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# POLYMICRO TECHNOLOGIES™ FUSED SILICA CAPILLARY TUBING: SELECTING A CUTTING METHOD

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Various techniques exist for cutting capillary tubing. In this note we revisit these methods and provide guidelines for selecting the most appropriate method.

**Introduction**

Fused silica capillary tubing is commonly produced in long, continuous lengths. Most applications require sectioning of the capillary into lengths that appropriately match the application. For example, ferrules for fiber alignment are typically a few millimeters long. Microfluidic and flow control pieces are generally 1 to 10cm. CE columns are often 30 to 100cm, while GC columns can be over 100m. The method for cutting to length must be suitably matched to the application.

The most common methods are standard cleaving, precision cleaving, laser cutting and saw cutting; each has been discussed in detail previously (1-2). It is important to understand the impact that capillary attributes (i.e. wall thickness, i.d., and o.d.) have on potential utilization of each cutting method. This note discusses selection guidelines.

**Standard Cleaving**

A sharp cutting tool is used to form a small flaw in the tubing surface. Stress is applied across this flaw and the tubing cleaves (3). The preferred cutting tool is a ceramic cleaving stone. Standard cleaving is done manually, often resulting in a slightly uneven end-face.

**Precision Cleaving**

A diamond blade is used to induce a flaw in the tubing surface. Stress is applied across this flaw by a proprietary robotic system to cleave the tubing. These high-precision systems provide outstanding repeatability. This method generates minimal debris; resulting parts are clean. End-face quality is excellent and <1° of perpendicularity is common.

**Saw Cutting**

Multiple capillary segments are bouled using a proprietary polymer and then sawed to length as a group. Sawing leaves a matte end finish and generates debris; cleanliness is always a concern. Chips and cracks in the end-face are common; lapping and then polishing can improve surface quality if the capillary wall is of sufficient thickness. Saw cutting is good for producing very short parts, i.e. down to 0.5mm.

**Laser Cutting**

This increasingly popular cutting technique employs a CNC multi-axis laser workstation to preform the cutting operation. End-faces are typically defect-free, with no sharp edges, chips, or cracks; less than 1mm of polyimide is removed during processing. Sufficient thermal mass and rigidity must be present in the tubing for optimal results.

**Discussion**

Table 1 compares various cutting methods for a number of key tubing attributes and commonly requested finished product concerns. This information is a general guideline; there are many nuances to cutting capillary tubing. Not all points are addressed herein; for example, length tolerances vary depending upon the desired length and cutting method. End-face perpendicularity is highly dependent upon the tubing o.d. In many cases, best results are obtained with the polyimide coating intact. Objective items are ranked, rather than offering specific values.

**Conclusion**

This note discusses four commonly used techniques for cutting capillary and provides guidelines for use in selecting a cutting method. For assistance with your specific application please contact a Polymicro Technical Sales Specialist.

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| Table 1: Guidelines for use in comparing and selecting cutting methods for capillary tubing. | | | | |
|---|---|---|---|---|
| Attribute and Impacts | Standard Cleaving | Precision Cleaving | Saw Cutting | Laser Cutting |
| Min Length (mm) | 20 | 25* | 0.5 | 7 |
| Max Length (cm) | No Limit | No Limit | 4.5 | 200 |
| Min ID (µm) | No Limit | No Limit | 100** | 10 |
| Min OD (µm) | 90 | 90 | 250 | 100 |
| Min Wall Thickness (µm) | 20-25 | 25-35 | 45 | 40 |
| End Face Quality: 1 is Highest | 3 | 2 | 4 | 1 |
| End Face Angle: 1 is Lowest | 4 | 1 | 3 | 2 |
| Cleanliness: 1 is Cleanest | 3 | 2 | 4 | 1 |
| *Based on an OD between 350µm & 665µm; 40mm min other sizes<br>**Based on 5mm or longer part | | | | |

**References**


*(1) J. Macomber, L. Begay, LCGC Application Notebook, Sept. 2003 p.72.*

*(2) J. Macomber, et.al, LCGC Application Notebook, June. 2005 p.81.*

*(3) "Cleaving Procedure," The Book on the Technologies of Polymicro, Polymicro Technologies LLC Publication, p A-2, (2005).*