ZEUS®

POLYMER EXTRUSIONS

CATALOG 11

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ZEUS®

APPLICATIONS

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Applications
Medical

As the leading supplier of fluoropolymer tubing in the medical device market, ZEUS is well adapted to servicing a wide range of customer needs. We are well experienced at working with all of the organizational elements of a medical device manufacturer. To assist these specialized requests we established a medical department over 15 years ago within our sales force and staffed it with highly-trained and medical device oriented technical salespeople. ZEUS is a true pioneer of high performance plastics in this industry.

For the R&D engineer working on a new innovative device we offer quick turnaround, technical support, and free samples for prototyping. We work with production engineers to help improve yields and throughput. Regulatory specialists appreciate our quality systems and USP Class VI certified polymers. Purchasing agents appreciate our stocking programs and the level of service and delivery we offer the industry. We offer a true cross functional relationship to our customers

On the materials side, we offer a wide range of fluoropolymers and specialized plastics with a history of successful medical device applications. Many of our extruded, heat shrink, and multi-lumen tubes have been chosen for their pure, smooth, non-toxic, non-allergenic properties, as well as their compatibility with human tissues and fluids.

Most of what we manufacture for the medical device industry is extremely tight toleranced tubing. With our staff of skilled polymer experts and over 40 years of extrusion experience we are experts at customizing the properties of our polymers through process and material modification technologies.

Applications
Industrial

With more than 450,000+ sq ft. of manufacturing space ZEUS is ready to meet the challenges of the industrial markets. We have a strong working knowledge of a multitude of industries, including: automotive, chemical processing, electronic, aerospace and aviation, fiber optics, environmental and analytical. We understand that new products and material enhancements are critical for our customers to remain competitive and successful. ZEUS offers a wide variety of standard and specialized products to meet your needs. ZEUS' knowledgeable technical sales personnel are standing by to help you design the product you need.

Fluid Handling

The demand for fluoropolymer tubing in fluid applications continues to increase as requirements become more specific. With sizes from .002" up to 2.0" inside diameters, ZEUS' line of chemically resistant extrusions withstands corrosive fluids like sulfuric acid, hydrocarbon fuels and strong mineral acids.

High purity resins are used to extrude tubing with the lowest levels of extractables and the smoothest surface finish for use in semiconductor and pharmaceutical applications. FEP Lined Polyethylene tubing for environmental applications and PEEK™ tubing for analytical applications are a few of the specialty markets served. FEP, PFA and MFA tubing support applications ranging from laboratory plumbing, food processing and adhesive transfer systems to fuel, paint and hydraulic lines.

Increasing barrier properties creates tubing with the lowest water vapor transmission rates of any plastic. This is an example of the advances ZEUS has made to remain a leader in highly engineered extrusions. As new applications develop the need for our exceptional polymer product line increases significantly.

Electrical/Mechanical

ZEUS has the broadest product line of fluoropolymer tubing used for mechanical and electrical insulation applications. Low friction, lightweight, high temperature resistance, high dielectric and tensile strength are just a few of the characteristics of fluoropolymers. These attributes allow fluoropolymers to be used in many applications where other plastics would fail. ZEUS tubing has met or exceeded the critical environments in aviation programs worldwide. Some of these products include AWG tubing and heat shrinkable tubing for insulation, in addition to spiral cut cable wrap and convoluted tubing for wire harnesses and cable assemblies.

A few examples of the wide array of electrical applications includes microware cable insulation featuring extrusions directly over wire, connector and terminal sleeves, fiber optic cable jacketing, hermetic motor insulation and battery pack and capacitor encapsulation.

Mechanical applications are not limited to the industry standard materials. Chemical modifiers are used for enhanced push-pull cable jacketing, wafer thin bushings, watertight encapsulation, greaseless bearings, tire valve seals and chafe guards. To extend the life of many components, ZEUS also supplies a wide range of heat shrinkable extrusions that have become an effective means of applying a tight jacketing that stands up to the hostile environments of 500°F heat, abrasion and shock.

ZEUS®

EXTRUDED SIZES

EXTRUDED SIZES

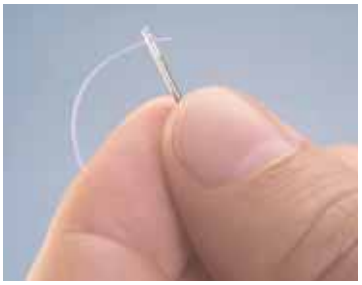
PTFE Sub-Lite-Wall®

Extruded & Heat Shrinkable Tubing

All Sub-Lite-Wall® is custom ordered

Dimensions (Inches)

EXTRUDED			HEAT SHRINK			
AWG Size	Inside Diameter Inches	Wall Thickness Inches	Ordered As AWG Size No.	Expanded I.D. Min. Inches	Recovered I.D. Max. Inches	Recovered Wall Thickness Inches
44	0.0020	0.0020	34	0.020	0.008	0.0020
42	0.0025	0.0020	33	0.025	0.010	0.0020
40	0.0030	0.0020	32	0.030	0.012	0.0020
38	0.0040	0.0020	30	0.034	0.015	0.0020
36	0.0050	0.0030	28	0.038	0.018	0.0020
34	0.0060	0.0030	26	0.046	0.022	0.0020
32	0.0080	0.0030	24	0.050	0.027	0.0020
30	0.0100	0.0030	22	0.055	0.032	0.0020
28	0.0130	0.0030	20	0.060	0.039	0.0020
26	0.0160	0.0030	18	0.076	0.049	0.0020
24	0.0200	0.0020	16	0.093	0.061	0.0020
22	0.0250	0.0020	14	0.120	0.072	0.0020
20	0.0320	0.0020	12	0.150	0.089	0.0020
18	0.0400	0.0015	10	0.191	0.112	0.0020
16	0.0650	0.0015	8	0.240	0.141	0.0025
14	0.0730	0.0015				
12	0.0840	0.0015				
10	0.0980	0.0020				
8	0.1100	0.0020				
6	0.1620	0.0025				
4	0.2040	0.0035				
2	0.2580	0.0040				
0	0.3250	0.0050				



Now available in Sub-Lite-Wall® configurations with wall thicknesses down to .001 on many sizes. +/-.0005" (.013mm). Tolerances available in most sizes. Call us for more details.

ZEUS SUB-LITE-WALL® Tubing is available in both regular extruded micro-miniature dimensions, and in heat shrink versions. Inside diameters, outside diameters, and wall thicknesses are uniform throughout. **The dimensions and tolerances shown here are only a guide.** You can write your own specifications with the assurance that ZEUS can meet your requirements completely in either extruded or heat shrink version.

PACKAGING: See Technical Information for more details.

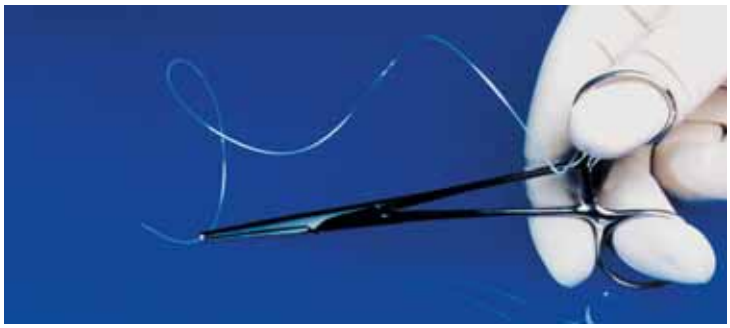
PTFE Sub-Lite-Wall®

Extruded & Heat Shrinkable Tubing

All Sub-Lite-Wall® is custom ordered

Metric Dimensions (mm)

EXTRUDED			HEAT SHRINK			
AWG Size	Inside Diameter (mm)	Wall Thickness (mm)	Ordered As AWG Size No.	Expanded I.D. Min. (mm)	Recovered I.D. Max. (mm)	Recovered Wall Thickness (mm)
44	0.051	0.051	34	0.508	0.203	0.051
42	0.064	0.051	33	0.635	0.254	0.051
40	0.076	0.051	32	0.762	0.305	0.051
38	0.102	0.051	30	0.864	0.381	0.051
36	0.127	0.076	28	0.965	0.457	0.051
34	0.152	0.076	26	1.168	0.559	0.051
32	0.203	0.076	24	1.270	0.686	0.051
30	0.254	0.076	22	1.397	0.813	0.051
28	0.330	0.076	20	1.524	0.991	0.051
26	0.406	0.076	18	1.930	1.245	0.051
24	0.508	0.051	16	2.362	1.549	0.051
22	0.635	0.051	14	3.048	1.829	0.051
20	0.813	0.051	12	3.810	2.261	0.051
18	1.016	0.038	10	4.851	2.845	0.051
16	1.651	0.038	8	6.096	3.581	0.064
14	1.854	0.038				
12	2.134	0.038				
10	2.489	0.051				
8	2.794	0.051				
6	4.115	0.064				
4	5.182	0.089				
2	6.553	0.102				
0	8.255	0.127				



Now available in Sub-Lite-Wall® configurations with wall thicknesses down to .001 on many sizes. +/-.0005" (.013mm.) Tolerances available in most sizes. Call us for more details.

ZEUS SUB-LITE-WALL® Tubing is available in both regular extruded micro-miniature dimensions, and in heat shrink versions. Inside diameters, outside diameters, and wall thicknesses are uniform throughout. **The dimensions and tolerances shown here are only a guide.** You can write your own specifications with the assurance that ZEUS can meet your requirements completely in either extruded or heat shrink version.

PACKAGING: See Technical Information for more details.

Dimensions (Inches)

Custom Sizes Available

INSIDE DIAMETER				WALL DIMENSIONS					
AWG Size	Min.	Nom.	Max.	Standard Wall Nom.	Standard Wall Tol.	Thin Wall Nom.	Thin Wall Tol.	Lightweight Wall Nom.	Lightweight Wall Tol.
32	0.008	0.010	0.012	0.005	±.002	0.005	±.002	-	-
30	0.010	0.012	0.015	0.009	±.002	0.009	±.002	0.006	±.002
28	0.013	0.015	0.018	0.009	±.002	0.009	±.002	0.006	±.002
26	0.016	0.018	0.021	0.009	±.002	0.009	±.002	0.006	±.002
24	0.020	0.022	0.026	0.012	±.002	0.010	±.003	0.006	±.002
23	0.023	0.026	0.029	0.012	±.002	0.010	±.003	0.006	±.002
22	0.025	0.028	0.032	0.012	±.002	0.010	±.003	0.006	±.002
21	0.029	0.032	0.035	0.012	±.002	0.010	±.003	0.006	±.002
20	0.032	0.034	0.038	0.016	±.003	0.012	±.003	0.006	±.002
19	0.036	0.038	0.042	0.016	±.003	0.012	±.003	0.006	±.002
18	0.040	0.042	0.046	0.016	±.003	0.012	±.003	0.006	±.002
17	0.045	0.047	0.052	0.016	±.003	0.012	±.003	0.006	±.002
16	0.051	0.053	0.058	0.016	±.003	0.012	±.003	0.006	±.002
15	0.057	0.059	0.065	0.016	±.003	0.012	±.003	0.006	±.002
14	0.064	0.066	0.072	0.016	±.003	0.012	±.003	0.008	±.002
13	0.072	0.076	0.081	0.016	±.003	0.012	±.003	0.008	±.002
12	0.081	0.085	0.091	0.016	±.003	0.012	±.003	0.008	±.002
11	0.091	0.095	0.101	0.016	±.003	0.012	±.003	0.008	±.002
10	0.102	0.106	0.112	0.016	±.003	0.012	±.003	0.008	±.002
9	0.114	0.118	0.124	0.020	±.004	0.015	±.003	0.008	±.002
8	0.129	0.133	0.139	0.020	±.004	0.015	±.003	0.008	±.002
7	0.144	0.148	0.155	0.020	±.004	0.015	±.003	0.008	±.002
6	0.162	0.166	0.174	0.020	±.004	0.015	±.003	0.010	±.003
5	0.182	0.186	0.195	0.020	±.004	0.015	±.003	0.010	±.003
4	0.204	0.208	0.218	0.020	±.004	0.015	±.003	0.010	±.003
3	0.229	0.234	0.244	0.020	±.004	0.015	±.003	0.010	±.003
2	0.258	0.263	0.273	0.020	±.004	0.015	±.003	0.010	±.003
1	0.289	0.294	0.305	0.020	±.004	0.015	±.003	0.010	±.003
0	0.325	0.330	0.342	0.020	±.004	0.015	±.003	0.012	±.003

PACKAGING: See Technical Information for more details.

Meets or exceeds the following specifications where applicable
TFE SW - ASTM D 3295, AMS 3653, MIL-I-22129
TFE TW - ASTM D 3295, AMS 3655
TFE LW - ASTM D 3295, AMS 3654
FEP SW - ASTM D 3296, L-P-389
FEP LW - ASTM D 3296, L-P-389

On all cases of military or commercial specifications, latest revisions apply. Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

ZEUS' TUBING complies with UL-224, has been assigned UL FILE NO. E-64007, and is listed under the UL "RECOGNIZED COMPONENT PROGRAM". (CSA-OPT) File # 082582 has been awarded for PTFE, FEP SW and TW.

Metric Dimensions (mm)

Custom Sizes Available

INSIDE DIAMETER				WALL DIMENSIONS					
AWG Size	Min.	Nom.	Max.	Standard Wall Nom.	Standard Wall Tol.	Thin Wall Nom.	Thin Wall Tol.	Lightweight Wall Nom.	Lightweight Wall Tol.
32	0.20	0.25	0.30	0.13	±.05	0.13	±.05	–	–
30	0.25	0.30	0.38	0.23	±.05	0.23	±.05	0.15	±.05
28	0.33	0.38	0.46	0.23	±.05	0.23	±.05	0.15	±.05
26	0.41	0.46	0.53	0.23	±.05	0.23	±.05	0.15	±.05
24	0.51	0.56	0.66	0.30	±.05	0.25	±.08	0.15	±.05
23	0.58	0.66	0.74	0.30	±.05	0.25	±.08	0.15	±.05
22	0.64	0.71	0.81	0.30	±.05	0.25	±.08	0.15	±.05
21	0.74	0.81	0.89	0.30	±.05	0.25	±.08	0.15	±.05
20	0.81	0.86	0.97	0.41	±.08	0.30	±.08	0.15	±.05
19	0.91	0.97	1.07	0.41	±.08	0.30	±.08	0.15	±.05
18	1.02	1.07	1.17	0.41	±.08	0.30	±.08	0.15	±.05
17	1.14	1.19	1.32	0.41	±.08	0.30	±.08	0.15	±.05
16	1.30	1.35	1.47	0.41	±.08	0.30	±.08	0.15	±.05
15	1.45	1.50	1.65	0.41	±.08	0.30	±.08	0.15	±.05
14	1.63	1.68	1.83	0.41	±.08	0.30	±.08	0.20	±.05
13	1.83	1.93	2.06	0.41	±.08	0.30	±.08	0.20	±.05
12	2.06	2.16	2.31	0.41	±.08	0.30	±.08	0.20	±.05
11	2.31	2.41	2.57	0.41	±.08	0.30	±.08	0.20	±.05
10	2.59	2.69	2.84	0.41	±.08	0.30	±.08	0.20	±.05
9	2.90	3.00	3.15	0.51	±.10	0.38	±.08	0.20	±.05
8	3.28	3.38	3.53	0.51	±.10	0.38	±.08	0.20	±.05
7	3.66	3.76	3.94	0.51	±.10	0.38	±.08	0.20	±.05
6	4.11	4.22	4.42	0.51	±.10	0.38	±.08	0.25	±.08
5	4.62	4.72	4.95	0.51	±.10	0.38	±.08	0.25	±.08
4	5.18	5.28	5.54	0.51	±.10	0.38	±.08	0.25	±.08
3	5.82	5.94	6.20	0.51	±.10	0.38	±.08	0.25	±.08
2	6.55	6.68	6.93	0.51	±.10	0.38	±.08	0.25	±.08
1	7.34	7.47	7.75	0.51	±.10	0.38	±.08	0.25	±.08
0	8.26	8.38	8.69	0.51	±.10	0.38	±.08	0.30	±.08

PACKAGING: See Technical Information for more details.

Meets or exceeds the following specifications where applicable
TFE SW - ASTM D 3295, AMS 3653, MIL-I-22129
TFE TW - ASTM D 3295, AMS 3655
TFE LW - ASTM D 3295, AMS 3654
FEP SW - ASTM D 3296, L-P-389
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Dimensions (Inches)

Custom Sizes Available

INSIDE DIAMETER				WALL DIMENSIONS					
				Standard Wall		Thin Wall		Lightweight Wall	
AWG Size	Min.	Nom.	Max.	Nom.	Tol.	Nom.	Tol.	Nom.	Tol.
1/8	0.120	0.125	0.130	0.020	±.004	0.015	±.003	—	—
1/8	0.125	0.130	0.135	—	—	—	—	0.008	±.002
3/16	0.188	0.192	0.198	0.020	±.004	0.015	±.003	0.010	±.003
1/4	0.250	0.255	0.260	0.020	±.004	0.015	±.003	0.010	±.003
5/16	0.313	0.321	0.332	0.020	±.004	0.015	±.003	0.012	±.003
3/8	0.375	0.387	0.394	0.025	±.005	0.015	±.003	0.015	±.005
7/16	0.438	0.451	0.458	0.025	±.005	0.018	±.004	0.018	±.005
1/2	0.500	0.515	0.520	0.025	±.005	0.018	±.004	0.018	±.005
5/8	0.625	0.643	0.650	0.025	±.005	0.020	±.004	0.020	±.005
3/4	0.750	0.772	0.775	0.030	±.006	0.025	±.005	0.020	±.005
7/8	0.875	0.902	0.927	0.035	±.007	—	—	—	—
1	1.000	1.030	1.060	0.035	±.007	—	—	—	—
1-1/4	1.250	1.287	1.325	0.040	±.007	—	—	—	—
1-1/2	1.500	1.550	1.580	0.045	±.007	—	—	—	—

INDUSTRIAL SPECIFICATION TUBING			
Frac. Sizes Spec'd by ID	I.D.	O.D.	Nominal Wall
1/32	0.031±.004	0.063±.004	.015
1/16	0.063±.005	0.125±.005	.030
3/32	0.094±.005	0.156±.005	.030
1/8	0.125±.005	0.188±.005	.030
3/16	0.188±.005	0.250±.005	.030
1/4	0.250±.005	0.313±.005	.030
5/16	0.313±.005	0.375±.005	.030
3/8	0.375±.005	0.438±.005	.030
7/16	0.438±.005	0.500±.006	.030
1/2	0.500±.006	0.563±.006	.030

INDUSTRIAL SPECIFICATION TUBING			
Frac. Sizes Spec'd by ID	I.D.	O.D.	Nominal Wall
9/16	0.563±.006	0.625±.006	.030
5/8	0.625±.006	0.688±.006	.030
11/16	0.688±.006	0.750±.006	.032
3/4	0.750±.006	0.830±.006	.040
7/8	0.875±.006	0.965±.006	.045
1	1.000±.010	1.10±.010	.050
1-1/8	1.125±.015	1.215±.015	.045
1-1/4	1.250±.015	1.340±.015	.040
1-1/2	1.500±.015	1.580±.015	.040

PACKAGING: See Technical Information for more details.

Meets or exceeds the following specifications where applicable
TFE SW - ASTM D 3295, AMS 3653, MIL-I-22129
TFE TW - ASTM D 3295, AMS 3655
TFE LW - ASTM D 3295, AMS 3654
FEP SW - ASTM D 3296
FEP LW - ASTM D 3296

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Metric Dimensions (mm)

Custom Sizes Available

INSIDE DIAMETER				WALL DIMENSIONS					
				Standard Wall		Thin Wall		Lightweight Wall	
AWG Size	Min.	Nom.	Max.	Nom.	Tol.	Nom.	Tol.	Nom.	Tol.
1/8	3.05	3.18	3.30	0.51	±.10	0.38	±.08	—	—
1/8	3.18	3.30	3.43	—	—	—	—	0.20	±.05
3/16	4.78	4.88	5.03	0.51	±.10	0.38	±.08	0.25	±.08
1/4	6.35	6.48	6.60	0.51	±.10	0.38	±.08	0.25	±.08
5/16	7.95	8.15	8.43	0.51	±.10	0.38	±.08	0.30	±.08
3/8	9.53	9.83	10.01	0.64	±.13	0.38	±.08	0.38	±.13
7/16	11.13	11.46	11.63	0.64	±.13	0.46	±.10	0.46	±.13
1/2	12.70	13.08	13.21	0.64	±.13	0.46	±.10	0.46	±.13
5/8	15.88	16.33	16.51	0.64	±.13	0.51	±.10	0.51	±.13
3/4	19.05	19.61	19.69	0.76	±.15	0.64	±.13	0.51	±.13
7/8	22.23	22.91	23.55	0.89	±.18	—	—	—	—
1	25.40	26.16	26.92	0.89	±.18	—	—	—	
1-1/4	31.75	32.69	33.66	1.02	±.18	—	—	—	—
1-1/2	38.10	39.37	40.13	1.14	±.18	—	—	—	—

INDUSTRIAL SPECIFICATION TUBING

Frac. Sizes Spec'd by ID	I.D.	O.D.	Nominal Wall
1/32	0.79±0.10	1.60±0.10	.38
1/16	1.60±0.13	3.18±0.13	.76
3/32	2.39±0.13	3.96±0.13	.76
1/8	3.18±0.13	4.78±0.13	.76
3/16	4.78±0.13	6.35±0.13	.76
1/4	6.35±0.13	7.95±0.13	.76
5/16	7.95±0.13	9.53±0.13	.76
3/8	9.53±0.13	11.13±0.13	.76
7/16	11.13±0.13	12.70±0.15	.76
1/2	12.70±0.15	14.30±0.15	.76

INDUSTRIAL SPECIFICATION TUBING

Frac. Sizes Spec'd by ID	I.D.	O.D.	Nominal Wall
9/16	14.30±0.15	15.88±0.15	.76
5/8	15.88±0.15	17.48±0.15	.76
11/16	17.48±0.15	19.05±0.15	.81
3/4	19.05±0.15	21.08±0.15	1.02
7/8	22.23±0.15	24.51±0.15	1.14
1	25.40±0.25	27.94±0.25	1.27
1-1/8	28.58±0.38	30.86±0.38	1.14
1-1/4	31.75±0.38	34.04±0.38	1.02
1-1/2	38.10±0.38	40.13±0.38	1.02

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Meets or exceeds the following specifications where applicable
TFE SW - ASTM D 3295, AMS 3653, MIL-I-22129
TFE TW - ASTM D 3295, AMS 3655
TFE LW - ASTM D 3295, AMS 3654
FEP SW - ASTM D 3296
FEP LW - ASTM D 3296

On all cases of military or commercial specifications, latest revisions apply. Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

ZEUS' TUBING complies with UL-224, has been assigned UL FILE NO. E-64007, and is listed under the UL "RECOGNIZED COMPONENT PROGRAM". CSA File # 082582 has been awarded for PTFE, FEP SW and TW.

Dimensions (Inches)

Custom Sizes Available

Fractional Spec'd by OD	O.D.	I.D.	Nominal Wall Thickness
1/4	0.250+/-.005	0.125+/-.005	0.063
5/16	0.313+/-.005	0.188+/-.005	0.063
3/8	0.375+/-.005	0.250+/-.005	0.063
7/16	0.438+/-.005	0.313+/-.005	0.063
1/2	0.500+/-.006	0.375+/-.006	0.063
9/16	0.563+/-.006	0.438+/-.006	0.063
5/8	0.625+/-.006	0.500+/-.006	0.063
11/16	0.688+/-.006	0.563+/-.006	0.063
3/4	0.750+/-.006	0.625+/-.006	0.063
13/16	0.813+/-.006	0.688+/-.006	0.063
7/8	0.875+/-.006	0.750+/-.006	0.063
15/16	0.938+/-.006	0.813+/-.006	0.063
1	1.000+/-.010	0.875+/-.010	0.063

Metric Dimensions (mm)

Fractional Spec'd by OD	O.D.	I.D.	Nominal Wall Thickness
1/4	6.35+/-.13	3.18+/-.13	1.60
5/16	7.92+/-.13	4.78+/-.13	1.60
3/8	9.52+/-.13	6.35+/-.13	1.60
7/16	11.13+/-.13	7.95+/-.13	1.60
1/2	12.70+/-.15	9.52+/-.15	1.60
9/16	14.30+/-.15	11.13+/-.15	1.60
5/8	15.88+/-.15	12.70+/-.15	1.60
11/16	17.48+/-.15	14.30+/-.15	1.60
3/4	19.05+/-.15	15.88+/-.15	1.60
13/16	20.65+/-.15	17.48+/-.15	1.60
7/8	22.23+/-.15	19.05+/-.15	1.60
15/16	23.83+/-.15	20.65+/-.15	1.60
1	25.40+/-.25	22.23+/-.25	1.60

PACKAGING: See Technical Information for more details.

Dimensions (Inches)

Custom Sizes Available

INSIDE DIAMETER				WALL DIMENSIONS	
AWG	ID Minimum	ID Nominal	ID Maximum	Wall Nominal	Tolerance
24	.020	.022	.026	.016	+/- .003
23	.024	.027	.030	.016	+/- .003
22	.025	.0285	.032	.016	+/- .003
21	.030	.033	.036	.016	+/- .003
20	.032	.036	.040	.018	+/- .003
19	.036	.040	.044	.020	+/- .004
18	.040	.0445	.049	.020	+/- .004
17	.045	.0495	.054	.020	+/- .004
16	.051	.056	.061	.020	+/- .004
15	.057	.062	.067	.020	+/- .004
14	.064	.069	.074	.020	+/- .004
13	.072	.077	.082	.020	+/- .004
12	.081	.086	.091	.020	+/- .004
11	.091	.096	.101	.020	+/- .004
10	.102	.107	.112	.025	+/- .005
9	.114	.119	.124	.025	+/- .005
8	.129	.135	.141	.030	+/- .005
7	.144	.151	.158	.030	+/- .005
6	.162	.17	.178	.030	+/- .005
5	.182	.19	.198	.032	+/- .005

Fractional Spec'd by ID	O.D.	I.D.	Nominal Wall Thickness
5/32	0.250+/-.005	0.156+/-.005	0.047

* This product is specified as HW and dimensionally manufactured to ID/OD

PACKAGING: See Technical Information for more details.

Dimensions (Inches)

Ordered As Diameter	Tolerances
0.028	±.002
0.031	±.002
0.035	±.002
0.039	±.002
0.047	±.002
0.050	±.002
0.055	±.002
0.062	±.002
0.070	±.002
0.078	±.003
0.094	±.003
0.100	±.003
0.109	±.003
0.125	±.003
0.150	±.003

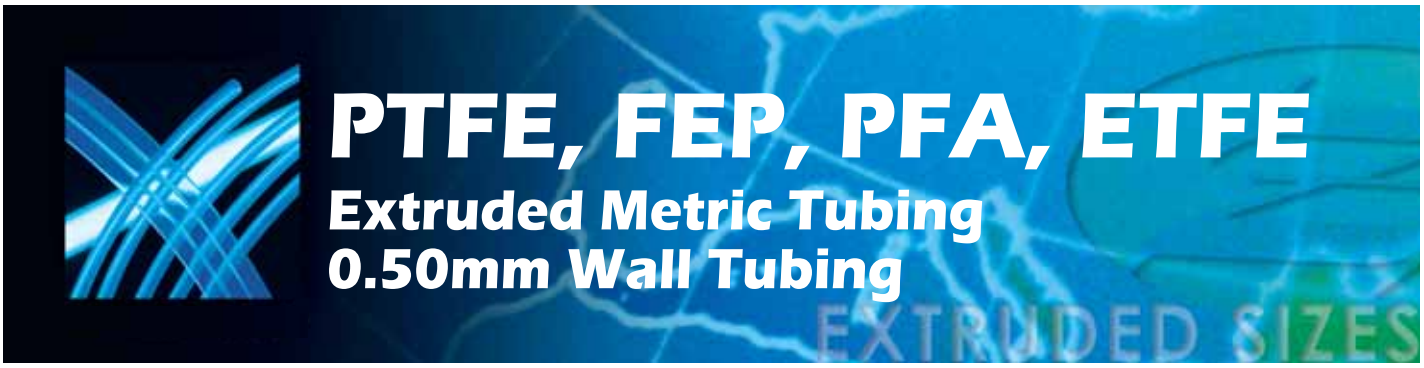
Metric Dimensions (mm)

Custom Sizes Available

Ordered As Diameter	Tolerances
0.71	±.05
0.79	±.05
0.89	±.05
0.99	±.05
1.19	±.05
1.27	±.05
1.40	±.05
1.57	±.05
1.78	±.05
1.98	±.08
2.39	±.08
2.54	±.08
2.77	±.08
3.17	±.08
3.81	±.08

PACKAGING: See Technical Information for more details.

Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request. Meets or exceeds the following specifications (where applicable) ASTM-D-3295.



Custom Sizes Available

Ordering Size (ID/OD)	I.D.	Tolerance + / -	Wall Thickness
0.50/1.50	0.50	0.05	0.50+/-0.07
1.00/2.00	1.00	0.05	0.50+/-0.07
1.50/2.50	1.50	0.10	0.50+/-0.07
2.00/3.00	2.00	0.10	0.50+/-0.07
2.50/3.50	2.50	0.15	0.50+/-0.07
3.00/4.00	3.00	0.15	0.50+/-0.07
3.50/4.50	3.50	0.15	0.50+/-0.07
4.00/5.00	4.00	0.15	0.50+/-0.07
4.50/5.50	4.50	0.20	0.50+/-0.07
5.00/6.00	5.00	0.20	0.50+/-0.07
5.50/6.50	5.50	0.20	0.50+/-0.07
6.00/7.00	6.00	0.20	0.50+/-0.07
6.50/7.50	6.50	0.20	0.50+/-0.07
7.00/8.00	7.00	0.20	0.50+/-0.07
7.50/8.50	7.50	0.20	0.50+/-0.07
8.00/9.00	8.00	0.20	0.50+/-0.07
8.50/9.50	8.50	0.30	0.50+/-0.07
9.00/10.00	9.00	0.30	0.50+/-0.07
12.00/13.00	12.00	0.30	0.50+/-0.07
13.00/14.00	13.00	0.50	0.50+/-0.07

PACKAGING: See Technical Information for more details.

On all cases of military or commercial specifications, latest revisions apply. Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

PTFE, FEP, PFA, ETFE

Extruded Metric Tubing
1.00mm Wall Tubing

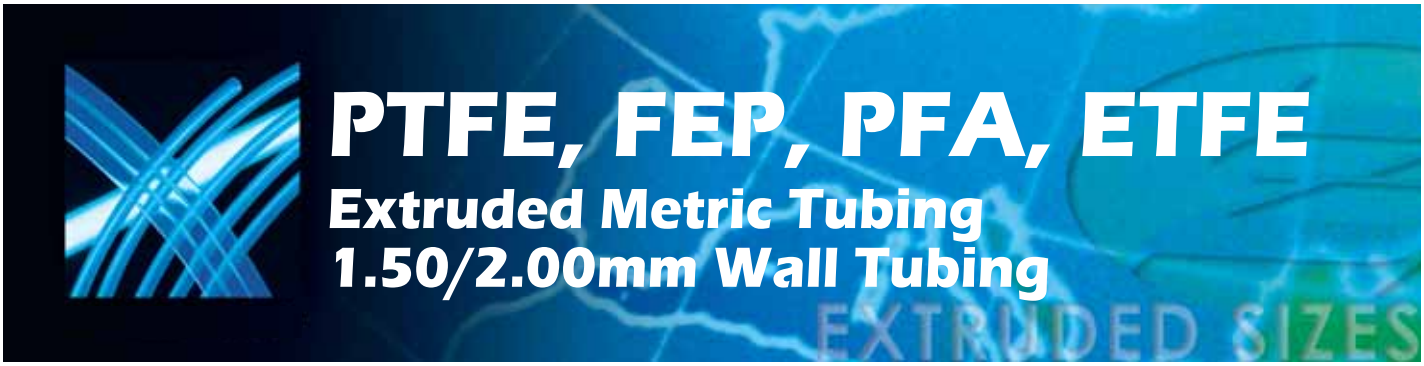
EXTRUDED SIZES

Custom Sizes Available

Ordering Size (ID/OD)	I.D.	Tolerance + / -	Wall Thickness
1.00/3.00	1.00	0.05	1.00+/-0.15
2.00/4.00	2.00	0.10	1.00+/-0.15
2.50/4.50	2.50	0.15	1.00+/-0.15
3.00/5.00	3.00	0.15	1.00+/-0.15
3.50/5.50	3.50	0.15	1.00+/-0.15
4.00/6.00	4.00	0.15	1.00+/-0.15
4.50/6.50	4.50	0.20	1.00+/-0.15
5.00/7.00	5.00	0.20	1.00+/-0.15
5.50/7.50	5.50	0.20	1.00+/-0.15
6.00/8.00	6.00	0.20	1.00+/-0.15
6.50/8.50	6.50	0.20	1.00+/-0.15
7.00/9.00	7.00	0.20	1.00+/-0.15
7.50/9.50	7.50	0.20	1.00+/-0.15
8.00/10.00	8.00	0.20	1.00+/-0.15
8.50/10.50	8.50	0.30	1.00+/-0.15
9.00/11.00	9.00	0.30	1.00+/-0.15
9.50/11.50	9.50	0.30	1.00+/-0.15
10.00/12.00	10.00	0.30	1.00+/-0.15
10.50/12.50	10.50	0.30	1.00+/-0.15
11.00/13.00	11.00	0.30	1.00+/-0.15
12.00/14.00	12.00	0.30	1.00+/-0.15
13.00/15.00	13.00	0.30	1.00+/-0.15
14.00/16.00	14.00	0.30	1.00+/-0.15
15.00/17.00	15.00	0.40	1.00+/-0.15
16.00/18.00	16.00	0.40	1.00+/-0.15
18.00/20.00	18.00	0.40	1.00+/-0.15
19.00/21.00	19.00	0.40	1.00+/-0.15
19.50/21.50	19.50	0.40	1.00+/-0.15
20.00/22.00	20.00	0.40	1.00+/-0.15
21.00/23.00	21.00	0.50	1.00+/-0.15
22.00/24.00	22.00	0.50	1.00+/-0.15
22.50/24.50	22.50	0.50	1.00+/-0.15
23.00/25.00	23.00	0.50	1.00+/-0.15
23.50/25.50	23.50	0.50	1.00+/-0.15
25.00/27.00	25.00	0.50	1.00+/-0.15
26.00/28.00	26.00	0.50	1.00+/-0.15
27.00/29.00	27.00	0.50	1.00+/-0.15
28.00/30.00	28.00	0.50	1.00+/-0.15
29.00/31.00	29.00	0.50	1.00+/-0.15
30.00/32.00	30.00	0.60	1.00+/-0.15
32.00/34.00	32.00	0.60	1.00+/-0.15
37.00/39.00	37.00	0.60	1.00+/-0.15
38.00/40.00	38.00	0.60	1.00+/-0.15
40.00/42.00	40.00	0.75	1.00+/-0.15
42.00/44.00	42.00	0.75	1.00+/-0.15
43.00/45.00	43.00	0.75	1.00+/-0.15
45.00/47.00	45.00	0.75	1.00+/-0.15
45.50/47.50	45.50	0.75	1.00+/-0.15
48.00/50.00	48.00	0.75	1.00+/-0.15
50.00/52.00	50.00	0.75	1.00+/-0.15

PACKAGING: See Technical Information for more details.

On all cases of military or commercial specifications, latest revisions apply. Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.



1.50mm Wall Tubing

Ordering Size (ID/OD)	I.D.	Tolerance + / -	Wall Thickness
1.50/4.50	1.50	0.10	1.50+/-0.20
2.00/5.00	2.00	0.15	1.50+/-0.20
3.00/6.00	3.00	0.15	1.50+/-0.20
5.00/8.00	5.00	0.20	1.50+/-0.20
6.00/9.00	6.00	0.20	1.50+/-0.20
10.00/13.00	10.00	0.30	1.50+/-0.20
12.00/15.00	12.00	0.30	1.50+/-0.20
13.00/16.00	13.00	0.30	1.50+/-0.20
14.00/17.00	14.00	0.30	1.50+/-0.20
16.00/19.00	16.00	0.40	1.50+/-0.20
18.00/21.00	18.00	0.40	1.50+/-0.20
19.00/22.00	19.00	0.40	1.50+/-0.20
20.00/23.00	20.00	0.50	1.50+/-0.20
21.00/24.00	21.00	0.50	1.50+/-0.20
22.00/25.00	22.00	0.50	1.50+/-0.20
25.00/28.00	25.00	0.50	1.50+/-0.20
28.00/31.00	28.00	0.50	1.50+/-0.20
29.00/32.00	29.00	0.50	1.50+/-0.20
30.00/33.00	30.00	0.60	1.50+/-0.20
40.00/43.00	40.00	0.75	1.50+/-0.20
49.00/52.00	49.00	0.75	1.50+/-0.20

2.00mm Wall Tubing

Custom Sizes Available

Ordering Size (ID/OD)	I.D.	Tolerance + / -	Wall Thickness
2.00/6.00	2.00	0.10	2.00+/-0.20
4.00/8.00	4.00	0.15	2.00+/-0.20
6.00/10.00	6.00	0.20	2.00+/-0.20
8.00/12.00	8.00	0.20	2.00+/-0.20
10.00/14.00	10.00	0.30	2.00+/-0.20
12.00/16.00	12.00	0.30	2.00+/-0.20
14.00/18.00	14.00	0.40	2.00+/-0.20
16.00/20.00	16.00	0.40	2.00+/-0.20
20.00/24.00	20.00	0.50	2.00+/-0.20
25.00/29.00	25.00	0.50	2.00+/-0.20
28.00/32.00	28.00	0.50	2.00+/-0.20
28.50/32.50	28.50	0.50	2.00+/-0.20
32.00/36.00	32.00	0.60	2.00+/-0.20
36.00/40.00	36.00	0.60	2.00+/-0.20
40.00/44.00	40.00	0.75	2.00+/-0.20
46.00/50.00	46.00	0.75	2.00+/-0.20

PACKAGING: See Technical Information for more details.

On all cases of military or commercial specifications, latest revisions apply.
Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

Now available in Sub-Lite-Wall® configurations with wall thicknesses down to .002 on many sizes. +/-.001" (.025mm) tolerances available in most sizes. Call us for more details.

Custom Sizes Available

Dimensions (Inches)

I.D.	O.D.	Pressure Rating*
.003	.020	2000 psi
.005	.020	2000 psi
.010	.020	2000 psi
.003	.062	5000 psi
.005	.062	5000 psi
.007	.062	5000 psi
.010	.062	5000 psi
.020	.062	5000 psi
.030	.062	5000 psi
.040	.062	5000 psi
.055	.062	5000 psi
.062	.125	5000 psi
.080	.125	3000 psi

Metric Dimensions (mm)

I.D.	O.D.	Pressure Rating*
.076	.508	2000 psi
.127	.508	2000 psi
.254	.508	2000 psi
.076	1.575	5000 psi
.127	1.575	5000 psi
.178	1.575	5000 psi
.254	1.575	5000 psi
.508	1.575	5000 psi
.762	1.575	5000 psi
1.016	1.575	5000 psi
1.397	1.575	5000 psi
1.575	3.175	5000 psi
2.032	3.175	3000 psi

The dimensions and tolerances shown here are only a guide.

* Suggested maximum safe operating pressure

PACKAGING: Contact Sales Offices for more information.

ZEUS®

HEAT SHRINKABLE EXTRUSIONS

HEAT SHRINKABLE EXTRUSIONS

ZEUS
Heat Shrink Fluoropolymer Tubing

HEAT SHRINKABLE EXTRUSIONS

ZEUS heat shrink tubing offers a unique combination of properties in its tubing, including outstanding electrical characteristics; excellent chemical and solvent resistances; purity; lubricity and outstanding performance reliability.

ZEUS has mastered the art of manufacturing fluoropolymer heat shrink tubing and can supply it with recovered walls as thin as .002". Please contact a ZEUS representative to learn more about customer sizes, packaging, lengths and colors.

Heat Shrink Application Tips

1. Always assure good ventilation in the immediate work area prior to beginning the heat shrinking process.

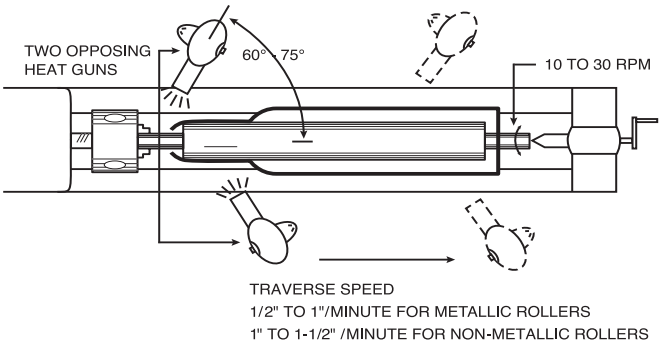
   Caution: Fumes may cause nausea and dizziness.

2. The mandrel to be covered by the heat shrink must be able to withstand the required temperature for material recovery (see table at right).

3. The mandrel being covered may act as a heat sink (especially metal mandrels). Therefore, ZEUS recommends preheating mandrels.

4. Heat shrink should be allowed to recover a minimum of 20%. Highly restricted radial recovery tends to induce longitudinal change and increase the tendency for splitting.

TOP VIEW - ROLLER IN LATHE



SAME PROCEDURE APPLIES FOR MANUAL ROTATION

5. Ovens are the most reliable way to recover heat shrink products due to their ability to ensure even heating and reduce the risk of over heating the material which can lead to brittleness and cracking. If a heat gun will be used please refer to the picture above illustrating the proper application of heat to achieve the most uniform recovery.

6. See Chart for recovery temperatures.

HEAT SHRINK RECOVERY TEMPERATURE

Material	Recovery Temperature
PTFE	654°F - 670°F 346°C - 354°C
FEP (1" ID or less)	400°F - 420°F 204°C - 216°C
FEP (1" ID or greater)	420°F - 440°F 216°C - 227°C

The heat shrink temperatures listed in this catalog are general guidelines. Actual shrink temperatures may be higher or lower depending on the design and dimensions of the heat shrink, application techniques and other factors. Please contact a Zeus technical account manager for more information.

Dimensions (inches)

Custom Sizes Available

STANDARD WALL					THIN WALL					LIGHTWEIGHT WALL				
Ordered as AWG Size No.	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as AWG Size No.	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as AWG Size No.	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.
30	0.034	0.015	0.009	±.002	30	0.034	0.015	0.009	±.002	30	0.034	0.015	0.006	±.002
28	0.038	0.018	0.009	±.002	28	0.038	0.018	0.009	±.002	28	0.038	0.018	0.006	±.002
26	0.046	0.022	0.010	±.002	26	0.046	0.022	0.010	±.002	26	0.046	0.022	0.006	±.002
24	0.050	0.027	0.012	±.002	24	0.050	0.027	0.010	±.002	24	0.050	0.025	0.006	±.002
22	0.055	0.032	0.012	±.002	22	0.055	0.032	0.012	±.003	22	0.055	0.031	0.006	±.002
20	0.060	0.039	0.016	±.003	20	0.060	0.039	0.012	±.003	20	0.060	0.038	0.006	±.002
19	0.065	0.043	0.016	±.003	19	0.065	0.043	0.012	±.003	19	0.065	0.043	0.006	±.002
18	0.076	0.049	0.016	±.003	18	0.076	0.049	0.012	±.003	18	0.076	0.046	0.006	±.002
17	0.085	0.054	0.016	±.003	17	0.085	0.054	0.012	±.003	17	0.085	0.054	0.006	±.002
16	0.093	0.061	0.016	±.003	16	0.093	0.061	0.012	±.003	16	0.093	0.057	0.006	±.002
15	0.110	0.067	0.016	±.003	15	0.110	0.067	0.012	±.003	15	0.110	0.063	0.006	±.002
14	0.120	0.072	0.016	±.003	14	0.120	0.072	0.012	±.003	14	0.120	0.072	0.008	±.002
13	0.140	0.080	0.016	±.003	13	0.140	0.080	0.012	±.003	13	0.140	0.080	0.008	±.002
12	0.150	0.089	0.016	±.003	12	0.150	0.089	0.012	±.003	12	0.150	0.089	0.008	±.002
11	0.170	0.101	0.016	±.003	11	0.170	0.101	0.012	±.003	11	0.170	0.099	0.008	±.002
10	0.191	0.112	0.016	±.003	10	0.191	0.112	0.012	±.003	10	0.191	0.110	0.008	±.002
9	0.205	0.124	0.020	±.004	9	0.205	0.124	0.015	±.004	9	0.205	0.122	0.008	±.002
8	0.240	0.141	0.020	±.004	8	0.240	0.141	0.015	±.004	8	0.240	0.139	0.008	±.002
7	0.270	0.158	0.020	±.004	7	0.270	0.158	0.015	±.004	7	0.270	0.154	0.008	±.002
6	0.302	0.178	0.020	±.004	6	0.302	0.178	0.015	±.004	6	0.302	0.172	0.010	±.003
5	0.320	0.198	0.020	±.004	5	0.320	0.198	0.015	±.004	5	0.320	0.192	0.010	±.003
4	0.370	0.224	0.020	±.004	4	0.370	0.224	0.015	±.004	4	0.370	0.214	0.010	±.003
3	0.390	0.249	0.020	±.004	3	0.390	0.249	0.015	±.004	3	0.390	0.241	0.010	±.003
2	0.430	0.278	0.020	±.004	2	0.430	0.278	0.015	±.004	2	0.430	0.270	0.010	±.003
1	0.450	0.311	0.020	±.004	1	0.450	0.311	0.015	±.004	1	0.450	0.301	0.010	±.003
0	0.470	0.347	0.020	±.004	0	0.470	0.347	0.015	±.004	0	0.470	0.347	0.012	±.003

AMS-DTL-23053/12

PACKAGING: See Technical Information for more details.

On all cases of military or commercial specifications, latest revisions apply. Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

UL File # E64007 / CSA File # 082582.

PTFE Heat Shrink

2 to 1 Shrink Ratio

Approximate Ratio of Expanded I.D. to Recovered I.D. – AWG Sizes

HEAT SHRINKABLE EXTRUSIONS

Metric Dimensions (mm)

Custom Sizes Available

STANDARD WALL					THIN WALL					LIGHTWEIGHT WALL				
Ordered as AWG Size No.	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as AWG Size No.	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as AWG Size No.	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.
30	0.86	0.38	0.23	±.05	30	0.86	0.38	0.23	±.05	30	0.86	0.38	0.15	±.05
28	0.96	0.46	0.23	±.05	28	0.96	0.46	0.23	±.05	28	0.96	0.46	0.15	±.05
26	1.17	0.56	0.25	±.05	26	1.17	0.56	0.25	±.05	26	1.17	0.56	0.15	±.05
24	1.27	0.69	0.30	±.05	24	1.27	0.69	0.25	±.05	24	1.27	0.64	0.15	±.05
22	1.40	0.81	0.30	±.05	22	1.40	0.81	0.30	±.08	22	1.40	0.79	0.15	±.05
20	1.52	0.99	0.41	±.08	20	1.52	0.99	0.30	±.08	20	1.52	0.97	0.15	±.05
19	1.65	1.09	0.41	±.08	19	1.65	1.09	0.30	±.08	19	1.65	1.09	0.15	±.05
18	1.93	1.24	0.41	±.08	18	1.93	1.24	0.30	±.08	18	1.93	1.17	0.15	±.05
17	2.16	1.37	0.41	±.08	17	2.16	1.37	0.30	±.08	17	2.16	1.37	0.15	±.05
16	2.36	1.55	0.41	±.08	16	2.36	1.55	0.30	±.08	16	2.36	1.45	0.15	±.05
15	2.79	1.70	0.41	±.08	15	2.79	1.70	0.30	±.08	15	2.79	1.60	0.15	±.05
14	3.05	1.83	0.41	±.08	14	3.05	1.83	0.30	±.08	14	3.05	1.83	0.20	±.05
13	3.56	2.03	0.41	±.08	13	3.56	2.03	0.30	±.08	13	3.56	2.03	0.20	±.05
12	3.81	2.26	0.41	±.08	12	3.81	2.26	0.30	±.08	12	3.81	2.26	0.20	±.05
11	4.32	2.57	0.41	±.08	11	4.32	2.57	0.30	±.08	11	4.32	2.51	0.20	±.05
10	4.85	2.84	0.41	±.08	10	4.85	2.84	0.30	±.08	10	4.85	2.79	0.20	±.05
9	5.21	3.15	0.51	±.10	9	5.21	3.15	0.38	±.10	9	5.21	3.10	0.20	±.05
8	6.10	3.58	0.51	±.10	8	6.10	3.58	0.38	±.10	8	6.10	3.53	0.20	±.05
7	6.86	4.01	0.51	±.10	7	6.86	4.01	0.38	±.10	7	6.86	3.91	0.20	±.05
6	7.67	4.52	0.51	±.10	6	7.67	4.52	0.38	±.10	6	7.67	4.37	0.25	±.08
5	8.13	5.03	0.51	±.10	5	8.13	5.03	0.38	±.10	5	8.13	4.88	0.25	±.08
4	9.40	5.69	0.51	±.10	4	9.40	5.69	0.38	±.10	4	9.40	5.44	0.25	±.08
3	9.91	6.32	0.51	±.10	3	9.91	6.32	0.38	±.10	3	9.91	6.12	0.25	±.08
2	10.92	7.06	0.51	±.10	2	10.92	7.06	0.38	±.10	2	10.92	6.86	0.25	±.08
1	11.43	7.90	0.51	±.10	1	11.43	7.90	0.38	±.10	1	11.43	7.65	0.25	±.08
0	11.94	8.81	0.51	±.10	0	11.94	8.81	0.38	±.10	0	11.94	8.81	0.30	±.08

AMS-DTL-23053/12

PACKAGING: See Technical Information for more details.
Custom Pantone colors or ZEUS standard colors available on request.
UL File # E64007 / CSA File # 082582.

PTFE Heat Shrink

2 to 1 Shrink Ratio

Approximate Ratio of Expanded I.D. to Recovered I.D. – Fractional Inch Sizes

HEAT SHRINKABLE EXTRUSIONS

Dimensions (inches)

Custom Sizes Available

STANDARD WALL					THIN WALL					INDUSTRIAL WALL				
Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.
1/8	0.215	0.130	0.020	±.004	1/8	0.215	0.130	0.015	±.003	1/8	0.166	0.130	0.030	±.005
1/4	0.410	0.260	0.020	±.004	1/4	0.410	0.260	0.015	±.003	3/16	0.250	0.193	0.030	±.005
5/16	0.470	0.329	0.020	±.004	5/16	0.470	0.329	0.015	±.003	1/4	0.333	0.257	0.030	±.005
3/8	0.560	0.399	0.025	±.006	3/8	0.560	0.399	0.015	±.003	5/16	0.415	0.320	0.030	±.005
7/16	0.655	0.462	0.025	±.006	7/16	0.655	0.462	0.018	±.004	3/8	0.498	0.383	0.030	±.005
1/2	0.750	0.524	0.025	±.006	1/2	0.750	0.524	0.018	±.004	7/16	0.580	0.448	0.030	±.006
5/8	0.930	0.655	0.030	±.006	5/8	0.930	0.655	0.020	±.004	1/2	0.666	0.510	0.030	±.006
3/4	1.125	0.786	0.035	±.008	3/4	1.125	0.786	0.025	±.005	9/16	0.748	0.572	0.030	±.006
7/8	1.310	0.911	0.035	±.008	7/8	1.310	0.911	0.030	±.006	5/8	0.830	0.637	0.030	±.006
1	1.500	1.036	0.035	±.008	1	1.500	1.036	0.030	±.006	11/16	0.915	0.700	0.032	±.006
										3/4	1.000	0.764	0.040	±.007
										7/8	1.170	0.891	0.045	±.007
										1	1.330	1.020	0.050	±.008

LIGHTWEIGHT WALL				
Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.
1/8	0.215	0.130	0.008	±.002
1/4	0.410	0.260	0.010	±.003
5/16	0.470	0.329	0.012	±.003

AMS-DTL-23053/12

PACKAGING: See Technical Information for more details.
Custom Pantone colors or ZEUS standard colors available on request.
UL File # E64007 / CSA File # 082582.

Metric Dimensions (mm)

Custom Sizes Available

STANDARD WALL					THIN WALL					INDUSTRIAL WALL				
Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.	Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.
1/8	5.46	3.30	0.51	±.10	1/8	5.46	3.30	0.38	±.08	1/8	4.22	3.30	0.76	±.13
1/4	10.41	6.60	0.51	±.10	1/4	10.41	6.60	0.38	±.08	3/16	6.35	4.90	0.76	±.13
5/16	11.94	8.36	0.51	±.10	5/16	11.94	8.36	0.38	±.08	1/4	8.46	6.53	0.76	±.13
3/8	14.22	10.13	0.64	±.15	3/8	14.22	10.13	0.38	±.08	5/16	10.54	8.13	0.76	±.13
7/16	16.64	11.73	0.64	±.15	7/16	16.64	11.73	0.46	±.10	3/8	12.65	9.73	0.76	±.13
1/2	19.05	13.31	0.64	±.15	1/2	19.05	13.31	0.46	±.10	7/16	14.73	11.38	0.76	±.15
5/8	23.62	16.64	0.76	±.15	5/8	23.62	16.64	0.51	±.10	1/2	16.92	12.95	0.76	±.15
3/4	28.58	19.96	0.89	±.20	3/4	28.58	19.96	0.64	±.13	9/16	19.00	14.53	0.76	±.15
7/8	33.27	23.14	0.89	±.20	7/8	33.27	23.14	0.76	±.15	5/8	21.08	16.18	0.76	±.15
1	38.10	26.31	0.89	±.20	1	38.10	26.31	0.76	±.15	11/16	23.24	17.78	0.81	±.15
										3/4	25.40	19.41	1.02	±.18
										7/8	29.72	22.63	1.14	±.18
										1	33.78	25.91	1.27	±.20

LIGHTWEIGHT WALL				
Ordered as ID	Expanded I.D. Min.	Recovered I.D. Max.	Recovered Wall Thickness Nom.	Tol.
1/8	5.46	3.30	0.20	±.05
1/4	10.41	6.60	0.25	±.07
5/16	11.94	8.36	0.30	±.07

AMS-DTL-23053/12

PACKAGING: See Technical Information for more details.
Custom Pantone colors or ZEUS standard colors available on request.
UL File # E64007 / CSA File # 082582.

Dimensions (inches)

Ordered As Fractional I.D.	Expanded I.D.	RECOVERED – AFTER HEAT SHRINK		
		I.D. Max.	Wall Thickness Nom.	Wall Thickness Tol.
5/64	0.078	0.025	0.009	±.002
1/8	0.125	0.037	0.012	±.002
3/16	0.187	0.050	0.012	±.002
1/4	0.250	0.063	0.012	±.002
5/16	0.312	0.078	0.012	±.002
3/8	0.375	0.096	0.012	±.002
7/16	0.438	0.112	0.012	±.002
1/2	0.500	0.144	0.015	±.004
9/16	0.562	0.155	0.015	±.004
5/8	0.625	0.178	0.015	±.004
11/16	0.687	0.198	0.015	±.004
3/4	0.750	0.224	0.015	±.004
7/8	0.875	0.244	0.015	±.004
1	1.000	0.278	0.015	±.004
1-1/4	1.250	0.347	0.015	±.004
1-1/2	1.500	0.400	0.015	±.004
1-3/4	1.750	0.450	0.015	±.004
2	2.000	0.520	0.020	±.005
2-1/4	2.250	0.585	0.020	±.005
2-1/2	2.500	0.650	0.020	±.005
2-3/4	2.750	0.710	0.020	±.005
3	3.000	0.775	0.020	±.005
3-1/4	3.250	0.835	0.020	±.005
3-1/2	3.500	0.900	0.025	±.005
3-3/4	3.750	0.960	0.025	±.005
4	4.000	1.025	0.025	±.005

Metric Dimensions (mm)

Custom Sizes Available

Ordered As Fractional I.D.	Expanded I.D.	RECOVERED – AFTER HEAT SHRINK		
		I.D. Max.	Wall Thickness Nom.	Wall Thickness Tol.
5/64	1.98	0.64	0.23	±.05
1/8	3.18	0.94	0.31	±.05
3/16	4.75	1.27	0.31	±.05
1/4	6.35	1.60	0.31	±.05
5/16	7.92	1.98	0.31	±.05
3/8	9.53	2.44	0.31	±.05
7/16	11.13	2.84	0.31	±.05
1/2	12.70	3.66	0.38	±.10
9/16	14.27	3.94	0.38	±.10
5/8	15.88	4.52	0.38	±.10
11/16	17.45	5.03	0.38	±.10
3/4	19.05	5.69	0.38	±.10
7/8	22.23	6.20	0.38	±.10
1	25.40	7.06	0.38	±.10
1-1/4	31.75	8.81	0.38	±.10
1-1/2	38.10	10.16	0.38	±.10
1-3/4	44.45	11.43	0.38	±.10
2	50.80	13.21	0.51	±.13
2-1/4	57.15	14.86	0.51	±.13
2-1/2	63.50	16.51	0.51	±.13
2-3/4	69.85	18.03	0.51	±.13
3	76.20	19.68	0.51	±.13
3-1/4	82.50	21.21	0.51	±.13
3-1/2	88.90	22.86	0.64	±.13
3-3/4	92.95	24.38	0.64	±.13
4	101.60	26.03	0.64	±.13

PACKAGING: See Technical Information for more details.
Custom Pantone colors or ZEUS standard colors available on request.
Complies with AMS-DTL-23053/12. UL File # E64007 / CSA File # 082582.

Dimensions (inches)

Custom Sizes Available

Size	As Supplied Inside Diameter Min.	Recovered – After Shrinking I.D. Will Shrink to at Least	Wall Thickness Min.	Wall Thickness Nom.	Wall Thickness Max.
24	0.031	0.027	0.006	0.008	0.010
22	0.036	0.032	0.006	0.008	0.010
20	0.045	0.039	0.006	0.008	0.010
18	0.060	0.049	0.006	0.008	0.010
16	0.075	0.061	0.007	0.009	0.011
14	0.092	0.072	0.007	0.009	0.011
12	0.115	0.089	0.007	0.009	0.011
10	0.141	0.114	0.007	0.010	0.013
9	0.158	0.124	0.007	0.010	0.013
8	0.180	0.143	0.007	0.010	0.013
7	0.197	0.158	0.007	0.011	0.015
6	0.225	0.180	0.007	0.011	0.015
5	0.248	0.198	0.007	0.011	0.015
4	0.290	0.226	0.007	0.011	0.015
3	0.310	0.249	0.007	0.011	0.015
2	0.365	0.280	0.008	0.012	0.016
1	0.400	0.311	0.008	0.012	0.016
0	0.440	0.349	0.008	0.012	0.016

Fractional Inch (decimal) Tubing

Size	As Supplied Inside Diameter Min.	Recovered – After Shrinking I.D. Will Shrink to at Least	Wall Thickness Min.	Wall Thickness Nom.	Wall Thickness Max.
3/8 (0.375)	0.500	0.383	0.011	0.015	0.019
7/16 (0.438)	0.580	0.448	0.016	0.020	0.024
1/2 (0.500)	0.666	0.510	0.016	0.020	0.024
5/8 (0.625)	0.830	0.637	0.021	0.025	0.029
3/4 (0.750)	1.000	0.764	0.026	0.030	0.034
7/8 (0.875)	1.170	0.891	0.031	0.035	0.039
1 (1.000)	1.330	1.020	0.031	0.035	0.039
1-1/8 (1.125)	1.500	1.145	0.031	0.035	0.039
1-1/4 (1.250)	1.666	1.270	0.031	0.035	0.039
1-3/8 (1.375)	1.833	1.390	0.031	0.035	0.039
1-1/2 (1.500)	2.000	1.570	0.031	0.035	0.039

COMPLIES WITH: AMS-DTL-23053/11

PACKAGING: See Technical Information for more details.

COLOR: Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

CUSTOM SPECIFICATIONS AND TOLERANCES QUOTED UPON REQUEST

PFA quoted upon request

UL File # E64007
CSA File # 082582

FEP Heat Shrink

1.3 to 1 Shrink Ratio

Approximate Ratio of Expanded I.D. to Recovered I.D. – AWG/Fractional Inch Sizes

HEAT SHRINKABLE EXTRUSIONS

Custom Sizes Available

Metric Dimensions (mm)

Size	As Supplied Inside Diameter Min.	Recovered – After Shrinking I.D. Will Shrink to at Least	Wall Thickness Min.	Wall Thickness Nom.	Wall Thickness Max.
24	0.79	0.69	0.15	0.20	0.25
22	0.91	0.81	0.15	0.20	0.25
20	1.14	0.99	0.15	0.20	0.25
18	1.52	1.25	0.15	0.20	0.25
16	1.91	1.55	0.18	0.23	0.28
14	2.34	1.83	0.18	0.23	0.28
12	2.92	2.26	0.18	0.23	0.28
10	3.58	2.90	0.18	0.25	0.33
9	4.01	3.15	0.18	0.25	0.33
8	4.57	3.63	0.18	0.25	0.33
7	5.00	4.01	0.18	0.28	0.38
6	5.72	4.57	0.18	0.28	0.38
5	6.30	5.03	0.18	0.28	0.38
4	7.37	5.74	0.18	0.28	0.38
3	7.87	6.32	0.18	0.28	0.38
2	9.27	7.11	0.20	0.30	0.41
1	10.16	7.90	0.20	0.30	0.41
0	11.18	8.86	0.20	0.30	0.41

Fractional Inch (mm) Tubing

Size		As Supplied Inside Diameter Min.	Recovered – After Shrinking I.D. Will Shrink to at Least	Wall Thickness Min.	Wall Thickness Nom.	Wall Thickness Max.
3/8	(9.53)	12.70	9.73	0.28	0.38	0.48
7/16	(11.13)	14.73	11.38	0.41	0.51	0.61
1/2	(12.70)	16.92	12.95	0.41	0.51	0.61
5/8	(15.88)	21.08	16.18	0.53	0.64	0.74
3/4	(19.05)	25.40	19.41	0.66	0.76	0.86
7/8	(22.23)	29.72	22.63	0.79	0.89	0.99
1	(25.40)	33.78	25.91	0.79	0.89	0.99
1-1/8	(28.58)	38.10	29.08	0.79	0.89	0.99
1-1/4	(31.75)	42.32	32.26	0.79	0.89	0.99
1-3/8	(34.93)	46.56	35.31	0.79	0.89	0.99
1-1/2	(38.10)	50.80	39.88	0.79	0.89	0.99

COMPLIES WITH: AMS-DTL-23053/11

PACKAGING: See Technical Information for more details.

COLOR: Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

CUSTOM SPECIFICATIONS AND TOLERANCES QUOTED UPON REQUEST

PFA quoted upon request

UL File # E64007
CSA File # 082582

Custom Sizes Available

Dimensions (inches)

Size		Expanded I.D.	Recovered I.D.	Wall Thickness	
Fractional	Decimal	Minimum	Maximum	Nom.	Tol.
3/32	0.093	0.093	0.056	0.008	±0.003
1/8	0.125	0.125	0.075	0.010	±0.003
3/16	0.188	0.188	0.115	0.010	±0.003
1/4	0.250	0.250	0.150	0.010	±0.003
3/8	0.375	0.375	0.225	0.012	±0.003
1/2	0.500	0.500	0.300	0.015	±0.004
3/4	0.750	0.750	0.450	0.020	±0.004
1	1.000	1.000	0.600	0.025	±0.005
1-1/2	1.500	1.500	0.900	0.030	±0.005
2	2.000	2.000	1.200	0.030	±0.005

Metric Dimensions (mm)

Size		Expanded I.D.	Recovered I.D.	Wall Thickness	
Fractional	mm	Minimum	Maximum	Nom.	Tol.
3/32	2.36	2.36	1.42	0.20	±0.08
1/8	3.18	3.18	1.91	0.25	±0.08
3/16	4.78	4.78	2.92	0.25	±0.08
1/4	6.35	6.35	3.81	0.25	±0.08
3/8	9.53	9.53	5.72	0.31	±0.08
1/2	12.70	12.70	7.62	0.38	±0.10
3/4	19.05	19.05	11.43	0.51	±0.10
1	25.40	25.40	15.24	0.64	±0.13
1-1/2	38.10	38.10	22.86	0.76	±0.13
2	50.80	50.80	30.48	0.76	±0.13

COMPLIES WITH: AMS-DTL-I-23053/11

PACKAGING: See Technical Information for more details.

COLOR: Supplied in natural unless otherwise specified. Custom Pantone colors or ZEUS standard colors available on request.

CUT PIECES: QUOTED ON REQUEST

CUSTOM SPECIFICATIONS AND TOLERANCES QUOTED UPON REQUEST
CSA File # 082582

Features:
• Shrink temperature 626°F/330°C– 680°F/360°C • Recovered wall range of 0.004" to 0.009" • Custom sizes and lengths available upon request
Benefits:
• Excellent abrasion resistance • Outstanding radiation resistance • High continuous operating temperature
• Extends life of the protected item • Adhesion to metals • Available in colors
Key Performance Attributes:
Forms a highly protective, shrink-to-fit shield against abrasion, extreme temperatures, high pressure, and dielectric interference.
Sample Applications:
• Electrical component insulation • Protective jacketing provides excellent abrasion resistance
• Wire/cable insulation for medical devices • Wire splicing • Reusable medical devices
Technical Notes:
• Zeus will assist in developing custom heat-shrink processes • Fillers available • Class VI approved materials available

PEEKshrink® 1.4:1 Heat Shrinkable AWG Tubing						
			Recovered Dimension After Shrinking			
			Wall Thickness			
Zeus P/N	Ordered as AWG Size	As Supplied Inside Diameter Min	Recovered ID Max	Minimum	Nominal	Maximum
85322	17	0.038	0.027	0.005	0.007	0.009
85318	16	0.045	0.032	0.005	0.007	0.009
85184	15	0.055	0.039	0.005	0.007	0.009
85204	14	0.085	0.060	0.005	0.007	0.009
85197	13	0.092	0.065	0.005	0.007	0.009
85189	12	0.101	0.072	0.005	0.007	0.009
85313	11	0.112	0.080	0.005	0.007	0.009
85310	10	0.125	0.089	0.005	0.007	0.009
85298	9	0.137	0.098	0.005	0.007	0.009
85294	8	0.160	0.114	0.005	0.007	0.009
85146	7	0.174	0.124	0.005	0.007	0.009
85063	6	0.200	0.143	0.005	0.007	0.009
85213	5	0.221	0.158	0.005	0.007	0.009
85236	4	0.252	0.180	0.005	0.007	0.009
85243	3	0.277	0.198	0.005	0.007	0.009
85246	2	0.316	0.226	0.005	0.007	0.009
85255	1	0.349	0.249	0.005	0.007	0.009
85326	0	0.392	0.280	0.005	0.007	0.009

Standard Put Up: 4FtLgth

PEEKshrink® Tubing Properties

Properties	ASTM	Units	
Tensile Modulus	D638	KSI	1,309
Tensile Stress at Yield	D638	PSI	14,503
Glass Transition Temp	D3418	°F/°C	321/161
Dielectric Strength	D149	V/mil	3570
Thermal Endurance	NEMA MW 1000	°F/°C	752/400
Crystallinity	D3814	%	40

This data is based on PEEKshrink® recovered on a .575" mandrel. Tubing performance and characteristics may change based on tubing size.

PEEK™ Properties

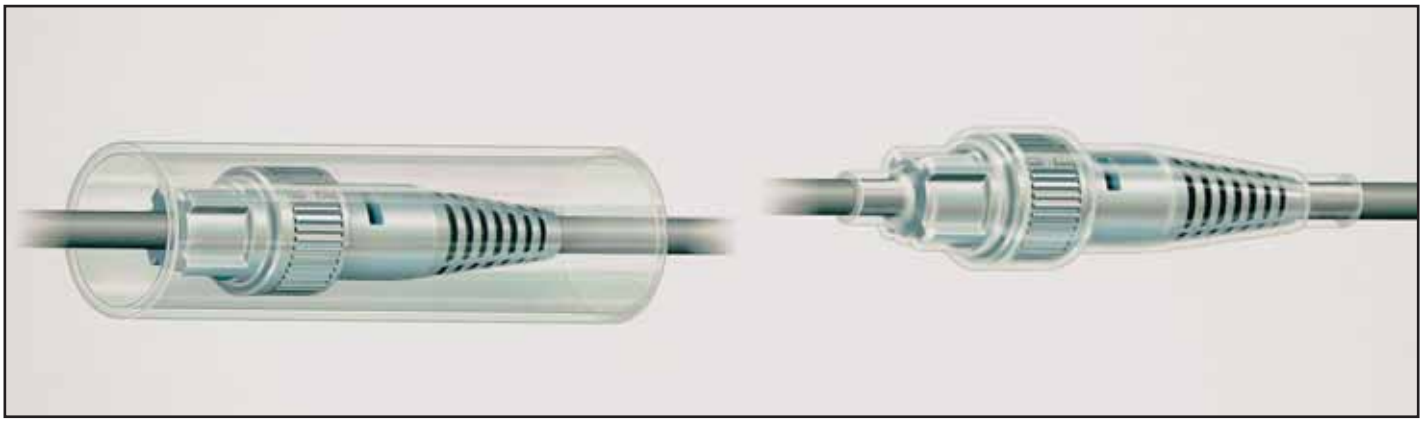
Properties	ASTM	Units	
Tensile Modulus	D638	KSI	621
Tensile Stress at Yield	D638	PSI	13,488
Glass Transition Temperature	D3418	°F/°C	289/143
Dielectric Strength	D149	V/mil	>500
Flammability Rating	UL 94		VO
Radiation Resistance		MRad	up to 1000
Coefficent of Friction	D1894		.35 - .50
Elongation	D638	%	50

These properties are based on natural resin and are for reference only. Actual performance may vary.

Heat Shrink Tubing Offering a Tight, Moisture-Resistant, Wear-Proof Encapsulation

Custom Sizes Available

- **Outer tubing of PTFE shrinks for tight fit when heat is applied.**
- **Inner layer of FEP melts and flows to encapsulate parts.**



ZEUS Dual-Shrink® tubing of fluoropolymer PTFE/FEP is constructed with an exterior of heat shrink PTFE and an inner layer of FEP. It is easy to apply, and is designed to provide a tight, moisture-proof bond over wires, cables, connectors, splices, terminals, etc. The PTFE shrinks tightly over inserted parts when the covered section is heated, while the FEP melts and flows into a solid or near-solid encapsulation with a fit so tight that it can withstand the most severe stresses involving pull or vibration. ZEUS Dual-Shrink tubing provides all the outstanding electrical, chemical, and mechanical properties of PTFE including a service temperature up to 450°F/232°C. Custom specifications and tolerances quoted upon request.

Dimensions (inches)

Custom Sizes Available

STANDARD WALL				LIGHTWEIGHT WALL			
Item No.	As Supplied I.D. Min.	Recovered Dim. I.D. Will Shrink To at Least	After Shrinking Total Wall Thickness-Norm.	Item No.	As Supplied I.D. Min.	Recovered Dim. I.D. Will Shrink To at Least	After Shrinking Total Wall Thickness-Norm.
ZDS-S-036	0.036	0.000	N/A	ZDS-L-065	0.065	0.000	N/A
ZDS-S-060	0.060	0.000	N/A	ZDS-L-115	0.115	0.045	0.015
ZDS-S-130	0.130	0.000	N/A	ZDS-L-130	0.130	0.060	0.015
ZDS-S-160	0.160	0.000	N/A	ZDS-L-180	0.180	0.065	0.015
ZDS-S-190	0.190	0.062	0.035	ZDS-L-190	0.190	0.070	0.015
ZDS-S-250	0.250	0.125	0.035	ZDS-L-240	0.240	0.150	0.020
ZDS-S-350	0.350	0.190	0.035	ZDS-L-350	0.350	0.210	0.025
ZDS-S-450	0.450	0.312	0.055	ZDS-L-480	0.480	0.315	0.032
ZDS-S-700	0.700	0.440	0.055	ZDS-L-700	0.700	0.500	0.040
ZDS-S-950	0.950	0.630	0.065	ZDS-L-1000	1.000	0.700	0.045

Metric Dimensions (mm)

STANDARD WALL				LIGHTWEIGHT WALL			
Item No.	As Supplied I.D. Min.	Recovered Dim. I.D. Will Shrink To at Least	After Shrinking Total Wall Thickness-Norm.	Item No.	As Supplied I.D. Min.	Recovered Dim. I.D. Will Shrink To at Least	After Shrinking Total Wall Thickness-Norm.
ZDS-S-036	0.91	0.000	N/A	ZDS-L-065	1.65	0.000	N/A
ZDS-S-060	1.52	0.000	N/A	ZDS-L-115	2.92	1.14	0.38
ZDS-S-130	3.30	0.000	N/A	ZDS-L-130	3.30	1.52	0.38
ZDS-S-160	4.06	0.000	N/A	ZDS-L-180	4.57	1.65	0.38
ZDS-S-190	4.83	1.57	0.89	ZDS-L-190	4.83	1.78	0.38
ZDS-S-250	6.35	3.18	0.89	ZDS-L-240	6.10	3.81	0.51
ZDS-S-350	8.89	4.83	0.89	ZDS-L-350	8.89	5.33	0.64
ZDS-S-450	11.43	7.92	1.40	ZDS-L-480	12.19	8.00	0.81
ZDS-S-700	17.78	11.18	1.40	ZDS-L-700	17.78	12.70	1.02
ZDS-S-950	24.13	16.00	1.65	ZDS-L-1000	25.40	17.78	1.14

PACKAGING: See Technical Information for more details.
Custom Pantone colors or ZEUS standard colors available on request.
Dual-Shrink Tubing is a ZEUS registered trademark

ZEUS Roll Covers extend the life and reliability of rollers and improve product quality. A brief application of heat molds the cover snugly around the roll, forming a skin-tight, high-strength, impregnable jacket impervious to corrosive chemicals, solvents, acids, shock, abrasion, high temperatures, and moisture. They eliminate sticky build-up problems. With the use of a convenient heat source, such as a hot air gun, ZEUS Roll Covers can be quickly and easily shrunk onto the rolls. Cleaning can be done with a solvent or reagent.

Custom Sizes Available

For the printing, paper, textile, and food packaging industries, and others

- No sticking
- No picking
- Low maintenance
- Flexibility
- Excellent chemical resistance
- Handles delicate materials
- Saves labor costs
- Cuts cleaning time
- High temperature resistance

Dimensions (Inches)

Large Diameter

Ordered As Size	To Cover Roll Dia. Min.	Max.
1-1/4	1.0	1.3
1-1/2	1.4	1.7
2	1.8	2.1
2-1/2	2.2	2.6
3	2.7	3.1
3-1/2	3.2	3.6
4	3.5	4.2
5	4.4	5.2
6	5.4	6.2
7	6.4	7.2

Small Diameter

Ordered As Size	To Cover Roll Dia. Min.	Max.
1/2	.440	.550
5/8	.540	.700
3/4	.640	.800
7/8	.760	.950
1	.880	1.100

Metric Dimensions (mm)

Large Diameter

Ordered As Size	To Cover Roll Dia. Min.	Max.
1-1/4	25.40	33.02
1-1/2	35.56	43.18
2	45.92	53.34
2-1/2	55.88	66.04
3	68.58	78.74
3-1/2	81.28	91.44
4	88.90	106.68
5	111.76	132.08
6	137.16	157.48
7	162.56	182.88

Small Diameter

Ordered As Size	To Cover Roll Dia. Min.	Max.
1/2	11.18	13.97
5/8	13.72	17.78
3/4	16.26	20.32
7/8	19.30	24.13
1	22.35	27.94

WALL THICKNESS: .020" (.508mm) Nominal

COLOR: Natural. Custom colors available upon request.

PACKAGING: See Technical Information for more details.

Complete technical information provides helpful data to speed production and cut maintenance.

ZEUS®

SPECIALTY PRODUCTS

SPECIALTY PRODUCTS

Custom Sizes Available

Standard Flex Convoluted

Part Number	Military Spec.	Identifier	Max I.D.	Min I.D.	Max O.D.	Max. Wall Thick	Conv/Inch +/-1"	Weight (LBS) Per CFT Maximum	Min. Bend Radius
ZCT TS-012	AMS-T-81914/1	**01	0.188	0.181	0.32	0.023	8	2.0	0.500
ZCT TS-018	AMS-T-81914/1	**02	0.281	0.273	0.414	0.027	7 1/2	2.9	0.750
ZCT TS-020	AMS-T-81914/1	**03	0.312	0.303	0.45	0.027	7 1/2	3.6	0.875
ZCT TS-024	AMS-T-81914/1	**04	0.375	0.364	0.53	0.029	7	4.2	1.000
ZCT TS-028	AMS-T-81914/1	**05	0.437	0.425	0.59	0.029	7	4.9	1.250
ZCT TS-032	AMS-T-81914/1	**06	0.500	0.485	0.66	0.029	7	5.2	1.500
ZCT TS-040	AMS-T-81914/1	**07	0.625	0.608	0.78	0.035	7	6.9	1.750
ZCT TS-048	AMS-T-81914/1	**08	0.750	0.730	0.975	0.035	6	10.4	1.875
ZCT TS-056	AMS-T-81914/1	**09	0.875	0.850	1.10	0.035	6	11.3	2.250
ZCT TS-064	AMS-T-81914/1	**10	1.000	0.975	1.26	0.035	4 1/2	12.6	2.500
ZCT TS-072	AMS-T-81914/1	**11	1.125	1.105	1.39	0.035	4 1/2	13.8	2.750
ZCT TS-080	AMS-T-81914/1	**12	1.250	1.210	1.539	0.035	4	15.5	3.000
ZCT TS-096	AMS-T-81914/1	**13	1.500	1.440	1.85	0.040	4	21.7	3.750
ZCT TS-079	AMS-T-81914/1	**14	1.750	1.690	2.10	0.045	4	25.3	4.250

The table above details ZEUS and AMS-Spec. numbers and dimensions for our standard PTFE convoluted tubing. Custom sizes and configurations are also available. **PFA does not conform to MIL-T. Please contact us for more information.**

Extra Flex Convoluted

Part Number	Military Spec.	Identifier	Max I.D.	Min I.D.	Max O.D.	Max. Wall Thick	Conv/Inch +/-1	Weight (LBS) Per CFT Maximum	Min. Bend Radius
ZCT TE-012	AMS-T-81914/2	**01	0.188	0.181	0.32	0.023	10	2.2	0.313
ZCT TE-018	AMS-T-81914/2	**02	0.281	0.273	0.414	0.026	9	3.8	0.438
ZCT TE-020	AMS-T-81914/2	**03	0.312	0.306	0.450	0.027	9	4.8	0.438
ZCT TE-024	AMS-T-81914/2	**04	0.375	0.364	0.530	0.029	9	5.6	0.500
ZCT TE-028	AMS-T-81914/2	**05	0.437	0.427	0.590	0.029	9	6.5	0.500
ZCT TE-032	AMS-T-81914/2	**06	0.500	0.485	0.660	0.029	9	6.9	0.750
ZCT TE-040	AMS-T-81914/2	**07	0.625	0.608	0.780	0.029	9	9.2	0.750
ZCT TE-048	AMS-T-81914/2	**08	0.750	0.730	0.975	0.035	8	13.8	0.938
ZCT TE-056	AMS-T-81914/2	**09	0.875	0.860	1.100	0.035	8	15	0.938
ZCT TE-064	AMS-T-81914/2	**10	1.000	0.975	1.260	0.035	7	16.8	1.125
ZCT TE-072	AMS-T-81914/2	**11	1.125	1.105	1.390	0.035	6	17.5	1.125
ZCT TE-080	AMS-T-81914/2	**12	1.250	1.210	1.539	0.035	6	19.6	1.250
ZCT TE-096	AMS-T-81914/2	**13	1.500	1.450	1.810	0.038	6	26	2.000

The table above details ZEUS and AMS-Spec. numbers and dimensions for our extra-flex PTFE convoluted tubing. Custom sizes and configurations are also available. **PFA does not conform to MIL-T. Please contact us for more information.**

Custom Sizes Available

Standard Convoluted

Part Number	Military Spec.	Identifier	Max I.D.	Min I.D.	Max O.D.	Max. Wall Thick	Conv/Inch +/-1/2"	Weight (LBS) Per CFT Maximum	Min. Bend Radius
ZCT-FS-012	AMS-T-81914/3	**01	.187	.181	.320	.018	8	1.5	.500
ZCT-FS-018	AMS-T-81914/3	**02	.281	.273	.414	.018	8	1.7	.750
ZCT-FS-020	AMS-T-81914/3	**03	.312	.306	.450	.018	8	1.9	.750
ZCT-FS-024	AMS-T-81914/3	**04	.375	.364	.510	.018	8	2.2	.875
ZCT-FS-028	AMS-T-81914/3	**05	.437	.427	.571	.018	8	3.1	.875
ZCT-FS-032	AMS-T-81914/3	**06	.500	.485	.650	.023	7	4.0	1.250
ZCT-FS-040	AMS-T-81914/3	**07	.625	.608	.770	.023	7	4.8	1.500
ZCT-FS-048	AMS-T-81914/3	**08	.750	.730	.930	.023	6	6.1	1.750
ZCT-FS-056	AMS-T-81914/3	**09	.875	.860	1.073	.023	5	7.0	2.000
ZCT-FS-064	AMS-T-81914/3	**10	1.000	.975	1.226	.023	5	8.5	2.370
ZCT-FS-072	AMS-T-81914/3	**11	1.125	1.105	1.390	.023	5	9.3	2.370
ZCT-FS-080	AMS-T-81914/3	**12	1.250	1.210	1.539	.023	4	10.9	2.750
ZCT-FS-096	AMS-T-81914/3	**13	1.500	1.437	1.832	.023	4	12.6	3.380

The table above details ZEUS and AMS-Spec. numbers and dimensions for our standard FEP convoluted tubing. Custom sizes and configurations are also available.

Extra Flexible Convoluted

Part Number	Military Spec.	Identifier	Max I.D.	Min I.D.	Max O.D.	Max. Wall Thick	Conv/Inch +/-1	Weight (LBS) Per CFT Maximum	Min. Bend Radius
ZCT-FE-012	AMS-T-81914/4	**01	.188	.181	.320	.018	10	1.7	.31
ZCT-FE-018	AMS-T-81914/4	**02	.281	.273	.414	.018	10	2.0	.41
ZCT-FE-020	AMS-T-81914/4	**03	.312	.306	.450	.018	10	2.1	.41
ZCT-FE-024	AMS-T-81914/4	**04	.375	.359	.510	.018	10	2.5	.50
ZCT-FE-028	AMS-T-81914/4	**05	.437	.427	.571	.018	10	3.9	.50
ZCT-FE-032	AMS-T-81914/4	**06	.500	.480	.650	.023	9	4.6	.75
ZCT-FE-040	AMS-T-81914/4	**07	.625	.603	.770	.023	9	5.5	.75
ZCT-FE-048	AMS-T-81914/4	**08	.750	.725	.930	.023	8	6.9	.93
ZCT-FE-056	AMS-T-81914/4	**09	.875	.860	1.073	.023	7	8.9	1.25
ZCT-FE-064	AMS-T-81914/4	**10	1.000	.970	1.226	.023	7	9.5	1.25
ZCT-FE-072	AMS-T-81914/4	**11	1.125	1.105	1.390	.023	7	10.5	1.43
ZCT-FE-080	AMS-T-81914/4	**12	1.250	1.205	1.539	.023	6.5	11.2	1.43
ZCT-FE-096	AMS-T-81914/4	**13	1.500	1.437	1.832	.023	5.5	12.0	1.75

The table above details ZEUS and AMS-Spec. numbers and dimensions for our Extra Flexible FEP convoluted tubing. Custom sizes and configurations are also available. Specs shown are for only Class 1 tubing.

Custom Sizes Available

Standard Convoluted

Part Number	Military Spec.	Identifier	Max I.D.	Min I.D.	Max O.D.	Max. Wall Thick	Conv/Inch +/-1	Weight (LBS) Per CFT Maximum	Min. Bend Radius
ZCT-ES-012	AMS-T-81914/6	**01	.187	.181	.320	.018	8	1.2	.500
ZCT-ES-018	AMS-T-81914/6	**02	.281	.273	.414	.018	8	1.4	.750
ZCT-ES-020	AMS-T-81914/6	**03	.312	.306	.450	.018	8	1.5	.750
ZCT-ES-024	AMS-T-81914/6	**04	.375	.364	.510	.018	8	1.8	.875
ZCT-ES-028	AMS-T-81914/6	**05	.437	.427	.571	.018	8	2.5	.875
ZCT-ES-032	AMS-T-81914/6	**06	.500	.485	.650	.023	7	3.2	1.250
ZCT-ES-040	AMS-T-81914/6	**07	.625	.608	.770	.023	7	3.9	1.500
ZCT-ES-048	AMS-T-81914/6	**08	.750	.730	.930	.023	6	4.9	1.750
ZCT-ES-056	AMS-T-81914/6	**09	.875	.860	1.073	.023	5	5.6	2.000
ZCT-ES-064	AMS-T-81914/6	**10	1.000	.975	1.226	.023	5	6.8	2.37
ZCT-ES-072	AMS-T-81914/6	**11	1.125	1.105	1.390	.023	5	7.5	2.37
ZCT-ES-080	AMS-T-81914/6	**12	1.250	1.210	1.539	.023	4	8.8	2.75
ZCT-ES-096	AMS-T-81914/6	**13	1.500	1.437	1.832	.023	4	10.2	3.38

The table above details ZEUS and AMS-Spec. numbers and dimensions for our standard ETFE convoluted tubing. Custom sizes and configurations are also available.

Extra Flexible Convoluted

Part Number	Military Spec.	Identifier	Max I.D.	Min I.D.	Max O.D.	Max. Wall Thick	Conv/Inch +/-1	Weight (LBS) Per CFT Maximum	Min. Bend Radius
ZCT-EE-012	AMS-T-81914/5	**01	.188	.181	.320	.018	10	1.4	.31
ZCT-EE-018	AMS-T-81914/5	**02	.281	.273	.414	.018	10	1.6	.41
ZCT-EE-020	AMS-T-81914/5	**03	.312	.306	.450	.018	10	1.7	.41
ZCT-EE-024	AMS-T-81914/5	**04	.375	.359	.510	.018	10	2.0	.50
ZCT-EE-028	AMS-T-81914/5	**05	.437	.427	.571	.018	10	3.1	.50
ZCT-EE-032	AMS-T-81914/5	**06	.500	.480	.650	.023	9	3.7	.75
ZCT-EE-040	AMS-T-81914/5	**07	.625	.603	.770	.023	9	4.4	.75
ZCT-EE-048	AMS-T-81914/5	**08	.750	.725	.930	.023	8	5.6	.93
ZCT-EE-056	AMS-T-81914/5	**09	.875	.860	1.073	.023	7	7.1	1.25
ZCT-EE-064	AMS-T-81914/5	**10	1.000	.970	1.226	.023	7	7.6	1.25
ZCT-EE-072	AMS-T-81914/5	**11	1.125	1.105	1.390	.023	7	8.4	1.43
ZCT-EE-080	AMS-T-81914/5	**12	1.250	1.205	1.539	.023	6	9.0	1.43
ZCT-EE-096	AMS-T-81914/5	**13	1.500	1.437	1.832	.023	5	9.6	1.75

The table above details ZEUS and AMS-Spec. numbers and dimensions for our Extra Flexible ETFE convoluted tubing. Custom sizes and configurations are also available. Specs shown are for only Class 1 tubing.

Custom Sizes Available

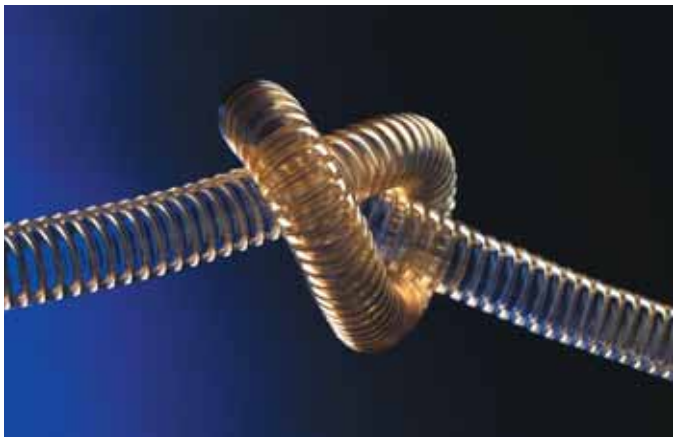
PEEK™ Convoluted

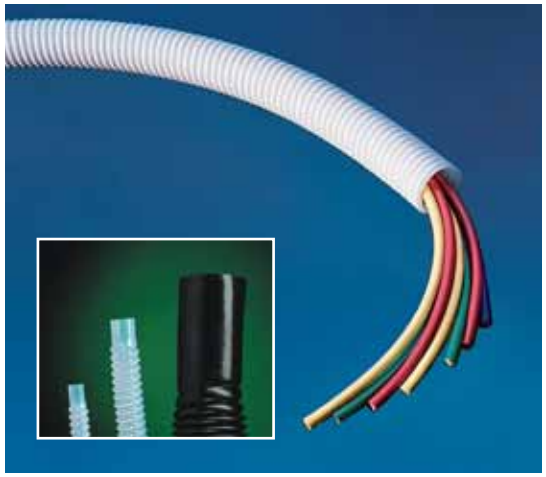
(Available in Natural or Black Color)

Size	Min ID	Max OD	Max Wall	Conv/Inch +/- 1
1/4	.242"	.380"	.012"	7.5
3/8	.364"	.530"	.012"	7.0
1/2	.485"	.660"	.012"	7.0
3/4	.730"	.975"	.012"	6.0

Put Up: Random lengths; ZEUS to produce longest lengths; coiled.

PEEK™ does not conform to MIL-T. Please contact us for more information.





PTFE Slitting and Cuffing

Longitudinal slit convoluted tubing as well as cuffed PTFE convoluted tubing are available upon request. Slitting convoluted tubing allows pre-existing wires to be conveniently slipped into the tubing. Cuffing of ZEUS PTFE convoluted tubing provides the ideal smooth surface to attach mechanical connectors and fittings.

Capabilities include:

- Cuff one or both ends of tubing
- Cuff to specific custom lengths
- Special testing available

Custom Sizes Available

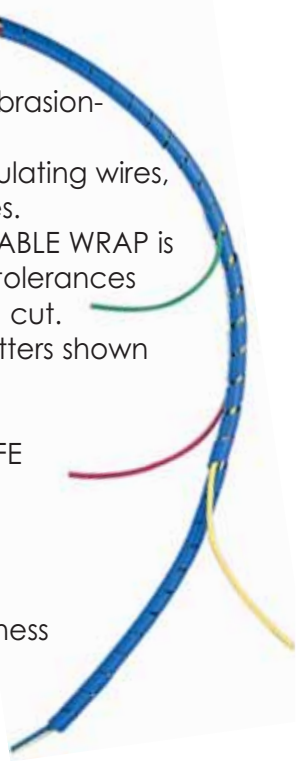
Dimensions (inches)

Ordered by Outside Diameter A	Cut From PTFE, FEP, PFA, ETFE Industrial Tubing Size I.D. B	Wall C	Bundle Diameter Maximum D	Pitch of Helical Cut E
1/8	1/16	0.030	1/2	1/4
3/16	1/8	0.030	1	1/4
1/4	3/16	0.030	2	3/8
5/16	1/4	0.030	2-1/2	3/8
3/8	5/16	0.030	3	7/16
1/2	7/16	0.030	4	9/16
5/8	9/16	0.030	5	5/8
3/4	11/16	0.032	6	7/8
1	15/16	0.040	8	1

Metric Dimensions (mm)

Ordered by Outside Diameter A	Cut From PTFE, FEP, PFA, ETFE Industrial Tubing Size I.D. B	Wall C	Bundle Diameter Maximum D	Pitch of Helical Cut E
3.18	1.59	0.76	12.70	6.35
4.76	3.18	0.76	25.40	6.35
6.35	4.76	0.76	50.80	9.53
7.94	6.35	0.76	63.50	9.53
9.53	7.94	0.76	76.20	11.11
12.70	11.11	0.76	101.60	14.29
15.88	14.29	0.76	127.00	15.88
19.05	17.46	1.02	152.40	22.23
25.40	23.81	1.02	203.20	25.40

Supplied in natural unless otherwise specified.
Custom Pantone colors or ZEUS standard colors available on request.



ZEUS SPIRAL-CUT CABLE WRAPS are expandable abrasion-resistant wraps for harnessing and insulating wires, cable, and bundles. ZEUS SPIRAL CUT CABLE WRAP is extruded to close tolerances and then precision cut.

Use chart and letters shown when ordering

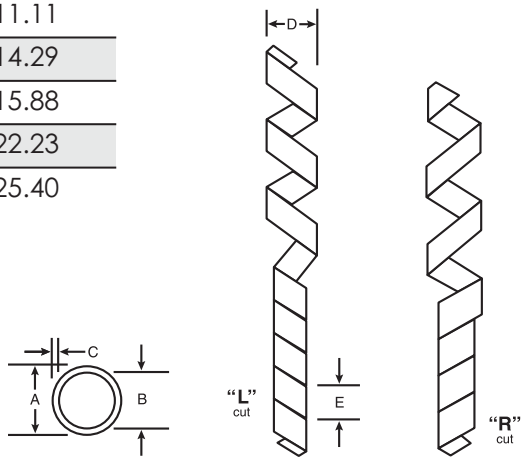
"A" = O.D. of PTFE Tubing

"B" = I.D.

"C" = Wall Thickness

"D" = Maximum Bundle Diameter

"E" = Pitch

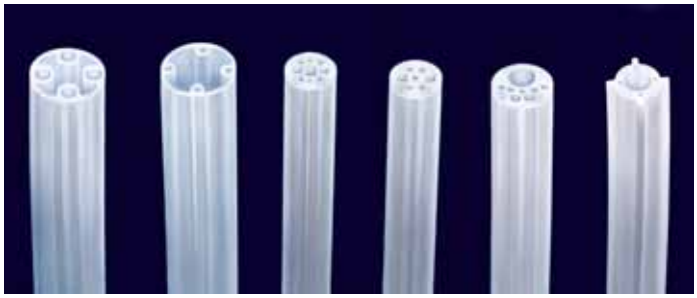


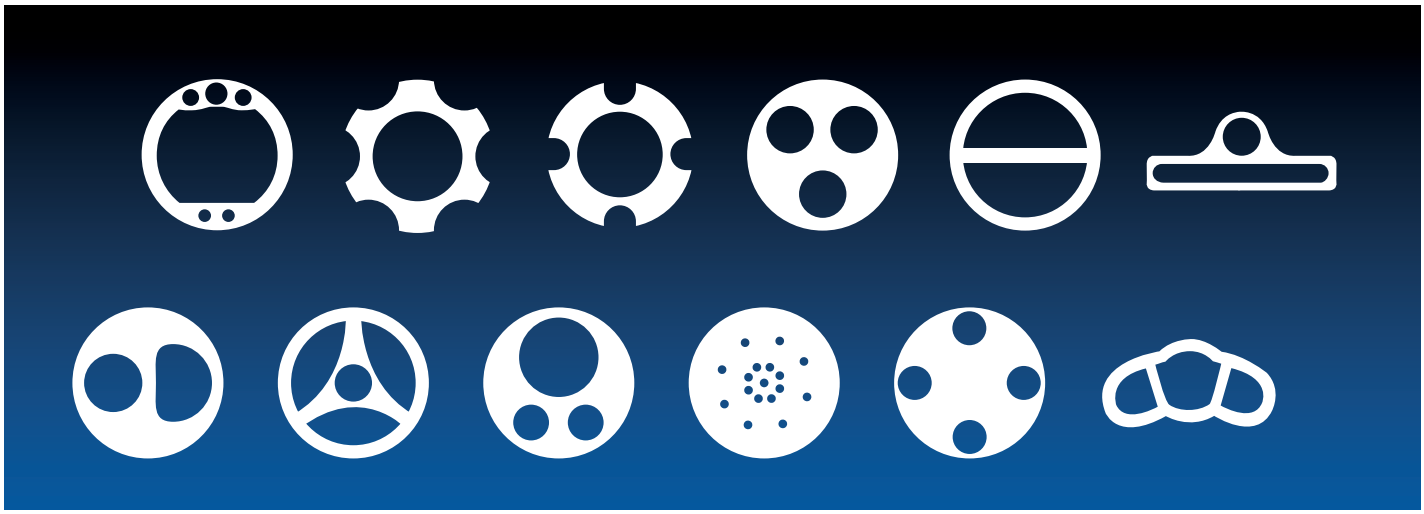
Custom Sizes Available

Multi-Lumens: Unique extrusions providing multiple lumens or passages. All multi-lumens are custom designed in different resins including but not limited to: PTFE, ePTFE, FEP, PFA, PEEK™ and more. Design configurations are unlimited and are specific to your needs with all aspects kept confidentially to each customer.

A Multitude Of Multi-Lumen Advantages

- Highly flexible
- Impervious to most corrosives
- Inert • Non-toxic
- Heat resistant to 500°F.
- Superior lubricity
- Biocompatible
- Reliable fluid transfer
- High dielectric strength

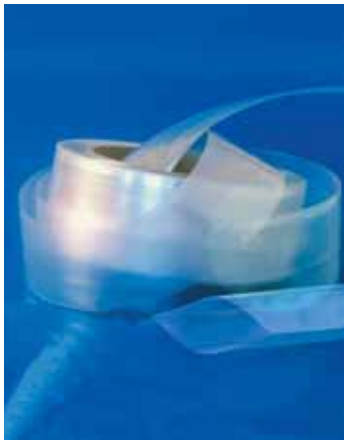




Custom Sizes Available

PET, FEP, PFA, PEEK™, PE and EVA

Dedicated to fulfilling the changes in the markets our customers serve, ZEUS is pleased to offer lay-flat tubing. Lay-flat tubing was traditionally designed to meet the needs for ultra-thin walls in the lighting and roller industries but now has applications in many medical and industrial markets. Lay-flat tubing made of high quality polymers offer strength, lubricity, chemical inertness and biocompatibility.



PET, FEP, PFA, PEEK™ and PE

Wall Sizes:	.002" to .008"
ID Ranges:	.250" to 5.000"
Lay Flat Widths:	.400" to 7.75"
H/S:	Expansion ratios up to 2:1 when applicable
Put Up:	Spooled or cut to length

ZEUS specializes in made-to-order sizes designed for your unique application.

Custom Sizes Available

ZEUS Dual Tube® is a superior, easy handling fluoropolymer tubing typically used for water monitoring and other applications. It is produced as a single unit of two independent tubes of similar or variable sizes that stay together until separation is required. Once separated the surface of each tube is smooth and contains no flaws, flat spots, ridges, or other defects that can interfere with sealing.

ZEUS Dual Tube® is supplied in smooth tangle-free, easy-to-handle, extra long lengths that are tough, durable and chemically inert so that sample properties cannot be affected. Long-term exposure to contaminants cannot impair performance, and it is simple to clean and reuse. Samples obtained remain pure and free of mineral and organic sediments. ZEUS Dual Tubes can be manufactured from PTFE, FEP, Polyethylene and other resins in a variety of configurations.

- Makes monitoring accurate & effective
- Insures consistent sampling results
- Superior reliability
- Non-contaminating
- Protects integrity of sample & well water

ZEUS also has a complete line of **FEP-Lined Polyethylene** (and other resins) tubing developed specifically for the high purity requirements of the environmental monitoring industries. Contact one of our Technical Representatives for more details on this unique product and how it can be beneficial to your application.

Measurements (inches)

1/2" OD x 3/8" ID	and	1/2" OD x 3/8" ID
3/8" OD x 1/4" ID	and	1/4" OD x 1/8" ID
1/4" OD x 1/8" ID	and	1/4" OD x 1/8" ID
1/2" OD x 3/8" ID	and	3/8" OD x 1/4" ID
1/2" OD x 3/8" ID	and	1/4" OD x 1/8" ID
3/8" OD x 1/4" ID	and	3/8" OD x 1/4" ID

Metric Measurements (mm)

12.70 OD x 9.53 ID	and	12.70 OD x 9.53 ID
9.53 OD x 6.35 ID	and	6.35 OD x 3.18 ID
6.35 OD x 3.18 ID	and	6.35 OD x 3.18 ID
12.70 OD x 9.53 ID	and	9.53 OD x 6.35 ID
12.70 OD x 9.53 ID	and	6.35 OD x 3.18 ID
9.53 OD x 6.35 ID	and	9.53 OD x 6.35 ID

Supplied in a variety of ODs and IDs
Other custom sizes and combinations quoted on request

Custom Sizes Available

Splines

ZEUS can provide custom splined extrusions over wire for the coaxial cable manufacturer. With tight tolerances, custom lengths and unique wire cores. All extrusions are done to customer specifications.

Wire, Cables, Coaxial Cores

These extrusions are special and unique because of tolerances, concentricity, finish, lengths and many other considerations. New and unexplored avenues of applications become a reality due to the unmatched capabilities of Zeus' extrusion processes.

- Withstands continuous temperatures to 500°F with PTFE
- Outstanding concentricity
- Shockproof
- Abrasion proof
- Moisture proof

Snaptube®
Restores Damaged Conductors

Dimensions (inches)

Item No.	Nominal I.D.	Nominal Wall Thickness	Recommended Bundle Dia. Max.
ZST-I-250	1/4	.030	.200
ZST-I-437	7/16	.030	.400
ZST-I-562	9/16	.030	.500
ZST-I-625	5/8	.035	.600
ZST-I-812	1 3/16	.035	.750
ZST-I-1000	1	.040	.975
ZST-I-1375	1 3/8	.045	1.350

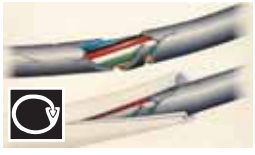
Metric Dimensions (mm)

Item No.	Nominal I.D.	Nominal Wall Thickness	Recommended Bundle Dia. Max.
ZST-I-250	6.35	.76	5.08
ZST-I-437	11.11	.76	10.16
ZST-I-562	14.29	.76	12.70
ZST-I-625	15.88	.89	15.24
ZST-I-812	20.64	.89	19.05
ZST-I-1000	25.40	1.02	24.77
ZST-I-1375	34.93	1.14	34.29

Standard Lengths: 5-foot and 10-foot

Custom Sizes: Other lengths, and smaller or larger diameters quoted on request.

Colors: Natural. Other colors are available per MIL-STD-104 and quoted upon request.



Custom Sizes Available

ePTFE tubing from ZEUS is made by expanding PTFE tubing, under controlled conditions, during the manufacturing process. This process alters the physical properties of the tubing by creating microscopic pores in the structure of the material. The resulting tubing is imparted with unique physical properties that make it ideal for use in medical devices, electronic insulators, high performance filters, and a host of other applications.

Key Properties

ePTFE differs from regular PTFE tubing in that the material is microporous, soft, very flexible, has a lower dielectric constant, increased linear strength, and improved biocompatibility.

- Microporous
- Air permeable
- Soft and flexible
- Biocompatible
- Chemically resistant
- High linear strength
- Chemically inert
- Low dielectric constant
- Excellent radial expansion
- Excellent UV resistance
- Certified USP Class VI resin
- Low coefficient of friction
- Watertight (low pressure)
- Hydrophobic/hydrophilic

ZEUS ePTFE Capabilities

Through extensive investments in R&D, ZEUS has developed a wide range of ePTFE processing capabilities. This broad control over the manufacturing process allows ZEUS to manipulate the physical and mechanical properties of the material. The dimensions of the tubing, as well as the IND and porosity ranges, can be designed to match your proprietary specifications.

- Tubing:
  OD range = <1.5"
  ID range = >0.005"
- Monofilament
  OD = >0.003"
- IND Range: 1µ-200µ+
- ePTFE Multi-Lumen
- Variable porosity
- Long continuous lengths available
- ePTFE over wire
- Custom material properties
- Chemical impregnation
- Custom colors

Custom Sizes Available

ZEUS Support

For over 40 years, ZEUS has assisted medical device engineers in bringing their concepts and ideas to reality. Today, we work closely with numerous manufacturers to confidentially assist them in the development of new products and technology.

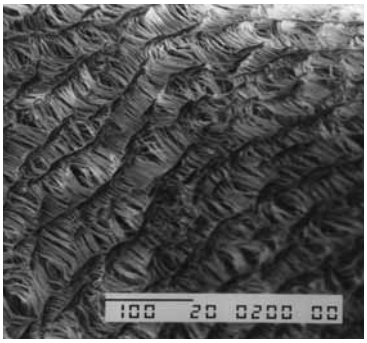
- Test reports
- Technical sales staff
- SEM analysis
- R&D engineering support
- Special certs
- Custom packaging
- Product development
- Medical grade inspection
- Confidential support
- Porosity/filtration testing

Biocompatability

The structure of ePTFE is unique in that the material is made up of a number of solid nodes inter-connected by a matrix of thin fibrils. The spacing between the nodes (IND) is what allows the material to excel in applications requiring cellular ingrowth. ePTFE is well known in medical research papers for its endothelization and thrombogenic properties. PTFE resin has long been utilized for implantable medical devices due to its biocompatibility and proven track record. ZEUS has performed independent testing and holds USP Class VI certification for our PTFE resins.

Internodal Distance (IND)

The amount of expansion in ePTFE is typically referred to as internodal distance (IND). IND is a measure of the average distance between the material's nodes. ZEUS is experienced in manufacturing ePTFE with IND sizes ranging from 1µ to over 200µ.



ZEUS®

VALUE ADDED SERVICES

VALUE ADDED SERVICES

The Benefits of ZEUS Value Added Services and Operations

In response to requests from our customers and our inherent knowledge of our product, ZEUS has developed extensive experience in performing a variety of secondary operations and valued added services that allow you to focus on your core processes. By having ZEUS perform secondary or value added operations, our customers have recognized increased economies of scale, improved yields, and increased manufacturing efficiencies.

Our Value Added operations for our customers have proven to:

- Provide solutions for customers who cannot perform secondary applications in-house
- Reduce labor costs and time
- Improve efficiency
- Reduce material cost (economies of scale)
- Reduce scrap and waste
- Reduce capital expenditure
- Reduce need for prototyping because of our high familiarity with tubing
- Increase yields
- Increase gross profits
- Reduce lead time to end user
- Reduce overhead costs

Bump/Draw-down

Utilizing various manufacturing and secondary processes, ZEUS has developed the technology to vary the ID and OD of tubing along the length of the extrusion. Often referred to as "Bump Tubing", "Draw-downs", or "Bubble Tubing", this technology allows for unique design solutions. Some applications for this technology utilize the variability in dimensions for the attachment of fittings and parts as well as adjustments in flexibility.

- Tight tolerances
- Available in thermoplastics and PTFE
- Variable transition lengths
- ID or OD may be modified

Custom Cutting

- Tight tolerances available
- Ability to control ovality
- In-line cutting
- Clean, crisp cuts
- Angle cuts on one/both ends available

Custom Packaging & Labeling

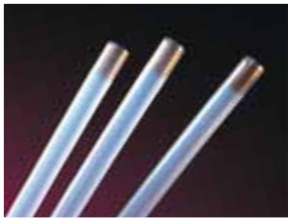
- ZEUS has ability to print labels and bar codes to customer's specifications.
- Ability to package and apply label/bar code using customer supplied materials which reduces/eliminates customers need to repackage
- Blank-package materials for distributors
- Custom packaging to customers specifications available

Drilling

- Custom, clean and burr-free holes
- Single and multiple hole configurations available
- High-speed automation capability

Etching

- Improves the bondability of tubing without effecting mechanical properties



- Can be done over the length of the tube or for specific lengths on the end
- Extrusions can be etched on the ID, OD or tip
- Additional details available in the Technical Information section

Applications include:

- Insulator for fiber optic cable
- Roller covers
- Medical devices
- Anywhere bonding is required

Flaring & Flanging

Flaring and flanging is often used to facilitate the attachment of tubing to fittings or to allow for ease of insertion of items into the inside of the tube.

ZEUS' expertise in manufacturing fluoropolymer tubing has lead to the development of unique capabilities for flaring and flanging tubing. Through an investment in R&D and engineering, ZEUS has developed automated flaring lines and special tooling

that allows us unsurpassed flaring and flanging capabilities.

Experience, equipment, and capacity are the reason many of our customers have chosen to outsource their secondary operations to ZEUS. Additionally, ZEUS has developed a wide range of tooling parts required to produce many common flare angles and sizes reducing your lead times and costs.

Heat Sealing

In applications such as fluid storage, the ends of a polymer tube often need to be sealed closed. Similar to the process used to seal the end of a toothpaste tube, ZEUS can thermoplastically weld closed the end of thin wall lay-flat tubing.

The end of thicker walled tubing can also be heat sealed together in a process known as tipping.

Heat Shrinking over Mandrels

Our experience at manufacturing precision fluoropolymer heat shrink affords us the unique ability to perform efficient heat shrinking over customer-supplied mandrels. Rather than developing a manufacturing process to achieve the ideal balance of oven time and temperature many customers have chosen to have ZEUS perform these operations for them. Our heat shrinking processes and equipment allow us to quickly and efficiently shrink tubing over our customer's parts reducing their equipment and labor costs while decreasing their development costs and production time.

Product Analysis & Enhancement

At ZEUS we're committed to helping make our products work in your application. Our customers are continually challenging us to push the properties and tolerances of our products further. To support this challenge ZEUS has assembled an exceptional team of engineers, technicians and polymer experts.

These experts have successfully customized a wide range of polymers for industry applications ranging from cutting-edge medical devices to state of the art electronics applications.

Through a scientific process of resin selection, process modification and resin additives, ZEUS can adjust the ways that a polymer will perform in your application. Common modifications range from the addition of fillers to improve the radiopacity of a polymer to the addition of carbon for static conductivity.

Advanced modifications might include challenges such as increasing the tensile and mechanical properties of a polymer. These challenges are supported by a team of the most experienced polymer experts in the industry, an advanced analytical lab, and a dedicated R&D facility.

Product Assembly - High Volume

As a world leader in fluoropolymer extrusion, ZEUS is the perfect partner to outsource your high-volume parts assembly. Top manufacturers in industries such as automotive and medical devices trust ZEUS to supply them with high volume tubing based subcomponents.

In addition to world-class extrusion capability, ZEUS has developed world-class machining and fabrication capabilities housed in a dedicated facility. Combined with our experienced engineering department ZEUS has successfully automated time consuming parts assembly.

Our capabilities allow us to reduce your overall costs and help speed your product to market. ZEUS has been delivering pre-packaged sub-components to leading manufacturers and is in an ideal position to offer these services to you.

Product Assembly - Light

Our tubing is used in many advanced products ranging from minimally invasive medical devices to high-performance audio cables and automotive sub-components.

As experts in the manufacturing and modification of the tubular products we offer, many companies have turned to ZEUS to supply various tubing-based sub-components. ZEUS has met this request with our light-product assembly value added services.

Retractable Coil Tubing

ZEUS is pleased to offer a wide range of custom fluoropolymer coiled tubing. Fluoropolymer resins, often called by the trade name Teflon®, include PTFE, FEP, PFA, ETFE, PVDF, MFA and other resins. These plastics are known for their excellent chemical resistance, non-stick surfaces, as well as a number of other high-performance properties.

Through a proprietary manufacturing process, ZEUS "heat sets" fluoropolymer tubing into a helical coil that allow for a high degree of flexibility and retractability. This heat setting process fuses the tubing into the helical formation and allows the material to stretch and retract to its programmed position. Custom sizes, coils, and colors can all be manufactured to meet the requirements of your application.

Scoring

- Partial slit of a tube's wall running axially along the length
- Facilitates removal of tubing from a device
- Facilitates removal of tubing when used as a manufacturing tool

Slitting

(Longitudinal cut that goes through the entire wall of the tube along its axial length)

- Allows a tube to be slipped over other components and easily removed (easily installed)
- Spiral slitting also available

Striping

(Straight and spiraled axial stripes along the length of a tube)

- Radio opaque stripes available
- Helps identify a tube in a bundle
- Custom widths available
- Able to match custom colors

Thermosetting/Forming

- Use heat to set a tube into a certain shape

Tube Tipping

Tipping the end of a plastic tube is one of the secondary services we perform for our customers. Tipping involves forming a radius or chamfering the end of the tube to facilitate the assembly of parts.

Through an extensive investment in our secondary services and capabilities, ZEUS engineers have developed a broad portfolio of tipping capabilities. Thermoforming technology can be used to radius the tip in a variety of customer-specified designs. Specialty grinding can be used in applications where thermoforming may not be an option.

From pronounced tips to a slight easing of the tube's edges ZEUS can perform a range of tipping operations. Over the years we have explored a broad portfolio of tipping configurations ranging from decreasing the ID of the tube as the tip profile changes to a complete closure of the end of the tube at the tip.

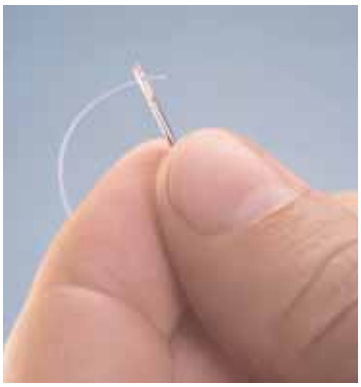
ZEUS®

TECHNICAL INFORMATION

TECHNICAL INFORMATION

Background

- Originally discovered in the 1930's by DuPont® scientist Dr. Roy Plunkett, PTFE was first used in the top secret Manhattan Project during WWII. DuPont® commercialized PTFE under the tradename Teflon® in the late 1940's. Extrudable grades of PTFE were commercialized later and in 1966 Zeus was founded and began development of advanced manufacturing processes for PTFE.
- As a recognized foundational pioneer of the PTFE tubing market Zeus has developed a high performance manufacturing process that allows us to produce a broad range of products for a sizable array of markets and applications.
- The unique properties of PTFE has made it the polymer of first choice for many advanced applications. With the lowest coefficient of friction of any polymer and an extremely broad working temperature range, PTFE has been designed into products from advanced medical devices to high temperature industrial equipment. Because of it's unparalleled chemical resistance and extreme chemical inertness, PTFE has become a choice plastic for the chemical and analytical sciences industries.



Key Properties

- Very lubricious - Lowest coefficient of friction of any polymer
- Working temperature range -454°F (-270°C) to 500°F (260°C)
- Chemically resistant (all common solvents, acids and bases)
- Chemically inert
- Low extractables
- Excellent dielectric insulation properties

Additional Properties

- Biocompatible - Certified USP Class VI
- Flame resistant: UL 94 VO
- Limiting oxygen index greater than 95
- ETO and autoclave sterilizable

Zeus Capabilities

- Fillers available: radio opaque (barium, bismuth and tungsten), glass, bronze, carbon, pigment, and more
- Etching available for bondability
- Ultra-tight tolerances
- Extruded forms: tubing, special profiles, heat shrink, monofilament and multi-lumen

Resin Properties

FEP - Fluorinatedethylenepropylene

TECHNICAL INFORMATION

Background

- The development of PTFE was a significant breakthrough in polymer sciences. The special processing requirements of PTFE led researchers to develop a melt-processable version of PTFE resulting in FEP. This new resin was compatible with existing processing methods and equipment. Melt processability also allowed for long continuous extrusions of FEP in applications such as wire and cable.

- While similar to PTFE in properties FEP has some distinct differences. It has a slightly higher coefficient of friction, lower continuous service temperature, and is more transparent than PTFE. FEP also offers lower gas and vapor permeability properties and excellent UV resistance.

Key Properties

- Transparent
- Excellent coefficient of friction
- Chemically resistant and inert
- Gamma, ETO, e-beam and autoclave sterilizable
- Maximum working temperature 400°F (204°C)
- Excellent transmission of ultraviolet rays
- Lower gas and vapor permeability than PTFE
- Low absorption of solvents (less than 1%)
- Increased translucence compared to PTFE

Additional Properties

- Excellent dielectric insulation properties
- Melt weldable and thermoformable
- Easy to clean
- Biocompatible - Certified USP Class VI
- Environmentally stable
- Flame Rating: UL 94 VO
- Limiting oxygen index greater than 95

Zeus Capabilities

- Etching available for bonding
- Material modification: radio opaque fillers, glass, carbon, UV inhibitors, pigments and many more

- Tight tolerance extrusions
- Extruded forms: tubing, lay-flat tubing, special profiles, heat shrink, monofilament and multi-lumen

Resin Properties

PFA/MFA - Perfluoroalkoxy

TECHNICAL INFORMATION

Background

- PFA was developed to increase the continuous service temperature of FEP resin. Melt processability allows PFA to be processed in longer continuous lengths than PTFE.

Key Properties

- Excellent clarity and flexibility
- Maximum working temperature 500°F (260°C)
- Combines attributes of PTFE and FEP
- Chemically resistant to all common solvents
- Maintains a mechanical strength at high temperatures
- Available in high purity grades
- Chemically inert

Additional Properties

- Excellent solvent resistance
- Low gas permeability
- Smoother surface texture
- Ultra-low levels of ionic extractables
- Gamma, ETO, e-beam and autoclave sterilizable
- Flame resistant: UL 94 VO

Zeus Capabilities

- Material modification: bismuth, glass, carbon, pigments and many more

- Tight tolerance extrusions
- Extruded forms: tubing, lay-flat tubing, special profiles, heat shrink, monofilament and multi-lumen.

Resin Properties

PVDF - Polyvinylidenefluoride

TECHNICAL INFORMATION

Background

- PVDF is often referred to by one of it's trade names, Kynar®. It was designed primarily for applications requiring excellent chemical resistance, high levels of purity, and superior mechanical properties. PVDF is often used as a lining or protective barrier in chemical applications.

Key Properties

- Superior tensile properties and impact strengths
- Excellent resistance to creep and fatigue
- Excellent mechanical properties over a broad temperature range
- Excellent radiation resistance

Additional Properties

- Excellent resistance to cut-through
- High dielectric strength over a wide temperature range
- Chemically resistant (all common solvents, acids and bases)
- Chemically inert

Zeus Capabilities

- Material modification; bismuth, glass, carbon, pigments and many more
- Tight tolerance extrusions
- Extruded forms: tubing, lay-flat tubing, special profiles, monofilament and multi-lumen

Resin Properties

THV - Tetrafluoroethylene hexafluoropropylene vinylidene fluoride

TECHNICAL INFORMATION

Background

- THV resin is a terpolymer of tetrafluoroethylene, hexafluoropropylene and vinylidene fluoride. THV is the most flexible fluoropolymer available and has the highest degree of optical clarity. Combined with the traditional chemical and environmental resistance of fluoropolymers, THV is an ideal choice for many applications.

Key Properties

- Excellent barrier properties
- Exceptional optical clarity
- Good UV transmittance
- Easily weldable

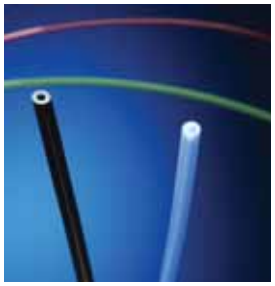
Additional Properties

- High limiting oxygen index: Does not support combustion

Zeus Capabilities

- Tight tolerance extrusions
- Extruded forms: tubing, lay-flat tubing, special profiles, monofilament and multi-lumen

Background



- ETFE is used in applications requiring excellent impact resistance and good resistance to stress cracking. The resin maintains these properties up to its continuous working temperature of over 300°F (149°C). ETFE is the resin of choice for applications requiring a fluoropolymer with superior mechanical properties.

Key Properties

- Excellent impact resistance
- Increased durability and stiffness over other fluoropolymers
- Higher pressure rating than other fluoropolymers
- Higher tensile strength and creep resistance than other fluoropolymers
- Greater crush resistance than other fluoropolymers

Additional Properties

- Gamma, ETO and e-beam sterilizable
- Maximum working temperature 302° F (150°C)
- Chemical resistant
- Flame rating: UL 94 VO
- Limiting oxygen index 30

Zeus Capabilities

- Material modification: glass, carbon, pigments and many more
- Tight tolerance extrusions
- Extruded forms: tubing, lay-flat tubing, special profiles, monofilament and multi-lumen

Resin Properties

PEEK™ - Polyetheretherketone

TECHNICAL INFORMATION

Background

- PEEK™ is a high performance engineered polymer with amazing strength and heat resistant properties. PEEK™ has become a popular replacement for metal in applications such as aerospace where weight is a primary concern. It has also become the gold standard for HPLC analytical science applications due to its purity, high burst pressure, and chemical resistance. In medical applications PEEK's biocompatibility, high tensile strength, and lubricity have made it an ideal replacement for stainless steel. PEEK™ is a very rigid plastic with excellent lubricity and is tan in its natural color.

Key Properties

- Ideal replacement for stainless steel for weight and chemical compatibility
- Exceptional torsional stability
- Thermoformable
- Resistant to gamma radiation
- High burst pressure
- High repeat autoclavability

Additional Properties

- High strength
- High temperature resistance
- Outstanding resistance to chemicals and solvents
- Excellent impact and wear resistance
- Low flammability value
- Excellent creep and fatigue resistance
- Excellent hydrolysis resistance

Zeus Capabilities

- Tight tolerance extrusions
- Material modification: radio opaque fillers, glass, carbon, pigments and many more
- Extruded forms: tubing, lay-flat tubing, analytical tubing, Sub-Lite-Wall® tubing

Resin Properties

PET - Polyethylene Terephthalate Polyester

TECHNICAL INFORMATION

Background

PET resin has become the polymer of choice for price sensitive applications requiring excellent mechanical and physical properties. ZEUS specializes in the extrusion of PET heat shrink available in lay-flat form.

Key Properties

- Clarity
- UV resistant (with additive)
- Extremely strong
- Shrink-back temperature begins at 180°F (82°C)
- Operating temperature exceeding 338°F (170°C)
- Low cost resin

Additional Properties

- Excellent dielectric strength
- Extremely low water absorption
- Very lightweight

Zeus Capabilities

- Available with ultra-thin walls
- Available in PET Lay-Flat® tubing and heat shrinkable configurations
- Material modification: radio opaque fillers, glass, carbon, UV inhibitors, pigments and many more
- Specialty colors

Since its development in 1935, Nylon has found a home in applications ranging from automotive and aerospace to life saving medical devices and equipment. Nylon is available in a wide range of grades suited for many custom applications. ZEUS extrudes Nylon tubing and lay-flat tubing and can assist in the selection of the specific grade of Nylon best suited for your applications.

Zytel® (Nylon 6/6)

- Strongest unreinforced aliphatic nylon
- Most abrasion resistant unreinforced aliphatic nylon
- Better low temperature toughness than Nylon 6 or acetal
- Improved stiffness with addition of glass fibre - unlike acetal
- Good fatigue resistance

Grilamid®/Rilsan® A/ Vestamid® (Nylon 12)

- Lowest moisture absorption of any commercial nylon
- Chemically resistant
- Excellent dimensional stability and electrical properties
- Low density
- FDA approved

Rilsan B® (Nylon 11)

- Low water absorption
- UV resistant
- Good tensile strength
- Heat resistant
- Low impact strength

Pebax®

- Available in 35-72 and custom durometers
- High resilience
- Good low temperature properties
- Wide range of flex modulus

- Excellent resistance to fatigue during flexing
- Very good tensile strength
- Material modification: radio opaque fillers such as barium, bismuth or tungsten

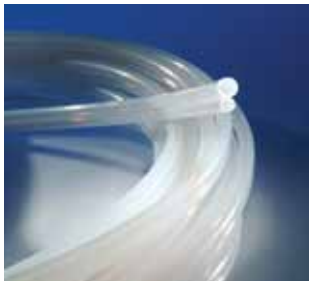
Resin Properties

PE - Polyethylene

TECHNICAL INFORMATION

HDPE

- Maximum temperature: 150° F (66°C) - short duration; 130°F (54°C) - long duration
- Inherent lubricity
- Excellent chemical resistance
- Hardest and stiffest version of PE
- More resilient than LDPE



- Resistant to sunlight and UV attack
- Tensile strength: 3,200 - 4,500 psi

MDPE

- Maximum temperature: 150°F (66°C) - short duration; 130° F (54°C) - long duration
- Tensile strength: 1,900 – 4,500 psi
- Excellent chemical resistance
- Inherent lubricity
- Other properties are between HDPE and LDPE

LDPE

- EVA available as a Lay-flat
- Maximum temperature: 150°F (66°C) - short duration; 130° F (54°C) - long duration
- Inherent lubricity
- Excellent chemical resistance
- Softest and most flexible version of PE
- High elongation giving it excellent impact strength
- Tensile strength: 1,200 - 4,000 psi

Zeus Capabilities

- Tubing
- Dual tube®
- Special shapes
- Lay-flat tubing

Colors

Standard colors are produced to a Pantone® chart color range. ZEUS can also produce custom colors from tubing samples or other subcomponents to meet your unique specification. ZEUS will work closely with you to match colors to a Pantone® range. Please note that there may be some color variation due to pigment changes from lot to lot. ZEUS will minimize this variance to best effort. ZEUS has also developed the technology to extrude tubing with an integrated straight or spiral stripe of a contrasting color. Minimums and pricing for colors will vary so please contact a Technical Salesperson for assistance.

Packaging Information

ZEUS offers the widest variety of packaging options anywhere. Whatever your packaging requirements, ZEUS can meet your needs!

ZEUS also offers the highest levels of cleanliness available for the processing and packaging of material. Our ISO Class 7 certified clean rooms assure your tubing will be ready to use in the most demanding applications. Polybags, chosen for their anti-static capabilities, are available in various thicknesses to further minimize particulate matter, such as dust, from being present in your tubing. Cleanliness is something you can count on when using ZEUS tubing.

ZEUS will go the extra mile in making sure your tubing arrives in the condition you require. We use many types of protective air cushioned bubble wrap to secure tubing during transit. For continuous use needs, ZEUS can secure spliced material with a variety of strong tapes, staples or tied knots. Very short-cut pieces (1" or less) can be placed in protective vials that are easy to handle and store. Numerous spool and box sizes are available to meet any and all packaging needs, or your boxes and spools can be used.

All ZEUS tubing, whether in boxes or on spools, comes properly labeled with your part number and manufacturers lot number ensuring complete traceability of every foot of tubing. Additional information, such as quantity and description of put-up, will also appear on all labels. Let us send you a sample of our tubing and see how complete and descriptive our labeling is.

We never rest in researching new and better methods to package our products to match the uncompromised quality level of the tubing itself. Whatever packaging method you need, ZEUS stands ready to meet your requirements in a timely and professional manner.

Please refer to the tables below for ZEUS standard product packaging specifications:

Standard Packaging Configurations

Product	Size	RPL's Length (ft.)	RPL's Min. Length (ft.)	Cont. Length (ft.)	Straight Length (ft.)	Packaging
AWG	#15 - #32	1000	50*	500 & 1000	n/a	spooled
**5 splice max. per spool*	#10 - #14	500	50*	250 & 500	n/a	spooled
	#9	250	50*	100 & 250	n/a	spooled
	#0 - #8	100	50	50 & 100	n/a	coiled
SW, TW, LW	1/8" - 3/8"	250	50	100 & 250	n/a	coiled
	7/16" - 3/4"	100	50	50 & 100	n/a	coiled
	greater than 7/8"	n/a	n/a	n/a	8	pieces

Standard Packaging Configurations

Product	Size	RPL's Length (ft.)	RPL's Min. Length (ft.)	Cont. Length (ft.)	Straight Length (ft.)	Packaging
Industrial Wall	1/32"	1000	50*	500 & 1000	n/a	spooled
**5 splice max. per spool*	1/16" - 3/8"	250	50	100 & 250	n/a	coiled
	7/16" - 3/4"	100	50	50 & 100	n/a	coiled
	greater than 7/8"	n/a	n/a	n/a	8	pieces
Heavy Construction	1/4" - 3/8"	250	50	100 & 250	n/a	coiled
Size by OD	7/16" - 5/8"	100	50	50 & 100	n/a	coiled
	11/16" - 15/16"	50	25	25 & 50	n/a	coiled
	greater than 1"	n/a	n/a	n/a	8	pieces
Heavy Wall	non-standard product; will not be stocked unless inventory required					
Monofilament (Beading)	.028" - .070"	1000	50*	1000	n/a	spooled*
**5 splice max. per spool*	.078" - .109"	500	50*	500	n/a	spooled*
	.125" - .150"	200	35*	200	n/a	spooled*
Heat Shrink Tubing		n/a	n/a	n/a	4	pieces
Dual-Shrink Tubing		n/a	n/a	n/a	4	pieces
Convoluted	012-018	Available	50	200 & 400	n/a	coiled
	020-024	Available	50	150 & 300	n/a	coiled
	028-032	Available	50	100 & 200	n/a	coiled
	ZCT-040	Available	30	75 & 150	n/a	coiled
	048-064	Available	25	50 & 100	n/a	coiled
	072-096	Available	10	15 & 25	n/a	coiled
FEP Roll Covers		n/a	n/a	n/a	5 & 10	pieces

Product	Size ID (in.)	Tol. (.in)	OD (in.)	Tol. (in.)	Cont. Spooled (ft.)	Cont. Coiled (ft.)
PEEK™	.003	±.001	.062	±.002	100	50
Natural color	.005	±.001	.062	±.002	100	50
	.007	±.001	.062	±.002	100	50
	.010	±.001	.062	±.002	100	50
	.015	±.002	.062	±.002	250	100
	.020	±.002	.062	±.002	250	100
	.030	±.002	.062	±.002	250	100
	.062	±.003	.125	±.003	250	100

Shelf Life and Storage Requirements

Extruded Tubing

Fluoropolymer tubing does not have a determined shelf life. Extensive weathering and aging tests have been conducted and they revealed little to no degradation when exposed to weather, U.V. light, or extreme temperatures. Fluoropolymer tubing contains no antioxidant, plasticizers, U.V. blockers, antistatic agents or other additives which would bleed out during normal storage.

Heat Shrink

PTFE and FEP Heat Shrink tubing conforming to AMS-DTL-I-23053/11 and /12 are labeled with expiration date on tubing. All ZEUS products are labeled with date of manufacture.

ZEUS has tested heat shrinkable tubing that has been aged more than 20 years and revealed no adverse characteristics.

Test Reports/Services

ZEUS' quality is the standard that other manufacturers aim for. Our quality control procedures surpass the industry standards in both the quality of the product and quality and detail of the documentation. ZEUS tubing runs through laser micrometers, making statistical process control data available upon request. Some of the state-of-the-art test equipment available through ZEUS testing labs include:

- Scanning Electron Microscope (SEM)
- Contact Angle Testers
- Laser Micrometers
- Dielectric Tester
- Optical Comparator
- Instron Tensile Tester
- Differential Scanning Calorimeter
- Melt Flow Index Tester
- Specific Gravity Tester
- Vacuum/Pressure Tester
- Other Specialized and Proprietary Testers

A Certificate Of Conformance is sent with every shipment, and test reports certifying conformance to military and commercial specifications are available upon request. Etched tubing is shipped with a certificate of etch, assuring you that the tubing has met ZEUS' rigorous quality standards. Additionally, ZEUS can offer customized testing and certification for the most challenging applications.

Traceability

We at ZEUS take great pride in our ability to maintain full traceability on all parts that we manufacture. Complete traceability is ensured through our ERP system. We can track equipment, inspectors, date of shipment as well as the resin lot that the material was produced from. Through our unsurpassed quality control, we have the ability to trace each lot to its origins as well as supply all test data from each individual lot. ZEUS lot numbers appear on all packaging and shipping containers.

Visual Appearance

ZEUS specializes in manufacturing tubing from a variety of fluoropolymer resins for numerous applications. The finished tubing from these different resins can be visually similar, especially if the tubing has had pigment added to it.

The following describes several aspects of the visual appearance of ZEUS tubing that may be helpful in choosing and working with the finished products.

Most fluoropolymer tubing, whether it be PTFE (Polytetrafluoroethylene), FEP (Fluorinatedethylenepropylene), PFA (Perfluoroalkoxy), ETFE (Ethylenetetrafluoroethylene), or one of the many other resins ZEUS extrudes, appears a clear to milky white color in its natural, unpigmented state. The clearest fluoropolymer resin is FEP, which allows for a high level of light transmission. PFA is quite clear as well, while PTFE material tends to be more milky in color. Levels of clarity can be modified to some extent through different processing methods and the use of a variety of grades of resin at ZEUS.

Pigmented tubing is available in virtually any color you desire. From the brightest fluorescent yellows, pinks and oranges to the most opaque blues and blacks, ZEUS offers the widest range of colors available in fluoropolymer tubing. Levels of translucency and transparency can be modified to meet your specifications, and samples of many colors are available for inspection at no charge. ZEUS can even match a specific color currently at use in your product line through the use of color swatches. We also manufacture pigmented tubing to specific colors on the Munsell and Pantone color charts.

ZEUS inspection procedures insure all tubing meets the stringent quality standards our customers require. Medical Grade Inspection is available for all products ZEUS manufactures, whether or not a medical application is the end use. We constantly inspect for any particulate matter that may limit performance in your application. Our ISO Class 7 certified clean room assures you of the utmost attention to your purity needs. ZEUS exceeds the highest cleanliness standards set forth in the most demanding industries and applications. You can be assured of the purest, highest quality tubing available when using ZEUS tubing.

All ZEUS tubing is inline visually inspected 100 percent by our highly trained inspection personnel, as well as by our exclusive array of dual axis Zumbach laser micrometers. We are constantly inspecting for any particulate matter that may limit performance in your application. ZEUS routinely limits particulate matter to less than .020", and we strive to supply the cleanest tubing available for the most stringent requirements possible. As a pioneer in fluoropolymer extrusion technology, ZEUS provides virtually flawless products unrivaled in the industry.

Whether your field is medical, semi-conductor, computer, electronics, environmental, or any one of a number of industries demanding impeccable cleanliness, ZEUS is your source for the highest quality fluoropolymer tubing available.

Tubing Bend Radius

The question is often raised as to what is the minimum bend radius of a specific size of tubing. The bend radius is established primarily by three different factors: diameter, wall thickness, and resin. ZEUS prides itself in its sample program through which we work with companies to find the right material and perfect size.

As a general guide, however, we have performed a series of bend tests that we hope will guide you in determining the size that is most suitable for you.

The following is a guide to the bend radius of our PTFE Industrial Wall tubing: Based on a minimum of 36" lengths:

Size	Diameter*
1/32" Industrial	.660"
1/16" Industrial	1.375"
3/32" Industrial	2.00"
1/8" Industrial	3.25"
3/16" Industrial	4.00"
1/4" Industrial	6.50"
5/16" Industrial	8.00"
3/8" Industrial	9.00"
7/16" Industrial	9.50"
1" Industrial	12.00"

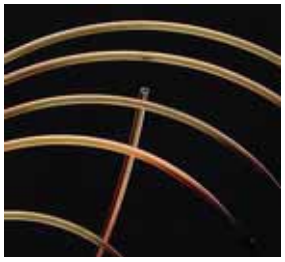
*Please Note: The bend radius is 1/2 the diameter.

Biocompatibility and Certified USP Class VI Approved Zeus Medical Grade Products

ZEUS is proud to offer USP Class VI approval certification with each order in response to the unique requirements of the medical device manufacturing community.

The following resins are certified USP Class VI approved, used for medical, diagnostic, and analytical applications consisting of extruded tubing, heat shrink tubing, profiles and multi-lumens:

- PTFE - Polytetrafluoroethylene
- FEP - Fluorinatedethylenepropylene
- PFA - Perfluoroalkoxy
- ETFE - Ethylenetetrafluoroethylene
- PEEK™ - Polyetheretherketone



In addition, ZEUS has certified USP Class VI tests for many pigments and compounds used in conjunction with USP Class VI-tested resins.

ZEUS has tested the resins and pigments meet the following USP Plastics Class VI requirements:

Biological Reactivity

- Systemic Injection (Acute Systemic Toxicity, Mice)
- Intracutaneous Test (Intracutaneous Toxicity, Rabbits)
- Implantation Test (Implant, Rabbits)

In addition to the extensive testing ZEUS does on their resins, we offer 100 percent traceability on all your orders. You can be assured that when you purchase your tubing from ZEUS, it will pass subsequent traceability test requirements. Additional testing may also be available for certain resins.

Burst Pressure

ZEUS has been supplying fluoropolymer tubing to manufacturers of high pressure devices since our inception. The innate strength of all fluoropolymers make their use in these kinds of applications an ideal choice. Below, you will find a formula for calculating the maximum burst pressure by using Tensile Strength Values.

Typical burst pressure ranges for all of our polymers can be found in the Summary of Properties sheet at the end of this catalog.

$$P = \frac{T(x^2 - y^2)}{Y^2\left(1 + \frac{x^2}{y^2}\right)}$$

P = Burst Pressure

$X = \frac{OD}{2}$

$Y = \frac{ID}{2}$

T = Tensile Strength

The above equation is theoretical. It does not factor steam pressure, altitude, etc., and it is calculated at ambient room temperature. The burst pressure result is meant as a guideline in design, not a definitive number.

Chemical Compatibility

Fluoropolymer resins are essentially chemically inert. This has long been one of the greatest assets of these plastics. Fluoropolymers are an ideal transport medium for today's highly volatile chemical compounds and exotic fluids. The widespread acceptance within the chemical, environmental, aviation, aerospace, and medical industries is a testament to fluoropolymers' unique ability to withstand and resist a wide variety of liquid and gaseous compounds.

There are very few chemicals, such as molten alkali metals, turbulent liquid or gaseous fluorine, chlorine trifluoride, or oxygen difluoride, that are known to react with fluoropolymers.

To a lesser degree, halogenated organic chemicals may be absorbed by fluoropolymer resins. This will cause a very slight change in weight or possibly a slight swelling. This phenomenon is less evident in FEP and PFA extrusions because they are relatively less permeable than PTFE extrusions.

Concentricity Formula

To determine a tube's concentricity use the following formula:

W min is the minimum wall thickness and W max is the maximum wall thickness of the sleeve as taken from any location of the wall of a tubing's cross section. This can be measured using a toolmakers micrometer or optical comparator.

- ASTM D 2671 11.3

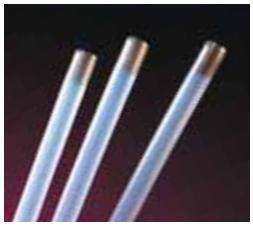
$$C = 100 \times \frac{(W\ min)}{(W\ max)}$$

Etching - Technical Questions

Why would I need to etch tubing?

Fluoropolymers such as PTFE, FEP, and PFA (often called Teflon®) are very lubricious (slippery). This lubricity and the chemical composition of fluoropolymers reduces their bondability. Etching alters the surface properties of the polymer allowing it to be bonded with conventional adhesives.

How does it work?



Etching is performed by the chemical reaction between a sodium solution and the fluorine molecules on the surface of the tubing. Fluorine molecules are stripped from the carbon backbone of the fluoropolymer. This leaves the carbon atoms with a deficiency of electrons. When the etched material is exposed to air, oxygen molecules, water vapor, and hydrogen allow restoration of the electrons. This restoration process results in a group of organic molecules responsible for adhesion.

Will etching change the properties of my tubing?

The etching process only penetrates to a depth of a few angstroms so the properties of the tubing will remain mostly unaffected. However the etching process will darken the surface of the material, usually to a brown or tan shade. Surface lubricity is also reduced by the etching process.

How should I store etched tubing?

Etched fluoropolymers will "grab" molecules from the air to repair their electron deficiency. This results in a weakening of the surface etching. For this reason, all etched materials should be stored in their original sealed bags. ZEUS ships all etched tubing orders in sealed black protective bags to prevent degradation from UV radiation.

Does a darker color mean a better etch?

Not necessarily. Color is not a reliable indicator of etch quality. For this reason ZEUS includes etch certifications with each order shipped.

How is the etch tested?

The etched material is tested using the contact angle method. Contact angle measurements of liquid droplets on substrate surfaces are used to characterize surface wettability. As shown in Figure 1 below, the contact angle is defined as the angle between the substrate support surface and the tangent line at the point of contact of the liquid droplet with the substrate. In this picture, example "B" demonstrates a more effective etch than example "A" .

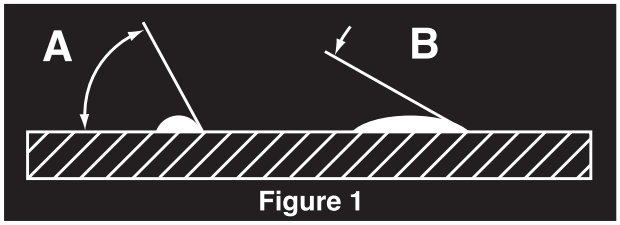


Figure 1

ZEUS performs contact angle tests on all etched tubing orders and includes a Certificate of Compliance with the material. Test results are available by request.

What is the shelf life on etch products?

Many etched products have an almost unlimited shelf life when stored properly. ZEUS recommends following good inventory practices, rotating stock, and using inventory as soon as possible.

Fillers Used in Fluoropolymer Tubing

There are a number of reasons why a filler may enhance the performance of ZEUS tubing, such as increased tensile strength, higher resistance, and increased rigidity. The following information may help to choose the filler that best suits your application. Contact a ZEUS representative for more information.

INDUSTRIAL USES

GLASS

Glass fillers are used to increase abrasion resistance in potentially harsh mechanical applications. Small glass beads are added to the resin and are blended in during the extrusion process. The finished tubing is extremely strong and resistant to the many sources of wear fluoropolymer tubing may be subjected to in an industrial application. Glass also increases the corrosion resistance at high temperatures. ZEUS has also developed a special technology to produce glass-filled PTFE with a smooth surface finish.

BRONZE

Bronze fillers increase creep resistance and machinability of the finished tubing. Bronze filled tubing has low friction and high thermal conductivity.

CARBON

Carbon fillers help dissipate static that can be present in numerous applications. Carbon also increases wear resistance when heavy loads are in constant contact with the tubing. Carbon filled tubing is black in color.

MEDICAL USES

BISMUTH and TUNGSTEN

Bismuth is used to allow PTFE, Pebax®, and other tubing to be visualized on a fluoroscopic screen during invasive procedures. This allows the physicians to see the surgical implantable device both during and after the procedure has been completed. Visualizing the device allows the physician to guide and maneuver the device for proper

placement or alignment. Bismuth will also allow the device to be visualized on routine diagnostic radiographs. Bismuth is well accepted in the medical profession to be in contact with the body.

BARIUM

Barium is used in FEP and other tubing as bismuth is used in PTFE tubing above. Surgical or implantable devices can be viewed on fluoroscopic screens during and after surgeries and on diagnostic radiographs. And, as bismuth, it is medically accepted for contact with the body.

Gamma Radiation

ZEUS has a long and successful history in medical markets around the world from the simplest laparoscopic instruments to the most complex multi-channel catheters. When gamma and e-beam sterilization was developed, ZEUS was one of the first fluoropolymer extruders to offer information on this increasingly popular sterilization method.

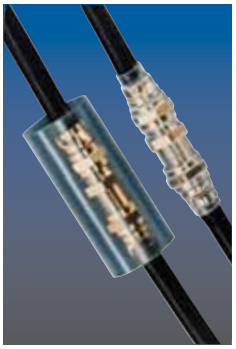
ZEUS specializes in the extrusion of fluoropolymers, engineered thermoplastics and other high-performance resins. Each of these resins has the ability to withstand varying degrees of gamma radiation. PTFE, however, is not recommended for use in applications that require gamma sterilization. For additional information on the gamma resistance of the resins you are working with, please contact one of our Technical Sales Representatives. Below you will find a brief explanation of how gamma sterilization works.

Gamma radiation has been discovered to be an effective low-temperature sterilizing method. It is cost effective for both large and small companies. It is a penetrating sterilant. Gamma processing is a highly reliable procedure. No area of the product being sterilized is left with uncertain sterility. Even high-density products, such as pre-filled containers can be readily processed and used with confidence. Today, many of the common polymers used in medical devices and packaging are naturally radiation stable.

Gamma rays are emitted from radioactive materials such as Cobalt 60 and Cesium 137. The product being sterilized is placed near the radiation source until the required dose is absorbed. This low-temperature process can sterilize a package at under 100°F (38°C). Products exposed to these gamma rays acquire no radioactivity. This allows the product to be used immediately after sterilization. Gamma rays penetrate both thick and thin objects, as well as dense materials. The high penetration allows materials to be sterilized in bulk.

Heat Shrink Recovery

ZEUS offers heat shrinkable tubing that provides a state-of-the-art method for the application of a tight, protective covering to items that will be subjected to the extremes of heat, corrosion, shock, moisture, and other critical environmental conditions. Heat shrinkable tubing extends the life of such items indefinitely and assures their reliable performance.



Heat shrink tubing is offered in a variety of sizes, dimensions, and shrink ratios. ZEUS has developed the technology to manufacture heat shrink in a wide range of polymers. ZEUS provides this unique tubing in the expanded state, and with a brief application of heat, the tubing molds itself tightly around anything it is applied to. Typical applications using our heat shrink tubing are as diverse as component covering, water proofing, mechanical protection, strengthening, shock protection, abrasion protection, corrosion protection, encapsulation, insulation, dust proofing, sterilization, splicing, cable binding and tying, strain relief, marking, and coding.

PTFE HEAT SHRINK

Heat shrinkable PTFE tubing requires a sustained exposure to temperatures ranging from 654°F - 670°F (346°C - 354°C) for as much as 10 minutes to ensure full recovery. PTFE heat shrink completes its recovery during the cooling cycle. The mandrel being covered must be able to withstand this range of temperature. We recommend preheating large-diameter mandrels and giving sufficient time for recovery. Even heating and cooling of all sides will provide the best results.

FEP HEAT SHRINK

Heat shrinkable FEP tubing having an "as supplied" ID less than 1" requires a sustained exposure to temperatures ranging from 400°F to 420°F (204°C - 216°C) for as much as 10 minutes to ensure full recovery.

Heat shrinkable FEP tubing having on "as supplied" ID of 1" or larger requires a sustained exposure to temperatures ranging from 420°F to 440°F (216°C - 227°C) for as much as 10 minutes to ensure full recovery.

All of our products conform to both military and commercial standards, and, in most cases, exceed the intent of these standards. The heat shrink temperatures listed in this catalog are general guidelines. Actual shrink temperatures may be higher or lower depending on the design and dimensions of the heat shrink, application techniques and other factors. Please contact a ZEUS technical account manager for more information.Whether you are interested in the aerospace, electronic, electrical, chemical, optical, medical, nuclear or automotive fields, we are confident that our company can assist you with your heat shrinkable tubing needs.

Low Temperature Rating

Fluoropolymer resins maintain their lubricity, abrasion resistance, and strength at temperatures below freezing. Extensive testing at 0°F (-18°C) and lower have shown that PTFE is the ideal choice for cryogenic applications. With a low temperature range of -450°F (-268°C), showing little or no embrittlement, PTFE remains highly flexible at temperatures below -100°F (-73°C).

Lubricity *(Coefficient of Friction)*

Lubricity is defined in the Webster's New World Dictionary as "slipperiness; smoothness". It is more widely known in our industry as the coefficient of friction. Lubricity is one of many unique characteristics of fluoropolymers that separates itself from other polymers. The fluoropolymers have a smooth surface with a slippery feel.

Because of the low coefficient of friction, there have been many practical non-lubricated and minimally-lubricated mechanical systems developed around fluoropolymers. The low coefficient of friction is a result of low interfacial forces between its surface and other materials and the comparatively low force of deform.

Fluoropolymer's low coefficient of friction properties are tremendous advantages in increasing flow rates, reducing friction in critical applications, and allow the materials to be cleaned easily. In fact, PTFE has a coefficient of friction that is, amazingly enough, comparable to ice on ice, and it even remains stable under severe load.

Additional information on the lubricity properties of the polymers ZEUS extrudes is available in the Summary of Properties sheet at the end of this catalog.

Permeability

Definition:

1. To spread or flow throughout...
2. To pass through opening or small gaps of...
3. Charge, saturate, suffuse, impregnate, or transfuse.
4. Permeation is the product of two functions - the diffusion between molecular chains and the solubility of the permanent in polymer. Diffusion is driven by a concentration gradient for liquids and a partial pressure gradient for gasses. Solubility is related to the affinity of the PERMANENT for the polymer.

To get a true test of permeation, the test should be run on the final component, due to the structure of polymers and the many variables that can effect its PERMANENT. For example, increasing the temperature raises the permeation rate.

Water Absorption

Water absorption in polymers can be effected by the polymer selected, fillers used, and processing method. A range of typical water absorption properties can be reviewed in our summary of properties sheet at the end of this catalog. If water absorption is a key concern please contact a ZEUS Technical Salesperson for advice in selecting the ideal resin for your application.

Relationship for gaseous permeation is:

P = D S

P is the permeability (cm3(STP)/sec-cm-cm Hg)

D is the diffusion coefficient (sm2/sec)

S is the solubility coefficient (cm3(STP)/cm3-cm Hg)

Sterilization Methods

ZEUS is a resource tool for your concepts and ideas - your innovative inspirations. Among our wide array of materials available, each has its own specialties, not excluding medical and ultrapure applications where the purest, sterilized product is a necessity. This is truer in materials requiring sterilization, such as "in-vitro" applications.

Coupled with the ability to provide certified USP Class VI certified materials for implantable devices and the ability to inspect and package in ISO Class 7 certified clean rooms, is the materials capabilities to be sterilized with the most widely accepted sterilization methods known to man.

Please see the following table to select the best material suited for your sterilization method of choice.

Sterilization methods:
ETO, Autoclave, and Gamma

Resin	ETO	Autoclave	Gamma
PTFE	Excellent	Average	Poor
FEP	Excellent	Excellent	Good
PFA	Excellent	Excellent	Excellent
ETFE	Excellent	Excellent	Excellent
PEEK™	Excellent	Excellent	Excellent
PE	Excellent	Excellent	Excellent
KYNAR®	Excellent	Excellent	Excellent
POLYIMIDE	Excellent	Excellent	Excellent

UV Compatibility

ZEUS tubing is virtually unaffected by weather or prolonged exposure to ultraviolet light. Independent testing on samples exposed to virtually all climatic conditions confirm the weather resistant properties of fluoropolymer tubing. Where applications demand complete dependability in these conditions, fluoropolymers are the answer. Resistance to extreme heat, cold, and ultraviolet light encountered in radar and other electronic components, such as antenna bushings, are excellent examples of the value of this material in these applications.

Ultraviolet transmittance can be another useful aspect of fluoropolymer tubing. While levels of UV transmittance vary among the fluoropolymer resin family, ZEUS tubing is used in applications such as water purification with excellent results. Crystallinity and wall thickness also affect the level of transmittance tubing will allow. Contact a ZEUS Technical Representative for more information on this very useful property of fluoropolymer tubing.

Summary Of Properties

Extruded Fluoropolymers

The table below lists the generally accepted summary of electrical, mechanical and thermal properties of non-pigmented polymer resins from which ZEUS fabricates its line of tubing, beading, shapes and other unique extrusions.

	PROPERTY	ASTM	UNITS	PTFE	FEP	PFA	ETFE	PVDF	PEEK	LDPE	HDPE
MECHANICAL	Tensile Strength	D1708	PSI	2,500-4,000	3,500	4,000	7,500	D638 5,000	D638 13,300	D638 2,100	D638 4,500
	Specific Gravity	D792		2.13-2.24	2.15	2.15	1.70	1.8	1.32	.92-.94	.95-.97
	Coefficient of Friction	Dynamic (<10 ft/min)		0.1	0.2	0.2	0.23	0.3	0.35 -0.5	0.18	
	Compressive Strength	D695	PSI	3,500	2,200		7,100	11,600	17,100	2,700-3,600	
	Impact Strength 73°F	D256	Ft-Lb/in	3.5	No Break	No Break	No Break	3-6	655	1.0	10
	Flexural Modulus 73°F	D790	PSI	27,000	95,000	95,000	200,000		530,800		100,000
	Tensile Modulus	D638	PSI	80,000	60,000	40,000	120,000	348,000	522,100	38-75	155-155
	Hardness-Durometer	D2240		D-50-65	D-55	D-60	D-75	D-76-80		D50	D64
	Elongation	D1708	%	200-400	300	300	100-300	D638 150	D638 50	D638 425	D638 7,800
	Flexural Strength	D790	PSI	No Break	No Break	No Break	37.9 5,500	10,750	24,700		
	Water Absorption	D570	%	<0.01	<0.01	0.03	<0.03	<0.04	<0.05	<0.01	<0.01
	Deformation Under Load (73°F, 1000 PSI, 24 HR)	D621		3.5	1.8	2.0	0.6				
	Linear Coefficient of Expansion (70-212°F) (212-300°F) (300-408°F)	D696	in/in/°F	 $7.5x10^{-5}$ $8.5x10^{-5}$ $10.5x10^{-5}$	 $4.5\text{-}5.8x10^{-5}$	 $6.7x10^{-5}$ $9.4x10^{-5}$ $11.1x10^{-5}$	 $5.0x10^{-4}$ $7.0x10^{-4}$	 $7.1x10^{-5}$	 $2.6x10^{-5}$	 In/In/°c $2x10^{-4}$	 In/In/°c $1.1x10^{-5}$
	Flex Life (MIT)			>1,000,000	15,000	15,000	12,000				
	Creep Resistance	D674	LB/Sq In			40,000					
ELECTRICAL	Dielectric Strength (ShortTerm) 10Mil Film	D149	V/Mil	>1,400	>2,000	>2,000	>2,000	>1080	>500	450-1000	450-500
	Volume Resistivity	D257	ohm-cm	$>10^{18}$	$>10^{18}$	10^{18}	$>10^{16}$	$>10^{13}$	$>4.9x10^{16}$		
	Surface Resistivity	D257	ohm/Sq	$>10^{18}$	$>10^{16}$	10^{17}	$>10^{14}$				
THERMAL	Continuous Service Temperature		°F	500	400	500	302	235	482	190	248
	Melting Point	DTA	°F	635-650	500-530	575-590	490-535	352	633	350	370
	Thermal Conductivity	C-177	BTU/hr/ft²/°F.in	1.7	1.4	1.32	1.65	1.31	1.2		
	Heat of Fusion		BTU/lb	29-37	11	13	20				
	Specific Heat	C-177	Cal/g/°C								
	25°C 100°C 200°C 275°C			0.23 0.25 0.27 0.29	0.26	0.256 0.283 0.334 0.391	0.46-0.47	.30-.34			
	Low Temperature Embrittlement		°F				-150°				
	Deflection Temperature 66 PSI 264 PSI		°F	 252 131	 138 134	 166 118	 220 160	 235	 285	 220	 340
	Heat of Combustion		BTU/lb	2.200		2,200	8,100				
OTHER	Flammability Rating	UL 94		VO	VO	VO	VO	VO	VO	VO	VO
	Refractive Index	D542		1.35	1.338	1.35	1.40				
	Limiting Oxygen Index			>95	>95	>95	30-31				