



Light-Guiding Fused-Silica Capillary Tubing

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Synthetic fused-silica capillary tubing is widely used in the separation sciences, including the popular fields of gas chromatography, capillary liquid chromatography, and capillary electrophoresis. From its advent in the late 1970s, steady advances in product quality have emerged. Light-guiding fused-silica capillary tubing is the latest step in this continuing development.

Improved purity of the synthetic fused silica, more durable external coatings, and tightening of specification tolerances are cornerstones in capillary tubing advancements. Researchers have successfully used capillary tubing filled with a high refractive index liquid to form an optical wave guide. In one specific application, a low refractive index, external fluoropolymer-coated capillary was employed in a Raman spectroscopy device (1). Although a viable product for light-guiding applications, fluoropolymer-coated capillary has never achieved the low cost or durability desired. A nonliquid-filled light-guiding capillary with a durable polyimide coating has been developed to fill this void.

Experimental Design

The tubing preform consists of a standard high-OH silica tube overlaid with a layer of fluorine-doped synthetic fused silica. The tube interior is not modified from the pure fused-silica surface as on standard capillaries. This preform was then drawn using standard operating procedures into capillary tubing. A polyimide coating was applied, yielding products with dimensional specifications essentially identical to the corresponding standard capillary products.

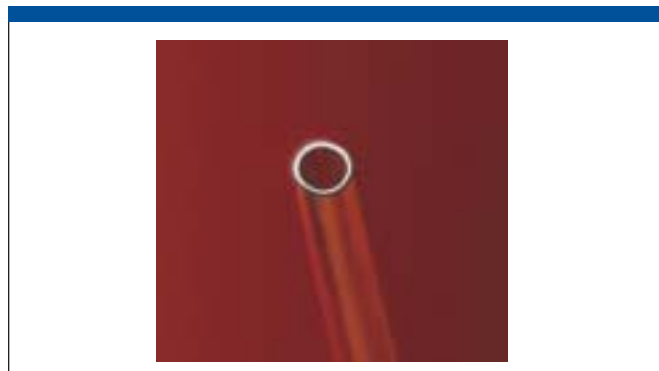


Figure 1: LTSP250350 transmitting white light.

Results

It is clear from casual inspection that this capillary tubing embodies the light-guiding properties of a fiber yet retains its basic tubing design, internal surface chemistries, and high strength. Figure 1 is an image of the end of an LTSP250350 light-guiding capillary tube, being illuminated on its opposite end by a white light source.

Although additional testing continues, initial results indicate that attenuation (with an air-filled interior) is similar to a standard high-OH multimode-step index optical fiber. Initial attenuation results indicate values of ~20 dB/km at 500 nm and values <15 dB/km at 800 nm. Several sizes have been successfully produced, including i.d./o.d. combinations (in μm) of: 50/150, 50/375, 75/200, 150/375, and 250/350. No glass surface chemistry differences have been seen and none are expected. Depending on the substances introduced to the capillary interior, the light-guiding properties can be modified significantly.

Conclusions

A light-guiding capillary offers a new horizon in capillary tubing applications, including

- Unique sample detection and analysis
- Increased pathlength detection cells
- Evanescent wave optics
- UV transmission inside of capillary allows for coaxial light-activated chemistries, curing of UV adhesives, and detection of light-producing reactions; that is, fluorescence
- Chromatographic columns with new frit technologies for improved durability

This latest advance in tubing technologies should prove to bring exciting opportunities to both old and new capillary techniques.

Reference

- (1) D. Che and S. Liu, Long Capillary Waveguide Raman Cell, U.S. patent number 5,604,587, 1997.

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