

Chromatography

2014/5 & Fluid Transfer

Ferrules

Graphite 1/16"OD to 2.0inch ID

most Polymers
Machinable
by
Chromalytic

Graphite/Polyimide

Polyimide, Valcon

Teflon PEEK

Metal - Stainless Steel

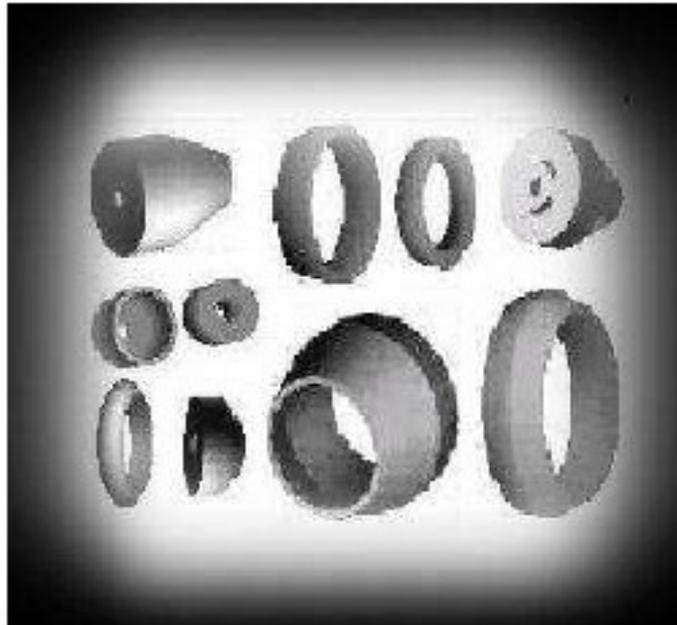
CHROMALYTIC Tech

made in AUSTRALIA

RESTEK

VICI

VALCO
CHEMINERT



NEW! PBI Ferrules UNIQUE

- Experimental HIGH Temperature ASK!

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Website NEW : www.chromalytic.com.au E-mail : info@chromtech.net.au Tel: 03 9762 2034 . . . in AUSTRALIA

Ferrules can be made of graphite, Vespel® (polyimide), Vespel®-graphite mixtures, and Teflon® (polytetrafluoroethylene, PTFE) Even though graphite is not a polymer, its characteristics are more similar to the synthetic polymers than metal ferrules. Attributes of these ferrule materials are summarized in Table 1.

Graphite and polymeric ferrules have several advantages for use in gas chromatography over metal (especially hard metal) ferrules:

- They can seal against imperfect surfaces with little force
- They can be used with virtually any type of tubing or column including glass and fused silica
- They can also be hand drilled with a pin vise to get the right size for any given tube or column

However, because they are organic and porous, graphite and polymeric ferrules do have some general weaknesses that constrain their uses as well:

- Polymers have a limited temperature range (compared to metal ferrules)
- They are more permeable to air infiltration (a function of polymer density)
- They sometimes come out of their commercial packaging, or the lab

drawer, contaminated. They are then a source of ghost peaks and baseline disturbances. Contamination comes from poor manufacturing processes as well as poor choices in packaging (the contamination comes from the packaging).

A common practice is to leave ferrules in GC oven prior to use for conditioning

- They can also interact with sample components or solvent causing tailing or losses, especially at trace levels

Graphite has been a favorable ferrule material for capillary column use from the beginning of gas chromatography. It is very forgiving because it is so soft and can deform and seal in almost any space. Graphite is easy to identify because it can be deformed, or scratched. Incorrect size ferrules can sometimes be used easily either to expand the hole to accommodate a larger column or to compress a larger ferrule just by putting it on the column and tightening the fitting a little more than usual.

The graphite is easily reformed in both cases to create a near perfect seal.

However, this malleability can lead to one of the biggest problems with graphite ferrules as well.

This ability of graphite to reform can cause it to extrude through openings in fixtures into adjacent spaces. Graphite pieces can end up contaminating areas like the bottom of the inlet or the detector jet.

These graphite pieces can interact with sample causing losses, tailing, and can become a constant source of contamination as graphite is an absorbent

A second major problem with 100% graphite ferrules is that they are very permeable to air due to their semi-lamated structure.

So, when using air sensitive columns (e.g., carbowax) or detectors (e.g., mass spectrometers or ECDs) Graphite/Polyimide are preferred - much more dense & impermeable. Some inlet and detector designs use graphite ferrules wherein the graphite is contained within a secondary metal tube.

This provides the benefits of graphite ferrule material, while greatly addressing the issues of deformation, extrusion, and air diffusion.

Graphite Ferrules are resilient enough for glass and ceramic tube use.

Chromalytic have a unique market extending sizes to fit tube size from 1/16"x0.3 up to a Maximum od 2.0inches (50mm) ID

Polyimide is a polymer with high temperature stability (310-35-degC max) and low outgassing.

Because of its relatively high temperature stability, polyimide is the coating of choice for the outside of fused silica columns. Polyimide ferrules are easy to identify because they are brown (see Figure 1).

Polyimide is very hard but is softened with admixtures of Graphite and under pressure in-situ can be molded into shapes that match fitting profiles, and devices typically designed for metal ferrules.

Even though it has high temperature stability, polyimide softens when heated, problematic in high-heat zones. It tends to bind onto the tube and can fix inside the fitting.

For this reason, 100% polyimide ferrules find most use outside the GC oven.

These are preferred over metal ferrules for room temperature or low temperature connections since they are much more forgiving than metal ferrules when sealing against flawed tubing, they can also be removed without having to be cut off the tubing.

They also have low air permeability.





Graphite/Polyimide (15% is common) greatly reduces binding .

The mixture retains the benefits of:

- Being able to be molded into desired shapes
- High temperature stability
- Ferrule does not extrude when tightening
- Can seal against imperfect surfaces
- Has low air permeability
- Soft enough for use with fused silica

Because of these benefits, graphite/polyimide ferrules are the dominant ferrule type when making fused silica column connections in the GC oven.

Graphite/polyimide ferrules do tend to shrink with temperature cycling, so they need to be retightened several times (after cool down) within the first 10 temperature programmed runs or so.

Extended use above 300degC also tend to "dry out" the polymer and may crack on re-tightening

PTFE ferrules and other similar fluoro polymers (PFA and ETFE) are very inert and have minimal interaction with samples and solvents.

They are very easy to seal, often requiring only hand tightening.

When disconnecting fittings, PTFE fittings slide right off the tubing and can be re-used multiple times.

However, PTFE (TEFLON) they have the most restricted upper temperature limit (250degC)

and are somewhat permeable to air, so use inside the GC oven is quite limited.

PTFE ferrules are used primarily for low temperature applications requiring the most inert connections, and for tubing connections outside the oven - for more reliable, easily adjustable and removable connections.

PTFE ferrules are lower cost and are often used for compressed air supply lines for valve actuators.

ETFE (Tefzel) is a melt polymer compare to PTFE (which is sintered) and thus harder and less air permeable than PTFE and often preferred for solvent lines in LC/HPLC applications

PBI Ferrules (experimental by Chromalytic) . . . offer potential higher temperature usage than Polyimide versions fused silica and GC/MS are targeted uses

Customer feedback on PBI Ferrules s welcome

Ferrule Type	Temp Limit	Typical Uses	Advantages	Limitations
Graphite (100%)	450 °C	General purpose for capillary column connections to inlets and detectors	Easy to use, can be tightened to hold column in place without siezing, column can be readjusted	Allows air diffusion. Not for MS or oxygen-sensitive detectors
		Recommended for high temperature and cool down-column applications	Can be removed easily	Overtightening can extrude graphite into inlet or detector. Pieces flake off and stay behind, causing peak tailing and sample losses
			High temperature limit	Soft, easily deformed or destroyed
			Most forgiving of receiver imperfections	Interacts with solvent, causing tailing
		Can be re-used		
Polyimide/ Graphite (85%/15%)	350 °C	General purpose for capillary and packed glass columns	Easy reliable connections	Design specific to fitting
		Recommended for MS or oxygen-sensitive detectors	Reusable and remakesable	Shrinks with tempearure cycling. Must re-tighten frequently
		Reliable, leak-free connection	Maintains shape, does not flake off particles	Siezes on column, cannot be re-adjusted, must be cut off
Polyimide (100%)	280 °C	Isothermal operation	Easy reliable connections	
		Reliable seals even with flawed receiver surfaces, forms to sealing surface	Reusable and remakesable	Can shrink at elevated temperatures, must re-tighten frequently
		Excellent sealing material when making metal or glass connections	Can be removed easily if used at room temperature	Can glue connections together if excoeeding recommended temperature limit and destroy fitting
		Excellent for external	Low air permeability	
PTFE	<260 °C	External connections not involving carrier gas	Easy connections	Allows air diffusion. Not for MS or oxygen-sensitive detectors
		Valve actuator gas lines	Can be re-used	Limited use inside oven
		Glass packed columns used at low temperatures	Very forgiving of receiver imperfections	
		Can seal with very little pressure.		

Gas chromatography relies on tubing, plumbing for gas flows and ferrules for sealing connecting fitting and would not be a practical routine technique without ferrules

– these essential consumables that provide a pressure seal between the atmosphere and the gas flow path. Ferrules are used in junctions that can be disconnected and remade. Proper selection and use of ferrules ensures a reliable installation. Incorrect selection and/or implementation can cause problems and can affect the quality of analytical results.

Chromatography Plumbing

The need for a leak-free and reliable flow path is essential in gas chromatography.

In particular the requirements of GC fittings are quite demanding compare to normal plumbing

They must be able to withstand high temperatures for long periods of time and wide variations as experienced in GC ovens for example. Connections outside the oven and at near ambient conditions are far less demanding or where constant temperatures are used such as a valve oven, inlet or detector.

Ferrules are used to provide a seal between a tube and a fitting; union, a valve, a transfer line, or device requiring attachment of a tube or chromatography column. For permanent connection, then the tubes can be soldering, braising, cementing, etc. can be used.

A ferrule is used to make a reusable connection. The simplest ferrule seal uses some easily deformable material such as a rubber gasket or O-ring common in many industrial and domestic situations.

Unfortunately, such a connection cannot satisfy the special requirements of GC and liquid chromatography is more demanding requiring sealing material with unique characteristics.

- Use of gases with very high diffusivities – these gases (He and H₂) can be prone to leakage
- Air can also back diffuse through leaks, even against a pressure gradient
- Many of the detectors used in GC can detect air leading to raised detector baseline and increases drift
- Many of the stationary phases used in GC are sensitive to air through oxidation which will lower column and increase column activity to polar compounds, as well as increasing detector noise due to bleed of liquid phase decomposition products
- Larger leaks of course will waste gas, which can be quite expensive (e.g., when using High Purity grades required for some sensitive detectors; GC-MS, Helium Ionisation and even TCD)
- Leaks in the sample flow path will vent sample (inlet side) or effluent (detector side) causing errors in the result in loss of sample and cause errors and inconsistencies in results
- Where mass flow control is required, leaks can cause serious errors in retention time (packed column inlets but more so with low flow rate capillary columns), with variations in split ratios.

Exacerbated by variations in temperature, vibration, and time. Some of these effects can be offset by using chemical standards where such leaks are constant,

Metal Ferrules

come in two basic designs: one- and two-piece.

Swagelok is the premier manufacturer of two-piece ferrule designs and the de facto standard over many years.

The two-ferrule design has some advantages (at a price premium) over single ferrule designs.

Swagelok fittings are ubiquitous in the GC laboratory.

Single-ferrule formats serve the same purpose as two-ferrule designs. Parker and VICI-Valco are examples

It is MOST important to match both the ferrule and fitting with those from the same manufacturer and NOT to mix them..

Hard metal ferrules (#316SS) are only used with similar hard tubing material.

The seal is actually made over a relatively narrow region near the tip of the ferrule.

The cone design of the ferrule directs the tightening force from the nut to the back of the ferrule to its cone tip which in turn compresses onto the underlying tube.

If the tube is a glass or fused-silica column, it would break.

Soft metal (#304SS) or polymeric tubes, in contrast, will deform, allowing the ferrule to “bite” into them permanently.

- Metal ferrules can be used at high temperatures and can withstand wide temperature cycling, and are ideal for fixed installation in heated zones such as valve ovens and heated inlets and detectors.
- However, when used for extended periods at high temperatures, the ferrule can seize into the fitting.
- If overtightened they can also distort both the ferrule and the fitting so that on reuse orientation may be different requiring even more excessive force to re-swage them into a good seal
- In some situations they just won't reseal and in fact may need to be cut off the tubing and replaced
- Hard metal ferrules usually come in either brass or stainless steel.

Stainless steel is more inert than brass and is required for normal sample paths.

Outside the sample path, use the same ferrule material as the fitting or fixture.

One should never use a stainless ferrule with a brass fitting or fixture because steel is harder and can permanently damage the fitting. A brass ferrule can be used with a stainless fitting if you are prepared to cut off the ferrule if it becomes scored.

Metal Ferrules have a number attractive attributes . . .

- Metal has the least permeability to air
- Metal fittings and ferrules can effectively seal over the largest pressure and temperature range
- Metal fittings and ferrules are extremely rugged and can take a lot of abuse
- Metal fittings can be and remade many times (if not over tightened)

Problems arise . . . however, because of their hardness, and failures can occur:

- Improper matching of ferrule and seat designs (avoid using/mixing generic fittings and ferrules)
- Over tightening can cause irreversible damage to the fitting as well as the ferrule.
- Improper installation (inserting tubing into fitting too far and/or over tightening)

can cause the end of the tubing to bulge in the fitting, making it difficult or impossible to remove.

- Seizing of the ferrule to the fitting after long periods at elevated temperature.
- Inability to seal over fine-lined striations in the metal tubing itself and scoring of the ferrule material

Whilst not ideal sandpaper can be used with care to improve imperfections in tubing

Rotating the tube is far better than length wise

Soft Metal Ferrule material (e.g., **Siltite-SGE** and **Aluma-Seal** Restek) is now available which can be used for fused-silica column connections,

- They can deform slightly so that they seal with less force than is necessary with hard metal ferrules otherwise impossible with glass or fused silica.
- They are soft enough to be used with fused-silica capillary columns.
- They are a little more forgiving of imperfect surfaces than hard metal ferrules.
- They have very low (or no) air permeability and can be used over the full range of GC temperatures.
- Unlike polymeric ferrules, soft metal ferrules do not shrink and therefore do not need periodic retightening.
- They are specially coated to reduce the risk of seizing in fittings.

Soft metal ferrules seize onto the column upon first use, so connections must be done with some care.

These **soft metal ferrules** are particularly suited for MS transfer lines or capillary column connections where one does not typically need to trim the swaged column end regularly.

Even though they deform slightly soft metal ferrules should still be used with fittings that have the proper corresponding taper design. To benefit from using this style ferrule, spare replacement parts such as a new baseplate for the inlet or a special reverse nut for transfer line connections.

Glass and Fused Silica capillary connections - -

- Most ferrules require close tolerance matching of Tubing OD and ferrule ID
 - Hard ferrules have no give and tend to "crunch" the tubing
- Polymeric Ferrules are softer and more forgiving where applicable
- Graphite probably provides the best all-round ferrule material

For glass and ceramic tubing . . . reducing Graphite Ferrules overcome many adaptations of metric tube size and Imperial size fittings.

Care is needed to select tubing as round as possible is important in obtaining a "re-doable" and effective seal. With care Graphite Ferrules can be reused although extrusion into the thread of the Nut does occur making them difficult to remove.

For Reducing Ferrule application end-pressure on the tubing is a limitation with Graphite Ferrules

- the tube can be forced out the back of the nut

. . . graphite after all is a lubricant and glass is smooth . . . of course

Extreme application with large OD tubing may benefit by centreless grinding of the glass tube / ceramic and/or grooving or roughening of the glass surface

Glass tubes to 2" diameter and ceramic tubes to 1000degC are possible - although the graphite does tend to oxidise and burn away in contact with air **Caution PRESSURE LIMITATIONS Low Pressure High Flow applications are OK through . . . with CARE !**

. Enclosed in an inert atmosphere temp to >1500degC are possible (ceramic tubes)

- often there are Just NO Alternatives to Graphite ferrules

Inertness - SS Fittings and Ferrules

Silcosteel is a patented process where a film of fused silica is vacuum deposited onto SS surfaces dramatically improving the inertness to many aggressive fluids and reactive compounds in sampling and in chromatography use.

Coated tubing and fittings even extend to anti-corrosion, anti-coking and Ultra High vacuum applications. Silco-treated Swagelok and Parker fittings are available from Restek and a custom coating service of customer supplied parts is available from SilcoTek (enquiries to **Chromalytic Tech.**)

*** IMPORTANT - SS Ferrules must NOT be "Silco-treated"**

Ordinary uncoated SS ferrules are perfect when used in a "silco-treated" fitting but "silco-on silco" will NOT seal

Basically the mating surfaces are like sand-paper on a micron scale

some Applications

Ferrule Type	Temp Limit	Typical Uses	Advantages	Limitations
Metal (1-piece or 2-piece)	> 450 °C	External connections	High pressure limit	No at all forgiving of flaws in fitting/fixture
		Gas lines to GC	High temperature limit	Ferrule and fitting designs must match, no mixing of designs
		Gas sampling valves and associated tubing	Very low (no) diffusion of air through ferrule	Can seize after long use at high temperature
			Extremely rugged	Tightening technique is critical (not too loose, not too tight) for proper seal and ability to re-use
Soft metal	> 450 °C	Capillary column connections to inlets and detectors	Low (or no) air permeability	Permanently attaches to tubing upon first use. Must be cut off to be replaced.
		Capillary column connection to MSD transfer line	Much more forgiving of fitting imperfections than hard metal	Can be easily overtightened sealing the first time but significantly decreasing probability of resealing a second time
		Column connections to Capillary Flow Technology and other styles of gas phase microfluidic devices	Connections can be disconnected and reconnected multiple times	Ferrule and fitting designs must match for proper seal and re-seal
		External connections of 1/16" gas lines	High temperature use	

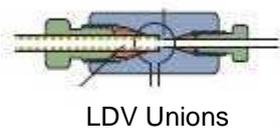
Swagelok 2p Ferrules



VICI LDV 1-P Ferrules

High Performance Chromatography

Require absolute minimum of dead-volume effects and maintaining "stream-line" flow often requiring perfect matching of ferrules and fittings - to ensure high column efficiency. VICI-Valco has many options for **LDV connections** including **fused silica adaptors** and profile ferrules.



LDV Unions



Polyimide/Valcon "profiled" ferrules



SILCOSTEEL MXT Unions

Graphite Ferrules

the "PERFECT" Connection for GC and Glass Tubes

also Graphite/Polyimide for GC/MS (Vacuum Application)

500degC in air
 "unlimited" in inert gas
 Soft and Malleable
 No phase transitions
 like plastics

Graphite Ferrules - ALL sizes from 2mmOD to 2.0 in ID

- have been proven in over 25 years production by Chromalytic Technology with "millions" being sold "world-wide" mainly through some of the leading chromatography distributors and OEMs.

Full range of sizes from 0.3mm ID for capillary columns right up to 2.0-in for preparative columns and industrial applications;

Industrial Applications : **glass/ceramic tube** reactor/catalyst tubes, pump glands. **there is a size to fit ALL applications !**

If we haven't got it already we will guarantee to make it for you !

- Maximum temperature use to 500 deg-C or much higher in a "capture fitting" or if protected in an inert atmosphere.
- They are soft and malleable and extrude into shape to fill minor imperfections in tubing and "distorted fittings".
- They have an ideal "feel" for use with glass and fused silica capillary tube to help avoid crushing on over-tightening.
- They will not stick or bind to tubing and the nut/ferrule can simply be slid off the tubing for re-use.

Specifically for GC . . . ALL types of GCs are catered for including OEM specific ferrules; for example HP/Agilent inlet seals, injector liner O-rings; 8mm, 1/4, 5mmOD for Carlo Erba / Fisons /Thermo / Shimadzu; capture type cup GC column seals. etc

OEM Enquiries Welcome

3 basic Profiles are available . . .

- **SF** - Single (Piece) Ferrule for **Swagelok** and similar fittings eg **Parker**.
- **GF** - Front ferrule design for use with a "backing ferrule" or in Chromalytic "butt-type" connection fittings, injection systems.
- **Short profile** - "short" specially designed for HP/Agilent GC capillary GC column inlet seals.

Also . . .

Graphite O-rings (6.35mm and 6,5mm ID) for HP/Agilent GC injector liners.

Cup Graphite Seals for CE/Fisons/ThermoQuest , Shimadzu and the NEW **CT** graphite capture fittings - **Enquire !**

Capture Ring graphite seal for 8mm OD Fisons/CE/TQ liners.

Graphite/Polyimide Ferrules - 1/8"ID max

: material tends to be cost prohibitive - Other Sizes to special Order

These are precision machined (and NOT moulded) to give a perfect fit in all Swagelok and Parker 1/16-in fittings.

Temperature use is limited to about 320 deg-C.(phase transition)

They are made from **15% graphite/polyimide** selected by . . . **Chromalytic Technology** as being the best compromise in "softness", non-stickability and crack resistance. They are preferred over **Graphite Ferrules** for vacuum operation or use in GC/MS for reduced air diffusion. For long term use - they may tend to "dry out" and may crack on re-tightening after use at high temperature.



Single Piece

Ferrule Size / Cat.#

1/16" to :	
0.3mm	SF100/0.3G
0.4mm	SF100/0.4G
0.5mm	SF100/0.5G
0.8mm	SF100/0.8G
1.0mm	SF100/1.0G
1.2mm	SF100/1.2G
1/16"	SF100G

1/8" to :

0.4mm	SF200/0.4G
0.5mm	SF200/0.5G
0.8mm	SF200/0.8G
1.0mm	SF200/1.0G
1.2mm	SF200/1.2G
1/16"	SF200/100G
1/8"	SF200G
3/16"	SF300G

1/4" to :

0.5mm	SF400/0.5G
0.8mm	SF400/0.8G
1/16"	SF400/100G
1/8"	SF400/200G
6mm	SF400/M6G
1/4"	SF400G

3/8"

1/2"	SF600G
5/8"	SF800G
3/4"	SF1000G
7/8"	SF1200G
1.0-in	SF1400G
1-1/4-in	SF1600G
1-1/2-in	SF2000G
1-3/4-in	SF2400G
2.0-in	SF2800G
	SF3200G

Metric

5mm	SFM5G
10mm	SFM10G
12mm	SFM12G
14mm	SFM14G
16mm	SFM16G
18mm	SFM18G

Front Ferrule Type

Ferrule Size / Cat.#

1/16" to :	
0.4mm	GF100/0.4
0.5mm	GF100/0.5
0.8mm	GF100/0.8
1.0mm	GF100/1.0
1/16"	GF100

1/8"	GF200
1/4" to 3/16"	GF400/300
1/4 to 6mm	GF400/M6
1/4"	GF400

"Specials"

Agilent O-rings	GFO-6.35HP
6.35mm	GFO-6.5HP
6.5mm	
Inlet Seals (Short)	
0.3mm	GF0.3HP
0.4mm	GF0.4HP
0.5mm	GF0.5HP
0.8mm	GF0.8HP
1.0mm	GF1.0HP
1.2mm	GF1.2HP

(standard)

0.3mm	GF100/0.3HP
0.4mm	GF100/0.4HP
0.5mm	GF100/0.5HP
0.8mm	GF100/0.8HP
1.0mm	GF100/1.0HP
1.2mm	GF100/1.2HP

Fisons/CE/

0.3mm	CF0.3Fis
0.4mm	CF0.4Fis
0.5mm	CF0.5Fis
0.8mm	CF0.8Fis
1.0mm	CF1.0Fis
8mm	CF8.0Fis

Graphite/Polyimide 1/16"OD . . . Tube Fitting

0.3mm	SF100/0.3VG1
0.4mm	SF100/0.4VG1
0.5mm	SF100/0.5VG1
0.7mm	SF100/0.7VG1
0.8mm	SF100/0.8VG1
1.0mm	SF100/1.0VG1
1.2mm	SF100/1.2VG1
1/16"	SF100VG1
1/8"	SF200VG1
3/16"	SF300VG1
1/4"	SF400VG1

ANY size
to your
specifications
Generous Discounts
apply to OEMs
and for
"bulk" orders

Other Specials - for small "runs" a tooling cost may apply

Double-Hole Ferrules

1/16" Double-hole	SF100/2x0.5G
1/8" Double-hole	SF200/2xM0.5G
1/4" Double-hole	SF400/2xM0.5G
3/8" Double-hole	SF800/2xM0.8G

No-Hole Ferrules (Blanks)

1/16"	SF100/00G
1/8"	SF200/00G
3/16"	SF300/00G
1/4"	SF400/00G
3/8"	SF400/00G
1/2"	SF800/00G

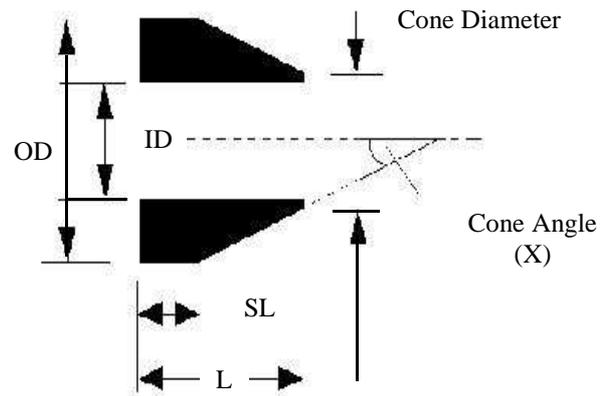
Note : **Teflon** and **PEEK** ferrules are also available for HPLC / LC / FIA applications . . . **Enquire !**

Graphite Ferrules

CUSTOM Specifications

**"Not ALL Things
are possible"**

To Order Custom-made "Specials" ... Ferrule Specifications required		
Size in ... Inches <input type="checkbox"/> or ... mm <input type="checkbox"/>		
Material	Required	Tolerance Required
- Graphite	<input type="checkbox"/>	
- Graphite/Polyimide 15%	<input type="checkbox"/>	
- Teflon (PTFE)	<input type="checkbox"/>	
- PEEK	<input type="checkbox"/>	
- Kel-F / Tefzel	<input type="checkbox"/>	
Other (specify)		
ID		
OD		
Length		
Shoulder length (SL)		
Cone diameter (CD)		
Quantity Required		



The **Cone Angle** is generally incidental in production - but typically for the SF type ferrules (X)=17 degrees +-1 deg
The shape is actually determined by all other dimensions
The **Overall Length** is the easiest parameter to vary in production simply by varying the **Shoulder Length (SL)** whilst retaining a constant **Cone Angle (X)**

for Specials - a tooling set-up cost of \$75 to \$150 may apply for small quantities depending on the actual size.

Typical Ferrule Dimensions and Tolerances (sizes in inches)						ID	Min	Max
Catalog #	ID	L	SL	CD	OD	0.3mm	0.0125	0.0135
SF100/...G	0.3mm-1/16"	0.170	0.100	0.075	0.125	0.4mm	0.160	0.0175
GF...HP	0.3mm-1/16"	0.090	0.050	0.072	0.125	0.5mm	0.020	0.0215
GF100/...HP	0.3mm-1/16"	0.120	0.080	0.072	0.125	0.7mm	0.027	0.0285
GF100/...	0.3mm-1/16"	0.135	0.095	0.075	0.125	0.8mm	0.310	0.320
SF200/...G	0.4mm-1/8"	0.250	0.120	0.135	0.250	1.0mm	0.040	0.042
SF400/...G	0.5mm-1/4"	0.255	0.120	0.260	0.375	1.2mm	0.047	0.049
HP O-ring	6.35mm,6.5mm	0.100	-	-	0.375	1/16"	0.063	0.0645
SF600G	3/8"	0.320	0.160	0.390	0.500	1/8	0.125	0.1265
SF800G	1/2"	0.375	0.160	0.520	0.675	1/4	0.250	0.252
SF1000G	5/8"	0.400	0.160	0.660	0.815	3/8	0.375	0.387
SF1200G	3/4"	0.450	0.180	0.790	0.945	Graphite Ferrules will squash into shape and actual sizes are far less critical than for metal ferrules.		
SF1400G	7/8"	0.525	0.200	0.780	1.125			
SF1600G	1.00"	0.575	0.250	1.040	1.25			
SF2400G	1-1/2"	0.875	0.340	1.560	1.75			
SF3200G	2.00"	1.100	0.275	2.090	2.60			

Typical Manufacturing Tolerances	L	SL	ID	CD	OD
	+ 0.005	+ 0.005	+ 0.002	+ 0.002	+ 0.000
	- 0.005	- 0.005	- 0.000	- 0.000	- 0.002
	Cone Angle(X)				

*** tighter tolerance is possible but generally at extra cost**

ANY Size - IF it is practical !
... **THEN we can make it !**
Types include "capture type" and "cup seals" and "encapsulated" ferrules ... **Enquire !**
BUT ! We suggest YOU draw it exactly to scale first to PROVE it is feasible in principle in the first place !

Custom Precision Machining

- Metal ... in ANY material Stainless Steel - any grade 303 / 304/ 316/ Inconel, Brass
- ANY type of plastics ... Vespel / Graphite/polyimide / Teflon / PEEK / Kel-F / Nylon / polypropylene etc etc
- "small" runs a specialty ... **We do NOT try and compete with large auto-repetition shops**
... If you can buy mass-produced / cast or moulded products we can't compete ... we "specialise in specials"

 **tech tip**
Choosing the Right Ferrule

Although graphite and Vespe^l/graphite ferrules each have advantages and disadvantages, the choice of ferrule composition is largely a personal preference. Graphite ferrules are soft, easy to seal, stable to 450°C, and contain no binders that might off-gas. Vespe^l/graphite ferrules work better for vacuum and high-pressure applications (e.g., GC/MS) because they will not fragment or allow oxygen to permeate into the system, whereas graphite ferrules will. Because Vespe^l/graphite ferrules are made from a harder material, they might require retightening after several temperature cycles. Alumaseal™ ferrules are ideal for GC/MS. They will not crack or fragment and require no retightening after temperature cycles.



graphite ferrules



Reusable!

graphite ferrules



graphite ferrules

Vespe^l® Ferrules

- 100% high-temperature polyimide.
- Stable to 350°C.
- Durable, leak-tight.

Vespe^l® ferrules**Graphite Ferrules**

- Preconditioned to eliminate out-gassing.
- High-purity, high-density graphite.
- Smoother surface and cleaner edges than conventional graphite ferrules.
- Contain no binders that can off-gas or adsorb analytes.
- Stable to 450°C.

Vespe^l®/Graphite Ferrules

- 60%/40% Vespe^l/graphite blend, offering the best combination of sealing and ease of workability.
- Seal with minimal torque, reusable, and preferred for vacuum and high-pressure uses.
- Stable to 400°C.
- Recommended for mass spec transfer lines.

Capillary Ferrules—For 1/16-Inch Compression-Type FittingsAvailable in Vespe^l®, graphite, or Vespe^l/graphite.

Ferrule ID	Fits Column ID	qty.	Vespe ^l	Graphite	Vespe ^l /Graphite
0.3mm	< 0.18mm	10-pk.	22213	20233	20275
0.4mm	0.18/0.25/0.28mm	10-pk.	22214	20200	20211
0.4mm	0.18/0.25/0.28mm	50-pk.	—	20227	20229
0.5mm	0.32mm	10-pk.	22215	20201	20212
0.5mm	0.32mm	50-pk.	—	20228	20231
0.6mm	0.28mm**	10-pk.	—	—	20232
0.8mm	0.45/0.53mm	10-pk.	22216	20202	20213
0.8mm	0.45/0.53mm	50-pk.	—	20224	20230
1.0mm	0.75mm*	10-pk.	22217	21058	24912
1.2mm	0.75mm	10-pk.	22218	—	—
1.6mm	1.00mm*	10-pk.	—	21060	—

Encapsulated Ferrules—For 1/16-Inch Compression Fittings

- Reusable—will not deform and stick in fittings.
- Less torque needed to seal ferrule.
- Restek's unique blend of graphite minimizes fragmentation and outgassing.

Ferrule ID	Fits Column ID	qty.	cat.#	price
0.4mm	0.25mm	10-pk.	21036	
0.5mm	0.32mm	10-pk.	21037	
0.8mm	0.53mm	10-pk.	21038	

Compact Ferrules—For Agilent 5890/6890/6850/7890 GCsAvailable in graphite or Vespe^l/graphite.

Ferrule ID	Fits Column ID	qty.	Graphite	Vespe ^l /Graphite
0.4mm	0.25/0.28mm	10-pk.	20250	20238
0.4mm	0.25/0.28mm	50-pk.	20251	20239
0.5mm	0.32mm	10-pk.	21007	20248
0.5mm	0.32mm	50-pk.	21008	20249
0.8mm	0.45/0.53mm	10-pk.	20252	20263
0.8mm	0.45/0.53mm	50-pk.	20253	20264
1.0mm	0.75mm*	10-pk.	21059	21056
1.6mm	1.00mm*	10-pk.	21061	21057

*For micropacked columns.

**For 0.28mm MXT columns.

Standard Ferrules—For 1/16-, 1/8-, and 1/4-Inch Fittings

Available in Vespel®, graphite, or Vespel®/graphite.

Fitting Size	Ferrule ID	qty.	Vespel	Graphite	Vespel/Graphite
1/4"	3/16"	5-pk.	—	—	20258
1/16"	1/16"	10-pk.	22210	20207	20218
1/8"	1/8"	10-pk.	22211	20208	20219
1/8"	reduce to 1/16"	10-pk.	—	20209	20220
1/4"	1/4"	10-pk.	22212	20210	20221
1/4"	reduce to 1/8"	10-pk.	22219	20225	20222
1/4"	reduce to 1/16"	10-pk.	—	20226	20223

**Two-Hole Ferrules—For 1/8-Inch and 1/16-Inch Compression-Type Fittings**

Fitting Size	Ferrule ID	Fits Column ID	qty.	Vespel/Graphite
1/16"	0.4mm	0.25/0.28mm	5-pk.	24848
1/16"	0.5mm	0.32mm	5-pk.	24849
1/8"	0.8mm	0.45/0.53mm	5-pk.	20246

**Reducing Ferrules**

Available in graphite or Vespel®/graphite.

Fitting Size	Ferrule ID	Fits Column ID	qty.	Graphite	Vespel/Graphite
1/8"	0.4mm	0.25mm	5-pk.	20205	20254
1/8"	0.5mm	0.32mm	5-pk.	20205	20255
1/8"	0.8mm	0.53mm	5-pk.	20206	20215
1/4"	0.4mm	0.25mm	5-pk.	20203	—
1/4"	0.5mm	0.32mm	5-pk.	20203	20257
1/4"	0.8mm	0.45/0.53mm	5-pk.	20204	20217

**Blank Ferrules—For 1/16-Inch Fittings**

Fitting Size	Ferrule ID	qty.	Vespel/Graphite
1/16"	no hole	10-pk.	20240

**Alumaseal™ Ferrules***

- Aluminum construction—will not crack or fragment.
- No retightening required after temperature cycles—excellent for GC/MS.
- Eliminate out-gassing, make leak-tight seals, for less detector noise.
- Unique two-piece design permanently locks on fused silica tubing without causing breakage.
- Will not stick in fittings, unlike Vespel® or graphite.
- Stable to 550°C.
- Use with any 1/16" compression-type fitting.

Ferrule ID	Fits Column ID	qty.	cat.#	price
0.4mm	0.25mm	10-pk.	21472	
0.5mm	0.32mm	10-pk.	21473	
0.8mm	0.53mm	10-pk.	21474	

*Patent pending.



restek
innovation!

**Alumaseal™
Ferrules**

- Will not crack or fragment.
- Excellent for GC/MS.

Ferrules

**Teflon® Ferrules**

- Upper temperature limit 250°C.
- 100% Teflon®; completely inert.
- One-piece design requires no back ferrule.

Fitting Size	Ferrule ID	qty.	cat.#	price
1/16"	1/16"	10-pk.	21122	
1/16"	0.4mm	10-pk.	21123	
1/16"	0.5mm	10-pk.	21124	
1/16"	0.8mm	10-pk.	21125	
1/8"	1/8"	10-pk.	21126	
3/16"	3/16"	10-pk.	21127	
1/4"	1/4"	10-pk.	21128	

Graphite Ferrules—M4 Fittings for Thermo Scientific TRACE, 8000, 8000 TOP & Focus GCs

Ferrule ID	Fits Column ID	Similar to TS part #	Graphite 2-pk. price	Graphite 10-pk. price
0.3mm	0.10/0.15mm	—	22221	22222
0.4mm	0.18/0.28mm	29013488 (2-pk.) 29053488 (10-pk.)	20280	20281
0.5mm	0.32mm	29013487 (2-pk.) 29053487 (10-pk.)	20282	20283
0.8mm	0.45/0.53mm	29013486 (2-pk.) 29053486 (10-pk.)	20284	20285

**5mm Ferrules for Shimadzu 17A GCs**

- For use with **packed columns**.
- Graphite construction.

Description	qty.	cat.#	price
5mm Ferrules for Shimadzu 17A GCs	10-pk.	21121	

Graphite Ferrules for Shimadzu 17A, 2010, & 2014 GCs

- Graphite 2-piece construction.
- Available in 0.4, 0.5, and 0.8mm sizes.
- Packaged on mandrel for easy handling.



Ferrule ID	Fits Column ID	qty.	cat.#	price
0.4mm	0.25mm and less	10-pk.	24827	
0.5mm	0.32mm	10-pk.	24828	
0.8mm	0.53mm	10-pk.	24829	

also **available**

Restek now carries Swagelok fittings in brass & stainless steel.

See pages 237-239 or visit www.restek.com and search on Swagelok.

MXT™-Union Connector Kits for Fused Silica Columns

- Low-dead-volume, leak-tight connection.
- Reusable.
- Siltek® treatment ensures maximum inertness.
- Ideal for connecting a guard column or transfer line to an analytical column.
- Use to oven temperatures of 360°C.
- Available in union and “Y” configurations.
- Can also be used for fused silica to metal connections.

These MXT™ connectors can be used with fused silica tubing, because of a Valcon polyimide 1/32-inch one-piece fused silica adaptor. This unique graphite-reinforced composite allows a capillary column to slide into the adaptor and be locked in place simply by loosening and tightening the fitting.

MXT™-Union Connector Kits for Fused Silica Columns

Each kit contains the MXT™ union, two 1/32-inch nuts and two one-piece fused silica adaptors.



Description	qty.	cat.#	price
For 0.25mm ID Fused Silica Columns	kit	21386	
For 0.32mm ID Fused Silica Columns	kit	21385	
For 0.53mm ID Fused Silica Columns	kit	21384	

MXT™ “Y”-Union Connector Kits for Fused Silica Columns

Each kit contains the MXT™ union, three 1/32-inch nuts and three one-piece fused silica adaptors.



Description	qty.	cat.#	price
For 0.25mm ID Fused Silica Columns	kit	21389	
For 0.32mm ID Fused Silica Columns	kit	21388	
For 0.53mm ID Fused Silica Columns	kit	21387	



Adaptor Ferrules



20389

Valco™ Connectors—One-Piece Valcon Polyimide Adaptor Ferrule for Fused Silica

Fused silica adaptor ferrules are Valcon polyimide, a unique graphite-reinforced composite, specially prepared to maximize mechanical stability at temperatures to 350°C. The determining factor for selecting adaptor ferrule size is the fused silica tubing OD.

1/32-Inch Adaptor Ferrule (Valcon Polyimide)

Tubing OD	Tubing ID	Valco #	qty.	cat.#	price
0.25 ≤ 0.40mm	0.25mm	FS.4-5	5-pk.	20137	
0.40 ≤ 0.50mm	0.32mm	FS.5-5	5-pk.	20140	
0.50 ≤ 0.80mm	0.53mm	ZF5V-5	5-pk.	20141	
1/32" Replacement Nut			5-pk.	20389	

MXT™ Low-Dead-Volume Connector Kits for Metal Columns

These low-dead-volume connectors are Siltek® treated to make them inert to active compounds, just like our MXT® columns. They can be used at temperatures up to 430°C without degrading the deactivated layer. Purchase the appropriate ferrules for connecting 0.28, 0.32 or 0.53mm ID tubing.

MXT™ Low-Dead-Volume Connector Kits for Metal Columns

- Connect a guard column/transfer line to an MXT® stainless steel column.
- Low thermal mass tracks rapid oven temperature programming.
- Stainless steel ferrules and nuts.
- Available in “Y” and union configurations.
- Siltek® treatment ensures ultimate inertness.



Each kit contains the MXT™ union, two 1/32-inch ferrules and nuts.

Description	qty.	cat.#	price
For 0.28mm ID MXT Columns	kit	20397	
For 0.32mm ID MXT Columns	kit	20536	
For 0.53mm ID MXT Columns	kit	20394	

MXT™ Low-Dead-Volume “Y” Connector Kits for Metal Columns

- Connect two MXT® columns to one inlet or one MXT® column to two detectors.



Each kit contains the MXT™ union, three 1/32-inch ferrules and nuts.

Description	qty.	cat.#	price
For 0.28mm ID MXT Columns	kit	20396	
For 0.32mm ID MXT Columns	kit	20537	
For 0.53mm ID MXT Columns	kit	20395	

1/32-Inch Stainless Steel Replacement Ferrules for MXT™ Connectors

Ferrule ID	Fits Column ID	qty.	cat.#	price
0.59mm	0.28mm	10-pk.	20398	
0.53mm	0.32mm	10-pk.	20535	
0.79mm	0.53mm	10-pk.	20399	





Zero-Dead-Volume Valco® Internal Union

Ends of tubing seat squarely at bottoms of fitting details. 300 series stainless steel. For 1/16" OD tubing. Stainless steel ferrules included.

Description	Union Bore	Valco #	qty.	cat.#	price
Internal Union	0.15mm	ZU1XC	ea.	20147	
Internal Union	0.25mm	ZU1C	ea.	20148	
Internal Union	0.75mm	ZU1	ea.	20149	
Internal Union	1/16"	ZUIT	ea.	20150	



Zero-Dead-Volume Valco® Internal Reducing Union

Connect two sizes of tubing, using zero-dead-volume fittings on each end. For 1/8" to 1/16" OD tubing. Stainless steel ferrules included.

Description	Union Bore	Valco #	qty.	cat.#	price
Internal Reducing Union	0.25mm	ZRU21C	ea.	20151	
Internal Reducing Union	0.75mm	ZRU21	ea.	20152	
Internal Reducing Union	1/16"	ZRU21T	ea.	20153	



Zero-Dead-Volume Valco® Internal Tee

Connect three lines. 300 series stainless steel; stainless steel ferrules included. For 1/16" OD tubing.

Description	Union Bore	Valco #	qty.	cat.#	price
Internal Tee	0.25mm	ZT1C	ea.	20154	
Internal Tee	0.75mm	ZT1	ea.	20155	



Zero-Dead-Volume Valco® Internal Cross

Connect four lines. 300 series stainless steel; stainless steel ferrules included. For 1/16" OD tubing.

Description	Union Bore	Valco #	qty.	cat.#	price
Internal Cross	0.25mm	ZX1C	ea.	20156	
Internal Cross	0.75mm	ZX1	ea.	20157	



Male Pipe to Valco® Internal Adapter

Makes a minimum volume connection from a female pipe fitting on a pressure gauge or regulator to a Valco® zero-dead-volume fitting. 300 series stainless steel; stainless steel ferrules included.

Description	Fitting Size	Bore	Valco #	qty.	cat.#	price
1/8" NPT Male						
Internal Adapter	1/16" ZDV	1.0mm	PZA21	ea.	20158	
1/4" NPT Male						
Internal Adapter	1/16" ZDV	1.0mm	PZA41	ea.	20159	



Nuts & Ferrules for Valco® Connectors

Description	Valco #	qty.	cat.#	price
1/16" Stainless Steel Ferrules	ZF1-10	10-pk.	20286	
1/16" Stainless Steel Nuts	ZN1-10	10-pk.	20287	



1/16-Inch Valco® Adaptor Ferrules

Tubing OD	Tubing ID	Valco #	qty.	Valcon Polyimide		Polyimide		
				cat.#	price	qty.	cat.#	price
0.25–0.4mm	0.1–0.25mm	FS1.4-5	5-pk.	20142		2-pk.	21015	
0.4–0.5mm	0.32mm	FS1.5-5	5-pk.	20143		2-pk.	21016	
0.5–0.8mm	0.53mm	FS1.8-5	5-pk.	20144		—	—	—
0.8mm (1/32")	—	FS1.9-5	5-pk.	20145		—	—	—

also available

Treated Fittings!

See pages 237-241 for our Siltek®/Sulfinert® treated and Silcosteel®-CR treated fittings, as well as many more brass and stainless steel fittings from Swagelok® and Parker.



Ferrules

Valco metal ferrules cut a ring near the end of the tube, preventing tube release at high pressures without significantly deforming and restricting the tube interior. (However, if the hardness of the tubing is equal to or greater than that of the ferrule, deformation of the tube rather than a cut ring is likely.) Make up usually takes only about a 1/4 turn beyond the point where the ferrule first starts to grab the tubing. Polymeric ferrules seal by the increased friction from compression.

Valco zero volume ferrules may be used with all Valco fittings and with those of most other manufacturers. The maximum pressure limit is generally determined by the yield strength of the tubing. The maximum pressure for softer materials (such as brass and polymers) is lower, and depends on the tubing used. If in doubt about a particular combination, consult our technical staff.

For trace gas analysis, use gold-plated ferrules to achieve sealing with $<10^{-9}$ cc/atm/sec leakage.



MORE INFORMATION

For more detailed information on metals, refer to the discussion on pages 254-255.

Metal ferrules

	Prod No	Price	Prod No	Price	Prod No	Price
Package of 10:	Stainless, Type 303		Stainless, Type 316		Stainless, Gold-plated	
1/32"	ZF5-10		ZF5S6-10	\$40	ZF5GP-10	
1/16"	ZF1-10		ZF1S6-10	30	ZF1GP-10	
1/8"	ZF2-10		ZF2S6-10	22	ZF2GP-10	
1/4"	-		ZF4S6-10	19	ZF4GP-10	
Sold individually:	Hastelloy C		Nickel		Titanium	
1/32"	ZF5HC		ZF5NI	\$9	ZF5TI	
1/16"	ZF1HC		ZF1NI	8	ZF1TI	
1/8"	ZF2HC		ZF2NI	8	ZF2TI	
1/4"	ZF4HC		ZF4NI	9	ZF4TI	
Package of 10:	Brass					
1/32"	ZF5B-10					
1/16"	ZF1B-10					
1/8"	ZF2B-10					
1/4"	ZF4B-10					

- Not available

Larger sizes and/or specific materials may be available on special order.

METALS

AT A GLANCE

Hastelloy C®HC
Resistant to pitting;
Resists oxidizing atmospheres

Nickel NI
Resistant to caustics,
high temp halogens,
and hydrogen halides

Stainless steel,
Gold-platedGP
More inert than standard stainless

Stainless steel,
Type 303
GC, gas lines, general purpose

Stainless steel,
Type 316S6
LC with high chloride ion in solutions

TitaniumTI
Outstanding resistance to most media except hydrofluoric acids

Brass B
Not recommended for most chromatographic applications

0.25 mm = .010"
0.50 mm = .020"
0.75 mm = .030"

1.0 mm = .040"
1.5 mm = .060"
2.0 mm = .080"

4.6 mm = .180"
6.0 mm = .236"
6.4 mm = .253"

7.0 mm = .275"
10.0 mm = .400"

27.0 mm = 1.08"

1/32" = 0.8 mm
1/16" = 1.6 mm
1/8" = 3.2 mm

1/4" = 6.4 mm
3/8" = 9.5 mm
1/2" = 12.7 mm



Polymeric ferrules

MORE INFORMATION
 PEEK ferrules page 63
 Grooved PEEK
 ferrules 63

For more detailed
 information on polymers,
 refer to the discussion
 on page 256.

**POLYMERS
 AT A GLANCE**

CTFE KF
*Resists all inorganic
 corrosives.
 Produced as Kel-F®*

FEP FEP
*Chemical resistance
 equals PTFE, but lower
 creep and higher
 friction*

PTFE, Glass-filled TFG
*Inert, mechanically
 stable*

PTFE, Virgin TF
*Inert; very soft, easily
 cold flows.
 Produced as Teflon®*

Polyimide, Graphite GV
*Soft, easy to form fer-
 rules*

Polyimide, Valcon V
*High temp, graphite
 reinforced*

Polyimide, Virgin V1
*High temp, electrical
 insulator*

	Prod No	Price	Prod No	Price	Prod No	Price
<i>Package of 10:</i>	PTFE, Virgin		PTFE, Glass-filled		FEP	
1/32"	ZF.5TF-10		ZF.5TFG-10		ZF.5FEP-10	
1/16"	ZF1TF-10		ZF1TFG-10		ZF1FEP-10	
1/8"	ZF2TF-10		ZF2TFG-10		ZF2FEP-10	
1/4"	ZF4TF-10		ZF4TFG-10		ZF4FEP-10	
3/8"	ZF6TF-10		ZF6TFG-10		ZF6FEP-10	
1/2"	ZF8TF-10		ZF8TFG-10		ZF8FEP-10	

	Prod No	Price	Prod No	Price
<i>Package of 10:</i>	PFA		CTFE	
1/32"	ZF.5PFA-10		ZF.5KF-10	
1/16"	ZF1PFA-10		ZF1KF-10	
1/8"	ZF2PFA-10		ZF2KF-10	
1/4"	ZF4PFA-10		ZF4KF-10	
3/8"	ZF6PFA-10		ZF6KF-10	
1/2"	ZF8PFA-10		ZF8KF-10	

	Prod No	Price	Prod No	Price	Prod No	Price
<i>Package of 5:</i>	Polyimide, Graphite		Polyimide, Valcon		Polyimide, Virgin	
1/32"	ZF.5GV-5		ZF.5V-5		ZF.5V1-5	
1/16"	ZF1GV-5		ZF1V-5		ZF1V1-5	
1/8"	ZF2GV-5		ZF2V-5		ZF2V1-5	
1/4"	ZF4GV-5		ZF4V-5		ZF4V1-5	
3/8"	ZF6GV-5		ZF6V-5		ZF6V1-5	
1/2"	ZF8GV-5		ZF8V-5		ZF8V1-5	

**FERRULE
 IDENTIFICATION**

To differentiate among
 the most commonly
 ordered metal ferrules,
 ring(s) are engraved on
 the non-sealing surfaces.



Reducing Ferrules

Reducing ferrules provide an inexpensive way to connect small temporary transfer lines to valves or fittings designed for larger tubing. For long term use, we recommend our reducing unions, internal reducers (IZRs), or external reducers (EZRs), as appropriate.

Internal ZDV (zero dead volume) reducing ferrules are designed for use with all standard Valco internal style fittings – that is, those with a male nut and female fitting detail. The ferrule features an integral pilot which fills the pilot cavity (the space between the end of the ferrule and the bottom of the detail), yielding a zero dead volume fitting.

External ZDV reducing ferrules are designed for use with all standard external style fittings – that is, those with a female nut and a male fitting detail. This ferrule has a slightly longer pilot than the internal version, to accommodate the longer external detail. The result is a zero dead volume fitting. A single groove indicates that the ferrule has the longer pilot and is for use in an external detail.

Standard reducing ferrules can be used where mixing is not a problem, such as with liquid or gas delivery. A 1/16" to 1/32" ferrule of this style is simply a 1/16" ferrule with a 1/32" hole.



Internal reducing ferrules

Use these ferrules in internal type fitting details, with nuts that have external threads.

	Prod No	Price	Prod No	Price	Prod No	Price
Package of 5:	PTFE, Glass-filled		PEEK		Polyimide, Valcon	
1/16" to 1/32"	ZRF1.5TFG-5		ZRF1.5PK-5		ZRF1.5V-5	
1/8" to 1/32"	ZRF2.5TFG-5		ZRF2.5PK-5		ZRF2.5V-5	
1/8" to 1/16"	ZRF21TFG-5		ZRF21PK-5		ZRF21V-5	
1/4" to 1/16"	ZRF41TFG-5		ZRF41PK-5		ZRF41V-5	
1/4" to 1/8"	ZRF42TFG-5		ZRF42PK-5		ZRF42V-5	
Package of 5:	CTFE		Polyimide, Virgin			
1/16" to 1/32"	ZRF1.5KF-5		ZRF1.5V1-5			
1/8" to 1/32"	ZRF2.5KF-5		ZRF2.5V1-5			
1/8" to 1/16"	ZRF21KF-5		ZRF21V1-5			
1/4" to 1/16"	ZRF41KF-5		ZRF41V1-5			
1/4" to 1/8"	ZRF42KF-5		ZRF42V1-5			

MORE INFORMATION

Internal reducers (IZR)..... page 34
 External reducers (EZR)..... 35
 Ferrule removal kits.... 16

For 1/16" and 1/32" reducing ferrules with smaller ODs for use with fused silica, see the FS and FSR adapters on pages 16-17.

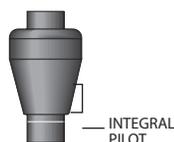
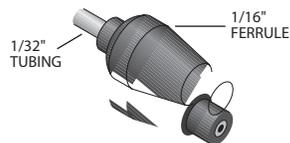
TECH TIP

Fittings for 360 micron tubing are available on pages 57-58.

TECH TIP

If you are doing resistive heating of traps or columns, note that our virgin polyimide ferrules are effective electrical insulators.

Virgin polyimide is produced as Vespel®.



Internal reducing ferrule (ZRF)



PEEK reducing ferrule and internal nut
 (Order nut separately.)

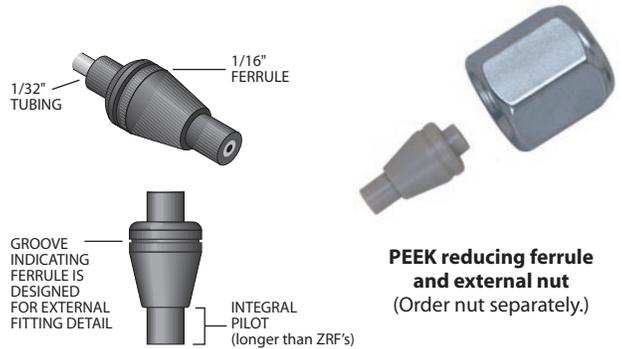
OPTION

Available in Virgin Polyimide.

External reducing ferrules

Use these ferrules in external type fitting details, with nuts that have internal threads.

	Prod No	Price	Prod No	Price	Prod No	Price
<i>Package of 5:</i>	PTFE, Glass-filled		PEEK		Polyimide, Valcon	
	1/16" to 1/32"	EZRF1.5TFG-5	EZRF1.5PK-5		EZRF1.5V-5	
	1/8" to 1/32"	EZRF2.5TFG-5	EZRF2.5PK-5		EZRF2.5V-5	
	1/8" to 1/16"	EZRF21TFG-5	EZRF21PK-5		EZRF21V-5	
	1/4" to 1/16"	EZRF41TFG-5	EZRF41PK-5		EZRF41V-5	
	1/4" to 1/8"	EZRF42TFG-5	EZRF42PK-5		EZRF42V-5	
<i>Package of 5:</i>	CTFE					
	1/16" to 1/32"	EZRF1.5KF-5				
	1/8" to 1/32"	EZRF2.5KF-5				
	1/8" to 1/16"	EZRF21KF-5				
	1/4" to 1/16"	EZRF41KF-5				
	1/4" to 1/8"	EZRF42KF-5				

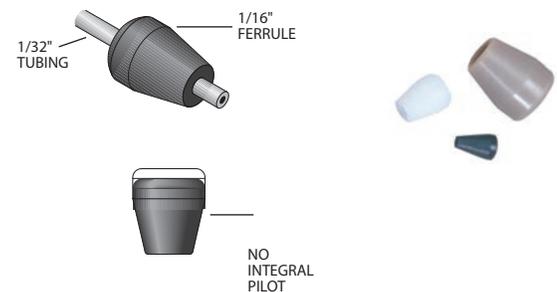


External reducing ferrule (EZRF)

Standard reducing ferrules

Use these ferrules for bulk distribution only, since the resulting connection will not be zero dead volume. These ferrules can be used in either internal or external type fitting details.

	Prod No	Price	Prod No	Price	Prod No	Price
<i>Package of 5:</i>	PTFE, Glass-filled		PEEK		Polyimide, Valcon	
	1/16" to 1/32"	RF1.5TFG-5	RF1.5PK-5		RF1.5V-5	
	1/8" to 1/32"	RF2.5TFG-5	RF2.5PK-5		RF2.5V-5	
	1/8" to 1/16"	RF21TFG-5	RF21PK-5		RF21V-5	
	1/4" to 1/16"	RF41TFG-5	RF41PK-5		RF41V-5	
	1/4" to 1/8"	RF42TFG-5	RF42PK-5		RF42V-5	
<i>Package of 5:</i>	CTFE					
	1/16" to 1/32"	RF1.5KF-5				
	1/8" to 1/32"	RF2.5KF-5				
	1/8" to 1/16"	RF21KF-5				
	1/4" to 1/16"	RF41KF-5				
	1/4" to 1/8"	RF42KF-5				



Standard reducing ferrule (RF)

0.25 mm = .010"
0.50 mm = .020"
0.75 mm = .030"
1.0 mm = .040"
1.5 mm = .060"
2.0 mm = .080"
4.6 mm = .180"
6.0 mm = .236"
6.4 mm = .253"
7.0 mm = .275"
10.0 mm = .400"
27.0 mm = 1.08"
1/32" = 0.8 mm
1/16" = 1.6 mm
1/8" = 3.2 mm
1/4" = 6.4 mm
3/8" = 9.5 mm
1/2" = 12.7 mm

Fused Silica Adapters

Fused silica adapters are available in Valcon polyimide for use up to 350°C and in PEEK for lower temperature applications (up to 175°C). Valcon polyimide is a unique graphite-reinforced composite, specially prepared to maximize mechanical stability at high temperatures. Small blocks are subjected to extreme loads by a process known as hot isostatic pressing, with individual ferrules

subsequently machined from these blocks. The result of this two-step process is a fused silica adapter with high temperature stability which far exceeds that of parts produced by conventional molding. Note that the determining factor in adapter size selection is the fused silica tubing's outer diameter, or OD. Typical ODs for common columns are included in the product number tables.



One piece fused silica adapter (FS)

The one piece FS adapter, essentially a reducing ferrule, is recommended for use in fittings where the polyimide ferrule will not be removed. Connections are made and disconnected by loosening the fitting nut and sliding the tube out.

Package of 5:

	Tubing OD:	Polyimide, Valcon		PEEK		Polyimide, Virgin	
		Prod No	Price	Prod No	Price	Prod No	Price
1/32" Adapters	< 0.25 mm	FS.25-5		FS.25PK-5		FS.25V1-5	
	0.25 ≤ 0.40 mm	FS.4-5		FS.4PK-5		FS.4V1-5	
	0.40 ≤ 0.50 mm	FS.5-5		FS.5PK-5		FS.5V1-5	
	0.50 ≤ 0.80 mm	ZF.5V-5		ZF.5PK-5		ZF.5V1-5	
1/16" Adapters	< 0.25 mm	FS1.2-5		FS1.2PK-5		FS1.2V1-5	
	0.25 ≤ 0.30 mm	FS1.25-5		FS1.25PK-5		FS1.25V1-5	
	0.30 ≤ 0.35 mm	FS1.3-5		FS1.3PK-5		FS1.3V1-5	
	0.35 ≤ 0.40 mm	FS1.4-5		FS1.4PK-5		FS1.4V1-5	
	0.40 ≤ 0.50 mm	FS1.5-5		FS1.5PK-5		FS1.5V1-5	
	0.50 ≤ 0.80 mm	FS1.8-5		FS1.8PK-5		FS1.8V1-5	
	0.80 ≤ 0.90 mm	FS1.9-5		FS1.9PK-5		FS1.9V1-5	
	0.90 ≤ 1.0 mm	FS11.0-5		FS11.0PK-5		FS11.0V1-5	

TEMPERATURE RATINGS

Polyimide adapters can be used at temperatures up to 350°C.

PEEK adapters are not recommended for use above 175°C.

TECH TIP

Virgin polyimide adapters are effective electrical insulators, making them the ideal choice for capillary electrophoresis.

Virgin polyimide is produced as Vespel®.

TECH TIP

If a fused silica tube breaks off in a through-type union, remove the nuts and the tube opposite the broken one. Clear the fitting by passing a drill or wire of the appropriate diameter into the unbroken side and through the center of the fitting.

Our **ferrule removal kit**, left, can be used to remove ferrules from all types of fittings.

Ferrule removal kit

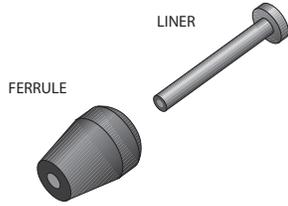
These tapered tools have teeth designed to grip and remove fused silica adapters if they get stuck in a fitting detail. Each kit has two sizes of tools, so they can retrieve 1/32" and 1/16" adapters.

Prod No Price
FRK1 \$23



WHICH ADAPTER FOR WHICH COLUMN?

Column ID	Typical column OD	1/32" adapter	1/16" adapter
< 0.20 mm	0.25 mm	FS.25	FS1.25
0.25 mm	0.4 mm	FS.4	FS1.4
0.32 mm	0.5 mm	FS.5	FS1.5
0.53 mm	0.8 mm	ZF.5V	FS1.8



Removable fused silica adapters (FSR)

The FSR adapter is the only adapter recommended for use in valves. It consists of a liner which slides over the fused silica tubing and a ferrule which makes up on the liner. The polyimide liner has an enlarged diameter at one end which is captured by the nut, so the liner and the tube within it are removed as the nut is unscrewed from the valve. The 1/16" FSR adapter includes a special counter-bored 1/16" nut. The 1/32" FSR adapter uses standard Valco 1/32" nuts.

MORE INFORMATION

Fused silica
 Unions . pp 18-19, 58, 61
 Fittings 18-21
 A pin vise and drill index are useful for enlarging the inner diameters of the FS adapters.
 Pin vise and drill index 55

REPLACEMENT PARTS

Ferrules	<i>(package of 5)</i>	
1/32" Polyimide	ZF.5V-5	\$30
1/16" Polyimide	ZF1V-5	25
	<i>(package of 10)</i>	
1/16" PEEK	ZF1PK-10	33
Nuts	<i>(package of 10)</i>	
1/32" SS	ZN.5-10	29
<i>Special nuts for FSRs:</i>		
1/16" SS	ZCN1-10	30
1/16" SS long	LZCN1-10	45

100 µm	= .004"
150 µm	= .006"
0.25 mm	= .010"
0.50 mm	= .020"
0.75 mm	= .030"
1.0 mm	= .040"
1.5 mm	= .060"
2.0 mm	= .080"
4.6 mm	= .180"
6.0 mm	= .236"
6.4 mm	= .253"
7.0 mm	= .275"
10.0 mm	= .400"
27.0 mm	= 1.08"
1/32"	= 0.8 mm
1/16"	= 1.6 mm
1/8"	= 3.2 mm
1/4"	= 6.4 mm
3/8"	= 9.5 mm
1/2"	= 12.7 mm

Package of 5:

1/32"

Removable adapters	Tubing OD:	
	< 0.25 mm	FSR.25-5
	0.30 ≤ 0.35 mm	FSR.3-5
	0.35 ≤ 0.40 mm	FSR.4-5
	0.40 ≤ 0.50 mm	FSR.5-5

1/32"

Replacement liners	Tubing OD:	
	< 0.25 mm	FSL.25-5
	0.25 ≤ 0.40 mm	FSL.4-5
	0.40 ≤ 0.50 mm	FSL.5-5

Polyimide, Valcon
 Prod No Price

Package of 5:

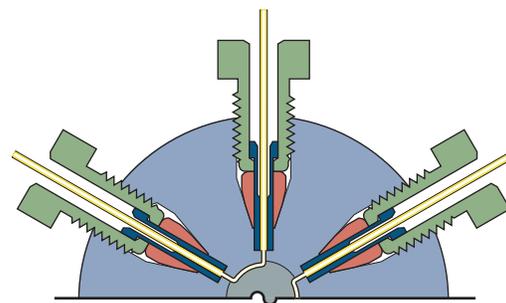
1/16"

Removable adapters	Tubing OD:		
	< 0.15 mm	-	FS1R.15PK-5
	< 0.20 mm	FS1R.2-5	FS1R.2PK-5
	0.20 ≤ 0.40 mm	FS1R.4-5	FS1R.4PK-5
	0.40 ≤ 0.50 mm	FS1R.5-5	FS1R.5PK-5
	0.50 ≤ 0.80 mm	FS1R.8-5	FS1R.8PK-5
	0.90 ≤ 1.0 mm	FS1R1.0-5	FS1R1.0PK-5

1/16"

Replacement liners	Tubing OD:		
	< 0.15 mm	-	FS1L.15PK-5
	< 0.20 mm	FS1L.2-5	FS1L.2PK-5
	0.20 ≤ 0.40 mm	FS1L.4-5	FS1L.4PK-5
	0.40 ≤ 0.50 mm	FS1L.5-5	FS1L.5PK-5
	0.50 ≤ 0.80 mm	FS1L.8-5	FS1L.8PK-5
	0.90 ≤ 1.0 mm	FS1L1.0-5	FS1L1.0PK-5

Polyimide, Valcon **PEEK**
 Prod No Price Prod No Price



Removable FSR adapters in a valve

Australian / International FERRULES - Price List July 2014

Graphite Ferrules - Straight - in USD / AUD

Custom GFs

Catalog #	Fitting Size	Hole ID	Description	USD/AUD	QTY
<i>In AUSTRALIA Prices are the same but in AUD</i>					
SF100G	1/16"	1/16"	Ferrules, Graphite,1/16"ID	25.00	10-pk
GF100	1/16"	1/16"	Ferrules, Graphite,FRONT,1/16"ID	25.00	10-pk
SF200G	1/8"	1/8"	Ferrules, Graphite,1/8"ID	25.00	10-pk
GF200	1/8"	1/8"	Ferrules, Graphite,FRONT,1/8"ID	25.00	10-pk
SF300G	3/16"	3/16"	Ferrules, Graphite,3/16mmID	25.00	10-pk
SFM5G	5mm	5mm	Ferrules, Graphite,Varian 5mmID	25.00	10-pk
GF400	1/4"	1/4"	Ferrules, Graphite,FRONT,1/4"ID	25.00	10-pk
SF400G	1/4"	1/4"	Ferrules, Graphite,1/4"ID	25.00	10-pk
SF400SPEC	1/4"	1/4"	Ferrules, Graphite,1/4"ID	30.00	10-pk
SF600G	3/8"	3/8"	Ferrules, Graphite,3/8"ID	30.00	10-pk
SFM10G	10mm	10mm	Ferrules, Graphite,10mmID Metric	30.00	10-pk
SFM12G-1	12mm	12mm	Ferrules, Graphite,12mmID Metric	4.20	ea
SF800G	1/2"	1/2"	Ferrules, Graphite,1/2"ID	42.00	10-pk
SFM14G-1	14mm	14mm	Ferrules, Graphite,14mmID Metric	4.80	ea
SF1000G-1	5/8"	5/8"	Ferrules, Graphite,5/8"ID	4.80	ea
SF1200G-1	3/4"	3/4"	Ferrules, Graphite,3/4"ID	5.60	ea
SF1400G-1	7/8"	7/8"	Ferrules, Graphite,7/8"ID	6.80	ea
SF1600G-1	1.0"	1.0"	Ferrules, Graphite,1.0"ID	8.10	ea
SFM25G-1	25mm	25mm	Ferrules, Graphite,1-1/4"ID	8.10	ea
SF2000G-1	1-1/4"	1-1/4"	Ferrules, Graphite,1-1/4"ID	12.00	ea
SF2400G-1	1-1/2"	1-1/2"	Ferrules, Graphite,1-1/2"ID	15.00	ea
SF2800G-1	1-3/4"	1-3/4"	Ferrules, Graphite,1-3/4"ID	18.00	ea
SF3200G-1	2.0"	2.0"	Ferrules, Graphite, 2.0"ID	21.00	ea

NOTES : Graphite Ferrules

2 Sizes of HP ferrules for HP/Agilent 5890

GF100/- - - HP size to fit standard HP inlet seal nut (0.125-in long)

GF- - - HP a short version to fit shallow recess HP nut (0.090-in Long

Custom Ferrules : ANY size to order - providing it is physically feasible for us to make.

We need accurate dimension "specs" OD / ID / Overall Length / Shoulder Length and OD

at Cone Tip. Note : For Swagelok Ferrule shapes the cone angle is normally 17-deg

There may be a "one-off" tooling charge of USD90(<1/2"ID) to- \$150 depending on size

- if this is required for a "special" ie not a stock item.

Discounts : apply depending on **Total \$ Order** value or on Qty(each) . . . at **your** best rate!

USD10-99, 0%; USD100-500, 10% . . . Also OEM and Distributor Discounts : . **Enquire !**

Qty Discount

min10-99 less 0%
 100-499 less 10%
 500-1000 less 20%
 1000+ less 25%
 in \$ or each
 at your best rate

Plus Freight Cost

Int'l Air Courier
 USD75 per 500g
 \$95/1kg . . . at cost

Delivery Times : Availability - most standard sizes are ex stock in reasonable Qty's

Production Lead Time : most sizes are ex-stock or 4-5 days production for qty to 500 each;

larger qty approx 7+ days from date of order . . . PLUS transit time

Shipping :

In Australia via Local Courier Aud 5 per 3kg; \$30 Interstate metro

International - Air Express Courier Door-to-door.

USA : USD 75.00 per 500g, USD95/ 1kg,

Transit time : approx 3 to 5 days (most countries eg. UK, USA, Canada . . .)

Other Countries - **please enquire !**

Payment by Bank Transfer or Credit Card via on-line PayPal (we send a separate PP Invoice on request)

. . . plus Company Name; Street Delivery address; Contact Phone Number required.

Prices include packing in plastic vials 10-pk unless specified otherwise. Also available "bulk-packed" for large quantities.
 -1 suffix designates order qty : each - 50 for a 50-pk at 20% Discount . . . packed in plastic vials or separately for large sizes

Australian / International FERRULES - Price List July 2014
Graphite Ferrules - Reducing Prices per 10-pk - in USD / AUD
Custom GFs

Cat.#	Size	Hole ID	Description	USD/AUD	QTY
<i>In AUSTRALIA Prices are the same but in AUD</i>					
SF100/0.3G	1/16"	0.3mm	Ferrules, Graphite,1/16"x0.3mmID	30.00	10-pk
SF100/0.4G	1/16"	0.4mm	Ferrules, Graphite,1/16"x0.4mmID	25.00	10-pk
SF100/0.5G	1/16"	0.5mm	Ferrules, Graphite,1/16"x0.5mmID	25.00	10-pk
SF100/0.8G	1/16"	0.8mm	Ferrules, Graphite,1/16"x0.8mmID	25.00	10-pk
SF100/00G	1/16"	No-Hole	Ferrules, Graphite,1/16"xNo-Hole	25.00	10-pk
SF100/1.0G	1/16"	1.0mm	Ferrules, Graphite,1/16"x1.0mmID	25.00	10-pk
SF100/1.2G	1/16"	1.2mm	Ferrules, Graphite,1/16"x1.2mmID	25.00	10-pk
SF100/2xM0.5G	1/16"	Dble-Hole	Ferrules, Graphite,1/16"xDouble0.5mmID	35.00	10-pk
GF200/100	1/8"	1/16"	Ferrules, Graphite,FRONT,1/8x1/16"ID	25.00	10-pk
SF200/0.4G	1/8"	0.4mm	Ferrules, Graphite,1/8"x0.4mmID	25.00	10-pk
SF200/0.5G	1/8"	0.5mm	Ferrules, Graphite,1/8"x0.5mmID	25.00	10-pk
SF200/0.8G	1/8"	0.8mm	Ferrules, Graphite,1/8"x0.8mmID	25.00	10-pk
SF200/00G	1/8"	No-Hole	Ferrules, Graphite,1/8"xNo-Hole	25.00	10-pk
SF200/1.0G	1/8"	1mm	Ferrules, Graphite,1/8"x1.0mmID	25.00	10-pk
SF200/1.2G	1/8"	1.2mm	Ferrules, Graphite,1/8"x1.2mmID	25.00	10-pk
SF200/100G	1/8"	1/16"	Ferrules, Graphite,1/8"x1/16"ID	25.00	10-pk
SF200/2x0.5G	1/8"	Dble-Hole	Ferrules, Graphite,1/8"xDouble0.5mmID	35.00	10-pk
SF200/2x0.8G	1/8"	Dble-Hole	Ferrules, Graphite,1/8"xDouble0.8mmID	35.00	10-pk
SF300/100G	3/16"	1/16"	Ferrules, Graphite,3/16"ID	25.00	10-pk
SFM8.5/5/4.5G	5mm	5mm	Ferrules, Graphite,Shimadzu 5mmID	25.00	10-pk
GF400/200SP	1/4"	1/8"	Ferrules, Graphite,1/4-1/8" Flat	25.00	10-pk
SF400/00G	1/4"	No-Hole	Ferrules, Graphite,1/4"xNo-Hole	25.00	10-pk
SF400/100G	1/4"	1/16"	Ferrules, Graphite,1/4"x1/16"ID	25.00	10-pk
SF400/0.8G	1/4"	0.8mm	Ferrules, Graphite,1/4"x0.8mm"ID	25.00	10-pk
SF400/0.5G	1/4"	0.5mm	Ferrules, Graphite,1/4"x0.5mm"ID	30.00	10-pk
SF400/200G	1/4"	1/8"	Ferrules, Graphite,1/4"x1/8"ID	25.00	10-pk
SF400/300G	1/4"	3/16"	Ferrules, Graphite,1/4"x3/16"ID	25.00	10-pk
SF400/M6G	1/4"	6mm	Ferrules, Graphite,1/4"x6mm"ID	25.00	10-pk
GF400/200	1/4"	1/8"	Ferrules, Graphite,FRONT,1/4"x1/8"	25.00	10-pk
GF400/100	1/4"	1/16"	Ferrules, Graphite,FRONT,1/4"x1/16"	25.00	10-pk
GF200/100	1/8"	1/16:	Ferrules, Graphite,FRONT,1/8"x1/16"	25.00	10-pk
SF600/00G	3/8"	No-Hole	Ferrules, Graphite,3/8"xNo-Hole	42.00	10-pk
CF0.3FIS	1/16"	0.3mm	Ferrules, Graphite Capture Cup 0.3mmID	85.00	10-pk
CF0.4FIS	1/16"	0.4mm	Ferrules, Graphite Capture Cup 0.4mmID	85.00	10-pk
CF0.5FIS	1/16"	0.5mm	Ferrules, Graphite Capture Cup 0.5mmID	85.00	10-pk
CF0.8FIS	1/16"	0.8mm	Ferrules, Graphite Capture Cup 0.8mmID	85.00	10-pk
CF1.0FIS	1/16"	1.0mm	Ferrules, Graphite Capture Cup 1.0mmID	85.00	10-pk
GF0.3HP	1/16"	0.3mm	Ferrules, Graphite,0.3mm ID HP Short	25.00	10-pk
GF0.4HP	1/16"	0.4mm	Ferrules, Graphite,0.4mm ID HP Short	25.00	10-pk
GF0.5HP	1/16"	0.5mm	Ferrules, Graphite,0.5mm ID HP Short	25.00	10-pk
GF0.8HP	1/16"	0.8mm	Ferrules, Graphite,0.8mm ID HP Short	25.00	10-pk
GF1.0HP	1/16"	1.0mm	Ferrules, Graphite,1.0mm ID HP Short	25.00	10-pk
GF1.2HP	1/16"	1.2mm	Ferrules, Graphite,1.2mm ID HP Short	25.00	10-pk
GF100/0.4	1/16"	0.4mm	Ferrules, Graphite,FRONT,1/16"IDx0.4mmID	25.00	10-pk
GF100/0.5	1/16"	0.5mm	Ferrules, Graphite,FRONT,1/16"IDx0.5mmID	25.00	10-pk
GF100/0.8	1/16"	0.8mm	Ferrules, Graphite,FRONT,1/16"x0.8mmID	25.00	10-pk
GF100/1.0	1/16"	1.0mm	Ferrules, Graphite,FRONT,1/16"x1.0mmID	25.00	10-pk
GF100/1.2	1/16"	1.2mm	Ferrules, Graphite,FRONT,1/16x1.2mmID	25.00	10-pk
GF100/0.3HP	1/16"	0.3mm	Ferrules, Graphite,0.3MM ID HP Standard	30.00	10-pk
GF100/0.4HP	1/16"	0.4mm	Ferrules, Graphite,0.4MM ID HP Standard	25.00	10-pk
GF100/0.5HP	1/16"	0.5mm	Ferrules, Graphite,0.5mm ID HP Standard	25.00	10-pk
GF100/0.8HP	1/16"	0.8mm	Ferrules, Graphite,0.8mm ID HP Standard	25.00	10-pk
GF100/1.0HP	1/16"	1.0mm	Ferrules, Graphite,1.0mm ID HP Standard	25.00	10-pk

Prices include packing in plastic vials 10-pk unless specified otherwise. Also available "bulk-packed" for large quantities.
 -1 suffix designates order qty : each - 50 for a 50-pk at 20% Discount . . . packed in plastic vials or separately for large sizes

Australian / International FERRULES - Price List July 2014

Graphite/Vespel (polyimide) (15%C) Ferrules 10-pk

Cat.#	Size	Hole ID	Type	Description	USD/AUD	Qty
<i>In AUSTRALIA Prices are the same but in AUD</i>						
SF100/0.3VG	1/16"	0.3mm	Reducing	Ferrules, Graphite/VESPEL, 1/16"x0.3mmID	36.00	10-pk
SF100/0.4VG	1/16"	0.4mm	Reducing	Ferrules, Graphite/VESPEL, 1/16"x0.4mmID	36.00	10-pk
SF100/0.5VG	1/16"	0.5mm	Reducing	Ferrules, Graphite/VESPEL, 1/16"x0.5mmID	36.00	10-pk
SF100/0.7VG	1/16"	0.7mm	Reducing	Ferrules, Graphite/VESPEL, 1/16"x0.7mmID	36.00	10-pk
SF100/0.8VG	1/16"	0.8mm	Reducing	Ferrules, Graphite/VESPEL, 1/16"x0.8mmID	36.00	10-pk
SF100/1.0VG	1/16"	1.0mm	Reducing	Ferrules, Graphite/VESPEL, 1/16"x1.0mmID	36.00	10-pk
SF100/1.2VG	1/16"	1.0mm	Reducing	Ferrules, Graphite/VESPEL, 1/16"x1.2mmID	36.00	10-pk
SF100VG	1/16"	1/16"	Straight	Ferrules, Graphite/VESPEL, 1/16"ID	36.00	10-pk
SF200VG	1/8"	1/8"	Straight	Ferrules, Graphite/VESPEL, 1/8"ID	42.00	10-pk
SF300VG	3/16"	3/16"	Straight	Ferrules, Graphite/VESPEL, 1/8"ID	42.00	10-pk
SF400VG	1/4"	1/4"	Straight	Ferrules, Graphite/VESPEL, 1/4"ID	48.00	10-pk

Teflon Ferrules 10-pk

SF100T	1/16"	1/16"	Straight	Ferrules, TEFLON, 1/16"ID	30.00	10-pk
SF200T	1/8"	1/8"	Straight	Ferrules, TEFLON, 1/8"ID	30.00	10-pk
SF300T	3/16"	3/16"	Straight	Ferrules, TEFLON, 3/16"ID	36.00	10-pk
SF400T	1/4"	1/4"	Straight	Ferrules, TEFLON, 1/4"ID	36.00	10-pk
SF600T	3/8"	3/8"	Straight	Ferrules, TEFLON, 3/8"ID	42.00	10-pk
SF100/1.0T	1/16"	1.0mm	Reducing	Ferrules, TEFLON, 1/16"x1.0mmID	30.00	10-pk
SF100/0.8T	1/16"	0.8mm	Reducing	Ferrules, TEFLON, 1/16"x0.8mmID	30.00	10-pk
SF100/0.5T	1/16"	0.5mm	Reducing	Ferrules, TEFLON, 1/16"x0.5mmID	30.00	10-pk
SF200/100T	1/8"	1/16"	Reducing	Ferrules, TEFLON, 1/8"x1/16"ID	36.00	10-pk
SF400/100T	1/4"	1/16"	Reducing	Ferrules, TEFLON, 1/4"x1/16"ID	36.00	10-pk
SF400/200T	1/4"	1/8"	Reducing	Ferrules, TEFLON, 1/4"x1/8"ID	36.00	10-pk
SF400/300T	1/4"	3/16"	Reducing	Ferrules, TEFLON, 1/4"x13/16"ID	36.00	10-pk

Kel-F Ferrules 10-pk

SF1428/100KF	Nut	1/16"	Straight	Ferrules, Kel-F, Single-Cone 1/16"ID for 1/4-28 Nylon Male F'Less Fingertight Nut	20.00	10-pk
SF1428/200KF	Nut	1/8"	Straight	Ferrules, Kel-F, Single-Cone 1/8"ID for 1/4-28 Nylon Male F'Less Fingertight Nut	20.00	10-pk

Kel-F* is similar to Tefzel* and ETFE* Trade Names

PEEK Ferrules 10-pk

SF100PK	1/16"	1/16"	Straight	Ferrules, PEEK, Single-Cone 1/16"ID	30.00	10-pk
DF100PK	1/16"	1/16"	Straight	Ferrules, PEEK, Double-Cone 1/16"ID	30.00	10-pk

Many more Ferrule Sizes / Configurations are available from VICI-Cheminert; VICI-Jour; Restek including fused silica adaptors and 1/32" and in other materials

Prices include packing in plastic vials 10-pk unless specified otherwise. Also available "bulk-packed" for large quantities. -1 suffix designates order qty : each - 50 for a 50-pk at 20% Discount . . . packed in plastic vials or separately for large sizes