Microtrac

Total Solutions in Particle Characterization

Europe GmbH

Nanotrac Wave

Particle Size, Zeta Potential and Molecular Weight Analyser

Nanotrac Wave

Microtrac has been a pioneer in particle sizing technology for over 30 years. The Nanotrac Wave is the latest generation of sub-micron Particle Size and Zeta Potential analysers from Microtrac. The enhanced design on the Nanotrac Wave features faster measurements, smaller particle size capability (to 0.8 nm), higher precision, higher accuracy and advanced software capabilities in a small, robust dynamic light scattering instrument with no moving components. Nanotrac Wave complies with the ISO 13321 standard for Dynamic Light Scattering.

The main features of the Nanotrac Wave are

Technology - Dynamic Light Scattering incorporating the patented Controlled Reference Method for advanced power spectrum analysis of Doppler shifts under Brownian Motion.

Range - Measurement capability from 0.8 to 6500 nanometers. Zeta Potential from -125 to +125MV Sample Size: Typically less than 3ml in standard cell, or 0.2ml with small cell option.

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Rapid Analysis - 15 to 30 second analysis times in most cases.

Analysis Simplicity - No “A Priori” or advance knowledge of the sample is required. Nanotrac will accurately report monomodal, multimodal, broad and narrow distributions without the need to select special calculation algorithms.

Accuracy - Measures using Mie scattering calculations for spherical particles and proprietary Mie calculations for non-spherical particles. **This feature is unique to all Microtrac instruments.**

Repeatability - Better than 1% from instrument to instrument for 100nm polystyrene.

Traceability - Particle Size measurements traceable to NIST standards.

Concentration - Capable to measure up to 40% by solids in some cases. This feature reduces the need to dilute samples which may affect particle size or colloid stability. Low concentration measurements can be as low as 0.1 ppm for 200nm polystyrene.

Temperature Control - Precise temperature control using a Peltier control device.

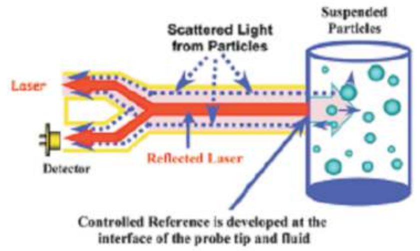
Versatility - Nanotrac Wave probe can be external for use in Dip-N-Run or in-line applications. Nanotrac Wave is also compatible with the **Zetrator** titration device.

Security/Validation - Nanotrac Wave FLEX software is compatible with FDA 21 CFR Part 11 protocols. Full IQ/OQ validation documentation is available for Nanotrac Wave.

How Nanotrac Wave works

Particles suspended in a dispersing fluid are subject to random collisions with the thermally excited molecules of the dispersing fluid resulting in Brownian motion. The velocity and direction of the resulting motion are random but the velocity distribution of a large number of mono-sized particles averaged over a long period will approach a known functional form, in this case the size distribution of the particles.

In the Nanotrac Wave, light from a laser diode is coupled to the sample through an optical beam splitter in the Nanotrac probe assembly. The interface between the sample and the probe is a sapphire window at the probe tip. The sapphire window has two functions! Firstly, it reflects the original laser back through the beam splitter to a photodetector. This signal which has the same frequency as the original laser acts as a reference signal for detection, offering Heterodyne detection. Secondly, the laser passes through the sapphire window and is scattered by the particles which are in suspension but moving under Brownian motion. The laser is frequency shifted according to the Doppler effect relative to the velocity of the particle. Light is scattered in all directions including 180 degrees backwards. This scattered, frequency shifted light is transmitted through the sapphire window to the optical splitter in the probe to the photodetector. These signals of various frequencies combine with the reflected signal of un-shifted frequency (Controlled Reference) to generate a wide spectrum of heterodyne difference frequencies. The power spectrum of the interference signal is calculated with dedicated highspeed FFT (Fast Fourier Transform) digital signal processors. The power spectrum is then inverted to give the particle size distribution.



The Nanotrac incorporates a highly accurate temperature sensor in the sample cell. By describing the fluid temperature and viscosity characteristics in the Nanotrac algorithm, these parameters can be included in determining accurate particle size distributions. Also, because the laser light needs only to penetrate approximately 200 to 300 microns into the sample to generate a power spectrum, the Nanotrac can accurately determine particle size distributions at significantly higher concentrations than other methods.

Zeta Potential Measurement

The Nanotrac Wave also has the capability to measure Zeta Potential using a specific sample cell for size as well as charge measurements, Zeta Potential measurement capability is provided by additional hardware in the form of :

1. A voltage source with programmable amplitude and wave form.
2. An insulating sample cell, with optical probes opposed by electrodes.
3. Optical probes, with sample interface window consisting of typical sapphire, but with specialized metallic and semiconductor optical coatings applied.

For Zeta Potential, coated-window opto-electric probes are paired with their opposite electrodes in an insulating sample cell. A voltage source is applied between the optical probes and their electrodes, creating an electric field which induces particle movement toward the opposite electrode charge. Particle motion is analysed while under the influence of the field. Particle size distribution is determined from the velocity distribution of particles suspended in a dispersing medium, using the principles of dynamic light scattering. The Nanotrac Wave analyser measures the additional velocity imparted to the charged particles when placed in an electric field. Particle electrophoretic mobility is calculated from this additional velocity component. Zeta potential is calculated from mobility using accepted relationships between mobility and zeta potential. The relationship between zeta potential and mobility is given by the Smoluchowski equation:

$$\zeta = \mu\eta/\varepsilon$$

where

ζ = zeta potential,
μ = mobility,
η = viscosity,
ε = dielectric constant

for water at 25degC.

Nanotrac Wave Sample Modules

The Nanotrac Wave provides the user with a versatile selection of Sample Modules depending on measurement requirements. Users can easily change from size measurement only to size and zeta potential measurement by changing to the relevent sample module. For users requiring temperature control there is also a module with a controlled Peltier device (see foto).

The sample is introduced to a removable Teflon sample cell. The sample cell and probe tip can be sterilized for users in the bio-technology sector.

Flow through cells are available for interfacing with the Microtrac Zetrator facilitating comprehensive foreward and backward titration sequences for product stability applications.

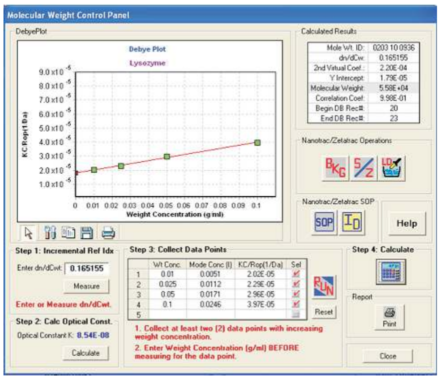
Molecular Weight Measurement

The Nanotrac Wave measures Molecular Weight using the Hydrodynamic sample properties of the material and also through the generation of Debye Plots. Hydrodynamic MW is determined from the size of suspended molecules by Dynamic Light Scattering, Hydrodynamic molecular weight is calculated using

$$MW = A\rho\pi D^3/6$$

where A is Avogadros number, ρ is molecular density and D is the Hydrodynamic Diameter.

The measurement of Molecular Weight using the Debye plot depends upon an accurate measurement of the light that is scattered by a molecular suspension of known concentration, C. The ratio of total scattered-light to total incident-light is the Rayleigh ratio, R. The Debye MW expression relates the MW to the Rayleigh ratio and to the sample concentration:



For Microtrac DLS Analysers, the angle of incident-to-scattered light is 180° (backscatter). The Rayleigh Ratio is calculated from the DLS Analyser's measurement of the backscattered light intensity.

From the Debye plot 2nd Virial co-efficient can also be generated.

Nanotrac Wave : Technical Data

Particle Size	0.8 to 6500 nanometers (displayed in nanometers, microns or angstroms)
Zeta Potential	-125 to +125 mV, Mobility -10 to +10 µm/µsec/V/cm , size range 10 nm to 20 microns
Molecular Weight	1kDa to 20 MDa, Hydrodynamic and Debye Plot with 2nd Virial co-efficient calculation
Sample Volume	Size only - 50 ul to 500 ul, with micro insert min 10 to 20 ul. Zeta 0.7 to 3 ml.
Measurement Angle	180 Degrees
Repeatability	1% or better for 100 nm Polystyrene
Concentration Limits	From ppb to 40% by volume in certain conditions.
Laser	Laser Diode, 780 nm , 3 mW, Class IIIB, no alignment required.
Temperature Control	5 to 90 Degrees Centigrade +/- 0.2 Degrees using Peltier Device
Sample Cell Modules	Nano, Zeta, Micro insert for Nano Cell, Flow thru cell with or without cap.
Chemical Compatibility	Aqueous, polar and non polar organic solvents. Surfaces: Stainless steel, sapphire and Teflon
pH Range	2 to 12 pH
Conductivity Range	1 to 200 mS/cm
Environmental	Operating Temperature 10 to 50 Degrees C Humidity up to 90% non-condensing
Dimensions	15L x 14W x 13H inches (38.1 x 35.5 x 33 cms)
Weight	30 Lbs, approx 15 Kg
Electrical	90 to 240 VAC, 47 to 63 Hz, 5 Amps

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