Tametar<sup>®</sup> Electroconductive Fiber



## 3.2 Newstar<sup>®</sup> Filament

Newstar® raw white filament is available in 200d/100f, 1200d/600f and 1600d/800f. It is of high tenacity in natural bright luster, being the ideal material for protective apparel, electrical insulation, rubber reinforcement, etc.

### 3.3 Tametar<sup>®</sup> Electroconductive Fiber

Tametar® Electroconductive fiber is available in 1.3d, 1.5d, 1.7d, 2.0d, 2.5d, 3.0d with cut lengths of 38mm, 51mm, 76mm, 85mm and 102mm. It has high tenacity, good textile property and excellent conductivity. The specific resistance is 10<sup>4</sup> Ω•cm at room temperature. Its excellent flame resistance and mechanical property make it ideal for protective apparel as well as industrial applications.



Newstar<sup>®</sup> Meta-aramid is integrity of many excellent properties including high temperature resistance, inherently flame resistance, electrical insulation, corrosion resistance, radiation resistance and good spinnability. It is playing irreplaceable roles in many areas.

### 4.1 Personal Protection

Personal protective fabrics made of Newstar® does not burn, melt or bring poison gas. It is widely used in metallurgy, construction, vessel building, petroleum industry, chemical industry, automobiles, electrical power, gas industry and special protective apparel for fire-fighters, military and policemen, racing drivers, etc.



- Firefighting Apparel
- Arc Protection Apparel
- Protective Apparel for Welding Workers

