Why Use a Probe for Dynamic Light Scattering? Why NOT a Cuvette?

Featuring: Particle Size Analysis using a stainless steel probe in the Nanotrac Model 150 (in-instrument sample container); Nanotrac Model 250 (Dip 'N' Run feature) and Nanotrac 350 (automated, in-line instrument) for Dynamic Light Scattering measurements.

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Applications Note

SL-AN-03 RevA

Provided By:
Microtrac, Inc.
Particle Size Measuring Instrumentation

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Cuvettes are small containers having 4 sides that are transparent. For many years chemists and biochemists have used these cuvettes or cells to contain samples that are to undergo spectrometric measurements by IR, UV, VIS, Nephelometry and other instruments such as Photon Correlation Spectroscopy. These devices typically require a glass, quartz or plastic cuvette having excellent properties of optical clarity, surface smoothness, exacting dimensions and no imbedded imperfections. It is well accepted that changing cuvettes can cause variability of spectroscopic data. Therefore, matched sets of quartz cells or cuvettes are often obtained at considerable expense wherein the manufacturer would strive to assure that the optical characteristics were identical for each. An alternative to such a purchase is to use the same cuvette assuring that it is never damaged. Plastic cells have become available that are less expensive but may have optical imperfections requiring their immediate disuse and disposal.

With these thoughts in mind as well as those listed in table, Microtrac Inc. developed a particle size measurement probe design for dynamic light scattering that addresses the issues in order to provide a rugged design that can be used inexpensively and easily. Yet, it offers tremendous flexibility in its use and application to meet or exceed the wide range of customer's needs. By means of using of using the same optics, variations found in cuvettes is eliminated. The table provides a comparison of the Nanotrac probe to the use of 4-sided transparent cells or cuvettes.

How the Nanotrac works

The Nanotrac is designed to provide the easiest dynamic light scattering measurement by providing a specially designed probe (Patented) in concert with advanced mathematical concepts and electronics. The probe provides light to the sample and also collects the scattered light for data analysis. Light travels through an optical fiber to a chemically rugged transparent tip. A portion of the laser light is reflected and travels through the optical fiber to a silicon detector. The rest of the light passes through the tip and interacts with the particles. The velocity of the particles imparts a shift in the frequency of the light that undergoes interference. The probe tip captures the light. After capture, the light passes down the same path as the reflected laser. At the detector, the frequency shifted light arrives and produces fluctuations in the reported signal. The fluctuating signals are provided to a Digital Signal Processor using a Fast Fourier Transform that converts the signals into a power spectrum (Patented concept). The power spectrum contains a distribution of frequencies that are inversely proportional to the size of particles. Further computations and use of Mie scattering considerations provide a full description of the particle size distribution without need for special analytical or deconvolution programs. As part of the development, the reflected laser is used as a local oscillator and acts as a reference to which the frequency shifted light is compared. Thus, the technology has been termed the CRM (Controlled Reference Method). See the Microtrac, Inc website for more details on the technology and for sales/applications specialists in your area. **www.Microtrac.com**

Design Issue	Nanotrac Answer	Other Dynamic Light Scattering and Photon Correlation Spectroscopy Instruments
Requirement for re-focusing or alignment due to cuvette wall optical effects	**NONE** - EVER	Cell Dependent; background issues, alignment may take as long 5 minutes per measurement.
Potential for breakage and damage	**NONE -** EVER	Glass and quartz may fracture
Maintenance costs of expendables	**NONE -** EVER	Usage Dependent
Contamination from previous usage	Quick rinse avoids issue	Rinse, clean and dry
Transfer need from beaker or vial to cuvette/cell – potential loss of important sample	**NONE** – Use same container as used for preparation, synthesis or isolation	Transfer usually required to cuvette or cell
Upfront expense beyond instrument purchase	**NONE**	Yes
Volume required for measurement	As small as 25λ ✓ Range 0.025 – 3 ml with Model 150 ✓ 1ml to 1000 ml; any shape container with Model 250 ✓ Flow through for in-line	Typically 1-3 cc
In-line measurement capability	YES	Generally no
Need for light to traverse cuvette dimensions ✓ Cleanliness of cell issue ✓ Limited concentration issue	NONE ✓ Background measurement avoids extraneous or ghost peaks ✓ High concentration capability	Yes ✓ All faces of cuvette must be scrupulously clean ✓ Scattering too many times from many particles (multiple scattering) limits concentration and accuracy.
Measurement using various container sizes and shapes	Vial opening diameter must exceed 1 cm for probe immersion. Will fit inside a standard size cuvette.	Limited to specified size cuvette holder
Construction ruggedness	Stainless Steel	Glass or plastic
Need to evaluate cell optical properties for multi-sample measurements	NONE – background measurements avoids reporting contaminating particles. No other optical issues.	Cells may differ in optical focus, clarity, imperfections and cleanliness; can cause background issues
Sample concentration	Automated, active, on-screen concentration guide to avoid multiple scattering or too low concentrations. Wide range of concentrations permitted.	Limited concentration permitted; estimated guidelines on safe concentrations only. Often only a non-active, “count” determination
Chemical resistance	Compatible with all known organic solvents	Plastic dissolution an issue


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