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INSULATION DIRECTORY / ENCYCLOPEDIA ISSUE

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Section 3-3: Fibrous Products: Fibers; Yarns; Cords; Twines; Lacing Tapes; and Untreated Felts, Mats, Woven Tapes, and Fabrics

New Developments

Fibers made from inorganic boron nitride are available. The material is said to be chemically inert, abrasive resistant, dielectrically strong, to withstand temperatures in inert atmosphere up to 2482°C and in oxidizing atmosphere to 927°C, and to provide a good strength to density ratio which offers a wide variety of possible applications since boron nitride can now take the form of thread, paper, textile, and composite reinforcements. It is immune to attack by most organic solvents and most corrosive agents. Tensile strength is over 200,000 psi and modulus of elasticity is 13,000,000 psi. It is white in appearance and has a silk-like texture. In addition to desirable electrical insulation and reinforcing properties, it is suggested as an effective shield for radiation. The development was announced by The Carborundum Co.

A new family of high performance finishes for fiber glass fabrics used in reinforcing plastics requiring long term wet strength retention has been developed by J. P. Stevens & Co., Inc. Called the S900-series, the new finishes are claimed to be useful with polyester, epoxy, and phenolic resins and to make obsolete prior finishes such as Volan, S550, and A1100. A pilot evaluation of the finishes for electrical high pressure laminates and low pressure applications in the aircraft and aerospace field has been successfully completed.

"Nomex" polyamide fibers, which had been considered difficult to dye, are now available in a line of heat resistant colors which withstand exposure to 204°C for 200 hours minimum with little or no color change, according to the Industrial Yarn Div., Belding Corticelli. The yarns are used for sewing, braiding, identification, and insulation.

Two lines of non-woven fabrics prepared from "Nomex" high temperature resistant nylon have been introduced by the Fiber Products Div., The Kendall Co. One is a thick, lofty material made by mechanical entanglement without addition of binders. The other is said to be a thin, tough web held together with a high temperature binder system. Both types may be saturated with compatible resins or combined with other components to make composite insulation.

According to J. P. Stevens & Co., Inc., there is increasing usage of high purity quartz yarn in braided insulation for thermocouple wire, high temperature hook-up wire, space separators, coaxial cables, and various heating elements.

Author Credits

This entire section was staff prepared.

In the first portion of this section various terms are explained while in the middle portion the various fibers commonly used in electrical insulation materials are briefly described and evaluated. The last portion covers the forms which are available such as cords, tapes, fabrics, etc. Note that only untreated forms (except cords and lacing tapes) which are not described elsewhere are included in this section. For example, braided sleevings appear in section 3-6, treated fabrics in section 3-7, pressure sensitive cloth tapes in section 3-9, etc.

DEFINITIONS AND EXPLANATIONS OF TERMS

There are two forms of fibers—*staple fibers* which are the short fibers such as those of cotton, and *filament fibers* which are long strands such as

those of many man-made fibers and silk.

Yarn construction can be varied according to actual fiber or fibers used, whether the fiber is staple or filament, staple length, size, weight, amount of twist, number of plies, etc. *Spun yarns* are produced by cleaning, paralleling, attenuating, and twisting staple fibers into yarn by spinning. Tensile properties of a spun yarn are determined both by the fiber used and by the degree of frictional adherence provided by the nature of the fiber and the twisting effect. Spun yarns wear well and offer good flexibility because individual fibers can move within the yarn construction. They also generally are characterized by a good bulking factor and absorption. The *cotton system* is used for spun yarn sizes—it is the number of 840-yard hanks per pound. From a weight and bulk standpoint, *filament yarns* normally have better tensile properties than spun yarns but they do not compare in absorption and adherence, although these latter properties can be improved by construction. The *denier system* is used for many filament yarns—it is the number of grams per 9000 meters of length (in practice, the number of half-decigrams per 450-meter skeins). A filament yarn denier is the equivalent of 5315 divided by the cotton yarn number. To achieve the advantages of each, spun yarns and filament yarns may be twisted together into *plied yarns* and plied yarns may be twisted into *cabled yarns*.

In *woven tapes and fabrics*, the yarns which run lengthwise of the fabric are known individually as *ends* and collectively as the *warp*. The yarns running widthwise of the fabric are identified individually as *picks* and collectively as the *filling*.

In woven materials the most common type of weave is the *plain weave* or *taffeta weave* in which each warp yarn alternately goes over or under each filling yarn. This type of weave can be very tightly woven and generally permits sufficient stretch to conform well to irregular surfaces, the degree of conformability depending, of course, on the actual weave construction. In *twill weaves*, each warp yarn goes over two or more filling yarns, with the interlacing advancing one pick on successive warps. *Satin weaves* have fewer interlacings than plain weaves. The interlacings are regularly spaced in satin weaves. *Leno* is a variation of a plain weave—it is an open, net-like weave with the warps interlocked to prevent slippage. Of course, many weave variations are possible.

Mat or matting is a non-woven material in which there is an oriented or random distribution of the fibers (generally, except with chopped strand glass mat the production process used may involve some parallelizing of the fibers but theoretically, if perfect random distribution were possible, the strength would be equal in all directions). Bonding agents or resins are frequently used by the mat producers to achieve bonding together of the fibers and facilitate further processing into other forms by converters.

Lap is a felted form designed for recarding into a more refined felted material. It is a parallel collection of ribbon-like felted slivers. *Slivers* are the stranded fibers as they come from the carding or combing machines.

Felt is made of matted fibers which have been worked into a compact material by rolling and pressure. Bonding agents or resins are generally used.

Roving is a collection of carded fibers rubbed into a single soft and bulky strand without twist or a sliver which has been drawn out and slightly twisted. In the case of glass, roving is a collection of continuous filament untwisted strands into a single bulky strand.

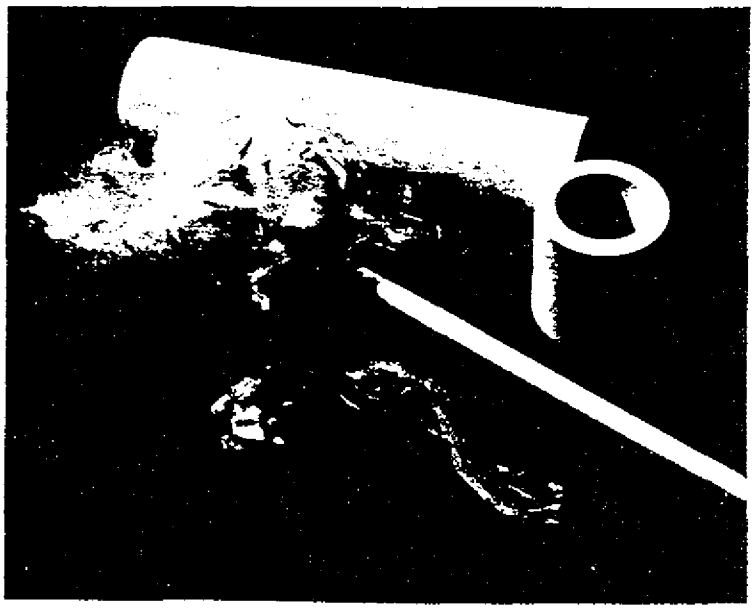
FIBERS

Acetate

Acetate fibers are cellulose based fibers in filament form characterized by high dielectric strength and a dielectric constant of about 5.0 at 60 cps and 50% RH. Cellulose acetate is a non-corrosive material which permits its use in contact with delicate conductors. It is resistant to transformer oils, weak acids, weak alkalies, salt water, and most ordinary varnish solvents such as naphtha, toluol, and alcohol.

There has been some mention of the use of acetate fibers in varnished fabrics but the primary electrical application appears to be in the form of woven cloth for pressure sensitive electrical tapes because of non-corrosiveness. Some use as woven tapes for coil wraps is also reported, as well as a yarn serving on wires.

A related material developed from acetate and tradenamed "Fortisan,"



Chemically inert, high temperature resistant boron nitride. The Carborundum Co.

can withstand continuous temperatures of 316°C and up to 538°C intermittently—fusing can be accomplished by briefly heating at about 338-371°C.

Roving

As previously mentioned, roving is a collection of carded fibers rubbed into a single soft and bulky strand without twist or a sliver which has been drawn out and slightly twisted, except that in the case of glass, roving is a collection of continuous filament untwisted yarns into a single bulky strand.

For electrical applications, the primary roving materials are asbestos and glass. Ceramic fiber roving is also suggested for applications similar to asbestos roving but where even greater heat resistance is required.

Asbestos roving is used extensively in wires where heat is involved because of its thermal properties. The roving is wrapped over the conductor without compacting the fibers too densely in order to retain the thermal insulation qualities. It is useful in heater cords, heat resisting fixture wires, appliance cords where heat is a problem such as toasters and irons, heating elements, shipboard cable, etc.

Plain asbestos roving is a mixture of asbestos and cotton or other organic fibers. Reinforced asbestos roving has a core of cotton, nylon and cotton, glass, or other yarns to provide additional strength. Asbestos roving is covered by ASTM D-375-59, Specifications for Asbestos Roving for Electrical Purposes, with Methods of Test for; and military specification MIL-I-3053C.

Glass roving is widely used in reinforced plastics. Both standard rovings and chopped strand can be supplied. Some of the plastics applications include use of glass roving at the edges of large plastic products to provide extra edge strength; in molding compounds; and in plastic rod stock.

Fused silica or quartz roving is used for plastics reinforcement and filament winding.

Lap

Lap is a fire resistant, untwisted, ribbon-like form of asbestos felt made from slivers of asbestos fiber blended with cotton or other organic fibers. It is used as a wrapping on wire and cable in the same manner as asbestos roving.

Felts and Mats

Felts and mat-like materials are non-woven products with either oriented or randomly distributed fibers permitting strength, conformability, and stretchability to be fairly well equalized in all directions or accentuated in a desired direction. Strength of an otherwise weak web is increased by inclusion of binder (which may be a homogenous fiber or resinous in nature) or by combination with a carrier. Practically any fibrous material can be supplied in mat or felt form but for electrical uses, the common types are asbestos mat and felt, glass mat, and polyester mat. A percentage of binding agents such as fibers, starch, phenolic resins, epoxy resins, polyester resins, or silicone resins is generally used.

Asbestos felts have been used to some extent for wire and cable insulation. They are also used in prepregs and as a base for laminated plastics. Asbestos felts and glass cloth reinforced asbestos mats are generally available treated with asphalt, polyvinyl acetate, silicone, and polytetrafluoroethylene resins in sheeting and tape forms for electrical insulation.

The primary electrical use for glass mat is as base reinforcing material for rigid plastic laminates (see section 3-14).

Non-woven polyester mats can be manufactured from 100% polyester fibers without the use of adhesives or similar binding agents—thermoplastic polyester fibers can be used for bonding purposes by means of a hot calendering process. A large variety of thicknesses and weights are available. These mats reportedly have better moisture and temperature resistance than cellulosic paper and woven cotton fabrics and are more flexible and conformable than woven glass. The felt-like construction is said to permit excellent penetration of impregnants. In tape form, the untreated plain mat can be used for hand taping of irregularly shaped coils. To increase lengthwise tensile strength for machine taping wor the mat can be reinforced with co tinuous polyester filaments runnir lengthwise in parallel (no adhesi used). Light polyester woven fabri can also be used for reinforcemer The mat is used in various composi insulation constructions such as a ca rier for flexible manufactured mi products and the polyester mat/poi ester film/polyester mat sandwich —the latter composite can be ma without adhesives and can be su plied plain or with a treatment su as an epoxy coating. Mats with va ous fully cured varnish treatments epoxy coatings are available as w as a semi-cured epoxy constructi which can be cured in place to for a void-free moisture barrier. App cations for these products inclu motor slot insulation, phase and lay insulation, lead wire insulation, a outer wraps.

Cords, Twines, and Lacing Tapes

Cords and lacing tapes are di cussed together because their applic tions are so similar—they both a used for tying down insulation a windings, lashing of motor coils a transformer windings, banding armatures and commutators, holdi leads in position, wire and cal harnessing, and general electron lacing work. In addition, cords m be used for space filling and sepa tion purposes. Cords are yarns whi have been twisted or plied together weaker fibrous cords may use anoth type of fibrous yarn for reinfor ment. Lacing tapes are braided woven. There are also some rou braided cords.

Fibers commonly used in electri cords and lacing tapes include cott glass, nylon, and polyester. Asbest polytetrafluoroethylene, silica, a vinyl cords are also available. Co and tapes may be treated in vario ways to improve properties such abrasion resistance, knotting streng flame resistance, fungus resistan handling, fray resistance, holdi ability at high temperatures, e Treatments include wax, oil, n prene, vinyl, silicone, polyester, v nish, polytetrafluoroethylene, rubl sizing, etc.

A glass cord impregnated with

uncured high temperature epoxy resin is used for commutator string bands, lacing, and tying. The resin prevents glass abrasion during handling and provides extra toughness and bonding strength after curing.

The 100% polyester mats described previously can also be slit into tape and subsequently twisted into twines suitable for coil tying applications. In this form, they have excellent knot strength and abrasion resistance and are compatible with resin impregnation systems.

Typical types of cords and lacing tapes are shown in the table.

Typical Cords and Lacing Tapes*

Description	Nom. Dimen., Inch	Break Str., Lbs.
Plain asbestos, unsized	1/16	
Plain asbestos, sized	3/32	
Cotton cable laid	1/64	13
Cotton cable laid	1/8	108
Flax cable laid	3/64	50
Glass, untreated	.077	307
Glass cord, uncured epoxy	1/16	100**
Glass, neoprene treated	.085	250
Glass, vinyl coated	.065	176
Glass, flat braid, vinyl coated	.080x.010	50
Glass, flat braid, silicone treated	.080x.010	50
Glass, flat braid, PTFE treated	3/32x.012	65
Glass, braided cord, PTFE treated	.045	45
Nylon, flat braid, waxed	3/32x.012	50
Nylon, flat braid, synthetic rubber	.090x.0125	50
Polyester, flat braid	3/32x.012	50
Polyester, flat braid, waxed	.035x.005	4
Polyester, flat braid, synthetic rubber	.220x.014	145
PTFE, flat braid	.025x.014	10
PTFE, round twist, synthetic rubber	.010	4
PTFE, flat braid, silicone finish	.110x.011	33
PTFE, flat braid, pre-shrunk	.031x.023	15
Silica, flat braid	.090x.017	45
Silica cord	.090	10
Vinyl, round	1/32	2.5
Vinyl, square	1/8x1/8	49.6
Vinyl, rectangular	1/16x3/16	37.2

*Note that a variety of sizes and treatments not listed in table are available. Breaking strength values shown are minimum or average. Temperature limits are generally determined by the fiber, treatment, and application.
**Cured strength is 210 lbs.

Woven Tapes

Although this portion is primarily concerned with untreated woven tapes, the availability of a parallel strand cotton tape should be mentioned since it is used for similar coil winding purposes. The parallel strands are bonded together with a special adhesive but this treatment is strictly for bonding purposes and not for improvement of other properties as is the case with treated tapes covered in other sections.

The most common tapes for electrical insulation are woven from cot-

ASTM Physical Requirements for Cotton Tape

ASTM Type	Thickness, Inches	Width, Inches	Total Ends (Warp)	Picks Per Inch (Filling)	Min. Yds. Per Lb.	Breaking Strength, Min. Lbs.	Recommended Yarn Numbers
A-1	.005	½	36	36	350	25	20/1 Warp
		¾	56	36	270	30	38/1 Filling
		1	72	36	200	40	
A-2	.007	½	36	36	290	25	
		¾	56	36	190	30	
		1	72	36	140	40	20/1 Warp
		1¼	92	36	110	50	30/1 Filling
		1½	108	36	90	60	
A-3	.007	½	36	28	300	25	
		¾	56	28	200	30	
		1	72	28	150	40	20/1 Warp
		1¼	92	28	120	50	30/1 Filling
		1½	108	28	100	60	
B-1	.013	½	52	40	220	40	
		¾	76	40	150	65	
		1	100	40	115	85	20/1 Warp
		1¼	135	40	85	115	30/1 Filling
		1½	148	40	75	130	
B-2	.020	½	40	40	110	50	
		¾	60	40	95	75	
		1	80	40	70	100	20/2 Warp
		1¼	100	40	55	125	20/1 Filling
		1½	120	40	45	150	
C-1	.030	½	60	40	110	60	
		¾	80	40	90	75	
		1	100	40	70	90	20/2 Warp
		1¼	132	40	55	115	20/1 Filling
		1½	150	40	45	140	

"A" indicates plain weave; "B" is herringbone weave (at least single point twill, two up and two down); and "C" is non-elastic weave.

Polyester Fiber Tape

Thickness, Inch	Width, Inch	Total Ends	Picks Per Inch	Break. Strength, Lbs.	Nom. Yds./Lb.
.0035	½	50	72	30	600
	⅝	62	"	37	480
	¾	75	"	45	400
	1	100	"	60	300
	1¼	125	"	75	240
	1½	150	"	90	200
.005	½	50	72	30	600
	⅝	62	"	37	480
	¾	75	"	45	400
	1	100	"	60	300
	1¼	125	"	75	240
	1½	150	"	90	200

ton, glass, and asbestos yarns but woven polyester, silica, acetate, and various combinations are also available.

Woven tapes are used for taping field and armature coils, banding wire insulation, cushioning insulation for the end turns of coils, tying and fastening purposes, coil wraps, transformer insulation, anchoring and insulation of leads, wire and cable insulation wraps, splice insulation, physical spacing, and filling of space.

When tapes are applied, they can be lapped (generally one-third to one-half), edge butted (which might take more time), or spaced (which provides only physical spacing). In order to reduce labor time, it is important to always use the widest tape width possible when applying tape wraps but it should be rememembered that narrow tape widths provide the smoothest wrap for tiny or sharply curved coils and components.

Selection of proper tape material, weave, width, thickness, construction, etc., should be determined by the requirements of the application—factors to be considered include tensile strength, machine or hand wrapping, heat resistance, cushioning, tear strength, elongation, conformability, ability to be impregnated, and compatibility with other materials in the insulation system.

It is possible to slit tape from woven cloth sheeting but very little of this type is used because of poor tear strength and raveling. Woven tapes generally are woven to the width desired with a selvage edge—this type of edge is obtained by weaving the warp yarns closer together at the edge in order to increase tear strength and prevent raveling.

Woven asbestos tape for electrical insulation is commonly called listing. Asbestos tape is generally available in both commercial and underwriters' grades in widths from ½ to 3 inches. Both ferrous and non-ferrous types are made—ferrous means that the magnetic iron in the tape does not exceed 2% and that the total iron content (magnetic and chemically combined) does not exceed 6%—non-ferrous means that the magnetic iron does not exceed 0.75% and the total iron content does not exceed 1.75%. Variations in construction are possible such as combining asbestos warp yarns and cotton filling yarns or reinforcing the asbestos with glass. For the asbestos fine tapes in thicknesses of .010", .015", .020", .025", and .030", underwriters' grade is standard. Commercial grade is used for thicknesses of 1/32", 1/16", ⅛", 3/16", and ¼". Other grades can be supplied on special order. Asbestos is used because of its thermal properties, flexibility, and resilience.

ASTM D 315-62T, Specifications and Methods of Test for Asbestos Tape for Electrical Purposes, covers underwriters' grade tape in thicknesses from .010" to .030" and widths from ½" to 2". Construction specifications tabulate the total ends, picks per inch, and pounds per 100 feet for each thickness and width.

Cotton tapes are supplied in a variety of weaves, thicknesses, widths, and constructions to provide different degrees of tensile strength, tear strength, elongation, resilience, and other properties. Plain weave tapes with their excellent stretchability are used most widely but there is also some use of herringbone weave (twill) which are also called webbing or staybindings. Cotton tapes readily absorb varnishes and other impregnants.

Cotton tapes are covered by ASTM D 335-51, Specifications for Woven Cotton Tapes for Electrical Purposes. The table shows the ASTM physical requirements for cotton tape.

Most glass tape for electrical insulation is woven from continuous filaments, the staple fibers being used only where cushioning and resilience are desirable. As with cotton tapes, a wide variety of tape constructions are available. Many of these are shown in the tables.

Tight weave B tapes using continuous filament 450 yarns (except 225 used in the warp in .005 and .007 thicknesses) and medium weave tapes using continuous filament 225 yarns represent constructions introduced many years ago and are designed to meet military specification MIL-Y-1140C. The B weave tapes are very flexible and possess maximum

Specifications for Glass Tapes Using 75's and 150's Singles Yarns

Thickness, Inch	Width, Inch	Construction: Warp Total Ends	Construction: Filling Picks/In.	Min. Av. Breaking Strength, lbs.
.004A	½	25	24	86
	¾	37	24	131
	1	49	24	157
	1½	73	24	234
.005A	½	26	26	183
	¾	37	26	260
	1	49	26	345
	1½	71	26	500
.007A	½	26	26	183
	¾	37	26	260
	1	49	26	345
	1½	71	26	500
.010A	½	22	16	310
	¾	33	16	465
	1	44	16	620
	1½	66	16	930
.004B	½	25	30	86
	¾	37	30	131
	1	49	30	157
	1½	73	30	234
.005B	½	26	34	183
	¾	37	34	260
	1	49	34	345
	1½	71	34	500
.007B	½	26	34	183
	¾	37	34	260
	1	49	34	345
	1½	71	34	500

Above tapes use 75's yarns except that .005" thicknesses use 150's in filling and .004" tapes u 150's in both warp and filling.

tensile strength—the tight weave often makes them preferable for hand taping where tension may not be evenly distributed across the tape width. The B weave tape is the only one available in a space-saving .003" thickness. The A weave tapes using continuous filament 225 yarns are now used to a somewhat limited extent—high tensile strength makes them suitable for most applications. The medium weave C tapes were introduced after the original B and A glass tapes. The C weave tapes are more open weave than the B or A tapes and are made with lower cost continuous filament 150 yarns—tensile strength is generally slightly less than the preceding tapes but the lower cost C tapes are suitable for many machine taping jobs.

More recently, glass tapes using low cost, finer filament 150's and 75's singles yarns were developed. These tapes are said to offer improved pliability, conformability, abrasion resistance, and ability to be thoroughly impregnated by insulating varnishes. These tapes are suggested for replacing the A-225 and C-150 tapes and in some cases, the B weave tapes.

ASTM D-580-49 covers Standard Methods of Testing and Tolerances for Woven Glass Tapes.

Glass yarns are now woven in combination with polyester yarns for certain applications where some stretch is desirable.

Typical physical specifications for polyester fiber tape are also tabulated.

Cloths

For electrical insulation purposes, cloths and fabrics are nearly always treated or combined in some manner. They serve primarily as treated cloth insulation materials and prepregs (see section 3-7) and as base materials for laminated plastics (see section 3-14). They are also used in composite insulations (see sections 3-8 and 3-15). Asbestos, cotton, glass, and glass/polyester are generally used for treated fabrics but there has been some usage of nylon, rayon, and silk. Asbestos, cotton, glass, and nylon are commonly used for laminated plastics with limited usage of silica, polyester, quartz, and other man-made materials. Much of the general informa-

****Glass Tapes Using 450's, 225's, or 150's Yarns**

Thickness, Inch	Width, Inch	Total Ends	Picks Per Inch	Approx. Yds./Lb.	*Min. Breaking Strength Range, Lbs
		Tight (B) Weave			
.003	½	21	42	620	45
	¾	30	42	419	60-64
	¾	45	42	282	95-97
	1	63	42	206	135
	1½	108	42	122	190-232
.005	½	21	39	279	125-129
	¾	27	39	216	148-166
	¾	39	39	149	244-249
	1	51	39	113	313-335
	1½	75	39	77	459-477
.007	½	21	39	231	125-129
	¾	27	39	179	148-166
	¾	39	39	123	239-244
	1	51	39	94	313-335
	1½	75	39	63	459-477
		Medium (A) Weave			
.005	½	24	35	258	100-106
	¾	32	35	185	135-142
	1	42	35	140	160-175
	1½	62	35	95	250
.007	½	24	32	179	130-161
	¾	32	32	128	175-215
	1	42	32	97	240-283
	1½	62	32	67	370-418
.010	½	16	21	133	160-213
	¾	24	21	89	250-321
	1	32	21	68	350-428
	1½	48	21	45	550-662
.015	½	14	16	95	210-319
	¾	20	16	66	320-426
	1	26	16	50	440-593
	1½	40	16	33	660-835
		Medium (C) Weave			
0.005	½	24	29		90-114
	¾	32	29		124-152
	1	42	29		158-200
	1½	62	29		232-295
0.007	½	24	29		114-132
	¾	32	29		152-177
	1	42	29		200-232
	1½	62	29		295-342
0.010	½	16	21		165
	¾	24	21		249
	1	32	21		332
	1½	48	21		497
0.015	½	14	16		207-254
	¾	20	16		296-376
	1	26	16		386-490
	1½	40	16		593-752
0.020	½	11	14		253-334
	¾	15	14		345-464
	1	21	14		485-632
	1½	31	14		713-962
0.025	½	20*	14		450-608
	¾	30*	14		690-912
	1	40*	14		920-1216
	1½	62*	14		1426-1885

**Intended as a guide and not for establishing specifications.*

***Tight weave B quality tape uses 450's yarns except that .005 and .007" thicknesses use 225's in warp. Medium weave A quality uses 225's yarns. Medium weave C quality uses 150's yarns.*

tion given for woven tapes would also apply to fabrics such as strength, flexibility, resilience, stretchability, etc.

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SUPPLIER DIRECTORY LISTING

NOTE: Numbers in parentheses following each product covered in this section correspond with the numbers shown in front of each supplier of products listed here (thus indicating which firms supply the product concerned). Only company names are listed here—see Part 4, section 4-1, for addresses of suppliers. Bold face type indicates advertisers—see advertisers' listing at back of book for page numbers of advertisements.

Products Covered in this Section

Fibers, Threads, and/or Yarns (Plain or Coated)

Acetate (8, 16, 23, 25, 53, 64, 69, 78)
Asbestos (3, 33, 38, 42, 48, 60, 61, 67)
Ceramic (14, 52, 54)
Cotton (5, 8, 13, 15, 17, 33, 53, 69, 81)
Fused quartz (34, 67, 71, 73)
Glass (13, 24, 32, 33, 43, 51, 53, 57, 67, 68, 70, 71, 72, 81, 83)
Polyamide (nylon) (1, 5, 8, 23, 36, 64, 69, 71)
Polyamide (heat resistant type tradenamed "Nomex") (8, 13, 23, 33, 36, 69, 71)
Polyester (5, 8, 13, 16, 17, 23, 25, 33, 36, 53, 63, 64, 69, 71, 78, 81)
Polypropylene (5, 8, 17, 53, 65, 69, 71)
Polytetrafluoroethylene (2, 5, 8, 13, 19, 23, 27, 36, 69)
Rayon (8, 17, 33, 64, 69, 81)
Silica (37, 40, 51, 67)

Cords, Twines, and Lacing or Tying Tapes, Treated and Untreated

Asbestos (3, 18, 42, 60, 61, 67)
Ceramic (4, 14, 52, 54)
Cotton (6, 8, 13, 17, 18, 35, 78, 81)
Flax (8, 17, 22)
Glass (9, 15, 18, 32, 36, 39, 43, 53, 57, 67, 68, 70, 71, 76, 77, 81, 82, 83)
Paper (13, 18, 46, 49, 65, 74)
Polyamide (heat resistant type tradenamed "Nomex") (8, 9, 13, 15, 18, 36, 69, 71, 77)
Polyamide (nylon) (6, 8, 10, 18, 22, 36, 41, 69, 71, 77)
Polyester (6, 8, 13, 15, 17, 18, 22, 36, 41, 53, 69, 71, 77, 79, 81)
Polytetrafluoroethylene (2, 8, 10, 13, 18, 19, 22, 36, 41, 69, 77, 79)
Silica (36, 37, 40, 67, 68, 73)
Vinyl (12, 18, 22, 36, 41, 53, 58, 59, 68, 80, 82)

Roving and Lap

Asbestos (3, 42, 60, 61)
Ceramic (4, 14, 54)
Glass (21, 43, 44, 55, 57, 67, 81)
Polyamide (heat resistant type tradenamed "Nomex") (45)
Polyester (45)
Quartz (34, 44, 67, 73)
Silica (33, 37, 40, 44, 67)

Mats and Felts, Untreated

Asbestos (3, 5, 60, 61)
Ceramic (4, 14, 54)
Cotton (5, 28, 45, 56)
Glass (24, 29, 43, 55, 62, 67, 81)
Polyamide (heat resistant type tradenamed "Nomex") (45)
Polyester (20, 26, 45, 51, 56, 81)
Polypropylene (45, 56, 65)
Quartz (34, 67, 73)
Silica (37, 40, 67)

Woven Tapes, Untreated and Non-Adhesive

Acetate (18, 53, 67, 69, 78)
Asbestos (3, 7, 18, 42, 60, 61)
Ceramic (14)
Cotton (11, 15, 18, 30, 35, 53, 69, 75)
Glass (7, 15, 18, 21, 30, 39, 42, 53, 60, 66, 67)
Glass/asbestos (7, 18, 42, 67)
Glass/polyester (7, 15, 18, 39, 67)
Polyamide (heat resistant type tradenamed "Nomex") (15, 69)
Polyester (7, 15, 18, 20, 53, 69, 78)
Quartz (15, 34, 67, 73)
Silica (37, 40, 67)

Cloth and Fabric, Untreated and Non-Adhesive

Acetate (18, 53, 67)
Asbestos (3, 7, 18, 42, 60, 61, 67)
Asbestos/glass (3)
Asbestos/polyester (3)
Ceramic (14)
Cotton (18, 45, 50, 53, 67, 81)
Glass (7, 18, 21, 29, 42, 50, 53, 67, 81)
Polyamide (Nylon) (18, 45, 67)
Polyamide (heat resistant type tradenamed "Nomex") (18, 45, 67)
Polyester (18, 20, 45, 47, 53, 67)
Polyester/glass (18, 50, 53, 67)
Polypropylene (18, 45, 47, 53, 65, 67)
Quartz (34, 67, 73)
Rayon (18, 45, 50, 67)
Silica (37, 40, 67)

Suppliers of Preceding Products

1—Allied Chemical Corp.
2—Amerco, Inc., Tetrafluor Div.
3—AMERICAN ASBESTOS TEXTILE CORP.
4—Aremco Products, Inc.
5—ARVEY CORP., LAMCOTE DIV.
6—The Atkins & Pearce Mfg. Co.
7—Atlas Asbestos Co., Seal-Tite Mfg. Co., Div.
8—BELDING-CORTICELLI, INDUSTRIAL YARN DIV.
9—BENTLEY-HARRIS MFG. CO.
10—Birnbach Radio Co., Inc.
11—Bo-Buck Mills Inc.
12—The Borden Co., The Borden Chemical Co., Div.
13—THE BORDEN CHEMICAL CO., MYSTIK TAPE DIV.
14—The Carborundum Co., Refractories & Electronics Div.
15—CAROLINA NARROW FABRIC CO.
16—Celanese Corp., Celanese Plastics Co., Div.
17—Chadwick Yarn Co.
18—Chase & Sons, Inc.
19—Chemplast Inc.
20—Chevron Chemical Co., Oronite Div.
21—Clark-Schwebel Fiber Glass Corp.
22—*Dapun Electronics & Cable Corp.*
23—E. I. DU PONT DE NEMOURS & CO., (INC.)
24—The Eagle-Picher Co.
25—Eastman Chemical Products, Inc., Subsidiary of Eastman Kodak Co.
26—The Eaton-Dikeman Co.
27—Enflo Corp.
28—Fabrican Products
29—Fiber Glass Industries, Inc.
30—Fiber Mfg. Co.
32—GENERAL CABLE CORP.
33—General Electric Co., *Insulating Materials* Dept.
34—General Electric Co., Lamp Glass Dept.
35—General Printed String Co.
36—Gudebrod Bros. Silk Co., Inc.
37—Haveg Industries, Inc., Sil-Temp Materials D
38—Heaman Mines Ltd.
39—HESS, GOLDSMITH & CO., HORACE LINT DIV.
40—Hitco, Materials Div.
41—Icore Industries
42—JOHNS-MANVILLE
43—Johns-Manville Fiber Glass Inc.
44—Kaufman Glass Co.
45—THE KENDALL CO., FIBER PRODUCTS DIV
46—Kraielt Co.
47—*Kressilk Products, Inc.*
48—Lake Asbestos of Quebec Ltd.
49—John A. Manning Paper Co.
50—*Milliken Industrials Inc., Exeter Div.*
51—3M CO.
52—Mitronics, Inc.
53—Mutual Industries, Columbia Electrical Tap Div.
54—National Beryllia Corp.
55—Owens-Corning Fiberglas Corp., Fiberglas Industrial Materials Div.
56—Pellon Corp., *Industrial Div.*
57—Pittsburgh Plate Glass Co., Fiber Glass Di
58—Plastic Extrusion & Engineering Co., Inc.
59—Plymouth Rubber Co., Inc.
60—H. K. PORTER CO., INC., THERMOID DIV
61—RAYBESTOS-MANHATTAN, INC., ASBEST TEXTILE DIV.
62—Reichhold Chemicals, Inc.
63—Riegel Paper Corp., Industrial Films Div.
64—Robison Rayon Co., Inc., Atlantic Yarns D
65—Schlichter Products Co.
66—*Smooth On Mfg. Co., Inc.*
67—J. P. STEVENS & CO., INC., INDUSTRIAL GLASS FABRICS DEPT.
68—SUFLEX CORP.
69—SYNTHETIC THREAD CO., INC., WIRE & CABLE DIV.
70—Taconic Plastics
71—JONATHAN TEMPLE & CO., INC.

72—Tensolite Insulated Wire Co., Inc., Subs of Carlisle Corp.
73—Thermal American Fused Quartz Co.
74—E. W. Twitchell, Inc.
75—United Shoe Machinery Corp.
76—VARFLEX CORP., VARFLEX SALES CO., DIV.
77—Western Filament Corp.
78—Wm. E. Wright & Sons Co., Trimtex Inc
79—Tri-Point Industries, Inc.
80—The Borden Chemical Co., Resinite Western Operations
81—CPS Industries, Inc., Ripco Products D
82—Electra Insulation Corp.
83—DODGE FIBERS CORP.