Internally Teflon-AF Coated Capillary Cell for Optical Fibre Remote Spectroscopy.

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Abstract:
A novel method of enhancing fibre-remote fluorescence and Raman spectroscopic measurements of compounds in aqueous solution is demonstrated. The method uses a water-cored optical waveguide/capillary tube sample cell, internally coated with Teflon-AF.

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Liquid samples are conventionally examined by focusing light to a spot and collecting the inelastically-scattered light emitted from the illuminated volume. Alternatively light may be launched axially into a capillary tube containing the sample. In the case of a silica capillary surrounded by air, the light is confined within the cell by total internal reflection at the external wall of the cell, thus extending the interaction length. Light scattered within the cell at angles greater than the critical angle is also confined, and may be guided towards the collection optics of a spectrometer.

Capillary cells are a common means of increasing the amount of scattered or emitted light collected by the input of a spectrometer, and are simple to couple to optical-fibre probes[1]. By using a capillary cell with a lower refractive index than the sample under examination, light is confined by total internal reflection at the inside wall of the cell. As the light is confined wholly within the sample itself, the enhancement is maximised. Unfortunately such arrangements have previously not been possible for aqueous analytes, due to the difficulty of fabricating a cell with a lower refractive index than that of water (n=1.33 from 525 - 1000 nm).

The Teflon-AF family of amorphous fluoro-polymers has many useful optical properties[2], including a peculiarly low refractive index and a reasonable optical transmission ($n<1.32$ and $T>90\%$ over a cm, in the visible/NIR region of the spectrum). A 5 μm thick coating of Teflon AF1600 has been deposited on to the inside of a 1.6 mm internal diameter capillary tube, to use as a light-guiding capillary cell. Optical waveguiding has been demonstrated within this cell, and its optical transmission has been compared with that of a similar, uncoated, capillary tube. Using a 120 mm long coated cell the intensity of light collected from an internal scatterer was inferred from experiment to increase by a factor of at least 16, compared with the bare tube. Enhancement factors for various analytes will be given in the presentation and compared with a mathematical model for the system.

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1. Schwab, SD and McCreery, RL; Applied Spectroscopy, 44 (1987), 126.

2. Lowry, JH et al; Optical characteristics of Teflon AF fluoroplastic materials, Optical Engineering, 31 (1992), 1982.