

IFPAC



Combi fiber-optic probes for multimodal spectroscopy using Raman, MID IR-absorption, UV-Vis-NIR transmission and Fluorescence for remote process monitoring

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Abstract:

Here we present our latest combi fiber optic probes that combines Raman, mid-IR (ATR FTIR), Reflection and Transmission techniques in a single probe for research and industrial applications. Joint use of two or more spectroscopic techniques enhances the capabilities of analytical methods. Multispectral measurements combining infrared (IR), Raman, fluorescence, and other spectra can be more efficient than individual methods. This synergic effect of the data augmentation has been shown for a number of practical applications. In some cases, different modalities with their own advantages and drawbacks mutually compensate for the weaknesses of their counterparts. However, the integration of complex systems into compact scanning probes presents numerous challenges, as the need for miniaturization and efficient light delivery imposes extreme constraints on the system.

Combination of two (or more) spectral methods in a single probe is always practicable and handy. Compared to individual probes, it saves space and necessary sample volume, it takes a single connection port for an in-line measurement, it can be manipulated with one hand, it requires less cleaning and maintenance effort. The most essential advantage of the multispectral probes is the possibility of simultaneous measurement at the same sample point. In some situations, it is critical for the analysis results. Multispectral probe is required for a consistent spatial mapping in solid heterogeneous samples. In liquid samples, the measurement at the same point can be critical for a rapidly changing environment, such as stream or turbulent medium, as in the real-time process monitoring. In both cases even simultaneous measurements in different points cannot guarantee that chemically identical portions of analyte are observed, as required.

Combining different spectroscopic techniques within the same probe is facilitated by the application of fiber optics. Advances in the development of chalcogenide (CIR) and polycrystalline infrared (PIR) fiber materials expand the analytical spectral range covered by the modern probes towards mid-infrared. A recently developed multispectral probe combining attenuated total reflection (ATR) mid-infrared and fluorescence spectroscopy has shown its efficiency in the classification of biological tissue types. In food and pharmaceutical industries, the use of complementary methods such as infrared absorption and Raman spectroscopy are highly desirable due to the compositional complexity of raw materials and products. Our latest developed probe also allowed us to combine Raman and infrared absorption into a single probe shaft. The family of our standard multispectral probes include combinations such as ATR(mid-infrared)-Trans-Flection(NIR)-Raman, Raman-Reflection(NIR), ATR(mid-infrared)-Fluorescence-Raman that are used in R&D applications and process monitoring.

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