Tubing

Measuring and monitoring the drawing of capillary tubing.

SGE has a number of unique tubing products (Glass Lined Tubing - GLT™, and PEEK™ coated fused silica tubing - PEEKsil™) that allow chromatographers to perform applications not possible without these formats.

Read on to learn more about how the choice of the correct tubing can enhance your chromatography and biotechnology applications.

Fused Silica Tubing

SGE has been manufacturing silica capillary for over 30 years and has brought together technologies employed by optical fiber and tube re-draw industries, and merged them with silica glass structure and surface sciences. This melding of technologies ensures a complete understanding of all aspects necessary for production of high purity and high quality capillary.

Coated fused silica capillary tubing exhibits remarkable flexibility, with most sizes capable of being looped to a bend radius of 1 inch without the glass fracturing. The key to this flexibility comes from the coating material that protects the glass from abrasive damage. The resins SGE uses are semiconductor grade polyimides that possess excellent high temperature and electrical insulating properties. The resins also offer exceptional scuff resistance, which is important for applications where the capillary is frequently handled.

High Temperature Polyimide Coating

- Low Coefficient of Thermal Expansion (CTE): closely matches glass substrate.
- High modulus of elasticity: low deformation when “stretched”.
- High tensile strength: supports “tight coiled” capillary applications.
- Continuous operation +400 °C: polyimide cross-linking ensures adequate thermal protection.
- Solvent resistant: cannot be damaged by laboratory chemicals.
- Moderately high modulus of elongation: good flexibility.

Acrylate Coating

- Resistant to UV breakdown: durable to UV exposure.
- Low surface tension finish: repels oil and water.
- Good optical properties: high light throughput from UV to IR.
- High modulus of elongation: good flexibility.
- Thermoplastic properties: excellent welding properties.
- Easy window production: either chemical or thermal.
- Zero residue on glass after window production.

Once the drawing process is complete, the capillary tubing is subjected to stress testing many times above general handling levels to ensure it is free from structural defects.

The capillary tubing features are:

- High homogeneity.
- 100% proof tested for strength.
- Excellent resistance to thermal shock.
- Chemical inertness.
- Standard polyimide temperature resistance to +400 ˚C – equivalent to other high temperature polyimides.
- Polyimide coating is chemically resistant.
- Acrylic coating UV transparent (>240 nm).
- Low dielectric constant, low dielectric loss.
- Impermeable to all gases (except H_2, He).

- Free of thermal hysteresis.
- Low weight loss (below devitrification temperature).
- Optical properties of uncoated – transparent above 180 nm.
- High intrinsic tensile strength.
- Uncoated, temperature resistant to 1000 ˚C.
- Pressure resistant to 1000 bar.
- Very low thermal expansion.
- Internal surface modification is available.

Fused Silica Stability

Fused silica is very stable chemically and shows excellent resistance to acids. These properties make it ideal for applications involving various solvents, distillation of acid solutions and organic reactions. However, in hydrofluoric and phosphoric acids, alkalis and alkali-metallized compounds, dissolution of silica glass and surface devitrification may occur.

Internal Diameter	15 µm = ± 2 µm 25 µm = ± 2 µm 50 µm = ± 3 µm 250 µm = ± 6 µm 320 µm = ± 6 µm 530 µm = ± 10 µm
Outside Diameter	360 µm = ± 10 µm 430 µm = ± 10 µm 700 µm = ± 15 µm
Iron	< 8 ppb
Lithium	< 10 ppb
Sodium	< 8 ppb
Potassium	< 10 ppb
Magnesium	< 10 ppb
Manganese	< 5 ppb
Titanium	< 10 ppb
Chlorine	0 ppb
Zirconium	< 10 ppb

Table 1. Fused silica tubing specification

Non-Deactivated Fused Silica

- Used in a wide range of capillary GC, HPLC and Bioanalytical applications.
- Made from high quality fused silica.
- Tubing protected with a high temperature Polyimide resin.

Non-Deactivated Fused Silica Capillary Tubing

ID (mm)	Tubing OD (mm)#	Length (m)	Pack Size	Part No.
0.005	0.285	10	1	062456
0.01	0.285	10	1	062458
0.025	0.15	10	1	062461
0.025	0.285	10	1	062460
0.025	0.363	Sold per meter as a continuous length *	1	062710
0.04	0.14	10	1	0624625
0.05	0.15	10	1	0624635
0.05	0.22	10	1	062463
0.05	0.363	Sold per meter as a continuous length *	1	062711
0.06	0.22	10	1	0624655
0.075	0.19	10	1	062466
0.075	0.363	Sold per meter as a continuous length*	1	062712
0.1	0.2	10	1	0624685
0.1	0.363	10	1	062469
0.1	0.363	25	1	062470
0.11	0.17	10	1	062454
0.11	0.17	25	1	062457
0.15	0.22	10	1	062472
0.15	0.22	25	1	062473
0.15	0.285	10	1	062474
0.15	0.363	Sold per meter as a continuous length *	1	062713
0.22	0.363	10	1	062475
0.22	0.363	25	1	062476
0.25	0.363	10	1	062492
0.32	0.43	10	1	062478
0.32	0.43	25	1	062479
0.53	0.68	10	1	062481
0.53	0.68	25	1	062482

*One meter is one unit, e.g. to order 14 meters of 0.150 mm ID x 0.363 mm OD, the order must be for 14 of Part No. 062713. This will be supplied as a continuous length of 14 meters.

Nominal OD.

W: www.velocityscientific.com.au
E: info@velocityscientific.com.au
P: 1300 855 315

Deactivated Fused Silica Tubing

Deactivated fused silica tubing is an essential ingredient in maintaining a high performance chromatography system. Deactivated Capillary tubing will suit almost all applications, including retention gaps (improving the solvent effect for splitless injection volumes – ensuring maximum resolution), guard columns (to increase the life expectancy of your capillary column) and transfer lines (interfacing the analytical column to a mass spectrometer, or allowing the column effluent to be split and diverted to different detector systems).

Larger bore deactivated tubing (0.22 – 0.53 mm) provides a chemically inert flowpath for sample introduction for Purge and Trap systems, Headspace Analyzers and Multidimensional Systems.

It is important to note that tubing used for the above applications needs to achieve the highest possible level of chemical inertness and thermal stability, ensuring no interference with the quantitative and qualitative processes of an analysis. In addition, this tubing needs to have no retention of the solvent, minimal retention or interaction of the solute, and be wettable by the solvent of interest.

SGE range of tubing is:

- 0.025 – 0.53 mm ID.
- Quality guaranteed – individually tested performance of each 30 m length from which all shorter (2, 5 and 10 meter) lengths are prepared. A test report is included with each column providing a history of its performance.
- Chemically inert and thermally stable up to 380 °C.
- Suitable for organic and aqueous solvents.
- Ideal for biotechnology applications.
- Methyl deactivated for use with hydrocarbons (pentane, hexane, heptanes, iso-octane, aromatics and mixed solvents – n-parrafins/chlorinated solvents).
- Phenyl deactivated tubing is recommended to be used where wetability needs to be improved.

Custom tubing is available upon request, contact your local SGE office.

Methyl Deactivated Fused Silica Capillary Tubing

Tubing ID (mm)	Tubing OD (mm)#	Length (m)	Pack Size	Part No.
0.025	0.285	2	1	062442
0.05	0.22	2	1	062444
0.05	0.363	2	1	06244503
0.06	0.22	2	1	062445
0.075	0.19	2	1	0624450
0.075	0.363	2	1	06244502
0.1	0.363	25	1	0624455
0.11	0.17	2	1	062446
0.11	0.31	2	1	0624459
0.125	0.363	2	1	06244501
0.15	0.22	2	1	0624460
0.15	0.22	5	1	0624461
0.15	0.22	10	1	0624463
0.15	0.363	2	1	0624465
0.15	0.363	5	1	0624475
0.17	0.3	2	1	0624491
0.17	0.3	5	1	062449

Nominal OD.

Methyl Deactivated Fused Silica Capillary Tubing Continued

Tubing ID (mm)	Tubing OD (mm)#	Length (m)	Pack Size	Part No.
0.22	0.363	2	1	0624469
0.22	0.363	5	1	062447
0.22	0.363	5	5	064050
0.22	0.363	10	1	0624478
0.22	0.363	25	1	0624474
0.25	0.363	2	1	0624431
0.25	0.363	5	1	0624432
0.25	0.363	5	5	064051
0.25	0.363	10	1	0624434
0.32	0.43	2	1	0624470
0.32	0.43	5	1	0624471
0.32	0.43	5	5	064052
0.32	0.43	10	1	0624476
0.32	0.43	25	1	0624473
0.53	0.68	2	1	0624479
0.53	0.68	5	1	062448
0.53	0.68	5	5	064054
0.53	0.68	10	1	064033
0.53	0.68	25	1	064034

Nominal OD.

Phenyl Deactivated Fused Silica Capillary Tubing

Tubing ID (mm)	Tubing OD (mm)#	Length (m)	Pack Size	Part No.
0.22	0.363	5	1	064102
0.22	0.363	10	1	064103
0.25	0.363	5	1	064061
0.25	0.363	10	1	064062
0.32	0.43	5	1	064108
0.53	0.68	5	1	064114

Nominal OD.

Capillary Electrophoresis Tubing

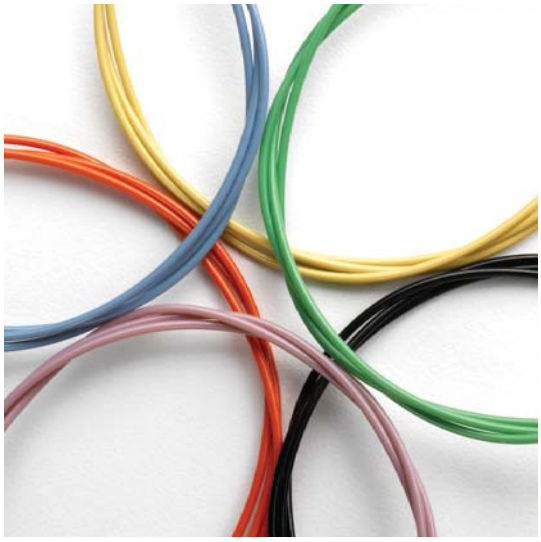
- Manufactured from precision bore tubing.
- Hydrophobic and hydrophilic surface treatments are available to enable tubing use with proteins, peptides and enzymes.
- Wide pH range.
- 30, 50, 75 and 100 µm ID.
- Column-to-column reproducibility.

Treatment Type	Phase	Polarity	pH range	Application
Untreated	Free silanol sites allow bonding.	N/A	N/A	Field coating
ES2	Amide, hydrophobic, hydrolytically stable.	Moderately polar	5-9	Proteins, peptides, enzymes
ES20	Polyethylene glycol phase, weakly hydrophilic.	Polar	2-10	Proteins, peptides

Description	Tubing ID (mm)	Tubing OD (mm)	Length (m)	Pack Size	Part No.
Untreated	0.03	0.363	1	1	062801
ES20 Treated	0.05	0.363	1	1	062881
Untreated	0.05	0.363	1	1	062803
ES2 Treated	0.075	0.363	1	1	062812
Untreated	0.075	0.363	1	1	062813
Untreated	0.1	0.363	1	1	062823

W: www.velocityscientific.com.au
E: info@velocityscientific.com.au
P: 1300 855 315

PEEKsil™ Tubing (Fused Silica Lined PEEK™)



PEEKsil™ is polymer-sheathed fused silica tubing with an effective outside diameter of 1/32", 1/16" or 0.36 mm. SGE is the only manufacturer of this inert chromatography tubing. The sheathing polymer is polyether ethyl ketone (PEEK™) that is mechanically strong and has ideal characteristics for sealing with conventional metal or polymer ferrule systems. PEEKsil™ may be used as a direct replacement for conventional stainless steel as well as a replacement for PEEK™ tubing used in liquid chromatography systems. The PEEK™ polymer exterior coating and the fused silica combination *(Figure 1)* makes PEEKsil™ very robust. PEEKsil™ is therefore capable of withstanding high pressures *(Table 2)*, making it ideal for capillary HPLC and LC/MS applications.

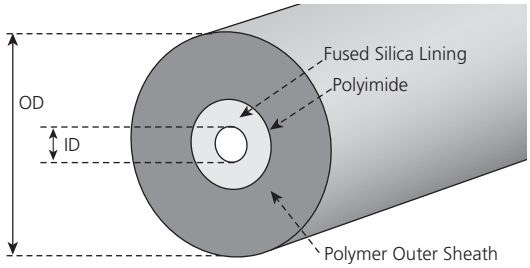


Figure 1.

Pressure Rating		
50 micron	≤	25,000 psi
100 micron	≤	15,000 psi
175 micron	≤	8,500 psi
200 micron	≤	6,000 psi

Table 2. Pressure Rating for PEEKsil™.

Expert Tip :
PEEKsil™ tubing is an excellent alternative to PEEK™ tubing as its internal bore is unaffected by any organic solvents.

- PEEKsil™'s smooth wall allows lower carry over or cross contamination between samples which can lead to improved reproducibility.
- The smooth wall of PEEKsil™, particularly for smaller inside diameter HPLC column systems, gives lower band broadening and therefore higher efficiency and resolution.
- Small inside diameters of stainless steel tubing are prone to blockage. The smooth wall of fused silica tubing means that it is far less likely to block.
- PEEKsil™ is compatible with most organic solvents. PEEKsil™ is resistant to strong acids and has an effective pH range of 0-10. PEEKsil™ is not compatible with hydrofluoric acid.
- Fused silica is renowned for its extremely low absorption characteristics, especially when compared with the absorption of sensitive sample components on stainless steel.
- The inside diameter of fused silica tubing can be produced far more precisely and with a greater range of sizes than is available with stainless steel (see part number listing table on opposite page). 50 micron ID PEEKsil™ is perfect for LC/MS applications. Furthermore, the fused silica bore is unaffected by organic solvents, unlike PEEK™ tubing which is prone to contraction in some organic solvents.
- The use of PEEKsil™ complements SGE's full range of non-metallic HPLC columns (see pages 208-210 for ProteCol™ HPLC Columns) and cartridges to give a metal free HPLC analytical system. This is advantageous for ion chromatography and sensitive samples such as proteins.
- PEEKsil™ is inherently straight, but is very flexible, which makes connection between columns, detectors and injectors easier than with more rigid stainless steel tubing.

- The flexibility of PEEKsil™ eliminates strain on components in precision HPLC systems. PEEKsil™ may also be coiled and used as the external loop of an injection valve.
- PEEKsil™ can be used in all applications where solvents must be pumped under high or low pressures with little flow resistance or possibility of contamination. Typical uses are in HPLC connecting lines, sample loops and sample lines.

Color	Tubing ID (mm)	Tubing OD	Length (mm)	Pack Size	Part No.
Orange	0.025	0.36 mm	50	2	0624371
Orange	0.025	0.36 mm	100	2	0624372
Orange	0.025	0.36 mm	150	2	0624373
Orange	0.025	0.36 mm	250	2	0624374
Orange	0.025	0.36 mm	500	2	0624375
Beige / Natural	0.05	0.36 mm	50	2	0624376
Beige / Natural	0.05	0.36 mm	100	2	0624377
Beige / Natural	0.05	0.36 mm	150	2	0624378
Beige / Natural	0.05	0.36 mm	250	2	0624379
Beige / Natural	0.05	0.36 mm	500	2	0624380
Orange	0.025	1/32"	50	2	0624241
Orange	0.025	1/32"	100	2	0624242
Orange	0.025	1/32"	150	2	0624243
Orange	0.025	1/32"	250	2	0624245
Orange	0.025	1/32"	500	2	0624249
Beige / Natural	0.05	1/32"	50	2	0624261
Beige / Natural	0.05	1/32"	100	2	0624262
Beige / Natural	0.05	1/32"	150	2	0624263
Beige / Natural	0.05	1/32"	200	2	0624264
Beige / Natural	0.05	1/32"	250	2	0624265
Beige / Natural	0.05	1/32"	500	2	0624269
Black	0.075	1/32"	50	2	0624271
Black	0.075	1/32"	100	2	0624272
Black	0.075	1/32"	150	2	0624273
Black	0.075	1/32"	250	2	0624275
Black	0.075	1/32"	500	2	0624279
Red	0.1	1/32"	50	2	0624311
Red	0.1	1/32"	100	2	0624312
Red	0.1	1/32"	150	2	0624313
Red	0.1	1/32"	250	2	0624315
Red	0.1	1/32"	500	2	0624319
Purple	0.15	1/32"	50	2	0624341
Purple	0.15	1/32"	100	2	0624342
Purple	0.15	1/32"	150	2	0624343
Purple	0.15	1/32"	250	2	0624345
Purple	0.15	1/32"	500	2	0624349
Orange	0.025	1/16"	50	5	0624225
Orange	0.025	1/16"	100	5	0624226
Orange	0.025	1/16"	150	5	0624227
Orange	0.025	1/16"	200	5	0624228
Orange	0.025	1/16"	500	2	0624229
Beige / Natural	0.05	1/16"	50	5	0624251
Beige / Natural	0.05	1/16"	100	5	0624252
Beige / Natural	0.05	1/16"	150	5	0624254
Beige / Natural	0.05	1/16"	200	5	0624253
Beige / Natural	0.05	1/16"	500	2	0624250
Black	0.075	1/16"	50	5	0624290
Black	0.075	1/16"	100	5	0624291
Black	0.075	1/16"	150	5	0624292
Black	0.075	1/16"	200	5	0624293
Black	0.075	1/16"	500	2	0624294
Red	0.1	1/16"	50	5	0624301
Red	0.1	1/16"	100	5	0624302
Red	0.1	1/16"	150	5	0624304
Red	0.1	1/16"	200	5	0624303
Red	0.1	1/16"	500	2	0624300
Purple	0.15	1/16"	50	5	0624230
Purple	0.15	1/16"	100	5	0624231
Purple	0.15	1/16"	150	5	0624232
Purple	0.15	1/16"	200	5	0624233
Purple	0.15	1/16"	500	2	0624234
Yellow	0.175	1/16"	50	5	0624351
Yellow	0.175	1/16"	100	5	0624352
Yellow	0.175	1/16"	150	5	0624354
Yellow	0.175	1/16"	200	5	0624353
Yellow	0.175	1/16"	500	2	0624350
Blue	0.2	1/16"	50	5	0624202
Blue	0.2	1/16"	100	5	0624203
Blue	0.2	1/16"	150	5	0624205
Blue	0.2	1/16"	200	5	0624204
Blue	0.2	1/16"	500	2	0624201
Grey	0.3	1/16"	50	5	0624214
Grey	0.3	1/16"	100	5	0624215
Grey	0.3	1/16"	150	5	0624216
Grey	0.3	1/16"	200	5	0624217
Grey	0.3	1/16"	500	2	0624218
Bone White	0.53	1/16"	50	5	0624365
Bone White	0.53	1/16"	100	5	0624366
Bone White	0.53	1/16"	150	5	0624367
Bone White	0.53	1/16"	200	5	0624368
Bone White	0.53	1/16"	250	2	0624369
Bone White	0.53	1/16"	500	2	0624370

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W: www.velocityscientific.com.au
E: info@velocityscientific.com.au
P: 1300 855 315

GLT™ (Glass Lined Tubing)

GLT™ (Glass Lined Tubing) was invented and patented by SGE to enable the achievement of a completely inert chromatographic system. It is made by fusing a borosilicate glass lining onto the inside surface of stainless steel tubing. GLT™ can either be used as straight tubing or it can be machined or shaped into virtually any chromatography accessory - the options are limitless.

- GLT™ exhibits excellent resistance to strong acids and bases unlike inferior silica coated brands.
- GLT™ is biocompatible making it ideal for many HPLC applications. A mirror surface finish allows high HPLC column efficiencies.
- GLT™ can withstand high temperatures. Maximum temperature for continuous use of GLT™ is 500 °C. The glass is secured to the steel wall because of the higher coefficient thermal expansion of the steel relative to the glass.
- GLT™ can be used for: reactor tubing transfer lines, flow lines for stack probes for environmental monitoring, HPLC columns for protein and biosensitive analyses, mass spectrometer interfaces, thermal desorption tubes, inert tee pieces and unions.
- GLT™ can be formed into a multitude of shapes and can also be joined by welding or silver soldering.
  - Bending: GLT™ can be bent without damage to the glass lining by heating it with a gas-air burner in the region where the bend is required. When the metal tubing turns medium red (approximately 800 °C) it can be slowly bent to the desired angle while still in the flame. It is important that the tubing is not bent in the cold condition, or the glass lining will shatter.
  - Silver-Soldering: After first removing the black oxide layer, the metal sheath can be silver-soldered by conventional methods. It is important that excessive heat is not applied to the tubing, or the glass lining may become non-uniform. On completion of soldering, the components should not be quenched but allowed to cool slowly to ambient temperature. Take care not to allow hot flux to come into contact with the glass liner.

Tubing comes in a wide range of sizes with outer diameters of 1/16", 1/8", 1/4", 1/2" (standard), 8 and 4 mm (non-standard) and internal diameters between 0.3 – 9.5 mm. GLT™ can be machined to form union fittings and a range of other chromatography accessories. There is no limit to the range of applications GLT™ can service. Contact SGE for a complete custom-made solution to your flow, transfer and system operation problems.

GLT™ (Glass Lined Tubing)

Tubing ID (mm)	Tubing OD	Length (cm)	Part No.
0.3	1/16"	30	082707
0.3	1/16"	60	082708
0.3	1/16"	90	082709
0.3	1/16"	180	082710
0.4	1/16"	30	082712
0.5	1/16"	30	082717
0.5	1/16"	60	082718
0.5	1/16"	90	082719
0.5	1/16"	180	082720
0.7	1/16"	30	082722
0.7	1/16"	60	082723
0.7	1/16"	90	082724
0.7	1/16"	180	082725
0.8	1/16"	30	0827352
0.8	1/16"	60	0827353
0.8	1/16"	90	0827354
0.8	1/16"	180	0827355
0.5	1/8"	30	0827375
0.5	1/8"	60	0827376
0.5	1/8"	90	0827377
0.75	1/8"	30	082732
0.75	1/8"	60	082733
0.75	1/8"	90	082734
0.75	1/8"	180	082735
1	1/8"	30	082737
1	1/8"	60	082738
1	1/8"	90	082739
1	1/8"	180	082740
1.5	1/8"	30	082742
1.5	1/8"	60	082743
1.5	1/8"	90	082744
1.5	1/8"	180	082745
1.8	1/8"	30	082747
1.8	1/8"	180	082750
2	1/4"	90	082760
4	1/4"	30	082767
4	1/4"	60	082768
4	1/4"	90	082769
4	1/4"	180	082770
9.5	1/2"	60	08277028

Connections

Use of Swagelok® ferrules with larger ID GLT™ may result in cracking of the glass liner. The use of graphite ferrules is recommended for connecting GLT™. Swagelok® metal ferrules may only be used with 2 and 3 mm ID 1/4" OD, and 1.5 mm ID and under 1/8" OD GLT™.

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W: www.velocityscientific.com.au
E: info@velocityscientific.com.au
P: 1300 855 315