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DIMENSIONAL STUDY OF CAPILLARY TUBING USED FOR GAS CHROMATOGRAPHY

Synthetic fused silica capillary tubing continues to be the material of choice for modern Gas Chromatography columns. In this application note, we examine dimensional specifications of GC tubing from a historical perspective and compare it to empirical data from current production runs.

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INTRODUCTION

In efforts to improve the performance of gas phase separations, chromatographers turned to the use of synthetic fused silica capillary tubing in the late 1970s(1). Such tubing is now widely accepted as the standard for GC columns and a variety of other analytical applications including CE, Capillary LC and CEC. Among the challenges facing early tubing producers was the need to draw material with consistent dimensional specifications. As the Separation Sciences have pressed forward, manufacturers have been asked to provide tubing with ever improving dimensional control.

Polymicro is unmatched in responding to this market demand. **Table 1** summarizes several important dimensional parameters from a historical perspective; the three most commonly employed GC products are included (2). Advances in raw materials, manufacturing processes and metrology have allowed for production of capillary with increasingly tighter tolerances. Results from current tubing production are discussed below.

EXPERIMENTAL

Synthetic fused silica capillary tubing used in this study included TSP250350 (0.25mm ID), TSP320450 (0.32mm ID) and TSP530660 (0.53mm ID). All material was produced using standard draw conditions and normal operating parameters. Individual samples were measured using Olympus PME3 inverted microscopes fitted with a cross hair filar and a Microcode II digital encoder. All microscopes were calibrated weekly against NIST certified standards and Gauge R&R studies were conducted on all operators as prescribed by Polymicro Standard Operating Procedures. Data was analyzed using MINITAB™ statistical software.

For each tubing size, a sample was collected from the end of every spool of material produced over the period of the study. Although a number of parameters were measured and recorded, only ID and Total OD were included in this review, as they are considered critical to finished column performance. Each data set included a minimum of 1000 samples.

RESULTS

Table 2 summarizes the current specifications and statistical data resulting from this study. ID mean values are all within 0.5 µm of the target specification, indicating that the manufacturing processes are well centered. The histogram shown in Figure 1 is typical of the data collected.

Statistical analysis of ID data indicates that greater than 99.73% of all material produced is in specification. A probability value of 99.97% was found for TSP250350 and further, over 75% of the material would fall within ± 2µm of the target. Similar calculations on Total OD yield equally impressive results, with probabilities exceeding 99.99%. Please note that this is a statistical analysis only. Process control is achieved through in-line laser monitoring during each draw and by conducting beginning and end measurements on all tubing spools produced. Only material that meets specification is released for distribution.

Table 1: Summary of GC Tubing Specifications, Past and Present

Product	ID Specification (µm)		OD Specification (µm)	
	1990	2001	1990	2001
TSP250350	250 ± 12	250 ± 6	350 ± 15	360 ± 10
TSP320450	320 ± 12	320 ± 6	430 ± 20	435 ± 10
TSP530660	542 ± 12	536 ± 6	665 ± 25	665 ± 15

Table 2: Summary of GC Tubing Study Results

Product	Current Specification		ID Statistical Data			Total OD Statistical Data		
	ID	Total OD	Mean	Std Dev	% in Tol.	Mean	Std Dev	% in Tol.
TSP250350	250 ± 6	360 ± 10	250.4	1.62	99.97	358.1	1.68	99.99
TSP320450	320 ± 6	435 ± 10	320.5	1.76	99.90	435.9	2.04	99.99
TSP530660	536 ± 6	665 ± 15	536.4	1.97	99.73	664.8	2.91	99.99

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CONCLUSION

As the gas chromatography market has evolved, it has become increasingly important to supply material with greater ID accuracy and tighter ID tolerances. Data shown summarizes the state-of-the-art at this time for popular GC tubing products. The data presented in this note represents one of several studies currently underway at Polymicro and emphasizes the ongoing commitment to advancements in manufacturing expected from a market leader.

REFERENCES

(1) R.D. Dandeneau and E.H. Zerenner, HRC&CC 2 (6), 351-356 (1979)

(2) Polymicro Technologies, LLC. Master Control Documents from Archive MINITAB is a trademark of Minitab Inc.

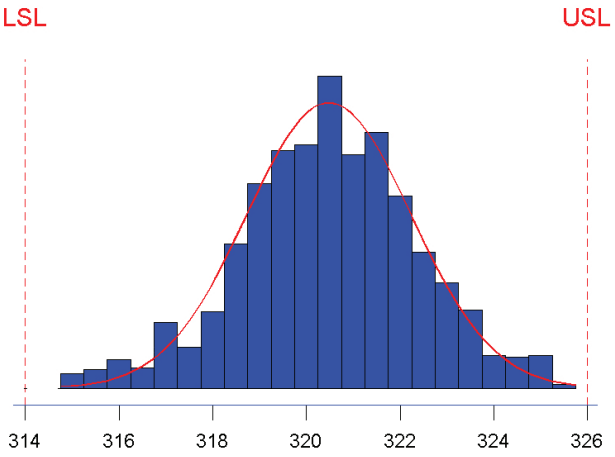

Fig. 1 Histogram of TSP320450 IDData, N = 1,217