Scientific Tubing

Glass Lined Tubing (GLT™)
PEEKsil™ Tubing
Fused Silica Tubing

PRODUCT DATA

Scientific Tubing

Glass Lined Tubing (GLT™)

WHAT IS GLT™?

GLT (Glass Lined Tubing) was invented and patented by SGE to address the problem of achieving 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.

UNIQUE ADVANTAGES

GLT IS INERT
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 IS STABLE
GLT can withstand high temperatures.
The glass is secured to the steel wall because of the higher coefficient thermal expansion of the steel relative to the glass.

GLT IS VERSATILE
GLT can be formed into a multitude of shapes and can also be joined by welding or silver soldering.

APPLICATIONS
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 RANGE
Tubing comes in a wide range of sizes with outer diameters of 1/16 inch, 1/8 inch, 1/4 inch, 1/2 inch, 8 and 4mm and internal diameters between 0.3 - 4.6mm. GLT can be machined to form union fittings and a range of other chromatography accessories.

GLT CUSTOM DESIGN SERVICE AND OEM CONFIGURATIONS
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.

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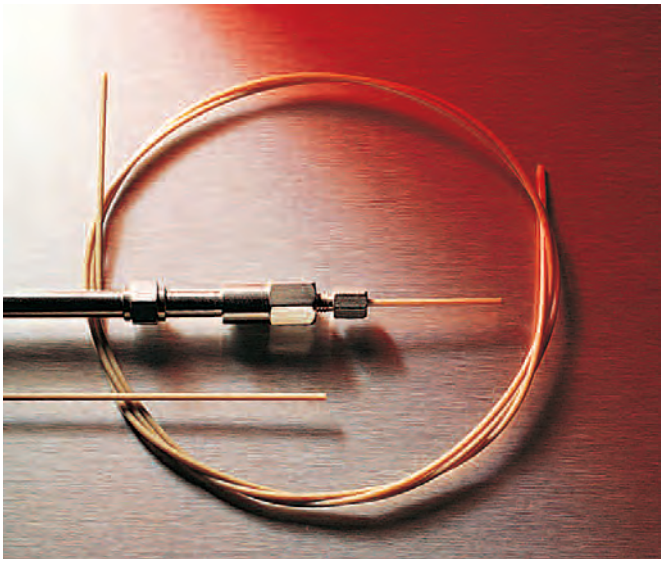
PEEKsil™ Tubing

PEEKsil™ is polymer-sheathed fused silica tubing with an effective outside diameter of 1/32 inch or 1/16 inch. The sheathing polymer is polyether ether 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.



ADVANTAGES OF PEEKsil™

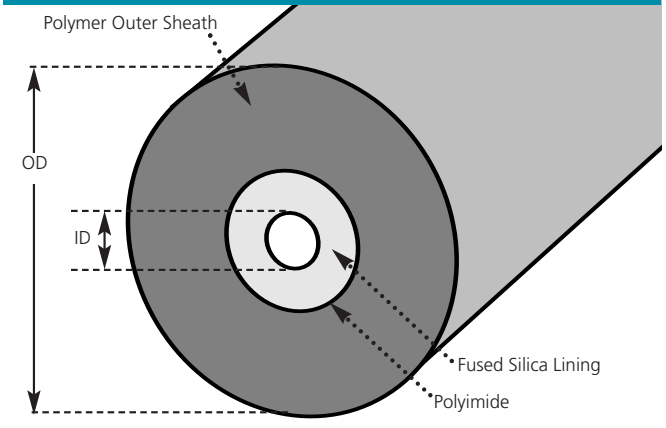
ROBUST TUBING

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 1**), making it ideal for capillary HPLC and LC/MS applications.

TABLE 1. PRESSURE RATING

50 micron	>	15,000psi
100 micron	=	15,000psi
175 micron	=	8,500psi
200 micron	=	6,000psi

FIGURE 1. PEEKsil TUBING CROSS-SECTION



SMOOTH WALL SURFACE

The fused silica internal wall of PEEKsil provides an exceptionally smooth surface, free of imperfections, which ensures excellent flow characteristics. Stainless steel, in contrast, has a very rough and pitted inner wall surface, which has several detrimental effects on the performance of a liquid chromatography system.

- PEEKsil's smooth wall allows lower carry over or cross contamination between samples that can lead to improved reproducibility.
- The smooth wall of PEEKsil, particularly for smaller inside diameter LC 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.

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PEEKsil™ Tubing

SOLVENT COMPATIBILITY

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. (see **Table 4**)

INERTNESS

Fused silica is renowned for its extremely low absorption characteristics, especially when compared with the absorption of sensitive sample components on stainless steel.

PRECISION OF INSIDE DIAMETER

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 **Table 2**). 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.

TABLE 2. PEEKsil™ PHYSICAL DIMENSIONS

PEEKsil ID	=	50	±	3 micron
	=	100	±	5 micron
	=	175	±	5 micron
	=	200	±	5 micron
	=	300	±	5 micron

ZERO METAL CONTACT IN HPLC

The use of PEEKsil complements SGE's full range of non-metallic HPLC columns and cartridges to give a metal free HPLC analytical system. The sample and mobile phase do not come into contact with metal in PEEKsil tubing. This is advantageous for ion chromatography and sensitive samples such as proteins.

EASE OF CONNECTION

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.

APPLICATIONS OF PEEKsil

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.

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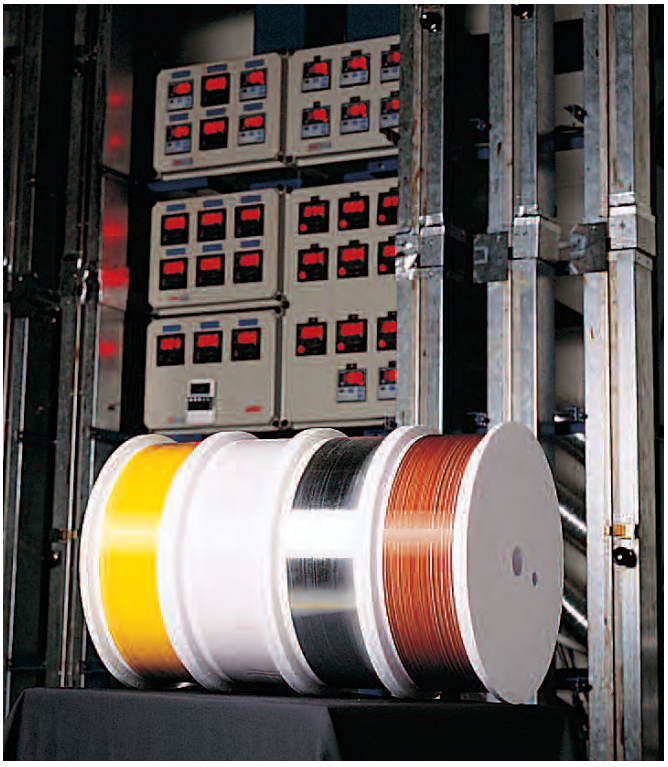
Fused Silica Tubing

SGE commenced manufacturing silica capillary more than 25 years ago. In that time we've become a market leader in manufacture and development of capillary tubing for Gas Chromatography (GC), Capillary Electrophoresis (CE), Liquid Chromatography (LC) and DNA sequencing. We have brought together technologies employed by optical fiber and tube redraw industries and blended them with silica glass structure and surface sciences. This amalgam of technologies insures a complete understanding of all aspects necessary for production of high purity and high quality capillary.



FEATURES OF SGE FUSED SILICA

- Very low thermal expansion
- High homogeneity
- Excellent resistance to thermal shock
- Very good chemical inertness
- Easily machined to exacting tolerances
- Low dielectric constant
- Low dielectric loss
- Good UV and IR transparency
- Impermeable to all gases (except H_2, He)
- Free of thermal hysteresis
- Low weight loss (below devitrification temperature)

SPECIFICATIONS OF SGE FUSED SILICA TUBING

MANUFACTURING CAPACITY

- Internal diameter: 1µm to 800µm
- Outside diameter: 100µm to 1000µm
- Internal diameter tolerance: ± 0.5 %
- Outside diameter tolerance: ± 3µm
- Lengths: 0.01m to >5000m
- End finished – cleaved, saw cut, flame polished or hermetically sealed

FEATURES:

- Standard polyimide temperature resistant to +400°C – equivalent to other high temperature polyimides
- High intrinsic tensile strength
- Uncoated temperature resistant to 1000°C
- 100% prooftested
- Pressure resistant to 1000 bar
- Polyimide coating is chemical resistant
- Acrylic coating UV transparent
- Internal surface modification available
- Optical properties of uncoated - transparent above 180nm

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TABLE 3. SUBSTRATE FUSED SILICA IMPURITIES
OH typically 1000PPM

Trace Element	Concentration (ppb)
Aluminum	20
Calcium	<10
Copper	<8
Iron	<8
Lithium	<10
Sodium	<8
Potassium	<10
Magnesium	<10
Manganese	<5
Titanium	<10
Chlorine	0
Zirconium	<10

FUSED SILICA REACTION WITH ELEMENTS AND COMPOUNDS:

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. Reactions by alkali, strong acid solutions and various elements to varying degrees are shown in **Table 4**.

PHYSICAL AND MECHANICAL PROPERTIES OF FUSED SILICA:

The mechanical properties of fused silica make it the ideal choice over softer composite glasses such as borate based or alkali glass. Fused silica has high fracture toughness thus making the tubing less vulnerable to applied stresses that may lead to catastrophic failure.

TABLE 5.

Characteristic (Temp: 20°C)	Units	Fused Silica
Density	g/cm^3	2.20
Hardess (Micro-Vickers)	kg/mm^2	765 – 800
Hardness	Moh's	7
Young's Modulus	kg/cm^2	741.32
Rigidity Modulus	kg/cm^2	316.95
Poisson's Ratio	—	0.180
Compressibility	kg/cm^2	11.50
Tensile Strength	kg/cm^2	500
Bending Strength	kg/cm^2	700
Torsional Strength	kg/cm^2	300
Thermal Conductivity	Wm-1 K-1	1.38

TABLE 4. FUSED SILICA REACTIVITY

Element/Compounds	Reactivity
Hydrofluoric acid	Severely reactive
Sodium Polyphosphate	Mildly reactive
Sodium Metaphosphate	Reactive
Zinc Phosphate, Zinc Fluoride, $Zn_3(PO_4)_2$	Reactive above 200°C
Lithium	Reactive above 250°C
Phosphoric acid	Reactive above 150°C
Ammonia	Reactive above 550°C
Cu, Ca, $ZnCl_2$	Reactive above 600°C
Barium sulfate, TeO_2	Reactive above 700°C
Ce, Mg, $CaCl_2$, CuO	Reactive above 800°C
BaO, BCl_3, Ge	Reactive above 900°C
MgO, Fe_2O_3, BeI_2	Reactive above 950°C
H_2S & S (particularly with carbon), Li_2SO_4, Zn_2SiO_4	Reactive above 1000°C
Carbon	Reactive above 1050°C
Chlorine gas, Sulfur dioxide, Nitrogen	non-reactive
S, Al_2O_3, CaO, Zn-Sulfate	Reactive above 200°C
Fe	Reactive when moist

Element/Compounds	Reactivity
P, $BaCl_4$, KCl	Reactive
Potassium fluoride	Highly reactive when fused
Zinc oxide	Reaction above 420°C
Fluorine gas	No reaction under 300°C
Silicon nitride	Reaction above 1250°C
Al, Mg,	Rapid reaction between 700°C - 800°C
Silicon, PbO, CuCl, $Sr(NO_3)_2$	Reactive when fused
Hydrogen	Surface reactive at high temperatures >1000°C
H_2O, Na_2WO_4, LiCl, V_2O_5	Devitrification accelerated at high temperatures
O_2, Cl, Br, I, S, HCl	non-reactive
Ag, Au, Cd, Hg, Pt, Mo, Sn	non-reactive
H_2SO_4, HNO_3, organic acid, Na_2SO_4, Borate Nitrate	non-reactive
Nitrous Oxide, Carbon Monoxide	non-reactive

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ELECTRICAL PROPERTIES OF FUSED SILICA:

Fused silica is a good electrical insulator, retaining high resistivity at elevated temperature, high surface resistance and excellent high frequency characteristics.

TABLE 6.

Characteristic	Units	Fused Silica
Log10 Volume Resistivity (250°C)	ohms/cm	0.160
Dielectric Constant (1Mhz, 20°C)	—	3.800
Dielectric Strength	kV/mm	25-40
Loss Tangent (1Mhz 20°C)	%	0.0010

EXTERIOR COATINGS FOR FUSED SILICA TUBING

Polyimide films are frequently used as a "stress buffer" or protective overcoat for capillary tubing. Polyimide stress buffers are typically 15-20 microns in thickness and protect the delicate glass substrate from damage during handling and from induced stress from instrument valves or fixtures. SGE has a range of different types of coating materials available. Two typical types are detailed below.

HIGH TEMPERATURE POLYIMIDE COATING FEATURES

- Low 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 crosslinking ensures adequate thermal protection
- Solvent resistant: cannot be damaged by laboratory chemicals
- Moderately high modulus of elongation: good flexibility

ACRYLATE COATING FEATURES

- 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

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