NanoPlus HD

Zeta Potential and Nano Particle Analyzer

Particulate Systems
a division of micromeritics

KNOW MORE, ELEVATE UNDERSTANDING, REMOVE VARIABLES

NanoPlus HD Zeta Potential and Nano Particle Size Analyzer

Overcome the unknown or discover more about your product than ever before.

- High definition analysis with 70 mW of laser power finds small volume aggregates in mixtures.

- Discover true zeta potential with multi-point measurement scans for isoelectric point, formulation constancy and uniformity in colloidal systems. Know, predict and quantify the stability of your product.

- Learn more and save time with the ability to measure within the entire dynamic range of the NanoPlus HD in a single analysis.

Reach deeper into acquired data to increase yield, optimize process, and find new capabilities.

- Improved sensitivity for increased raw data quality advances results accuracy.

- Avalanche Photodiode Detection (APD) permits high sensitivity detection of even small volume, diluted samples. Lets you successfully acquire data in valuable and challenging low volume analyses.

- Generate customized 3D plots to track changes, compare lots or see pH affects. Use acquired data to positively impact your continual process improvement initiatives.

Protect data integrity, secure repeatability and accuracy for high confidence results.

- Exceptional multi-point electrophoretic mobility detection eliminates EOF affects.

- Utilize the intelligent SOP (standard operating procedure) Designer and the preloaded liquid dispersion properties. Spend time understanding data and its impact instead of investing in method tuning and control.

- Broad range of temperature control secures sample integrity with protein and biological samples, keep sample bioactivity intact. Specially engineered analysis cells with parallel electrodes eliminate thermal damage to protein or biological materials.

The Next Generation Zeta Potential and Particle Size Analyzer-NOW

- Colloidal solution stability in liposome and monoclonal antibody development
- Quantitative determination of oral and injectable suspension stability
- Pharmacokinetic drug delivery studies of nano-emulsions
- Pigment and ink characterization
- Qualitative and quantitative assessments of nano-cosmetics
- Cosmetic slip casting evaluation and chemical dosing for colloidal stability
- *And many more*

"This instrument has solved a particle size problem that we could not solve with a different manufacturer's instrument... The NanoPlus software is easy to use and logical."

William Betz, Senior Scientist at Sigma-Aldrich

NanoPlus HD Particle Size & Zeta Potential Analyzer

The NanoPlus HD is a unique instrument that utilizes photon correlation spectroscopy and electrophoretic light scattering techniques to determine particle size, zeta potential, and molecular weight. The instrument is compact and easy to use with an extended analysis range, intuitive software, and multiple sample cells to fit the user's application.

The NanoPlus HD also features improved sensitivity and reduced analysis time through the upgraded HD-APD (avalanche photo diode).

The instrument is available in two model configurations:

NanoPlus HD-1
Nano Particle Sizing Instrument

NanoPlus HD-3
A Combination Nano Particle Sizing and Zeta Potential Instrument

The NanoPlus HD Series

Particle size: 0.1 nm - 12.30 µm
Zeta Potential: -500 ~ +500 mV
Molecular Weight Range: 3.6×10^2 to 2×10^7 Da
Concentration range: 0.00001~ 40%

Particle Size

- Measures particle size of samples suspended in liquids in the range of 0.1 nm to 12.30 µm with sample suspension concentrations from 0.00001% to 40%

- Well-established photon correlation spectroscopy technique conforms to ISO 13321 and ISO 22412

- Combination of linear and log-scale correlators covers diverse sample characteristics

- Variety of sample cells available
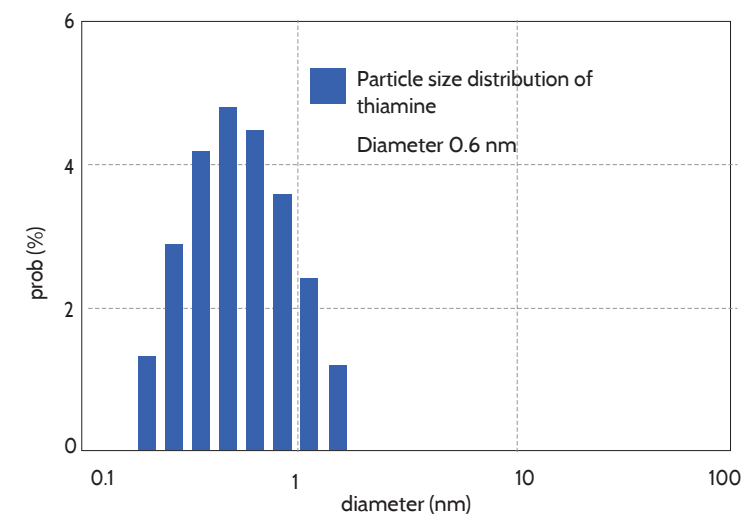
Zeta Potential

- Measures zeta potential of a sample suspension in the range of -500 mV to +500 mV with concentrations from 0.001% to 40%

- Reliable measurements based on electrophoretic light scattering technology conforms to ISO 13099-2

- Accurately characterizes both dilute and concentrated suspensions

- Capable of measuring the surface charge on solid surfaces, film, etc. based on probing particles
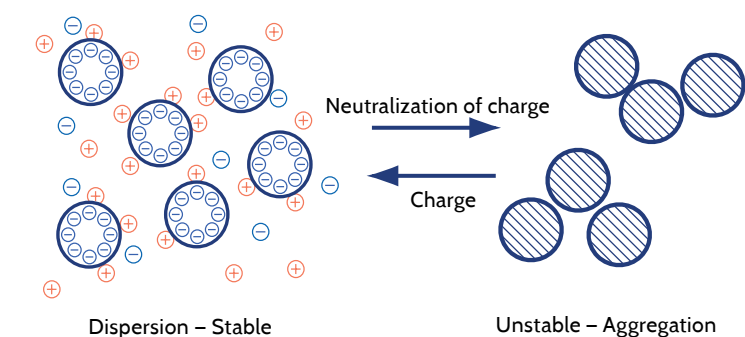
- Variety of sample cells available
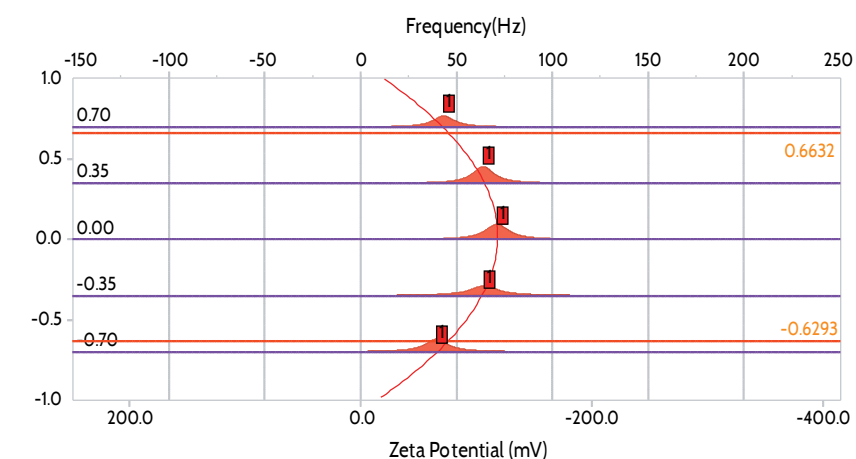
The NanoPlus HD is capable of obtaining high resolution zeta potential analyses even with multi-component samples. In the example on the right, a mixture of five polystyrene latexes of different particle sizes were measured. Five spectrums corresponding to each latex component was detected. The zeta potential of these components were in the range of -45 mV to -107 mV.
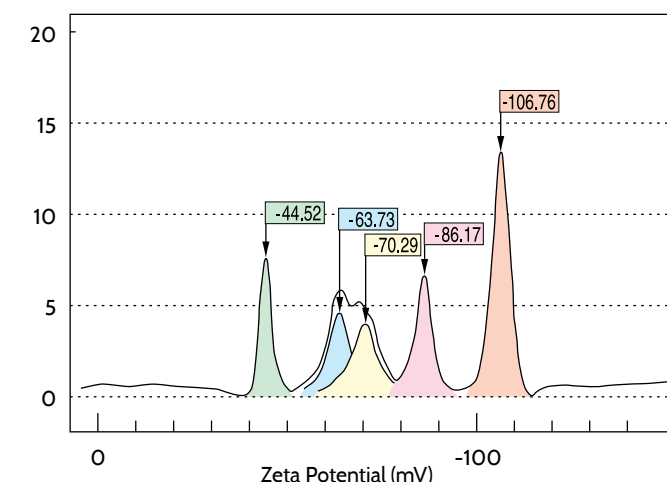
Evaluation of Dispersion Stability by Zeta Potential/Particle Size

As the absolute value of zeta potential increases, colloidal systems give generally stable dispersions due to electrostatic repulsion between particles. However, as the zeta potential approaches zero, the stability of the dispersion reduces and aggregation becomes likely.


Particle size distribution of thiamine
Diameter 0.6 nm

Dispersion – Stable   Neutralization of charge   Charge   Unstable – Aggregation

Principal of Particle Sizing and Zeta Potential Measurement

Principle of Particle Sizing

Particulates dispersed in a solution are normally subject to Brownian motion. The motion is slower with larger particles and faster with smaller particles. When laser light illuminates particles under the influence of Brownian motion, scattered light from the particles shows fluctuation corresponding to individual particles. The fluctuation is observed according to the pinhole type photon detection method so that particle size and particle size distributions are calculated.
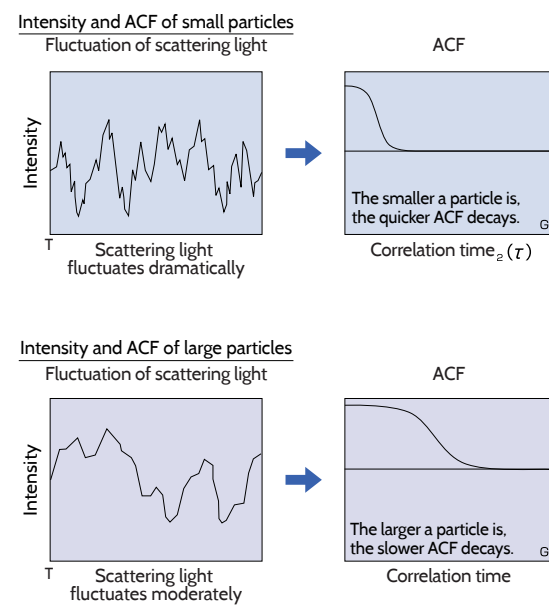
Colloid Particle in Brownian Motion

Incident beam
Measurement cell
Pinhole 1
Pinhole 2
APD (Avalanche Photo Diode)
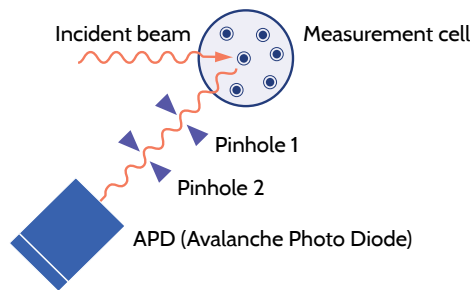
$G_2(\tau) = 1+\alpha(G_1(\tau))^2$
$G_1(\tau) = \exp(-Dq^2\tau)$
$d = kT/3\pi\eta D…$ Stokes-Einstein equation

$G_1(\tau)$, $G_2(\tau)$: Secondary and primary auto-correlation function (ACF)
D: Diffusion coefficent
q: Scattering vector
τ : Correlation time
d: Hydrodynamic diameter
k: Boltzmann's constant
T: Absolute temperature
η: Viscosity of medium

Difference of scattering intensity and autocorrelation function (ACF) between various sized particles

Intensity and ACF of small particles
Fluctuation of scattering light
ACF

Intensity
T
Scattering light fluctuates dramatically

The smaller a particle is, the quicker ACF decays.
Correlation time $_g(\tau)$

Intensity and ACF of large particles
Fluctuation of scattering light
ACF

Intensity
T
Scattering light fluctuates moderately

The larger a particle is, the slower ACF decays.
Correlation time

Principle of Zeta Potential Measurement

In most cases, colloidal particles possess a positive or negative electrostatic charge. As electrical fields are applied to the particle dispersion, the particles migrate in oppositely charged directions. As particles are irradiated in migration, scattering light causes Doppler shift depending on electrophoretic mobility. NanoPlus HD software calculates the amount of Doppler shift followed by electrophoretic mobility and zeta potential by combining a heterodyne system and photon correlation method to perform Fourier transform of obtained correlation function.

Slipping level
Major part of medium
Ion diffuse layer
Fixed layer
Colloidal particle
Electrophoresis
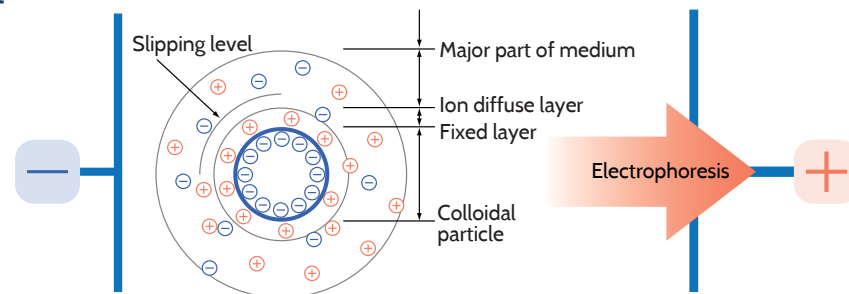
$\Delta v = 2Vn\sin(\theta/2)/\lambda$
$U = V/E$
$\zeta = \eta U/\varepsilon…$ Smoluchowski equation

Δv: Doppler shift
V: Velocity of particle movement
n: Refractive index
η: Viscosity
θ: Detect angle

λ: Wavelength of incidence light
U: Electrophoretic mobility
E: Electric field
ζ: Zeta potential
ε: Permitivity

# Determination of True Electrophoretic Mobility

When the measurement of electrophoresis is actually taken, an electroosmotic current is generated in the cell due to an electric charge on the cell wall. With a negatively charged cell wall, the electroosmotic flow phenomenon causes the positively charged ions and particles to gather together by the cell walls. The solution located by the cell walls migrates toward the negative electrode during electrophoresis. The solution located in the cell center moves in the opposite direction (toward the positive electrode) to compensate for the flow by the cell walls. Therefore, an electroosmotic flow is created during electrophoresis. The NanoPlus HD is designed to measure electrophoretic mobility at several points in the cell to obtain a position (i.e. stationary point) not influenced by electroosmotic flow. As a result, the instrument can calculate and accurately measure electrophoretic mobility, even if the electroosmotic profile of the system is asymmetrical due to adsorption or sedimentation of the sample on the cell walls. The Multi-point determination allows for exceptional repeatability and reproducibility.

Cell wall
Stationary Layer
U_p
U_p
U_{osm}
Z
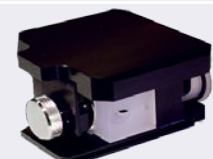Cell wall

Capillary
Quartz Cell
Platinum electrode
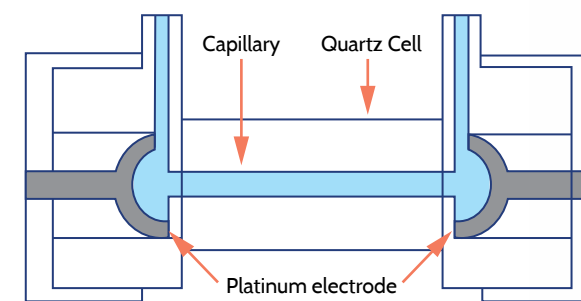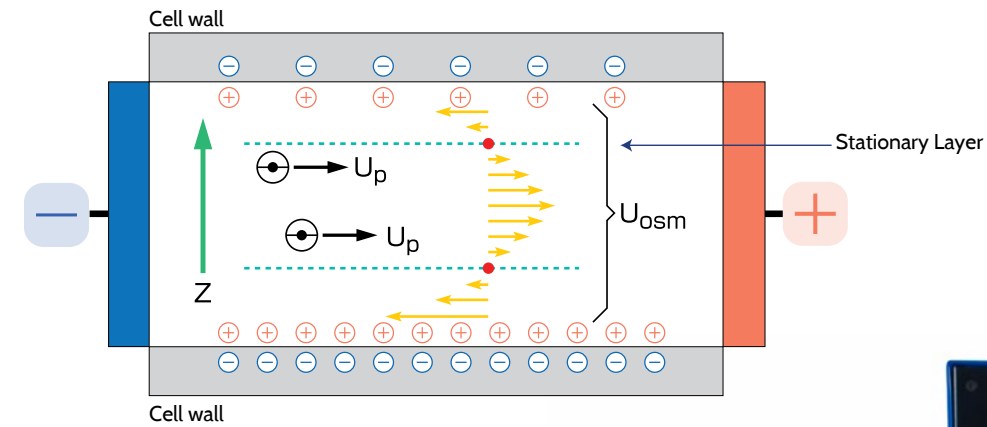
Design utilizes a straight capillary with parallel electrodes to provide greater accuracy by eliminating error associated with variable migration direction seen with other types of cell geometry.

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zeta/nano particle analyzer
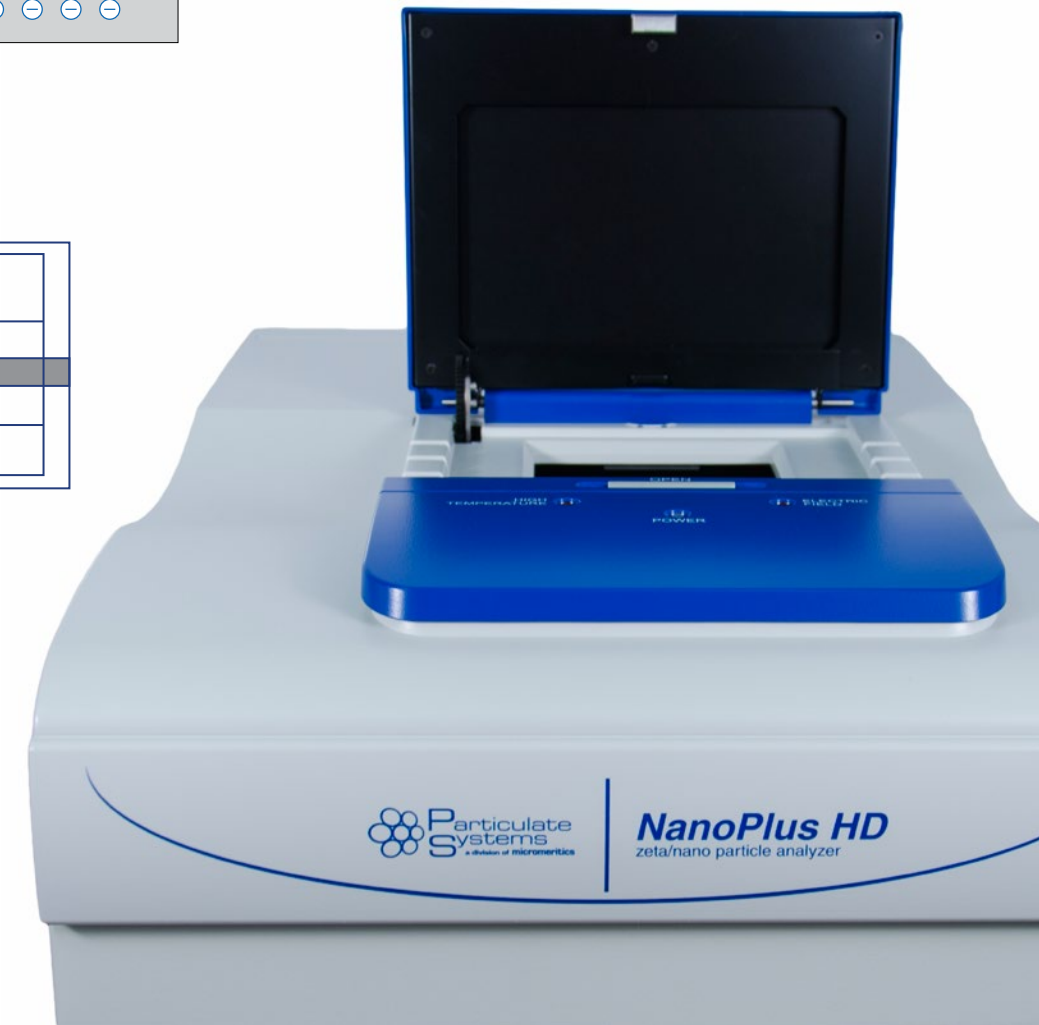
Optional Sample Cells

| Technique	Cell Description	Cell Volume	Scattering Angle	Sample Medium		Sample Concentration
PARTICLE SIZE						
	Standard Cell (in cell holder)	0.90 mL	165° Back-Scattering	Aqueous	Organic	Dilute/Concentrated
	Disposable	0.90 mL	165° Back-Scattering	Aqueous	Some Organic	Dilute/Concentrated
	Glass Micro Volume	20 µL	165° Back-Scattering	Aqueous	Organic	Dilute/Concentrated
	Disposable-Micro Volume	20 µL	165° Back-Scattering	Aqueous	Some Organic	Dilute/Concentrated
	Flow Cell (titration studies)	N/A	165° Back-Scattering	Aqueous	Some Organic	Dilute/Concentrated
ZETA POTENTIAL						
	Standard Flow Cell (zeta, size and titration studies)	0.70 mL	15° Forward-Scattering	Aqueous	Some Organic	Dilute/Concentrated
	Disposable-Micro Volume	130 µL	15° Forward-Scattering	Aqueous	Some Organic	Dilute/Concentrated
	High Concentration	0.70 mL	30° Forward-Scattering	Aqueous	Some Organic	Highly Concentrated
	Low Conductivity Cell (organic dispersions)	1.5 mL	15° Forward-Scattering	N/A	Organic	Dilute
	Solid Sample Cell (solid surface studies)	Min: 14 x 33mm Max 16 x 37mm up to 5mm thickness	15° Forward-Scattering	Aqueous	Some Organic	N/A

Method to Measure Zeta Potential of Solid Surfaces and FST Method

Evaluation of the Surface Charge of a Solid Sample by Zeta Potential

Novel method to measure the zeta potential of solid surfaces using probing particles.

- Surface charge of solid sample can be evaluated. Determination of electrostatic interactions between particles and flat surfaces
- Easy to use. Large sample size, min: 14 x 33 mm, max: 16 x 37 mm up to 5 mm thickness
- Solid surface modification analysis. Additive effect and particle adhesion. Zeta potential vs. pH/additive volume also available
- Wide sample application. Soft sample-like fibers can be measured
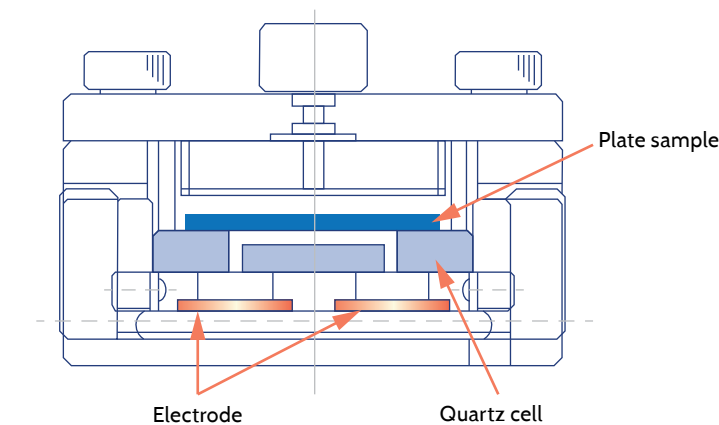
Applications:
- Fibers and textiles
- Thin films
- Shampoo and conditioner
- Membranes and filters
- Biomedical surfaces
- Semiconductor industry
- Polymer surfaces and coatings
- Optical glass polishing
- Protein adsorptive studies
- Paper and pulp industry
- Antimicrobial surfaces
- Packaging materials
- Recording media
- Printing and paint

Plate sample / Electrode / Quartz cell

Concept of FST Method

By conventional methods, scattered light from a concentrated suspension can not be measured correctly due to multiple scattering (A) or in very concentrated solutions due to its ability to transmit light. The FST method detects the scattered light from particles through a transparent electrode. The optical path length is minimized to reduce the effects of multiple scattering. Thus, the NanoPlus HD can perform a zeta potential measurement of a concentrated suspension with a high degree of accuracy (B).

FST: Electrophoretic mobility measurement of concentrated suspension using Forward Scattering through Transparent electrode

(A) Standard cell

(B) High concentration cell (Patented technology)
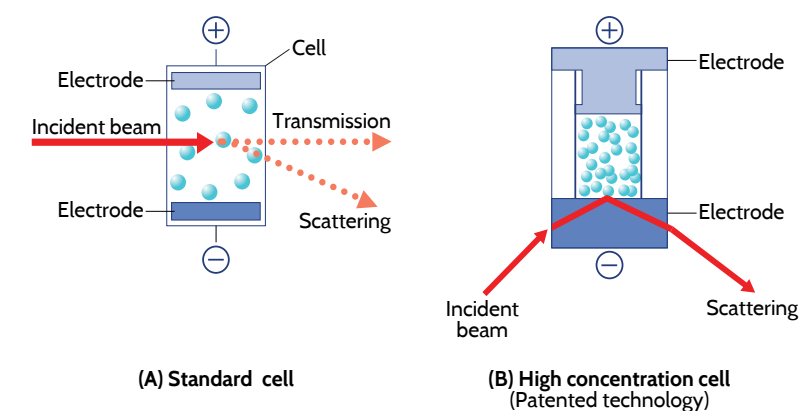
Intuitive Instrument Control, Data Acquisition, and Superior Analysis Results

The NanoPlus HD software provides intuitive and powerful instrument control, data acquisition, and data analysis. Our software is designed to enable the user to easily understand instrument control and method development to ensure that your lab productivity is always fully optimized.

SOP Designer

Intelligent and automatic creation of standard operating procedures.
Ensure that you get the best results, regardless of the operator or instrument utilized in an analysis. Our intelligent SOP designer permits you to establish fixed SOPs that generate reproducible and repeatable results time after time. Simply input the color-coded conditions for measurement, analysis, cell, and diluent conditions. Name and save your SOP, load your sample, and start your run.
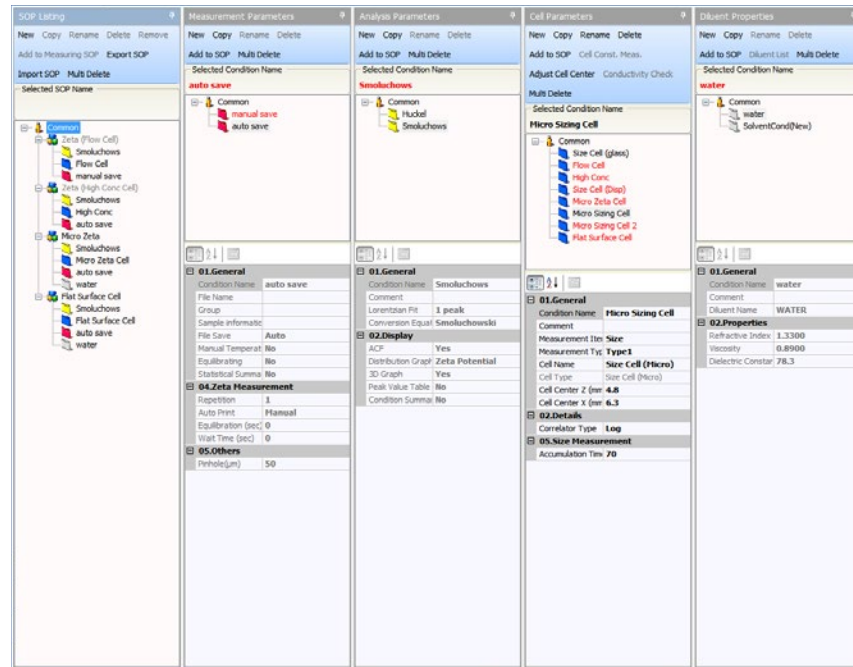
Configurable Security Levels

Easily and quickly set up four levels of security for accessing software, data collection, and report generation. Complies with 21 CFR Part 11 requirements.
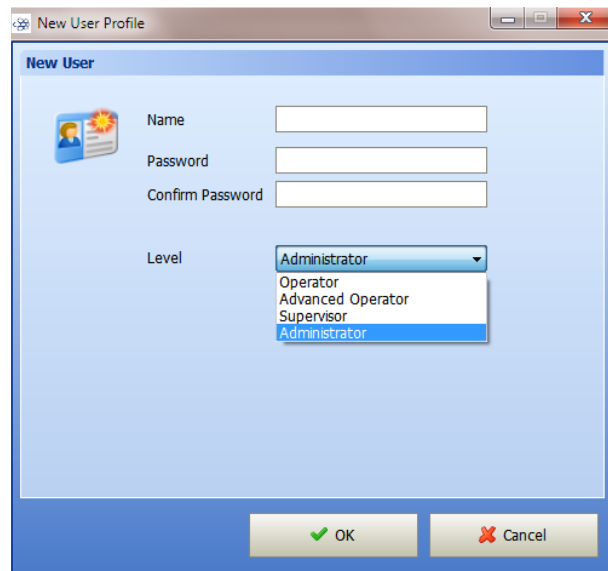
Easy Data File Back-up

Data back-up is automated. Simply choose the directory, network drive, or wireless data storage device directly from the NanoPlus HD software. A copy of all data files and SOP parameter files will automatically be backed up at the selected location as soon as it is generated, giving the researcher peace of mind.
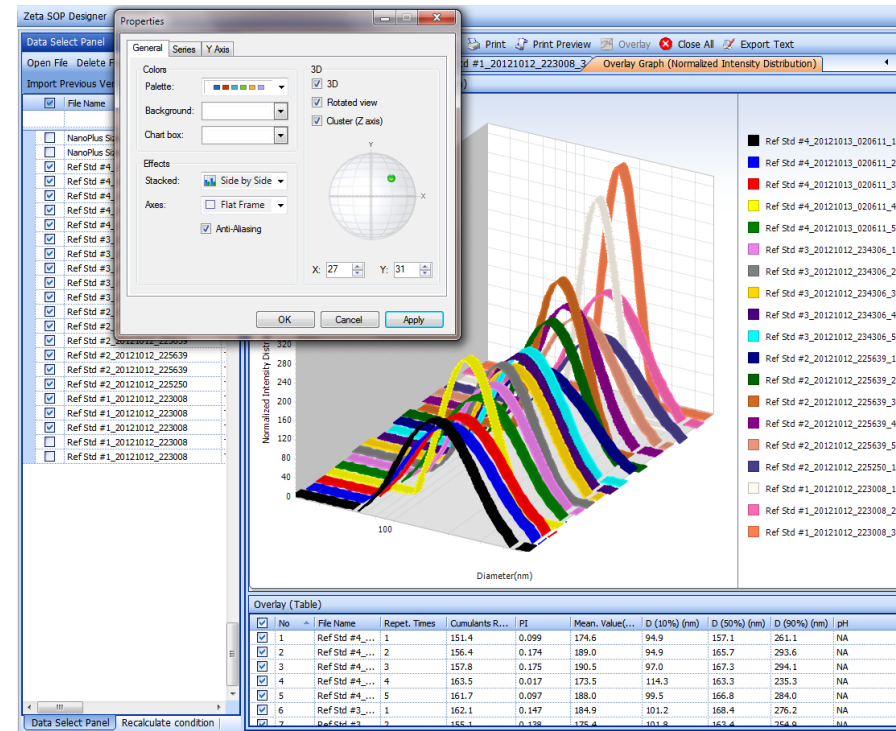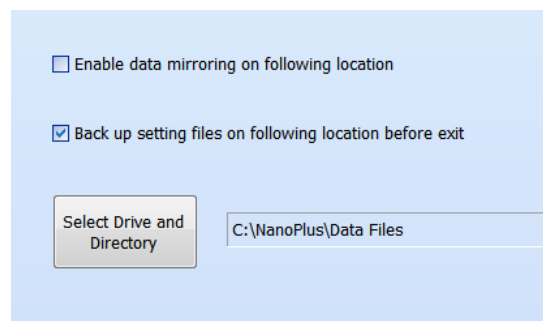
Customizable 3D Graph

Easily compare multiple data files using customizable 3D graphs. Use this function to track changes over time and compare lots, as well as monitor effects of pH changes, additive quantities, and temperature changes. This 3D visual representation of collected data is ideal for both R&D and quality control labs.
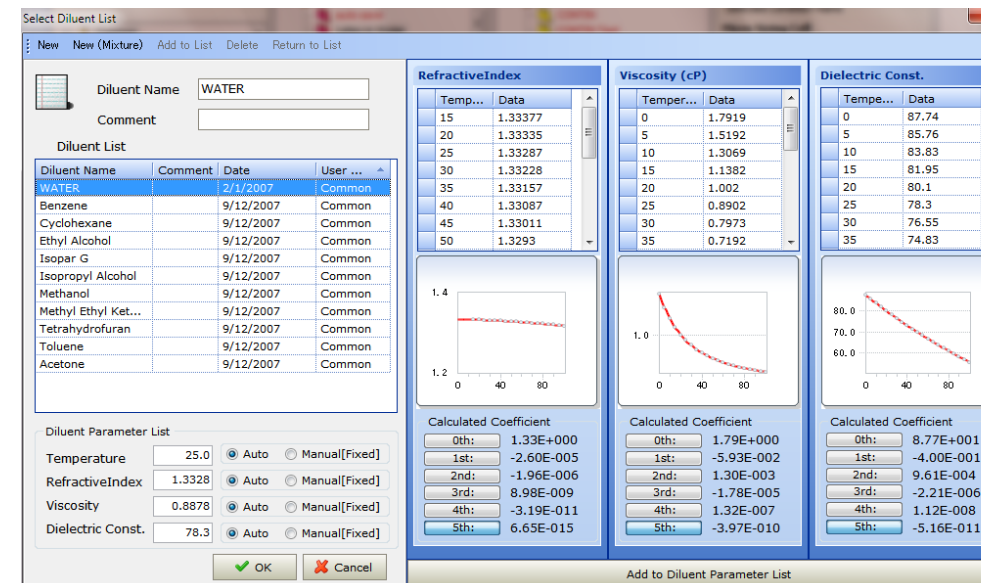
## Pre-Loaded, Dispersion Liquid Properties

There is no need to research dispersion liquid properties such as refractive index, viscosity, and dielectric constants. The NanoPlus HD software comes pre-loaded with all common dispersion liquids and required properties for size and zeta potential analysis, including different temperature variations.

Real-Time Analysis Monitoring

Data is presented in real time during analysis. The screen can be customized to present as many graphs and tables as needed to fully characterize the material in real time. Post analysis data files are easy to find, organize, and review.
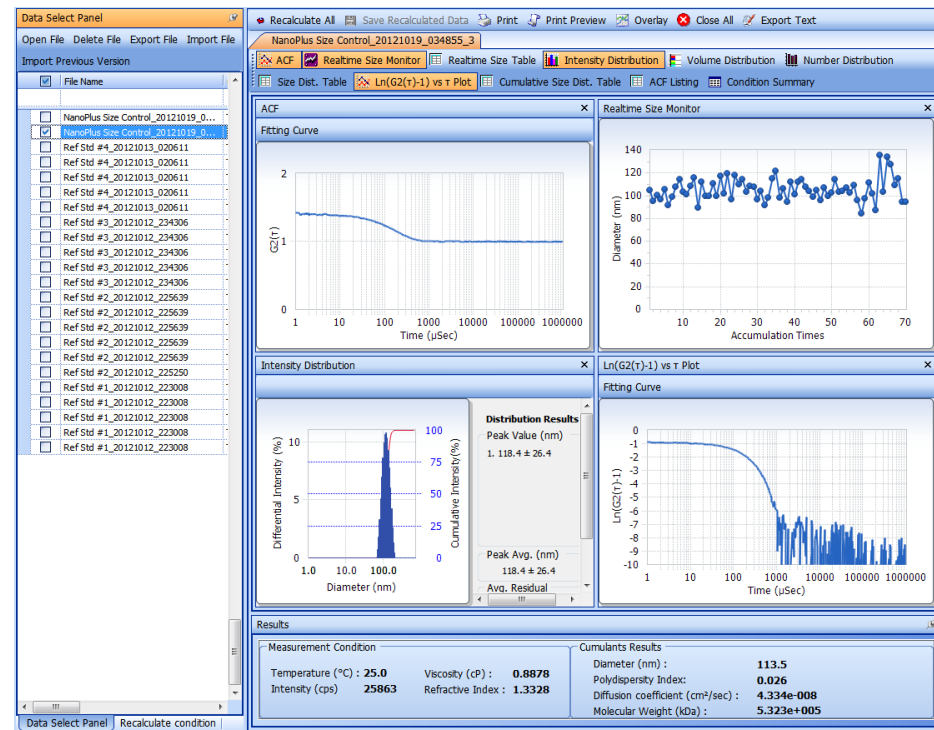
Particle Size Analysis Results
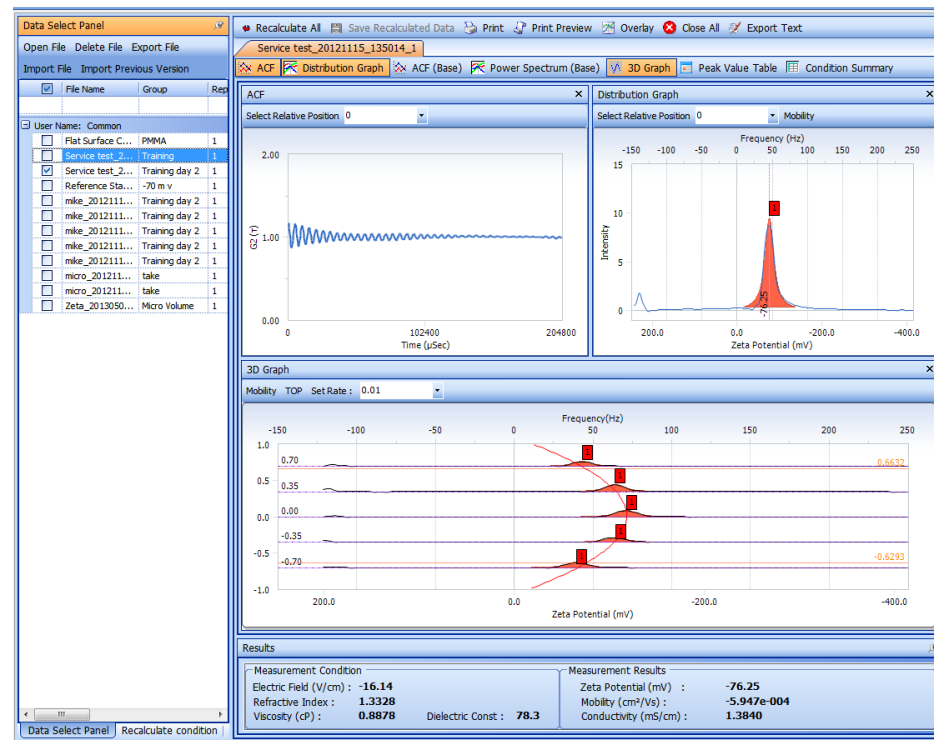
Zeta Potential Analysis Results

Accessories

The NanoPlus HD AT is used to titrate sample suspensions in a pH range from 1 to 13. The instrument automatically controls the pH of these suspensions and conducts titrations during both zeta potential or nano particle size analysis measurements.

Features

- Automatic unattended operation
- Automatic determination of isoelectric point
- Software control of the titration and measurement provides automatic control through standard operating procedures
- Automatically generated reports and graphs; plot size and zeta potential versus pH value and additive volume

Auto-Titrator Specifications

Function	Automatically performs liquid titration for zeta potential and particle size measurements
Principle	Automatic pH and additive control of suspension
Operation Temperature	15 to 35 °C
Dimensions	250(W) x 310(D) x 290(H) mm
Number of titrants	Maximum of three

Volume

Titrant volume	Standard glass vials: 50 mL Plastic vials: 50 mL
Sample volume	Minimum: 30 mL Maximum: less than 50 mL for standard vial
Titrant dispense volume	Minimum: 0.1 μL
Circulation flow rate	10 – 40 mL/min

pH

Maximum number of pH settings	100
pH probe	1 to 13
pH range	User definable up to pH calibration
pH calibration	Up to three points
Sample stirrer	Magnetic
pH tolerance increment	Minimum: 0.05 Maximum: 2

NanoPlus HD Particle Size Specifications

Features

Principle	Photon Correlation Spectroscopy (PCS), Dynamic Light Scattering (DLS)
Scattering Angle	165° Back-scattering
Minimum Sample Volume	Standard Cell: 0.9 mL, Micro Volume Cell: 20 μL
Concentration	0.00001 to 40%
Measurement Range	0.1 nm to 12,300 nm Size Distribution Range
Light Source	Semiconductor Laser Diode
Detector	HD Avalanche Photodiode
Laser Wavelength	660 nm
Laser Power	70 mW
Correlator	Includes both Time-Domain and Time-Interval correlators. Maximum of 1,000,000 equivalent channels
FDA 21CFR Part 11	Compliant

Temperature

Temperature Control	Peltier
Temperature Range	0° to 90°C (Temperature Gradient function available)
Temperature Accuracy	Within ±0.2 °C

Accessories

Optical Band Pass Filter	Optional accessory available for use with fluorescent materials
Autotitrator	Optional accessory with bubble elimination system available for automated adjustment of pH and quantitative addition studies, such as surfactant or flocculating agent activity
Organic Solvent Compatible	Standard glass cell

Molecular Weight

Principle	Dual Method: Dynamic Light Scattering (DLS) using Diffusion Coefficient and Static Light Scattering (SLS) using Debye Plot
Scattering Angle	165° Back-scattering
Minimum Sample Volume	Standard Glass Cell: 0.9 mL
Concentration	Sample dependent
Measurement Range	3.6×10^2 to 2×10^7 Da
Light Source	Semiconductor Laser Diode
Detector	HD Avalanche Photodiode

Due to continuous improvements, specifications are subject to change without notice.

NanoPlus HD Zeta Potential Specifications

Features

Principle	Electrophoretic Light Scattering (ELS)
Scattering Angle	15° Forward-scattering (dilute) 30° Forward Scattering (concentrated)
Minimum Sample Volume	Standard Glass Cell: 0.7 mL, Disposable Cell: 130 μL
Concentration	0.001 to 40%
Measurement Range	Zeta: -500 to +500 mV
Laser Power	30 mW
Light Source	Semiconductor Laser Diode
Detector	HD Avalanche Photodiode
Laser Wavelength	660 nm
Correlator	Includes both Time-Domain and Time-Interval correlators. Maximum of 1,000,000 equivalent channels
FDA 21CFR Part 11	Compliant

Temperature

Temperature Control	Peltier
Temperature Range	0° to 90°C (Temperature Gradient function available)
Temperature Accuracy	Within ±0.2 °C

Accessories

Optical Band Pass Filter	Optional accessory available for use with fluorescent materials
Autotitrator	Optional accessory with bubble elimination system available for automated adjustment of pH and quantitative addition studies, such as surfactant or flocculating agent activity
Organic Solvent Compatible	Optional accessory available for use with Low Conductivity solvents, i.e. Toluene, Benzene, Hexanes, etc.
Surface Zeta Potential Capable	Optional accessory available for determining zeta potential of flat surfaces, including Catalytic Plates, Fibers, Films, Wafers, Membranes, etc.

Due to continuous improvements, specifications are subject to change without notice.

Particulate Systems
a division of micromeritics

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To request a quote or additional product information, visit
particulatesystems.com

Contact your local Micromeritics sales representative
or our Customer Service Department at
770-662-3636