Nicomp® N3000 Dynamic Light Scattering Particle Size Analyzer

High resolution, particle size, and zeta potential measurements

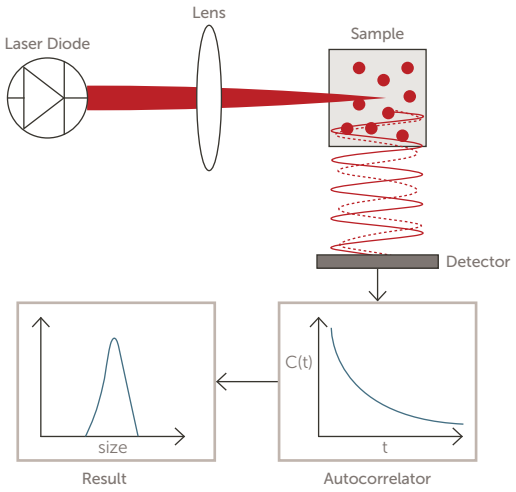
DYNAMIC LIGHT SCATTERING

Dynamic light scattering (DLS) is the preferred method for particle size analysis of nanoparticles. DLS is a fairly easy technique for many samples. Prepare the sample to the proper concentration, place a cuvette into the instrument, set measurement parameters, and generate the result. The basic size range for DLS is 0.3 nm – 10 µm, depending on the sample.

Basic Principles

The sample is placed in a cuvette where the particles experience Brownian motion. Smaller particles move faster than larger particles.

The cuvette is placed in the instrument where it is illuminated by a laser. The scattered light due to the Brownian motion is captured on a detector at a specific angle. The time signature of the scattered light is used to create an autocorrelation function that decays more rapidly for smaller particles and more slowly for larger particles. The translational diffusion coefficient (D) is determined from the autocorrelation function. The Stokes-Einstein equation is then used to calculate the particle radius R.



$D = kT/6\pi\eta R$

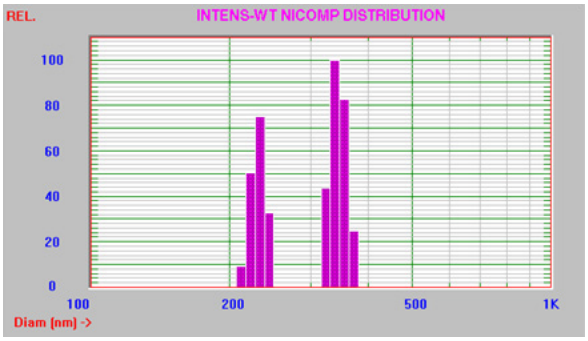
Where:
D = Diffusion coefficient
R = Particle radius
k = Boltzmann's constant
T = Temperature Kelvin
η = Shear viscosity of the solvent

Results

The basic results from the Nicomp measurement include the intensity mean size, the width of the distribution (polydispersity index, PI), and the Chi Square calculation. If the Chi Square value is greater than around 3, then the multi-modal Nicomp® algorithm should be considered rather than the single mode Gaussian result.

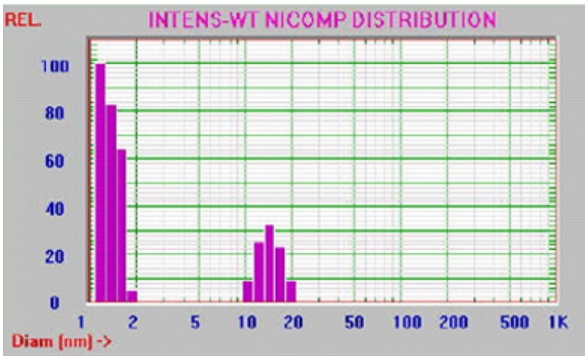
NICOMP ALGORITHM PROVEN TO BE ABLE TO RESOLVE CLOSE MULTIMODAL DISTRIBUTIONS

A key strength and unique feature of the N3000 is the multi-modal Nicomp algorithm. Other multi-modal algorithms require that peaks be separated by 2 x (200 – 400 nm). But the Nicomp algorithm is capable of resolving peaks as close as 220 – 340 nm as seen below.

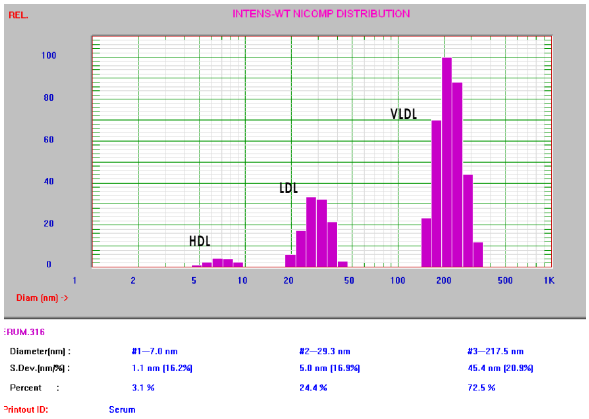


220 and 340 nm polystyrene latex (PSL) standards

There is no magic involved. Just good detection showing you where the main peak is found and where the secondary population of aggregates is located in the sample. The result below shows the main peak of Fullerenes at 1.3 nm and the secondary peak of aggregates at 14.6 nm.



The Nicomp algorithm can also resolve results with three peaks as seen below for cholesterol.



These are just three of hundreds of results that prove the unmatched resolution of the Nicomp algorithm.

APPLICATIONS

The dynamic light scattering capabilities of the Nicomp N3000 ensure precise sizing for nanometer sized particles, making it ideal for applications such as:

- Abrasives
- Academic/Research
- Beverages
- CMP slurries
- Colloidal systems
- Cosmetics
- Dispersions
- Emulsions
- Drug delivery
- Fuel additives
- Inks
- Liposomes
- Macro-molecules
- Metals
- Micelles
- Nanoparticles
- Paints/Pigments
- Pharmaceutical colloids
- Polymers
- Proteins
- Semiconductors
- Specialty chemicals

EASILY EXPAND THE SYSTEM TO INCLUDE ZETA POTENTIAL ANALYSIS

Zeta potential is a measure of the charge on the surface of particles or emulsion droplets. This charge is an indication of dispersion stability. Dispersions with a zeta potential near zero are typically unstable and prone to aggregation or phase separation. A higher zeta potential indicates expected greater stability.

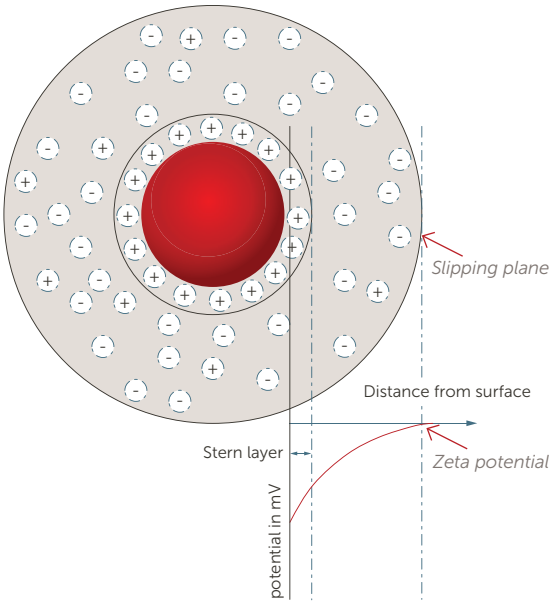
Measurement

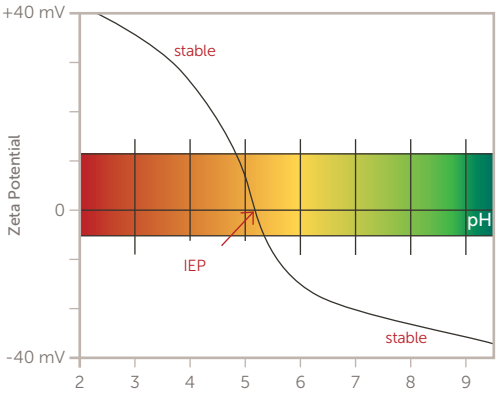
A sample is pipetted into a standard square cuvette and a dip cell containing two palladium electrodes is inserted into the cuvette. The electrodes apply an electric field, causing the particles to migrate to the pole of opposite charge. The direction of the particle motion indicates if the particles are positively or negatively charged. The speed of the particle motion is used to calculate the magnitude of the charge.

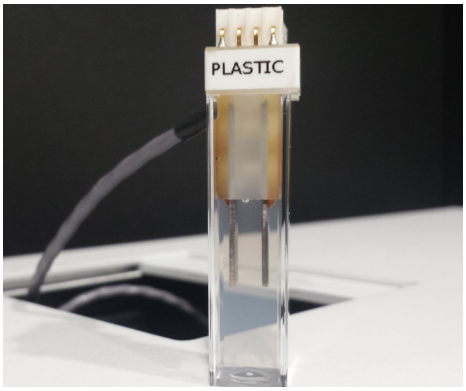
The Nicomp measures the particle motion using a patented DSP based phase analysis light scattering (PALS) technique that is extremely sensitive and robust. Measurements can be made at low electric field strengths which is much more gentle on fragile samples such as proteins or other biomolecules.

Applications

The most common use of zeta potential is in the formulation of new suspensions and emulsions. Both the particle size and zeta potential are useful indications of which formulations should prove more stable over time. Another application is the determination of what pH generates a zero zeta potential value – the Isoelectric point (IEP).







NICOMP UNIQUE FEATURES

Options and Accessories

The standard Nicomp is configured with a 12 mW red laser diode and a PMT detector at 90 degrees. A wide range of options and accessories makes it easy to configure your system to match your samples and application.

High-power Laser Diodes – improve sensitivity to small and/or weak scattering particles. Options include 15, 35, 50 and 100 mW red laser diodes and 50 and 100 mW green laser diodes.

Avalanche Photo Diode (APD) Detectors – improve the signal to noise ratio and sensitivity for dilute macro-molecular based systems that do not scatter light well. The result: a seven fold increase in photomultiplier gain without a significant cost increase. Many systems are sold with two detectors; a PMT for zeta potential and an APD for particle size.

Low-volume Cells – are suitable for both particle sizing and zeta potential. All Nicomp systems come with a box of 300 µL round cells that are easily centrifuged prior to analysis.

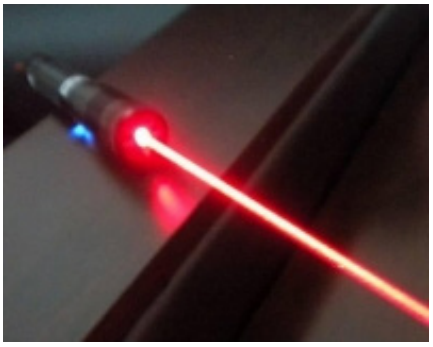
Autodilution[Pat.] – eliminates the need for manual dilution of concentrated samples. High concentration emulsions are a typical sample where autodilution facilitates reproducible results.

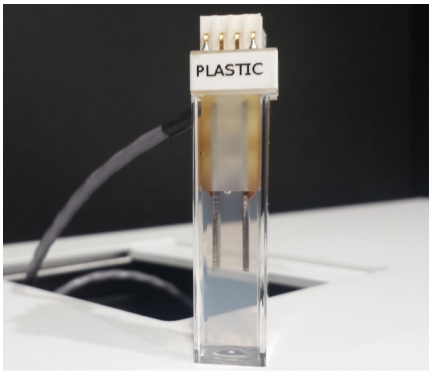
Multi-angle Goniometer – makes the Nicomp the only lower price multi-angle DLS system on the market. Ideal for advanced users, complex distributions and enhanced sensitivity to larger particles.

Autosampler – module allows for automated batch sampling. Combines with autodilution for completely automated operation.

Phase Analysis of Light Scattering (PALS) – measures small phase shifts, enhancing sensitivity and improved zeta potential results in high ionic strength or organic solvent environments. All Nicomp Z3000 systems also come with frequency analysis zeta potential.

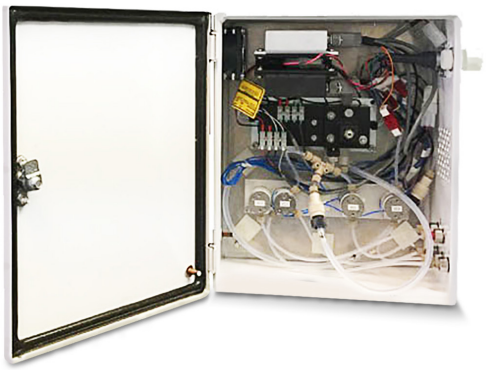
High Voltage Zeta Potential Cell – to measure at higher electric field strengths (up to 250 V/cm) in organic solvents.



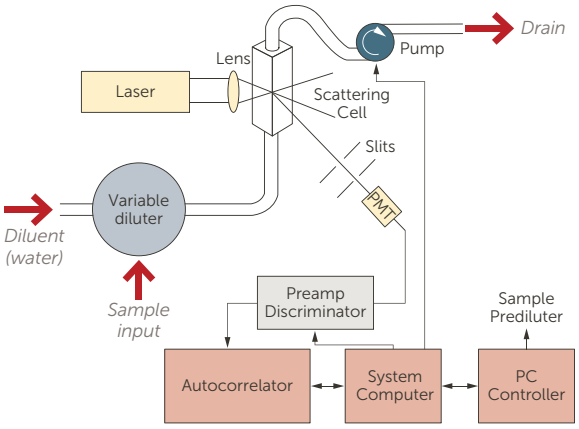


ONLINE APPLICATION

The Nicomp Online Module – provides online monitoring of a manufacturing process.

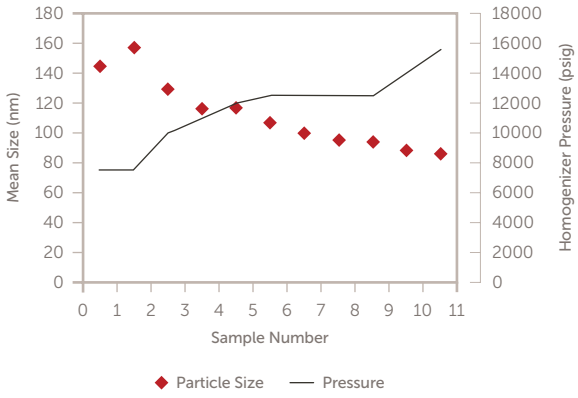


A sample port is connected to the process application. The fluidics of the Nicomp accepts sample, dilutes it to a useable concentration, makes a measurement, and proceeds to empty the sample to drain or introduce back into the process operation. Size measurements are typically made every 2 – 3 minutes.

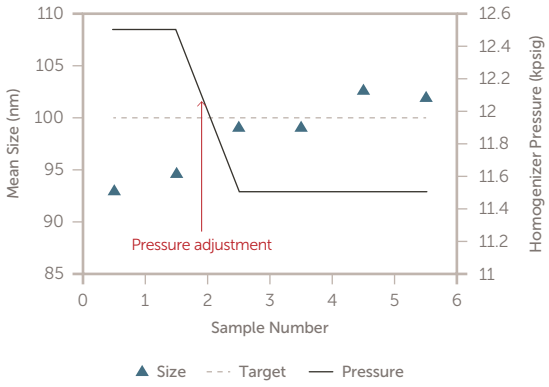


Here is an example of a Nicomp Online system that was installed down stream of a high pressure homogenizer. The sample was automatically diluted in water conditioned to match the process chemistry.

In the first experiment it took 11 in-process samples at variable pressure (black line) throughout the homogenization process to develop a pressure-size correlation (red diamonds).



In the second experiment the initial size readings were approximately 5 – 7 nm under the target size so pressure adjustments were made to achieve the desired 100 nm size.



START ACHIEVING ULTIMATE CONFIDENCE IN YOUR RESULTS WITH OUR COMPLETE FAMILY OF PARTICLE ANALYZERS

We also offer our unique single particle optical sizing (SPOS) line of AccuSizer® systems. The AccuSizer is both a liquid particle counter and a sophisticated particle size analyzer that provides particle size and concentration in particles/mL. A range of AccuSizer sensors and sampler fluidics have been developed to cover a wide range of sizes (150 nm – 2500 µm) and sample concentrations.

Using the Nicomp and the AccuSizer together provides unique insight into emulsion and suspension stability. The Nicomp provides the mean size while the AccuSizer shows the larger tail of the distribution.

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