Stable Bonded GC PLOT Columns

- Innovative bonding process minimizes particle release, reducing column blockage and protecting instrument parts.
- More consistent flow means stable retention times in Deans and related flow switching techniques.
- Outstanding peak symmetry improves impurity analysis for gases, solvents, and hydrocarbons.

Quick Reference Chart

PLOT Column	Description/Application
Rt-Silica BOND (p. 120)	Bonded silica Light hydrocarbons, sulfur gases, carbon dioxide, and halocarbons
Rt-Alumina BOND/Na_2SO_4 (p. 121) MXT-Alumina BOND/Na_2SO_4 (p. 129)	C1–C5 hydrocarbons Purity analysis of ethylene, propylene, butenes, butadiene
Rt-Alumina BOND/KCl (p. 122)	C1-C10 hydrocarbons, C1-C5 isomers Purity analysis of ethylene, propylene, butene, butadiene.
Rt-Alumina BOND/CFC (p. 123)	Multi-halogenated alkanes, C1-C-5 range Chlorofluorocarbons (CFCs)
Rt-Alumina BOND/MAPD (p. 124) MXT-Alumina BOND MAPD (p. 129)	Trace analysis of methylacetylene, propadiene, acetylene
Rt-Msieve 5A (p. 125) MXT-Msieve 5A (p. 129)	Permanent gas analysis He, Ne, Ar, O_2, N_2, Xe, Rn, CH_4, and CO
Rt-Q-BOND (p. 126) MXT-Q-BOND (p. 129)	Nonpolar porous polymer High retention for solvents, alcohols, polar volatiles, CO_2, sulfur, and ppm water in solvents
Rt-QS-BOND (p. 127)	Intermediate polarity porous polymer (polarity between Q-BOND and S-BOND) Neutral solvents, ketones, esters, hydrocarbons, and baseline separation of ethane, ethene, acetylene
Rt-S-BOND (p. 127) MXT-S-BOND (p. 129)	Intermediate polarity porous polymer Light gases in ethylene and propylene, ketones, esters, hydrocarbons
Rt-U-BOND (p. 128)	Polar porous polymer More retention for polar compounds

PLOT Column Phase Cross-Reference: Similar Selectivity

Restek® Rt® and MXT® Columns	Porous Layer	Supelco	Alltech	Agilent (J&W, Varian, Chrompack)	Quadrex
Silica BOND	Bonded silica	———	———	CP Silica PLOT, GS-GasPro	———
Alumina BOND/Na_2SO_4	Aluminum oxide	Alumina-Sulfate	AT-Alumina	GS-Alumina ,CP-Al_2O_3/NA_2SO_4	———
Alumina BOND/KCl	Aluminum oxide	Alumina-Chloride	———	GS-Alumina KCl, HP PLOT Al_2O_3, CP-Al_2O_3/KCl	———
Alumina BOND/CFC	Aluminum oxide		**unique** product		
Alumina BOND/MAPD	Aluminum oxide	———	———	Select Al_2O_3 MAPD	———
Msieve 5A	Molecular sieve 5A	Molsieve 5A	AT-Molesieve	HP PLOT Molesieve, CP-Molsieve 5A	PLT-5A
Q-BOND	100% Divinylbenzene	Supel-Q-PLOT	AT-Q	HP PLOT Q ,CP-PoraPLOT Q, CP-PoraBOND Q	———
QS-BOND	Intermediate polarity porous polymer	———	———	GS-Q	———
S-BOND	DVB vinylpyridine polymer	———	———	CP-PoraPLOT S	———
U-BOND	DVB ethylene glycol-dimethylacrylate polymer	———	———	HP PLOT U, CP-PoraPLOT U, CP-PoraBOND U	———

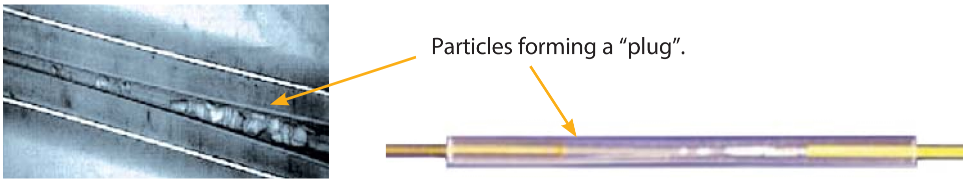
Stable Bonded Porous Layer Open Tubular (PLOT) Columns

- Stabilized particle layers improve robustness and reproducibility of retention and flow.
- Fully compatible with valve switching and Deans switching systems.
- Highly efficient, reproducible analyses; ideal for permanent gases, solvents, and hydrocarbons.
- Innovative manufacturing procedure reduces particle generation and improves performance of porous polymer and molecular sieve PLOT columns.

Porous layer open tubular (PLOT) columns are very beneficial for solving application problems, especially for the analysis of volatile compounds. PLOT columns have a unique selectivity, allowing for the separation of gaseous compounds at room temperature. Due to the adsorption mechanism of the supports used in PLOT columns, permanent gases and light hydrocarbons can be resolved at room temperature; columns can then be programmed to higher temperatures to elute higher boiling compounds.

Traditional PLOT Columns Offer Poor Stability
The traditional PLOT column is built with a 5–50 µm layer of particles adhered to the tubing walls. Because this layer of particles generally lacks stability, PLOT columns must be used very carefully, as particle release is common and can cause unpredictable changes in retention time and flow behavior. Traditional PLOT columns also must generally be used in conjunction with particle traps to prevent the contamination of valves, injectors, and GC detectors. Detectors contaminated with particles typically generate electronic noise, which shows up chromatographically as a spike in the baseline. In extreme cases, detector flow can be obstructed by particle buildup. Particles can also affect valves by becoming lodged in the valve and causing leaks or restricting flow. Figure 1 shows an example of blockage caused by particle accumulation inside a press-fit connector.

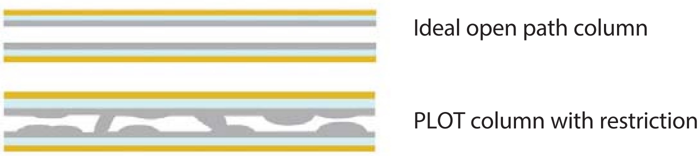
Figure 1: Particles released from traditional PLOT columns can cause blockages.



Restek® PLOT Columns Offer Improved Stability to Minimize Particle Release
Restek has developed technology and procedures to manufacture PLOT columns with concentric stabilized adsorption layers. These next generation PLOT columns show a constant flow behavior (permeability) and have significantly improved mechanical stability, resulting in easier operation, better chromatography, and reduced particle release. Greater particle stability means more reproducible retention times, virtually no spiking, and longer column lifetimes. This innovative Restek® stabilization chemistry is currently applied to all fused silica and metal PLOT columns.

Consistent Flow Restriction Factor (F) Guarantees Reproducible Flow
Thick layers of particles are difficult to deposit in a homogeneous layer, and in traditionally manufactured PLOT columns, this results in variable coating thicknesses. The positions where the layer is thicker act as restrictions and affect flow (Figure 2). Depending on the number and intensity of these restrictions, traditional PLOT columns often show greater variation in flow restriction than wall coated open tubular (WCOT) columns. In practice, conventional PLOT columns with the same dimensions can differ in flow by a factor of 4 to 6 when operated at the same nominal pressure. For applications where flow is important, such as with Deans switching, the nonreproducible flow behavior of most commercially available PLOT columns is a problem.

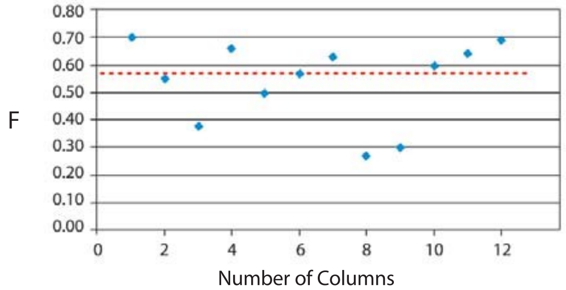
Figure 2: Inconsistent coating thicknesses result in restrictions that cause significant variation in flow.



In order to measure flow restriction reproducibility, Restek introduced a new factor: the flow restriction factor (F). This factor is based on the retention time of an unretained marker compound, as measured on both coated and uncoated tubing using the same backpressure setting (Equation 1). For quality control purposes, methane is used as the marker when evaluating porous polymer columns, and helium is used for testing molecular sieve 5A columns.

Flow restriction factor determination can be used to assess both the degree of column restriction and the reproducibility of the column coating process. Flow restriction can also be calculated (Equation 2). Figure 3 shows typical results for PLOT columns manufactured using a conventional process. Because of the difference in flow restriction, individual columns have very different flow characteristics. In contrast, Figure 4 shows results for columns made using our Rt®-QS-BOND (bonded porous polymer) PLOT column process. Clearly, Restek's manufacturing process results in greater consistency in both column coating thickness and flow restriction, which results in more stable retention times and better performance in Deans and related flow switching techniques. Flow restriction factors are specified on the certificate of analysis (CofA) included with every Restek® PLOT column, and the values are listed on the report.

Figure 3: Traditional PLOT columns show significant flow variability, indicating inconsistent column coating thicknesses.



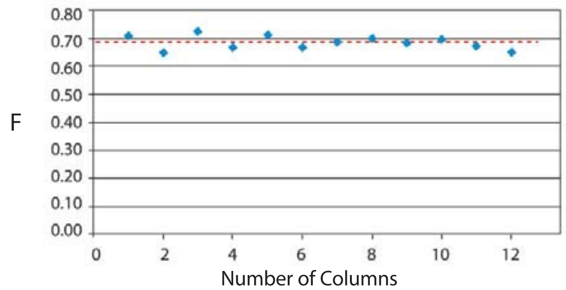
Equation 1: Flow restriction factor (F) is used to demonstrate coating consistency.

$$F = \frac{t_{R1} \text{ of unretained component (uncoated tubing)}}{t_{R2} \text{ of unretained component (coated column)}}$$

t_R = retention time

Note: F values will always be <1 as the coated column always has more restriction than the uncoated column.

Figure 4: PLOT columns from Restek offer consistent flow restriction, giving more reproducible results column-to-column.



Equation 2: Percent flow restriction of coated column.

$$\% \text{ restriction} = (1–F) \times 100$$

See what makes Restek's new **Rt®-Silica BOND** column the best on the market! ....**page 120**

Restek's PLOT columns are exceptionally robust, featuring concentric stabilized coating layers. They allow for more consistent gas flows and are recommended for applications sensitive to variation in retention time or flow. These PLOT columns are a significant advance in technology and are ideal for efficient, reproducible analyses of permanent gases, solvents, and hydrocarbons.

Fused Silica Capillary & PLOT Column Ferrule Guide

GC Column ID	Ferrule ID
0.15 mm	0.4
0.18 mm	0.4
0.25 mm	0.4
0.32 mm	0.5
0.53 mm	0.8

free literature

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