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Polyimide-Coated Capillary Tubing: Key Handling Issues ›

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Polyimide coated fused silica capillary tubing is widely used in the separation sciences. In this application note, we share some of our perspectives on several common handling issues researchers are likely to encounter when using capillary tubing.

Introduction

Fused silica capillary tubing is used in a broad range of analytical instrumentation, including GC, CE, Capillary LC and CEC. Unique temperature and chemical resistance properties of polyimide, coupled with the high purity of synthetic fused silica, make capillary the perfect solution for many of the challenges facing today's researchers.

Bulk capillary is provided on spools and is often further modified by the user. Capillary is also available as precut segments, many times with engineered features added, or as capillary assemblies such as a windowed capillary or capillary arrays. Many factors can affect the ultimate lifetime of a capillary product. Three key factors are general handling, bending stress and cleaving.

General Handling

Cleanliness of any surface that comes into contact with the capillary is critical. Debris on work surfaces, such as glass particles from previous cleaving operations, can lead to breakage and is often perceived as apparent brittleness. Especially troublesome are small particles that become embedded in the polyimide, and lead to breakage during further processing or use. Consider placing butcher paper on your workbench and change it regularly to provide a clean work area.

If capillary is placed onto, or routed through, a manufacturing device, consider all surfaces or features that could contact the capillary and make sure these are routinely cleaned of any debris, especially after any breakage. Surfaces should be smooth and free of manufacturing defects such as burrs or sharp edges. Keep this in mind during fixture design and manufacture.

Bending Stress

Capillary is often exposed to bending either during user manufacturing processes or subsequent use. The minimum bend radius should always be taken into account. Polymicro capillary is tested during manufacture to typically 100 kpsi of bend stress. A common oversight is the incorporation of rollers or guides that expose the capillary to stresses well above 100 kpsi. Equation 1 below will allow calculation of the actual applied stress in your application.[1]

Equation 1: $\sigma_a = (E*r)/(R+C_{th}+r)$
Where: σ_a *is applied stress, E is Young's modulus, r is ½ the glass outer diameter, R is the bend radius and* C_{th} *is the coating thickness.*

Cleaving

The goal of any cleaving tool is to penetrate through the polyimide and impart a sub-micron defect into the outer glass surface. Once a defect is generated, applying a linear tension to the defect separates the capillary. Ceramic cleaving stones and diamond tip devices are common. Semi-automated and automated cleavers at Polymicro allow for high-volume low-cost cleaving.

Cleave end finish vary by method. Matching cleave quality to application requirements is essential. Examples of good and bad cleaves for CE capillary are shown in Figures 1a and 1b. A general misconception is that cleaving and breakage are unrelated. A poor cleave generates excessive glass debris inside of the capillary which can lead to internal flaws and subsequent breakage. This effect is most common in large ID capillary. Laser cutting is a reliable alternative for some capillary applications.

Conclusion

Cleaving quality, bending stress and general handling are all key issues facing most capillary users. For questions on your specific application, please contact a Polymicro Technical Sales Specialist.

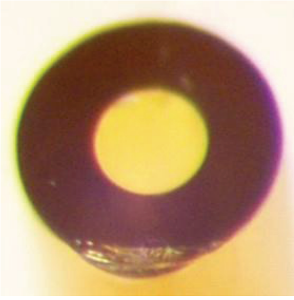

Figure 1a
Acceptable CE quality cleave.

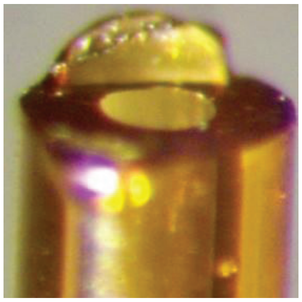

Figure 1b
Unacceptable cleave: commonly seen when bending rather than applying linear tension to form cleave.

References

(1) "Mechanical Stress & Fiber Strength," *The Book on the Technologies of Polymicro,* p.2-21 to 2-23 (2002).

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