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CAPILLARY TUBING: UNIQUELY SHAPED INTERNAL AND EXTERNAL GEOMETRIES

Synthetic fused silica capillary tubing is commonly used in applications where round geometries are of critical importance. However, there are times when round surfaces complicate analytical efforts. This application note discusses capillary with unique geometries and related design considerations.

BY JOE MACOMBER AND DREW STASIAK

INTRODUCTION

Gas Chromatographers have used fused silica capillary tubing for nearly 30 years. One critical aspect of today's capillary tubing is roundness. Even slight ovality in GC tubing will lead to unwanted band-broadening. The design of most CE systems require round capillary for proper optical performance. However, as Zare demonstrated by exploring alternate geometries for CE [1], not all applications are best served by round capillaries.

Polymicro launched a square i.d. square o.d. capillary in the late 1990's which was used by Yeung for DNA sequencing [2]. This tubing family is now commonly referred to as the WWP series. In this instance i.d. refers to internal dimension and o.d. to outer dimension [3]. Subsequently, a number of different shapes have been produced for a variety of applications. An overview of the range of unique shapes and general design considerations are discussed herein.

MATERIALS

Like most round capillary, WWP and other shaped capillary have two fundamental components. The glass substrate is the same high purity synthetic fused silica used in other capillary products (i.e. TSP series); therefore equivalent surface chemistries can be expected. The second component is the protective outside coating, which is typically either polyimide or acrylate. Large o.d. tubing can be produced without an external coating; however, special handling must be considered.

POTENTIAL GEOMETRIES AND DESIGN CONCERNS

Shapes produced to date include the standard square-square and a range of other shaped i.d. and o.d configurations. The most common geometries are outlined in Table I. Although the method for shaping the i.d is proprietary, precision grinding is often employed for shaping the o.d. It is common practice to select the desired i.d. shape then mate it to an o.d. geometry which best suits the overall need. The most common o.d. geometry is actually round, however a number of other shapes including square and rectangular have been drawn. Multilumen products are possible. Figure 1 displays a multi-lumen with rectangular i.d. and square o.d.

Dimensional specifications of concern include i.d. and o.d. radii and flatness, parallelism between i.d. and o.d. flats, angular accuracy of all corners and concentricity of the i.d. shape to the o.d. shape. Verification of dimensional conformance at appropriate frequency is increasingly well understood.

Wall thickness must always be considered. It is extremely difficult to maintain geometries if the wall thickness at any radial point falls below 100 µm. Conversely, as the wall thickness increases, the net yield of the process will fall dramatically.

Polyimide is the preferred coating for small o.d. products i.e. 300-600 µm. As the o.d. increases, or if the aspect ratio of the o.d. exceeds ~2.5:1, acrylate is often considered. It is important to note capillary with shaped geometries can be postprocessed similar to standard capillary. Examples include precision cleaving, laser cutting, windowing, etc.

CONCLUSION

Synthetic fused silica capillary tubing with unique geometrical cross sections are of growing importance. The added complexity requires careful consideration of design inputs. For assistance with your questions, contact a Polymicro Technical Sales Specialist.

Table I: Any combinations of these i.d. and o.d. geometries can be produced.

Common i.d. Geometries	Potential o.d. Geometries
Square	Round
Rectangular	Square
Triangular	Rectangular
Trapezoidal	Oval
Oval	One Flat Side

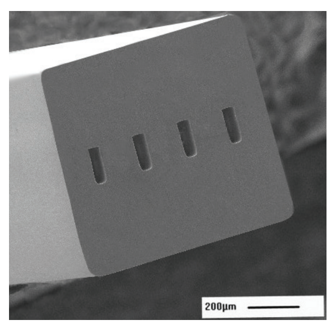

Figure 1: *Example of unique geometry capillary with 4 rectangular i.d. channels (50 µm x 125 µm) and a square o.d. (600 µm)*

REFERENCES

(1) T. Tsuda, J. Sweedler, R. Zare "Rectangular Capillaries for Capillary Zone Electrophoresis" Anal. Chem 1990, 62, 2149-2152

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