HexForce® Reinforcements

Woven Fabrics
Unidirectional Fabrics
Glass
Carbon
Aramid
Hybrids

Technical Fabrics Handbook





HEXCEL®

REINFORCEMENTS FOR COMPOSITES

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COMPANY PROFILE

Hexcel Corporation is a leading advanced composites company. It develops, manufactures and markets lightweight, high-performance structural materials; including carbon fibers, reinforcements, prepregs, honeycomb, matrix systems, adhesives and composite structures, used in commercial aerospace, space and defense and industrial applications such as wind turbines.

As the most vertically integrated supplier in the industry, Hexcel is better able to control the cost, quality and delivery of its products. Vertical integration also 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 manufactures a wide range of reinforcements for the manufacture of structural composites, used in aerospace, military, transportation and industrial applications. Reinforcements in the form of fabrics or non-wovens are made using a variety of high performance fibers, including glass, carbon, aramids, and specialty reinforcements.

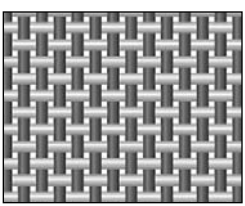
PARAMETERS FOR WOVEN FABRIC SELECTION

In selecting a woven fabric for industrial applications, a number of design parameters may be considered. These are broken down into four basic variables: yarn weight, thread count, weave pattern and fabric finish. The wide range of yarn weights provides the base for fabric design. Yarn weight, combined with thread count [the number of warp ends (lengthwise) and filling picks (widthwise) per inch] determines the strength, weight and thickness of the fabric.

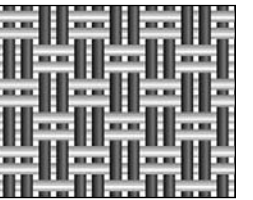
Basic weaving concepts are utilized in the manufacture of fiber glass and high performance fabrics. The technology, however, is advanced to incorporate specialized precision equipment to meet the exacting demands of modern industry. Almost any weave can be woven; however, for industrial purposes there are six basic patterns as described below.

Plain

The plain weave consists of yarns interlaced in an alternating fashion one over and one under every other yarn. The plain weave provides good fabric stability but is generally the least pliable.

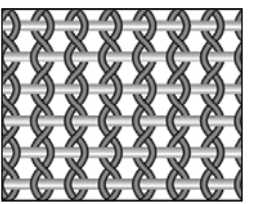


Basket



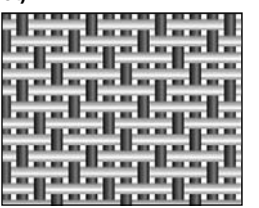
The basket weave is similar to the plain weave except that two or more warp yarns and two or more filling yarns are alternately interlaced over and under each other. The basket weave is more pliable, flatter and stronger than the plain weave, but is not as stable.

Leno



The leno weave is used where relatively low numbers of yarns are involved. The leno weave locks the yarns in place by crossing two or more warp threads over each other and interlacing with one or more filling threads.

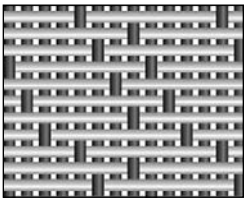
Four Harness Satin (Crowfoot)



The four harness satin weave is more pliable than the plain weave and is easier to conform to curved surfaces typical in reinforced plastics. In this weave pattern there is a three-by-one interfacing where a filling yarn floats over three warp yarns and under one.

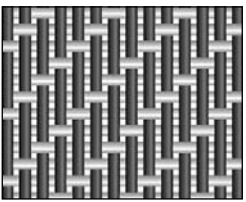
Eight Harness Satin

The eight harness satin is similar to the four harness satin except that one filling yarn floats over seven warp yarns and under one. This is a very pliable weave and is used for forming over curved surfaces.



Twill Weave

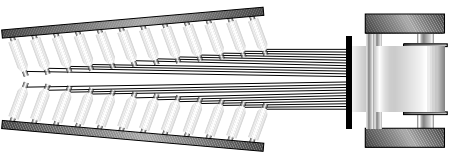
The twill weave is more pliable than the plain weave and has better drapability while maintaining more fabric stability than a four or eight harness satin weave. The weave pattern is characterized by a diagonal rib created by one warp yarn floating over at least two filling yarns



THE PROCESS
CONVERTING YARN TO FABRIC

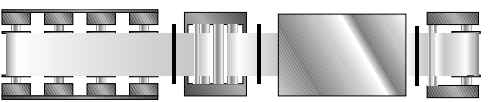
1. Warping

The first step in the warping stage is beaming, where purchased yarn is transferred from the bobbin creel to section beams. Most input yarn is in singles form; however, some yarn is twisted and plied together to yield unique properties. The section beams constitute the machine direction or thread sheet segment of yarn in the loom. Several section beams are produced and consolidated into a group called a set, which provides the input for the slashing process.



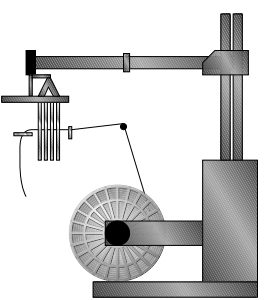
2. Slashing

The slashing process combines the warp ends of the set's multiple section beams into a single beam for weaving called a warp or loom beam. Sizing is applied to the threadsheet filaments and to avoid abrasion of individual strands.



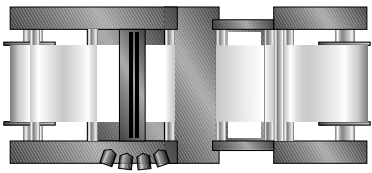
3. Entering

The final stage of preparation is entering, where the warp is set up for installation in the loom. A warp can contain over 4,500 individual ends, depending on the design of the style. Each warp end is drawn through a drop wire, heddles and a reed, either by hand or by machine. These parts work together to mechanically arrange and control the warp yarn spreadsheet during the weaving process on the loom.



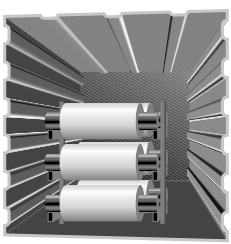
4. Weaving

After the warp beam is installed in the loom, then either rapier technology for heavy fabrics, or air jet technology for lighter fabrics is used to interlace the filling yarns at 90 degree angles to the warp ends on the loom. The fabric, called greige or loom state, is then wound onto a roll or steel drums called mandrels, and the weaving process is complete.



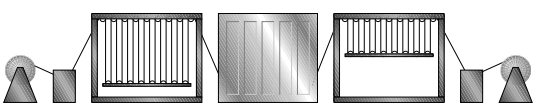
5. Heat Cleaning

The next stage is batch oven cleaning, where the mandrels are placed on racks, loaded into large ovens, and exposed to high temperatures until all organic binders are removed and a pure clean glass fabric is produced. Organic, polymer-based fabrics are not exposed to this process (fabrics of Kevlar®/ Twaron® fibers).



6. Finishing

In the finishing stage a coupling agent (finish) or chemical treatment is applied to the fabric, and the finished glass is ready for use. The finish serves to provide optimum adhesion between the fiber surface and the matrix resin, to provide fabric stability and protection (weave set), or to provide chemical protection and resistance.



CARBON FIBER FABRICS

CARBON FABRICS

Hexcel manufactures the most complete line of carbon fabrics and specialty reinforcements for the composite industry and offers a thorough line of globally certified aerospace products.

Carbon fiber reinforcements, when properly engineered into the appropriate matrix, can achieve one of the strongest and most rigid composite structures available with significant weight savings when compared to metals and other materials.

In addition to the high strength-to-weight ratio, carbon fiber reinforcements are thermally and electrically conductive, have very low CTE and excellent fatigue resistance.

Hexcel Corporation can provide users with a wide variety of commercially available fabrics and specialty reinforcements with different ranges of tensile strength, modulus, and thermal/electrical conductivities.

Our fabric product line includes traditional 0/90 fabrics, +/-45 degree fabrics, flat-tow 12K fabrics, heat-set uni-directional fabrics, multi layered stitch bonded fabrics, lightning strike (LS) fabrics, double-weave fabrics, and hybrid (multiple fibers) fabrics woven with standard modulus or IM fibers. Many of these fabrics are qualified to major aerospace programs with listings on specifications such as BMS9-8, BMS9-17, 5PTMCT01, LMACT01, etc. and are available with our enhanced surface treatments such as PrimeTex™ ZB.

Our Specialty Reinforcements product line includes a number of different technologies that produce an endless variety of carbon-reinforced designs for preform products and your composite needs. (See “Specialty Reinforcements Materials” in this section)

Hexcel’s staff, with expertise in the areas of textile development, finishing technology, resin chemistry, composite technology, and applications engineering, is readily available to investigate development requirements for engineered fabrics, coated fabrics, and specialty composite-reinforced structures.

Often a process is limited by the use of “off-the-shelf” textile reinforcements. Hexcel offers the development consultation services required to best tailor the textile component to the final product. Throughout Hexcel’s history our product development staff has worked closely with our customers to create innovative solutions to unique requirements. For Technical questions, dial (830) 401-8180.

CARBON FABRICS NOMENCLATURE

Carbon fabrics from Hexcel have a specific nomenclature which enables us to know the fiber used and the weave style as well as any tracers, tracer fiber and the tracer spacing if in the fabric. This nomenclature is referred to as the “description” on our fabric label that is placed on each box of carbon fabric. Here are some examples of the nomenclature for the US and Europe:

US EXAMPLES:

SGP203CSDL means:
S = IM7 Type Fabric
GP = GP sizing
203 = 203 gsm fabric
CS = Crowfoot Satin (4 Harness Satin Weave)
D = SCG 75 1/0 0.7z 933
L = Tracer yarn every 12” in warp, 6” in fill

F3B282(GP) means:
F = Fabric
3B = 3K AS4C
28 2= Style 282 (193 gsm)
(GP) = GP sizing
(This style has no tracers)

AGP280-5HAB means:
A = AS4 Type Fabric
GP = GP sizing
280 = 280 gsm fabric
5H = 5 Harness Satin Weave
A =195d. 1.7s t.965 Kevlar®
B = Tracer yarn every 3” in warp, none in fill

EUROPEAN EXAMPLES:

48193S-P means:
4 = Carbon
8 = 12K
193 = Weight of fabric in gsm
S = 12K AS4CGP FLAT TOW
P = Plain

48370S-2T means:
4 = Carbon
8 = 12K
370 = Weight of fabric in gsm
S = 12K AS4CGP FLAT TOW
2T = 2/2 Twill

43193 S 1070 TCT means:
4 = Carbon
3 = 3K
193 = Weight of fabric in gsm
S = 3K AS4 GP
1070 = 1070mm width
T = Tracers
C = Tracers in warp
T = Tracers in fill

PAN Carbon Fibers Data

Producer	Fiber Name	Availability (filaments/tow)	Tensile Strength (ksi)	Tensile Modulus (msi)	Elongation (%)	Density (g/c3)
Hexcel	AS2C	3K	644	32.0	1.90	1.80
	AS4	3K, 6K, 12K	647/626/649	33.5	1.80	1.78/1.78/1.79
	AS4C	3K, 6K, 12K	647/626/634	33.5	1.80	1.78
	AS4D	12K	689	35.5	1.80	1.79
	AS7	12K	700	35.0	1.80	1.79
	IM6	12K	833	40.5	1.90	1.76
	IM7	6K, 12K	770/822	40.0	1.80/1.90	1.78
	IM8	12K	885	44.0	1.80	1.78
	IM9	12K	890	44.0	1.90	1.80
	IM10	12K	1010	44.0	2.10	1.79
Cytec	T300	1K, 3K, 6K, 12K	545	33.5	1.60	1.76
	T650/35	3K, 6K, 12K	620	37.0	1.70	1.76

Toray	T300	1K, 3K, 6K, 12K	512	33.4	1.50	1.76
	T700	6K, 12K, 24K	711	33.4	2.10	1.80
	T800	6K, 12K	796	42.6	1.90	1.81
Toho Tenax	HTA40	3K H13/E13	580/575	34.5/34.6	1.69/1.57	1.77
	HTA40	6K H13/E13	575/555	34.5/34.6	1.67/1.74	1.77
	HTA40	12K H13/E13	575/575	34.5/34.3	1.65/1.65	1.77
	UTS50	12K E13/F13	705/705	35.2/35.2	2.00/2.00	1.79
	UTS50	24K	735	35.3	2.09	1.79
	IMS60	24K	825	42.0	1.97	1.79
	HMA35	12K	465	51.2	0.91	1.77
	HTS40	3K	610	34.3	1.78	1.77
	HTS40	6K	630	34.3	1.82	1.77
	HTS40	12K	620	34.3	1.80	1.77
	STS40	24K	615	35.1	1.75	1.77
Tairyfil	TC-35	12K	580	35.0	1.60	1.80

Actual values may vary. For additional information, please contact a Technical Service Representative at (830) 401-8180.

PRIMETEX™ ZB FABRICS

In many end products it is desirable to have a lower crimp fabric to reduce resin rich areas. Hexcel's PrimeTex™ ZB finishing process for carbon fabrics will give you a more uniform spread where the filaments in each tow are spread out creating a thinner and more closed fabric that can give you better mechanicals and less porosity in a composite as well as a uniform cosmetic appearance. PrimeTex™ ZB can also be used to lower the mass in a composite where lighter weight is the key characteristic. We have the capability to provide this technology from both our US and European facilities.

To understand the PrimeTex™ ZB process, the following chart will show the same style woven with a variety of fibers, the fabric closure as it comes off the loom, and the fabric closure after going through the PrimeTex™ ZB process:

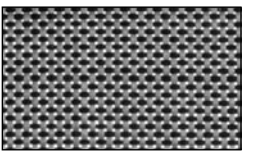
PrimeTex™ 200 GSM
3K Plain Weave Closure Comparison

Designation	Fiber	Loom-Fabric Closure	After Spreading-Fabric Closure
43199 9 1250	Grafil TR30S 3K A	90.0%	<99%
43199 UB 1250	HexTow® AS2 J 3K HS CP3000	92.5%	<99%
43199 UE 1250	HexTow® AS4C GP 3K HS CP3000	90.7%	<99%
43199 SB 1250	HexTow® AS4C GP 3K HS CP4000	90.7%	<99%
43199 D 1250	Tenax E HTA40 E13 3K	91.5%	<99%
43199 DA 1250	Tenax E HTA40 E13 3K	91.5%	<99%
43199 K 1250	Thornel T650/35 3K UC309 GV2	89.5%	<99%
43199 B 1250	Torayca FT300B 3k 40B	93.0%	<99%
43199 6 1250	Torayca T300B 3k 40B L2	93.0%	<99%

In addition to the chart above comparing the same style with different fibers, here are some examples of the various fabrics before and after the PrimeTex™ ZB process:

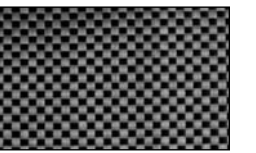
200 GSM Plain Weave AS2C J 3K CP3000

Before PrimeTex™ ZB



HexForce® 43199
UB 1250-92.5% Closure

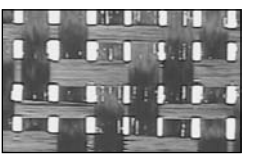
After PrimeTex™ ZB



PrimeTex™ 43199
UB 1250 ST- 99.5% Closure

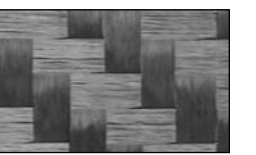
193 GSM, 2/2 Twill T700 12K

Before PrimeTex™ ZB



HexForce® 48194
C 1270-<95% Closure

After PrimeTex™ ZB



PrimeTex™ 48194
C 1270 ST->99.7% Closure

Hexcel has established the PrimeTex™ ZB process on several fabrics in both the US and Europe. On the following pages are products that the US and Europe currently offer with this process. This is not a complete listing so please contact a Technical Service Representative at (830) 401-8180 if you need information on a style that is not listed here.

PrimeTex™ ZB Fabric Construction

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd^2)	Fabric Weight (g/m^2)
262	Plain	12	8	3K Carbon, 33MSI	3K Carbon, 33MSI	4.78	162
282	Plain	12	12	3K Carbon, 33MSI	3K Carbon, 33MSI	5.78	196
284	2/2 Twill	12	12	3K Carbon, 33MSI	3K Carbon, 33MSI	5.78	196
286	4H Satin	12	12	3K Carbon, 33MSI	3K Carbon, 33MSI	5.78	196
43161	Plain	10	10	3K Carbon, 33MSI	3K Carbon, 33MSI	4.72	160
43162	2/2 Twill	10	10	3K Carbon, 33MSI	3K Carbon, 33MSI	4.72	160
43199	Plain	12.7	12.7	3K Carbon, 33MSI	3K Carbon, 33MSI	5.90	200
43200	2/2 Twill	12.7	12.7	3K Carbon, 33MSI	3K Carbon, 33MSI	5.90	200
46193	Plain	11	11	6K Carbon, 40 MSI	6K Carbon, 40 MSI	5.78	196
48192	Plain	3	3	12KCarbon, 33MSI	12KCarbon, 33MSI	5.70	193
48193	Plain	3	3	12KCarbon, 33MSI	12KCarbon, 33MSI	5.70	193
48194	2/2 Twill	3	3	12KCarbon, 33MSI	12KCarbon, 33MSI	5.70	193

48280	Plain	4	4	12KCarbon, 33MSI	12KCarbon, 33MSI	8.26	280
48286	2/2 Twill	4.5	4.5	12KCarbon, 33MSI	12KCarbon, 33MSI	8.4	285
48350	Plain	5	5	12KCarbon, 33MSI	12KCarbon, 33MSI	10.20	346
48370	2/2 Twill	6	6	12KCarbon, 33MSI	12KCarbon, 33MSI	10.90	370
48400	Plain	6.3	6.3	12KCarbon, 33MSI	12KCarbon, 33MSI	11.80	400
AGP280-5H	5H Satin	17	17	AS4GP 3K	AS4GP 3K	8.26	280
AH280-5H	5H Satin	17	17	AS4H 3K	AS4H 3K	8.28	281
AGP370-2T	2/2 Twill	11	11	AS4GP 6K	AS4GP 6K	10.96	372
AGP370-5H	5H Satin	11	11	AS4GP 6K	AS4GP 6K	10.90	370
AH370-5H	5H Satin	11	11	AS4H 6K	AS4H 6K	10.90	370
TGP196-P	Plain	7.5	7.5	IM10 12K	IM10 12K	5.78	196

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

FDS (FABRIC DE-SIZE)

Carbon fibers are typically produced with a sizing (binder) on them which aids in processing the fibers later with less broken filaments. In some markets and for some resin systems, it is preferred not to have this chemistry on the carbon fiber surface. Hexcel has developed a proprietary de-sizing process to remove this chemical from the carbon fiber surface. Below are products we currently offer with this process. This is not a complete listing so please contact a Technical Service Representative at (830) 401-8180 if you need information on a style that is not listed here.

FDS Fabric Construction

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd^2)	Fabric Weight (g/m^2)
284(E)	2/2 Twill	12.5	12.5	AS2CJ 3K	AS2CJ 3K	5.76	195
ACGP370-8H	8H Satin	24	23	AS4CGP 3K	AS4CGP 3K	10.86	368
AGP280-5H	5H Satin	17	17	AS4GP 3K	AS4GP 3K	8.26	280
AGP370-2T	2/2 Twill	11	11	AS4GP 6K	AS4GP 6K	10.96	372
AH280-5H	5H Satin	17	17	AS4H 6K	AS4H 6K	8.28	281
F3B282(GP)	Plain	12.5	12.5	AS4CGP 3K	AS4CGP 3K	5.72	194
F4G584	8H Satin	24	24	T650 3K	T650 3K	10.88	369
SGP370-8H	8H Satin	21	21	IM7GP 6K	IM7GP 6K	10.90	370

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Carbon Fabric Construction Data-Hexcel Fibers

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd²)	Fabric Weight (g/m²)	Common Style
262(E)	4H Satin	12.5	8	AS2CGP or J 3K	AS2CGP or J 3K	4.78	162	✔
282(E)	Plain	12.5	12.5	AS2CGP or J 3K	AS2CGP or J 3K	5.76	195	✔
284(E)	2/2 Twill	12.5	12.5	AS2CJ 3K	AS2CJ 3K	5.76	195	✔
286(E)	4H Satin	12.5	12.5	AS2CJ 3K	AS2CJ 3K	5.72	194	✔
ACGP193-P	Plain	12.5	12.5	AS4CGP 3K	AS4CGP 3K	5.72	194	
ACGP196-P	Plain	12.5	12.5	AS4CGP 3K	AS4CGP 3K	5.78	196	
ACGP205-2T	2/2 Twill	13	13	AS4CGP 3K	AS4CGP 3K	6.04	205	
ACGP205-P	Plain	13	13	AS4CGP 3K	AS4CGP 3K	6.04	205	
ACGP206-P	Plain	13	13	AS4CGP 3K	AS4CGP 3K	6.04	205	✔
ACGP280-5H	5H Satin	18	18	AS4CGP 3K	AS4CGP 3K	8.30	281	
ACGP350-5H	5H Satin	11	11	AS4CGP 3K	AS4CGP 3K	10.32	350	✔
ACGP370-2T	2/2 Twill	24?	23?	AS4CGP 3K	AS4CGP 3K	10.88	369	

ACGP370-8H	8H Satin	24	23	AS4CGP 3K	AS4CGP 3K	10.86	368	✔
ACJ193-P	Plain	12.5	12.5	AS4CJ 3K	AS4CJ 3K	5.74	195	
AGP185-CS	4H Satin	11	11	AS4GP 3K	AS4GP 3K	5.46	185	✔
AGP185-P	Plain	11	11	AS4GP 3K	AS4GP 3K	5.46	185	
AGP193-P	Plain	11.5	11.5	AS4GP 3K	AS4GP 3K	5.66	192	✔
AGP195-CS	4H Satin	11.5	11.5	AS4GP 3K	AS4GP 3K	5.70	193	✔
AGP280-5H	5H Satin	17	17	AS4GP 3K	AS4GP 3K	8.26	280	✔
AGP370-2T	2/2 Twill	11	11	AS4GP 6K	AS4GP 6K	10.96	372	
AGP370-5H	5H Satin	11	11	AS4GP 6K	AS4GP 6K	10.90	370	✔
AGP370-8H	8H Satin	22	23	AS4GP 3K	AS4GP 3K	10.88	369	✔
AGP380-5H	5H Satin	11.3	11.3	AS4GP 6K	AS4GP 6K	11.20	380	
AGP790-3T	3/1 Twill	17	12	AS4GP	AS4GP	23.14	785	
AH280-5H	5H Satin	17	17	AS4H 6K	AS4H 6K	8.28	281	✔
AH370-5H	5H Satin	11	11	AS4H 6K	AS4H 6K	10.90	370	✔

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Carbon Fabric Construction Data-Hexcel Fibers (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd²)	Fabric Weight (g/m²)	Common Style
F3A282	Plain	11.5	11.5	AS4GP 3K	AS4GP 3k	5.70	193	
F3A286	4H Satin	11.5	11.5	AS4GP 3K	AS4GP 3K	5.64	191	
F3B262(GP)	Plain	12.5	8	AS4CGP 3K	AS4CGP 3K	4.72	160	✔
F3B262(J)	Plain	12.5	8	AS4CJ 3K	AS4CJ 3K	4.72	160	
F3B282(GP)	Plain	12.5	12.5	AS4CGP 3K	AS4CGP 3K	5.72	194	✔
F3B282(J)	Plain	12.5	12.5	AS4CJ 3K	AS4CJ 3K	5.72	194	
F3B284(GP)	2/2 Twill	12.5	12.5	AS4CGP 3K	AS4CGP 3K	5.76	195	
F3B284(J)	2/2 Twill	12.5	12.5	AS4CJ 3K	AS4CJ 3K	5.76	195	
F3B286(GP)	4H Satin	12.5	12.5	AS4CGP 3K	AS4CGP 3K	5.70	193	
F3B286(J)	4H Satin	12.5	12.5	AS4CGP 3K	AS4CGP 3K	5.70	193	
F4M282	Plain	12.5	12.5	IM7GP 6K	IM7GP 6K	5.80	197	
F4M466	5H Satin	16	16	IM7GP 6K	IM7GP 6K	8.40	285	

F6B613(GP)	5H Satin	12	12	AS4CGP 6K	AS4CGP 6K	11.26	382	
HGP196-P	Plain	11	11	IM8GP 6K	IM8GP 6K	5.72	194	
SGP145-P	Plain	8	8	IM7GP 6K	IM7GP 6K	4.26	144	
SGP193-P	Plain	11	11	IM7GP 6K	IM7GP 6K	5.70	193	✔
SGP196-P	Plain	11	11	IM7GP 6K	IM7GP 6K	5.78	196	✔
SGP203-CS	4H Satin	11.5	11.5	IM7GP 6K	IM7GP 6K	6.02	204	✔
SGP273-5H	5H Satin	15.5	15.5	IM7GP 6K	IM7GP 6K	8.00	271	
SGP275-5H	5H Satin	8	8	IM7GP	IM7GP	8.08	274	
SGP280-5H	5H Satin	16	16	IM7GP 6K	IM7GP 6K	8.26	280	
SGP315-5H	5H Satin	9	9	IM7GP	IM7GP	9.26	314	
SGP370-8H	8H Satin	21	21	IM7GP 6K	IM7GP 6K	10.90	370	✔
TGP196-P	Plain	7.5	7.5	IM10GP 12K	IM10GP 12K		0	
XAGP280-5H	±45° 5H Satin	34	34	AS4GP 3K	AS4GP 3K	8.38	284	
XC1400	±45° 4H Satin	12	12	IM7GP 6K	IM7GP 6K	6.02	204	✔
XSGP196-P	±45° Plain	22.5	22.5	IM7GP 6K	IM7GP 6K	5.88	199	

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Aerospace Carbon Fabric Construction Data

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd²)	Fabric Weight (g/m²)	Common Style
F3C282	Plain	12.5	12.5	HTA40 3K	HTA40 3K	5.76	195	
F3G282	Plain	12.5	12.5	T300 3K	T300 3K	5.70	193	
F3GR282	Plain	12.5	12.5	T300 3K	T300 3K	5.66	192	✔
F3T282	Plain	12.5	12.5	T300 3K	T300 3K	5.70	193	✔
F4G282	Plain	12.5	12.5	T650 3K	T650 3K	5.70	193	✔
F3C433	5H Satin	18	18	HTA40 3K	HTA40 3K	8.30	281	✔
F4G433	5H Satin	18	18	T650 3K	T650 3K	8.40	285	
F3C584	8H Satin	24	24	HTA40 3K	HTA40 3K	10.80	366	✔
F3G584	8H Satin	24	24	T300 3K	T300 3K	10.74	364	
F3GR584	8H Satin	24	24	T300 3K	T300 3K	10.72	363	✔
F3T584	8H Satin	24	24	T300 3K	T300 3K	10.76	365	
F4G584	8H Satin	24	24	T650 3K	T650 3K	10.88	369	

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Commercial Carbon Fabric Construction Data

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd²)	Fabric Weight (g/m²)	Common Style
84	Plain	16	16	1K Carbon, 33MSI	1K Carbon, 33MSI	2.48	84	
130	Plain	24	24	1K Carbon, 33MSI	1K Carbon, 33MSI	3.74	127	
160	Plain	12	12	3K Carbon, 33MSI	1K Carbon, 33MSI	3.92	133	✔
262	Plain	12	8	3K Carbon, 33MSI	3K Carbon, 33MSI	4.78	162	✔
282	Plain	12	12	3K Carbon, 33MSI	3K Carbon, 33MSI	5.78	196	✔
284	2/2 Twill	12	12	3K Carbon, 33MSI	3K Carbon, 33MSI	5.78	196	✔
286	4H Satin	12	12	3K Carbon, 33MSI	3K Carbon, 33MSI	5.78	196	✔
433	5H Satin	18	18	3K Carbon, 33MSI	3K Carbon, 33MSI	8.40	285	
444	2/2 Twill	18	18	3K Carbon, 33MSI	3K Carbon, 33MSI	8.40	285	
463	2/2 Twill	9	9	6K Carbon, 33MSI	6K Carbon, 33MSI	8.40	285	
584	8H Satin	24	24	3K Carbon, 33MSI	3K Carbon, 33MSI	11.00	373	✔

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Commercial Carbon Fabric Construction Data (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd^2)	Fabric Weight (g/m^2)	Common Style
613	5H Satin	12	12	6K Carbon, 33MSI	6K Carbon, 33MSI	11.10	376	
670	2/2 Twill	11	11	12K Carbon, 33MSI	12K Carbon, 33MSI	19.80	671	✔
690	Basket 2X2	10	10	12K Carbon, 33MSI	12K Carbon, 33MSI	18.70	634	
48193	Plain	3	3	12KCarbon, 33MSI	12KCarbon, 33MSI	5.70	193	✔
48280	Plain	4	4	12KCarbon, 33MSI	12KCarbon, 33MSI	8.26	280	
48350	Plain	5	5	12KCarbon, 33MSI	12KCarbon, 33MSI	10.20	346	
48370	2/2 Twill	6	6	12KCarbon, 33MSI	12KCarbon, 33MSI	10.90	370	✔

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Heatset Uni Construction Data

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd²)	Fabric Weight (g/m²)	Common Style
GA030	Plain Heatset	13	4	3K Carbon, 33MSI	Proprietary	3.13	106	
GA045	Plain Heatset	10	4	6K Carbon, 33MSI	Proprietary	4.61	156	
GA060	Plain Heatset	7	4	12K Carbon, 33MSI	Proprietary	6.66	226	✔
GA080	Plain Heatset	8	4	12K Carbon, 33MSI	Proprietary	7.90	268	
GA090	Plain Heatset	10	4	12K Carbon, 33MSI	Proprietary	9.10	309	✔
GA120	Plain Heatset	13	4	12K Carbon, 33MSI	Proprietary	13.20	448	
GA130	Plain Heatset	14	4	12K Carbon, 33MSI	Proprietary	14.16	480	✔
GA132	Plain Heatset	14	2	12K Carbon, 33MSI	Proprietary	14.15	480	
GA140	Plain Heatset	14	4	12K Carbon, 33MSI	Proprietary	13.40	454	
GA160	Plain Heatset	16	4	12K Carbon, 33MSI	Proprietary	15.70	532	
GA180	Plain Heatset	19	4	12K Carbon, 33MSI	Proprietary	17.70	600	

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Heatset Uni Construction Data (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd²)	Fabric Weight (g/m²)	Common Style
SA047	Plain Heatset	10	4	SCG 1250 Roving 463	Proprietary	4.82	163	
SA060	Plain Heatset	13	4	SCG 1250 Roving 463	Proprietary	6.60	224	
SA083	Plain Heatset	11	4	SCG 750 Roving 463	Proprietary	8.50	288	
SA120	Plain Heatset	16	4	SCG 750 Roving 463	Proprietary	12.81	434	
KA060	Plain Heatset	20	4	HM Aramid 2160 Denier	Proprietary	6.18	210	
KA090	Plain Heatset	10	4	HM Aramid 8050 dtex	Proprietary	9.10	309	

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

SPECIALTY AND HYBRID COMPOSITE REINFORCEMENTS

SPECIALTY AND HYBRID REINFORCEMENT MATERIALS

NC2-Advanced Non-Crimp Fabric: Patented multi-axial material with potential advantages and capabilities: use large tow fibers, lower aerial weight plys (even with large tow fibers), and binder application to individual plys. Available for non-aerospace applications.

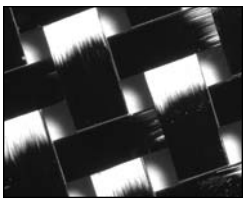
- Rolls up to 100 inches wide
- 2-4 Plys (angles 0° and between 45° and 90°)
- Ply aerial weights down to 100 gsm
- Stitch pattern variability

Tackified (powdered) Fabrics: Binder is applied to fabric to aid in the infusion process. It is generally applied at 2.5 percent on either one side or both sides of the fabric.

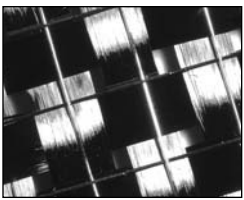
Dry Uni-Directional Material: Dry UD products are suitable for many applications including preform construction. Various processes are used to hold the fibers in place depending on the applications and requirements.

LIGHTNING STRIKE FABRICS

Hexcel has carbon fabrics with interwoven wires for lightning strike applications where both structural integrity and lightning protection are required in a single ply. Standard plain weave designs are available (IWWF) where the wire is woven inside the weave next to an adjacent carbon tow, as well as the more elaborate pattern designs like our patent pending “double weave”, where the woven wire is 92 percent on the surface of the carbon weave.



Plain Weave
70 g wire interwoven
193 g 6K fabric



92% of wire positioned
on top of carbon

Lightning Strike Fabrics

Style	Weave	Warp Yarn(1)	Warp Yarn(2)	Fill Yarn(1)	Fill Yarn (2)	Construction	Total Fabric Weight
AGP193PBLS	Plain	AS4GP 3K	Phos/Bnz	AS4GP 3K	Phos/Bnz	11.5:11.5 X 11.5:11.5	261 g/m^2
XLS9103	Plain	IM7GP 6K	Phos/Bnz	IM7GP 6K	Phos/Bnz	11.2:11.2 x 11.2:11.2	260 g/m^2
XLS9104	Dbl Plain	IM7GP 6K	Phos/Bnz	IM7GP 6K	Phos/Bnz	11.2:11.2 x 11.2:11.2	260 g/m^2
XLS9123	Plain	AS4GP 3K	Phos/Bnz	AS4GP 3K	Phos/Bnz	11.5:11.5 x 11.5:11.5	260 g/m^2

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Hybrid Composite Fabrics

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd^2)	Fabric Weight (g/m^2)	Common Style
716	Plain	16	16	3K Carbon, 33 MSI	ECG 75 1/0	4.99	169	✓
717	Plain	16	16	3K Carbon, 33 MSI	SCG 75 1/0	4.99	169	
790	Plain	12.5	13	3K Carbon, 33 MSI	Kevlar® 49, 2160 d.	6.70	227	
1168	2/2 Twill	7.25 7.25	7.25 7.25	3K Carbon, 33 MSI Kevlar® 49, 2160 d.	3K Carbon, 33 MSI Kevlar® 49, 2160 d	7.44	252	
1119	Plain	20 4	22	SCG 150 1/2 1K Carbon, 33MSI	SCG 150 1/2	3.70	125	
1320	Modified Plain	12.5 6.25	25	ECG 37 1/0x2 3K Carbon, 33 MSI	ECG 37 1/0x2	7.30	248	

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Specialty Fabrics

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Fabric Weight (oz/yd^2)	Fabric Weight (g/m^2)	Thickness (mils)	Thickness (mm)	Common Style
TEF7	5 H Stain	32	30	Thorstrand + ECG 150 1/0	Thorstrand + ECG 450 1/0	8.57	291	11.4	0.29	✓
1B301 F48	4 H Satin	54	50	ECG 75 1/0	ECG 150 1/2	8.38	283	9.0	0.23	

Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

FIBER GLASS FABRICS

PHYSICAL PROPERTIES OF FIBER GLASS

The versatility of glass as a fiber makes it a unique industrial textile material. Fiber glass in fabric form offers an excellent combination of properties from high strength to fire resistance. Wide ranges of yarn sizes and weave patterns provide unlimited design potential, allowing the end user to choose the best combination of material performance, economics and product flexibility.

Dimensional Stability
Fiber glass is a dimensionally stable engineering material. Fiber glass does not stretch or shrink after exposure to extremely high or low temperature. The maximum elongation for "E" glass at break is 4.8 percent with a 100 percent elastic recovery when stressed close to its point of rupture.

Moisture Resistance
Glass fibers do not absorb moisture, and do not change physically or chemically when exposed to water.

High Strength
The high strength-to-weight ratio of fiber glass makes it a superior material in applications where high strength and minimum weight are required. In textile form, this strength can be unidirectional or bidirectional, allowing flexibility in design and cost.

Fire Resistance
Fiber glass is an inorganic material and will not burn or support combustion. It retains approximately 25 percent of its initial strength at 1,000ºF.

Chemical Resistance
Most chemicals have little or no effect on glass fiber. The inorganic glass textile fibers will not mildew, rot or deteriorate. Glass fibers are affected by hydrofluoric, hot phosphoric acids and strong alkaline substances.

Electrical Properties
Fiber glass is an excellent material for electrical insulation. The combination of properties such as low moisture absorption, high strength, heat resistance and low dielectric constant makes fiber glass fabrics ideal as a reinforcement for printed circuit boards and insulating varnishes.

Thermal Conductivity
A low coefficient of thermal expansion combined with high thermal conductivity properties make glass fabrics a dimensionally stable material that rapidly dissipates heat as compared to asbestos and organic fibers.

INDUSTRIAL APPLICATIONS FOR FIBER GLASS FABRIC

Fiber glass fabrics are used in a wide range of industrial applications. High strength, dimensional stability, design flexibility and excellent electrical properties are some of the characteristics that ensure optimum performance and economy with this highly engineered material.

Reinforced Plastics

Fiber glass fabrics used as reinforcement for plastics have replaced traditional materials such as wood, steel, and aluminum in a vast array of products. The inherent strength, light weight, dimensional stability and low tooling costs derived from fiber glass reinforced plastics help make many products more durable, attractive and maintenance free.

Electrical

Fiber glass fabrics offer outstanding performance to the electrical industry. High strength, dimensional stability, temperature resistance and excellent electrical properties provide the basis for use as the prime reinforcement in high pressure laminates for printed circuit boards. Fiber glass fabrics coated with chemistry such as epoxy, silicone, rubber, Teflon® and neoprene, as well as reinforcing mica products, provide the long term durability and reliability needed in insulating high voltage generators, transformers, switches and cables.

Coated and Laminated Fabrics
High strength, dimensional stability, fire resistance and low cost are some of the advantages of using fiber glass fabrics to reinforce foils, plastic film and coatings. Protective covers, vapor barriers, window shades, movie screens, packaging tapes, awnings, protective clothing, gaskets, wall covering and conveyor belts are just some of the products that are improved through the use of fiber glass fabrics.

Thermal Insulation
Strength retention at high temperatures, corrosion and fire resistance, and ease of handling make fiber glass fabrics an important material for thermal insulation. Both the U.S. Navy and commercial shipyards use fiber glass fabrics almost exclusively as pipe lagging and for thermal pad covers.

Construction
From pipe wrap to wallboard seaming tape, fiber glass fabrics can be found throughout the construction industry. Fiber glass scrim is used to reinforce paper and film for insulation facings and to provide dimensional stability to asphalt used on roofing, roadways and bridge decks. Fabric structures such as tennis courts, sports centers and football stadiums use coated fiber glass fabrics as an economical way to encapsulate space.

FIBER GLASS YARN NOMENCLATURE

The wide variety of fiber glass yarns produced requires a special system of nomenclature for identification. This nomenclature consists of two parts—one alphabetical and one numerical. In addition, although the final result is the same, there are differences between the customary U.S. Systems and the TEX/Metric System.

U.S. System
Example: ECG 150-1/2

A. First Letter - "E" characterizes the glass composition (see Table I).

B. Second Letter - "C" indicates the yarn is composed of continuous filaments. "S" indicates staple filament. "T" indicates texturized continuous filaments.

C. Third Letter - Denotes the individual filament diameter: BC, D, DE, E, G, H, K (see Table II).

D. First Number - Represents 1/100 the normal bare glass yardage in one pound of the basic yarn strand. In the above example, multiply 150 by 100 which results in 15,000 yards in one pound (see Table II).

E. Second Number - Represents the number of basic strands in the yarn. The first digit represents the original number of twisted strands. The second digit separated by the diagonal represents the number of strands plied (or twisted) together. To find the total number of strands used in a yarn, multiply the first digit by the second digit (a zero is always multiplied as 1).

TEX/Metric System

Example: EC9 33 1X2

A. First Letter - "E" characterizes the glass composition (see Table I).

B. Second Letter - "C" indicates continuous filament. "T" indicates textured continuous filament. "D" indicates staple filament.

C. First Number - Denotes the individual filament diameter (see Table II) expressed in micrometers (microns).

D. Second Number - Represents the non-linear weight of the bare glass strand expressed in TEX. TEX is the mass in grams per 1,000 meters of yarn (see Table II).

E. Third Number - Indicates yarn construction or the basic number of strands in the yarn. The first digit represents the original number of twisted strands and the second digit after the "X" indicates the number of these strands twisted or plied together.

TABLE I
Glass Composition–By Weight

Composition	E Glass	S-2 Glass®
Silicon Dioxide	52-56%	64-66
Calcium Oxide	16-25%	
Aluminum Oxide	12-16%	24-26%
Boron Oxide	8-13%	
Sodium & Potassium Oxide	0-1%	
Magnesium Oxide	0-6%	9-11%

Fiber glass yarns are available in different formulations. "E" glass (electrical) is the most common all-purpose glass, while "S" Glass® (high strength) is used for special applications.

TABLE II
Basic Glass Yarn Stands

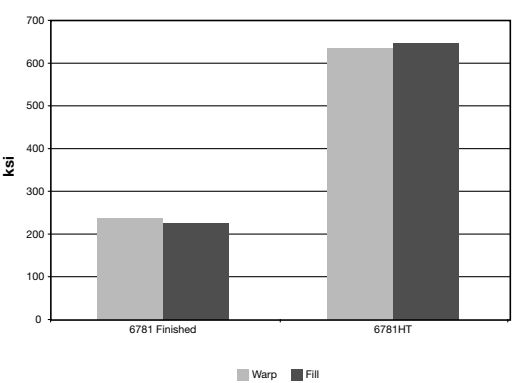
Filament Diameter			Strand Weight		
	U.S. Designation (inches)	Metric (microns)	U.S. x100= yd/lb	Designated TEX	Number of Filaments
BC	0.00017	4	150	33	1064
D	0.00023	5	1800	2.75	51
			900	5.5	102
			450	11	204
			225	22	408
DE	0.00025	6	300	16.5	204
			150	33	408
			100	50	612
			75	66	816
			50	99	1224
			37	134	1632
E	0.00029	7	225	22	204
			110	45	408
G	0.00036	9	150	33	204
			75	66	408
			50	99	612
			37	134	816
H	0.00043	10	25	198	816
K	0.00051	13	18	275	816

ULTRA HIGH PERFORMANCE GLASS PRODUCTS

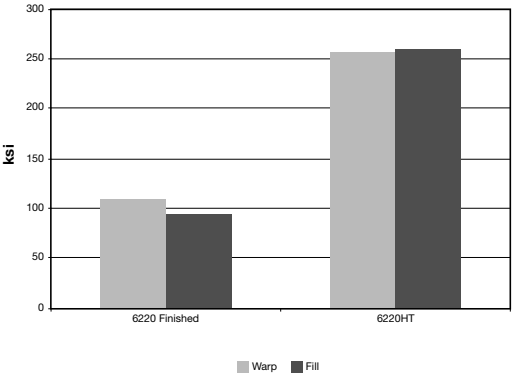
The HT fabrics are fashioned after the standard, high volume E-Glass aerospace 7781 and 120 styles. Complimenting these styles in fabric areal weight and weave pattern, **6781HT** and **6220HT** have similar characteristics in fabric hand, flexibility, weight, and thickness, but with the added benefit of superior impact resistance, tensile strength, and bond integrity using S-2 Glass® fiber.

The dry fabric tensile strength for HT fabrics is dramatically higher than typical S-2 Glass® fabrics made with standard starch oil sizing. Starch oil size fabrics require heat cleaning prior to finishing, significantly reducing fiber tensile strength. The HT fabrics have a simple yet effective organic sizing compatible with high temperature Epoxy, BMI, Phenolics, Cynate Esters, Thermoplastics, Polyamide, Polyimide, PEI, PEEK, PAI, LCP and others.

S-2 Glass® 6781 Dry Fabric Tensile Strength Comparison



S-2 Glass® 6220 Dry Fabric Tensile Strength Comparison



SURFBOARD AND RECREATION

Hexcel offers a variety of styles and finishes that should work in the surfboard and recreation markets for any of your needs.

We have developed a new finish with the ultimate product performance which provides the clarity necessary for colors with the softness to match our F81. Due to the finish attributes, we have named this “CLEAR”.

Finishes for surfboard and recreation markets:

CLEAR	Excellent clarity and softness for colors that “pop” and good lamination properties.
RWG	Resin compatible binder for polyester applications. Provides strength.
F16	Provides the green color for the retro board look.
F81	Standard surfboard finish.

Styles for surfboard and recreation markets:

1522	4 oz E-Glass
1579	4 oz Warp E-Glass
7533	6 oz E-Glass
7580	6 oz Warp E-Glass
7532	7.5 oz for Fins
1522RWG	4 oz Direct E-Glass
7533RWG	6 oz Direct E-Glass
4522	4 oz S-Glass
4579	4 oz Warp S-Glass
4533	6 oz S-Glass
4985	5 oz S-Glass

FIBER GLASS FABRIC FINISHES

Fiber Glass Fabrics are available with a variety of finishes and treatments.

Greige: Loom state fabric that includes the organic binders and size applied to the yarn prior to weaving.

Finished: Fully heat cleaned fabric treated with the coupling agent which provides a chemical bond between the fiber glass surface and various matrix resins.

The following finish charts offer recommended Hexcel finishes based on compatibility with resin systems and include special finish processes.

Hexcel Fiber Glass Finishes

Hexcel Finish	Recommended Matrix Resin(s)	Possible Matrix Resin(s)	Performance Features
F69	Epoxy Polyester		Silane finish for epoxy composites resins **BMS 9-3 Qualified**
F81	Epoxy Polyester Vinyl Ester Urethane Cyanate Ester	BMI Phenolic	Multifunctional silane for use with all major resin systems. Excellent wetting characteristics. Surfboard finish.
Z-6040/F46	Epoxy	Phenolic	Silane finish compatible with epoxy resins.
CS-767	Epoxy Polyimide Urethane Vinyl Ester	Cyanate Ester Polyester	Multifunctional silane for use with all major resin systems. Excellent wetting characteristics.
CS-724	Epoxy		Specially developed finish for structural composites. **BMS 9-3 Qualified**
CS-310	Epoxy		Silane finish **BMS 9-3 Qualified**
CS-550/Volan	Polyester Epoxy Phenolic	Vinyl Ester	Volan/Silane finish for structural polyester/vinyl ester and phenolic resins. Fabric will have a green tint from the Volan. **Volan is BMS 9-3 Qualified**
F50	Polyester Epoxy	Vinyl Ester Cyanate Ester Phenolic	Volan/Silane finish. Fabric will have green tint from the Volan. **BMS 9-3 Qualified**

Hexcel Fiber Glass Finishes (continued)

Hexcel Finish	Recommended Matrix Resin(s)	Possible Matrix Resin(s)	Performance Features
F3/F16	Polyester Vinyl Ester	Epoxy Phenolic	Volan finish compatible with structural epoxy, polyester/vinyl ester and phenolic resins. Fabric will have green tint from the Volan. **F3 is BMS 9-3 Qualified**
F43	Polyester	Vinyl Ester	Silane finish compatible with polyester and vinyl ester resin systems. Very good clarity
F72	Polyester		Silane finish
A1100/F40	Phenolic Acrylic	Urethane Epoxy	Silane Finish recommended for phenolic resins
A1100S	Phenolic	Urethane Epoxy	A1100 finish with soft hand
CS-4667	Phenolic		Silane finish for phenolic applications
F48	Silicone		Silicone high temperature release finish, applied to fabric style 1B301 only.
CLEAR	Polyester Epoxy		Surfboard finish with excellent clarity and wetting characteristics. Good fabric hand as well.

Other Finishes and Special Processes

Hexcel Finishes	Performance Features
Greige	Loom state fabric. No additional fabric finish processing. Used for coating applications.
F12	Heat cleaned fabric for silicone processes.
RWG	"Really White Glass"- surfboard fabric with resin compatible binder for polyester
"HT"	Direct size fabric that is very stable in high temperature applications and can be used in a wide variety of resins

FIBER GLASS FABRIC CONSTRUCTION DATA

Hexcel reserves the right to use equivalent yarns in fiber glass styles. The use of such yarns is designed to maintain the physical properties of the woven cloth. The values listed for weight, thickness, and breaking strengths are typical greige values, unless otherwise noted.

Fiber Glass Fabrics

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd^2)	Weight (g/m^2)	Thickness (mils)	Thickness (mm)	Strength (lbf/in)	Strength (lbf/in)	Common Style
101	Plain	75	75	ECD 1800 1/0	ECD 1800 1/0	0.49	17	0.78	0.02	39	37	
104	Plain	60	52	ECD 900 1/0	ECD 1800 1/0	0.57	19	1.0	0.03	68	59	
106	Plain	56	56	ECD 900 1/0	ECD 900 1/0	0.81	27	1.3	0.03	64	60	
108	Plain	60	47	ECD 900 1/2	ECD 900 1/2	1.42	48	2.2	0.06	89	64	✓
112	Plain	40	39	ECD 450 1/2	ECD 450 1/2	2.10	71	3.5	0.09	119	100	✓
116	Plain	60	58	ECD 450 1/2	ECD 450 1/2	3.12	106	3.9	0.10	177	148	✓
117	Plain	54	39	ECD 450 1/2	ECD 450 1/2	2.46	83	3.7	0.09	163	103	✓
120	4H Satin	60	58	ECD 450 1/2	ECD 450 1/2	3.14	106	3.9	0.10	177	150	✓
138	4H Satin	65	60	ECE 225 1/2	ECE 225 1/2	6.53	221	6.9	0.18	297	272	
162	Plain	28	16	ECE 225 2/5	ECE 225 2/5	12.00	407	13.8	0.35	650	400	
220	4H Satin	60	58	ECE 225 1/0	ECE 225 1/0	3.14	106	3.7	0.09	192	151	✓
232	4H Satin	48	30	ECG 37 1/0	ECG 75 1/2	12.75	432	14.0	0.36	550	450	

332	4H Satin	48	32	ECG 37 1/0	ECG 37 1/0	13.00	441	14.2	0.36	617	498	
333	4H Satin	48	32	ECDE 37 1/0	ECDE 37 1/0	13.00	441	14.0	0.36	600	425	
341	4H Satin	32	49	ECD 450 1/0	ECE 225 3/2	8.71	295	8.2	0.21	50	300	
403	4H Satin	54	50	ECG 75 1/0	ECG 150 1/2	8.40	285	8.9	0.23	440	350	
477	4H Satin	54	48	ECDE 150 1/0	ECDE 150 1/0	4.11	139	4.7	0.12	300	250	
520	Plain	18	17	ECG 75 1/3	ECG 75 1/3	8.70	295	9.1	0.23	330	310	
993	Plain	38	67	ECD 900 1/0	ECD 900 1/0	0.71	24	1.2	0.03	30	23	
1037	Plain	70	73	ECC 1200 1/0	ECC 1200 1/0	0.73	25	1.3	0.03	45	40	
1047	Plain	47	47	ECDE 100 1/0	ECDE 100 1/0	5.44	184	5.6	0.14	200	200	
1064	Plain	18	21	ECG 75 1/2	ECG 150 1/2	4.60	156	5.8	0.15	220	150	✓
1067	Plain	70	70	ECD 900 1/0	ECD 900 1/0	0.91	31	1.4	0.04	57	57	
1070	Plain	60	35	ECD 450 1/0	ECD 900 1/0	1.02	35	1.9	0.05	126	33	
1071	Plain	60	30	ECD 900 1/0	ECD 900 1/0	0.60	20	1.2	0.03	62	27	

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Fiber Glass Fabrics (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Strength (lbf/in)	Strength (lbf/in)	Common Style
1076	Plain	60	25	ECD 450 1/0	ECD 900 1/0	0.96	33	1.8	0.05	124	24	
1080	Plain	60	47	ECD 450 1/0	ECD 450 1/0	1.41	48	2.2	0.06	125	94	
1125	Plain	40	39	ECD 450 1/2	ECG 150 1/0	2.60	88	3.5	0.09	101	147	✓
1131	Plain	120	52	ECD 450 1/0	ECG 150 1/0	3.65	124	4.8	0.12	194	268	
1142	Plain	31	21	ECG 37 1/0	ECG 37 1/0	8.39	284	10.3	0.26	408	316	
1161	Plain	100	42	ECD 450 1/0	ECDE 100 1/0	3.86	131	5.0	0.13	154	346	
1165	Plain	60	52	ECD 450 1/2	ECG 150 1/0	3.66	124	4.1	0.10	165	268	
1167	Plain	60	55	ECD 450 1/2	ECG 150 1/0	3.79	129	4.2	0.11	163	265	
1188	4H Satin	47	30	ECH 25 1/0	ECG 150 1/0	12.02	408	11.8	0.30	750	130	
1280	Plain	60	60	ECD 450 1/0	ECD 450 1/0	1.65	56	2.2	0.06	128	116	
1297	Plain	50	20	ECD 450 1/0	ECD 900 1/0	0.79	27	2.0	0.05	112	33	
1299	Plain	50	20	ECD 450 1/0	ECD 450 1/0	0.92	31	2.0	0.05	101	40	

1311	Plain	32	21	ECE 225 3/2	ECE 225 3/2	8.49	288	9.7	0.25	471	335	
1500	Plain	49	42	ECE 110 1/0	ECE 110 1/0	4.89	166	5.3	0.13	227	234	
1501	Plain	46	45	ECE 110 1/0	ECE 110 1/0	4.95	168	5.3	0.13	220	220	
1507	Leno	20	10	ECG 75 1/3	ECG 37 1/3	10.10	342	19.7	0.50	300	310	
1520	Plain	24	20	ECG 150 1/2	ECG 75 1/0	3.51	119	4.3	0.11	152	171	
1522	Plain	24	22	ECG 150 1/2	ECG 150 1/2	3.63	123	4.7	0.12	175	137	✓
1522RWG	Plain	24	22	ECG 150 1/2 TD37	ECG 150 1/2 TD37	3.70	125	5.3	0.13	198	173	✓
1523	Plain	28	20	ECG 150 3/2	ECG 150 3/2	11.55	392	13.2	0.34	684	524	
1526	Plain	35	32	ECG 150 1/2	ECG 150 1/2	5.30	180	6.2	0.16	254	239	
1527	Plain	17	17	ECG 150 3/3	ECG 150 3/3	11.98	406	14.0	0.36	487	488	
1528	Plain	42	32	ECG 150 1/2	ECG 150 1/2	6.03	204	7.0	0.18	284	200	
1530	Plain	20	18	ECG 150 3/3	ECG 150 3/3	13.20	448	15.0	0.38	500	475	
1543	4H Satin	49	30	ECG 75 1/2	ECE 225 1/0	8.52	289	8.2	0.21	681	78	✓

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Fiber Glass Fabrics (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Strength (lbf/in)	Strength (lbf/in)	Common Style
1557	4H Satin	57	30	ECG 150 1/2	ECE 225 1/0	5.25	178	5.3	0.13	379	110	
1562	Leno	30	16	ECG 150 1/0	ECG 150 1/0	1.88	64	4.9	0.12	102	75	
1564	Plain	20	18	ECG 37 1/2	ECG 37 1/2	12.42	421	15.1	0.38	525	498	✓
1568	Leno	16	8	ECH 25 1/0	ECG 37 1/3	7.83	265	15.8	0.40	236	374	✓
1576	12H Satin	120	24	ECG 150 1/2	ECG 150 1/0	10.60	359	11.1	0.28	600	100	
1579	Plain	30	16	ECG 150 1/2	ECG 75 1/0	3.56	121	4.8	0.12	200	110	✓
1581	8H Satin	57	54	ECG 150 1/2	ECG 150 1/2	8.78	298	8.2	0.21	446	374	✓
1582	8H Satin	60	56	ECG 150 1/3	ECG 150 1/3	13.52	462	12.6	0.32	611	573	
1583	8H Satin	54	48	ECG 75 1/2	ECG 75 1/2	16.55	561	16.1	0.41	997	856	✓
1584	8H Satin	44	35	ECG 150 4/2	ECG 150 4/2	26.34	893	22.9	0.58	1000	900	
1597	Plain	30	30	ECG 37 1/4	ECG 37 1/4	38.46	1308	38.3	0.97	1475	1502	✓
1608	Plain	30	26	ECG 150 1/0	ECG 150 1/0	2.22	75	3.5	0.09	160	130	

1609	Plain	32	10	ECG 150 1/0	ECD 450 1/0	1.48	50	2.8	0.07	167	21
1610	Plain	32	28	ECG 150 1/0	ECG 150 1/0	2.36	80	4.0	0.10	175	145
1611	Plain	32	28	ECG 150 1/0	ECDE 150 1/0	2.42	82	4.0	0.10	160	152
1614	Leno	30	14	ECG 150 1/0	ECG 75 1/0	2.35	80	5.7	0.14	109	134
1620	Plain	20	20	ECG 150 1/0	ECG 150 1/0	1.60	54	3.2	0.08	111	102
1628	Plain	40	28	ECDE 150 1/0	ECDE 150 1/0	2.71	92	4.3	0.11	223	167
1632	Plain	30	32	ECG 150 1/0	ECG 75 1/0	3.75	127	4.9	0.12	159	331
1636	Plain	40	24	ECDE 150 1/0	ECDE 150 1/0	2.59	88	4.4	0.11	210	126
1652	Plain	52	52	ECG 150 1/0	ECG 150 1/0	4.13	140	4.4	0.11	229	201
1658	Plain	20	10	ECG 150 1/0	ECG 75 1/0	1.62	55	3.7	0.09	107	109
1659	Leno	20	10	ECG 150 1/0	ECG 75 1/0	1.66	56	4.5	0.11	78	103
1669	Plain	60	12	ECG 150 1/0	ECD 450 1/0	2.50	85	3.2	0.08	317	23
1674	Plain	40	32	ECG 150 1/0	ECG 150 1/0	2.87	97	4.2	0.11	210	163

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Fiber Glass Fabrics (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Strength (lbf/in)	Strength (lbf/in)	Common Style
1675	Plain	40	32	ECDE 150 1/0	ECDE 150 1/0	2.89	98	4.4	0.11	226	169	✓
1676	Plain	55	48	ECDE 150 1/0	ECDE 150 1/0	4.12	140	4.9	0.12	271	209	
1678	Plain	40	40	ECG 150 1/0	ECG 150 1/0	3.20	108	4.3	0.11	200	200	
1680	8H Satin	72	70	ECDE 150 1/0	ECDE 150 1/0	5.73	194	5.6	0.14	390	334	
1692	Plain	40	22	ECG 150 1/0	ECG 75 1/0	3.19	108	5.2	0.13	206	214	
1694	Plain	40	24	ECG 150 1/0	ECG 75 1/0	3.54	120	5.2	0.13	208	247	
1695	Plain	40	24	ECDE 150 1/0	ECDE 75 1/0	3.59	122	5.4	0.14	190	180	
1800	Plain	16	14	ECK 18 1/0	ECK 18 1/0	9.39	318	11.2	0.28	468	414	✓
1884	8H Satin	44	35	ECK 18 1/0	ECK 18 1/0	25.40	861	26.0	0.66	950	800	
1938	8H Satin	45	36	ECK 18 1/0	ECG 37 1/2	26.80	909	26.6	0.68	1000	900	
2025	Plain	20	14	ECDE 37 1/3 Text	ECDE 37 1/3 Text	17.05	578	26.2	0.67	575	340	

2112	Plain	40	39	ECE 225 1/0	ECE 225 1/0	2.10	71	3.0	0.08	120	120	
2113	Plain	60	56	ECE 225 1/0	ECD 450 1/0	2.35	80	2.8	0.07	223	106	
2114	Plain	56	48	ECE 225 1/0	ECE 225 1/0	2.69	91	3.3	0.08	190	160	
2116	Plain	60	58	ECE 225 1/0	ECE 225 1/0	3.12	106	3.4	0.09	201	181	
2125	Plain	41	38	ECE 225 1/0	ECE 225 1/0	2.60	88	3.5	0.09	120	120	
2157	Plain	60	35	ECE 225 1/0	ECG 75 1/0	4.32	146	5.9	0.15	184	288	
2165	Plain	60	52	ECE 225 1/0	ECG 150 1/0	3.68	125	4.4	0.11	211	252	
2166	Plain	60	38	ECE 225 1/0	ECG 75 1/0	4.80	163	6.0	0.15	185	300	
2313	Plain	60	64	ECE 225 1/0	ECD 450 1/0	2.45	83	2.8	0.07	234	126	
2523	Plain	28	20	ECH 25 1/0	ECH 25 1/0	11.47	389	13.6	0.35	517	390	
2532	Plain	16	14	ECH 25 1/0	ECH 25 1/0	6.87	233	9.5	0.24	345	278	✓
3070	Plain	70	70	ECDE 300 1/0	ECDE 300 1/0	2.83	96	3.0	0.08	188	164	
3313	Plain	61	62	ECDE 300 1/0	ECDE 300 1/0	2.43	82	2.9	0.07	173	159	

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Fiber Glass Fabrics (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Strength (lbf/in)	Strength (lbf/in)	Common Style
3434	5H Satin	34	34	ECG 37 1/0	ECG 37 1/0	10.77	365	10.9	0.28	562	560	
3582	8H Satin	60	56	ECG 50 1/0	ECG 50 1/0	13.76	467	13.8	0.35	700	600	✓
3731	Plain	17	15	ECG 37 1/0	ECG 37 1/0	5.10	173	6.7	0.17	350	300	✓
3733	Plain	18	18	ECG 37 1/0	ECG 37 1/0	5.59	190	7.1	0.18	377	328	✓
3734	Plain	16	11	ECG 37 1/2	ECG 37 1/3	10.45	354	14.6	0.37	393	400	
3743	4H Satin	49	30	ECG 37 1/0	ECE 225 1/0	8.43	286	7.9	0.20	389	33	✓
3780	Plain	22	16	ECG 37 1/0	ECG 75 1/2	5.90	200	7.8	0.20	300	250	
3783	8H Satin	54	48	ECG 37 1/0	ECG 37 1/0	16.15	546	15.7	0.40	750	563	✓
3784	8H Satin	45	36	ECG 37 1/2	ECG 37 1/2	25.79	874	24.2	0.61	1180	936	
3788	12H Satin	42	36	ECG 37 1/4	ECG 37 1/4	52.30	1773	48.7	1.24	1900	1600	
3884	8H Satin	46	36	ECDE 37 1/2	ECDE 37 1/2	26.50	899	26.7	0.68	1014	932	
4180	8H Satin	80	100	SCD 450 1/0	SCD 450 1/0	2.52	85	2.7	0.07	186	207	

4450	Plain	18	17	SCG 75 1/2 493	SCG 75 1/2 493	5.54	188	8.9	0.23	450	435	
4522	Plain	24	22	SCG 150 1/2	SCG 150 1/2	3.66	124	5.1	0.13	197	157	✓
4526	Basket 2x2	36	34	SCG 75 1/0 493	SCG 75 1/0 493	5.60	190	6.0	0.15	350	350	
4527	Plain	24	22	SCG 75 1/0 493	SCG 75 1/0 493	3.58	121	5.6	0.14	340	310	
4533	Plain	18	18	SCG 75 1/2	SCG 75 1/2	5.59	190	8.1	0.21	340	310	✓
4579	Plain	30	16	SCG 150 1/2	SCG 75 1/0	3.59	122	5.4	0.14	300	300	
4700	Plain	14	13	ECG 37 1/0	ECG 75 1/2	4.37	148	6.5	0.17	230	145	✓
4797	Leno	28	14	ECG 75 1/0	ECG 75 1/2	4.63	157	7.4	0.19	168	172	
4985	Plain	18	22	SCG 75 1/2	SCG 150 1/2	4.70	159	6.2	0.16	300	115	
6060	Plain	60	60	ECDE 600 1/0	ECDE 600 1/0	1.18	40	1.7	0.04	87	83	
6080	Plain	60	47	SCD 450 1/0	SCD 450 1/0	1.44	49	2.0	0.05	150	110	
6220	4H Satin	60	58	SCE 225 1/0	SCE 225 1/0	3.08	104	4.0	0.10	259	203	✓
6220 HT	4H Satin	60	58	SCE 225 1/0 933	SCE 225 1/0 933	3.05	103	3.9	0.10	257	259	✓

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Fiber Glass Fabrics (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Strength (lbf/in)	Strength (lbf/in)	Common Style
6543	4H Satin	48	30	SCG 75 1/2	ECE 225 1/0	8.52	289	8.6	0.22	700	90	✓
6557	4H Satin	57	30	SCG 150 1/2	ECE 225 1/0	5.31	180	5.8	0.15	250	90	
6580	8H Satin	72	72	SCG 150 1/0	SCG 150 1/0	5.60	190	5.6	0.14	350	300	
6581	8H Satin	56	54	SCG 150 1/2	SCG 150 1/2	8.75	297	10.4	0.26	250	250	✓
6771HT	8H Satin	46	45	SCG 75 1/0 933	SCG 75 1/0 933	7.06	239	8.0	0.20	589	645	✓
6781	8H Satin	57	54	SCG 75 1/0	SCG 75 1/0	8.94	303	9.6	0.24	568	454	✓
6781 HT	8H Satin	57	57	SCG 75 1/0 933	SCG 75 1/0 933	8.97	304	9.7	0.25	646	661	✓
7255	Plain	37	37	ECG 75 1/0	ECG 75 1/0	6.00	203	7.0	0.18	300	300	
7500	Plain	16	14	ECG 37 1/2	ECG 37 1/2	9.41	319	11.9	0.30	427	400	✓
7520	Plain	18	18	ECG 75 1/3	ECG 75 1/3	8.39	284	10.1	0.26	330	310	✓
7532	Plain	16	14	ECG 75 1/3	ECG 75 1/3	7.20	244	9.4	0.24	344	300	✓
7533	Plain	18	18	ECG 75 1/2	ECG 75 1/2	5.61	191	7.3	0.19	256	236	✓

7533RWG	Plain	18	18	ECG 75 1/2 TD37	ECG75 1/2 TD37	5.59	190	8.4	0.21	279	281	✓
7544	2 End Plain	28	14	ECG 37 1/2	ECG 37 1/4	17.99	612	19.1	0.49	711	721	✓
7547	8H Satin	54	46	ECG 75 1/2	ECG 75 1/2	16.24	551	15.7	0.40	847	635	
7562	Plain	30	18	ECG 75 1/3	ECG 75 1/3	11.55	392	13.2	0.34	618	384	
7579	Plain	26	20	ECG 75 1/0	ECG 150 1/2	3.61	122	5.2	0.13	203	127	
7580	Plain	24	14	ECG 75 1/2	ECG 37 1/0	6.09	206	7.4	0.19	300	200	✓
7581	8H Satin	57	54	ECG 75 1/0	ECG 75 1/0	8.99	305	8.9	0.23	576	509	✓
7587	Mock Leno	40	21	ECG 37 1/2	ECG 37 1/2	19.86	673	24.8	0.63	748	485	✓
7594	Triple Plain	48	24	ECG 37 1/2	ECG 150 1/2	17.76	602	16.6	0.42	1070	150	
7597	Double Satin	30	30	ECG 37 1/4	ECG 37 1/4	37.90	1289	40.3	1.02	1000	1100	✓
7624	Plain	44	24	ECG 75 1/0	ECG 75 1/0	5.53	187	7.0	0.18	353	248	
7626	Plain	34	32	ECG 75 1/0	ECG 75 1/0	5.37	182	6.0	0.15	285	287	

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Fiber Glass Fabrics (continued)

Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Strength (lbf/in)	Strength (lbf/in)	Common Style
7627	Plain	44	24	ECG 75 1/0	ECG 75 1/0	5.58	189	6.2	0.16	325	175	
7628	Plain	44	31	ECG 75 1/0	ECG 75 1/0	6.10	207	7.1	0.18	350	269	✓
7629	Plain	44	34	ECG 75 1/0	ECG 75 1/0	6.26	212	7.1	0.18	342	268	
7630	Plain	31	30	ECG 75 1/0	ECG 75 1/0	4.83	164	5.5	0.14	230	230	
7635	Plain	44	29	ECG 75 1/0	ECG 50 1/0	7.05	239	8.4	0.21	340	407	
7637	Plain	44	23	ECG 75 1/0	ECG 37 1/0	7.09	240	9.5	0.24	323	428	
7642	Plain	44	20	ECG 75 1/0	ECG 37 1/0 Tex	6.86	233	10.9	0.28	354	185	
7645	8H Satin	46	42	ECG 75 1/2	ECG 75 1/2	14.31	485	13.4	0.34	600	525	
7652	Plain	32	32	ECG 50 1/0	ECG 50 1/0	7.50	254	8.3	0.21	400	400	
7715	Modified Plain	80	18	ECG 75 1/0	ECG 150 1/0	7.32	248	7.4	0.19	650	70	✓
7725	2/2 Twill	54	18	ECG 75 1/0	ECH 25 1/0	8.61	292	8.9	0.23	440	360	✓

7781	8H Satin	57	54	ECDE 75 1/0	ECDE 75 1/0	8.87	301	8.6	0.22	501	408	✓
8000	Plain	81	8	ECG 75 1/2	Dacron R-14	12.66	429	12.2	0.31	703	48	
8800	4H Fancy Leno	17(8)	8	ECG 150 1/0-ECG 37 1/3	ECG 37 1/3	8.23	279	17.8	0.45	431	457	✓
76290	Plain	44	31	ECG 75 1/0	ECG 67 1/0	6.27	213	7.0	0.18	350	350	

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Fiber Glass Fabric Weight Index

Style	oz/yd²	(g/m²)	Style	oz/yd²	(g/m²)	Style	oz/yd²	(g/m²)	Style	oz/yd²	(g/m²)
101	0.49	17	1080	1.41	48	1614	2.35	80	2114	2.69	91
104	0.57	19	108	1.42	48	2113	2.35	80	1628	2.71	92
1071	0.60	20	6080	1.44	49	1610	2.36	80	3070	2.83	96
993	0.71	24	1609	1.48	50	1611	2.42	82	1674	2.87	97
1037	0.73	25	1620	1.60	54	3313	2.43	82	1675	2.89	98
1297	0.79	27	1658	1.62	55	2313	2.45	83	6220 HT	3.05	103
106	0.81	27	1280	1.65	56	117	2.46	83	6220	3.08	104
1067	0.91	31	1659	1.66	56	1669	2.50	85	116	3.12	106
1299	0.92	31	1562	1.88	64	4180	2.52	85	2116	3.12	106
1076	0.96	33	112	2.10	71	1636	2.59	88	120	3.14	106
1070	1.02	35	2112	2.10	71	1125	2.60	88	220	3.14	106
6060	1.18	40	1608	2.22	75	2125	2.60	88	1692	3.19	108

1678	3.20	108	1632	3.75	127	1501	4.95	168	6580	5.60	190
1520	3.51	119	1167	3.79	129	3731	5.10	173	7533	5.61	191
1694	3.54	120	1161	3.86	131	1557	5.25	178	1680	5.73	194
1579	3.56	121	477	4.11	139	1526	5.30	180	3780	5.90	200
4527	3.58	121	1676	4.12	140	6557	5.31	180	7255	6.00	203
1695	3.59	122	1652	4.13	140	7626	5.37	182	1528	6.03	204
4579	3.59	122	2157	4.32	146	1047	5.44	184	7580	6.09	206
7579	3.61	122	4700	4.37	148	7624	5.53	187	7628	6.10	207
1522	3.63	123	1064	4.60	156	4450	5.54	188	7629	6.26	212
1131	3.65	124	4797	4.63	157	7627	5.58	189	76290	6.27	213
1165	3.66	124	4985	4.70	159	3733	5.59	190	138	6.53	221
4522	3.66	124	2166	4.80	163	4533	5.59	190	7642	6.86	233
2165	3.68	125	7630	4.83	164	7533RWG	5.59	190	2532	6.87	233
1522RWG	3.70	125	1500	4.89	166	4526	5.60	190	7635	7.05	239

Fiber Glass Fabric Weight Index (continued)

Style	oz/yd²	(g/m²)	Style	oz/yd²	(g/m²)	Style	oz/yd²	(g/m²)	Style	oz/yd²	(g/m²)
6771HT	7.06	239	1543	8.52	289	7500	9.41	319	8000	12.66	429
7637	7.09	240	6543	8.52	289	1507	10.10	342	232	12.75	432
7532	7.20	244	7725	8.61	292	3734	10.45	354	332	13.00	441
7715	7.32	248	520	8.70	295	1576	10.60	359	333	13.00	441
7652	7.50	254	341	8.71	295	3434	10.77	365	1530	13.20	448
1568	7.83	265	6581	8.75	297	2523	11.47	389	1582	13.52	462
8800	8.23	279	1581	8.78	298	1523	11.55	392	3582	13.76	467
1142	8.39	284	7781	8.87	301	7562	11.55	392	7645	14.31	485
7520	8.39	284	6781	8.94	303	1527	11.98	406	3783	16.15	546
403	8.40	285	6781 HT	8.97	304	162	12.00	407	7547	16.24	551
3743	8.43	286	7581	8.99	305	1188	12.02	408	1583	16.55	561
1311	8.49	288	1800	9.39	318	1564	12.42	421	2025	17.05	578

7594	17.76	602	3784	25.79	874	7597	37.90	1289	
7544	17.99	612	1584	26.34	893	1597	38.46	1308	
7587	19.86	673	3884	26.50	899	3788	52.30	1773	
1884	25.40	861	1938	26.80	909				

Fiber Glass Fabric Thickness Index

Style	mils	mm	Style	mils	mm	Style	mils	mm	Style	mils	mm
101	0.78	0.02	6080	2.0	0.05	1669	3.2	0.08	6220 HT	3.9	0.10
104	1.0	0.03	108	2.2	0.06	2114	3.3	0.08	1610	4.0	0.10
993	1.2	0.03	1080	2.2	0.06	2116	3.4	0.09	1611	4.0	0.10
1071	1.2	0.03	1280	2.2	0.06	112	3.5	0.09	6220	4.0	0.10
106	1.3	0.03	4180	2.7	0.07	1125	3.5	0.09	1165	4.1	0.10
1037	1.3	0.03	1609	2.8	0.07	1608	3.5	0.09	1167	4.2	0.11
1067	1.4	0.04	2113	2.8	0.07	2125	3.5	0.09	1674	4.2	0.11
6060	1.7	0.04	2313	2.8	0.07	117	3.7	0.09	1520	4.3	0.11
1076	1.8	0.05	3313	2.9	0.07	220	3.7	0.09	1628	4.3	0.11
1070	1.9	0.05	2112	3.0	0.08	1658	3.7	0.09	1678	4.3	0.11
1297	2.0	0.05	3070	3.0	0.08	116	3.9	0.10	1636	4.4	0.11
1299	2.0	0.05	1620	3.2	0.08	120	3.9	0.10	1652	4.4	0.11

1675	4.4	0.11	7579	5.2	0.13	6557	5.8	0.15	76290	7.0	0.18
2165	4.4	0.11	1500	5.3	0.13	2157	5.9	0.15	3733	7.1	0.18
1659	4.5	0.11	1501	5.3	0.13	2166	6.0	0.15	7628	7.1	0.18
477	4.7	0.12	1557	5.3	0.13	4526	6.0	0.15	7629	7.1	0.18
1522	4.7	0.12	1522RWG	5.3	0.13	7626	6.0	0.15	7533	7.3	0.19
1131	4.8	0.12	1695	5.4	0.14	1526	6.2	0.16	4797	7.4	0.19
1579	4.8	0.12	4579	5.4	0.14	4985	6.2	0.16	7580	7.4	0.19
1562	4.9	0.12	7630	5.5	0.14	7627	6.2	0.16	7715	7.4	0.19
1632	4.9	0.12	1047	5.6	0.14	4700	6.5	0.17	3780	7.8	0.20
1676	4.9	0.12	1680	5.6	0.14	3731	6.7	0.17	3743	7.9	0.20
1161	5.0	0.13	4527	5.6	0.14	138	6.9	0.18	6771HT	8.0	0.20
4522	5.1	0.13	6580	5.6	0.14	1528	7.0	0.18	4533	8.1	0.21
1692	5.2	0.13	1614	5.7	0.14	7255	7.0	0.18	341	8.2	0.21
1694	5.2	0.13	1064	5.8	0.15	7624	7.0	0.18	1543	8.2	0.21

Fiber Glass Fabric Thickness Index (continued)

Style	mils	mm	Style	mils	mm	Style	mils	mm	Style	mils	mm
1581	8.2	0.21	2532	9.5	0.24	1188	11.8	0.30	1527	14.0	0.36
7652	8.3	0.21	7637	9.5	0.24	7500	11.9	0.30	332	14.2	0.36
7635	8.4	0.21	6781	9.6	0.24	8000	12.2	0.31	3734	14.6	0.37
7533RWG	8.4	0.21	1311	9.7	0.25	1582	12.6	0.32	1530	15.0	0.38
6543	8.6	0.22	6781 HT	9.7	0.25	1523	13.2	0.34	1564	15.1	0.38
7781	8.6	0.22	7520	10.1	0.26	7562	13.2	0.34	3783	15.7	0.40
403	8.9	0.23	1142	10.3	0.26	7645	13.4	0.34	7547	15.7	0.40
4450	8.9	0.23	6581	10.4	0.26	2523	13.6	0.35	1568	15.8	0.40
7581	8.9	0.23	3434	10.9	0.28	162	13.8	0.35	1583	16.1	0.41
7725	8.9	0.23	7642	10.9	0.28	3582	13.8	0.35	7594	16.6	0.42
520	9.1	0.23	1576	11.1	0.28	232	14.0	0.36	8800	17.8	0.45
7532	9.4	0.24	1800	11.2	0.28	333	14.0	0.36	7544	19.1	0.49

1507	19.7	0.50	1884	26.0	0.66	1597	38.3	0.97	
1584	22.9	0.58	2025	26.2	0.67	7597	40.3	1.02	
3784	24.2	0.61	1938	26.6	0.68	3788	48.7	1.24	
7587	24.8	0.63	3884	26.7	0.68				

ARAMID FABRICS

PHYSICAL PROPERTIES OF ARAMID FIBERS

Aramids – Kevlar®, Twaron®

High Strength

Aramid fibers are 43 percent lighter than fiber glass, with a density of 1.44 g/cc compared to 2.55 g/cc for fiber glass. Aramids are twice as strong as E-Glass, ten times as strong as aluminum and approach the strength of high strength carbon on a specific tensile strength basis.

Dimensional Stability

Aramids display excellent dimensional stability with a slightly negative coefficient of thermal expansion (-2.4×10^{-6}/°C).

Chemical Resistance

Aramids resist chemicals with the exception of a few strong acids and alkalis.

Thermal Stability

Aramids display excellent stability over a wide range of temperatures for prolonged periods. They show essentially no embrittlement or strength loss at temperatures as low as -320°F (-196°C). Aramids do not melt or support combustion but will start to carbonize at approximately 800°F (427°C).

APPLICATIONS OF ARAMID FABRICS

Aerospace

Hexcel manufactures aramid fabrics for use in aerospace applications. Aramid fabrics are used in aerospace ducting where low weight and strength are important. They are also used for secondary structures and containment cases where impact resistance is key.

Marine, Tooling and Recreational Products

Hexcel's aramid fabrics, exhibiting the properties of high strength and durability, are used in the recreational industry in a variety of applications ranging from boating to skiing. The market for recreational products is a dynamic market driven by strength, durability, clarity and cost. Hexcel's products are used in the manufacture of kayaks, boats, hydroplanes, canoes and a wide range of other recreational products where strength and low weight are essential.

ARAMID FIBERS NOMENCLATURE

Aramid Fibers are typically designated by denier, tex or decitex (dtex). Each is described below.

Denier

The denier system is used internationally to measure the size of silk and synthetic filaments and yarns. Denier number indicates the weight in grams of 9,000 meters of filament or filament yarn. For example, if 9,000 meters of yarn weigh 100 grams, it is a 100-denier yarn. The smaller the denier number, the finer the yarn.

$$\text{Denier} = \text{dtex} \times 0.9$$

Tex

The tex system is also applicable to the measurement of filament yarns. It is based on the weight in grams of one kilometer 3,300 feet) of yarn. Decitex (dtex), is defined as ten times tex.

$$\text{Tex} = \text{dtex}/10 \quad \text{Dtex} = \text{Tex} \times 10 = \text{denier}/0.9$$

For example, 840 denier yarn may also be designated as 933 dtex.

ARAMID FABRIC FINISHES

Hexcel Finish	Performance Features
CS-800/F100	Scour finish for Aramid fabric.
Greige	Loom state fabric. No additional fabric finish processing.

ARAMID FABRIC CONSTRUCTION DATA

Aramid Fabric Styles

Hexcel Style	AMS Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Breaking Strength (lbf/in)	Breaking Strength (lbf/in)	Common Style
170		Plain	12	12	Vectran 1500 denier	Vectran 1500 denier	4.9	166	10.6	0.27	1087	998	
170CS		Crowfoot	12	12	Vectran 1500 denier	Vectran 1500 denier	4.9	166	10.6	0.27	1012	987	
297		Plain Leno	14	14	Kevlar 29 6000 denier	Kevlar 29 6000 denier	12.4	420	33.5	0.85	890	609	
310		Plain	36	36	Kevlar LT 400 denier	Kevlar LT 400 denier	3.6	122	7.0	0.18	600	600	
328	328	Plain	17	17	Kevlar 49 1420 denier	Kevlar 49 1420 denier	6.5	220	12.8	0.33	905	940	
345	124	4H Satin	34	34	Kevlar 49 195 denier	Kevlar 49 195 denier	1.7	58	3.0	0.08	210	210	
348	181	8H Satin	50	50	Kevlar 49 380 denier	Kevlar 49 380 denier	5.1	173	8.7	0.22	720	658	

350	120	Plain	34	34	Kevlar 49 195 denier	Kevlar 49 195 denier	1.8	61	3.9	0.10	260	262	✓
351	220	Plain	22	22	Kevlar 49 380 denier	Kevlar 49 380 denier	2.2	75	4.8	0.12	296	298	✓
352	281	Plain	17	17	Kevlar 49 1140 denier	Kevlar 49 1140 denier	5.2	176	9.8	0.25	748	728	✓
353	285	4H Satin	17	17	Kevlar 49 1140 denier	Kevlar 49 1140 denier	5.2	176	9.3	0.24	688	686	✓
354		Plain	13	13	Kevlar 49 1420 denier	Kevlar 49 1420 denier	4.9	166	9.8	0.25	677	659	✓
372		Twill 4x4	72	72	Kevlar 49 195 denier	Kevlar 49 195 denier	3.7	125	7.2	0.18	556	584	
383		5H Satin	16	16	Kevlar 49 2160 denier	Kevlar 49 2160 denier	9.1	309	14.8	0.38	1131	1096	
384	1050	Basket 4x4	28	28	Kevlar 49 1420 denier	Kevlar 49 1420 denier	10.7	363	19.0	0.48	1360	1300	

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Aramid Fabric Styles

Hexcel Style	AMS Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Breaking Strength (lbf/in)	Breaking Strength (lbf/in)	Common Style
386		Basket 4x4	27	22	Kevlar 49 2160 denier	Kevlar 49 2160 denier	13.9	471	26.4	0.67	1785	1550	
388	1033	Basket 8x8	40	40	Kevlar 49 1420 denier	Kevlar 49 1420 denier	15.5	526	27.6	0.70	1935	1705	
431		Plain	31	31	Kevlar LT 400 denier	Kevlar LT 400 denier	3.1	105	6.0	0.15	572	586	
704		Plain	31	31	Kevlar 129 840 denier	Kevlar 129 840 denier	6.8	231	13.9	0.35	850	1084	
705		Plain	31	31	Kevlar KM2 850 denier	Kevlar KM2 850 denier	6.9	234	13.8	0.35	899	984	
706		Plain	34	34	Kevlar KM2 600 denier	Kevlar KM2 600 denier	5.4	183	11.1	0.28	756	884	
707		Plain	31	31	Kevlar KM2 600 denier	Kevlar KM2 600 denier	4.8	163	9.4	0.24	727	833	

708	Plain	31	31	Kevlar K129 600 denier	Kevlar k129 600 denier	4.7	159	8.6	0.22	672	735
710	Plain	24	24	Kevlar 29 1500 denier	Kevlar 29 1500 denier	9.7	329	19.4	0.49	1100	1200
711	Plain	29	29	Kevlar K129 600 denier	Kevlar K129 600 denier	4.5	153	8.7	0.22	776	819
713	Plain	31	31	Kevlar 29 1000 denier	Kevlar 29 1000 denier	8.2	278	16.8	0.43	761	1043
720	Plain	20	20	Kevlar 129 1420 denier	Kevlar 129 1420 denier	7.7	261	14.4	0.37	1091	1075
722	Plain	22	22	Kevlar 129 1420 denier	Kevlar 129 1420 denier	8.6	292	16.4	0.42	644	930
724	Plain	24	24	Kevlar 129 1000 denier	Kevlar 129 1000 denier	6.2	210	11.4	0.29	763	776
726	Plain	26	26	Kevlar 129 840 denier	Kevlar 129 840 denier	5.7	193	10.8	0.27	872	950

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Aramid Fabric Styles

Hexcel Style	AMS Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Breaking Strength (lbf/in)	Breaking Strength (lbf/in)	Common Style
727		Plain	26	26	Kevlar 129 1000 denier	Kevlar 129 1000 denier	6.7	227	12.3	0.31	974	970	
728		Plain	17	17	Kevlar 29 1500 denier	Kevlar 29 1500 denier	6.6	224	12.7	0.32	910	904	
729		Plain	17	17	Kevlar 129 1420 denier	Kevlar 129 1420 denier	6.6	224	12.8	0.33	905	892	
730		Plain	22	22	Kevlar 29 1000 denier	Kevlar 29 1000 denier	5.6	190	11.6	0.29	829	798	
731		Plain	31	31	Kevlar 129 1000 denier	Kevlar 129 1000 denier	7.9	268	15.2	0.39	892	962	
732		Plain	32	32	Kevlar 29 400 denier	Kevlar 29 400 denier	3.2	108	6.2	0.16	476	473	
735		Basket 2x2	35	35	Kevlar 29 1500 denier	Kevlar 29 1500 denier	14.1	478	25.4	0.65	1738	1794	

736	Basket 2x2	36	36	Kevlar 129 1420 denier	Kevlar 129 1420 denier	14.1	478	26.3	0.67	1950	2000
740	Plain	40	40	Kevlar 29 200 denier	Kevlar 29 200 denier	2.1	71	5.2	0.13	338	350
741	Plain	11	11	Kevlar 29 3000 denier	Kevlar 29 3000 denier	8.5	288	16.1	0.41	1100	1150
745	Plain	17	17	Kevlar 29 3000 denier	Kevlar 29 3000 denier	13.3	451	25.3	0.64	1194	1722
748	Basket 8x8	48	48	Kevlar 29 1500 denier	Kevlar 29 1500 denier	18.8	637	32.1	0.82	2200	2300
751	Plain	29	29	Kevlar KM2 600 denier	Kevlar KM2 600 denier	4.4	149	7.9	0.20	688	699
754	Basket 2x2	21	21	Kevlar 29 3000 denier	Kevlar 29 3000 denier	16.5	559	29.0	0.74	2000	2000
755	Basket 4x4	21	21	Kevlar 29 3000 denier	Kevlar 29 3000 denier	15.7	532	28.9	0.73	2000	2000

The physical properties listed are typical for greige (untreated) fabrics. Actual values may vary. For additional information, please contact a Technical Service Representative at 830-401-8180.

Aramid Fabric Styles

Hexcel Style	AMS Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Breaking Strength (lbf/in)	Breaking Strength (lbf/in)	Common Style
756		Plain	28	28	Kevlar KM2 400 denier	Kevlar KM2 400 denier	2.9	98	5.6	0.14	524	529	
759		Basket 4x4	24	24	Kevlar 29 3000 denier	Kevlar 29 3000 denier	18.0	610	30.0	0.76	2330	2500	
760		Basket 2x2	30	30	Kevlar 129 1420 denier	Kevlar 129 1420 denier	11.8	400	21.1	0.54	887	629	
779		Plain	70	70	Kevlar 159 200 denier	Kevlar 159 200 denier	3.8	129	8.5	0.22	389	576	
902		Plain	17	17	Spectra 900 1200 denier	Spectra 900 1200 denier	5.6	190	15.5	0.39	900	850	
903		Plain	21	21	Spectra 900 1200 denier	Spectra 900 1200 denier	7.0	237	19.1	0.49	1100	1100	
904		Plain	34	34	Spectra 900 650 denier	Spectra 900 650 denier	6.5	220	18.1	0.46	950	900	

945	Plain	45	45	Spectra 1000 215 denier	Spectra 1000 215 denier	2.6	88	6.0	0.15	500	475	
951	Plain	17	17	Spectra 1000 650 denier	Spectra 1000 650 denier	3.0	102	9.6	0.24	600	550	
955	Plain	56	56	Spectra 1000 215 denier	Spectra 1000 215 denier	3.4	115	8.4	0.21	700	650	
956	Plain	34	34	Spectra 1000 215 denier	Spectra 1000 215 denier	1.9	64	5.0	0.13	400	360	
960	Plain	32	32	Spectra 1000 375 denier	Spectra 1000 375 denier	3.2	108	8.0	0.20	600	550	
985	8H Satin	32	32	Spectra 1000 650 denier	Spectra 1000 650 denier	5.8	197	13.1	0.33	1050	1000	
1629 (Black)	Plain	14	14	Kevlar 100 1500 denier	Kevlar 100 1500 denier	5.2	176	10.3	0.26	785	793	✓
1629T (Black)	Plain	14	14	Technora 230B 1670 dtex	Technora 230B 1670 dtex	5.3	180	11.3	0.29	923	799	

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Aramid Fabric Styles

Hexcel Style	AMS Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Breaking Strength (lbf/in)	Breaking Strength (lbf/in)	Common Style
4000		Plain	18	18	Kevlar XLT 800 denier	Kevlar XLT 800 denier	3.7	125	7.3	0.19	675	654	
4010		Plain	22	22	Kevlar A200 600 denier	Kevlar A200 600 denier	3.4	115	6.0	0.15	625	650	
4015		Plain	22	22	Kevlar XLT 800 denier	Kevlar XLT 800 denier	4.6	156	8.5	0.22	790	782	
4020		Plain	24	24	Kevlar XLT 800 denier	Kevlar XLT 800 denier	5.0	168	8.8	0.22	700	725	
5328	328	Plain	17	17	Twaron 2200 1580 dtex	Twaron 2200 1580 dtex	6.4	217	12.0	0.30	700	750	
5348	181	8H Satin	50	50	Twaron 1055 405 dtex	Twaron 1055 405 dtex	4.9	166	8.0	0.20	660	650	
5351	220	Plain	22	22	Twaron 1055 405 dtex	Twaron 1055 405 dtex	2.2	75	4.6	0.12	287	288	

5352	281	Plain	17	17	Twaron 2200 1270 dtex	Twaron 2200 1270 dtex	5.2	176	10.7	0.27	830	815	
5353	285	4H Satin	17	17	Twaron 2200 1270 dtex	Twaron 2200 1270 dtex	5.2	176	9.7	0.25	784	779	✓
5354		Plain	13	13	Twaron 2200 1580 dtex	Twaron 2200 1580 dtex	4.9	166	10.0	0.25	568	600	
5383		5H Satin	16	16	Twaron 2200 2420 dtex	Twaron 2200 2420 dtex	9.4	319	13.0	0.33	104	104	
5384	1050	Basket 4x4	28	28	Twaron 2200 1580 dtex	Twaron 2200 1580 dtex	10.7	363	19.0	0.48	1360	1300	
5386		Basket 4x4	27	22	Twaron 2200 2420 dtex	Twaron 2200 2420 dtex	13.6	461	25.0	0.64	1826	1473	
5388	1033	Basket 8x8	40	40	Twaron 2200 1580 dtex	Twaron 2200 1580 dtex	15.3	519	26.9	0.68	1830	1790	
5704		Plain	31	31	Twaron T-2040 930 dtex	Twaron T-2040 930 dtex	6.8	231	12.9	0.33	916	971	

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Aramid Fabric Styles

Hexcel Style	AMS Style	Weave	Count Warp	Count Fill	Warp Yarn	Fill Yarn	Weight (oz/yd²)	Weight (g/m²)	Thickness (mils)	Thickness (mm)	Breaking Strength (lbf/in)	Breaking Strength (lbf/in)	Common Style
5713		Plain	31	31	Twaron T-2000 1100 dtex	Twaron T-2000 1100 dtex	8.2	278	16.3	0.41	900	925	
5724		Plain	24	24	Twaron T-2000 1100 dtex	Twaron T-2000 1100 dtex	6.5	220	11.0	0.28	760	775	
5726		Plain	26	26	Twaron T-2040 930 dtex	Twaron T-2040 930 dtex	6.0	203	10.0	0.25	760	770	
5728		Plain	17	17	Twaron T-2000 1680 dtex	Twaron T-2000 1680 dtex	6.9	234	12.1	0.31	775	800	
5731		Plain	31	31	Twaron T-2000 1100 dtex	Twaron T-2000 1100 dtex	8.1	275	16.1	0.41	949	987	
5745		Plain	17	17	Twaron T-1000 3300 dtex	Twaron T-1000 3300 dtex	13.4	454	24.2	0.61	1700	1800	
5755		Basket 4x4	21	21	Twaron T-1000 3300 dtex	Twaron T-1000 3300 dtex	16.2	549	30.0	0.76	2000	2000	

5930	Plain	27	27	Twaron T-2000 930 dtex	Twaron T-2000 930 dtex	5.8	197	10.5	0.27	872	955
5931	Plain	31	31	Twaron T-2000 930 dtex	Twaron T-2000 930 dtex	7.0	237	12.0	0.30	900	950
9000	Plain	13	13	Kevlar 29 1500 denier	ECG 18 1/0	7.8	264	10.2	0.26	656	648

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Technical Reference - English

Fiber	Density (lb/in^3)	Tensile Strength (ksi)	Tensile Modulus (msi)	Strain to Failure (%)	Specific Tensile Strength (10^6in)	Specific Tensile Modulus (10^8in)	Coefficient of Thermal Expansion ($10^{-6}/^0F$)	Decomposition Temperature (^0F)
E-Glass	0.095	500	10.5	4	5.28	1.11	3.00	1346
S-2 Glass®	0.090	665	12.5	5.5	7.42	1.40	0.90	1562
Carbon Fiber Standard Modulus PAN	0.064	530	33.5	1.5	8.33	5.27	-0.33	6332
Carbon Fiber Intermediate Modulus PAN	0.064	770	42.3	1.8	11.97	6.58	-0.33	6332
Carbon Fiber High Modulus PAN	0.066	610	63.3	1	9.18	9.52	-0.61	6332
Carbon Fiber Low Modulus Pitch	0.070	230	27	0.8	3.30	3.87	-0.33	6332
Carbon Fiber High Modulus Pitch	0.077	380	92	0.4	4.96	12.01	-0.81	6332

Kevlar® 49 1420 denier	0.052	424	15.8	2.5	8.15	3.04	-1.50	842
Kevlar® 29 1500 denier	0.052	424	10.9	3.4	8.15	2.10	-1.22	842
Kevlar® 129 840 denier	0.052	479	13.6	3.3	9.21	2.61	-1.22	842
Kevlar® KM2 850 denier	0.052	497	10.8	3.5	9.55	2.08	-1.22	842
Kevlar® LT 400 denier	0.052	497	13.6	3.4	9.55	2.61	-1.22	842
Kevlar® KM2 600 denier	0.052	497	11.8	3.6	9.55	2.27	-1.22	842
Spectra® 900 650 denier	0.035	348	11.4	3.6	9.93	3.25	-	302
Spectra® 1000 375 denier	0.035	410	14.9	3.1	11.70	4.25	-	302
Spectra® 2000 195 denier	0.035	465	16.4	2.9	13.27	4.68	-	302

Technical Reference - English (continued)

Fiber	Density (lb/in^3)	Tensile Strength (ksi)	Tensile Modulus (msi)	Strain to Failure (%)	Specific Tensile Strength (10^6in)	Specific Tensile Modulus (10^8in)	Coefficient of Thermal Expansion ($10^{-6}/^0F$)	Decomposition Temperature (^0F)
Twaron® 1000	0.052	507	9.4	3.7	9.74	1.81	-1.22	842
Twaron® 2000	0.052	479	12.9	3.3	9.21	2.50	-1.22	842
Twaron® HM	0.052	507	14.7	2.1	9.69	2.85	-1.33	842

Technical Reference - Metric

Fiber	Density (lb/in^3)	Tensile Strength (ksi)	Tensile Modulus (msi)	Strain to Failure (%)	Specific Tensile Strength (10^6in)	Specific Tensile Modulus (10^8in)	Coefficient of Thermal Expansion ($10^{-6}/^0F$)	Decomposition Temperature (^0F)
E-Glass	2.50	2600	72	4	13.42	2.82	1.6	730
S-2 Glass®	2.48	4800	85	5.5	18.86	3.55	0.48	8.50
Carbon Fiber Standard Modulus PAN	1.76	3657	231	1.5	21.18	13.38	-0.60	3500
Carbon Fiber Intermediate Modulus PAN	1.78	5313	292	1.8	30.42	16.71	-0.60	3500
Carbon Fiber High Modulus PAN	1.84	4209	437	1	23.31	24.19	-1.10	3500
Carbon Fiber Low Modulus Pitch	1.93	1587	186	0.8	8.38	9.84	-0.60	3500
Carbon Fiber High Modulus Pitch	2.12	2622	635	0.4	12.60	30.52	-1.45	3500

Technical Reference - Metric (continued)

Fiber	Density (lb/in^3)	Tensile Strength (ksi)	Tensile Modulus (msi)	Strain to Failure (%)	Specific Tensile Strength (10^6in)	Specific Tensile Modulus (10^8in)	Coefficient of Thermal Expansion ($10^{-6}/^0F$)	Decomposition Temperature (^0F)
Kevlar® 49 1420 denier	1.44	2926	109	2.5	20.71	7.72	-2.70	450
Kevlar® 29 1500 denier	1.44	2926	75	3.4	20.71	5.32	-2.20	450
Kevlar® 129 840 denier	1.44	3305	94	3.3	23.39	6.64	-2.20	450
Kevlar® KM2 850 denier	1.44	3429	75	3.5	24.27	5.27	-2.20	450
Kevlar® LT 400 denier	1.44	3429	94	3.4	24.6	7.52	-2.20	450
Kevlar® KM2 600 denier	1.44	3429	81	3.6	24.27	5.76	-2.20	450
Spectra® 900 650 denier	0.97	2401	79	3.6	25.23	8.26	-	150
Spectra® 1000 375 denier	0.97	2829	103	3.1	29.72	10.80	-	150

Spectra® 2000 195 denier	0.97	3209	113	2.9	33.71	11.89	-	150
Twaron® 1000	1.44	3498	65	3.7	24.76	4.59	-2.20	450
Twaron® 2000	1.44	3305	90	3.3	23.39	6.35	-2.20	450
Twaron® HM	1.45	3498	103	2.1	24.59	7.23	-2.40	450

SPECIFICATIONS

AMS 3824
This specification covers the basic forms of finished glass fabrics used by themselves or as components of other materials.

AMS 3902
This specification covers cloth woven from high-modulus, continuous, multifilament aramid yarn.

AMS-C-9084
This specification **replaces MIL-C-9084** and covers the requirement for glass fabrics that have been woven, cleaned and finished for further fabrication into glass fabric base resin laminates and sandwich materials.

ASTM-D-579
Standard specifications for Greige Woven Glass Fabrics. This specification includes the basic forms of greige woven glass fabrics and their testing.

ASTM-D-1668
This specification covers open mesh woven glass fabrics used for membrane waterproofing and built up roofing (Type II).

ASTM-D-4029
Standard specifications for finished woven glass fabrics. This specification includes finished fabrics woven from "E" glass fiber yarns intended as a reinforced material in laminated plastics for structural use.

SPECIFICATIONS

MIL-C-20079
This specification covers glass and tape used as lagging material over thermal insulation and as a facing material for hull insulation board.

MIL-C-22787
Vinyl coated glass fabrics. The base cloth is glass fabric.

MIL-I-24244
This specification covers thermal insulation with special corrosion and chloride requirements.

MIL-P-25515
Phenolic Laminates. Glass fabrics used as supports for phenolic resin laminates.

MIL-Y-1140
This specification covers the basic forms of untreated glass yarns and fabrics used by themselves or as components of other materials. The materials are generally used as electrical insulation, mechanical support or as structural members.

MIL-R-7575
Resin, Polyester, Low Pressure Laminates, Fiber Glass Base. Glass fabrics used as supports for polyester resin laminates.

MIL-R-9300
Resin, Epoxy, Low Pressure Laminates, Fiber Glass Base. Glass fabrics used as supports for polyester resin laminates.

SPECIFICATIONS

MIL-C-44050A
This specification covers cloth woven from high-modules, continuous, multifilament yarn.

U.S.C.G. Subpart 164-009
Non-combustible material for merchant vessels. Woven glass cloth containing not more than 2.5 percent lubricant is automatically considered non-combustible.

BMS 9-3
This specification covers the Boeing Commercial Airplane Company's requirements for woven, cleaned, and finished E-Glass fiber glass fabrics. End fabric uses are high performance structural prepreg for aircraft structure and wet lamination of tooling and structural composite repair.

BMS 9-8
This specification establishes requirement for woven and non-woven carbon reinforcements in a Boeing application.

BMS 9-17
This specification establishes requirements for intermediate modulus carbon fibers and fabric in a Boeing application.

CONVERSIONS

Areal Weight

oz/yd^2 x 33.9057 = g/m^2

g/m^2 x 0.0295 = oz/yd^2

Mass

oz: ounce, lb: pound

1 oz = 28.35 g • 1 g = 0.035 oz

1 lb = 0.454 kg • 1 kg = 2.205 lb

Force

N: Newton, daN: decaNewton

1 N = 0.102 kgf ≈ 0.1 kgf • 1 daN = kgf ≈ 1kgf

1 kgf = 9.81 N ≈ 10 N or 1 daN

1 lbf = 4.4482 N = 0.4536 kgf

Strength

Pa: Pascal, MPa: megaPascal

1 MPa = 1 N/mm^2

1 MPa = 10bars = 0.1 hbar ≈ 10 kgf/cm^2 or 0.1 kgf/mm^2

1 bar = 0.1 MPa =105 Pa ≈ 1daN/cm ≈ 1 kgf/cm^2

1 hbar = 10 MPa = 107 Pa ≈ $1kgf/mm^2$

100 psi (lbf/in^2) = 0.69 MPa • 1 MPa = 145 psi

1 psi (lbf/in^2) = 6894.76 Pa ≈ $0.0703kgf/cm^2$

Length

yd: yard, ft: foot, in: inch

UK mile: 1 mile = 1.609 km • 1 km = 0.62 mile

Nautical Mile: 1 mile = 1.852 km

1 yd = 0.91 m • 1 m =1.09 yd

1 ft (1/3 yd) = 0.3048 m • 1 m = 3.281 ft

1 in (1/12 ft) = 2.54 cm • 1 cm = 0.39 in

CONVERSIONS

Surface

1 sq in = 6.45 cm^2 · 1 cm^2 = 0.15 sq in
1 sq yd = 0.83 m^2 · 1m^2 = 1.19 sq yd
1 sq ft = 0.093 m^2 · 1 m^2 = 10.76 sq ft
1 sq mile = 2.59 km^2 · 1 km^2 = 0.30 sq mile
1 acre = 0.40 ha · 1 ha = 2.47 acre

Volume

1 cu in = 16.39 cm^3 · 1 cm^3 = 0.06 cu in
1 cu yd = 0.76 m^3 · 1 m^3 = 1.31 cu yd
1 cu ft = 28.31 dm^3 · 1 dm^3 = 0.035 cu ft

Density

1 lb/in^3 = 27.68 g/cm^3 · 1 g/cm^3 = 0.036 lb/in^3
1 lb/ft^3 = 0.016 g/cm^3 · 1 g/cm^3 = 62 lb/ft^3

Capacity

(US) Gallon: 1 gal = 3.781 · 1 l = 0.26 gal
(UK) Gallon: 1 gal = 4.541 · 1 l = 0.21 gal

Consumption

(US) 0 miles/gal = 23.50/100 km · 10 l/100 km = 23.8 miles/gal
(UK) 10 miles/gal = 28.21/100 km · 10 l/100 km = 29.5 miles/gal

Velocity

1 km/h = 0.2778 m/s · 1mph = 1.609 km/h = 0.4470 m/s

Yarn Conversions

Tex = 496,055/(yd/lb)
Dtex = Tex X 10 = Denier/.9
Denier = dtex X .9 = 9 tex
Denier = g/9000m
Tex = dtex/10 = g/1000m

CONVERSIONS

Energy and Power
J: Joule, cal: calorie, th: thermal unit, W: watt

Density
1 W = 1 J/s
1 Wh = 3 600 J = 0.860 kcal · 1 kcal = 4 185.5 J = 1,1626 Wh
1 kJ = 0.2389 kcal · 1 cal = 4.185 J = 0.2389 cal
1 th = 1,000 kcan

tep: ton (metric) equivalent fuel oil
tec: tonne (metric) equivalent coal

1 tep = 10,000 th = 11,626 kWh = 11.6 MWh = 1.5 tec 1 100 Nm^3 natural gas

Specific Heat
kj/kgK: kilojoule per kilogram Kelvin

Thermal Conductivity
1 W/mK or W/m°C = 0.860 kcal/mh°C

Coefficient of Thermal Loss:
1 W/m^3K or W/n^3C = 0.8m60 kcal/m^3h°C

Temperature
K: Kelvin, ˚C: degree Celsius, ˚F: degree Fahrenheit

TK = ˚C + 273.18˚
˚F = 9/5˚C + 32

NOTES

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