

# Selector Guide **Aerospace**

## About HEXCEL

Hexcel is the largest US producer of carbon fibre; the world's largest weaver of structural fabrics; the number one producer of composite materials such as prepregs, film adhesives and honeycomb; and a leading manufacturer of composite parts and structures.

As the most vertically integrated supplier in the industry Hexcel manufactures the full spectrum of advanced material solutions. This means that we can offer enhanced design flexibility and support to our customers worldwide.

Hexcel's research and technology function supports our businesses worldwide with a highly developed expertise in materials science, textiles, process engineering and polymer chemistry.

Hexcel has pioneered the development of prepregs for over 60 years. The HexPly® trademark is renowned in high performance industries.

With in-house weaving capabilities for the manufacture of unidirectional and woven reinforcement fabrics in glass, carbon and aramid fibres and hybrids - all marketed under the HexForce® brand name - Hexcel provides customers with a total package of composite solutions.

Our global technical support team is on hand to assist with material selection, processing, and can provide training to those who are new to composites technology.

## Hexcel in Aerospace

Hexcel is a world leader in the manufacture of advanced composite materials for the Commercial Aerospace, Helicopters, Space and Defense markets. From carbon fibres and reinforcement fabrics, through to RTM resins, prepregs, tooling materials and structural parts, Hexcel is present at every stage. Our fibre reinforced composite materials are complemented by our honeycomb technologies which extend from lightweight core materials to aircraft flooring panels, engineered core and Acousti-Cap® noise dampening systems. Hexcel is the only composites supplier that supplies this wide range of fibre reinforced matrix technologies together with an extensive range of honeycomb, adhesives and engineered products.

The focus of this selector guide is Hexcel's resin matrices, direct processes and reinforcements for aerospace prepregs.



### 1/ HexPly® Prepregs

Hexcel pioneered the development of composite materials to meet the requirements of early aircraft manufacturers. Ground-breaking projects included the construction of a full scale wing spar in flax fibre reinforced phenol formaldehyde resin for a Bristol "Blenheim" bomber. Weight-saving was a major driver in the exploration and development of these new materials, alongside the need for higher mechanical properties and greater design flexibility.

Sixty years on, the aerospace industry remains the greatest consumer of Hexcel prepregs, for civil aircraft, military jets, helicopters, aero-engines or space satellite and launchers. Hexcel's range of resin formulations for aerospace prepregs includes a wide range of epoxies for highly loaded parts and supreme toughness; BMI systems for high temperature performance; phenolics for fire, smoke and toxicity performance in aircraft interiors; and cyanate esters for space structures and satellite applications. HexPly® prepregs are available with HexForce® woven and multiaxial reinforcements, or as unidirectional tapes in various forms.



### 2/ HexFlow® Liquid Resins

Hexcel is a global leader in providing composite solutions for aerospace and other high performance applications. Hexcel pioneered the development of resin formulations for composites and is the premier worldwide supplier of prepregs, RTM and RFI systems. Hexcel is also a major manufacturer of carbon fibre and a leader in reinforcement fabrics and nonwovens for composites. Our unrivalled integrated product range means that Hexcel is the composite specialist.

Direct processes, covering a wide variety of techniques to combine resin and reinforcement, including RTM VaRTM and RFI, are the focus of this brochure which complements Hexcel's prepreg technology manual.



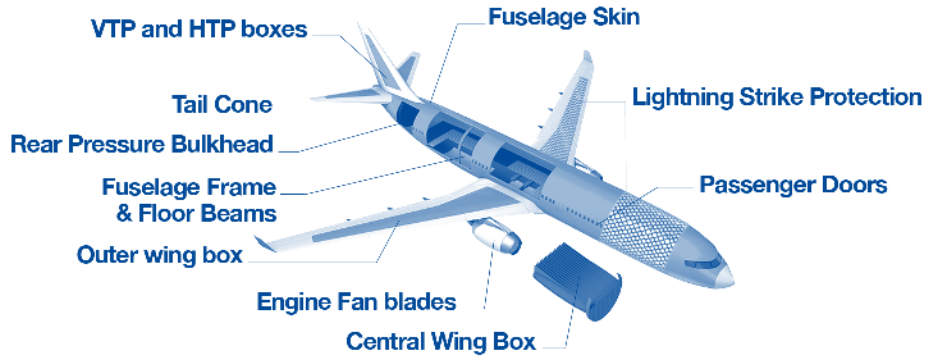
### 3/ HexForce® Reinforcements

The aerospace industry relies on Hexcel's woven glass, carbon, aramid and hybrid fibre fabrics for use in advanced composites. Due to the high strength, thermal and electrical insulating properties, and fire resistance of fibre glass and carbon fabrics, today's commercial aircraft industry uses HexForce® in the design and manufacture of radomes, interior panelling systems, secondary structures (wing-to-body or belly fairing, leading edges, parts and flight control systems), engine and nacelles.

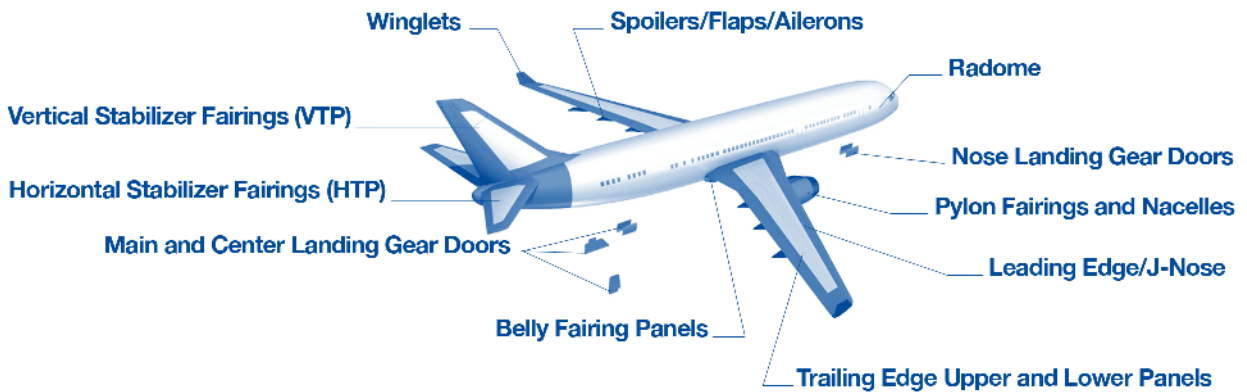
## Civil Aircraft

Hexcel is the preferred supplier of composite materials to the civil aerospace industry, with materials present in virtually every commercial aircraft currently built in the western world.

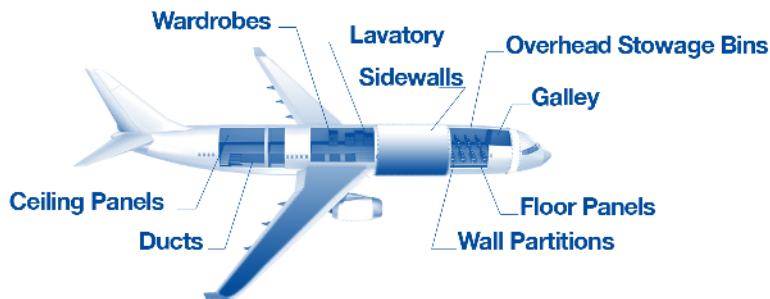
### PRIMARY STRUCTURES



### SECONDARY STRUCTURES



### INTERIORS

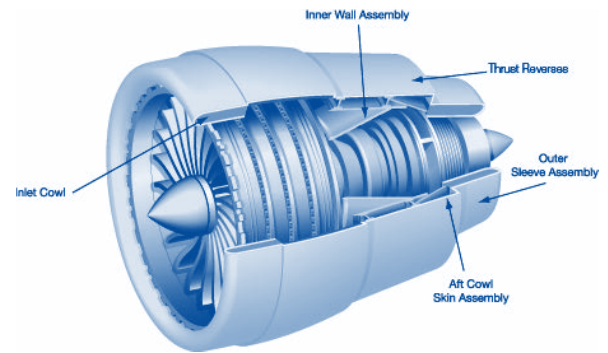


The drawings are generic, to allow the maximum number of potential applications to be identified. The drawings are not intended to represent a specific aircraft.

These generic drawings illustrate typical applications for HexForce® fabrics, HexPly® prepregs and HexFlow® Liquid Resins. For information on the full range of Hexcel products for aerospace (carbon fibres, adhesives, honeycombs, etc) please request a copy of our CD.

## Aero-engines

By the 1970's designers had turned to composites for the weight-savings necessary for the large nacelles required by the new generation of large high power turbofans. Today, engine nacelles and thrust reversers include so many major composite components that carbon fibre epoxy prepregs account for typically half the volume of the entire nacelle structure. The next step for aero-engine designers has been to apply composites technology to more complex structures within the engine itself.

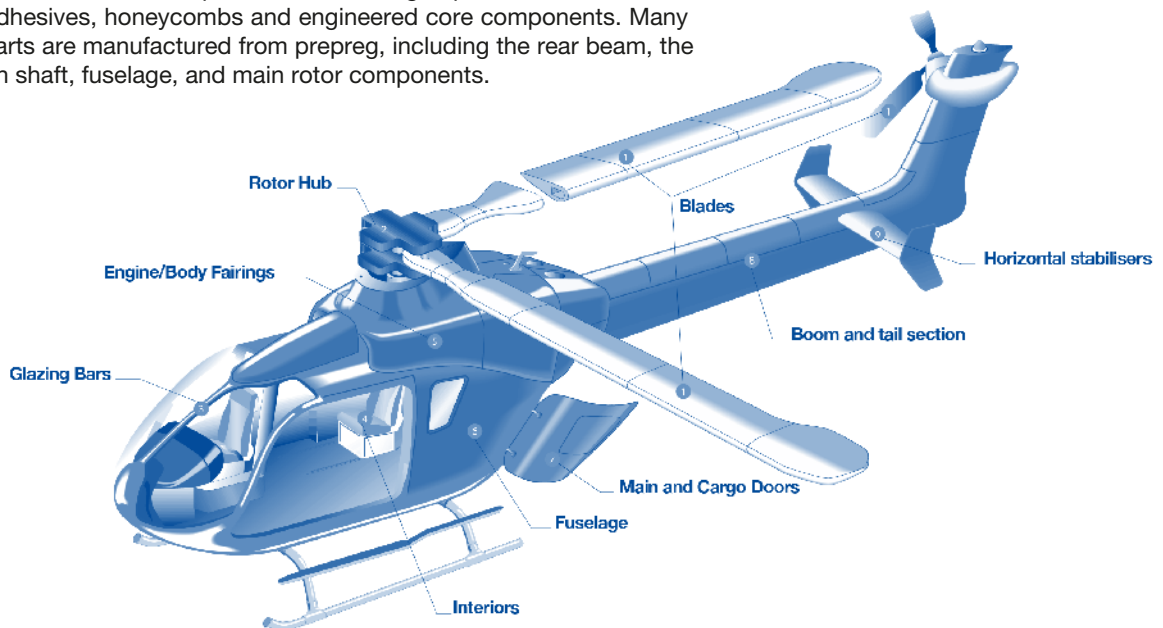


## Defence Aircraft

In their quest for superior performance, defence aircraft designers were the first to experiment with new materials and to demonstrate the effectiveness of composites.

## Helicopters

Both civil and defence helicopters consume large quantities of Hexcel's prepregs, adhesives, honeycombs and engineered core components. Many structural parts are manufactured from prepreg, including the rear beam, the transmission shaft, fuselage, and main rotor components.



## Space

Launching satellites into space creates the ultimate performance challenge for composite materials. In addition to the crucial weight savings, the materials also have to withstand extreme temperature fluctuations. The performance requirements can be accommodated by Hexcel's wide range of matrix systems.

The drawings are generic, to allow the maximum number of potential applications to be identified. The drawings are not intended to represent a specific aircraft.

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# Prepreg Resins

HEXPLY® RESIN SYSTEM	DRY TG ONSET (DMA) °C (°F)	TYPICAL CURE CYCLE		CURE PROCESS		FLOW CONTROLLED HIGH	OUTLIFE AT ROOM TEMPERATURE days	STORAGE AT -18°C (0°F) months	STANDARD PREPREG FORMS
		Temp °C (°F)	Time (mins)	AUTOCLAVE/ PRESS	VACUUM ONLY				
<b>EPOXIES</b>									
M26T	105 (220)	125 (255)	90	X	X	X	30	12	FABRIC
M76	130 (265)	135 (275)	180	X		X	21	12	UD TAPE/FABRIC
913	150 (300)	125 (255)	60	X		X	30	12	UD TAPE/FABRIC/TOWPREG
M92	160 (320)	125 (255)	90	X	X	X	60	12	UD TAPE/FABRIC/TOWPREG
M20	150 (300)	130 (265)	120	X	X	X	42	12	UD TAPE/FABRIC
8551-7	155 (315)	180 (350)	120	X		X	30	12	UD TAPE/FABRIC/ TOWPREG/SLIT TAPE
M91	185-190	180 (350)	120	X		X	42	12	UD TAPE/SLIT TAPE
M21	190 (375)	180 (350)	120	X		X	30	12	UD TAPE/FABRIC SLIT TAPE
8552	195 (385)	180 (350)	120	X		X	30	12	UD TAPE/FABRIC/ TOWPREG/SLIT TAPE
M56	198	180 (350)	180	X	X	X	35	12	UD TAPE/FABRIC SLIT TAPE
M18	200 (390)	180 (350)	120	X		X	30	12	UD TAPE/FABRIC/TOWPREG
M18/1	200 (390)	180 (350)	120	X		X	30	12	FABRIC
922-1	210 (410)	180 (350)	120	X		X	10	12	UD TAPE/FABRIC

## PHENOLICS

HT93	[80 (175) IN SERVICE]	125 (255)	120	X	X	X	30	14	FABRIC
200	200 (390) IN SERVICE]	150 (300)	30	X		X	30	12	FABRIC

## BMI

M65	300 (572)	191 (375)	240 (1)	X		X	30	12	UD TAPE/FABRIC/SLIT TAPE
F655	290 (550)	190 (375)	240 (1)	X		X	30	12	UD TAPE/FABRIC

## CYANATES

996*	165 (330)	180 (350)	120	X		X	14	6	UD TAPE/FABRIC
954-3	205 (400)	180 (350)	120	X		X	14	12	UD TAPE/FABRIC
954-6*	150 (300)	121 (250)	180	X		X	14	12	UD TAPE/FABRIC

# Liquid Resins

HEXPLY® RESIN SYSTEM	DRY TG ONSET (DMA) °C (°F)	TYPICAL CURE CYCLE		MOLDING PROCESS	
		Temp °C (°F)	Time (mins)	RTM.....	Infusion
<b>EPOXIES</b>					
RTM6	200°C	160°C	2H	X	X
RTM6-2	200°C	160°C	2H	X	X
VRM37*	190°C	180°C	2H	X	X
VRM22*	132°C	60°C +postcure 2H 121°C	4H	X	X
RTM 230 ST	150°C	190°C	2H	X	
<b>BMI</b>					
RTM 651	285°C	190°C +postcure 16H 230°C	4H	X	

\* AVAILABLE IN US ONLY. (1) + POST-CURE

# HexPly® product data

HEXPly® RESIN SYSTEM	ATTRIBUTES	TYPICAL APPLICATIONS	COMMERCIAL AIRCRAFT	INTERIORS	HELICOPTERS	MILITARY JETS	NACELLES ENGINES	SPACE	UAV'S
<b>M26T</b>	self adhesive, self extinguishing	fairings / sandwich structures	X		X				
<b>M76</b>	high toughness, self adhesive, flexible cure	space applications						X	
<b>913</b>	versatile system with high environmental resistance	structural components / fairings / helicopter blades	X		X				X
<b>M92</b>	self adhesive, self extinguishing versatile system with high environmental resistance	fairings / sandwich structures structural components	X		X				
<b>M20</b>	high temperature performance from low temperature cure	composite repair	X			X			
<b>8551-7</b>	extreme damage resistance, very high toughness	structural components / engine parts / fan blades	X				X		
<b>M91</b>	latest product for aerospace structure and aeroengine, excellent toughness with very high residual compression strength after impact	Aircraft and aeroengine primary structure	X				X		
<b>M21</b>	preferred product for aerospace structures. high toughness and excellent translation of IM fibre	primary structures	X				X		
<b>8552</b>	preferred product for aerospace structures.	structural parts	X		X	X	X	X	
<b>M56</b>	high temperature performance from Out of the autoclave cure, low density	primary and secondary structures out of autoclave	X				X		X
<b>M18</b>	low moisture uptake, low density	space applications						X	
<b>M18/1</b>	self extinguishing. very high temperature wet performance.	helicopter structural parts			X				
<b>922-1</b>	high service temperature	engine / nacelle structures	X				X		
<b>HT93</b>	low FST	aircraft interior panels / partitions		X					
<b>200</b>	low FST, excellent ablative properties	fire proof panels & components		X					
<b>M65</b>	high temperature, resistant BMI system	parts subjected to very high temperatures	X		X	X	X		
<b>F655</b>	high temperature	primary / secondary structures, engine components toughened	X				X		
<b>996</b>	low water pick up	space and satellite applications						X	
<b>954-3</b>	low water pick up	space and satellite applications						X	
<b>954-6*</b>	low water pick up	space and satellite applications						X	

# HexFlow® product data

HEXPly® RESIN SYSTEM	OUTLIFE AT RT	STORAGE COND.	TRANSPORT RESTRICTIONS	PRODUCT FORM
<b>RTM6</b>	15 days at 23°C	9 months -18°C	UN4.1	Monocomponent
<b>RTM6-2</b>	15 days at 23°C	9 months -18°C	no	Bi-component
<b>VRM37</b>	14 days at 23°C	6 months -18°C	no	Bi-component
<b>VRM22*</b>	14 days at 23°C	6 months -18°C	no	Bi-component
<b>RTM 230 ST</b>	30 days at 23°C	18 months -18°C	no	Monocomponent
<b>RTM 651</b>		12 months - -18°C	no	Monocomponent



# HS Carbon Fabrics

WEIGHT		STYLE	WEAVE	PRIMETEX® OPTION	WEIGHT RATE		
<i>gsm</i>	<i>oz/yd<sup>2</sup></i>				EU	US	warp %
<b>BALANCED FABRICS - HIGH STRENGTH FIBRES</b>							
84	2.48		84	PLAIN		50	50
98	2.89	G0801		PLAIN		50	50
98	2.89	43098		PLAIN	X	50	50
130	3.83	G0806	130	PLAIN		50	50
193	5.69	G0814/G0904/43193	282/AGP193	PLAIN	X	51	49
193	5.69		XAGP282P	BIAS PW		51	49
193	5.69	43195	284	TWILL 2X2	X	51	49
220	6.49	G0939/G0802		4 H SATIN		50	50
280	8.26	G0833/G0933/43280	AGP 280	5H SATIN		50	50
285	8.41	G0803/G0963	433	5H SATIN		50	50
286	8.44	G0986	463	TWILL 2X2	X	50	50
300	8.85	48302		TWILL 2X2	X	50	50
370	10.91	43364/43370	584	8H SATIN		50	50
370	10.91	G0926/46364	613	5H SATIN		50	50

"PRIMETEX® IS A RANGE OF CARBON FABRICS THAT HAVE BEEN PROCESSED FOR A SMOOTH, CLOSED WEAVE AND ENHANCED UNIFORM APPEARANCE: FIBRE TOWS ARE FLATLY WOVEN AND SPREAD IN BOTH WARP AND WEFT DIRECTIONS. HEXCEL SUPPLIES PRIMETEX® FABRICS WITH THE PHYSICAL PROPERTIES MENTIONED IN THE TECHNICAL DATASHEET. SHOULD YOU WISH TO ACHIEVE SPECIFIC COSMETIC EFFECTS WITH PRIMETEX®, PLEASE CONTACT HEXCEL."

## UNIDIRECTIONAL FABRICS - HIGH STRENGTH FIBRES

160	4.72	G0827/G0947		UD PLAIN		97	3
170	5.01	42165		UD PLAIN		98	2
300	8.85	48330		UD PLAIN		96	4



# IM-HM-UHM Carbon Fabrics

## INTERMEDIATE MODULUS FIBRES

98	2.89	46098		PLAIN	X	50	50
193	5.69	46195		TWILL 2X2	X	50	50
196	5.78		XSGP196 P	PLAIN		50	50
203	5.99		SGP203CS	CROW FOOT		50	50
203	5.99		XC1400	BIAS CROWFOOT		50	50
370	10.91	46370	SGP3708H	8H SATIN		50	50

## HIGH MODULUS FIBRES

200	5.99	48200		TWILL 2X2	X	50	50
285	8.41	48297		5H SATIN	X	50	50

## ULTRA HIGH MODULUS FIBRES

90	2.65	43090		PLAIN	X	50	50
150	4.42	46150		PLAIN		50	50
195	5.75	G0969		UD PLAIN		89	11



# Injectex® Fabrics for infusion or injection technology

## CARBON FABRICS

				POWDERING			
200	5.90	GB201/GB200		PLAIN	X	50	50
286	8.44	G0986	463	TWILL 2X2	X	50	50
290	8.55	G1157		UD PLAIN	X	96	4
370	10.91	G0926	613	5H SATIN	X	50	50
600	17.70	G1151		FORMABLE	X	50	50



# HexForce® product data

FIBER COUNT		REINFORCEMENT YARN		THICKNESS
warp yarns/cm	weft picks/cm	warp	weft	mm
6.3	6.3	HS 1K	HS 1K	0.09
7.4	7.4	HS 1K	HS 1K	0.10
2.3	2.3	HS 3K	HS 3K	0.09
10	10	HS 1K	HS 1K	0.13
4.9	4.8	HS 3K	HS 3K	0.20
4.9	4.8	HS 3K	HS 3K	0.20
4.9	4.8	HS 3K	HS 3K	0.20
5.5	5.5	HS 3K	HS 3K	0.23
7.0	7.0	HS 3K	HS 3K	0.29
7.2	7.2	HS 3K	HS 3K	0.29
3.5	3.5	HS 6K	HS 6K	0.29
1.8	1.8	HS 12K	HS 12K	0.30
9.5	9.5	HS 3K	HS 3K	0.37
4.6	4.6	HS 6K	HS 6K	0.37

7.9	4	HS 3K	EC5 5.5x2	0.16
8.1	4	HS 3K	EC5 5.5x2	0.17
4	4	HS 12K	EC9 34	0.31

# HexForce® product data

2.2	2.2	IM7 6K	IM7 6K	0.10
4.3	4.3	IM7 6K	IM7 6K	0.20
4.3	4.3	IM7 6K	IM7 6K	0.20
4.5	4.5	IM7 6K	IM7 6K	0.23
4.5	4.5	IM7 6K	IM7 6K	0.23
8.3	8.3	IM7 6K	IM7 6K	0.37

2.35	2.35	HM63 12K	HM63 12K	0.20
3.35	3.35	HM63 12K	HM63 12K	0.28

4.5	4.5	M60JB 3K	M60JB 3K	0.10
4.5	4.5	M55JB 6K	M55JB 6K	0.15
8	3	M55J 6K	HS 1K	0.21

## - Epoxy E01 binder for preforms

# HexForce® product data

4.7	4.7	HS 3K	HS 3K	0.20
3.5	3.5	HS 6K	HS 6K	0.29
6.7	3	HS 6K	EC9 34	0.31
4.6	4.6	HS 6K	HS 6K	0.38
7.4	7.4	HS 6K	HS 6K	0.60



## Carbon - Glass Hybrid Fabrics

WEIGHT <i>gsm</i> <i>oz/yd<sup>2</sup></i>		STYLE	WEAVE	warp	WEIGHT RATE %	weft
<b>BALANCED FABRICS - HIGH STRENGTH FIBRES</b>						
135	3.98	G1088	TWILL 2X2	16-34		16-34
170	5.01	G0874	PLAIN	16-34		16-34
170	5.01	43596	PLAIN	16-34		16-34
178	5.25	G0973/G1081	TWILL 2X2	25/18/7		25/18/7
185	5.46	G1177	TWILL 2X2	23-27		23-27
270	7.96	43743	TWILL 2X2	21-29		21-29



## Carbon - Aramid Hybrid Fabrics

WEIGHT <i>gsm</i> <i>oz/yd<sup>2</sup></i>		STYLE	WEAVE	warp	WEIGHT RATE %	weft
<b>BALANCED FABRICS - HIGH STRENGTH FIBRES</b>						
210	6.19	73210	TWILL 2X2	22-28		22-28



## Aramid Fabrics

WEIGHT <i>gsm</i> <i>oz/yd<sup>2</sup></i>		EU	STYLE	US	WEAVE	warp	WEIGHT RATE %	weft
<b>ARAMID BALANCED FABRICS</b>								
60	1.77	20796	350(AMS120)		PLAIN	50		50
120	3.54	21226			5H SATIN	50		50
166	4.90	21263		348	8H SATIN	50		50
175	5.16	20914		353(AMS 285)	4H SATIN	51		49



## Quartz Fabrics

WEIGHT <i>gsm</i> <i>oz/yd<sup>2</sup></i>		STYLE	WEAVE	WEIGHT RATE			FIBRE COUNT	
				warp	%	weft	warp yarns/cm	weft picks/cm
<b>BALANCED FABRICS</b>								
145	4.28	610	LENO	52		48	11.2	10.5
265	7.82	593	5H SATIN	50		50	19.5	19.5
292	8.61	581	8H SATIN	50		50	21	21
300	8.85	595	TWILL 2X2	50		50	9.2	9.2

## HexForce® product data

	FIBRE COUNT		REINFORCEMENT YARN		THICKNESS mm
	warp yarns/cm	weft yarns/cm	warp	weft	
	3.2/13.3	3.2/6.7	HS 1K/EC9 34	HS 1K/EC9 68	0.12
	1.4/4.5	1.4/4.5	HS 3K/ET9 68x2	HS 3K/ET9 68x2	0.17
	1.4/8.4	1.4/8.4	HS 3K/EC9 68	HS 3K/EC9 68	0.15
	2x(2.2/4.7/2.2)		2x(HS 3K/PE/ET9 68)		0.18
	2.2/6.7	2.2/6.7	HS 3K/EC9 68	HS 3K/EC9 68	0.19
	2.9/11.5	2.2/11.5	HS 3K/EC9 68	HS 3K/EC9 68	0.24

## HexForce® product data

	FIBRE COUNT				REINFORCEMENT YARN				THICKNESS mm
	warp yarns/cm	weft picks/cm	warp	weft	warp	weft	warp	weft	
	2.2	4.4	2.2	4.4	HS 3K	AR HM 1270	HS 3K	AR HM 1270	0.20

## HexForce® product data

	FIBRE COUNT		REINFORCEMENT YARN		THICKNESS mm
	warp yarns/cm	weft picks/cm	warp	weft	
	13.5	13.5	HM 215	HM 215	0.07
	14	14	HM 405	HM 405	0.15
	19.2	19.2	HM 405	HM 405	0.20
	6.7	6.5	HM 1270	HM 1270	0.20

## HexForce® product data

	REINFORCEMENT YARN		THICKNESS mm
	warp	weft	
	SI C9 67	SI C9 67	0.11
	SI C9 67	SI C9 67	0.20
	SI C9 67	SI C9 67	0.22
	SI C14 80x2	SI C14 80x2	0.22



## Peel Ply

WEIGHT		STYLE	FINISH DP	WEAVE	WEIGHT RATE	
<i>gsm</i>	<i>oz/yd<sup>2</sup></i>				warp	%
<b>POLYAMIDE FABRICS</b>						
95	2.80	BI9760 BLANC/ROSE	X	PLAIN	50	50
105	3.10	T0089	X	PLAIN	52	48
105	3.10	T0098	TRACERS	PLAIN	54	46

<b>POLYESTER FABRICS</b>						
90	2.65	BI9842	X	PLAIN	51	49

DP : Heat treated-Preformed (On Request)



## E and S-2 Glass Fabrics

WEIGHT		STYLE		WEAVE	WEIGHT RATE		FIBRE COUNT	
<i>gsm</i>	<i>oz/yd<sup>2</sup></i>	EU	US		warp	%	weft	warp yarns/cm
<b>BALANCED FABRICS</b>								
48	1.42	1080	1080	PLAIN	56	44	24	19
105	3.08	120	120	4H SATIN	51	49	24	23
105	3.08	220	220	4H SATIN	51	49	24	23
193	5.69	6580	6580	8H SATIN	50	50	28.3	28.3
200	5.90	7628	7628	PLAIN	59	41	17	11.8
200	5.90	1035	1035	TWILL 2X2	50	50	14	14
220	6.49	1034	X	4H SATIN	50	50	16	16
290	8.55	791	X	TWILL 2X2	50	50	7	7
300	8.85	1581	1581	8H SATIN	51	49	22	21
300	8.85	7581	7581	8H SATIN	51	49	22	21
300	8.85	7781	7781	8H STAIN	53	47	23.6	21
305	9.00	6781	6781	8H SATIN	50	50	22.5	22.5

<b>UNIDIRECTIONAL FABRICS</b>								
290	8.55	1543		UD 4H SATIN	90	10	19	11.8
365	10.77	1055		UD 5H SATIN	83	13	45	9

Other styles available on demand

Thickness: theoretical thickness of a cured ply with 50% fiber volume content



## Finish For E And S-2 Glass Fabrics

<b>BALANCED FABRICS</b>			
MATRIX	STYLE		DESCRIPTION
FINISH	EU	US	
Z 6040	X		EPOXY SILANE
TF 970	X		AMINOSILANE
A 1100	X		AMINOSILANE
F 69		X	SILANE
F 81		X	SILANE
HT		X	DIRECT SIZE E OR S-2 GLASS

## HexForce® product data

	FIBRE COUNT		REINFORCEMENT YARN		THICKNESS
	warp yarns/cm	weft	warp	weft	mm
	19	19	PA66 235	PA66 235	0.07
	22	20	PA66 235	PA66 235	0.08
	22	18.5	PA66 235	PA66 235	0.08
	28	28	HT 144	HT 144	0.07

## HexForce® product data

	REINFORCEMENT YARN		THICKNESS
	warp	weft	mm
	EC5 11	EC5 11	0.04
	EC5 11x2	EC5 11x2	0.08
	EC7 22	EC7 22	0.08
	S-2 34	S-2 34	0.15
	EC9 68	EC9 68	0.15
	EC9 68	EC9 68	0.15
	EC9 68	EC9 68	0.16
	EC9 68x3	EC9 68x3	0.22
	EC9 34x2	EC9 34x2	0.23
	EC9 68	EC9 68	0.23
	EC6 66	EC6 66	0.23
	S-2 68	S-2 68	0.23
	EC9 68x2	EC7 22	0.22
	EC9 68	EC9 68	0.28

## HexForce® product data

	EPOXY	POLYESTER	VINYLESTER	PHENOLIC





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