TECHNICAL NOTE: A CASE IN POINT(S)! PRODUCING SCULPTED-END CONICAL TIPPED FIBERS FOR MEDICAL APPLICATION

'Sculpted-end' is the common terminology that is applied to fiber ends that are other than flat or spherically curved. In this case a CONICAL TIP is discussed. It is excerpted from an article which appeared in the journal 'Cytometry' (Ref 1) and the resulting commercial version of the cytometer, the 'Miniflo', was discussed in 'Biophotonics International' (Ref. 3).

This note describes an application in which a conical tip on an optical fiber is used to optimize the information output in Flow Cytometry. It summarizes development performed at Lawrence Livermore Laboratories, something fully described in the journal Cytometry, in a paper entitled 'Flow Stream Waveguide for Collection of Perpendicular Light Scatter in Flow Cytometry'.

This paper reported "a new physical configuration for the detection of perpendicular light scatter or fluorescence in flow cytometry when using a fluid stream in air." The "…configuration increases the signal-to-noise ratio and narrows the coefficient of variation for uniformly sized latex spheres when compared to using a microscope objective to collect such light. The new technique views the scattered light that is trapped within the optical waveguide that is naturally formed by the flow stream in air" (ref 2). The technique involved the placement of a conically polished optical fiber into the flow stream with an optical detector at the fiber's other end. For perpendicular light scatter, the flow-stream waveguide achieves high collection efficiency (NA=0.88) as well as high efficiency of optical thoughput due to lack of surfaces between the light scatterers and the detector", obtaining " …10-fold higher signals with this technique than with a long-working-distance microscope objective. The flow stream waveguide is also much easier to align than traditional microscope-lens-based systems".

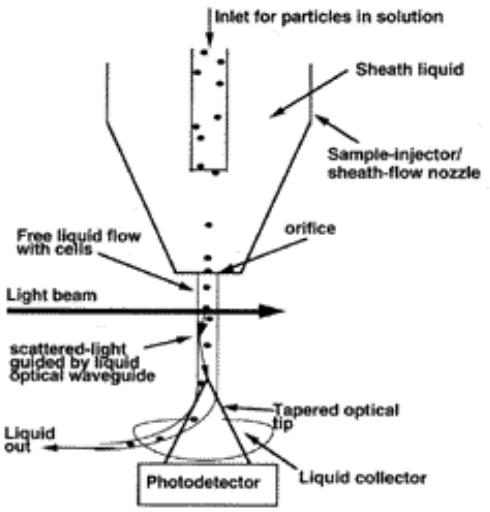

FIG. 1. Sketch of a flow cytometer with the flow-stream-waveguide configuration to collect perpendicular light scatter.

"The nominal 0.48-NA optical fiber…was polished into a 25° [included angle] cone with a polisher from ULTRA TEC…the time to polish the fiber tip typically 15 minutes".

The sort of ULTRA TEC equipment used for this development is pictured below. The fiber extends through the Hollow Spindle of the Micropositioner on ULTRAPOL, and for the cone tip, is automatically rotated while in contact with the lapping surface.

This equipment has been used for conical ends on fibers ranging down to 125 microns in diameter. In most cases ULTRA TEC has provided a specially designed and fabricated workholder to suit the particular application.

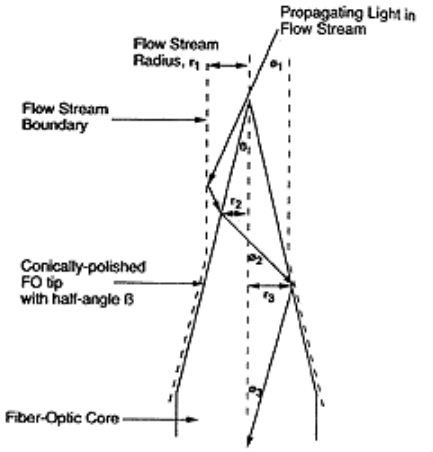

FIG. 2. Sketch of the passage of a light ray from the flow stream into a conically polished fiber optic (FO). ϕ_1 is the initial angle of propagation of the light ray within the flow-stream waveguide; ϕ_2 is the angle of propagation upon entering the FO, and ϕ_3 is the angle of propagation after one reflection. r_1 is the radius of the flow-stream. r_2 is the radius of the FO where the light ray enters the FO tip. r_3 is the width of the FO tip where the reflection occurs (see text).

References:

1. Raymond Mariella Jr., Gerrit van den Engh, Donald Masquelier, and Gerald Eveleth: Flow Stream Waveguide for Collection of Perpendicular Light Scatter in Flow Cytometry. Cytometry 24:27-31 (1996). This work was performed under the auspices of the US Dept. of Energy's Office of Non-proliferation and National Security. For reprints of the paper, address requests to Raymond Mariella Jr., LLNL, P.O. Box 808, Mail Stop 452, Livermore CA 94551.

2. Marriella Jr. RP, van den Engh GJ, Northrup MA: Aqueous carrier waveguide in a flow Cytometer. US Patent #5,475,487 issued 12 Dec 1995

3. 'Portable Cytometer targets biological weapons', BIOPHOTONICS INTERNATIONAL, September / October 1998, publ. Laurin Publishing

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