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Flexible Fused Silica Capillary: Impact of Aging on Strength >

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Synthetic fused silica capillary tubing is a material of key importance in a broad range of applications. Lifetime of capillary is often of interest, but limited investigation has been conducted. This note discusses recent findings on the impact of aging on tensile strength.

Introduction

One of the most important attributes of flexible fused silica capillary tubing is its outstanding strength. When made properly with a protective abrasion resistant coating and handled appropriately, this material has proven to maintain its strength remarkably well. Initial tensile strength and proper handling concepts have been discussed previously(1). Degradation of fused silica over time is certainly expected and significant work on the mechanical reliability of fused silica in the related fiber optic industry has been demonstrated in the form of fatigue testing(2). However, very little data exists on the impact of long term aging on capillary tubing tensile strength. Testing of 20 year old material has been conducted recently. This note discusses tensile strength results of aged capillary tubing as compared to recently produced material.

Experimental

Aged fused silica capillary for this study was produced in 1988 and 1989 and was stored on white Styrofoam spools with a hub diameter of 8". Although the actual storage conditions were not controlled, all product used in this study were in their original sealed polymer baggies. Only samples wherein the tubing had remained arc sealed from the external atmosphere were considered. Recently produced material was harvested directly from newly drawn tubing stock and was kept sealed until evaluated. Tensile strength testing was performed on a Tensile Tester, Instron Model 3344 (Instron, Norwood, MA).

Aged samples consisted of 3 sizes; these being 0.10mm, 0.32mm and 0.53mm i.d. capillary tubing (Polymicro Technologies, Phoenix, AZ). Based on the spool hub diameter, the applied stress levels during aging were 17 kpsi, 21 kpsi and 32 kpsi, respectively. Material of corresponding sizes used for control samples was stored on the same 8" size spool, but none had aged more than 4 weeks.

Results

Data from tensile strength testing is often displayed in the form of a Weibull Plot(3). Comparative display of all such plots is beyond the scope of this communication. A simple and yet informative method of comparison is to summarize the mean tensile strength. Average values for all samples tested by product i.d. are displayed in Table I. For comparison, the values of the control samples are included.

Table I: Mean Tensile Strength Comparisons (kpsi)					
0.1mm i.d.		0.32mm i.d.		0.53mm i.d.	
Aged Sample	Control	Aged Sample	Control	Aged Sample	Control
336	683	353	555	364	609

Table I: Mean Tensile Strength Comparisons (kpsi)

It is clear from the data that degradation in tensile strength has occurred after 20 years of aging. However, the material still retains good strength, with the mean values being well above the typical proof testing value of 100 kpsi. Data suggests this tubing would still pass a standard proof testing regime, but an elevated break rate may be expected. When the applied stress level of capillary of a typical 6" or 8" GC cage is calculated and compared against these findings, it is reasonable to conclude from a strength standpoint that this tubing could be used successfully to manufacture GC columns.

Conclusion

Polyimide coated fused silica capillary is a very strong material. With proper handling and storage, long lifetimes can be expected for most products. For specific questions, contact a Polymicro Technical Specialist.

References

- (1) J. Macomber, *LCGC Application Notebook*, June 2009, p. 5
- (2) B. Skutnick, T. Wei, *Fiber Optics Reliability: Benign and Adverse Environments*, *SPIE* Vol. 842 (1987), p. 41
- (3) "Mechanical Stress & Fiber Strength," *The Book on the Technologies of Polymicro*, 2005, p. 2.17

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