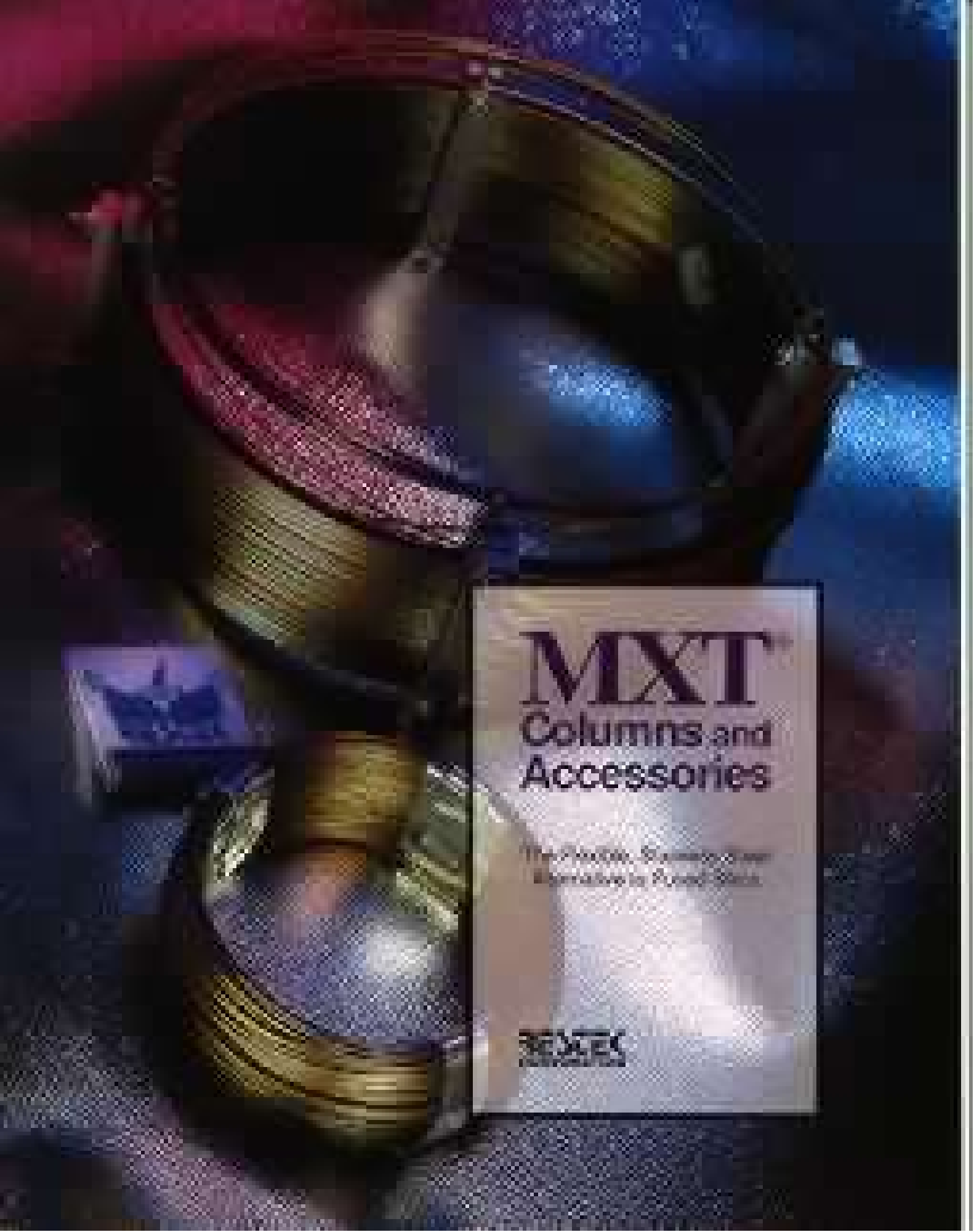
MXT
Columns and
Accessories

The New Generation of Flexible, Inert Stainless Steel Capillary Columns

Stainless steel columns have been used in capillary gas chromatography since 1957. Metal columns were extremely rugged and flexible, but suffered from poor inertness. Improvements in inertness were made with the advent of glass capillary columns. However, this increased inertness was obtained at the expense of flexibility. With the introduction of polyimide coated fused silica in 1979, a column material was finally available to chromatographers that provided the flexibility of stainless steel plus superior inertness. With fused silica columns, polyimide is coated on the outside of the tubing to increase the tubing strength. However, at oven temperatures greater than 36O”C, polyimide shrinks and becomes brittle, leading to spontaneous column breakage under normal stress. Although columns exist with aluminum cladding or higher temperature polyimides, spontaneous breakage and limited thermal stability still pose key problems. With the development of MXT" columns in 1991, an inert capillary column that could be operated at higher temperatures without the fear of breakage became reality.

MXT"stainless steel capillary columns are made inert by bonding a micron layer of deactivated fused silica to the interior tubing wall. This inert tubing is known as Silcosteel"? The Silcosteel" is further passivated using high temperature capillary column deactivation techniques. Once the surface is fully deactivated, the same stationary phases that are commonly available with fused silica capillary columns can be bonded onto the Silcosteel" surface to yield the new capillary columns.

Both fused silica and stainless steel MXT" capillary columns offer a high degree of inertness and flexibility. Stainless steel MXT" columns have the added advantage of being resistant to abrasion, scratches and spontaneous breakage. The flexible thin-walled stainless steel tubing used for MXT" columns is as easy to cut as polyimide coated fused silica tubing. The stainless steel tubing also prevents uv induced stationary phase degradation of polyethylene glycol and cyanosilicone polymers when exposed to sunlight. MXT" columns are preferred when using smaller coil diameters (3%” for MXT" columns vs. 7.65” for fused silica columns) commonly used in portable gas chromatographs or process control applications.

Since price and performance are similar, the deciding factor in whether to use fused silica or metal columns is often the degree of thermal stability, shock resistance, and ruggedness required for your particular analysis. Under harsh operating conditions, MXT" capillary columns are the best choice.

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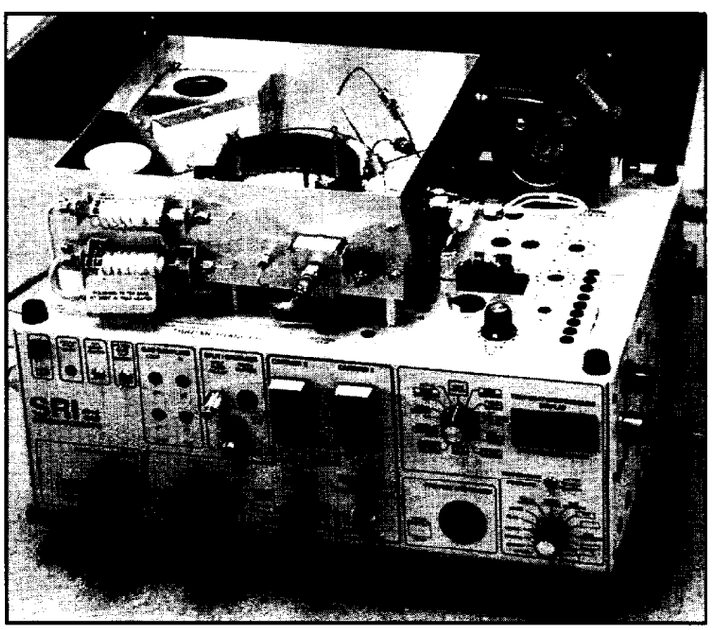

MXT@ columns are ideal for small ovens, portable GCs, process analyzers, or systems used for on-site monitoring hazardous waste facilities.

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MXT" Column Cross-Section

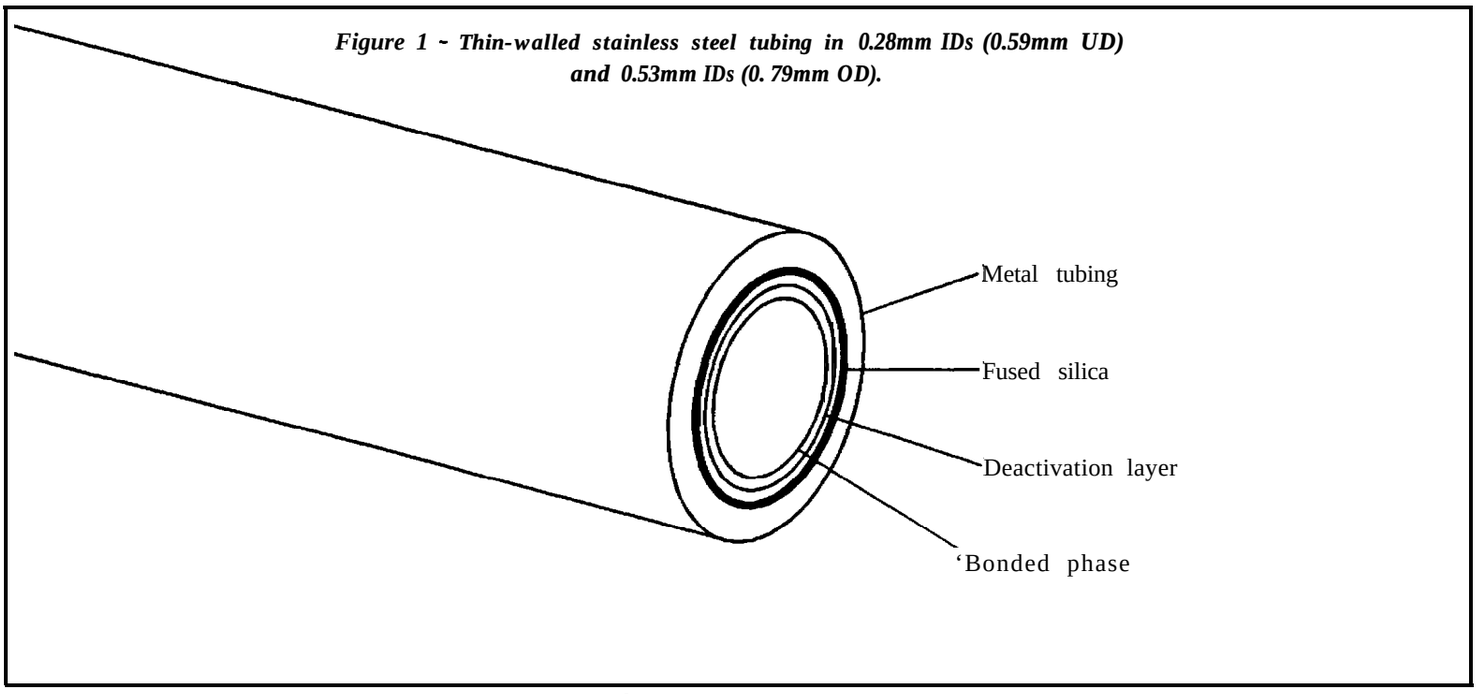


Figure 1 ~ Thin-walled stainless steel tubing in 0.28mm IDs (0.59mm UD) and 0.53mm IDs (0. 79mm OD).

Commonly Asked Questions. ..

What are MXT" columns?

MXT" columns are made by depositing a uniform, micron layer of flexible fused silica on the inner surface of stainless steel. The surface is then deactivated and made inert by the same process used to treat our Crossbond@ fused silica columns. A static coating and bonding process allows us to make columns in a wide variety of polarities.

What advantages do MXT" columns offer?

MXT" columns were developed to increase the utility of capillary chromatography. They offer combined benefits of fused silica and stainless steel capillary columns such as:

- High degree of inertness to active sample components
- Extreme flexibility without risk of spontaneous breakage
- No loss in tubing strength when continually heated above 400°C
- Rapid and uniform heat transfer
- Rugged, unaffected by abrasions or scratches
- Smaller coil diameter (31/2" for MXT" columns vs. 7.65" for fused silica)
- Equivalent pricing to fused silica columns

What are MXT" columns made from?

MXT" columns are made from thin-walled stainless steel tubing in 0.28mm and 0.53mm IDs. The tubing is half hard temper, so it springs back in place much like fused silica.

Why are MXT" columns easy to use?

MXT" columns can be installed directly into most instruments without any modification or pre-column adaptor.

Both the 0.28mm and 0.53mm ID columns can be installed using conventional 0.8mm graphite ferrules.

The inside diameter of the 0.53mm ID column is large enough to allow a standard 26 gauge needle to be inserted for on-column injections.

. MXT" columns are easily cut using a small file that is included with each column or a standard ceramic wafer.

· MXT" columns are ideal for small ovens, portable GCs, process analyzers, or GC/MS systems used for on-site monitoring hazardous waste facilities

Note: The technique used to cut MXT" columns** is **similar to that of fused silica tubing, but more deliberate pressure is required. Once the tubing is scored, it snaps cleanly with properly applied force. MX T" tubing should be handled similarly to polyimide** coated fused **silica tubing. Sharp kinks or bends less than l-inch in radius must be avoided. However, MXT" columns can withstand** much more **rugged operating conditions than fused silica.

Inertness

MXT" Columns Offer Comparable Inertness to Fused Silica Columns

Fused silica tubing is an extremely inert column material. It contains less than 5ppm of metal oxides and other contaminants and is very inert to active compounds. Fused silica also has a very smooth inner surface as shown by the scanning electron micrograph (SEM) in Figure 2. This smooth surface permits even stationary phase coatings and high column efficiencies. In comparison, untreated stainless steel contains hydrocarbons, metal oxides, and other contaminants that can adsorb active compounds. In addition, a stainless steel surface has many folds or ridges that are often several microns deep (Figure 3). This rough surface makes it difficult to coat stationary phases evenly, resulting in poor peak symmetry and low column efficiencies. MXT" (Silcosteel") tubing is made by depositing a micron layer of fused silica over the rough stainless steel metal surface. Figure 4 shows an SEM of an MXT" (Silcosteel") surface prior to deactivation or coating. Figure 4 also shows areas where the fused silica lining was selectively removed to expose the untreated stainless steel surface below. The SEM clearly illustrates how the fused silica deposition (Silcosteel" process) smooths the rough stainless surface. This smooth surface allows stationary phases to be coated with minimal loss of efficiency and renders the metal inactive, giving a high degree of inertness towards active compounds. The active sites are completely covered, creating essentially the same inner surface as a fused silica capillary column.

Silcosteel" Inertness is Demonstrated Using the Grob Test Mixture

Column inertness can be evaluated through the use of the Grob test mixture. The Grob test mixture contains a wide variety of functional groups that give discrete information about column inertness. Peak symmetry of polar compounds such as alcohols, aldehydes, and ketones are indicators of column inertness. Hydroxyl groups, commonly found in alcohols and diols, easily interact with any material in the sample flow path that has the ability to hydrogen bond. In severe cases, adsorption of polar compounds can become so pronounced that the compounds completely disappear. Hydrocarbons in the Grob test mixture act as reference peaks for the active compounds and polarity indicators. Fatty acid methyl esters are used to calculate column efficiency.

In Figure 5, 1.0ul of the Grob test mixture (5ng per component on-column) is injected on a 15m, 0.32mm ID, 0.25um Stabilwax" column. Column inertness is indicated by the excellent response and peak symmetry of the active sample components, 2,3-butanediol and I-octanol (peaks 4 and 5). To examine the inertness of fused silica tubing, a 5-meter piece of deactivated, fused silica guard column was butt-connected to the Stabilwax" column. Figure 6 shows that no difference in column inertness was

*Figure 2 - A **scanning electron microgtaph illustrates the surface characteristics of fused silica***

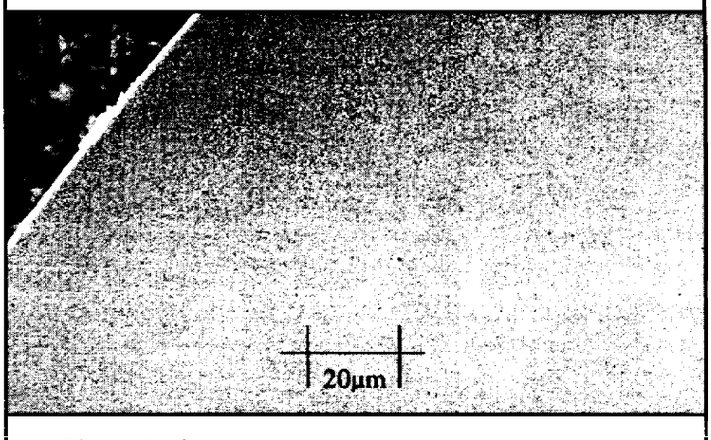


*Figure 3 - A **scanning electron micrograph illustrates the surface characteristics of stainless steel***

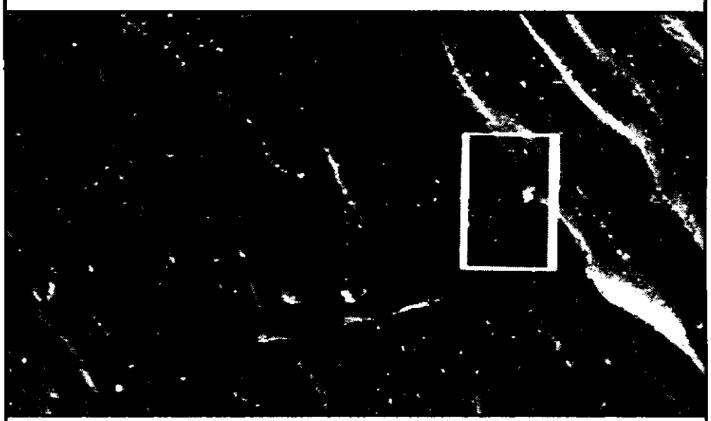
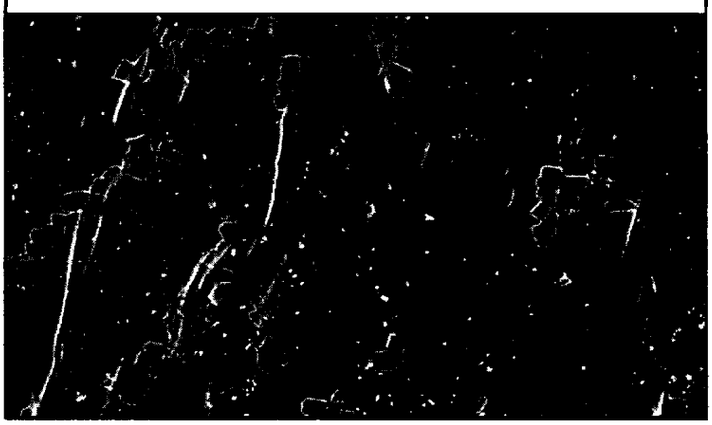


*Figure 4 - A scanning electron **micrograph illustrates the surface characteristics of MXT" (Silcosteel") tubing***



observed; compared to the Stabilwax" column. In Figure 7, a 5meter piece of cleaned, untreated stainless steel tubing was butt-connected to the Stabilwax" column. The bare stainless steel irreversibly adsorbs the active compounds 2,3-butanediol, 1-octanol, nonanal, and 2,6-dimethylaniline (peaks 4,5, 3, and 10), making it useless for trace level work.

By modifying the stainless steel surface, inertness can be improved. Figure 8 shows a 5-meter piece of Silcosteel" tubing butt-connected to the Stabilwa" column. Notice the increased inertness and peak symmetry of the 2,3-butanediol and 1-octanol on the Silcosteel" tubing compared to the bare stainless steel tubing.

Figures 5, 6, 7 & 8 - demonstrate the relative inertness of direrent column materials with the Grob test mixture

Figure 5 - A Stabilwal" column shows good inertness to active sample components

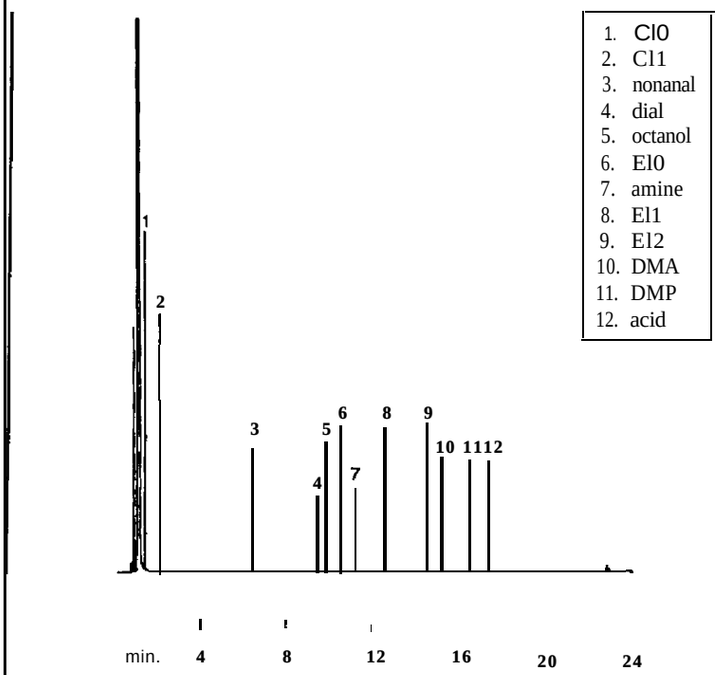


Figure 6 - The inertness of the Stabilwal" column is unchanged when a 5meter fused silica guard column is attached

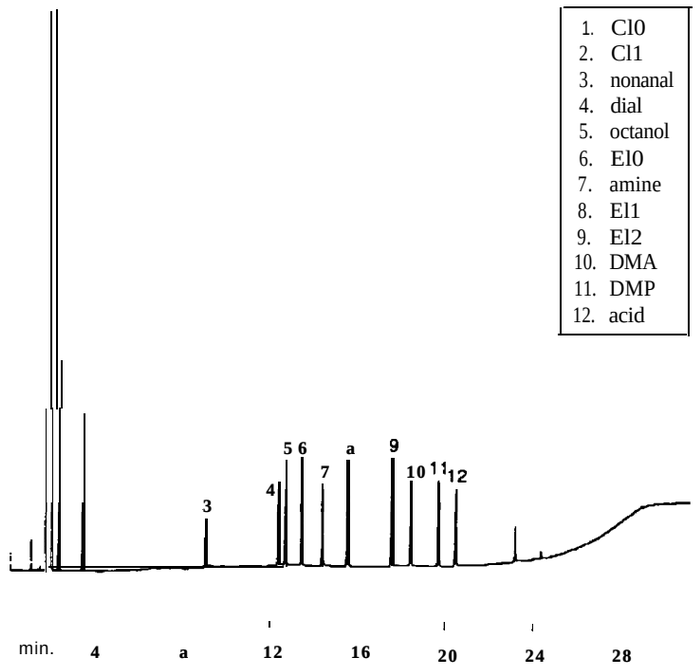


Figure 7 - Complete adsorption of many active compounds occurs when a 5-meter untreated section of stainless steel tubing is connected to the Stabilwax" column

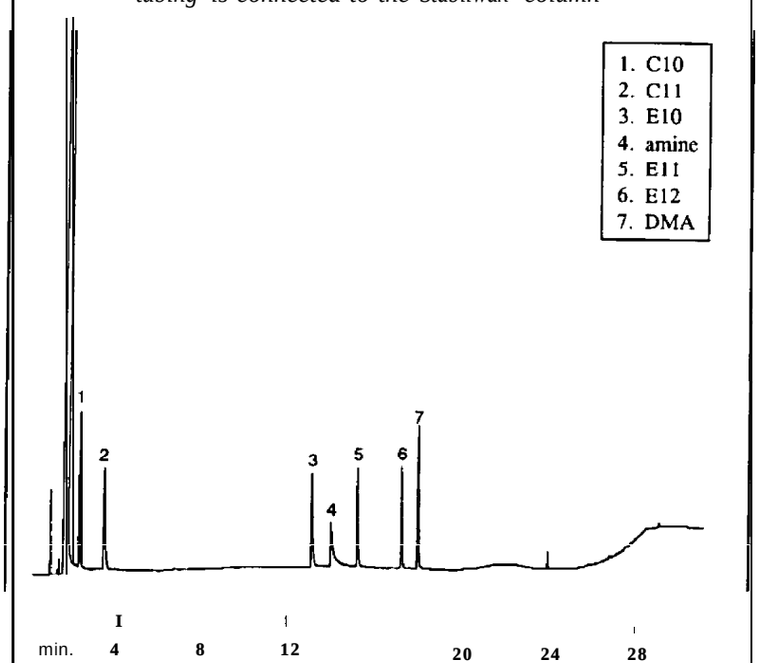
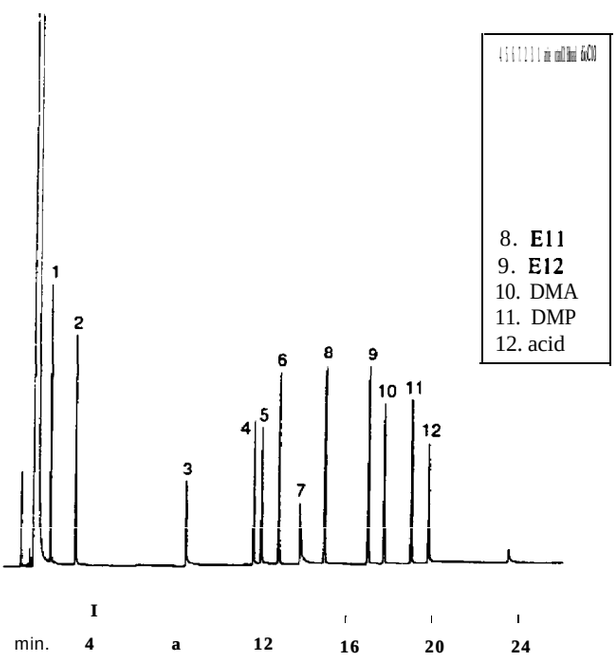


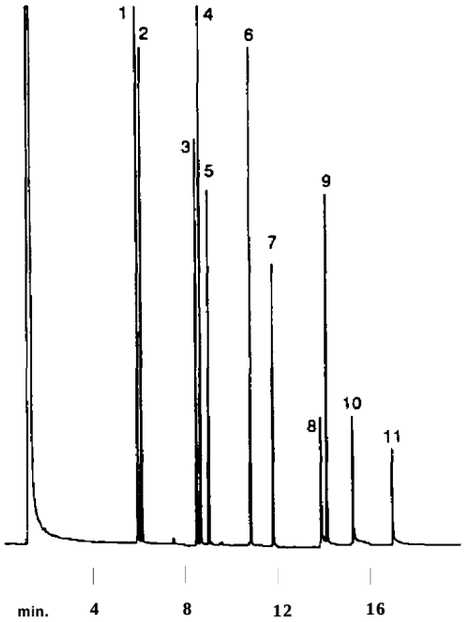
Figure 8 - The inertness of the Stabilwax" column is unchanged when a 5-meter piece of Silcosteel" tubing is attached



Active Environmental Compounds Are Excellent Test Probes to Evaluate Column Inertness

Capillary column inertness can also be illustrated by measuring the response of active environmental compounds at low concentration levels. The primary analytical column used in environmental labs is the 5% diphenyll **95%** dimethyl polysiloxane (XTI"-5). To examine the inertness of MXT" columns, Silcosteel" tubing was coated with a high temperature 5% diphenyl polysiloxane stationary phase and tested with several active environmental pollutants such as phenols and pesticides. Figure 9 shows an injection of EPA Method 604 phenols at **25ng/µl** on an MXT"-5 column. At this low concentration level, the excellent peak symmetry and response of highly active compounds such as 2,4-dinitrophenol,4-nitrophenol, and pentachlorophenol (peaks 5,6, & 8 respectively) indicate a high degree of inertness. Figure 10 shows the analysis of EPA CLP pesticides on an MXT"-5 column. Chlorinated pesticides, such as endrin and DDT, are also good indicators of column inertness since they readily decompose on active surfaces. The excellent response of these reactive compounds and the low ECD bleed illustrates the utility of the MXT" columns for analyzing active environmental pollutants.

Figure 9 - ***The MXT"-5 column demonstrates excellent inertness with EPA Method 604 phenols.***

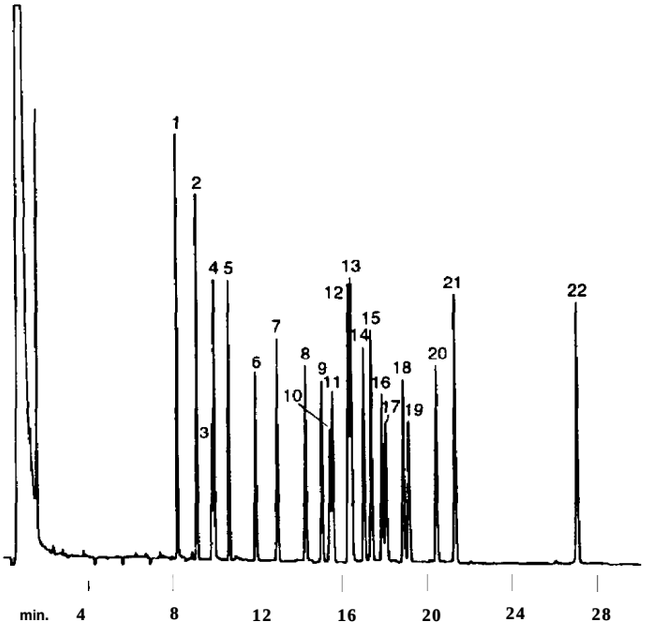


1. phenol
2. 2-chlorophenoi
3. 2-nitrophenol
4. 2,4-dimethylphenol
5. 2,4dichlorophenol
6. 4-chloro-3-methylphenol
7. 2,4,6-trichlorophenol
8. 2,4-dinitrophenol
9. 4-nitrophenol
10. 2-methyl-4,6-dinitrophenol
11. pentachlorophenol

30m, 0.28mm ID, 0.25pm MXT"-5 (cat.# 70224)
1.0ul splitless injection of EPA Method 604 phenols. Concentration 25ng/ul.

Oven temp.: 40°C to 250°C @ l0"C/min.
Inj./det. temp.: **280°C/300C**
Carrier gas: **hydrogen**
Linear velocity: **5Ocm/sec. set @ 40°C**
FID sensitivity: 2.56 x 10--10AFS
Splitless hold time: 1.5 min.

Figure 10 - ***The MXT"-5 shows low bleed and excellent inertness of CLP pesticides when used with an ECD.***



1. 2,4,5,6-tetrachloro-m-xylene (IS)	12. dieldrin
2. u-BHC	13. p,p'-DDE
3. o-BHC	14. endrin
4. y-BHC	15. endosulfan II
5. &BHC	16. p,p'-DDD
6. heptachlor	17. endrin aldehyde
7. aldrin	18. endosulfan sulfate
8. heptachlor epoxide	19. p,p'-DDT
9. y-chlordane	20. endrin ketone
10. endosulfan I	21. methoxychlor
11. a-chlordane	22. decachlorobiphenyl (IS)

Pesticide Mix A & B (cat.#'s 32003 & 32004)

30m, 0.53mm ID, 0.50um MXT"-5 (cat.# 70240)
1.0ul splitless injection of pesticides. Concentration 1.0ng/ul.

Oven temp.: **40°C to 150°C** @ 20"C/min., then to 275C @ 5"C/min.
Inj./det. temp.: 240°C/300C
Carrier gas: helium
Linear velocity: **74cm/sec. set @ 40°C**
ECD sensitivity: **33** **full scale**
Splitless hold time: 0.50 min.

Thermal Stability

MXT" Columns Have Excellent Thermal Stability

Capillary gas chromatography with fused silica columns is restricted to 360°C because of the limited thermal stability of the polyimide coating. At temperatures above 36O*C, the polyimide coating becomes very brittle, leading to spontaneous breakage and short column lifetimes. However, the superior thermal stability of stainless steel MXT" columns makes them ideal for high temperature analyses.

An example of such analysis is high temperature simulated distillation (SIM DIST). SIM DIST analyses have always been a problem with standard fused silica capillary columns since a high oven temperature (430°C) is required to elute sample components. At this high temperature, fused silica columns become brittle due to thermal shock. MXT" columns, specifically made for high temperature SIM DIST, are ideal because they can withstand being temperature programmed to 430°C repeatedly as shown in Figure 11.

Another example of high temperature analysis is high molecular weight polynudear aromatic hydrocarbons (PAHs). Successful quantitation of PAHs requires high oven temperatures to elute the components, maintain good peak symmetry, and minimize high molecular weight discrimination. While our XTI"-5 fused silica column can withstand 36O”C, an MXT"-5 can be repeatedly programmed to 360°C without any fear of spontaneous breakage or degradation of the exterior fused silica coating. Figure 12 (on page 8) shows the analysis of PAHs on an MXT"-5. Excellent peak symmetry and resolution of the PAH isomers are observed. The high thermal stability (360”) of the MXT"-5 permits the PAH isomers to elute during the temperature programming portion of the GC run. On columns with limited thermal stability, the would elute isothermally and exhibit broad peak shapes, decreased resolution, and longer analysis times.

With tubing temperature stability no longer a constraint of column maximum temperature, the thermal stability of the polymer and deactivation layer becomes the limiting factor. For thick film and polar stationary phases, the maximum operating temperatures for both MXF and fused silica columns are the same. Restek’s research chemists are working on new, higher temperature phases that will extend the operating range for capillary GC.

Figure 11 · High temperature SM DISTsample analyzed on an unbreakable MXP-SIA4 DISTat 430°C demonstrates excellent column thermal stability.

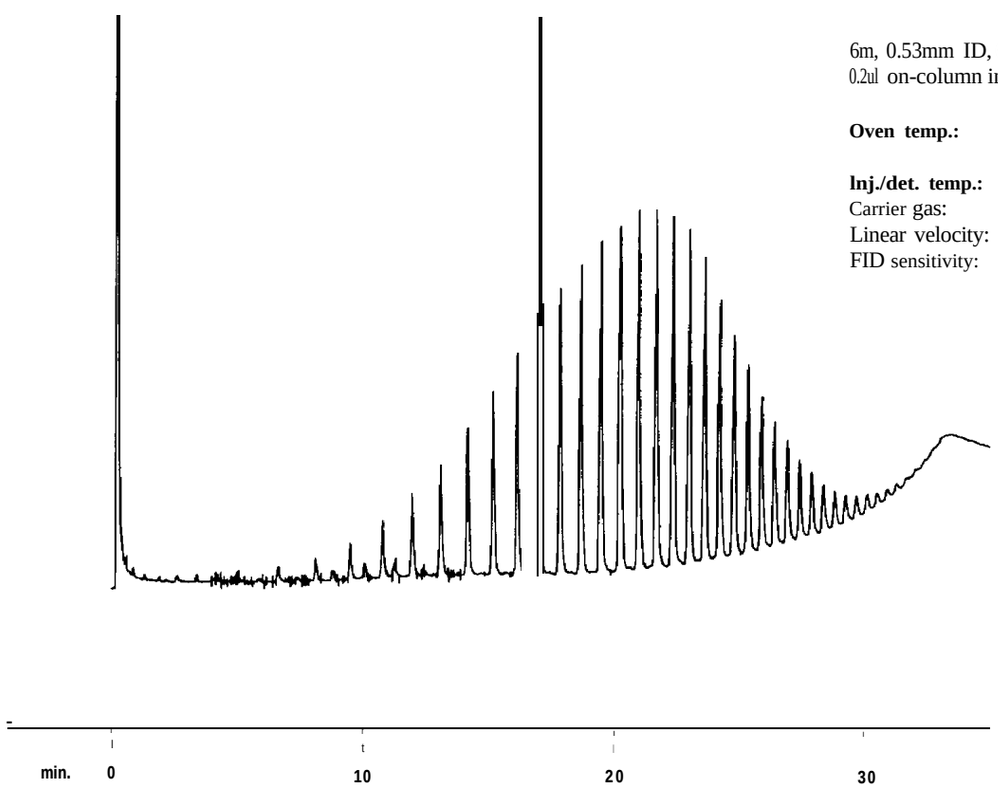
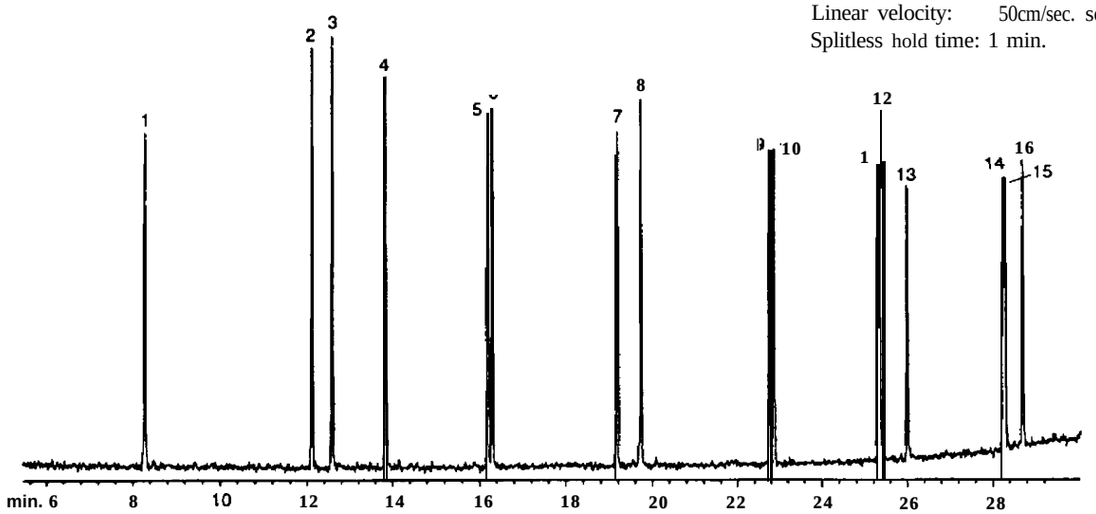


Figure 12 - Achieve excellent separation of polynuclear aromatic hydrocarbons on an MXT"-5.

SV Calibration Mix #5
(cat.# 31011)

30m, 0.28mm ID, 0.25um MXT"-5 (cat.# 70224)
1.0ul splitless injection of PAHs. Concentration 20ng/ul.

Oven temp.:	40°C to 325°C @ l0C/min. (hold 10 min.)
Inj./det. temp.:	280°C/325"C
Detector:	MS
Carrier gas:	helium
Linear velocity:	50cm/sec. set @ 325°C
Splitless hold time:	1 min.



1. naphthalene
2. acenaphthylene
3. acenaphthene
4. fluorene
5. phenanthrene
6. anthracene
7. fluoranthene
8. pyrene
9. benzo(a)anthracene
10. chrysene
11. benzo(h)fluoranthene
12. benzo(k)fluoranthene
13. benzo(a)pyrene
14. indeno(1,2,3-cd)pyrene
15. dibenzo(a,h)anthracene
16. benzo(g,h,i)perylene

Strength/Flexibility

MXT" Columns Offer Tubing Flexibility and Strength

Capillary tubing is inherently straight. To install the tubing in a traditional gas chromatograph, it must be wound into a coil. The stress exhibited on the tubing is dependent upon the coil diameter and internal diameter of the tubing. The smaller the column coil diameter, the higher the stress placed on the tubing and the higher the chance of column breakage. Larger internal diameter tubing is also more susceptible to stress fractures.

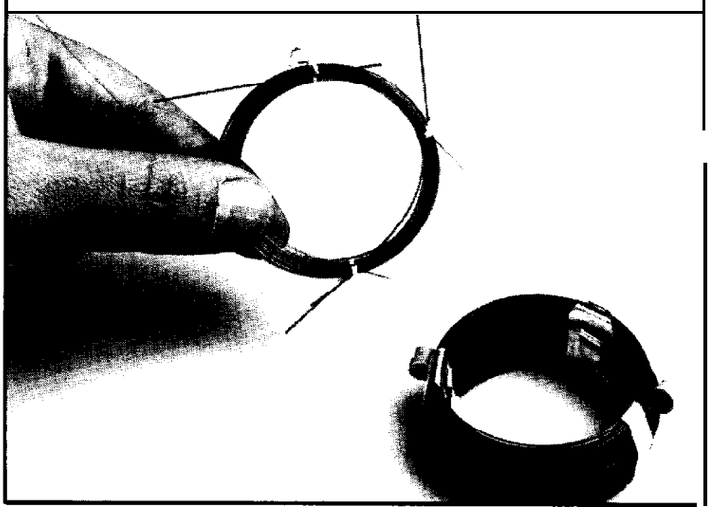
Because stainless steel is very flexible, MXT" columns can be coiled into much smaller diameters (2" minimum) than fused silica columns without risk of breakage. Figure 13 shows a 0.53mm ID fused silica column and an MXT" column coiled into a 2" column diameter. The limited flexibility of fused silica tubing creates stress fractures within the tubing, causing spontaneous breakage. This is eliminated with unbreakable MXT" columns.

Process and portable GC users also benefit from the ruggedness of MXT" columns. These columns can be tightened aggressively without worry of breakage. This alleviates the concern of replacing a broken fused silica column in a potentially dangerous situation. Hydrogen can now be safely used as a carrier gas because the risk of column breakage has been greatly reduced. MXT" columns can also withstand the bumping and jostling encountered when transporting portable GCs to hazardous sites in off-road vehicles. In addition, thin-walled MXT" columns promote a more uniform heat transfer, making them ideal for portable GCs because of their minimized power consumption.

Dependable stainless steel ferrules can be used to ensure a completely leak-free system. This allows process GC chromatographers to use hydrogen as a carrier gas which can double the throughput for an isothermal analysis of a sample stream (compared with using helium).

With inertness and resolution similar to fused silica columns, MXT" capillary columns can generate the same data without risk of down time from a broken column.

Figure 13 - Due to limited flexibility, stress fractures are created within the fused silica tubing, causing spontaneous breakage. Using unbreakable MXT" columns eliminates this.



MXT" Column – Installation

MXT" columns are made with thin-walled (0.004”- 0.005"), stainless steel tubing and are simple to install. Both the 0.28mm and 0.53mm ID columns can be installed using conventional 0.8mm ID graphite ferrules. MXT" columns can be installed directly into most instruments without any modification or pre-column adaptor. For instance, 0.28mm ID columns can be installed directly into a mass spectrometer source, eliminating the need for transfer lines and connectors.

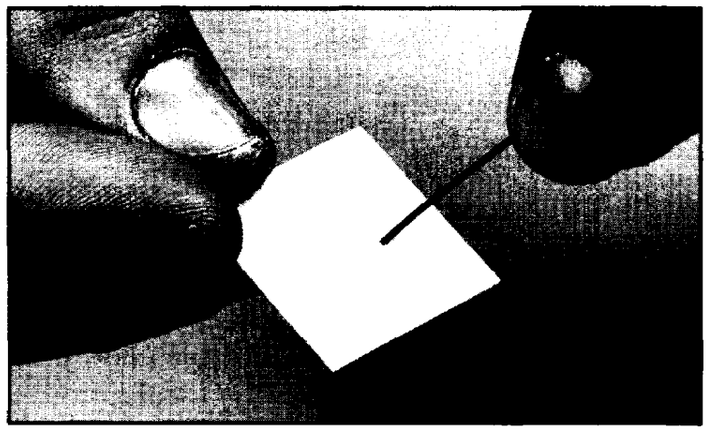
Note: Exert caution when using MXT" columns in gas chromatographs or GC/MS systems with electrically energized detector jets or orifices. MXT" columns, like aluminum clad fused silica, will conduct electricity and cause a short if the end of the column is installed too far into the detector with the detector energized. Always turn off the electrometer with Varian, Perkin-Elmer, and Shimadzu FIDs (since the detector jet is ungrounded) when installing MXT" columns.

Note: Refer to our Column Installation Guide for more detailed instructions.

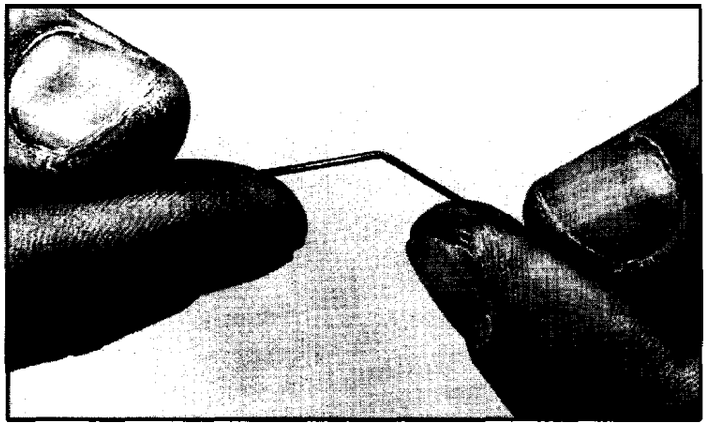
Cutting Metal Capillary Tubing

Cut metal capillary tubing by scoring the tubing wall (without cutting completely through) with the edge of a sharp file or ceramic scoring wafer 20116). Wipe any filings off of the tubing and bend it away from the score. Once the score opens, bend the tubing in the opposite direction (toward the score) until it snaps into two pieces. The roundness of the tubing should be preserved. If the hole is not round or there is a burr on the tubing, try the procedure again. We do not recommend using high speed wheels or grinders to cut the metal tubing since they may introduce metal filings into the tubing or ruin the polymer near the cut from the high temperatures created.

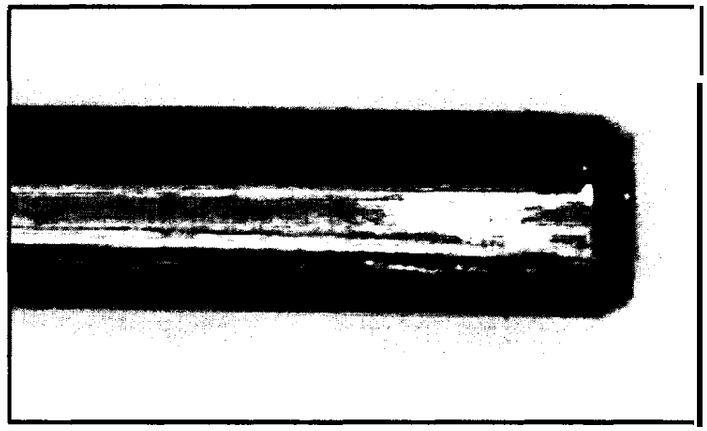
1. Score and wipe away filings.



3. Polish the end with a ceramic wafer and install, using the same procedure as a fused silica column.



2. Bend away from score first, then apply force in the opposite direction. Tubing should break cleanly.

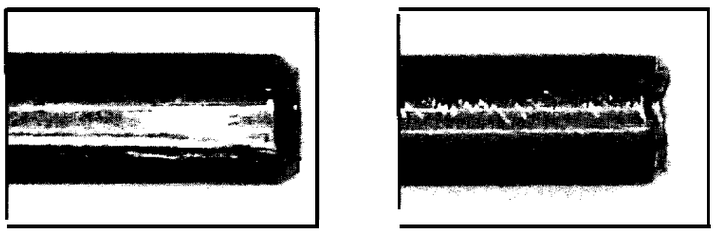


View of properly cut column end.

Can MXT" columns be used with direct injection glass inlet sleeves that utilize Press-Tight" tapers?

MXT" columns work with direct injection sleeves such as a Uniliner" or Vu-Tight", providing the column end is cut smoothly. The outer surface of the column is irregular when the tubing is initially cut with a file. Burrs must be removed and the column end must be rounded in a conical shape as shown in Figure 14.

Figure 14 - *MXT" tubing must be **cut squarely and burnished into a radially** uniform taper to sea/properly with direct injection sleeves.*



OK Not **OK**

The flat side of a ceramic scoring wafer can be used to polish or round the column end into a smooth conical shape that seals with the Press-Tight" taper in the glass inlet sleeve. The column should be purged with gas during the polishing operation to prevent metal fragments from entering the bore.

* ***Restek's R&D group is working on a ceramic de-burring tool that forms a perfect conical end on MXT" columns. Please call your** local **distributor for availability of this tool.***

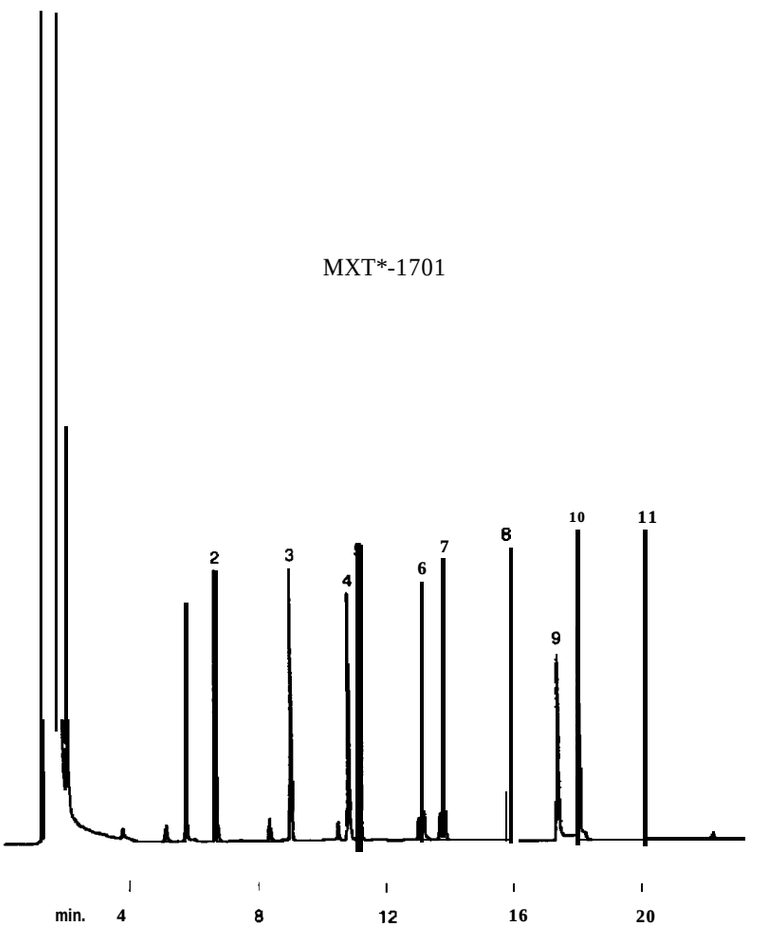
Figure 15 shows a chromatogram of the Grob test mixture obtained with an MXT" column installed in a Vu-Tight" direct injection sleeve. The sharp, solvent peak indicates a leak-free seal made between the MXT" column and Press-Tight" taper of the glass sleeve. The symmetrical peak shapes of the active Grob components, 2,3-butanediol and 1-octanol (peaks 1 and 4 respectively), indicate good column inertness in the direct injection sleeve.

***Figure 15 - The sharp solvent peak and symmetrical peak** shapes demonstrate the excellent chromatography obtained when connecting an MXT" column to a Vu-Tight" or other direct injection inlet sleeves that utilize a Press-Tight" taper.*

1. 2,3-butanediol
2. decane
3. undecane
4. octanol
5. nonanal
6. 2,6-DMP
7. 2,6-DMA
8. methyl-decanoate
9. dicyclohcxyiamine
10. methyl-undecanoate
11. methyl-dodecanoate

30m, 0.53mm ID, 1.0um MXT"-1701 (cat-# 72055)
1.0ul direct injection of the Grob test mix.
Concentration 10ng per component on-column.

Oven temp.: 40°C **to** 220°C @ 6"C/min., then 15C/min. to 280°C (hold 15 min.)
Inj./det. temp.: 250°C/280"C
Carrier gas: hydrogen
Linear velocity: 40cm/sec.
FID sensitivity: 8 x 10-10 AFS



MXT® Applications

This section features a wide variety of environmental, petrochemical, industrial chemical, and fragrance applications on Restek's MXT" columns

If you are interested in an application not shown, or need help optimizing your analysis, call your local distributor for assistance.

Applications Index

MXT" Product Listing & Accessories

Restek offers a large selection of MXT" capillary columns now available in eight different polarities!

* Custom columns are available: call your local distributor if the column you require is not shown here.

		0.28mm ID columns			0.53mm ID columns		
MXT"-1 (100% dhethyl polysiloxane) **Applications** SIM DIST, waxes, fuel oils, pharmaceutical & solvents	df um) / max temp.	15-meter cat.#	30-meter cat.#	60-meter cat&	15-meter cat.#	30meter cat.#	60-meter cat.#
	0.10 4oo"c	**70106**	**70109**	-_---_-_	———	———	———
	0.25 360°C	**70121**	**70124**	**70127**	**70122**	**70125**	**70128**
	0.50 330°C	**70136**	**70139**	**70142**	**70137**	**70140**	**70143**
	1.00 325*C	70151	70154	70157	70152	70155	70158
	1.50 320°C	——*	———	———	70167	70170	70173
	3.00 300°C	70181	70184	70187	70182	70185	70188
	5.00 275°C	———	———	-_-__	70177	70179	70183
	7.00 25OOC	———	———	__*__	70191	70192	70193
					105m, 0.53mm ID, 3.0um, cat.# 70189		
MXT"-5 (95 % dimethyl/ **5% diphenyl polysiloxane)** Applications semi-volatiles, pesticides, PCBs, environmental samples & essential oils	df um) / ma temp.	15 -meter cat.#	30-meter cat.#	60 me cat.W	5 -15-meter cat.#	30meter cat.#	6- meter cat.#
	0.25 360°C	**7022** 1	70224	70227	70222	70225	70228
	0.50 330°C	70236	70239	70242	70237	70240	70243
	1.0 325°C	7025 1	70254	70257	70252	70255	70258
	1.5 320°C	———	—	———	70267	70270	70273
	3.0 300°C	70281	70284	70287	70282	70285	70288
	5.0 275*C	———	———	———	70277	70279	70283
MXT"-1301 **(7% Cyanopropyl 93% dimethyl polysiloxane)** Applications volatile organics & pharmaceutical	dfum) / max.* temp.	15-meter cat.f	30-meter cat.#	60-meter cat.#	15meter cat.#	30-meter cat.#	60meter cat.t
	0.25 280°C	**7602** 1	**76024**	**76027**	**76022**	**76025**	**76028**
	0.50 270°C	**76036**	**76039**	**76042**	**76037**	76040	76043
	1.0 26oOC	7605 1	76054	76057	76052	76055	76058
	1.5 250°C	76066	76069	76072	76067	76070	76073
	3.0 240°C	———	———	———	76082	76085	76088
MXT"-20 **(80% dimethyl/20% diphenyl polysiloxane)** Applications flavor aromatics, alcoholic beverages	df um) / ma temp.	15-meter cat.#	30met cat.#	60meter cat.#	15-meter cat.#	30-meter cat.#	60-meter cat.#
	0.25 310°C	**7032**1	70324	70327	70322	70325	70328
	0.50 300°C	70336	70339	70342	70337	70340	70343
	1.0 295OC	70351	70354	70357	70352	70355	70358
	1.5 280°C	70366	7036	70372	70367	70370	70373
	3.0 260°C	70381	70384	70387	70382	70385	70388
MXT"-1701 (14% cyanopropyl **86% dimethyl polysiloxane)** Applications pesticides, PCBs, pharmaceutical, alcohols and solvents	df um) / max temp.	15-meter cat&	30-me cat.#	60 -meter cat.#	15-meter cat.#	30-meter cat.#	60meter cat.#
	0.25 280°C	**7202**1	72024	72027	72022	72025	72028
	0.50 270°C	72036	72039	72042	72037	72040	72043
	1.0 260°C	72051	72054	72057	72052	72055	72058
	1.5 250°C	72066	72069	72072	72067	72070	72073
	3.0 24O*C	———	———	__	72082	72085	72088
MXT"-Wax **,Crossbond" Carbowax")** **Applications** FAMEs, flavors, BTEX solvents, essential oils, EPA Method 603	df um) / ma temp.	15-meter cat.#	3 0meter cat.#	60-meter cat.t	15-meter cat.#	30-mete cat.#	60 meter cat.#
	0.25 250°C	**7062** 1	**70624**	**70627**	**70622**	**70625**	**70628**
	0.50 240°C	**70636**	**70639**	**70642**	**70637**	**70640**	70643
	1.0 230°C	7065 1	70654	70657	70652	7055 5	70658
	1.5 22OOC	———	———	———	70666	70669	70672
	2.0 230°C	———	———	-	700667	70670	

Special Application Specific Columns

		0.28mm ID columns			0.53mm ID columns		
MXT"-502.2 **Applications** **volatile organics**	**df (um)** / **max temp.** **1.6** **270°C** **3.0** **270°C**	**30-meter cat.#** 70919	**60-meter cat.#** 70920	**105-me cat.#** 70921	**30-meter cat.t** **70908**	**60-meter cat.#** **70909**	**105-meter cat.#** 70910
MXT"-Volatiles **Applications** **volatile organ&,** **trihalomethanes**	**df(um)** / **ma temp.** **1.25** **275°C** **2.0** **275OC** **3.0** **250°C**	**30-meter cat.#** **70924**	**60-meter cat.#** **70926**	**105-mete cat.#** **70928**	**30-meter cat.#** - **70925** 70922	**60 meter cat.#** **70927** 70923	**105-meter cat.#** **70929**
MXT"-624 **(Cm&onde 6% cyanopropyl-phenyl, 94% dimethyl** polysiloxane) Applications **EPA** Methods 502.2, 524,624,8240 & 8260	**df (um)** / **temp.** **3.00** **240°C**				**30-meter cat.#** **7097**1	**60-meter cat.#** 70973	**105-meter cat.#** 70975
					75m, 0.53mm ID, 3.0um, **cat.# 70974**		
SIM DIST MXT"-1	6m, 0.53mm ID, 0.15um, cat.# 70101*				*cat.# 70101's are tested at 400°C but may be run at 430°C.		
SIM DIST MXT"-2887 ASTM Method 2887	10m, 0.53rnm ID, 2.65pm, cat.# 70199**				**cat.# 70199's maximum temperature is 360°C.		

All maximum operating temperatures are for 30m columns. Maximum temperatures may be slightly iower for longer lengths.

Note: Custom columns are available upon request.

Choosing Ferrules **for "** **Columns**

Either graphite or ferrules can be used with " columns. Graphite ferrules are soft and pliable, allowing a 0.8mm ID size to seal both 0.28 and 0.53mm ID MXT" columns. Our recommended choice of ferrules for MXT" columns are graphite. They are available for standard l/16" Swagelok-type instrument fittings or in a special compact version for HP 5890 capillary inlets. Easy-to-use graphite ferrules offer thermal stability to 450°C. VespelQraphite ferrules are recommended for mass spectrometers or in applications where the seal will be under vacuum. Because Vespel"/graphite is hard, it must closely match the outside diameter of the column or a proper seal will not be made. Use 0.6mm ID Vespel"/graphite ferrules for 0.28mm ID columns and 0.8mm ID Vespel"/graphite ferrules for 0.53mm ID columns. Vespel"graphite ferrules can be re-used many times and they have a maximum operating temperature of 400°C. Always remember to tighten Vespel"/graphite ferrules after an initial thermal cycle to compensate for shrinkage.

Ferrules for l/16" Swagelok-type Capillary Fittings					
Ferrule ID	**Fits MXT" Column ID**	**Graphite cat&**		**Vespel*/Graphite cat.#**	
0.8mm	**0.53mm**	**20202**	10-pk.	**20213**	**10**-pk.
0.8mm	0.53mm	20224	`	20230	50-pk.
0.6mm	0.28mm			20232	10-pk.
Compact Graphite Ferrules for HP GCs (for capillary injection ports)					
0.8mm		20252	10-pk.	20253	50-pk.

MXT" Guard Columns & Transfer Lines

Fused Silica Lined, Stainless Steel Guard Columns

- Increase column lifetime
- Allow more injections before sample residue degrades column performance
- Prevent peak splitting during splitless analysis
- Prevent damage from harmful materials
- Five-meter length offers convenience: make the connection once and break off l/2-meter sections as contamination occurs
- A copy of the Grob test chromatogram is included to illustrate the actual inertness of the guard column
- Phenyl methyl deactivated surface provides optimum wettability for both polar and non-polar compounds

The life expectancy of an MXT" capillary column is greatly increased by using a 5-meter, deactivated, MXT" guard column. This prevents non-volatile contamination of the analytical column. Since the guard column is uncoated, sample components are allowed to enter the analytical column freely, while non-volatile contaminants are deposited in the guard column. Once contamination degrades performance, short lengths of the guard column can be removed, maintaining the analytical column's original length. When the guard column is totally contaminated, simply replace it with a new one.

Transfer Lines

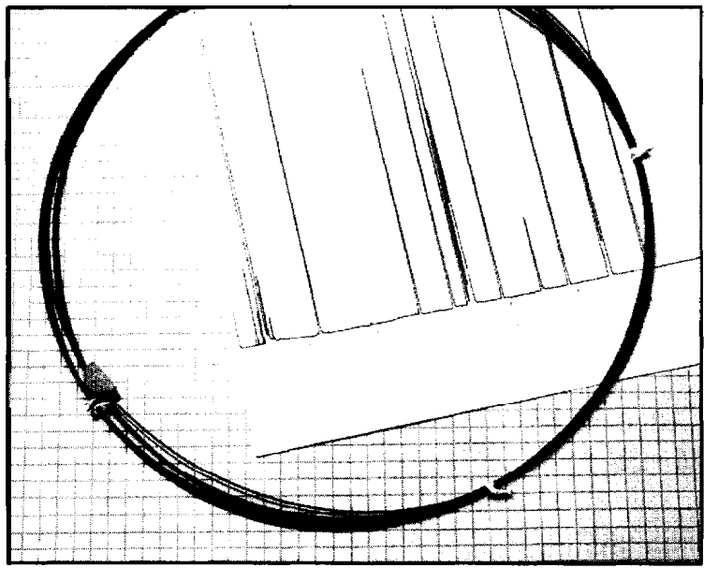
Useful for GC/MS, ITD, MSD, FTIR, purge & trap, headspace analyzers, and other instruments

Ideal for open split interfaces

Transfer lines provide inert flow paths from a sample introduction device, such as a purge & trap system or a headspace analyzer, to the inlet of an analytical column.

5-meter MXT" Guard Columns/Transfer Lines*:
0.28mm ID: cat.# 70044
0.53mm ID: cat.# 70045

* Longer lengths are available upon request.



Each guard column/transfer line is pretested with the Grob mix to ensure high inertness.

MXT" Low Dead Volume Connectors

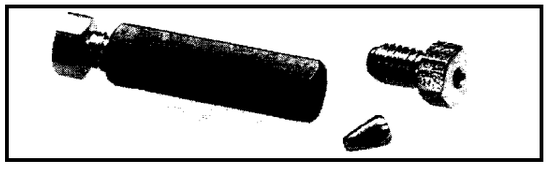
In response to customer requests, the Restek wizards have developed metal connectors to connect two MXT" columns together, to attach an MXT" guard column to an analytical column, or to perform confirmational analysis with two MXT" columns.

These low dead volume connectors are treated with Silcosteel" and deactivated to make them inert to active compounds, just like our MXT" columns. They will not cause peak tailing or affect system inertness and can be used up to **400°C** without degrading the deactivation layer. We chose a 1/32" Valco-type body size to minimize thermal mass and manufactured special metal ferrules that fit the OD of the 0.28 and 0.53mm ID MXT" columns, Purchase the appropriately sized replacement ferrules when connecting 0.28 and 0.53mm ID columns together with either the MXT" low dead volume or "Y" connector.

MXT@ Low Dead Volume Connector:

Connect guard columns/transfer lines to MXT" columns

Low thermal mass rapidly tracks oven temperature programming

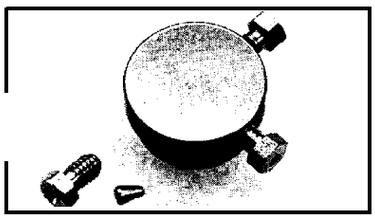


for 0.28mm ID MXT" columns: cat.# **20397** each
for 0.53 mm ID MXT" columns: **20394** each

MXT" Low Dead Volume "Y" Connector

.- Connect two MXT" columns to one inlet

Connect one MXT" cohumn to two detectors



for 0.28mm ID MXT" columns: cat.# 20396 each
for 0.53mm ID MXT" columns: cat.# 20395 each

MXT" Connector Replacement Stainless Steel Ferrules			
Ferrule ID	**Fits Column ID**	**cat.#**	
0.59mm	**0.28mm**	**20398**	**10-pk.**
0.79mm	**os3mm**	**20399**	**10-pk.**

I/32" Valco-type replacement nut: cat.# **20389 5-pk.**

1/4"- 3/16" Open End Wrench

A high quality miniature wrench to use with the MXT@ Low Dead Volume Connectors.

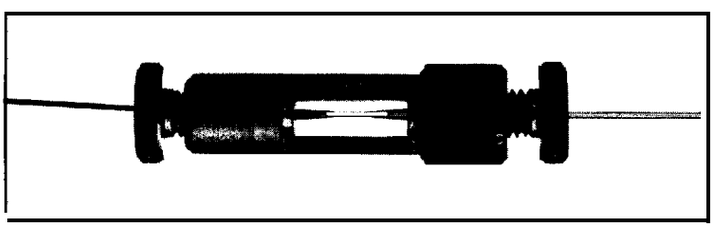
Open End Wrench: cat.# 20388 2~pk.

Connecting Fused Silica Tubing to Metal MX" Tubing

MXT" tubing can be connected to fused silica tubing by using a capillary Vu-Union" (cat. #20418) providing the end of the MXT" column is properly burnished into a conical shape. A fused silica Press-Tight" Connector cannot be used with MXT" columns because without polyimide coating on the outside of the tubing, a leak-free connection cannot be obtained. To connect a fused silica column to an MXT" column, follow the same procedure described when connecting MXT" columns to direct injection inlet sleeves with Press-Tight" tapers (page 10). Use the back, flat side of a ceramic wafer to shape the column end into a round conical taper.

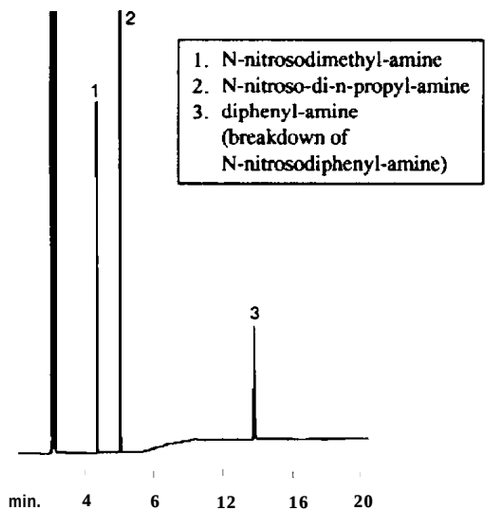
The photo below shows a microphotograph of an MXT" and fused silica capillary column connected via a Vu-Union" Notice the tight, dead volume free connection of the MXT" coIumn in the tapered glass insert.

Figure 16 shows a chromatogram generated by attaching a Smeter MXT" guard column to a 30-meter fused silica column. Note the symmetrical solvent peak shape and lack of component tailing indicating a successful, leak-free connection.



An MXT" column can be **connected to fused** silica tubing using a capillary Vu-Union", provided the MXT" column end is burnished in a conical shape.

Figure I6 - Symmetrical peak shapes are obtained when connecting an MXT" guard column to a 30-meter fused silica column with a Vu-Union"



Capillary Vu-Union"

One deactivated glass tapered insert (fits column ODs ranging from 0.35 to 0.74mm).

One metal housing body.

cat.# 20418 each - Order ferrules separately below.

Replacement Vu-Union" Deactivated Glass Inserts (fits column ODs ranging from 0.35 to 0.74mm).

cat.# 20419 3-pk.

Graphite Ferrules for the Vu-Union"

for 0.53mm ID MXT" columns:
cat.# 20202 10-pk. and cat.# 20224 50-pk.

Vespel"/Graphite Ferrules for the Vu-Union"

for **0.53mm ID MXT" columns:**
cat.# 20213 lo-pk. and cat.# 20230 50-pk.
for 0.28mm ID MXT" columns:
cat.# 20232

Silcosteel"

Silcosteel" Characteristics

- Inert, flexible, and strong
- High thermal stability (400°C)
- Available in long lengths
- Priced below GlassLinedTubing"(GLT)

Silcosteel" Tubing is Ideal for:

Transfer lines for purge & trap, mass spectrometers, FTIRs, and other instruments

Sample loops and sampling lines for active compounds

Replacing fragile glass packed columns

. On-line process chromatography

Restek's Silcosteel" is an alternative to GLT". Silcosteel" is flexible, strong, stainless steel tubing that has a highly inert surface. Unlike GLT", it can be bent into any configuration without heating, provided it isn't severely kinked or stretched. It can be cut with a standard tubing cutter or a high speed cut-off wheel. The inner surface of Silcosteel" can be rinsed with a variety of solvents, including water, without damaging the deactivation layer. (Rinsing with strongly acidic or basic aqueous solutions is not recommended.) Generally, Silcosteel" can be handled like fused silica tubing.

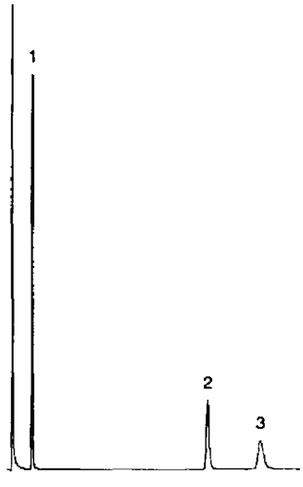
How is Silcosteel" Made?

Silcosteel" tubing is made with a unique process developed by Restek. This process uses a high temperature reaction to bond micron layers of pure, flexible fused silica directly onto the inner stainless steel surface. Then, these layers are thoroughly deactivated using the same proprietary process Restek uses to make Crossbond" capillary columns. The deactivation reagent, which contains phenyl and methyl groups, yields a highly wettable surface for both polar and non-polar compounds as discussed by Grob (Grob et. al., J. ***Chromatography, 334*** [1985] pp.129-155).

Replace Fragile Glass Packed Columns with Flexible, Inert Silcosteel"

Silcosteel" is the perfect replacement for glass packed columns*. It offers a high degree of inertness and allows the flexibility often required when connecting packed columns to different detectors or instruments. Compare Figures 17 and 18. Can you tell the difference between the Silcosteel*packed column and the glass packed column when low levels of highly reactive phenols are injected? The response for 2,4-dinitrophenol and pentachlorophenol are virtually indistinguishable!

Figure I7 - An 8'x 1/8" OD ***Silcosteel" packed column shows exceptionally high inertness to active compounds such as 2,4_dinitrophenol and pentachlorophenol***



1. naphthalene
2. 2,4-dinitrophenol
3. pentachlorophenol

* Note, Restek provides Silcosteel" tubing for chromatographers to pack their own columns. In addition, you can order pre-packed columns from one of our many distributors.

Figure 18 - An 8'x 3mm ID deactivated glass column also shows good inertness with the active phenol however, i it is not as ***flexible as Silcosteel" tubing.***

Answers to Commonly Asked Questions Regarding Silcosteel":

Can Silcosteel" be bent in 90° angles?

Yes, but it is extremely important to make gentle bends with rounded corners. Sharp bends kink the tubing and crack the fused silica layer, causing a loss of inertness. Treat SilcosteeP tubing like a fused silica capillary column.

Can metal Swagelok-type fittings be tightened on Silcosteel" tubing without causing damage?

Yes, the flexible fused silica coating compresses as the fitting is tightened and the ferrule bites into the metal wall. We recommend using Silcosteel"-treated fittings to maintain the high degree of inertness.

Can Silcosteel" be spot welded?

Silcosteel" and MXT" tubing may be welded or brazed if care is taken to limit the spread of heat generated during these processes. The siloxane deactivation layer will begin to decompose at temperatures greater than 400°C (in air), but the fused silica layer should not be harmed by the temperatures required for welding or brazing. Therefore, the catalytic nature of the stainless steel will remain masked by the fused silica, but surface silanol groups may become exposed by the absence of the siloxane deactivation layer.

Can Silcosteel" be used as an inert pathway for on-line process sampling or instrument transfer lines?

Yes. Due to the high inertness of Silcosteel" tubing and fittings, it is an excellent transfer line for inert or active compounds. SilcosteeP fittings allow thousands of feet of tubing to be connected together to maintain a truly inert pathway.

Can custom items be treated with Silcosteel"?

Yes, as long as the items can withstand over 400°C and hold pressure. We routinely treat items that require sharp kinks or bends, and parts that need to be inert. We can treat nickel or other types of metal as well. Please call your local distributor for more information.

Silcosteel" Fused Silica Lined Stainless SteeI Tubing

Length (in ft.)	ID 0.011" OD 0.022" (0.28mm) (.53mm) cat.#	ID 0.021" OD .031" (0.53mm) (0.79mm) cat.#	ID 0.010" OD 1/16"' (0.25mm) (1.6mm) cat.#	ID 0.020" OD 1/16" (0.51mm) (1.6mm) cat.#
6	20570	20563	20550	20524
25	2057 1	20564	2055 1	20525
50	20572	20565	20552	20526
200	20573	20566	20553	20527
>400	20574	20567	20554	20528

Length (in ft.)	ID 0.030" OD 1/16" (0.76mm) (1.6mm) cat.#	ID 0.040" OD 1/16"' (1.02m.m) (1.6mm) cat.#	ID 0.085" OD 1/8"' (2.16mm) (3.18mm) cat.#	ID 0.210" OD 1/4" (5.33mm) (6.35mm) cat.#
6	20530	20538	20545	20555
25	2053 1	20539	20546	20556
50	20532	20540	20547	20557
200	20533	20541	20548	20558
>400	20534	20542	20549	20559

Cull for availability of lengths greater than 400ft.

Intermediate lengths are available upon request at no extra cost.

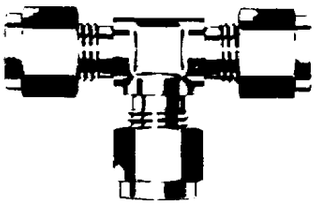
Use Inert SIcosteeP Fittings to Connect Silcosteel" Tubing

(Each fitting is deactivated and lined with a fused silica layer).

Unions

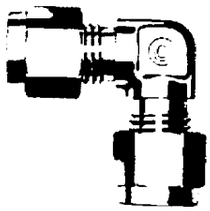
Size	cat.#
1/16"	**20510**
I/8"	20511
1/4"	20512

Tees



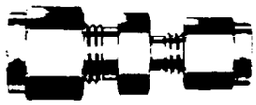
Size	cat .#
1/16"	**20513**
1/8"	20514
1/4"	20515

Elbows



Size	cat.#
1/4"	**20516**
l/8"	20517
I/4"	20518

Reducing Fittings



Size	cat.#
1/4to1/8"	**20510**
1/16"toI/4"	20511
1/8"to1/16"	20512

New! Straight Silcosteel" Tubing

Ideal for adsorbent traps and thermal desorption tubes

Available in 1/8" and 1/4" ODs

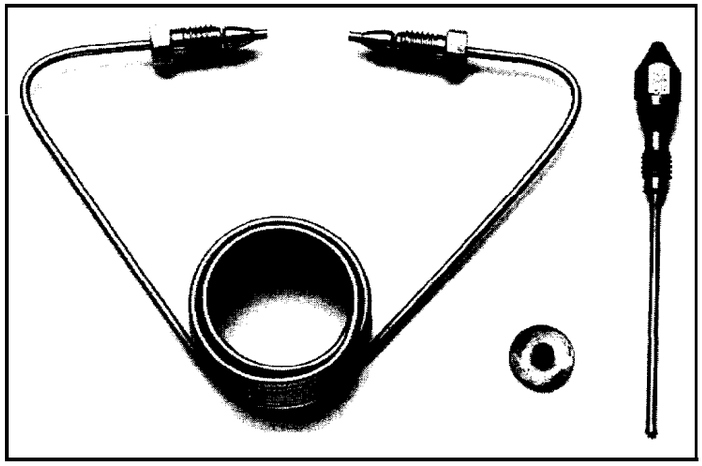
Easily cut to specific lengths

The inertness of Silcosteel" makes it ideal for the construction of adsorbent traps and thermal desorption tubes. Straight lengths of tubing are also useful for transfer lines and instrument interfaces. In response to customer requests, we now offer 18" straight lengths of 1/8"" and 1/4" OD Silcosteel" tubing. This tubing can be cut to your exact requirements using a standard tubing cutter. Straight SilcosteeP is available in individual pieces or in economical 5-packs.

ID 0.085" OD I/8" cat.#	ID 0.210" OD I/4" cat.#
20575	20577
20576	20578

Custom Parts

Custom parts can be treated with Silcosteel" upon request. The fused silica layer is ideal for extending the life of stainless steel tubing in corrosive atmospheres such as HCL and H2S gas. Metal pathways can be made inert to active chemicals such as sulphur, phenols, alcohols, glycols, and others. Injection systems, sample loops, transfer lines, detectors, jets, and any other metal part that contacts the sample stream can be passivated and rendered inert to adsorption. Call your local distributor for more information.



Instrument Grade Stainless Steel Tubing

Heat-Treated Stainless Steel Tubing

- Solvent cleaned and heat-treated to remove all volatile impurities
- Ideal for sensitive GC detectors such as ECDs, MSDs, NPDs, and FIDs that require pure carrier gas
- Perfect for concentrating inlet systems such as purge & trap or thermal desorption units
- Available in continuous lengths to minimize potential leaky detectors
- Economically priced

Heat-Treated to Eliminate Contaminants

Most stainless steel tubing contains hydrocarbon impurities that migrate into the carrier gas stream and cause background noise or ghost peaks. Solvent cleaned tubing can still contain contaminants that were either insoluble in the cleaning solvent, or left over as a residue from the cleaning process. Restek chemists found that gradient solvent rinsing, used in combination with a high temperature treatment under a flow of clean carrier gas is the best way to guarantee ultra high purity carrier gas lines. Background contamination is eliminated and new instruments can be plumbed with confidence.

Available in Longer Lengths

Tight manufacturing tolerances ensure close inside and outside dimensions. The 304 stainless steel tubing is annealed for added flexibility allowing kink free bends. Continuous lengths up to 500 feet are available to eliminate the need for connectors.*

Plumb your instrument with the best. Try Restek's heat treated, solvent cleaned, instrument grade tubing.

Top quality pre-cleaned stainless steel tubing without the expense!

StainlessSteel Tubing Dimensions	25ft. cat.#	26-100ft. cat.#	>100 ft. cat.#
0.010"ID, l/16"OD	21500	21501	21502
0.020"ID, 1/16"0D	21503	21504	21505
0.03"ID, 1/16"0	21506	21507	21508
0.040"ID, 1/16"O	21509	21510	21511
0.085"ID, 1/8"OD	21512	21513	21514
0.21"ID,1/4"OD	21515	21516	21517

Please inquire before ordering to determine the availability of continuous lengths up to 500 feet. The availability of long lengths is subject to inventory constraints.

Thermolite" Septa

Extensive testing has shown that Restek's Thermolite" septa has the lowest concentration of ghost peaks and exhibits the flattest baseline when compared to five leading competitor's septa. Low bleed septa are extremely important since the volatiles that emit from the septum can accumulate on the capillary column. These volatiles cause baseline rise and extraneous peaks, making component identification very difficult. This is accentuated when using splitless, on-column, or direct injection modes. The high resolving power of capillary columns makes low bleed septa even more important.

Thermolite" septa are easy to penetrate and do not fragment and tear since high quality silicone monomers are used instead of inexpensive, organic fillers. Our septa do not stick to the hot inlet or decompose while installed in the injection port. This eliminates small septa fragments from accumulating in the injection port sleeve. Therefore, less time is spent cleaning and changing inlet sleeves when high quality Thermolite@ septa are used. For more information, request Restek's *Guide to Minimizing* Septa Problems.

- Lowest bleed on FIDs, ECDs, and MSDs
- Each batch is QA tested for FID bleed
- High puncturability for easy needle penetration
- Useable at 340°C inlet temperatures
- Does not adhere to hot metal injectors
- Preconditioned and ready to use, no extra conditioning required

Instrument	Septum Size
Hewlett-Packard	
5890 series	l0mm/l lmm
5700,5880 series	9.5mm/ 11mm
Varian	
packed column injector	9.5mm/l0mm
split/splitless injector	l0mm/llmm
Perkin-Elmer	
Sigma series, 900, 990	llmm
8000 series	llmm
Tracor	
550,560	9.5mm
220,222	12.5mm
Gow-Mac (all models)	9Smm
Fisons/Carlo-Erba	17mm
8000 series	
Pye/Unicam	7mm

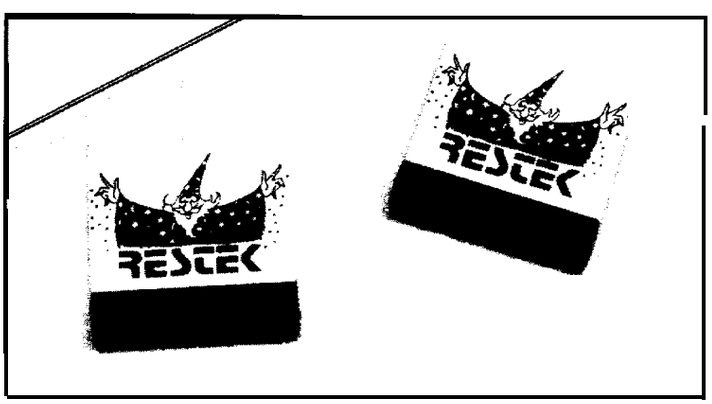
Septum Diameter	25-pack ***Free Can Cooler*** cat.#	50-pack ***Free Cofee Mug*** cat4	100-pack ***Free Stein*** cat .#
5mm (3/16")	***20351***	20352	20353
6mm (l/4")	20355	20356	20357
7mm	2038 l	20382	20383
9.5mm (3/	20359	20360	20361
l0mm	20378	20379	20380
11mm ('7/16")	20363	20364	20365
12.5mm (l/2)	20367	20368	20369
17mm	20384	20385	20386
Shimadzu Plug	20372	20373	20374

Receive a free can cooler, coffee mug, or stein with the purchase of Thermolite" septa!

Ceramic Scoring Wafer

The scoring wafer has four straight scoring edges to squarely cut fused silica. It also has four serrated edges that can be used to cut metal capillary columns.

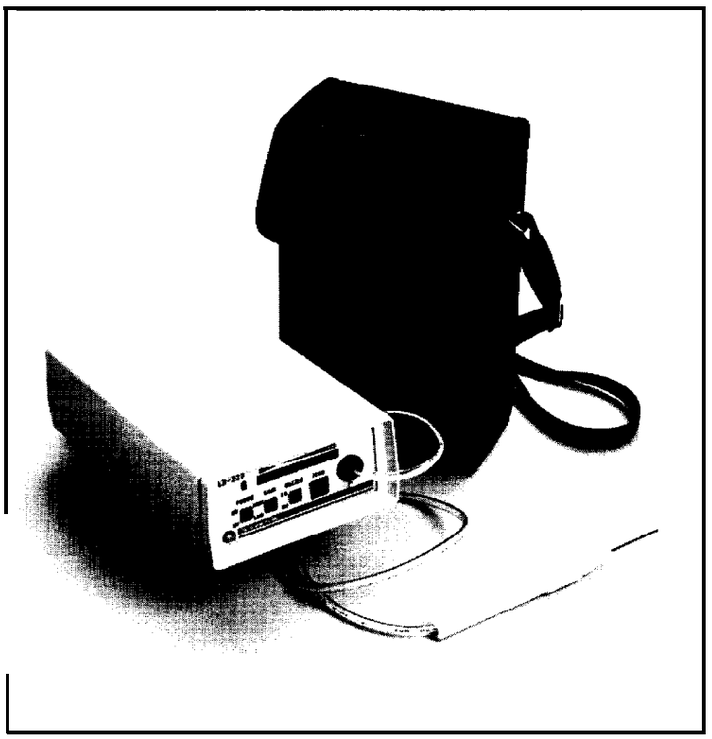
cat.# 20 116,



GL Sciences Leak Detector

Leaks in a gas chromatographic system can cause problems ranging from increased detector noise, baseline instabilities, and short column lifetimes, to wasting expensive carrier gases. GL Sciences' new portable Leak Detector LD-223 allows analysts to detect gas leaks down to 0.01ml/min. This leak detector's compact size is designed for easy transport and hand-held usage. Simple, push button operation allows one-touch zero adjustment, while the low dead volume sampling line provides quick sample response. Trace leaks of both helium and hydrogen can be detected using the high sensitivity range. Four AA alkaline batteries (not included) provide up to 12 hours of continuous operation.

- Portable size
- Quick response
- High sensitivity
- Simple operation
- Contamination-free leak detection



cat-# 21605

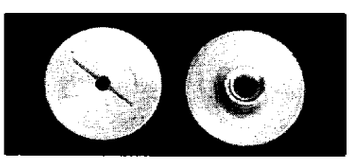
Modified Inlet Seals for HP 5890 GCs

The inlet seal at the base of the HP 5890 GC injection port comes into contact with the sample and must be changed frequently to prevent adsorption of active compounds. In addition, septa fragments and sample residue accumulate on the disk surface requiring replacement.

The seal occurs by deforming the disk against the injection port base upon tightening, forming a micro ring (as the microphotograph shows). Originally, the disks were manufactured from 303 stainless steel which did not deform will upon tightening, resulting in a small leak. The new disk design uses 203EZ stainless steel which is softer and deforms easier, making a completely leak-tight seal. (Due to the deformation of the seating surface, we do not recommend reusing inlet seals).

This new disk design increases column lifetime because oxygen cannot permeate into the carrier gas. Detector noise is also reduced with high sensitivity detectors such as ECDs or MSDs. (replaces HP part number 18740-20880.)

Replacement Inlet Seals:
cat.# 20390,2-pk.
cat.# 20391,



Restek's Digital Flow Calibrator

- Calibrated against NIST Standards
- Large LED display for easy readout
- Use with all chromatography gases
- Battery operated for portability

This battery operated digital flow calibrator is designed to measure and calibrate gas flows used in capillary chromatography. The flow calibrator is capable of measuring flow rates of 0.5-50mls/min. accurately, regardless of the gas type. It is an excellent tool for measuring the split vent flow and detector gas flows, and is capable of displaying the split ratio.

cat.# 20123

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