Brookhaven Instruments Corporation

NanoBrook Family

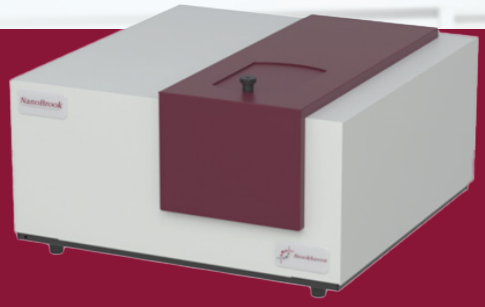
NanoBrook Omni

Protein Sizer | Nanoparticle Sizing
Zeta Potential | Molecular Weight

www.brookhaveninstruments.com

NanoBrook Series
Rapid, Reliable, and Accurate Analysis

Characterizing proteins, nanoparticles, polymers and more.



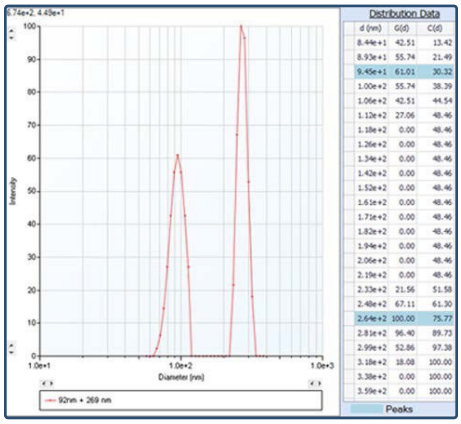
Brookhaven Instruments makes the choice easier with the NanoBrook Series of instruments.

Choose from particle sizing including backscatter for sizing measurements, zeta potential analysis, or combinations including molecular weight determination of small polymers and proteins.

- **Dynamic Light Scattering (DLS)**
  Range: 06 nm to 10 µm diameter.
  Three measurement angles: 90°, 173° & 15°
- **Speed and Efficiency**
  Rapid and accurate nanoparticle size distributions
- **Industry Compliant**
  Multimodal & unimodal size distribution software ISO 22412 compliant results
- **Easy to Use**
  Built-in automatic procedures and parameters (SOP)
- **Powerful**
  High power 40 mW temperature-controlled semiconductor laser
  Temperature control: 0° to 110°C
- **Fits into Existing Labs**
  Compact bench-top unit, USB connection
- **Valuable and Versatile**
  Molecular weight determination (relative and absolute through Debye plot analysis)
- **Disposable Cuvettes**
  No contamination or alignment
- **Zeta Potential**
  Proteins, peptides, mAbs, RNA, and other biological samples.
  Zeta potential in organic solvents, oily or viscous media, high-salt suspensions
  Samples near the isoelectric point (I.E.P)
  Two distinct methods for measuring zeta potential in aqueous solvents.
- **Electrophoretic Light Scattering (ELS)**
  Standar method for measuring zeta potenial in aqueous solvents.
- **Phase Analysis Light Scattering (PALS)**
  1,000 times more sensitive than other zeta potential techniques

Measurements of traditional colloids are typically made at 90° scattering angle due to the unbiased results measured. For nanoparticles and proteins, IgG and peptides, these <50 nm samples can be measured using the backscattering angle (173°) for best signal to noise and reproducibility of measurements.

Finally, the 15° detection angle can be selected for added sensitivity for trace aggregate signatures. Zeta Potential measurements are always performed using the 15° detection angle to minimize diffusion broadening.



Capable and Configurable

No two applications are alike. We offer a range of NanoBrook configurations so you get the functionality you need.

Backscattering with 173°

The NanoBrook series offers optional backscattering for the characterization of proteins, antibodies, nanoparticles, macromolecular assemblies, and other particles ranging from less than 1 nm to 10 µm.

Measuring Zeta Potential with ELS

Electrophoretic Light Scattering (ELS) can be used to characterize particles ranging from 1 nm to 100 µm, depending on the sample. NanoBrook models that utilize ELS will determine particle velocity, which is then used to determine the Zeta Potential of the sample.

Phase Analysis Light Scattering (PALS)

Utilize the PALS option when dealing with samples requiring heightened sensitivity. This typically includes samples with low Zeta Potential or mobilities suspended in oils, organic solvents, and high-salt fluids.

Molecular Weight Determination

If your NanoBrook model includes Dynamic Light Scattering (DLS) optics, then relative molecular weight can be calculated using the measured diffusion coefficient and a table of user-selectable constants, known as Mark-Houwink parameters. This method works well for many common materials in known solvents.

Absolute molecular weight, Mw, can be determined from Static Light Scattering (SLS) using a series of known concentrations (Debye Plot) with the NanoBrook.

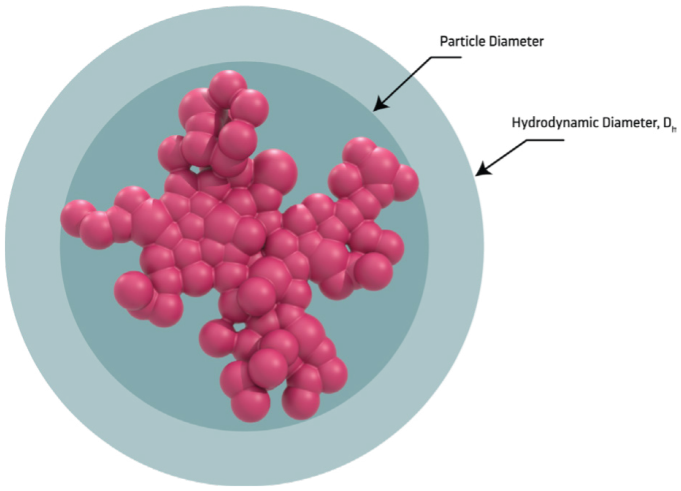
Based on the principles of Dynamic Light Scattering (DLS) for particle sizing distribution, and Laser Doppler Velocimetry (electrophoretic light scattering, ELS) for zeta potential, most measurements only take a minute or two. The instrument also includes Phase Analysis Light Scattering (PALS) measurements for samples with low mobilities (saline, PBS, organic solvents).

Principles of Operation

Many natural and manufactured products involve particulate materials either in their final state or at some stage in their production. Particle size and particle size distribution are, therefore, often critically important parameters.

Dynamic Light Scattering (DLS) provides a fast, simple method for submicron and nanoparticle sizing. In this technique, molecules or particles illuminated by a laser lead to random intensity fluctuations in scattered light arising from the Brownian motion of particles and proteins. These intensity fluctuations are then analyzed by autocorrelation to give a mean size and polydispersity (distribution width), or more complete distribution data even for multimodal distributions.

DLS relies on the fact that freely diffusing particles, moving randomly due to Brownian motion, will produce rapid fluctuations in scattered laser light. These fluctuations are rapid, on the order of tens of nanoseconds to hundreds of milliseconds, and are directly related to the size of particles. The autocorrelation method is used to quantify the speed at which these photo pulses become decorrelated from some initial state, which is then related directly to the motion of particles.

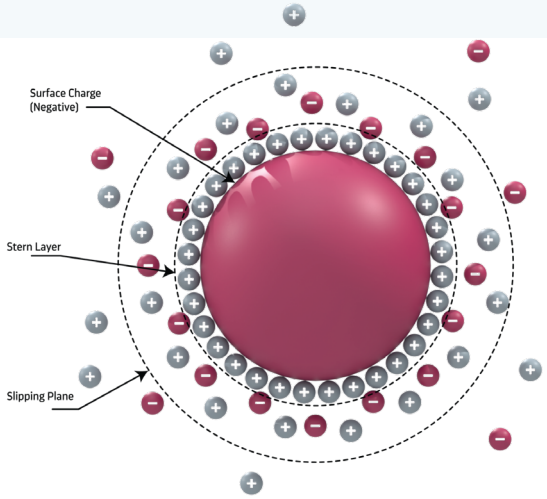


Zeta Potential

Almost all materials in contact with a liquid acquire an electronic charge on their surfaces. Zeta Potential is an important and useful indicator of this charge which can be used to predict and control the stability of suspensions or emulsions.

Zeta Potential is related to the charge that develops at the interface between a particle surface and its liquid medium. This electrostatic potential, measured in mV, may arise by any of several mechanisms. Among these are the dissociation of ionic groups on the particle surface and the differential adsorption of ions onto the surface. The effective charge at the particle surface impacts the distribution of ions near the surface, increasing the effective concentration of counterions close to the surface. Thus, an electrical double layer is formed in the region near the particle-liquid interface.

In an electric field each particle and its most closely associated ions move through the solution collectively, and the potential at the interface between this unit and the surrounding medium (the slipping plane) defines the Zeta Potential. When a layer of macromolecules is adsorbed on the particle's surface, it shifts the slipping plane further from the



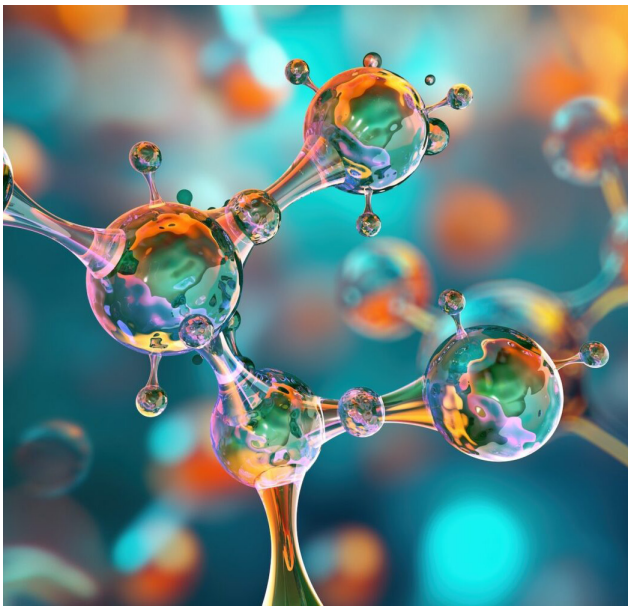
surface and alters the effective Zeta Potential. Zeta Potential is therefore a function of the surface charge of the particle, any adsorbed layer at the interface, and the nature and composition of the surrounding suspension medium. It can be experimentally determined and, because it reflects the effective charge on the particles and is therefore related to the electrostatic repulsion between them, the Zeta Potential has proven to be extremely relevant to the practical study and control of colloidal stability and flocculation processes.

Applications

The NanoBrook particle size and zeta potential analyzers incorporate all you need for fast, routine, sub-micron measurements of size and zeta potential.

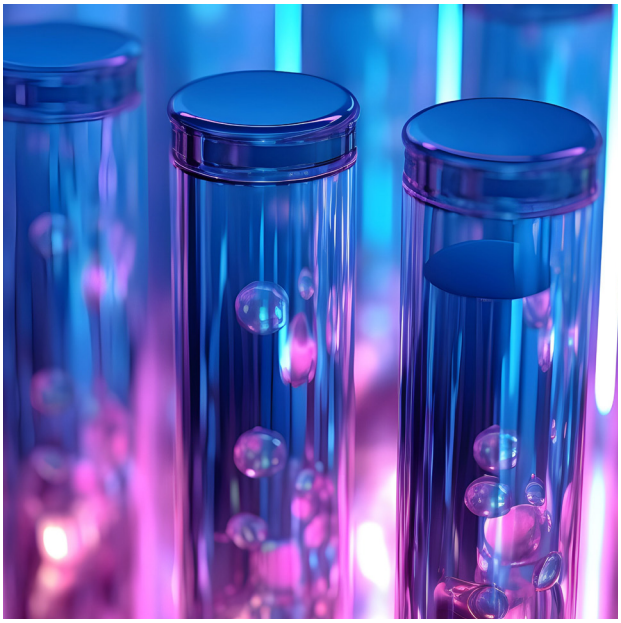
Proteins, nucleic acids, polysaccharides, and other bio-derived materials

Many common biological materials are suitable for characterization by particle sizing and zeta potential, often in the context of avoiding or detecting unwanted aggregation. Globular proteins, including serum proteins, peptides, antibodies, protein complexes, and antibody-drug conjugates all fall into this category. Much like nanoparticles, these biological samples derive their solution stability from Zeta Potential, and their aggregation is easily monitored by DLS. Similarly, biopolymers such as oligonucleotides and polysaccharides are readily characterized by the NanoBrook's two core measurement techniques.



Pharmaceutical preparations

One of the most difficult problems in the pharmaceutical industry is the preparation of physically stable dispersions of a drug in a suitable suspension vehicle. A stable dispersion is one in which the particles are completely unflocculated. An effective method for producing a colloidally stable dispersed system can best be devised after the conditions of maximum dispersion are established by means of electrophoretic mobility measurements. The stability of drug molecules in aqueous suspensions affects both dosage requirements and shelf life. Caking tendencies of pharmaceutical suspensions may also be studied with the aid of electrophoretic measurements.



Paints and pigments

The degree of dispersion of finely divided material is of no less importance in the paint industry. When dispersion of pigment particles is incomplete, the paint will behave as though it contains larger particles. The degree of dispersion can markedly affect the color quality, gloss, texture, and flow/dispersion relationships. Increased dispersion increases brightness and gloss (specular reflection) and gives a marked decrease in haze (diffuse reflection).

Micellar Samples

Surfactant micelles belong to a broad class of materials, often used to disperse sparingly soluble materials in desirable solvents; for example, a common use case is to disperse otherwise insoluble hydrophobic small-molecules in aqueous solvent. By the strictest definition, micelles are well-defined assemblies of surfactant monomers, arranged so as to sequester the insoluble portion of the surfactant into the core of the micelles. It is often useful to be able to measure the electrophoretic response (Zeta Potential) of common ionic surfactants, in addition to size (DLS). Many other types of micelles exist, composed of less traditional amphiphiles including nonionic surfactants, polymer micelles, and casein micelles.

The degree of dispersion of finely divided material fundamentally determines product stability, performance, and quality—from pharmaceutical shelf life to paint gloss to the solubilization of otherwise insoluble materials.

Oil/Water and Water/Oil emulsions

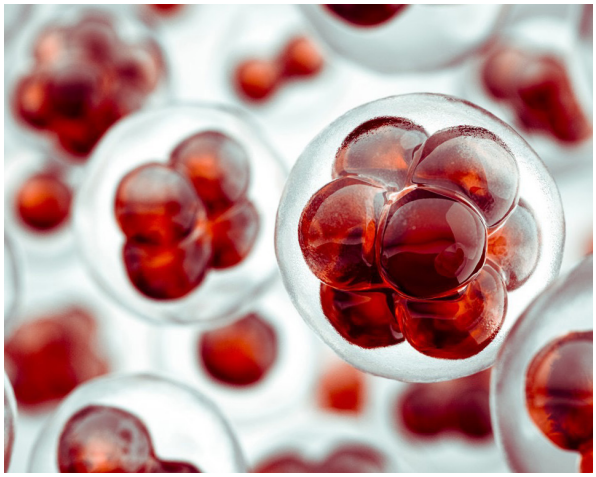
Interparticle repulsion due to the overlap of similarly charged electric double layers is an important stabilizing mechanism in O/W emulsions. When ionic emulsifiers are used, electric double layer repulsion may prevent the formation of a close-packed film. This film-expanding effect can be minimized by using a mixed ionic plus nonionic film, or by increasing the electrolyte concentration in the aqueous phase. Since stability of an emulsion is, in part, related to the electrokinetic conditions of the interface, electrophoretic mobility measurements made using the NanoBrook can thus provide information regarding both shelf storage stability and freeze-thaw stability.

Liposomes, exosomes, and other biocolloids

Self-assembled structures formed from bilayer-like structures are frequently used to encapsulate materials; in contrast to surfactant micelles, these kinds of structures contain an interior phase that is otherwise immiscible with the continuous bulk solvent phase. While micelles are often used to sequester small molecules, liposomes, exosomes, and other bioinspired encapsulation methods can be used to stabilize macromolecules. This type of encapsulation chemistry is very common in drug delivery (drug delivery, chemotherapy, etc.), and in preparing transfection reagents (delivering new genetic material to specific cells).

Nanoparticles

The vast majority of colloidally stable materials can be classified as nanoparticles, provided that their primary dimension is in the tens-to-hundred of nanometers. These particles are nearly always in a size range that makes them too small to observe by optical microscopy, making them ideal samples for particle size analyzers such as the NanoBrook. Colloidal particles are stabilized by a mixture of long-range electrostatic repulsion, and short-range attraction. Many nanomaterials are colloidally stable, including engineered materials, synthetic nanomaterials, and many biocolloids.



GENERAL SPECIFICATIONS

Laser	Standard Laser 40 mW red diode laser, nominal 640 nm wavelength, computer controllable.
Condensation Control	Purge facility using dry air, nitrogen preferred
Temperature Control	-5 °C to 110 °C, ± 0.1 °C, active control. No external circulator required.
Power Requirements	100/115/220/240 VAC, 50/60 Hz, 150 Watts
Dimensions	23.3 x 42.7 x 48.1 cm (HWD)
Weight	15-18 kg
Environmental Characteristics	Temperature 10 °C to 75 °C Humidity 0% to 95%, non-condensing
CE Certificate	Class I laser product, EN 60825-1:2001, CDRH

SPECIFICATIONS FOR PARTICLE SIZING AT 90°

Sample Type	Most nanoparticle, and colloidal-sized materials, in any non-absorbing liquid
Size Range	1 nm to 6 µm diameter. Depending on refractive index and concentration
Sample Cells	1 to 3 mL disposable plastic, 50 µL disposable, 40 µL quartz flow cell, 10 µL quartz minimum
Concentration Range	2 ppm to 50 mg/mL, depending on refractive Index, optical contrast, and concentration
Signal Processing	Dynamic Light Scattering (DLS)
Correlator	Brookhaven's TurboCorr, multitau, research grade with 510 hardware channels, covering the equivalent of 10^{10} linearly-spaced channels, 100% efficiency, real-time operation over the entire delay-time range
Precision	± 1% typically
Scattering Angle	90°
Data Presentation	Average & width, lognormal fit, and multimodal size distribution standard
Compliance	ISO22412 compliant results

SPECIFICATIONS FOR PARTICLE SIZING AT 173°

Sample Types	Most globular proteins, nanoparticles, and small polymers in any non-absorbing liquid
Size Range	<0.6 nm to 10 µm diameter, depending on refractive index and concentration
Sample Cells	50 µL disposable, 1 to 3 mL disposable plastic, glass, or 10 µL or 12 µL quartz cells
Concentration Range	0.1 ppm to 50 mg/mL, depending on refractive

SPECIFICATIONS FOR ZETA POTENTIAL

Sample Type	Most nanoparticle, polymer and colloidal-sized materials, suspended in any non-absorbing liquid, with relative permittivity > 20 and viscosity <5 cP ELS; relative permittivity > 1.5 and viscosity < 30 cP PALS
Size Range Suitable for Zeta Measurement	1 nm to 100 µm, sample dependent
Mobility Range	10^{9} to 10^{7} m^2 /V·s ELS; 10^{11} to 10^{7} m^2 /V·s PALS
Zeta Potential Range	-500 to 500 mV, sample dependent
Sample Cells	180 µL, 600 µL, 1250 µL
Maximum Sample Conductivity	220 mS/cm, sample dependent
Signal Processing	Sizing: Dynamic Light Scattering (DLS) Zeta Potential: Electrophoretic & true Phase Analysis Light Scattering (ELS & PALS)
Precision	± 3%, depending on salt concentration
Scattering Angle	15°
Data Presentation	Doppler Frequency Shift (ELS), Phase (PALS), electrophoretic mobility, zeta potential using Smoluchowski, Hückel, or Henry
Concentration Range	40% v/v, sample dependent

Customized Solutions

The NanoBrook comes in several standard configurations to suit a variety of particle characterization needs, including different combinations of sizing capabilities, Zeta Potential measurement, and molecular weight analysis. Your capabilities are even further expanded with several companion instruments and accessories, as well as internal customization. The NanoBrook series is a platform that has been used globally for many different situations including quality control, research and development, biopharmaceutical testing, and much more. No two applications are the same, and we are happy to make sure that you get the best instrument for your needs.

Please discuss your needs with your sales engineer or distributor, and we'll be happy to work on a solution that works for your unique situation.

About Brookhaven Instruments

Our talented team of scientists and engineers are dedicated to delivering the most accurate, reliable, and easy-to-use particle characterization instruments on the market. Our modular instrument design allows us to fully customize every aspect of our products, ensuring that our customers receive precisely what they need to meet their research goals. We are continuously improving our products based on feedback from customers, building on our legacy of innovation in particle science.

Brookhaven Instruments Corporation

300 Innovative Way, Suite 222
Nashua, NH, 03062

+1 (631) 758-3200 • info@BrookhavenInstruments.com

www.brookhaveninstruments.com